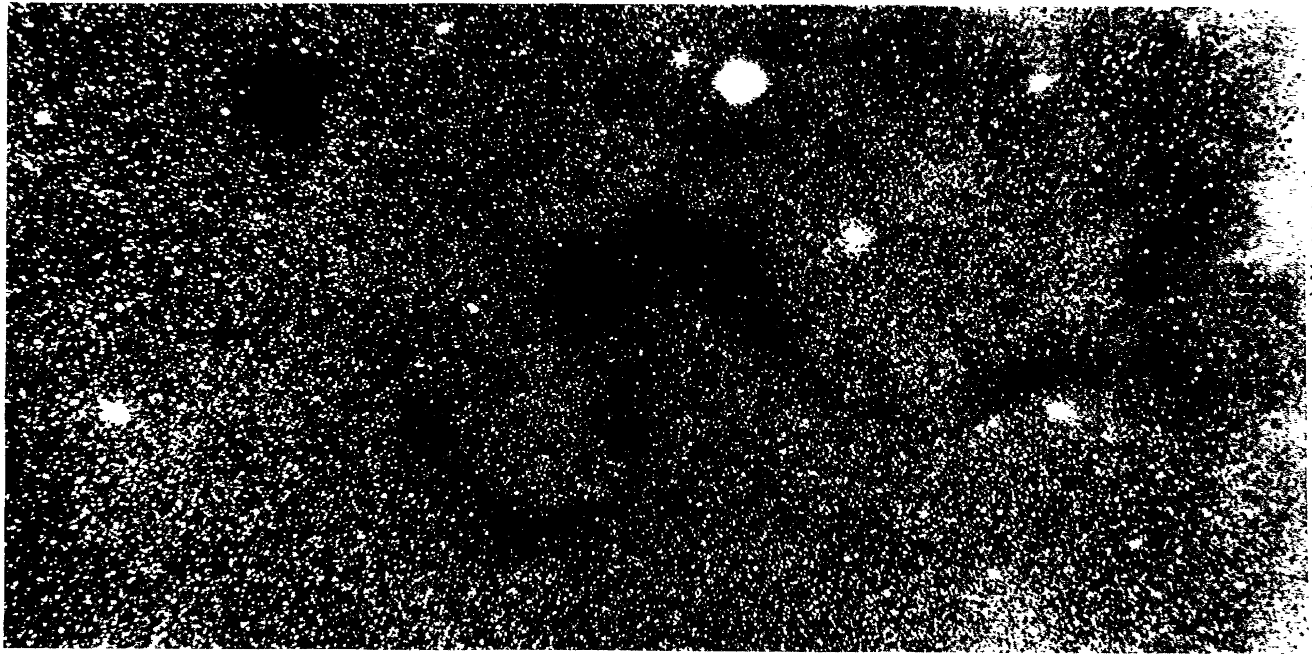


In that part of the heavens of which this is a picture the naked eye sees only inky blackness. Yet our sun with his little family of planets is like one of these multitudinous dots in the infinitudes of space. The earth receives more light from the stars that are, like these, never seen by the naked eye of man than from all the visible ones combined. Throughout the whole universe the invisible influences are the important ones. The invisible, the inaudible and the intangible constitute the *real* universe.

THE NEW SCIENCE AND THE OLD RELIGION

BY

THORNWELL JACOBS, M.A., Litt.D., LL.D.

PRESIDENT OF OGLETHORPE UNIVERSITY.

OGLETHORPE UNIVERSITY PRESS

OGLETHORPE UNIVERSITY

(SUBURB OF ATLANTA)

GEORGIA, U. S. A.

Published January, 1927

PRINTED IN THE UNITED STATES OF AMERICA.
OGLETHORPE UNIVERSITY PRESS,
Oglethorpe University, Ga., U. S. A

DEDICATED

TO

JOHN THOMAS LUPTON

MY COUNSELLOR

MY BENEFACTOR

AND MY FRIEND

PUBLISHERS' ANNOUNCEMENT

This volume is the first book to be printed and published by the Oglethorpe University Press. Both the composition and press-work were done entirely by students of the university; the manuscript is from the pen of the president of the university; and it will be used as a text-book in the class rooms of the university. This is believed to set a new precedent in the South, one which it is hoped will be followed by many colleges and universities throughout the southern states.

PREFACE

I was compelled to write this book because of my need of such a volume for use as a text in my class in Cosmic History at Oglethorpe University. This class is composed of members of the senior class. They come from the various departments, such as science, letters, arts, commerce, education. While many of them have a slight knowledge of science yet, like most seniors of our American colleges, they have no well co-ordinated conception of what, why, or where the world is. Their memories are crammed with a mass of undigested, unrelated facts, with expert training in some one subject, but as to any knowledge of the whence and whither of mankind, any conception of the trajectory of human progress, they lack it. What they have seemed to need is an introduction to life, a co-ordination of their knowledges, a foundation upon which they could build a logical conception of what life is all about and what it is for. I tried for years to find a book covering this subject to use as a text and failed. Hence, this volume.

Again, the majority of our religious leaders are, most uphappily, arrayed in fierce opposition to the evolutionary and revolutionary teachings of modern science. "Choose ye this day whom ye will serve," they cry. "God or Evolution." Stated thus, as a necessary disjunctive, the result is deplorable. Especially is this the case with those college men who are studying such sciences as biology, geology and palaeontology. In proportion as the choice is enforced, it is proving fatal to the churches, driving from their doors those whom they can least afford to lose. It is preposterous to suppose that the teachings of a Son of God could contradict the teachings of the suns of God. If anything on earth is certain it is that truth coheres. Any apparent contradiction can only be a difference of interpretation, either of the Bible or of nature. For harmony toleration plus charity is needed, not only, but they must be dominated by an honest search for the truth, with scientist and theologian warning themselves against overconfidence and committed to the principle that religion as well as science commits suicide when she adopts a final creed. The multitudes of younger scientific students reared in Christian homes find it difficult enough to retain their faith when the new knowledge flatly contradicts the old fashioned interpretation of Scripture without being told that there is no hope of accommodation between geology and Genesis. No greater service can be rendered them and with them millions of the thoughtful but perplexed reading public than the finding of a formula that will make it possible to retain their faith without stultifying their judgment. This volume represents such an attempt. It has produced very happy results in the class room. It is hoped that the student in the great outside university of daily life will likewise find it helpful in solving this perplexing problem.

Such a book should, of necessity, be simply and plainly written, and I have thought best to cast it in chronological order, thereby making it in fact a story of the earth and its inhabitants. It should be reverently written, that the superb spiritual values of science may become the property of its readers. It should, of course, be truthfully written. Indeed, what need could there possibly be of exaggerating the astounding facts which it covers, whose barest statement is full of holy mystery? Particularly have I had in mind the general reading public, hoping that they may find in it a helpful interpretation of their lives in terms of the new knowledge. I have written it also in the hope that parents would find it a fit instrument to put into the hands of their sons and daughters—anyone with a high school education can understand it—to orientate them with respect of the meaning and purpose and nature of life. The reader will not have gone far before he will see that the author is endeavoring to discover the purport, the inner meaning, the intention of the words that describe the immense mass of modern scientific discoveries, in order the better to interpret the mystery and deepen the values of life. The book is written to build good men and women, inside of the class room and out of it, by informing them of the new universe created by the magic of modern science, that, grasping its meaning, they may also grasp its power and blessing.

Oglethorpe University,
Georgia, 1927. THORNWELL JACOBS.

INTRODUCTION

By JUDGE EDGAR WATKINS,

(President of the Board of Directors of Oglethorpe University and Elder of the First Presbyterian Church of Atlanta, Georgia.)

In the beginning God created. None but God can comprehend the beginning nor is the method of creation described otherwise than by records yet but partially disclosed by science. In His Bible, God has revealed what man needs to know as a foundation for his faith, but God also reveals himself by His works. Truths are ever in harmony and there can be no conflict between revealed religion and nature's laws. Those who think there is conflict fail correctly to understand the one or the other or both.

Paul, the learned Jew of Tarsus, a pupil of the great Hebrew scholar Gamaliel, familiar with Greek poetry and Greek philosophy, perhaps the greatest of Christian teachers, advised that we "prove all things." This advice science accepts. The interpretation of scripture as well as the conclusions of science are subject to human limitations. Some of each we know but much of both we see darkly as through a glass. Some construe the general statement that "God created" as meaning an instant perfection of what was created. Augustine, a great theologian, said that God made "the seed of heaven and the earth (the universe) because it was certain that from this (seed) the heaven and the earth would be." Again he speaks of creation as a "series of causes." Scientists in similar language speak of creation as being a "continuity of process from the whirling nebula to the earth revolving round the sun, and from the cooling earth to awakening life, and from simple organisms to tentative men, and from groping hominids to Homo sapiens."

The Special Creationist may be right but one may refuse to accept his dictum and be as was Saint Augustine and hundreds of thousands now living, a sincere believer in the truths of revealed religion as found in the Bible. The scientist who believes and teaches the "continuity of process" from the "seed," the primary cause, the simplest organism to the highest development of life yet reached, may be wrong, but his beliefs and teachings do not justify excluding him from what Peter calls "the everlasting kingdom of our Lord and Savior Jesus Christ."

For man to exercise his God-given intelligence is a duty, not an offense. Those who fear the conclusions of science and condemn scientists, who claim that such conclusions are inconsistent with the Scriptures and that scientists are enemies of religion are driving from the Church sincere truth-seeking men and women. Some scientists unfortunately accept the statement of those who claim that there is of necessity a conflict between science and religion and believing a choice to be necessary take the side of science to the exclusion of religion.

Where, of two schools of thought, each sees only one side of the shield of truth, there is needed a book such as this is in which there is a comprehensive and accurate statement of the development of our universe, entertainingly written by a man who accepts and shows the harmony of the truths of faith and of science.

He who in the spirit of truth reads this book may not accept all its conclusions, but will, to use the language of the author, "find that his mind has been permanently stretched, that his idea of God has been broadened and deepened and illumined in proportion as the wonder and power and the glory of His creation has been grasped."

ACKNOWLEDGMENTS

It is evidently not within the power of any one man to be an authority on all the subjects covered by this volume. It is, however, quite within his power to consult those who are authorities on them and to avail himself of their knowledge, freely. This I have taken pains to do. Specific acknowledgment of my reliance upon them is often omitted from the text for literary reasons but is here fully and gratefully acknowledged:

Astronomy:

CHAMBERLIN—*Origin of the Earth*—University of Chicago Press.
JEFFREYS—*The Earth*—Cambridge.
PHILLIPS—*The Splendour of the Heavens*—McBride.
FLAMMARION—*Popular Astronomy*—Appleton.
SERVISS—*Curiosities of the Sky*—Harper .
HALE—*The New Heavens*—Scribners.
TODD—*New Astronomy*—American Book Company.
SHOWALTER—*Exploring the Glories of the Firmament*—National Geographic Magazine.
SERVISS—*Marvels of Astronomy*—Mentor.
LOWELL—*Evolution of Worlds*—MacMillan.
FLAMMARION—*Omega*—Cosmopolitan Company.
FLAMMARION—*Dreams of an Astronomer*—Appleton.
SERVISS—*Riding Through Space*—Mentor.
LOWELL—*Mars as the Abode of Life*—MacMillan.
ARRHENIUS—*The Destinies of the Stars*—Putnam.

Geology, Palaeontology, Biology, Anthropology:

PIRSSON & SCHUCHERT—*Geology*—John Wiley & Co.
LULL—*Organic Evolution*—MacMillan.
MACCURDY—*Human Origins*—Appleton.
KEANE—*Man, Past and Present*—Cambridge.
PEARL—*Biology of Death*—Lippincott.
KENDALL—*Civilization and the Microbe*—Houghton Mifflin and Company.
BARRELL, SCHUCHERT, WOODRUFF, LULL, HUNTINGTON—*Evolution of the World*—Yale University Press.
SOLLAS—*Beginning of the Earth*—Grolier Society.
WALLACE—*How Life Became Possible on Earth*—Grolier Society.
OSBORN—*Origin and Evolution of Life*—Scribners.
LANE—*Evolution and the Christian Faith*—Princeton University Press.
LULL, FARRIS, PARKER, ANGEL, KELLER, CONKLIN, —*Evolution of Man*—Yale University Press.
SCOTT—*Theory of Evolution*—MacMillan.
WILDER—*History of the Human Body*—Henry Holt & Co.
WILDER—*Pedigree of the Human Race*—Henry Holt & Co.
WILSON—*The Cell*—MacMillan.
WOODRUFF—*Foundations of Biology*—MacMillan.

ELLIOTT SMITH—*Essays on the Evolution of Man*—Oxford.
OSBORN—*Men of the Old Stone Age*—Scribners.
OSBORN—*Origin and Evolution of Life*—Scribners.
SHAPLEY, JEFFREY, LAKE—*Origin of Life*—Harvard Alumni Bulletin.
TYLER—*New Stone Age*—Scribners.
SHOWALTER—*Exploring the Mysteries of Plant Life*—National Geographic Magazine.

Chemistry, Physics:

CUSHMAN—*Chemistry and Civilization*—Dutton.
DUNCAN—*The New Knowledge*—Barnes.
FOURNIER—*Two New Worlds*—Longmans.
RUSSELL—*A. B. C. of Atoms*—Kegan Press.
SLOSSON—*Sermons of a Chemist*—Harcourt, Brace and Howe.
FLEMING—*Waves and Ripples*—Sheddon.

Archaeology, Pre-History, Mythology:

WALLIS-BUDGE—*Translations of Cuneiform Inscriptions of* British Museum.
JEREMIAS—*Die Babylonisch-Assyrischen Vorstellungen vom Leben Nach dem Tode*—Heinrissche Buchhandlung.
DELITSCH—*Babel and Bibel.*
BALDWIN—*Story of the Mind*—Appleton.
CLODD—*Story of Primitive Man*—Appleton.
RAGOZIN—*Chaldea*—Putnams.
BARTON—*Archaeology and the Bible*—American S. S. Union.
BREASTED—*Egypt*—Scribners.
GOODSPEED—*Babylonia*—Scribners.
FISKE—*Myths and Myth-Makers*—Houghton-Mifflin.
JASTROW—*Semitic and Babylonian Tradition*—Scribners.
DELITSCH—*Wo lag das Paradies?*
WALLIS-BUDGE—*Babylonian Life and History*—Revell.

General Works:

WHITEHEAD—*Science and the Modern World*—Macmillan.
THOMSON—*Outline of Science*—Putnam.
WHITE—*History of the Warfare of Science and Theology*—Appleton.
WELLS—*Outline of History*—MacMillan.
MASPERO—*Dawn of Civilization*—Appleton.
WHITEHEAD—*Science, Religion and Reality*—MacMillan.
MILLIKAN—*Science and Life*—Religious Press.
DARROW—*Through Science to God*—Bobbs-Merrill.
DORSEY—*Why We Behave Like Human Beings*—Harpers.

CONTENTS

LIST OF ILLUSTRATIONS

OMNIPOTENT

I hold with those who hold with God.
    That all is purpose, all is thought.
No protozoon e'er hath trod
    A pathway that He knoweth not.
Nor doth electron choose his way
    In answer to another's call.
O Presence, everywhere, for aye,
    Thou mystery of All in All!

So, I believe that God had known
    And loved me e'er He made a sun;
He planned this pathway, hard and lone;
    He built this steep my toil hath won;
And knowingly He placed yon flower
    Above all footprints, beckoning still.
Thus am I strong, as is His power;
    Invincible, as is His will.

THE NEW SCIENCE
and
THE OLD RELIGION

CHAPTER I

THE HEAVEN OF HEAVENS

In a book so ancient and revered that it commands the unequaled confidence of the civilized world, in the first volume of that book and in the first chapter of that volume is a story, remarkable and significant and utterly priceless.

The story describes, dramatically, the way in which all things began. It sums up the results of the reverent meditations of the then greatest minds, contemplating the science, philosophy and religious traditions of the fathers in the earliest days of recorded history. It begins with chaos, that world state "without form and void," the final stopping point of the primitive philosopher searching for the first cause. And darkness was upon the face of this vast watery Tehom when the spirit of God breathed upon its waters. Then the Maker created light, conceived as existing apart from and before the sun, moon and stars, and decreed a firmament to separate the watery chaos, dividing the waters that were to be above the firmament from those that were to be below, the former to give rain to the earth through the "windows of heaven," the latter to furnish a basis for that world which He thus "founded upon the seas and established upon the floods." Then He gathered together into one place the waters under the heaven until the dry land appeared, completely surrounded by the ocean-stream of that mighty river which would divide human sorrow from heavenly happiness, the earth from Elysium, the land of sin from the Fields of the Blessed. All this was the labor of three crowded days and then the Mighty Toiler fashioned sun and moon and stars to divide day and night and to advise man of signs and seasons. With them in the rigid firmament He set the stars. Followed the creation of the living inhabitants of sea and air, and man, made, alone of created things, in the image of his Maker. Then, tired with His vast labor, on the seventh day He rested, thus sanctifying the Sabbath and hallowing the seventh part of time forever.

Ancient as is this priceless document, it is yet young compared to those hoary traditions upon which it is founded and which it so thoroughly stripped of their polytheistic crudities and superstitions. For the story of this wonderful chapter sinks its roots deep in the past. It goes back to the very earliest hours of ordered life on earth along the Tigris and Euphrates, beyond the day of Nimrod and Eabani, further back than the tower of Babel and the temple of the seven spheres, past the fateful moment when the fountains of the great deep were broken up, to that earliest time when Mesopotamian man first grappled with the mighty problem of the origin of all things.

For when we lift the veil upon earliest history we find this same cosmogony in its essential features, the common belief of all those city-states that inhabited the valleys of the Tigris and Euphrates. Their earth also rose from amidst a great ocean enclosed by a mighty mountainous wall on which rested the vault of a rigid firmament from which hung the stars. "For the same heavens were of old and the earth standing out of water and in the water." Through a gate in the west the sun passed from, and through a gate in the east he entered into his labors. Marduk also had "gathered up the water of the sea together as an heap and laid up the depths in store-houses." He also had conquered the dragon of chaos, Tiamat, the Tehom, without form and void, establishing in the midst of the seas the foundations of the earth that they should not be moved forever. In His firmament He set Shamash to rule by day and Nannar to rule by night. Nebo became His messenger and Ishtar His star of love. Nergal He appointed to herd the dead, Nibiru to shepherd the clouds, and Ninib to number the years. As His torchbearers He named the Annunnaki. Thus He made the stars also. Then mixing with earth the blood of a god He formed men in His own image to rule the world of created things forever. This combination of theology and science constitutes the earliest cosmogony known to history and is the foundation upon which, for thousands of years, and even today among some, millions of believers

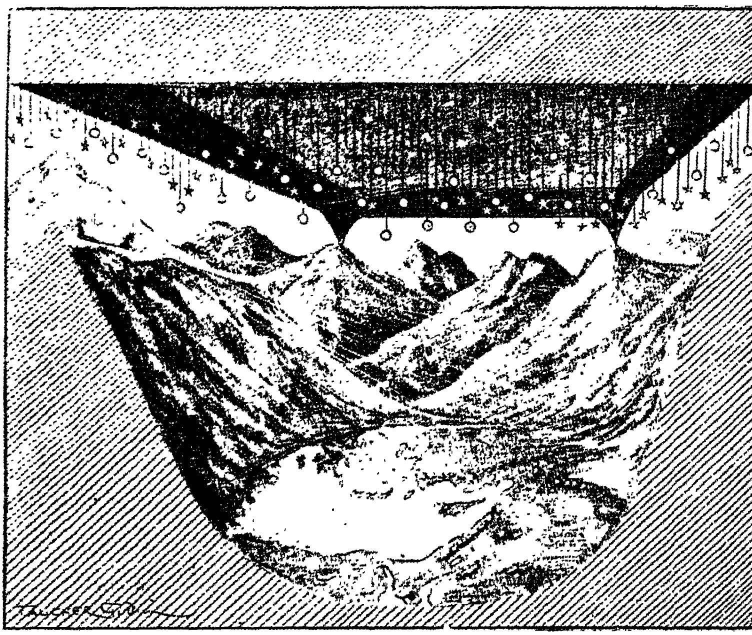
Ancient Chaldean conception of the heavens above, the earth beneath, Shualu within, and the waters around and under the earth. Through the Hebrew scriptures it greatly influenced Christian theology. (From Maspero's *Dawn of Civilization*, by courtesy of D. Appleton and Company, New York, publishers).

have placed their faith. A vast chaos without form and void (Tiamat, Tehom); a mighty wind (of Marduk, Ru'ah Elohim) moving upon the face of the waters; the conquest of chaos; the separation of the watery mass by a rigid firmament into two parts and the appearance of dry land as an island surrounded by a vast ocean stream, thus revealing the heavens above, the earth beneath, and the waters that are under the earth; the creation of all living things with man alone in the image of God; upon this earliest statement of belief millions still build their faith. If, to the picture, we add great mountain walls bordering the ocean-stream on all sides of the earth, supporting the vault of the firmament where the gods moved, a firmament that was not so far off but that a mighty tower could reach it or an eagle attain its glory, and in the interior of the earth imagine a vast hollow (hoehle, hell) where the dead reposed in shadowy coma, our ancient cosmogony is complete.

We must not overlook this underworld to which the dead descended, within the great mountain which was the world that rose above the surrounding ocean-stream. Arallu was its name, or Shualu (Hebrew, Sheol), and passing through its seven gated walls the deceased was stripped of all earthly possessions, lost life's vigor and was emasculated into a shade. Into this eternal repose no light entered. Dust lay deeply on bar and bolt. The only food was mud and dirt. It was a "land without return in a house of darkness . . . . . the dwelling place of Irkalla . . . . . whose entrant never comes out . . . . . the path to which never leads backwards . . . . . whose inhabitants have no light . . . . . . where dust is the nourishment and dirt is the food . . . . . they see no light . . . . they dwell in blackness . . . . . they are clad as birds in feathers, dust keeps collecting on door and bolt." And yet there, under the throne of Allat, the queen, are the waters of life which could restore Ishtar, the goddess of love each spring, to her lover, the vernal sun. Only Utanapishtim of blessed memory, he whose ark preserved mankind from the flood, escaped Arallu by being transported by the gods to the Fields of the Blessed on an island at the mouth of the great rivers, beyond the cavern of the setting sun and the ocean-stream that surrounded the earth. Such was the first cosmogony. Itself the product of thousands of years of myth and tradition, for thousands of years it has determined the thought of the world. With it our story begins.

We must not fail to note how reasonable it all was. If things began they must have begun with nothing or at least with jumbled chaos. The evidence of flood and storm and sea and river in their home land, rescued from the marshes of an equatorial sea, testified to the watery nature of the primitive mass. Only a rigid firmament above could hold back the vast floods that poured at times through the windows of heaven, and from immense reservoirs of the waters that were under the earth most come the gushing spring and the bubbling fount, suggesting ever the fear that the fountains of the great deep would again be broken up. How else but through a vast cavern could the sun retrace his pathway to the east? And where better than in some enormous hollow, larger but like that in which they had been placed, could the multitudes of departed lie, whose ghosts returned in dreams to witness their continued existence? Also, those beautiful objects that moved in the sky, doing so many things impossible to men, extremely long-lived by the testimony of tradition, always watching the earth, always brilliant, was not each a star, Ilu, El, Allah, Elohim, divine and powerful, kind, as the night with its prowling dangers was not kind, benevolent as the demons of darkness were dangerous? The imagination of the race playing upon the beautiful objects of earth and sea and sky since the days of Neanderthal man had reached this clear and convincing cosmogony. Mankind in its childhood, untelescoped, unspectroscoped, unmicroscoped, had begun the long task of interpreting the cosmos. Today we look back upon their conclusions fascinated by their charm, reverent over their earnestness and a bit saddened by the changes that increasing knowledge has compelled us to make in their ancient scheme of things. Our fir trees no longer are pressed against that sky, whose depths, today, are scarcely fathomed in light-years; no eagle now ascends to the heaven of Anu; the gods are no longer afraid that our babels will reach their abodes of bliss, nor do they now come down from heaven to walk in our gardens in the cool of the day. The old heavens and the old earth have passed away. And the gods, have they gone also?

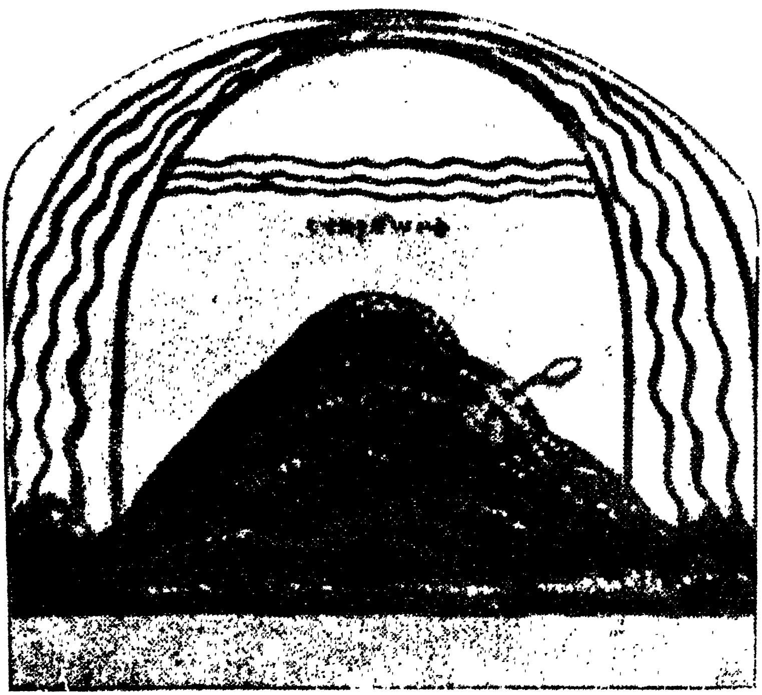
With few modifications this Chaldean cosmogony held sway over the minds of men for milleniums. Through the fathers of the Hebrews "who lived beyond the rivers and worshipped other gods" in Ur of the Chaldees, it became the Hebrew tradition and was imbedded in the scriptures. Accepted literally and in toto by the Christian church and buttressed by the theory of the verbal inspiration of the Bible, it was for centuries considered the perfect and final word of God as to the creation of the world. It furnished the backbone of that long warfare between theology and science so admirably sketched by White, many details of which are used herein.



The ancient Egyptian conception of the universe which was not widely different from the Chaldean. Note the boat of *Ra*, sailing around the world stream and the mountains upon which the firmament rested and by whose interposition night was produced. (From Maspero's Dawn of Civilization, courtesy of D. Appleton and Company, New York, publishers.)

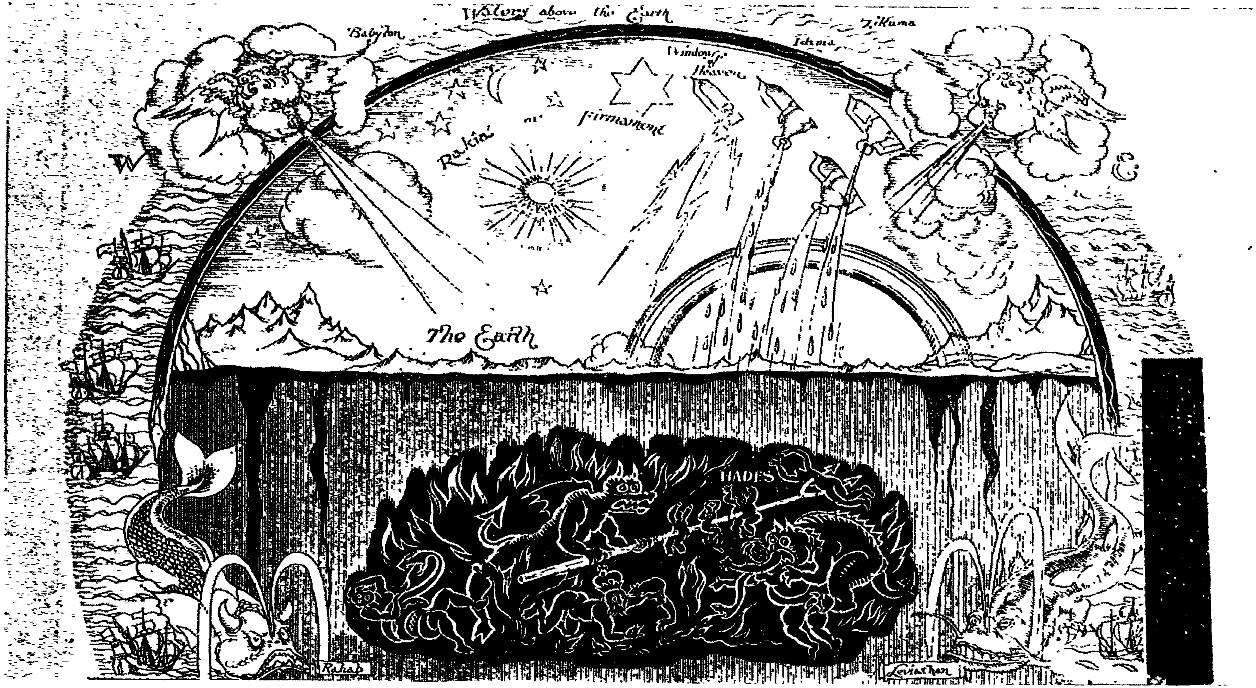
Such astronomical discoveries as were made could easily be harmonized with it. The fine beginning in modern science made by the Greeks with which such names as Pythagoras, Anaximander, Eratosthenes and Aristotle are associated lost its impulse and, finally, this same primitive faith, modified by the ancient Egyptian cosmogony and sanctified by the exegesis of Cosmas Indicopleustes, crystallized around it the sentiment of orthodox Christianity into a perfect accord assured from time to time by the infallible decrees of the popes.

The modifications wrought by Cosmas, whose system was typical of the orthodox views of his and many succeeding centuries are significant. He founded his theory directly upon the bed rock of Scripture which, either by statement or by necessary implication, taught that the sun rises and sets; that there are four corners of the earth, which when



One of the drawings by Cosmas showing the world mountain and the heavens above it. (Courtesy of the New York American.)

God shakes He makes its pillars to tremble. It was also founded upon the ancient Egyptian cosmogony which, in essentials, was similar to the Babylonian but differed as to important details. To the Egyptians of thousands of years before Christ the world was like a great box. On the bottom of the box was the earth whose center was Egypt, through which flowed the Nile from South to North and which was shaped like a parallelogram, longer than it was broad. On all sides rose mighty mountains and at its four



Fourteenth Century drawing showing the universe as conceived by theologians of the day. Note the firmament holding back the waters that were above the earth, except when they descended through the windows of heaven. Note also the strikingly realistic hell within the earth. (Courtesy of the New York American.)

corners rose four great peaks upon which rested the firmament. From the firmament the "fixed" stars were hung, and through its windows descended the rains. Beyond the four pillars of the earth flowed the ocean-stream on a sort of ledge upon the vast mountain range which formed the ramparts of the universe. The sun, in a boat, floated on the river from east to west in the southern sky. From west to east in the north the river and the boat of Ra were hidden by high intervening mountains. Cosmas accepted this ancient Egyptian cosmogony in its broad outlines and harmonized it with the ancient Chaldean and Hebrew cosmogonies afore-described and thus built his great system strictly upon the teaching of Scripture. "Praise Him ye heaven of heavens and ye waters that are above the heavens;" he considers this and similar passages as final. He notes that Isaiah speaks of the universe as a vault, that Job says this vault is joined to the earth, and Moses that the length of the earth is greater than its breadth. This world view of fixed firmament and waters above and below and around a central fixed earth remained a "fundamental" of Christianity for centuries.

But this fundamental postulate of systematic theology was not destined to last. Out of the days of the ancient Greeks, from the lips of Pythagoras and Plato and Aristotle had come the theory that the earth was not flat and four-cornered but was a sphere and Ptolemy the great Egyptian astronomer of the second century, author of the Almagest, had devised an astronomical system designed to explain the movements of the planets and stars which had long ceased to be gods, by attaching each of the sacred seven (Sun, Moon, Mercury, Venus, Mars, Jupiter and Saturn) to its crystalline sphere which revolved about the earth as a common center and which made such other circular revolutions as were necessary to explain their deviations.

One by one some of the greatest of Christian writers accepted this theory. Among them were Peter Lombard and Thomas Aquinas, "the most marvelous intellect between Aristotle and Newton." Soon Dante had drawn it, with his terrible witchery, in lines so lurid that the world would never forget its colors. Under the hand of these men the whole mighty figment of Chaldean and Egyptian imagination dissolved and the earth, still the center of the universe, becomes a sphere. Around it upon crystalline spheres, rotated by angels, revolve the Sacred Seven. The moon is first, then Mercury, then Venus, then the Sun. Afterward come Mars, Jupiter and Saturn. No Uranus or Neptune had as yet appeared. Eighth were the fixed stars, ninth the immovable prime mover and, surrounding all the universe, was the tenth, the empyrean, where was the throne of the Triune God who dwelt in a light that no man could enter while the music of the spheres, rising from the universe below, mingled with the anthems of the angels. Of these the seraphim and cherubim and thrones chanted His holy praises eternally in the empyrean; the dominions received his commands; the powers hurried the heavenly bodies to and fro, and the empires guarded others as they did His will among the sacred seven; the principalities protected the spirits of the nations; the archangels received the prayers of the saints and the angels busied themselves according to His will with earthly matters. No longer in the earth but below it was hell, inhabited by all the enemies of His will, of whom Lucifer was prince. From its sufferings some of these evil spirits escaped at times, among them Satan himself, to tempt men, to cause calamitous storms and pestilences and famines. Into its terrors the sinner entered at death to return no more forever. Above its door was written, "Leave hope behind all ye who enter here." This was the cosmogony of the middle ages. It was the last result of orthodox geocentric theology. It was the final word of God, revealing to mankind the form of his universe. He who denied it was an infidel.

But the ancient word of Pythagoras would not die. More than five hundred years before Christ he had divined the revolution of the planets around a central sun, and Aristarchus had been saved from exile only by the intervention of Pericles because he taught the same theory although he maintained that the central fire was as large as the whole Peloponessus. In the writings of other unbelievers, the same heresy had persisted sporadically but without affecting the main stream of the holy faith until the tragic day, May 24, 1543, when Nicholas Copernicus gave to the world his book on the "Revolutions of the Heavenly Bodies." Followed "starry Galileo and his woes," whose tiny telescope in the year 1610 revealed the moons of Jupiter and the phases of Venus with consequences which seemed to all the orthodox theologians to be destructive of the Christian faith. Giordano Bruno had already been burned at the stake in Rome on the Campo di

The Mediæval conception of hell portrayed by Civetta upon the walls of Ducal Palace of Venice. The sphere in the upper central part of the figure is the earth from which sinners are being tossed downward into the tortures of the "bad place."

Fiori in the year 1600 for maintaining that the sun was a star, and Galileo, threatened and persecuted until the fear of death was upon him, found safety only in perjuring himself and denying the truth of nature that the "Truth of the Bible" might not be questioned. So far the Catholic church. But the terrible fear for the ark of God gripped Protestantism also. Hear Martin Luther as he stretches out his hand to steady it: "An upstart astrologer who strove to show that the earth revolves . . . . . not the heavens or the firmament, the sun and the moon . . . . . this fool wishes to reverse the entire science of Astronomy. The sacred scripture tells us that Joshua commanded the sun to stand still and not the earth." And the mild and scholarly Melancthon: "The eyes are witnesses that the heavens revolve in the space of twenty-four hours. But certain men . . . . . have concluded that the earth moves and they maintain that neither the eighth sphere nor the sun revolves . . . . . Now it is a want of honesty and decency to assert such notions publicly and the example is pernicious. It is the part of a good mind to accept the truth by God and to acquiesce in it . . . . . the earth can be nowhere if not in the center of the universe." John Calvin asked, "Who will venture to place the authority of Copernicus above that of the Holy Scripture?" And John Wesley maintained that the Copernican theory "tended toward infidelity." Did not Scripture say that "the sun runneth about from one end of the heavens to another?"

The conflict grew more bitter as it engulfed all thinking men. The church utterly condemned the new theory. The Christian institutions of learning first forbade and then boasted that this "Pagan doctrine of the moving planets" was not permitted to be taught within their walls. At its best it was only an unproved theory. It was not in Aristotle. It plainly contradicted Scripture. To teach it and the plain facts revealed by the ever increasing number of telescopes was forbidden at all great universities; at Oxford and Cambridge, at Louvain, Pisa, Salamanca, at Wittenburg, the University of Luther and Melancthon. Father Clavius declared that "to see the satellites of Jupiter men had to make an instrument that would create them." And as to the valleys of the moon shown by Galileo's tiny telescope such wild statements plainly contradicted Scripture which positively declared that the moon was a great light. When the despised telescope revealed the spots on the sun whose motion suggested the rotation of that body, the astronomer of the University of Innspruck was forbidden by the father to mention it to his students. Little by little it was made clear among the orthodox that this monstrous Copernican theory vitiated the whole Christian plan of salvation. If it were once admitted that there were other planets, then there must be other Adams and floods and Noahs and Saviors. Also, had not Jesus ascended to Heaven and would he not return in like manner to judge the quick and the dead? Did not God "sit upon the circle of the heavens" and did not Paul state that he had been "caught up to the seventh heaven" where he heard things that it was not lawful for men to utter?

Finally, in 1615, Galileo was summoned before the Inquisition at Rome and forced to recant. Subsequently, Pope Paul V decreed that "the doctrine of the double motion of the earth about its axis and about the sun is false and entirely contrary to Scripture," and ordered that this opinion must neither be taught nor advocated. He further condemned "all writings which affirm the motion of the earth." But it was too late. As Castelli said: "Nothing that can be done can now hinder the earth from revolving." Little by little the new revelation of God won

The Mediæval conception of heaven as portrayed by Tintoretto on the walls of the Ducal Palace of Venice.

and the new theory "repugnant to Holy Scripture and to the Catholic interpretation of it" begun to be taught "not as an hypothesis but as an established fact."

Thus were the windows of heaven opened and the rain of starry truths began. Soon Kepler and Newton and Herschel had come and then Newcomb and Schiaparelli and Young and Flammarion and Lowell. Now we are upon modern days and the heritage of nearly half a millenium of astronomical toil is ours. We find ourselves weighing the sun, measuring the stars, analyzing the nebulæ. Verily with Etana we have ascended to the Heaven of Anu.

The universe as it is pictured to us by the modern astronomer, a vast spiral nebula, lense-shaped in form, containing hundreds of millions of suns; not unlike the spiral (*Canes Venatici*) shown above. If our sun and planets were transferred to the point in this spiral indicated by the letter S the heavens would be quite similar to those we view. (Photograph by Courtesy of Mt. Wilson Observatory.)

MY SEARCH FOR GOD

I told my soul I would search for God,
    And she bade me gladly try.
So I wandered long, my steps joy-shod,
    Till I bent me wearily
On failure's stones to lie.
    But from under my head the way I had trod,
Whispered: "I
    Am God."

I told my soul I would search for God,
    And she bade me madly try.
So I beat each beautiful bush with the rod
    Of hope, lest his flame be nigh.
Then I laid me down with a sigh.
    But the depth of defeat in the mouldering sod,
Whispered: "I
    Am God."

I told my soul I would search for God,
    And she bade me sadly try.
So I sought through the Book and the brook and the clod
    For the hand of Him, most high;
Nor voice, nor word, nor cry.
    But the infinite longing that bade me plod,
Whispered: "I
    Am God."

CHAPTER II

THE INHABITANTS OF THE HEAVENS

Among the ancient legends of the Euphrates Valley that have been preserved to us through the mishaps of centuries is that of Etana, friend of the eagle of Shamash. * That he might obtain for his agonized wife the plant which alleviates suffering, he besought the eagle to convey him to the heaven of Anu where, only, it might be found. Pitying his distressed friend, the eagle dares the enterprise. "Banish the clouds from thy face," he said, "come, I will carry thee to the heaven of Anu. Place thy breast against my breast, thy two hands upon the pinions of my wings, thy side against my side." This Etana did. Above the countryside they rose while the shepherds, stupefied at the prodigy, called to one another and their dogs howled in terror. For a double-hour they mounted upward, above the hills, the mountains, the clouds. Then the eagle called to Etana, " Behold, my friend, the earth, what it is! Regard the sea which the ocean contains! See the earth is no more than a mountain and the sea is no more than a lake." For a second double-hour they mounted. Again the eagle, "Behold, my friend the earth, what it is. The sea appears as a girdle of the earth!" At the end of a third double-hour again the eagle spoke, "See, my friend, the earth, what it is. The sea is no more than a rivulet made by a gardener." At length, they are come to the heaven of Anu. While they rest a moment Etana gazes about him and sees only the emptiness of space. Terror-stricken he would return but the eagle says, "Come, I will bear thee to Ishtar!" For a double-hour they ascend. "Friend, behold the earth, what it is," then said the eagle, "the face of the earth is flat, the sea is no larger than a mere." Again, after the fourth hour, he spoke, "Friend, behold the earth, what it is; the earth is no more than a square plat in a garden and the great sea is no larger than a puddle of water." Onward, upward! The third double-hour ends. Etana can stand it no longer. "Stop!" he cries. His eyes dim. He grows dizzy. His muscles relax. He falls to his death!

* The translation followed is that of Maspero.

So would the ancient Chaldeans warn the curious that no man may with impunity penetrate the holy above, heaven, the empire of the gods.

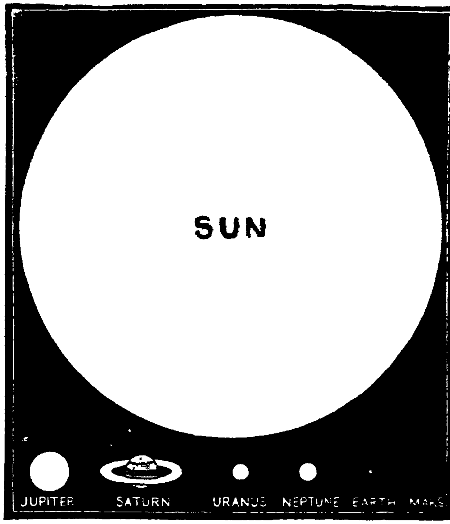
Yet have men not ceased to dare! "Come," they still say, "let us build us a tower that shall reach unto heaven." Only it is no longer done with brick and bitumen but with lenses and prisms and sensitive photographic films. Those

Etana carried to heaven by the eagle. (From Maspero's *Dawn of Civilization*, courtesy of D. Appleton and Company, New York.)

ancient astronomers, magi, see-ers, had only one tiny lens whose size was but one-fifth of an inch, the human eye. Galileo placed before his eyes a telescope whose lens was approximately two inches in size. Now a one-inch lens is just five times larger than the eye and a two-inch aperture would increase sight one hundred times since the amount of light collected would vary as the square of the diameter. Therefore, to the vision of the astonished Galileo there sprang sights no mortal eye had ever seen before. He was caught up past the heavens of the Sacred Seven, beyond the thrones of Shamash and Sin, of Nebo and Nergal and Ishtar, of Marduk and Ninib. In that strangely eventful moment of the year 1610 when he turned his telescope upon Jupiter he saw a sight so amazing as to make adequate description impossible. There, floating unsupported in the sky, swam a sun—fair, shining, globular. About him circled a family of little planets, travelling, as the event proved, in the same plane and in the same sense. Night after night he studied its meaning until the truth was clear. Copernicus was right! Gone are the waters above the firmament and below, gone are the heavens above the earth and hell below, gone forever. The very throne of God had vanished.

If we, with Etana and Galileo, could ascend so far into the sky that we could view our earth in the proportions it sustains to its sister planets, we, also would see:-

A great central fire, a vast burning thing, nearly a million miles in diameter, in unending eruption, too brilliant for the eye of men to view unshaded, slowly rotating, emitting flames of super-heated particles, burning gases, whose explosions reach a quarter of a million miles in length, and a vast corona of emitted particles about it.



The sun and planets, relative sizes. (From *The Vault of Heaven*, by Sir Richard Gregory, courtesy of Methuen and Co.)

A tiny planet some three thousand miles in diameter revolves around this mighty disc at a distance of some thirty - six million miles and at a speed of some thirty miles a second, making a complete revolution in eighty - eight days and by rotating on its own axis in the same period, keeping the same face eternally toward the central fire. There is little if any atmosphere around it and it is baked perpetually on one side and perpetually frozen on the other. This is the Roman Mercury, the Greek Hermes, the Babylonian Nebo, Messenger of the Gods, who darts here and there about the throne of the sun.

Just outside his elliptical orbit at a distance of some sixty-seven million miles from the sphere of flame, speeding at about twenty-two miles per second, revolving and perhaps rotating in a period of about two hundred and twenty-five days, is a sister planet, approximately seventy-seven hundred miles in diameter with an atmosphere dense with either vapor or dust. It is Venus, Aphrodite, Ishtar Ashtoreth, the queen of love and beauty, ever staring vacantly at her lord.

Just beyond her a twin planet sweeps swiftly along her ellipse at eighteen miles a second, and ninety-three millions of miles from the sun. Her diameter is seventy-nine hundred miles, her period of revolution is three hundred and sixty-five days, and of rotation twenty-four hours. Her atmosphere is at times clear gas, at times full of clouds. Vast oceans of water cover the greater part of her surface but here and there the dry lands appear, beautiful with grass and trees, vocal with songs of myriad birds. It is the earth, formerly the center of the universe, now a beautiful little planet, revolving around a modest yellow sun, accompanied by a palefaced moon, whose days of youth are behind her.

Beyond is a smaller planet, four thousand miles in diameter, with two little satellites, one hundred and forty-one million miles from the sun, revolving at fifteen miles per second, in a period of nearly seven hundred days, and rotating in about twenty-four and a half hours. Time and its smaller size have aged it rapidly. Its atmosphere is light, its water almost gone. Its mountains have been levelled and are those the channels and verdant valleys of intelligently directed moisture which gridiron its surface from pole to pole? It is Mars, ruddy and fierce, fighting grimly the last battle of planetary life. It is Nergal, shepherd of the dead, and the dust that reddens his atmosphere is like that which lies deep upon bar and bolt in Shualu.

A multitude of tiny worlds varying in size from a few inches to a hundred miles (four of them) in diameter lie between Mars and his neighbor. Unknown to the ancients they are called asteroids by the moderns. Revolving like planets, rotating doubtless in part, without life, cold as interstellar space, they represent what would perhaps have been another planet had not the disturbing effect of a great neighbor prevented.

That neighbor is Jupiter, Zeus-pater, Dyaush-pitar, the Marduk of ancient story. Four hundred and eighty million miles from the sun; eighty-six thousand miles in diameter, with a day of ten hours, a year of twelve earth-years, and a speed of eight miles per second in his path around the sun, he is the giant brother among the planets. He is thirteen hundred times as large as the earth, three hundred times as heavy and seems to glow with a dull red light from fires not yet cooled. About him float nine little worlds, for he, also is the father of a mighty family.

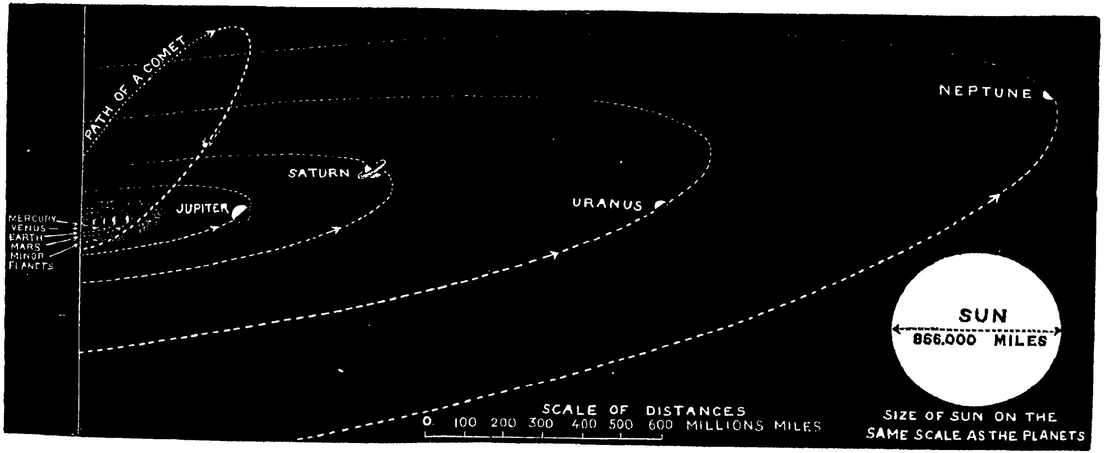


Diagram showing the orbits of the planets around the sun. (From *The Vault of Heaven*, by Sir Richard Gregory, courtesy Methuen and Company.)

Heavenly Bodies	Satellites	Diameter	Mean Dis. from Sun	Speed of Revolution	Time of Revolution	Speed of Rotation	Comp. Den. Water -1
Sun	8	866,000 Mi.	----------------	28 Day Rotation		App. 28 Das.	1.39
Mercury	0	3,000 Mi.	36,000,000	30 Mi. Sec.	88 Das.	Face to Sun	5.67 (?)
Venus	0	7,700 Mi.	67,000,000	22 Mi. Sec.	225 Das.	" " "(?)	4.85
Earth	1	7,918 Mi.	93,000,000	18 Mi. Sec.	365 Das.	24 Hrs.	5.58
Mars	2	4,000 Mi.	141,000,000	15 Mi. Sec.	687 Das.	24½ Hrs.	4.01
Jupiter	9	86,000 Mi.	483,000,000	8 Mi. Sec.	12 Yrs.	10 Hrs.	1.33
Saturn	10	73,000 Mi.	886,000,000	6 Mi. Sec.	29 Yrs.	10¼ Hrs.	.72
Uranus	4	32,000 Mi.	1,800,000,000	4 Mi. Sec.	84 Yrs.	11 Hrs. (?)	1.22
Neptune	1	35,000 Mi.	2,800,000,000	3 Mi. Sec.	165 Yrs.	Not Known	1.11

Beyond, at a distance of eight hundred and eighty million miles, lies Saturn, Ninib, shepherd of days, whose year is a life-time of twenty-nine earth-years, whose speed is six miles per second, whose day is less than half our day, and whose diameter is something more than seventy thousand miles. Ringed with glory and with a regal retinue of ten satellites he marked in olden days the end of space, the seventh heaven. Beyond lay only the lamps of the gods lighting their pathways to the empyrean.

These are the Sacred Seven but, lo, beyond lies yet another world, unknown to ancient eyes. It floats, with its four satellites, one billion, eight hundred million miles away from the central hearth, and its rate of motion around the sun is four miles per second. Its diameter is thirty-two thousand miles and its year more than eighty of ours. The probable length of its day is eleven hours. This is Herschel's star, Uranus, born too late to be a god.

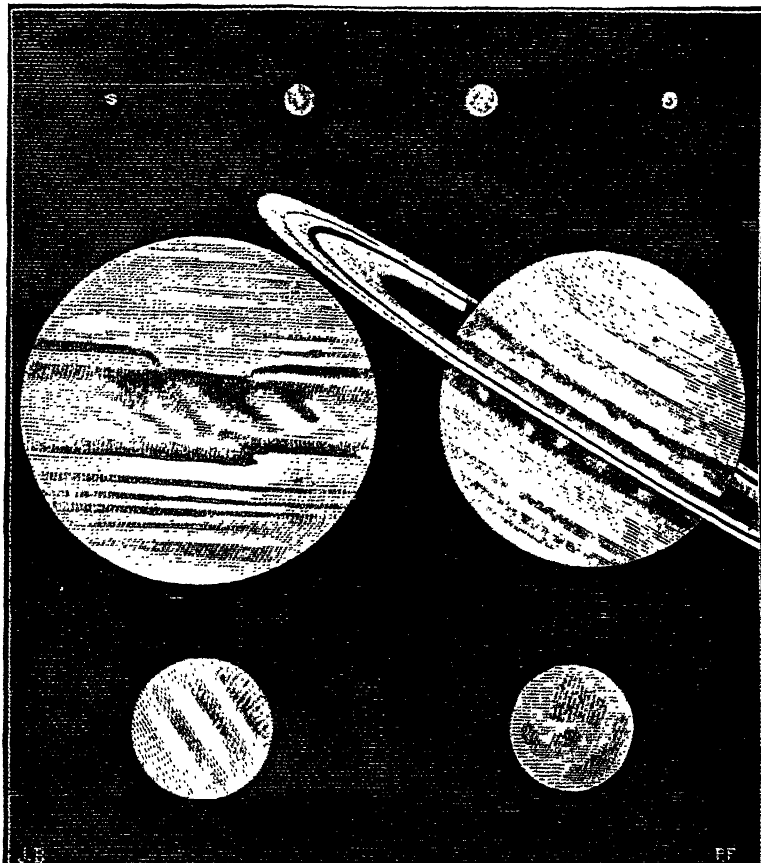
Nor is this the end. Two billion, eight hundred million miles from the father of them all, taking his leisurely way along his ellipse at the rate of about three miles per second, floats Neptune; he whose influence upon his neighbor caused the perturbations that in the hands of skillful men revealed a new world. Thirty-four thousand miles is his diameter and his day is as yet unmeasured. His is a patriarchal year of one hundred and sixty-five earth-years. One moon accompanies him on his way as he guards the outposts of the solar system.

Then Pluto

And as we look down on this wondrous vision we behold scattered here and there among the planets strange specters of wispy light, signs and wonders in the heavens, flaming swords of divine wrath, some with only tiny cores of filmy light but others, near the central fire, lengthened by vast "tails" of attenuated gas. These are the comets, members of the same family, children also of the sun.

And if our eyes are those of the eagle of Shamash we see, likewise, innumerable particles of world-stuff; some tiny as dust, others large and yet larger and all obedient to their father's law, pursuing their pathways around his throne. These are the shooting stars, the aerolites, the meteorites, that, falling from the sky, became in ancient times the Palladia of superstitious cities. They are interspersed throughout all the space of the solar system.

Such, then, is the sun and his family. It is as if we looked with Herschel upon a globe of fire two feet thick in the center of a field two and a half miles in diameter. A tiny mustard-seed (Mercury) twirls around it at a distance of 82 feet. Two peas (Venus and the Earth) lie 145



The eight planets that form the Sun's family, showing relative sizes. Reading from left to right beginning at top: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. (From Flammarion's *Popular Astronomy*, courtesy of D. Appleton and Company, New York.)

and 215 feet away, respectively. A large pin head represents Mars 327 feet off, and a quarter mile away a tangerine orange is Jupiter. A lemon two-fifths of a mile away stands for Saturn, while a cherry three-fourths of a mile off is Uranus, and another one and one-fourth miles off on the edge of the field represents Neptune. Or, if the diameter of the sun be reduced to one-third of an inch, the Earth would be represented by a tiny invisible speck one yard away and one-three hundredths of an inch in diameter. At a distance of about a hundred feet Neptune would lie and the nearest fixed star—our neighbor in space—would be as far away as Birmingham is from Atlanta, one hundred and sixty-five miles. Travelling at a mile a minute rate on the winds of our eagle we would pass our own moon in 186 days, Venus in 50 years, Mars in 93 years, Mercury in 108 years, the sun in 177 years, Jupiter in 744 years, Saturn in 1,510 years, Uranus in 3,200 years, Neptune in 5,000 years, and our neighbor stars in millions of centuries. Since the rate of sensation travelling along our nerves is approximately 92 feet per second, if an infant with an arm so long that it could reach to the sun were thereby to burn its fingers, it would not feel the pain for one hundred and sixty-seven years.

And as we regard the sun and his little family of eight planets, twenty-seven moons, eight hundred asteroids, and countless meteorites, aerolites and comets, there comes to us with overwhelming power the reflection that through all the differences of size and state there runs a unity that is undeniable. From the tiniest speck of world dust pursuing its lonely way along its arbit to the great central sun, there is no spot on which one can put his finger and say, here begins something different. Dust merges into grains of matter, grains of matter into little stones, stones into asteroids, asteroids into moons, moons into planets, planets into suns. Apparent differences of kind fade into differences of quantity and degree only. And as it is in size and appearance so it is also in temperature. From the little asteroid, cold as inter-stellar space (273 degrees below zero centigrade) to the flaming sun (2—10,000 degrees centigrade), temperature fades into temperature as we pass through asteroids, moons, and planets in varying stages of cooling. It is never a difference in kind, only in degree. Thus do those ancient gods still teach us the wisdom of heaven. Thus do they lay the foundations for all correct thinking about the whole vast universe of God. As the modern astronomer turns his great telescope upon them he sees only empty thrones where Nebo, Nergal and Ninib once sat, yet as he ponders the meaning of it all his thoughts follow the dim and hazy pathway that leads to the new empyrean. For this heaven is not as it was in the days of Etana, only empty space. It throbs with the hurried orders of purpose. Every moment, everywhere something is happening and these happenings tend toward an end. There is something doing in this universe. The tiniest asteroid, not man alone, is made in the Great Image. Nothing is unimportant. Each tiny bit of star dust is full of meaning. Again we feel the throbbing in the heart of that ancient dreamer upon whose ladder angels ascended and descended from heaven as he exclaimed: "Surely God

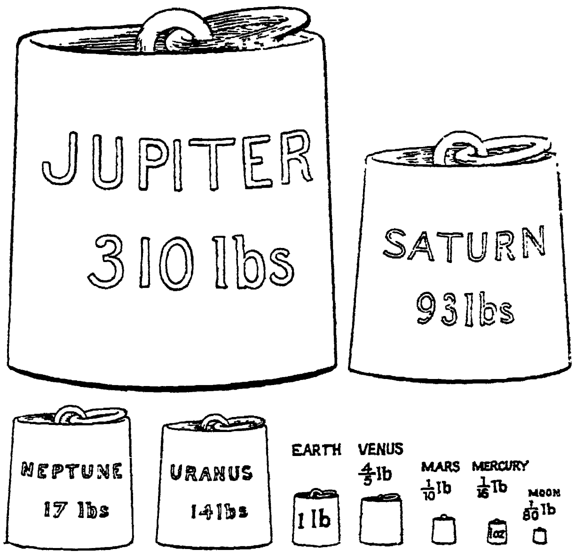
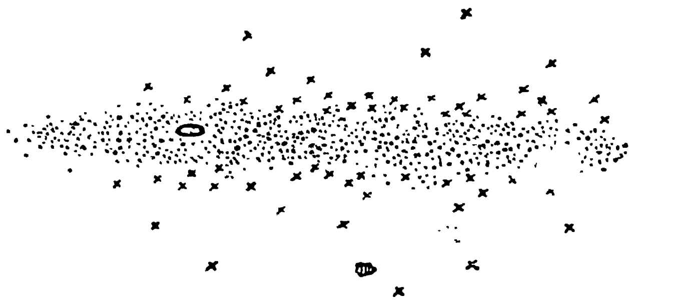


Diagram showing relative weights of the planets. (From *Vault of Heaven*, by Sir Richard Gregory, courtesy of Methuen and Company.)

is in this place and we knew it not. This is none other but the house of God, and this is the gate of heaven!"

These, then are the relative sizes and likenesses of the bodies that make up the solar system. But what of the stars? Here we find ourselves upon the threshold of the infinite. Human words fail, earthly measurements cease. The minds of men cannot conceive enough miles to estimate stellar distances. We seek a heavenly unit. The speed of light is inconceivably swift. By numerous ingenious methods it has been determined as 186,000 miles per second. Whether reflected from a distant mirror to another, revolving at a known rate and at a known distance away, or delayed in passing the 186,000,000 miles of the earth's orbit from the moons of Jupiter, the story is the same. This speed would circle the earth eight times in one second. It would travel nearly six thousand billion miles in a year. This distance is our unit, the light year. It is none too long.



THE GALAXY AS SEEN EDGEWISE

Here the "watch-shaped" stellar system is presented edgewise to the observer. The small elipse (at the left of center) shows the relative position of the "local cloud"—that is, the stars which are visible to the naked eye. The crosses indicate the position of globular clusters—outside the central part of the Galaxy but most numerous near it. The dark patch below is a Magellanic Cloud. The diameter of the system here represented is some 300,000 light years. (Courtesy of Harper's.)

Substituting the wings of the morning for those of the eagle of Shamash, we pass through the infinite. There is no up or down. The solar system contracts. The great planets converge. Then one by one they fade from the view of the naked human eye. Their moons are already invisible. Now Mercury, then Mars, then Venus, then the Earth fade away and Uranus, Neptune, Saturn and Jupiter follow. Our sun disappears into the distance as day after day we speed onward. A year passes. He is still more brilliant than any other heavenly object but another sun is brightening ahead of us. Another year and each is is brilliant as the other. Four years; our sun has dimmed into only an ordinary star, though still of the first magnitude while we hover above two vast flaming masses, the double sun, Alpha Centauri, nearest of all the stars to our little Earth. They swing about each other at a distance of some two billion miles and in a period of about eighty years and their mass is twice that of our own orb. Shall we say that about each circles a family of planets, a Nebo, an Ishtar, a Marduk, a little Earth upon the shores of whose rivers arise what temples to what gods? Nor do we seem nearer to any other stars by having sped upon the wings of light for four long years. They, also, as we, are alone in the skies. Such are the distances of the heavens.

Shall we cross the immensity that we call our universe? Lens-shaped, it lies in the sky. Toward the edge all around the stars crowd together into the "Milky Way." Toward the center where is our own sun and Alpha Centauri they are not so closely gathered. Above and below, (if we may regard the lense as placed flat upon space) as we look out from the center they thin far more rapidly than lengthwise.

We begin our journey. Disregarding accuracy of direct-tion, we pass, after eight light-years, the beautiful Sirius, brightest of all the stars of the northern hemisphere. Twenty odd years later we arrive at Vega. When a half century has passed we are at Capella and after three hundred and fifty years we near the vast Antares. To lift the veil of the Pleiades we travel more than three hundred years and when half a millenium has gone we are at Rigel. Another century lands us among the blue stars in Orion. These are our neighbors in space.

For, ever, as we pass onward, new suns come into our astonished vision while others fade into the black vault of heaven behind. But how shall we measure its immensity and how number the coutless hosts of suns that make up its lens-shaped form? In this vast universe there are doubtless more dead, burnt-out suns speeding through space than there are bright ones, and of course only a tiny proportion of the number of bright stars is visible to the naked eye. It has been estimated that on a clear night the human eye can discern perhaps three thousand stars and that the total number visible over the entire sky would not be more than 6,000. It is interesting to note that the earth receives three times as much light from stars invisible to the human eye as it does from those that may be seen. The moment that even an opera-glass is turned upon the darkest region of the sky new suns leap into being. Photographs taken through the greater telescopes show countless hosts of suns where the naked eye sees only the blackness of midnight. Yet each is as far from his neighbor as we are from ours—or at least as the planets are from one another. Even double suns like Alpha Centauri are separated by unthinkable distances for who can conceive two billion miles? And the countless hosts of them! By the most accurate estimates of modern astronomy they number some billion and a half, a sun and its attendant worlds for each human being now living on earth.

Photograph of a bit of heaven. Irregular nebula M17 Sagittarii, Omega. Neither the nebula nor any of the stars shown in this picture are visible to the naked eye, the brightest of the stars shown being 9.2 magnitude. (Photograph by courtesy of the Mt. Wilson Observatory.)

Though we take the wings of the morning and fly for centuries we do not reach its end. Seventy-five thousand years of travel at the rate of one hundred eighty-six thousand miles per second would hardly suffice to cover the thickness of our visible universe, while three hundred and seventy-five thousand is the estimate offered for its length and breadth. Perhaps two million light-years would not suffice to cover the distance from tip to tip of the outermost stars.

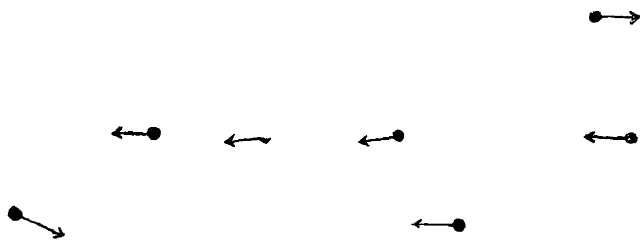
And so we are arrived at the limits of the visible universe and we find it not unlike a vast spiral nebula, lens-shaped, with two projecting arms on each side of a central disk.* But even when our imagination has carried us to the limit of our universe our astronomers point their most powerful telescopes to the north and the south of the galactic plane and they find here and there clusters of suns at incalculable distances beyond. In the constellation Hercules there is a globular star cluster commonly known as Messier thirteen. Apparently, it is a part of our universe. Estimates of its size indicate that its diameter measures some 500 light-years. It is composed of perhaps a million stars, at least 50,000 of which must be brighter than our own sun and some of them doubtless are hundreds of times brighter than is our sun. The distance at which these beautiful globular star clusters lie are so enormous as to be unthinkable. Number 7006 of the New General Catalogue is so far away that travelling with the speed of light it would take 215,000 years to arrive at its border. Upon them we should find in the blue of their empyrean other perhaps more brilliant and certainly more distant clusters requiring other hundreds of thousands of years to be reached even travelling at the speed of light. And so farther and farther into space the lure of our imagination leads us out among the million island universes each with its billion suns visible in our largest telescopes until we begin to realize that the heaven of heavens, the ultra-universe is infinite; that to it there are no bounds; that to measure it in millions of light-years is like measuring our galaxy in millimeters; and that our visible universe with its billion suns and its billions of planets is but an atom of space to fathom whose distances the wings of the eagle of Shamash would tire and even the wings of the morning fail.

Now perhaps the most illuminating fact that we find about our visible universe is that in this vast assemblage of suns and nebulæ, of planets and comets, of star clusters and cosmic dust there is found as in our solar system a definite uniformity of constitution and character. From the tiniest bit of matter, so minute that it may be driven by the power of the pressure of light, to the enormous masses of the thousands of stars that constitute the con-

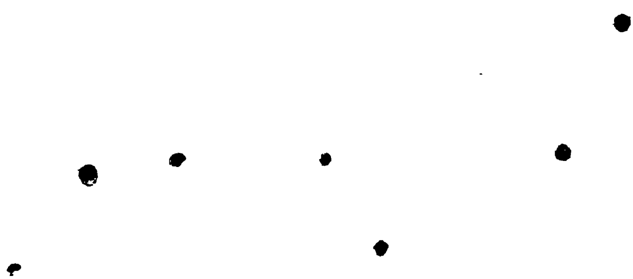
---

* See illustration on page 15, Chapter I.

stellation of the Pleiades there are regular gradations of size and temperature. From dust to grains of matter, to meteorites, to asteroids, to planets, to little suns, to sun clusters, to the whole vast universe itself we rise with slowly ascending steps as also from the cold of interstellar space to the 30,000 degrees centigrade surface temperature of the hottest stars. Heaven is after all composed of the



THE "GREAT DIPPER" AS IT IS



AS IT WILL BE

Diagram showing how the "fixed" stars are constantly changing their relative positions in heaven. The Big Dipper, *Ursa Major,* as it is and as it will be. (From *Curiosities of the Sky,* by Serviss, courtesy of Harper and Co., New York.)

same material as that of which the earth is composed, just hydrogen and oxygen, nitrogen, iron, sodium and calcium. The same materials as those of which our solar system was formed make up the glories of the skies. And if perchance some extra-telluric substance like nebulium appears we remind ourselves of how helium was first discovered in the sun but later on earth.

Perhaps the earliest impression made by the world upon the mind of a child is one of quiescence and fixedness. Only here and there does something move. All else is quite permanent, solid. Of the objects near at hand only the living are in motion. The stones move not, the trees abide, and the far off mountains, hazed in blue, are eternally at rest. Thus the earth seems fixed, immovable, and while here and there in the sky some object like the sun or moon may be in motion, yet when to them a few planets have been added, all of the other objects in the heavens seem so stationary that the whole world has for centuries known them as "fixed stars." Nothing appears so utterly permanent as the configuration of the constellations. Since time began has not the Great Dipper swung his handle about the pole? Did not the first among the ancients see the Seven Sisters as they are to-day, and have milleniums of years sufficed to shift in the faintest the triangle of the Lyre? Yet little by little our earth-child is destined to learn that things that seem so permanent and fixed and immovable are actually in a state of perpetual motion. Of the infinite speeds that lie in the atom we shall speak later, and of the changes wrought upon the face of the earth by the labor of the ages. This knowledge the youth receives with surprise but it is with astonishment that he learns that even the constellations in the heavens are never exactly the same for two successive nights, that as the centuries pass the Big Dipper will lose its handle and Cassiopeia's chair its rungs. Even for the stars there is no rest. This is perhaps the most astonishing thing that the human mind has found to be true about the universe. There is nothing at rest. From the tiniest bit of dust of a comet's tail to the whole vast grouping of suns and planets and nebulæ called the visible universe, all are in motion. The earth, rotating on its axis, revolves around the sun, tilting in this direction and in that, and follows the sun himself as he speeds through space at approximately twelve miles per second toward a point near the fair star Vega, and the whole visible universe, of which the sun is a part, throbs as if with the pulsation of some mighty heart, each of its suns and planets and comets and clusters of stars and wispy nebulæ hurrying upon its own destiny at speeds unmatched on little planets like ours. And the picture which modern astronomy presents to us of the flight of our universe itself through space is perhaps the greatest scientific idea ever conceived by the mind of man, for the universe, measured as it is as to breadth and length and thickness in hundreds of thousands of light-years and composed though it is of hundreds of millions of suns and planets and nebulæ and comets and wild, runaway masses of matter and faint misty nebulæ and gases more attentuated than the vacuum tubes of earth and perhaps of thousands of other strange things, of which we know nothing, seems to be obeying the same will and to be speeding upon the same kind of destiny as that which keeps urging our little world around her central orb. For with the eagerness of a runaway star the whole visible universe is being hurled through space at a speed which none can calculate for lack of that wherewith to measure it. There is reason to look upon our universe as a gigantic spiral nebula and if it is comparable in velocity to those spiral nebulæ whose speed of motion is known then our universe is moving through space at a rate of approximately 500 miles per second some forty times faster than our motion as a solar system and thirty times faster than our motion as a planet. And, on either side, up and down, to the north and south, above and below this universe, other universes, globular clusters of suns are being drawn in to take part with us in our destiny. For it seems that those star clusters that are farthest away are most closely knitted together while those that have come nearer to us are more open in their arrangement. In our universe itself there may still be discerned clusters that have separated under the great stresses of our galactic system, for example, the Pleiades, which consists of thousands of stars, festooned with nebulous wisps of matter from sun to sun. The great Dipper is another group, as also the Hyades. Perhaps those strange formations, the spiral nebulæ, are being driven with us by the

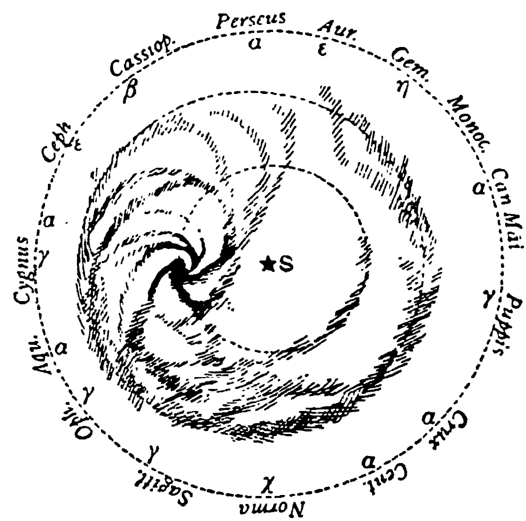


Diagram of Milky Way of which our sun is a modest little yellow star, showing position of the sun and picturing the Milky Way as a spiral nebula. After Easton. (From *The Destinies of the Stars*, by Arrhenius, courtesy of G. P. Putnam and Sons, New York.)

same power that drives us forward while from above and below the star clusters fall to join us in that mighty swing wherewith we are plummeting the ultra-universal space. "Hubble has found that some of the brightest and presumably the nearest of the spirals are at the distance of about a million light years. This places them infinitely outside of our system which, though estimates of its size vary, is hardly more than 300 light years across." (Stokely in Scientific Magazine.) Perhaps the spiral nebulæ are themselves island universes formed or forming in the unspeakable abysses of space, borne by the same forces and compelled by the same power that hurls us through the depths.

And from those abysses, looking down upon the many stretches of infinity, our universe, formerly the universe would doubtless appear as merely a speck of dust floating with its myriad fellows in the light of some vaster sunbeam. As it was with kingdoms and empires which grew ever smaller as the known world was enlarged; as it was with the earth, whose unimportance among its fellows was not conceived of except after centuries of argument; as it was with the whole solar system which seemed for so long a while the limit of heaven; so it is now with the universe. It is less than one leaf in a forest, tinier than one spark from a brand that is burning, smaller than one grain of sand on the unending beaches of the world stream.

In short, as our minds fail, confronted with the impossible task of grasping the infinite, we find that going on in the beyond which is going on here by our side. Everything, size, temperature, conditions of being—everything is relative. No two things are alike. Yet everything is like everything else. And nothing is at rest. The whole universe, all the universes seem hurried, eager, anxiously driven toward something that is to be. What does it all mean? What is happening in the heavens?

BACK FROM THE AGES

Alive, ajoy, aglow I came from Death
I, who when I was dead yet hurried on.
Aglow, afire, ablaze, my elements
Have shed their rays till now the light is low.
Till now the tug of time doth draw them down;
The terror-tug of Time doth draw them back
Into the Ages whither all men go.
Ah, long my part did wait for part to find
His fellow, loitering through the countless years;
I, multi-mingled man who might not fare
Forth to bright life till every atom fell
Into his place. I, child of chance—His strange
Weird chance—came forth to this dear day—and lived!
But now—(O setting sun!) I go away.
My world disintegrates. The friends of old
Approach me: Dullness, Darkness, Blindness, these
And Silence (O thou happy hearted noise!);
Old friends that with me were in my long wait
To live, who would with me again abide.
Farewell, Fair world, till we shall meet once more
As meet we shall when He doth cast the dice
Just as they fell before when forth I came
To light. Aeons shall lie as dust upon
His dial-plate whose seconds tell the death
Of suns grown cold while waiting on his will;
But come I shall tho' myriad's myriad worlds
Shall fall forth from his cup and have their day
Before the lucky cast shall summon us.
For, when they all have gone, my parts shall hear
Their cues and they shall come from far to be—
From calcium clouded, cosmic dust; from dead
Stars; from wee planets, warmed by unweighed suns;
From drifting meteor bands of coveyed worlds;
Come forth when he shall cast the lucky throw
That sets the sun a center for his train,
The world again a theater for men,
And men and world and sun the same as when
He cast us all into his lap before.
And this I know for he doth never cease
To play at making universes new,
[At making universes old he plays],
And in His game toys with the centuries
As toy eternities with tiny hours.
And he will gather me to act again
My part with those who played for him. For this
He needeth naught save time—and who may say
There lacketh centuries to wait His will?

CHAPTER III

WHAT IS HAPPENING IN THE HEAVENS

In one of the most beautiful constellations of the northern hemisphere is a star named Algol, otherwise known as Beta Persei, or the second brightest star in the constellation of Perseus. In a period of two days and twenty-one hours its light suddenly begins to dim and in four and one-quarter hours it drops more than a full magnitude. The ancient astronomers of the Arabian desert who watched in the clear sky of the tropics every variation of stellar light or position, were aware of this strange disappearance of a star in the heavens and named it, because of its sinister wink, el Ghoul, Algol, the demon. The modern astronomer has fathomed its significance and his spectroscope has divined its cause. It turns out that Algol is a binary star, double suns which revolve about each other in a plane which coincides with our line of sight. One of them is as brilliant as ours and the other is either black and dead or else so nearly burnt out as to eclipse its brilliant companion. Algol thus calls our attention to the multitudes of dark stars of which there seem to be as many in the sky as bright ones and these dark suns are in motion as rapid as their brilliant brothers. Dark nebulæ there are, also, and dead, burnt-out planets. Indeed, all planets capable of sustaining life are long since dead, speaking in solar terms. If, now, we picture to ourselves the heavens that we have described—billions of suns and planets and comets and meteors and nebulæ with clusters and swarms and clouds of suns, all in constant and perpetual motion at speeds varying from a few miles to hundreds of miles per second, we will see how reasonable it is to suppose that among so vast a multitude there must be, from time to time, near approaches and occasionally collisions.

Let us think for a moment of what this would mean. The effect of one heavenly body upon another, at a distance of millions of miles, is very marked. Our little earth, ninety-three million miles from the sun is never for a moment allowed to forget her dependence even upon the spots that darken his face and our moon 240,000 miles away, affects the very navigation of our seas by her influence upon them, in the tides that rise and fall by her command. This influence, of course, is increased in proportion as the distance decreases, nor is the tidal action confined to the waters of the earth, for every particle of its solid core, as well, feels its tug and consequent friction. Therefore, as two heavenly bodies approach and pass one another the time would come when the tides of their surfaces would rise not a few but hundreds of feet and then miles and then hundreds and thousands of miles, and this effect would be felt by their solid as well as by their liquid portions and would involve friction even in a cold burnt-out sun that would develop heat so intense as to vaporize the hardest stone. Should the collision be head-on, the heat generated would, of course, be enormously increased. It is calculated that two heavenly bodies, dead and burnt-out and cold as interstellar space, moving at the speed of our sun, striking one another in direct collision, would generate heat sufficient to vaporize each 100,000 times over.

Now there must occasionally be times when such catastrophes do occur in the sky, but for every direct head-on collision there would be scores of instances where suns would barely graze each other and hundreds or thousands of instances where they would come only so near together as to disrupt part of the outer surface of each hurling into space billions of particles, large and small, such fragments as fell into the burning sun, generating increased friction and heat. This would be aided by the eruptive tendency that is so prominent in our own sun which hurls great masses of its surface material at a speed as high as three hundred miles per second to a distance of some four hundred thousand miles. In the course of time many of the free fragments and particles would collect in common points or "nodes," probably through innumerable collisions, thus generating subsidiary centers of incandescence. As the orbital motion of any planet would be the resultant of the motions of those bodies which created it and as two closely placed knots or nodes would pick up more material from their outermost sides than from the space that lay between them, the planetary system would be self-spacing and this would account for Bode's Law according to which the relative distances of the planets from the sun vary according to a progressive series of four (4) added to 0, 3, 6, 12, 24, 48, 96, 192, for those inside of Neptune. For Neptune, the rule would naturally fail as it actually does, the distance being three hundred instead of three hundred and eighty-eight because there would not likely be as much planetary material revolving outside of the resultant planet. Of course other laws of which we are ignorant may have operated in this case also. The amount of disrupted matter and the amount of heat and light developed

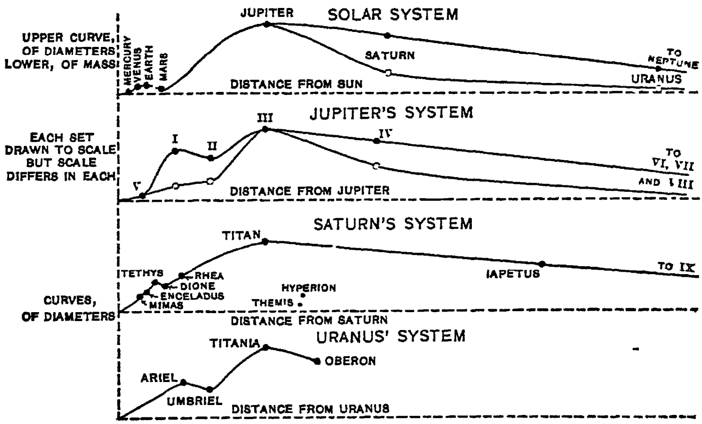


Diagram showing relative sizes of the planets and of their satellites. Note the curious uniformity of the graph with the double rise in sizes. (From Lowell's *Evolution of Worlds*, courtesy of the MacMillan Co.)

would depend upon the nearness of approach of the two suns to one another. A head-on collision would vaporize the masses of both into an immense nebula. A more distant approach would disrupt the surfaces of the two suns sufficiently to develop a more or less numerous series of satellites. An even more distant approach would only raise enormous tides of molten material on the surface of the living sun and create enormous stresses upon the body of the dead one. Now let us see whether the constitution of our solar system gives any evidence of having passed through any such catastrophe as that described above. As we study our sun and his eight planets with their twenty-seven moons and the eight hundred asteroids and numerous comets with billions of meteorites, we notice:

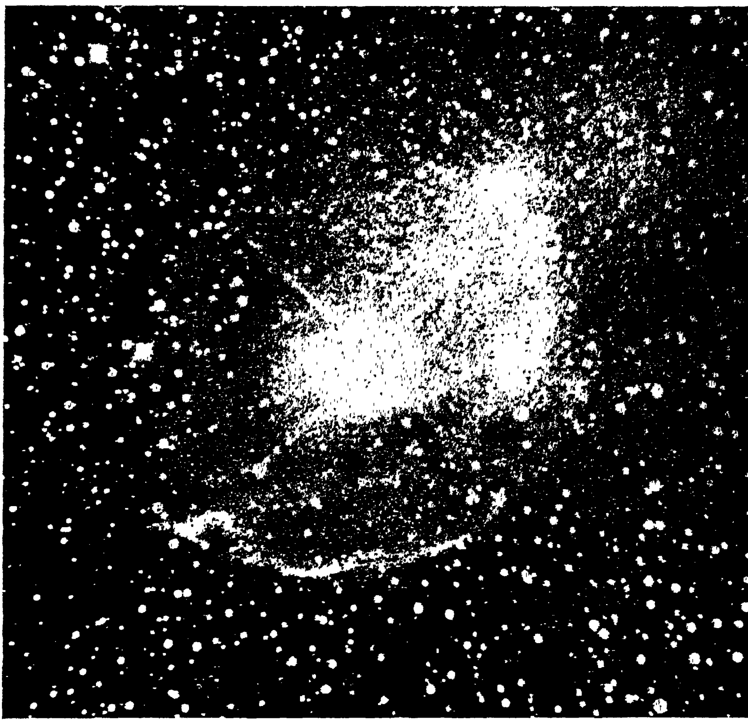
All the planets and moons and asteroids revolve about the sun in the same direction. This could hardly have been a matter of chance. Quite evidently the same force set them all going in the same sense.

All of the planets and moons revolve around the sun in the same plane. This again points definitely to an identical force acting upon them all alike. It is noteworthy that the lighter bodies, such as the asteroids, vary most from this plane which is to be expected if the force concerned is gravity.

All of the planets except the outermost as also of the satellites except the outermost in each case rotate on their axes in the same sense (opposite to the direction in which the hands of a clock move) in which they revolve. The exceptions to this rule noted above, namely: the outermost planets and satellites, can be explained on the supposition that the agent at work is tidal action which, acting with the greatest force upon those nearest the central orb has turned over both planets and satellites in their orbits. This tidal action, continuing its work, slows down the rapidity of rotation and finally brings each satellite to a state where it keeps its face perpetually turned toward its lord. This has already happened in the case of the moon and all satellites of all the planets in so far as we know. And it has also happened to Mercury and possibly to Venus. (Lowell.)

Further evidence of an initial catastrophe lies in the innumerable meteorites which fill the entire space of the solar system, twenty millions of which add annually a hundred thousand tons of matter to our earth, some of them consisting of stone and others largely of iron, but never of the same mechanical or mineralogical formation as any known minerals on this earth. This is particularly noteworthy in the case of the meteors constituted largely of iron, the Widmannstatten lines which occur in all siderites distinguishing the iron ore of the heavens from that of the earth. They exhibit every evidence of having been formed apart from oxygen and water under circumstances widely different from those of the earth. They are of every form and shape and show no signs of igneous action since disruption. Their known size is from dust grains to some thirty-seven tons but the great meteorite in the Canon Diablo is supposed to weigh millions of tons. Are they parts of a dark tramp star that lured our planets from the bosom of the sun?

It is noteworthy also that the density and specific gravity of the four inner planets is far greater than that of the four outer-most ones. This is in line with the theory that in case of disruption the surface of the disrupted sun would be the first to be drawn into space and would be



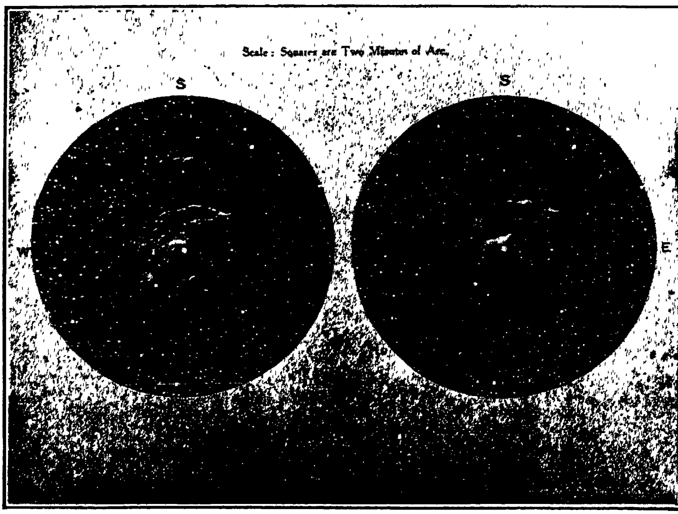
NOVA PERSEI, WITH ITS NEBULAR RINGS

(From *Curiosities of the Sky*, by Serviss, courtesy of Harper's.)

hurled forth the farthest, leaving the denser portions to be gathered nearest to the original center. Similar evidence exists also in the comets which fill the solar system and which sometimes, by disintegrating, produce the meteor-swarms.

And it should be noticed that the revolutions of all the planets, satellites and asteroids about the sun is in the same sense as that of the sun's own rotation.

In short, there is to be found in the solar system every evidence that it originated in a vast catastrophe brought about by the approach of one heavenly body so near to another as to disrupt one or both. Perhaps our mother sun was much like it is today and the tramp a small, burnt-out, dead star or meteor-swarm that perished in the catastrophe, part of his body falling into our sun, part being gathered up by the planets, and the rest remaining in the system in the form of innumerable asteroids and meteors.

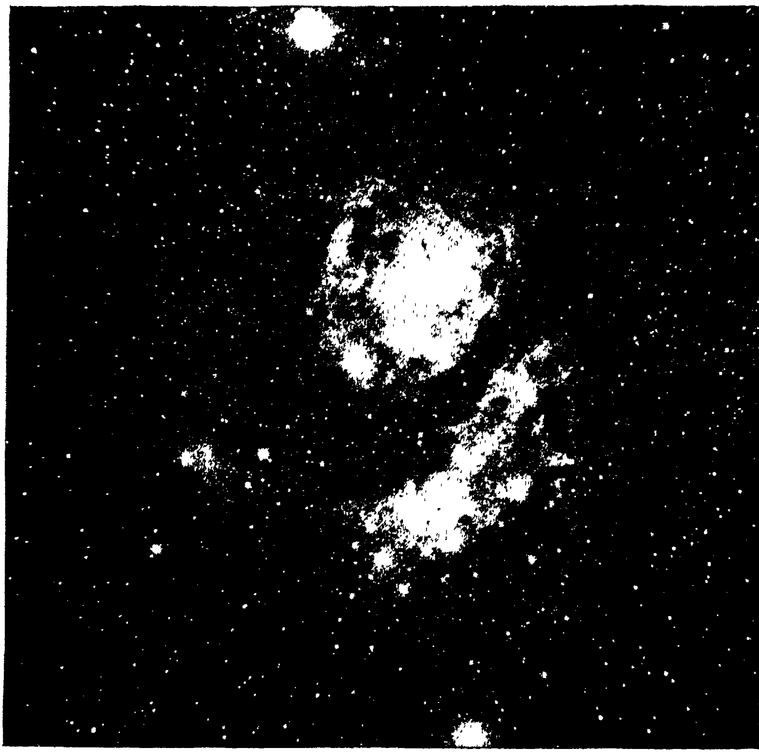


(From *Lowell's Evolution of Worlds*, courtesy of MacMillan Co.)

Out of the debris of this collision sprung the planets, satellites, asteroids, or better planetoids, comets and meteor-streams of the solar system as we know it today.

Now it would seem to be reasonable to suppose that if such has been the case with us it would also be the case with others. We might expect, therefore, in the heavens above, to find other instances of similar catastrophies and other evidence of similar collisions. And this is the case. Once in ever so often, some fifteen times in recorded history, the peoples of the earth have been astonished to notice a new star, a "nova," in the sky. One appeared in 1572. It was the famous Pilgrim star, the nova of Tycho Brahe. Significantly, these novæ seem confined to the regions of the Milky Way where the stars are crowded together most densely. In our own time, in the year 1901, came the beautiful Nova Persei which blazed forth suddenly in the constellation of Perseus to the astonishment of the earth and then slowly faded into its customary insignificance. The story of it is doubly illuminating because the science of astronomic photography and spectroscopy had by that time been so fully developed that it could be thoroughly studied. On February 21, 1901, there was no star larger than the twelfth magnitude at the point in the heavens where on February 22nd, it suddenly appeared. Within twenty-four hours it had become brighter than any star in the heavens. For a few days it maintained its fires and then, like some vast conflagration in the skies, died away. During the succeeding weeks it would occasionally flare up in periods of approximately three days. Thereafter its brightness decreased steadily until it sank again into invisibility to the naked eye. In the meantime both photographic and spectroscopic studies of the new star had been carefully made and their results coincided. Photographs taken as early as March showed the beginnings of a nebula surrounding the brighter nucleus and as the later negatives were developed the nebula grew into spirals plainly centering in the nova. (Lowell.) Then the spectroscopists reported customary nebular lines in its spectrum. There could no longer be any doubt about it. Some sort of enormous celestial collision had occurred. The most reasonable explanation of such an event is that some sun had either disrupted or crashed into another or else had passed through some vast meteor-stream or dark nebula so that an enormous amount of heat and light had been generated, turning an obscure star into a blazing sun. That which must of necessity sometime happen has in such cases probably occurred. What may be considered almost as final proof of the matter comes from the form which such collisions would logically and do actually take. Every one knows that the tides raised by the moon on the earth are developed at the same time on opposite sides of the world. Similarly, in the case of the approach of one sun so close to another as to disrupt its outer crust, releasing the inner fires or raising flaming tides upon its already molten oceans, these tides would be developed on opposite sides of the suns concerned. From each side disrupted arms, spiral-shaped, would fly like flaming pin-wheels and these arms would in the course of eternity condense into suns or planets or both, thus forming a spiral nebula.

The great spiral nebulæ should be carefully distingushed on the one hand from the tiny one from which our earth was probably born and on the other from the bright, green, gaseous, irregular nebulæ some four hundred of which occur in the Milky Way. The former, (the faint white spirals) seem to avoid the Milky Way but approximately



One of the beautiful irregular nebula in the heavens. N. G. C., 6523, Sagittarius. These bright, gaseous, green nebulae, supposed to consist of hot glowing nebulium, are among the most interesting objects in the universe. The mystery of their origin is as yet unsolved. They should be carefully distinguished from the faint, white spirals of which our own universe is probably one. (Courtesy of Mt. Wilson Observatory.)

a million of them are known in those regions of the sky where stars are least frequent. They are now commonly spoken of as island universes, galaxies like ours, consisting of billions of suns formed or forming. In them doubtless are also hundreds of green, gaseous nebulæ, as in ours, consisting also, perhaps, primarily, of nebulium. Our own bright, gaseous, green nebulæ seem to consist of hot, glowing nebulium, a state or form of matter unknown on earth, a thousand times more rarefied than our atmosphere and they are therefore of inconceivably large dimensions. Unlike the faint white spirals they abound in our universe where stars are most congregated. A suspicion already exists that they, though vastly more attenuated than a vacuum on earth are nevertheless the first visible stage

Photograph showing part of the nebularity south of Zeta Orionis. Note the curious dark mass of cosmic material that seems to intervene between the nebula and the earth. (Courtesy of the Mt. Wilson Observatory.)

of star-birth. Of them it is believed that stars are born by condensation. From such a diameter as that of Betelgeuse, over a million times larger than the sun in volume (diameter over two hundred million miles) they shrink, growing hotter and denser in the process, until they are as is our own sun in size and density, 865,000 miles in diameter and 1.4 denser than water. Nor has our sun reached the end, for the "New Variable" just south of the Big Dipper has a density of approximately 4.1 which may be compared with that of the earth, 5.53. Also with their other changes come changes of color, from red to white and then to red again as will appear later. Furthermore, whereas the new-born star is comparatively at rest, as it grows older the velocity of its "fall through space" is accelerated so that we have a series of giant, red, rarified, sluggish nebulium suns developing into smaller, denser, white, more swiftly moving helium and hydrogen suns and later into still smaller denser, swifter, yellow, metallic suns such as ours, and then into still smaller, denser, swifter,

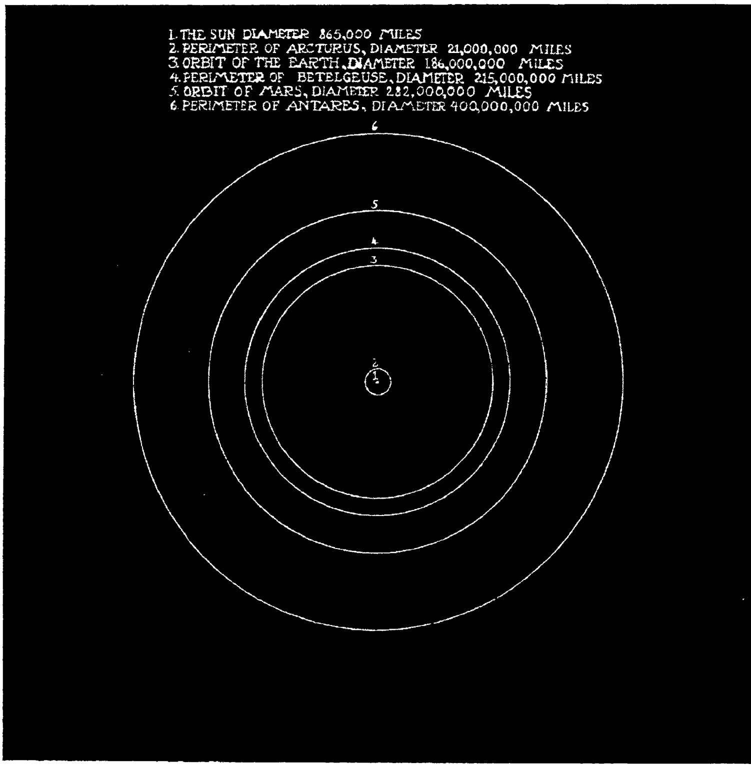


Diagram showing relative sizes of three of the giant red suns and the orbits of the earth and Mars and the size of our own sun. To see the earth, which is a million and a quarter times smaller than the sun, on the same scale would be beyond the limit of the most powerful microscope.

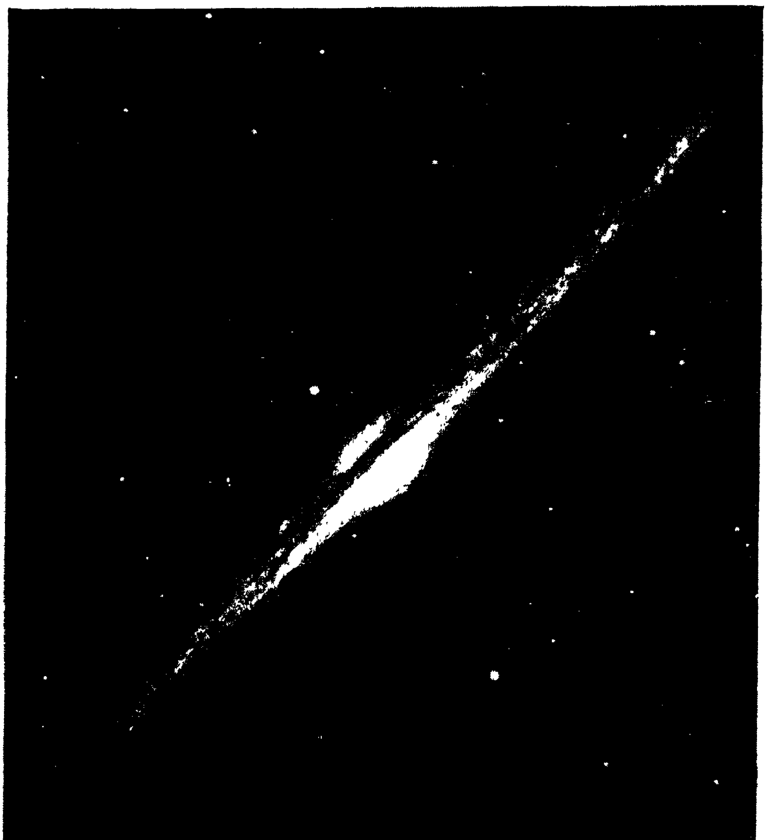
redder carbon suns and finally into still denser, swifter, smaller, lightless, dead suns such as the millions perhaps billions that help to press the pathways of the heavens. For it is generally believed that the dark invisible matter in the universe exceeds that which is bright and is therefore visible.

And these bright, gaseous, green, irregular nebulæ of nebulium content, whence come they? Do they spring from even more tenuous forms of matter, from the ether, from nothing? What is nothing? Is it a term to cover our ignorance of the supra-universes, of invisible, inaudible, intangible things? Perhaps there is no such thing as nothing. Perhaps everything is something. Nothing, space, ether, vacuum, are they also illusions? Shall we eventually track energy and power into their lair? Are they the mother of matter? And did our world not only, but all other worlds spring from their womb, the womb of nothing, the mother of all? Who knows? Perhaps in that western world which we call nothing lie many lands awaiting the ships of science. Many distinguished physicists look upon the two types of electricity, positive and negative, proton and electron, as strains or vortices in the ether rotating in opposite directions. Thus matter becomes interchangeable with energy and energy in its ultimate analysis becomes electricity and electricity is born of ether, vacuum, "nothing."

Let us carefully view a typical spiral nebula as it is photographed through one of our greatest telescopes.* As we look at their pin-wheel form we cannot help wondering whether they may not be galaxies like ours, wrecked and reconstructed or else modified in their shape by tidal action as they passed near to other universes. Perhaps some of them were once globular star clusters twisted into spirals when, during the eternity of the past, some other cluster or galaxy passed by. Looking upon one of these spiral nebulæ we see an enormous maelstrom whose mighty vortex is incandescent with inexpressible fury. Two vast foaming billows of white flame whirl about it. With unspeakable violence the starry stuff of which suns are born in fiery agony is being flung as if some stupendous pinwheel of the gods were hurling forth universes of flame. Vast masses of molten matter seem staggering dizzily into space, there to create solar systems from this maddened whorl. Afar into the abysses of heaven, incalculable billions of miles, this twisting tornado of fire hurls its embers to condense them into sparkling worlds gleaming like white-hot beads of glass upon a background of ebon night. Glowing with unimaginable intensity the cyclonic rain of incandescent suns leaps far out into space, scattering as upon a string its beaded systems of glowing starlets. In

* See page 15. An admirable description may be found in Serviss' *Curiosities of the Skies.*

the center is the brilliant effulgence of the heavenly crucible. On each side and exactly opposite one another project the two spiral arms. At first, nearest the central fires, they are of a uniform texture. Further out they



Remarkable photograph of the spiral nebula, Comæ Berenices exhibiting a rare spectacle of a spiral seen edgewise in the heavens. (Courtesy of Mt. Wilson Observatory.)

condense into cores of light which as the spiral extends further and further into space turn into brilliant points of light shining through a gossamer veil. Still farther away the misty nebula fails and a curved line of unveiled stars sparkle in youthful brilliance. God, what a tabernacle hast thou set in the heavens for thy suns; out of what chambers come these bridegrooms of light rejoicing to run their race! And in the mad mælstrom of such a fiery ocean as this, in some distant spot and hour our little sun was born, perhaps our entire universe of stars. For there are wise men among our astronomers who believe that our galaxy is just one of the spiral nebulæ as our sun is just one of the stars.

Nor have we lost the last spark of our fires. The heat of the earth, increasing at the rate of one degree to every sixty-five feet that we descend into her interior would alone be a sufficient witness to that faraway scene. The molten state in which the earth once existed is evidenced by the vast mass of igneous rock that rests below the sedimentary deposits the world over. If further witnesses were needed one has only to turn his telescope upon the larger planets of the solar system which, on account of their size, have cooled more slowly, and to note the ruddy glow of Jupiter and Saturn. Out of a vast calamity we have arisen and in that hour of catastrophe gathered the incalculable store of power and energy which has lasted us to this good day. In the pages that follow we shall trace the story of it, but it is well now to mark closely the fact that from that critical moment in which, in the midst of some stellar catalysm, our little earth sparkled amid the flames or reddened under the impact of colliding starlets, to the present time we have descended from a supreme pinnacle of heat and light and power and have been in the slow process of cooling, of losing our energy, and of descending to our death. What we once were Jupiter now is. What we shall some day be our own moon keeps screaming at us.

IN THE INFRA-WOOD

I dreamed of thee, sweet violet, one night,
And dreaming, prayed that I might tiny be
As thou, my little comrade; that the light
Within thy very soul might glow in me;
And all the secrets of thy blessedness,
And thine ephemeral, sweet tenderness
Might open to my love's wise master-key.

And lo, I dreamed an answer to my prayer.
For, swiftly, all things changed until I stood,
Ten thousand trillion times so small, and there,
Upon an infra-world, within thee, glowed
An infra-sunset of an atom-star;
And though vast galaxies thy petals are,
Behold, a sweet white violet in her wood.

And as I stooped to kiss her pallid cheeks,
So wanly lighted in her brooklet's cove,
I heard the twilight word the throstle speaks.
Eternal stars shone brilliantly above.
And all was as it ever here had been,
Though thy dear heart a milky way was seen;
So vast the cosmic forces of thy love!

CHAPTER IV.

THE MATERIAL OF HEAVEN

Our studies have brought us to the supreme hour of heavenly life and we have found it to be a moment of intense tragedy, of terrible catastrophe. We have seen a sun, aflame or perhaps, cindered and dead, hurled through space, followed by its little family of planets, throbbing with life or long since dark and blinded. In the course of infinite time that happens to it which must certainly happen. It grazes or crashes into some other system or into some train of meteors or into some dark nebula. Perhaps instead of a single solar system we are dealing with a double one, or a group of stars or a star cluster, in which case the catastrophe is the more terrible and the cataclysm the grander.

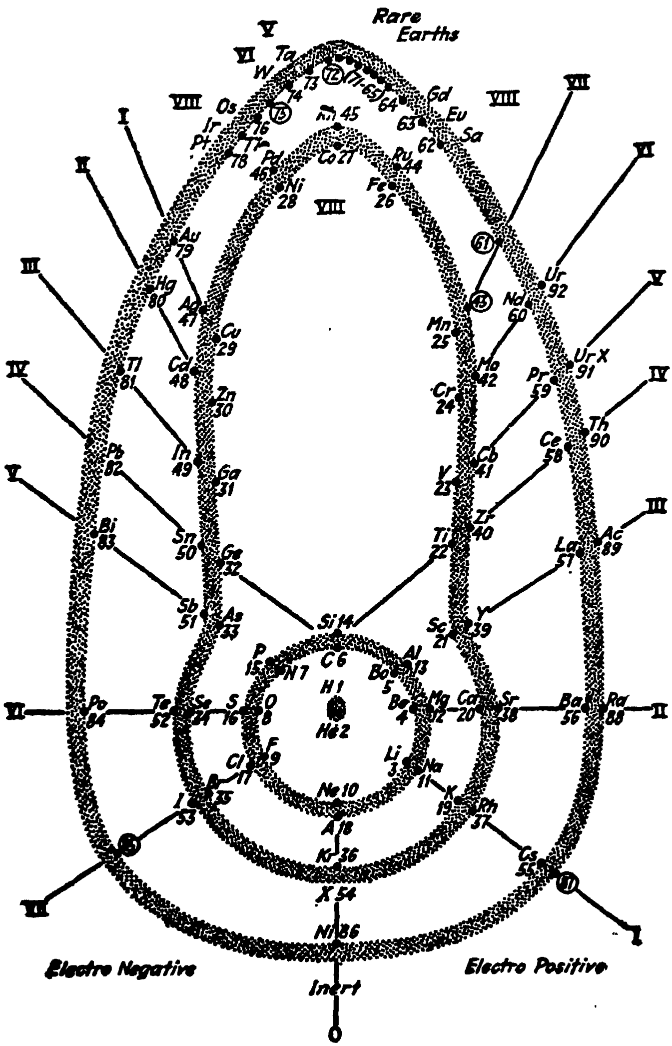
It is this moment of collision as Lowell has well said, which is the birth-hour in the heavens. In it is reached the heat pinnacle, the power pinnacle, the life pinnacle of the skies. From this moment begins the story of stellar evolution which traces change upon change as the temperature decreases until a moment comes when water ceases to boil and lasts until all the water is frozen, and in this tiny period comes life as we know it on earth.

Watchers of the skies must have noticed that all the stars are not of the same color. The dull red of Antares contrasts vividly with the yellow light of Capella, and the white beams of Sirius and the blue-white flames of Alnitam. It is the old story of the poker, told this time in the heavens. First, the poker is black like some star cold and dead. As we heat it it begins to glow with a dull red color. As we heat it still further it becomes brighter until it reaches a white heat and, before it melts, it attains a bluish-white tinge. If no further heat be applied, as it cools, the colors are reversed. First, the bluish, then white, then yellow, then red, then darkness. So it is in the skies. As the temperature rises under continuing contraction and repeated collisions of its component planetesimals, our star changes in color from dull red through yellow and white to the intensest heat of the blue-white stars, the hottest of all. Then at a certain point of density it begins to cool and consolidate until, when it reaches the last state of full redness, we have the densest form of solar constitution. Thus in the sky we have two types of red suns, the giant type whose redness is being born of contraction and innumerable collisions throughout an enormous volume and the dwarf type which has contracted until it has become almost solid.

Astronomers have set for themselves a solution of the question, what changes take place in the constitution of matter as it passes through the long range of heat represented by the change from red through white and back to red again. Perhaps an answer to that question may tell us something about the sort of stuff the universe is made of. To answer this question it will be necessary for us to come back to earth.

As we look about us here, we at once notice the differences in the appearance of visible objects. We sort them by our five senses, according to their color, their touch, their odor, their taste, and their sound. Where the difference is substantial we distinguish them by names. This is the sort of thing that mankind has been doing from the beginning, until today we find that we have named more than a quarter of a million different objects.

But the mind of man has always sought for a unity in these innumerable substances. The ancient philosophers divided them roughly into four classes; earth, air, fire and water. The chemist of yesterday found that when they were subjected to heat the number of their constituents diminished from 250,000 to ninety-two. These he was unable to further decompose so he called them "elements." The unscientific reader would recognize most of their names—such as gold, silver, iron, sulphur, oxygen, nitrogen, and hydrogen. It was long believed that this represented the end of the matter, that these elements were irreducible, unchangeable, and were the foundation bricks of the universe. The tiniest thinkable particle of each was called an "atom," that which could not be cut or divided further. When an atom of one element united with another element as, for instance, when an atom of chlorine (Cl) united with an atom of sodium (Na), they formed a compound—in this case, common salt (NaCl). A grain of salt could be divided and then divided further until, at last, one came to the point where, if he divided it again, it was not salt but an atom of the metal, sodium, and an atom of gas, chlorine. At that point it became and ceased to be a molecule. And so, for a long while, an atom was conceived of as ultimate, indivisible. Chemists often compared atom with atom. By various experiments an atom of one element was substituted for an atom of another and thus the relative weights of each were determined. One chemist, Prout, noticed that taking hydrogen, the lightest of all, as a unit the atomic weights of a great number of the othere were approximately whole numbers. He suggested, therefore, that perhaps the other atoms were composed of hydrogen monads or atoms, e. g. oxygen—which is approximately sixteen times as heavy as hydrogen would then be composed of sixteen hydrogen atoms. Another chemist, Dobereiner, noted certain marked resemblances of small groups of elements as to their chemical properties which thus divided themselves into triads, e. g. chlorine, bromine and iodine. Also, the atomic weight of the middle member of the triad is always almost exactly the average of the first and second. Another chemist, Newlands, pointed out that when the elements are all arranged according to their atomic weight from hydrogen (1) to uranium (238) there is a definite likeness of each eighth element of the list and that elements whose chemical habits are alike fall in the same column. Then Mendeleef formulated the periodic law, namely: "The properties of an element are a periodic function of its atomic weight." The law has well been called by Duncan whose admirable treatment of this subject we shall frequently follow herein, "God's Alphabet of the Universe." The table of the elements lists them by their atomic weights in series from top to bottom and in groups from left to right. Thus arranged each atom has its room and each group constitutes a family whose chemical properties resemble each other with a stricter than family likeness and the valence or "grabbing power" of each group is increased by one; that is, an atom of an element in the first group "grabs" or unites with one atom of a certain substance and an atom of the second group with two atoms of this substancc, and so on. Here and there is a vacant bed. Their occupants have not yet come home to the knowledge of men. They will be recognized when they come for their lineaments are known. Three such have already answered the call of chemical prophecy, scandium, gallium, and germanium, predicted



From "Within the Atom," by John Mills. Published by D. Van Nostrand Company

Atomic systems at the periodic table. Place numbers correspond to atomic numbers. Systems similarly situated, as indicated by radial lines, have similar chemical properties

EXPLANATION OF THE ABOVE CHART

Matter is granular in structure and electrical in nature. It is composed of tiny particles of positive and negative electricity known, more perfectly and surely than Neptune by Adams and Leverrier. Since the writing of this paragraph it is reported that two more of the elements have been discovered. It is all very wonderful and it has a strong flavor of law and order as if the relation between the "elements" were founded upon mathematics of some sort. If we only knew what lies within the atom itself! If we could only find a microscope that would enlarge a drop of water to the size of the earth! Is there such a microscope?

---

respectively, as electrons and protons. Any atom is formed by a central nucleus and one or more electrons at relatively enormous distances beyond the nucleus. In the simplest atom the nucleus is a single proton and there is one external electron like a planet about a central sun. In all other atoms the nucleus contains also electrons but always more protons than electrons. In the case of uranium, the heaviest atom, there are 92 more protons than electrons in the nucleus, and corresponding 92 planetary electrons. The atomic weight depends upon the total number of protons in the nucleus for the electrons are relatively negligible in weight. The chemical characteristics of an atom depends upon the number of planetary electrons, and more particularly in the group which is furthest from the nucleus. For example, lithium has two electrons close to the nucleus and one further out. Sodium has two close to the nucleus, eight somewhat further away, and an eleventh still further from the nucleus. Lithium and sodium, therefore, although different elements have somewhat similar characteristics because they have the same number of electrons in the group farthest from the nucleus. In a similar way fluorine has two electrons near the nucleus, and seven in a group further out, while chlorine has two near the nucleus and eight in the next group, and seven in the group farthest out. Fluorine and chlorine, although different chemical elements, have certain similarities in substance and chemical behaviour.

This fact that all of the atoms of chemical elements are built of similar elements of electricity and depend for their differences only on the relative positions of these elements, means that certain characteristics of chemical behaviour periodically recur as one progresses from the lighter to the heavier elements. The effect is much as if the atomic systems were arranged at a table with place numbers corresponding to their numbers of planetary electrons. Systems similarily situated, as indicated by the radial lines of the figure, have similar although not identical chemical properties. Three or four of the places at this table are vacant for the corresponding elements have never been discovered and isolated. At the time this figure was drawn there was considerable lack of knowledge as to the arrangement of the elements known as the "rare earth" group. The solution of this problem has been hastened by the hypothesis of Bohr, the famous Danish scientist, and particularly by the discovery of the element corresponding to atomic number 72 which is known as "hafnium." The figure shown, however, is for many practical purposes sufficiently accurate and serves to emphasize the fundamental order of our material universe. This is reprinted by permission from a popular presentation of the interesting problem of atomic structure called "Within the Atom" by John Mills, published by D. Van Nostrand Company.

An ordinary good human eye, says Fournier D'Albe, can distinguish approximately 200 dots to a linear inch. If more be added to the inch the dots become a line. An ordinary microscope which magnifies 300 times can, therefore, distinguish 60,000 dots to the inch. Under such an instrument a red blood corpuscle, of which 3,200 may be distinguished to the inch is a rather large object and a yeast cell (3000 to the inch) slightly larger. Diatoms (30,000 to the inch) are easily visible and even the tiny spores of certain infusoria among the smallest of living things (60,000 to the inch) are within the range. This was one of the frontiers of our ocular advance. Better microscopes were then made and the number of dots visible to the inch increased. The limit of microscopic power is set at about 150,000 dots to the inch because, when the thing seen becomes that small, light bends around it and it becomes invisible.

Our scientists, however, were not content to stop at that point, but they invented what is known as the ultra-microscope which acts upon the same principle as that by which a sun-beam detects a mote. The size of those motes is supposed to be approximately 200,000 to the inch, beyond the power of the most powerful microscope and yet perceptible. The ultra-microscope is able to detect the presence of so tiny a particle as would number a million to the inch. One would suppose that by this time we would have passed the size of molecules and have reached that of atoms for a millionth of an inch is inconceivably small. Indeed, in the "Brownian movement" the ultra-microscope reveals to us the zigzag dance of tiny particles bombarded by the molecules of the liquid in which they are suspended.

Yet smaller things are known. Thomson tells us that a grain of indigo will color a ton of water and a grain of musk will scent a room for years losing less than a millionth of its mass per year. Each is possible because of the emission of almost infinitely small particles. The thinness to which gold-leaf may be beaten is equally astonishing for the record shows that gold has been beaten to such thinness that 367,000 gold leaves may be laid one upon another before they would reach an inch in thickness. The method used in this calculation is unassailable. A little cube of gold is measured and the surface of the beaten leaf is measured and the mathematician does the rest. But we are acquainted with something a great deal thinner than the thinnest gold leaf. What child is there who has not blown his soap bubble? A similar calculation shows that the thickness of the dark part of the soap bubble is such that the thinnest part may be stated on a basis of three million to an inch. Yet this is not the limit, for a drop of oil spread over a definite surface and detected by the sprinkling of powder shows that its film is only a fifty-millionth of an inch in thickness. Now as this film must be at least two molecules thick we may say that a molecule is not larger than one one-hundred-millionth of an inch. This is, of course, inconceivably small. As we found in the heavens that we could no longer measure its distances in miles but required a light-year for our unit, so, as we begin our journey into the infinitely small, we find an inch too large as our measuring rod. Therefore we adopt the millimetre, of which there are twenty-five to the inch and the micron of which there are twenty-five thousand to the inch, and the micro-millimetre, of which there are twenty-five million to the inch, and we find, therefore, that our molecule is approximately one-fourth of a micro-millimetre in size and our atom three or four times smaller.

There is another pathway whereby the infinitely little may be approached. It traverses the realm of radiation in the ether. These radiations which are the same in kind but vary in wave length are known to us by various names. The wave length of wireless waves, many of which are used by our radio broadcasting stations, vary in length from many miles to about 100 inches. Then come the Hertzian waves whose wave lengths vary from 100 inches to one-fifth of an inch. Between the shortest Hertzian wave, approximately five to the inch, and the longest of the next series, the infra-red, 77 to the inch, is a gap which will doubtless be bridged shortly. The infra-red waves vary from 77 to the inch down to 35,000 to the inch. There the light waves begin, first the deep red and then on through orange, yellow, green, blue, indigo and violet down to 71,000 in the inch. Then the ultra violet, often referred to as the chemical rays or actinic rays begin with 71,000 to the inch on down to 1,000,000 to the inch. There then appears a slight unbridged gap. X-rays then begin, including wave lengths from 21,000,000 to the inch to about 256,000,000 to the inch. They merge into the gamma rays which vary from 256,000,000 to the inch up to 2,546,000,000 to the inch. Between the gamma rays and the recently discovered Milliken rays is an unbridged gap. The Milliken rays vary from approximately 384,000,-

000,000 to the inch up to approximately 641,000,000,000 to the inch. Doubtless beyond the Milliken rays lie an infinitude of undetected vibrations.

The reader will note with interest that the wave lengths

CONDENSED TABLE OF ETHEREAL WAVES IN OCTAVES

	Wave Length	Octaves	Wireless Tel.		Wave Length	Octaves	
Wave Lengths in Meters (M)	25600		Arbitrary starting point	Wave Lengths in Microns (μ) (μ = mm/1000)	348 190	27	Longest heat waves
	12800	1	Trans-ocean		95	28	
	6400	2			47	29	
	3200	3	Used by large ships		24	30	Infra-red
	1600	4			12	31	
	800	5	Used by small ships		6	32	Radiation
	400	6			3	33	
	200	7	Broadcasting and amateurs		1.5	34	
	100	8			0.75	35	Shortest heat waves & extreme vis red
	50	9	Longest Hertzian waves chiefly used by Hertz in his classical experimental work	Wave Lengths in Angstroms (A) (A = μ/10000)	3750 6700/3900	36	Visible Light
	25	10			3000 1875	37	Danger to eye begins here and increases with shorter waves
	12.5	11			937	38	
	6.25	12			468	39	Ultra-violet radiation
	3.125	13			234	40	
	1.56	14			117	41	
Wave Lengths in Millimeters (mm = M/1000)	781	15			58	42	
	390	16	Hertzian		29	43	
	195	17	Radiation		14.5	44	First measured X rays
	97	18			7.25	45	
	48	19			3.6	46	
	24	20			1.8	47	X Rays
	12	21			0.9	48	
	6	22			0.46	49	
	3	23	Shortest waves measured by Rhigi		0.23	50	
	1.5	24	Produced and measured by Nichols and Tear in 1922.		0.115	51	
	0.76	25			0.057	52	Gamma Rays.
	0.38	26	Shortest Hertzian waves		0.028	53	and shorter

THE ENTIRE KNOWN GAMUT
OF ETHER WAVES

Thanks to Dr. Millikan, the following data must now be added under the right hand column: "0.0004 A to 0.00067 A—*Cosmic or Millikan Rays.*" (Courtesy of Scientific American.)

of the shortest X-rays and of the longest gamma rays are about the "size" of a molecule, which, as we have already found out, is as empty as a solar system. The great penetrating power of X-rays, the still greater penetrating power of gamma rays and the extreme penetrating power of the Milliken rays may be attributed to their diminutive "size" enabling them with ease to pass through the open spaces of molecules and atoms.

Now, if this were the end of the matter it would be wonderful enough for we feel that same sense of infinity in contemplating the atom that we felt when, stationed upon our remotest star, we looked out over the universe of universes. But it is really only the beginning of wonders.

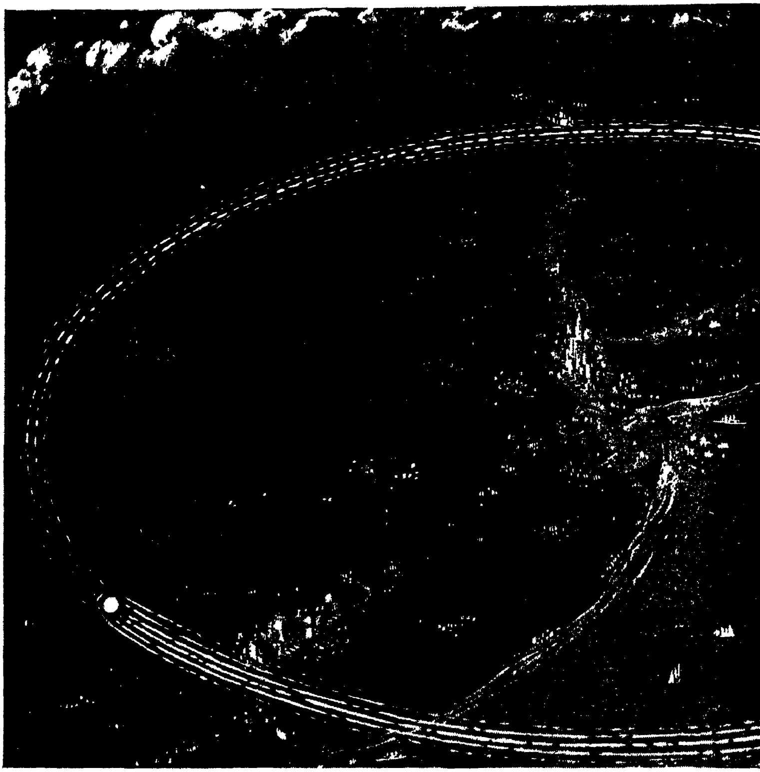
Again we start with the commonplace, the simple candle-flame and electroscope. An electroscope is a little instrument by which two gold leaves are connected with a wire supplying electricity to them. When the wire is electrified, so also are the leaves, and they immediately separate. After so long a while they will collapse, thus showing that the air which connects them is a conductor—though a poor one—of electricity.

But now, if, while the leaves are separated, we bring near them a candle flame, they will at once collapse, showing that the flame has supplied something to the air that increases its conductivity, which may be transferred and is not, therefore, dependent upon the presence or heat of the flame. Additional experiments show that all incandescent metals have the same quality. The mind of the experimenter at once concludes that this conductivity is in reality, particles of something which have been added to the air by the incandescent metal, and this conclusion is reinforced when he discovers that if the gas is made to pass through a space through which also an electric current is passing it loses its conductivity. This points to the electrical nature of the particles. The process by which the atmosphere or any other gas is made a conductor of electricity is called ionisation and the particles are called ions. We find that they are of two kinds, positive and negative—as is electricity itself. Of these like repel and unlike attract. The positive corpuscles are identical with protons, of which we shall speak later, and the negative particles are often called negative corpuscles or electrons. It is well to memorize these terms. These little negative corpuscles of electricity are quite the most interesting things for their size in the universe. They seem to be tiny particles of electricity which are expelled in enormous numbers at an unthinkable speed from glowing metals and incandescent gases. The flow of particles is increased as the atmospheric pressure is decreased, and as the temperature is raised. But we are astonished to learn that when metals are subjected to sunlight the same process takes place. In this case it is believed that ultra-violet rays are the chief excitant. Now what are these corpuscles, or negative ions? Are they as small as molecules or atoms? Have we found our microscope wherewith we may read the letters of the alphabet of the universe of God?

Heat a wire in a bulb from which the air can be exhausted. Place a metal plate just above the wire and connect it with an electrometer. Turn on the current. As the wires heat and before the air is exhausted the plate shows a charge of positive electricity. When the wire is white hot and the air exhausted from the bulb, the plate shows a negative charge. If a powerful magnet is brought near this stream of particles charging the plate it will be seen that some of the particles or rays are easily deflected from their course, others with great difficulty and in an opposite direction and a third part not at all. The first are the beta (negative) corpuscles, the second the alpha (positive) ions and the third are not particles but gamma rays, a species of light whose wave length is shorter even than that of X-rays. It has been a task of the physicists to measure the speed of these particles to obtain their mass and to weigh them in the balance. Through careful processes and by means of delicately beautiful experiments it has been learned that the speed of an electron varies from 10,000 miles per second, almost up to that of light itself, and that its mass is approximately 1,850 times less than the mass of an atom of hydrogen, the smallest and lightest of the atoms. We have magnified our drop of water in finding them to the size of the earth and our atom seems as large as a house while the corpuscles or electrons are as large as golf balls. Such is "solid" matter which seemed so continuous to the naked eye. Yet they are parts of matter! They are all alike in size and quality and conduct. Between them there is no observable difference in any respect. They have remarkable chemical properties altering the color of some substances. They produce heat. They push delicately balanced objects by their impact. They produce X-rays in bodies they strike. Are they the "bricks of the universe"? Are they the notes of the song of God?

So far has our tiny candle-flame led us into the night of our ignorance. And strangest of all, these negative corpusles which we shall now call electrons seem to be revolving around a central nucleus, our proton, thus forming a miniature solar system, the slowest of them moving at a speed equal to that of our earth around the sun. They seem to be arranged in circles. The simplest and lightest of all atoms, that of hydrogen, consists of a simple nucleus (one proton) charged positively to balance exactly its single electron, negatively charged. Yet the central nucleus of positive electricity is 1,850 times greater in mass than the electron. Its motion is much slower. Recalling that a gramme of hydrogen weighs one four hundred and fifty third of a pound we find that an atom of hydrogen weighs a million-millionth of a million-millionth of a gramme and a half. It requires 1,850 electrons to equal one hydrogen atom in size but they are probably of the same weight. The diameter of a hydrogen atom is estimated as approximately one three hundred millionth of an inch. The electron revolves around its nucleus seven thousand million times in a millionth of a second. Than an electron the earth is ten thousand trillion times larger. The dimensions of an electron are perhaps a hundred thousandth to a billionth the dimensions of the orbit. Multiply its orbit by its mass and the result by its velocity and you get "h," the quantum of Planck, the ultimate energy unit of the universe. So far the hydrogen atom.

The interior of the atom is a thing to be marvelled at. To contemplate the heaven of heavens is calculated to stretch the mind permanently. To contemplate the heavens within the heaven it is necessary for one to go just as far by imagination. Of course, all statements of physicists at the present stage of development of atomic knowledge are subject to correction, but speaking broadly the latest investigations indicate that the atom is not unlike our own solar system, that the distances separating the electrons from the central nucleus are comparable to the distances separating our planets from the central sun. Just as our sun is positively charged and our earth negatively charged (up to about one billion volts,) so the nucleus is positively charged and the electron negatively charged. In the atoms, in its normal state, the regular charge of the electron exactly balances the positive charge of the nucleus. The dimensions of the electron are perhaps one billionth of the dimensions of the entire atom which, latter, is bounded by the circumference of the orbit of the outermost electrons. It is interesting to note that the volume of all the planets of our solar system is estimated to be about one billionth of the volume of the solar system. In short, the atom is an empty thing, fully as empty as our solar system. A capable physicist uses this illustration: "If in the atom of helium we take the nucleus as represented by a large pea its planetary electrons



THE SPREAD OF ELECTRONS IN THE SIMPLE HYDROGEN ATOM

If a single atom of hydrogen gas were magnified some two billion million times, the central nucleus of it would be represented by a little particle the size of a buckshot on top of the Woolworth Building. Around this would revolve a forty-foot balloon representing the electron, the orbit of which would reach just beyond Philadelphia on one side and a little short of Albany on the other. (Courtesy of Popular Radio.)

may be represented as two rather smaller peas revolving around it, at a distance of a quarter of a mile." The amount of atomic energy has been definitely calculated. It is prodigious beyond the wildest dream of imagination.

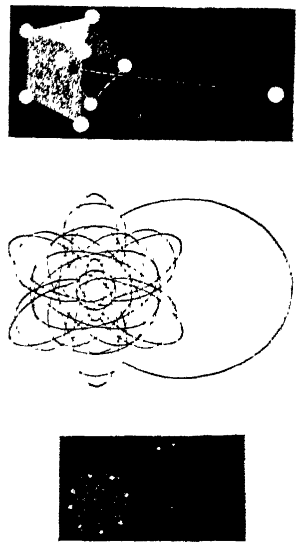
Competent physicists state that if we could transmute the atomic-power contained in one pint of water the energy so liberated would be sufficient to propel the Mauretania across the Atlantic and back at full speed.

Now when we learn that the nucleus of other elements from helium (the next lightest) to uranium, the heaviest, increase in their positive charge one unit from element to element we recall the monads of Prout, the triads of Dobereiner, the octaves of Newlands and the Periodic Law of Mendeleef. The nuclei of other elements would seem to be built of hydrogen nuclei and electrons. They differ thus from electrons which always seem to be alike and to have the same electric charge and the same mass. Inasmuch as the positive electric charge on the nucleus of a hydrogen atom exactly balances the negative charge on its electron, when the atom loses its electron it becomes positively charged. Helium is the second element in the table, its atomic weight is four (4) and its nucleus is charged with twice as much positive electricity. It seems, therefore, to have but two electrons although consisting of four "condensed" hydrogen atoms. Have the other two been transformed into energy and is this the explanation of the decimal difference in atomic weight? If so, this would seem to explain the fact that helium has a specific gravity of only twice that of hydrogen, although their ratios of atomic weights are as four to one. (H. 1.008, He. 4.) The nucleus of the fourth element has four times and the ninety second, ninety-two times as much. Similarly, an electron revolving around the nucleus is added with each element in the table. Helium has two electrons and uranium ninety-two. The atomic weight of uranium being 238, a normal uranium atom would consist of 238 hydrogen atoms, i. e. 238 hydrogen nuclei, positively charged protons, and 238 electrons negatively charged. Its number in the periodic table being 92, ninety-two of these electrons would revolve around the nucleus, the remaining 146 being packed with the 238 protons into the nucleus. Thus normally the atom is neutral since the charges of electricity exactly balance. If for any reason an electron is lost the atom becomes positively charged. If one is added it becomes negatively charged. While the arrangement of the electrons in atoms other than hydrogen is not known exactly it is commonly believed among physicists that they revolve around the central nucleus not unlike planets around a central sun. Some chemists believe that there are always eight electrons in the outer circle but otherwise that each circle increases in number of electrons. One of the most interesting of speculations has to do with spectra. As previously described white light is spread into a band when passed through a prism. Light from glowing gases is of two kinds. One shows a continuous band of colors like a rainbow and is supposed to result from the interference of radiating particles; the other shows sharp lines of individual colors and is believed to be of atomic origin. When white light passes through them, gases that are not glowing absorb the same colors they emit. This is the absorption spectrum, the former the emission spectrum of a gas. The electrons in the outer ring of the atom seem to have most to do with the spectrum (as with chemical properties) while X-rays seem to come from the electrons of the inner rings and radio-activity, to which we are almost come, from the nucleus. Further speculation suggests that when an atom contracts its orbit, thus losing energy, that energy is transmitted through the surrounding ether as light. When energy from the ether is absorbed by the electron it leaps to an enlarged orbit. But in all these speculations we must remember that we are dealing with objects as far from us as the outer universes.

The story of the discovery of radio activity as a property of matter comparable to heat, light, magnetism, and electricity is perhaps the most fascinating chapter in modern chemistry. Of these properties earliest man knew heat and light and was not Theophrastus, who first rubbed a piece of amber and noticed the magnetism thereby developed, the first known physicist? Electricity came to us later and now has come radio-activity.

It is an ancient saying that history has long roots and so we are not surprised to learn that the story of radio-activity goes back a long way. One day, while Professor Roentgen was experimenting with vacuum tubes, he was unexpectedly called from his laboratory and by chance placed a glowing bulb upon a book which he had been studying. In this book he had left a metal key of the ancient flat type to mark the place where he had been reading. By chance, also, under the book was a photographic plate in its holder. After a while, much to his astonishment, in developing a number of plates, he discovered the outline of the key and the puzzle of its presence could only be explained by remembering the conditions under which the picture had been taken. Thus, accidentally, was the remarkable discovery of X-rays made. These X-rays are closely associated in some way with the phosphorescence in a Crookes-tube. Their remarkable physical, chemical, and physiological properties are well known. An experimenter, named Leonard, devised a little aluminum window through which these rays could escape from the tube in which they are produced into the outer world and he found that after their escape they still manifested the same powers and properties. Another experimenter, Niewenglowski, resolved to determine whether the ability to take photographs did not inhere in other phosphorescent substances. He found that this was true of calcium sulphide and others. Thus the physicists had reached the point where they knew that the rays of certain substances, after they had been exposed to sun-light and had become phosphorescent retained for a certain period the power to penetrate "solid" matter.

We are now come to the discovery of radio-activity itself. Henri Becquerel, experimenting, also like Niewenglowski, with phosphorescent substances, one day placed some uranium salt over a photographic plate—uranium that had not been exposed to the sun-light—and found that it also possessed the property of emitting penetrating rays, "even when it had been kept completely sheltered from any previous exposure to light." Here, then, was a substance which could manufacture light and that light was of such a nature that it could penetrate "solid" matter. This was a



DIFFERENT IDEAS ABOUT THE INWARDNESS OF THE ATOM.

In the center is a diagram of a copper atom, which has twenty-nine electrons, each one moving in its orbit with a speed probably greater than 39,000 miles a second. At the top is a representation of the "static" idea of the sodium atom according to the theory of scientists holding that the electrons occupy relatively fixed positions. At the bottom is the diagram of the Bohr "dynamic" theory of the atom. The outermost electron has a variable orbit, as shown, and corresponds to the most distant atom in the top diagram. Remember that any atom with all its system of electrons, is so small that there are more than two quadrillions of them on the surface of an ordinary pinhead. (Courtesy of Literary Digest and Popular Radio.)

new property of matter and one that has proved to be of fascinating interest and tremendous importance to mankind. M. Pierre Curie and his wife, Madame Sklodowska Curie, continued the investigation by experimenting with pitchblende, the mother substance of uranium. They first noticed that some specimens of pitchblende were something like four times as radio-active as others, and from this they concluded that, unevenly distributed in the pitchblende, was some other substance which caused the radioactivity. By rigid analysis they proceeded to eliminate and to collect that substance until at last they were able to announce that "they had been able to prove that it is possible, by the methods of ordinary chemical analysis to abstract from pitchblende substances of which the radio-activity is in the neighborhood of one hundred thousand times greater than that of metallic uranium." To the principal one of these substances the name of radium was given. This took its place in group two of the table of elements. It is interesting to note that the proportion of radium in an ordinary specimen of pitchblende is approximately one in ten million—a smaller proportion than that of gold in sea-water. Since the original discovery, it has been found possible to still further refine the radium salts until they become something like one and one-third million times as radio-active as uranium. Radium is perhaps the most valuable and priceless substance on earth.

Immediately upon its discovery, the rays emitted from radio-active substances became the subject of careful study in the great physical and chemical laboratories of the world. Their power to take photographs through "solid" substances, to create phosphorescence in many substances, to produce remarkable physiological, electrical, chemical and physical effects were immediately noted and the inquiry was prosecuted until the physicists were able to answer with comparative certainty the questions: What are these rays?

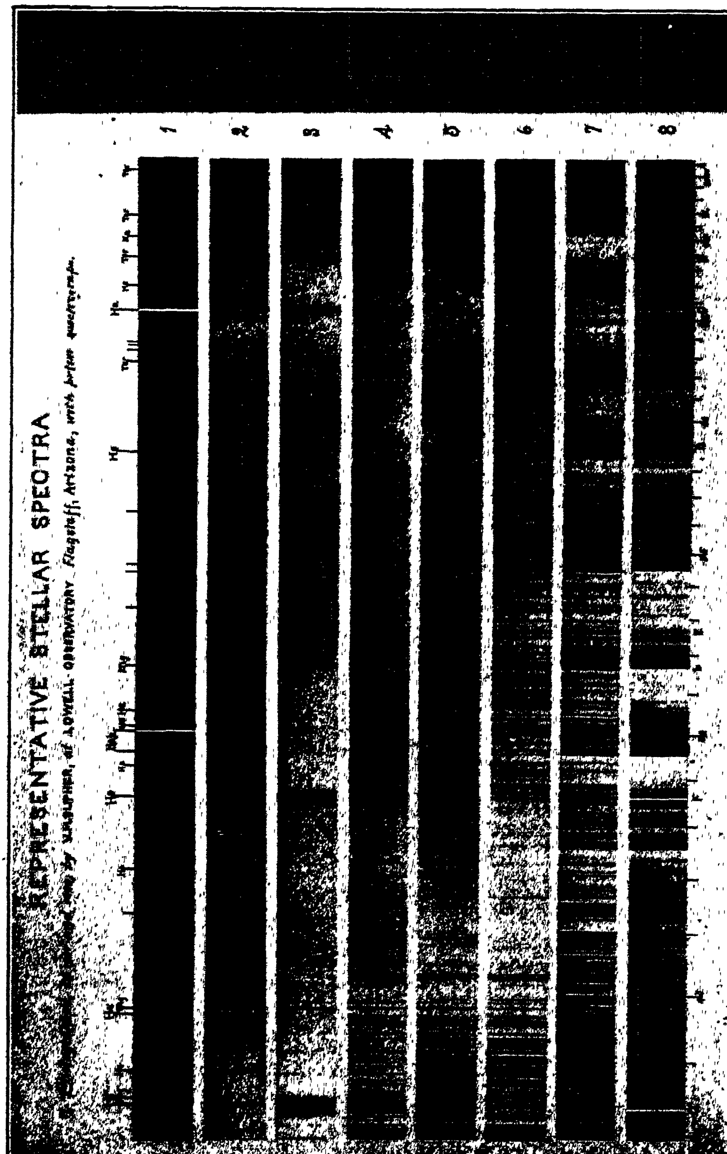
The remarkable part of it all is that the emissions from radio-active substances seem to be identical with those of incandescent metals. They consist of three classes known as alpha, beta and gamma rays. The alpha rays consist of particles of positively charged electricity; the beta rays consist of particles of negatively charged electricity, and the gamma rays consist of light-waves of a degree of shortness greater than those even of X-rays. A powerful magnet applied to the stream of emitted particles tells the same story. The alpha rays are only deflected with great difficulty and in an opposite direction from the beta rays which are easily deflected, and the gamma rays cannot be deflected at all by the most powerful currents known. The thing that happens to the radium itself is most remarkable. First of all it seems to be almost an eternal source of heat and light. As Duncan has put it, it is quite as if a man had discovered in the ground a red-hot stove that continued to give forth heat and light without diminution through the ages. The power thus emitted is incalculable.

Radio-activity seems to be largely concerned with the nucleus of the atom. The uranium atom, e. g., seems to be composed of a nucleus of two hundred and thirty-eight protons and one hundred and forty-six electrons, around which ninety-two electrons revolve. In the breakup of the uranium atom by radio-activity, the alpha and beta particles seem to come from the nucleus, which thus consists of both positive and negative electricity. As they leave the atom they change its constitution. As stated before, each atom has its atomic number, indicated by the number of its revolving electrons which is equalled by the positive charge of the nucleus. As these change in number, the substance itself changes and its chemical and physical properties change, its atomic weight changes, and its place in the periodic table changes, all of which is merely a matter of mathematics as the atoms of all substances are essentially the same, their various properties depending simply upon the number and arrangement of the two primal elements, positive and negative electricity, the proton and electron. So, to our amazement, we find the dream of the mediaeval alchemists coming true. We are face to face with the transmutation of the elements. We have in our hand the wand of Hermes that, by its touch, turned all things into gold. Uranium in the course of years changes into what is known as uranium X and its atomic weight descends from 238 to 236. The emission of alpha and beta particles still further changes it into radium whose atomic weight is 234. This process, continued, gives us radium emanation and helium, and still further continued gives us polonium, whose atomic weight is 210, and lead whose weight is 206. And now even as these words are written come Doctors Smits and Karssen, of the University of Amsterdam, backed by the Scientific American, relating the story of how they have at last succeeded in changing pure lead into mercury and thallium. Thus the transmutation of the elements stands revealed, and the age-long dream of the alchemists comes true.

Was there ever anything more utterly fascinating discovered by man? All things are one—or, at least, two. As it was with our solar system and the vast universe of which it is a part, so it is in the universe of the infinitely little. There is no essential difference in anything. The grain of dust merges into the grain of sand and that into the meteor and that into the asteroid and that into the moon and that into the planet and that into the sun and that into the multiple star system and star cluster, star swarm, and universe, and ultra universe. And, as we proceed in the other direction, our grain of dust becomes the mote, then the molecule, then the atom, then the electron, and then the——?

Now it is a singular thing that the brightest ray of illumination on this subject comes to us from the stars. We have before seen that a star is not different from a poker in respect of its heat history. We have seen that there are two classes of red stars in the skies, the vast nebulous, giant, red sun, gradually growing hotter and hotter by the contraction and collisions of unnumbered planetesimals, and the dense, dwarf red sun which has condensed as it has cooled and is passing on into the night and chill of death. Between them are the brighter red suns, then the yellow suns, then the white suns, then the blue-white suns, and then, in descending series, the white, yellow, red to deep red again.

The study of these changes in the stars made with that marvelous instrument, the spectroscope, has revealed certain facts which are of astounding interest, for it has been shown that the constitution of the stars depends upon their temperature. We have before described the work of the spectroscope—how, when white light is passed through a prism it is spread out into a band like the rainbow, running through all the colors, violet, indigo, blue, green, yellow, orange and red. When this light comes from a glowing solid or liquid or gas under heavy pressure, the spectrum is one continuous ribbon. If it comes from a glowing gas not under heavy pressure, instead of being continuous it consists of a few clear cut lines of color. If it passes through gases that are cold the gases seem to absorb the same light that they emit when glowing, and instead of the bright lines, the lines are dark. Thus each substance by the lines that it shows in the spectrum is revealed as to its chemical composition, not only, but as to its condition of temperature. Now on earth we know,



(From *The Evolution of Worlds*, by Lowell. Courtesy of MacMillan Co.)

broadly speaking, three degrees of intense heat, the temperature of the flame, the temperature of the arc, and the temperature of the electric spark of the highest possible potential. It was Lockyer who used to say, "For twenty years I longed for an incandescent bottle in which to store what the center of the spark produces. The stars have provided it." Now perhaps one of the most astonishing thing about spectra is that they extend beyond violet and within the red into regions where the human eye cannot see but which the physicist has his way of exploring. For the photographer comes to his aid and we find that as the star or poker passes beyond white heat there develops an invisible spectrum beyond the violet, thus lengthening the spectrum.

So the astronomer reports that those stars which are hottest are gaseous and of the longest spectrum, and those that are coldest are least gaseous and of the shortest spectrum. But this is again only the beginning of wonders, for it was at once noticed that the gaseous stars which were of the highest temperature, the blue-white stars of which Zeta Puppis and Gamma Argus and Alnitam are examples, consist only of a few gases, the hotter the fewer, and those gases are hydrogen and helium, whose atoms are the lightest known, and asterium which as yet has not been discovered on earth. Now when we remember that hydrogen consists of a simple nucleus with one electron revolving around it and helium consists of four hydrogen atoms in what is quite evidently a most stable arrangement and that all other atoms of all other substances grow more and more complex as we ascend the periodic table, we can see the vast significance of this fact. It is one of the greatest of discoveries of mankind.

As we descend the temperature scale of the stars we come to those stars of a medium temperature comparable to that of our electric spark of the highest potential. In them gases tend to disappear and to be replaced by metals as they appear to us on earth in a spark of high potential. As the temperature of the stars diminishes, one chemical element after another appears as we descend through the blue-white, the white, yellow and red suns. At the yellow we find stars like Arcturus and our own sun.

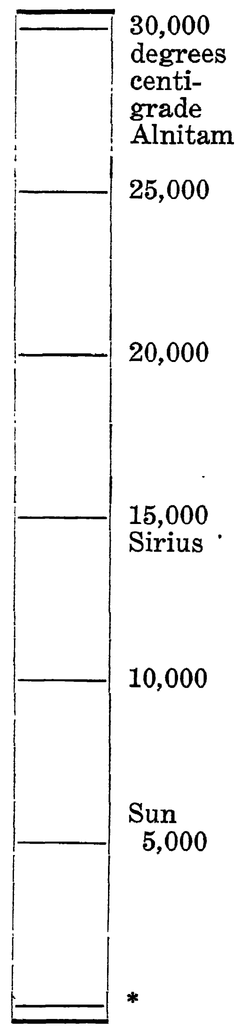
Furthermore, as the heat of the stars increases from that of our own sun upward we find various metals such as calcium, titanium, iron, appearing in states unknown on earth, characterized by astronomers as proto-calcium, proto-titanium, and proto-iron. Nor does this end even with the hottest star for there we find hydrogen and proto-hydrogen predominant, but we find lines of proto-magnesium and proto-calcium mingled with helium and asterium. Evidently that has happened in heaven which happened on earth, the application of heat has reduced the complex to the simple. Even here our earthly furnaces can melt one-fourth of a million different substances into a few elements and there even this remaining complexity disappears and we see the atoms themselves resolved into simpler and simpler formations—until, at last, we arrive at helium and hydrogen and proto-hydrogen, at positive and negative electricity.

It is most interesting to note that the order of appearance of the elements as we descend the scale of heat from the blue-white stars reveals that they are what we shall find later to be the "life-elements." We are almost come to the story of life itself and when we do we shall find that the elements which constitute the human body are those which also constitute the earth, the air, and sea-water. Their names are familiar to us: hydrogen, nitrogen, oxygen, carbon, sodium, magnesium, calcium, potassium, chlorine, bromine and sulphur. Thus the first-born elements of the stars are those that are fundamental to our own life processes. This again is one of those significant discoveries, too important to be over-valued.

And in this vast celestial thermometer what space does the period of temperature occupied by life on earth embrace? The hottest known stars are estimated to have a surface temperature of approximately 30,000 degrees centigrade. Thence they descend until we find Sirius at perhaps 15,000 degrees centigrade and Arcturus and our own sun at between 5,000 and 10,000 degrees centigrade. From this we descend the enormous distance to 212 degrees Farenheit (100 degrees Centigrade) when water boils and between that point and 32 degrees Farenheit, which is something like a second in a century, life on earth begins and ends.

Through all of the countless billions of years during which the temperature of a star like Alnitam is descending to the temperature of the earth and through all the multitudinous changes that take place, first in its atoms, then in its molecules, then in its compounds which grow more and more complex, there runs a perfect thread of exquisite evolution. Shall we be surprised when we find the same process and powers at work during the one second that we find life occupies out of the whole century?

Celestial Thermometer of Stellar temperatures



* This line is proportionately too thick to represent the temperatures (0-100 degrees C) at which life is possible on earth.

As we face this tiny but fascinating vista of the infinitely little, let us with Fournier D'Albe, for a moment release our imagination. Let us remember that what seems to us large or small is so only relatively. Largeness, for example, is simply size in excess of our own body, of its ability to create or compass, and a similar measure applies to distance. Time is measured by the rotation of our earth or its revolution around the sun. In either direction, as we look from our present standpoint, we see infinity. As we go in one direction our earth becomes smaller and smaller until it is but a speck of dust in the infinite expanse of the heavens, but one electron of some lens-shaped substance of which there are multitudes of molecules and atoms comprising what we know of our universe. In the infinity beyond that universe there may be anything, any possibility of form and life. Perhaps above us and just as invisible as we are to an electron is a supra-universe, composed of unthinkable numbers of universes like ours. And as it is above, so may it not be within? Also, here at last, amid inconceivably swift motion, we reach imperturbable calm. In a particle so minute that it is a million times smaller than the most powerful ultra-microscope can detect we first find perpetual stability and strength. Alone among mountains, planets, suns, universes, it changes not from day to day. Here, in contemplation of the infinitely little, we face the eternal. Fire cannot alter its peace, not even the fires of those hells of flame, the stars. No moth nor rust may corrupt its surface nor may any thief break through and steal. Death is to it an utter stranger. No power known to man can affect its eternal sameness or alter its immutable will. No vicissitudes of heat or cold, of life or death, of physics or chemistry can modify the ordered peace of its life. So ethereal as to border upon the spiritual world, it alone changes not in a universe of change. In it have we, then reached the Ultimate?

But suppose that tonight while you sleep the earth and all things on it and about it, including yourself, were to be reduced ten thousand trillion times in size which is the amount by which the world is larger than an electron. Suppose that motions, sizes, proportions, time, were all similarly reduced. Would you be able to tell the difference? Quite evidently not. Is it not then possible that, relatively speaking, the earth is an electron in some supra-world? And is it not conceivable that our electron is an earth; that once arrived on it we should find things not unlike what they are here where we also have our sun and vast open spaces around us and other stars, by the million, in our sky. If the earth were reduced to the size of a billiard ball we know that the inequalities of its surface such as mountains, and sea bottoms, would be imperceptible, for its surface would be smoother than that of a billiard ball. If with some mighty microscope of God we could magnify an electron until it became the size of the earth, is it utterly unthinkable to suppose that it, in turn, might be composed of 250,000 different substances of some ninety-two "elements" with their molecules and electrons? Electrons—and they in turn? Have we gone any further than our three hundred and seventy-five thousand light years took us in "our" universe? Are we face to face with Infinity? Yes.

There is no large or small. Everything is relative. As there may be not one or two but billions of supra-universes above ours, so there may be billions of infra-universes below. We can not think further, so we call it Infinity.

TO GOD, THE SUN

Amid the anthems of the marvelous matutinal choir,
O Shamash, hear these notes of praise.
For whom do all things sing as for Thee?
Scarcely has the sky reddened in the West,
E'er the call of the cardinal
Summons the whole world to worship.
Earth prays as the throstles sing.
The scarlet tanager pours forth his soul in adoration.
The flicker calls to his mate to rejoice,
And all the hopes of earth are in the robin's song.
A thousand warblers wake
When the whistle of the quail is heard.
And all loves that were lost are found
Again in the words of the wood-dove.
So, along the whole Atlantic seaboard,
They greet thy rising,
And ever before thee, on thy way,
Lies a pathway of song.
Over the mighty Appalachian hills
Voice after voice catches up the anthem
Upon thine approach; on over
The valley of the Father of waters;
On and upward until the vast Rockies are surmounted
And the silver voices of the choir melt
Into the unfathomable bass of the Pacific.
And then, in her turn,
Asia offers her stanza,
And Australia and Europe,
Each continent in its place,
When they know that thy footsteps are nigh.
Ever does the west furnish its myriad voices,
As thy choir awakes before thy coming.
It is the eternal morning song,
The matins that never cease,
Nor is there ever a moment, in all thy days,
When this everlasting spring-chant
Ascends not into thine ears.
And we who may not pass with thee
In thy swift journey through the heavens,
Hear, at the morning hour, thy woodchoir,
As they catch the notes, coming from the east,
And voice them ever westward.
So would we join them in their praise
And sing as they, to God.
Truly.

CHAPTER V.

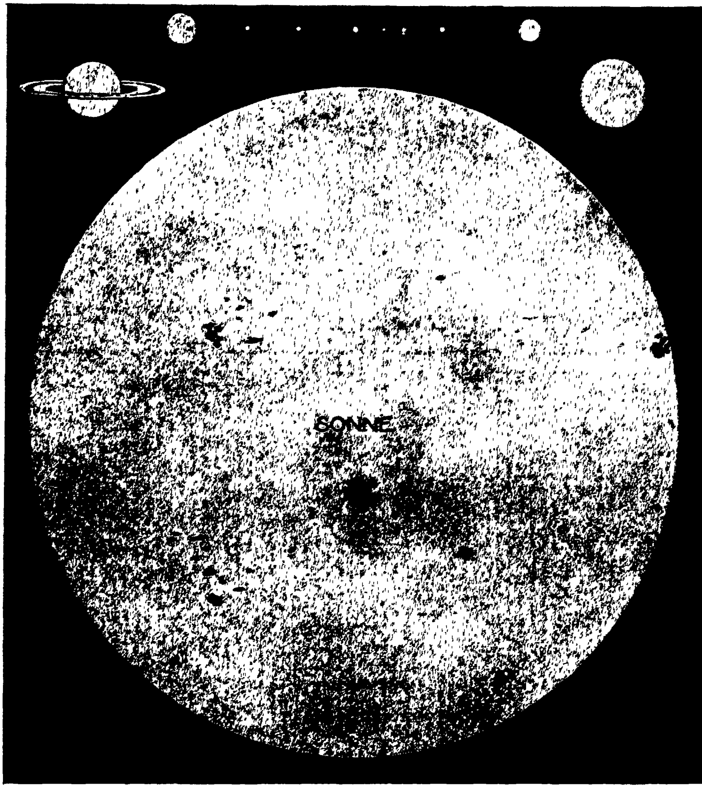
A HEARTH IN THE HEAVENS

Between the infinitely little and the infinitely large lies our universe and for us dwellers on the planet earth the center of life is the sun. About the sun revolves our tiny physical world, not only, but our intellectual world as well. From the beginning of the self-consciousness of mankind; from the earliest hour when human beings began to think about the world around them, the solar orb commanded the first place in their attention, their fear and their reverence. All the processes of earth-life were only too plainly dependent upon his will. Day and night, summer and winter, life and death, were all his to give or to withhold. He was the God of Gods and the Lord of Lords, so that all nations have founded their theologies upon him. When the first real scientists among the ancient Greeks began to consider the nature of the sun apart from his religious importance, their first step was to place him at a great distance and to magnify his size. Pythagoras taught that the sun must have a diameter of nearly 400 miles and must be distant from the earth approximately 45,000 miles. For teaching this, Anaxagoras, in the brilliant days of Pericles, was condemned to death and it was only by the intercession of the great Greek leader that his sentence was commuted to banishment. Another high light in the story of the discovery of the sun was the burning of Giordano Bruno at Rome in the year 1600 because he taught that the sun was a star.

This we now know him to be—just a good, average, modest little yellow star, located somewhat away from the center of the Milky Way. What he is to other intelligences on other planets, any one of 100,000,000 similar suns is to us. He is great only because he is near. Let us, following Flammarion, contemplate some of the astounding facts about our day-star revealed to us by our astronomers.

The unit in most discussions of solar matters is the distance between the center of the earth and the center of the sun. In round numbers it is 93,000,000 miles, a distance that, while it is covered by light in eight minutes and is, therefore, infinitesimal when compared to interstellar spaces, is, nevertheless, really so far that it is inconceivable to our minds. One can perhaps get an inadequate idea of what it means by imagining himself standing on the surface of the sun and looking for the earth. He would look in vain, for at such a distance the earth would be invisible to the naked eye. The determination of this distance is made in a number of ways, each of which tallies with the others. The transit of Venus, passing between the earth and the sun, which occurs in periods of slightly more than a century, was first suggested by Halley as an excellent method of arriving at the figure by processes of geometry. It was long ago noticed that the eclipses of the moons of Jupiter occurred just sixteen minutes later when the earth was in that part of its orbit most distant from that planet. It would thus take light sixteen minutes to traverse the long axis of the earth's orbit which is 186 million miles, and as the speed of light is known from other determinations, the distance of the sun could be easily calculated. The aberration of light offered another means of checking up on the figure which varies, of course, slightly on account of the ellipticity of the earth's orbit. By way of appreciation of just how far this 93,000,000 miles is one may reflect that an ordinary cannon ball, speeding at 1,064 feet per second would arrive at the sun in a little less than ten years. Sound would take nearly fourteen years. An express train, making 37 miles per hour, would take 266 years, and if one had an arm so long that he could sweep it through space and touch the sun he would not know it for 167 years. Even light, speeding at 186,000 miles per second, takes eight minutes to reach the earth from the sun.

And as the sun is distant, so is it also large. Measurements of the sun show that its diameter is just 108½ times larger than that of the earth and that if one million two hundred and fifty thousand earths were combined into one it would just equal the sun in size. The density of the earth is greater than that of the sun, and yet it would take something like 325,000 earths to weigh as much as the sun weighs, and even if all the planets and all of their satellites, with the asteroids and comets and meteor-swarms thrown in, were to be consolidated into one mass, the sun would still be 700 times larger than them all. Its diameter is approximately 866,000 miles which is a bit larger than Anaxagoras thought, who taught that it was about the size of the Peloponessus. Recalling that our moon is approximately 240,000 miles from the earth, it will be seen that were the earth in the center of the sun, the moon would be only a little more than half-way to its



The sun (with sun-spots) and eight planets in true size relations. Above, from left to right, are Saturn (with 3 rings and 9 satellites), Neptune (1 satellite), Mercury, Mars (2 satellites), Earth and Moon, Venus, Uranus (4 satellites), and Jupiter (9 satellites). From Kayser's *Abriss der Allgemeinen und Stratigraphischen Geologie*, 1922.

(Courtesy of John Wiley and Sons.)

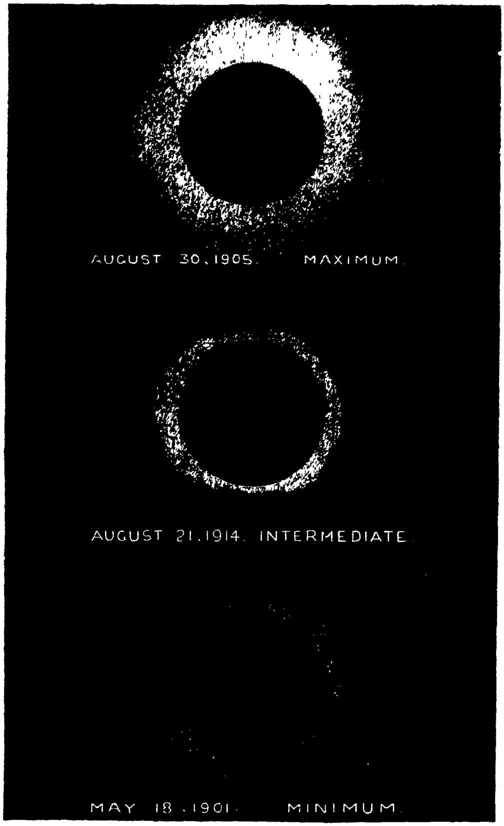
surface. To go around the circumference of this giant orb one must travel 2,700,000 miles. So much for its size.

And as it is large, so also is its heat terrific. It is sufficient in one hour to boil seven hundred thousand millions of cubic miles of ice. This heat to produce one second of which would require twelve quadrillions of tons of coal, in one second would melt a cylinder of ice three feet in diameter, stretching from the earth to the sun, and would turn it into steam in eight seconds. Expressed in another way, the heat continually received by the earth is equal to the work done by 543 billion steam engines, each of 400 horse power and each toiling constantly, and yet out of the total amount of energy radiated by the sun the earth only receives one part in two billion. One of the most astonishing facts discovered about the sun is that its heat varies from time to time by as much as 10%. The total amount received by the earth in one year would melt a layer of ice one hundred feet thick over the entire world.

And as is the heat, so also is the temperature of this gigantic monster. Water boils at 100 degrees centigrade; lead fuses at 325 degrees centigrade; silver melts at 945 degrees; gold at 1,245; iron at 1,500; platinum at 1,775. The temperature reached in our electric furnaces will run from 2,200 to 3,000. No heat above 4,000 degrees centigrade has been produced on earth. Announcement has just been made of the melting of carbon at a temperature of 6,300 degrees Fahrenheit. It is interesting to compare these figures with the surface temperature of the stars. Stars may roughly be divided into three classes. The first of these is the carbon stars, the big red giants, and the little red dwarfs whose temperature is between 3,000 and 4,000 degrees centigrade, the temperature of our electric furnaces. Examples of this type are Betelgeuse and Antares. Then come the metallic stars, generally yellow in color, temperature from 4,000 to 10,000 degrees centigrade, comprising such suns as Arcturus, Pollux, Capella, and our own sun. The third type are the hydrogen or white stars, composed of hydrogen, helium, asterium and the various "protos" whose temperature is from 10,000 to 30,000 degrees centigrade. In all of these cases the temperatures given are those of the radiating surfaces. The interior temperatures, of course, are not known. It is probable that they rise into the millions of degrees. It is believed that should a star reach a temperature above 12,000—30,000 degrees at the surface disintegration by radiation would set in and a nebula would be produced. Thus even intense temperature is self-compensating. It will be seen from the above that the temperature of our own sun is, on the surface, perhaps 8,000 degrees centigrade, the interior arising to inconceivable hotness. The marvel is that this great heat dynamo is not an affair of yesterday but has been functioning for millions of years, the best thought on the subject suggests hundreds of millions of years, and many of the wisest estimate the period at billions and even hundreds of billions of years. Each square yard of the sun's surface emits energy in excess of 75,000 horse-power perpetually.

How this enormous heat is produced over so long a period of time is, of course, the marvel of all astronomers. It cannot be by combustion for if the entire sun were of solid coal it would burn out in less than 5,000 years. No form of chemical combustion known to mankind could possibly produce such prolonged temperature. One of the most satisfactory explanations up to the present time is to be found in the contraction of the sun upon itself. Should this amount to as much as six miles per century it would account for the heat emitted by the sun. This is, of course, so small a proportion of the sun's diameter as to be impossible of detection within historic times. It would take five millions years for the sun to contract to one-half of its present size. This would take us back into Mesozoic days. It has been suggested that the fall of meteoric matter into the sun may have something to do with the maintenance of its heat. A meteor composed of solid anthracite falling into the sun from infinite space would generate 9,000 times as much heat as if it were burnt in pure oxygen. The fall of the earth into the sun would supply him heat for ninety-five years; Mercury could add only six and one-half years; Venus, eighty-four years; Mars, thirteen years; Jupiter, thirty-two thousand years; Saturn, ten thousand years; Uranus, sixteen hundred years; Neptune, nineteen hundred years. All the planets combined would, therefore, be able to furnish fuel for the solar system for about forty-five thousand years. Last, yet perhaps first in importance are the possibilities which lie in the discovery of radio-activity with respect to the sun's heat. If it be true, as many think, that the temperature of the sun is largely produced by radio-active substances, then we contemplate an indefinite prolongation of his life. And it must be added that each new discovery of science reminds us of some new possibility in nature not hitherto suspected. Perhaps all of the means indicated above have something to do with the way in which the solar heat is maintained. Perhaps there is some still more fundamental fact which a future astronomer will discover.

The pull of the sun, that is to say, the power of gravity exercised by it, is tremendous. Whereas on earth if a projectile should attain the velocity of seven miles per second it would leave our world forever, a projectile must be shot 378 miles per second in order to forsake the sun permanently. It is interesting to compare the power of the sun with that of the earth. The moon (or a stone at the



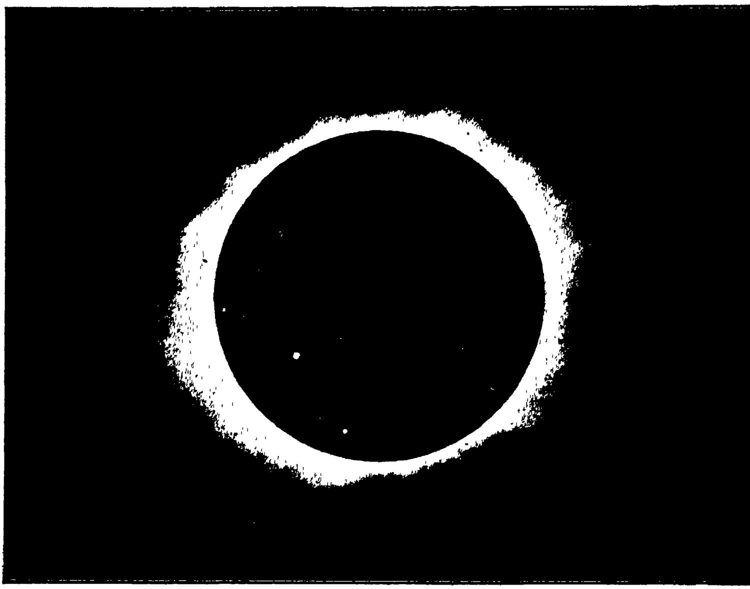
Three Typical forms of the Solar Corona. (From *The Vault of Heaven*, by Sir Richard Gregory, courtesy of Methuen and Company).

same distance) falls one-twentieth of an inch to the earth the first second. The same stone at the distance of the sun would fall nine (9) millionths of a millimeter (one-twenty-fifth of an inch). The earth (or a stone at the same distance) falls toward the sun 2.9 millimeters the first second. The muscles of the sun are 324,000 times stronger than those of the earth. Yet, in spite of the enormous radius of the sun and its lesser density, a hundred pound lad would weigh just 2,700 pounds on the sun. A running high-jumper who on earth could make, say, 7 feet, and on the moon about 40 feet, would on the sun rise only 3 inches. In fact, the human body would be flattened out by gravity on the surface of the sun like a leaf. The pendulum of an ordinary clock on the mantel would oscillate so rapidly there that it could not be counted.

The sun rotates on its axis, but not in equal time from equator to poles, the period varying from 25 to 38 days. The sun's equator is tilted about 7 degrees to the ecliptic. The period of rotation may be accurately estimated by the time that it takes the spots to pass from edge to edge. These sun spots are in themselves fascinating phenomena. They seem to be enormous, whirling masses of glowing gases, with tremendous currents moving upward and downward within them. Their intimate association with the aurora borealis and with magnetic storms on earth has been the subject of much speculation. Like most things in the universe they are periodic in their recurrence. They increase in frequency during a period of about 3½ years, and then for some 7½ years their frequency decreases. Oddly enough this period of eleven years coincides with the revolution of the double sun Alpha Centauri, our next door neighbor in space. Thus the comfort of the world as to temperature and other climatic conditions may be found to be dependent upon the relations of two stars some twenty-five millions of millions of miles away. Are then the stars as intimately associated with one another as the cells of the human body? Is the universe comparable to a living thing? Is every fragment of matter throughout its vast expanse intimately in touch with every other fragment? Our earth also feels the tug of this distant double sun, for his pull upon us, though he is over four light-years away, is something like a hundred million tons. Lo, neither man nor suns may live unto themselves nor die unto themselves.

The light of the sun is of course stupendous. It equals 600,000 full moons, and each particle of its surface is four times as bright as the brightest part of an electric arc. An electric light appears black by its side. Those who can comprehend an infinity of figures may be interested in knowing that its light represents 1,575,000,000,000,000,000 millions of candle power. Just one two-billionths of the light radiated by the sun reaches the earth.

As to the constitution of the sun, itself, our knowledge is naturally very limited. As one approaches the great orb from infinite space it ceases to be a mere point of light and slowly becomes a disk which grows larger and larger and brighter and brighter. When light years have changed into millions of miles, one reaches the light of that vast corona which surrounds the sun and which perhaps con-



THE CORONA

(From *Curiosities of the Sky*, by Serviss, courtesy of Harper and Brothers.)

sists of the minutest possible particles (shall we say electrons?) shot out from the great central mass of incandescent metals. This corona steadily thickens into a chromosphere composed largely of flaming hydrogen gas, scarlet in color, the same that is so beautifully visible during an eclipse. This chromosphere is perhaps from five to ten thousand miles in thickness. Beneath it is what the astronomers call the reversing layer, from five hundred to a thousand miles thick, consisting of gases, cooler than those beneath, through which the light of the sun, in passing, is reversed as to its spectroscopic lines, according to the law that when white light passes through cooler gases they absorb those rays which they would emit, if incandescent and under pressure. Beneath the reversing layer is the photosphere, a vast boiling ocean of white-hot metal vapors. This is the real surface of the sun and its temperature is almost 10,000 degrees centigrade. Indescribable storms sweep over its surface. In this vast caldron nothing is as it appears on earth. The metals are there in large part, such as iron, copper, aluminum. Approximately twenty-one elements are known to exist in the sun. Among these, iron, calcium, hydrogen and sodium are most clearly indicated. Oddly enough there is only slight evidence of the presence of oxygen and none of chlorine, nitrogen or gold. Is it possible that our ninety-two elements have been simplified into only a score?

What lies beneath the photosphere no one knows and few are found willing to hazard a guess. We know that the sun is not so dense as the earth, its density being approximately that of water. We know also that the pressure upon its interior must be inestimably heavy. There we imagine that the metals exist in a state unknown on earth, in the form of gases rendered super-solid under enormous pressure. Such is our Hearth in the Heavens, indescribably vast and glorious to us, but to the rest of the universe just a modest little yellow star among hundreds of millions. Three hundred of them would scarcely make a Betelgeuse and four hundred an Antares.

Yet who can find words wherewith adequately to describe the awful majesty of his angers? Who can picture to himself those vast eruptions rising to a height equal to the radius of the sun itself, over 400,000 miles, whose scarlet passions would consume our little earth and lick up our moon in its flames in the twinkling of an eye? Who can describe the ineffable glory of those fierce tornadoes called sun spots which open up the interior of the photosphere so that one can catch a glimpse of that sublime power which resides in fury unharnessed? Or who of us can attempt to tell the full story of what that tiny two-billionth part of light and heat which our little earth receives has meant to us; of how all life and motion, all vegetation and earthly verdure, all movement of wind and weather, all rippling of stream and river, all waves of lake and ocean, all pulsing of heart and artery, all brilliance of diamond and intellect, all muscles of steam and armature, all power of all sorts whatsoever—who can tell the full story of the dependence upon the sun of our earth which is but a tiny spark from his furnace? For after all, the

A SOLAR "PROMINENCE." PHOTOGRAPHED MAY 21, 1907

(From *Curiosities of the Sky*, by Serviss, courtesy of Harper and Brothers.)

world and its glory represent the gift of the sun. The wind bloweth whither he listeth. At his word the clouds are formed around the electrons that he sends forth, and pour out their floods. The mountains are the work of his fingers, chiselled by his rain-storms. The passions of the oceans are his also, and with his lightning he sends his messages to the ends of the heaven. When he wills he stores up his bright rays in peat and coal to comfort the coming generations or in diamonds to dazzle their eyes. He it is who loosens the frozen river or sends forth the equatorial storm upon its mission, and his is that silent power by which the chlorophyll of billions upon billions of leaves, gather together all the food for all living things. And such as he is to us are the other stars in the heavens to their own. Once they were believed to be fires fed by exhalations from the earth or lights hung up by gods in the sky. But reality is unspeakably more wonderful than the wildest dream of imagination, for we have found that all of the thousand million stars in the sky are suns, many of them vastly greater than ours. Perhaps it is this orientation which astronomy gives to its devotees that aids them in acquiring that fine sense of development and direction which is necessary to wisdom, and without which life is lost in a foggy maze. As we take up the story of our little planet we bear with us this consciousness of proportion as to time and space which, when it shall have been awakened in the minds of our leaders, especially our theologians and editors and statesmen, will constitute one of the finest benedictions that philosophical science can offer the human race.

THE LONG JOURNEY

The Sun will set gray and cold,
One by one the stars will come forth to comfort the winter night:
Sirius, King, brightest of all the sons of strength,
Who pursue the fair Pleiades in their flight to the west,
White Rigel too, and red-faced Betelgeuse,
Fair Castor with good Pollux by his side,
Rosy Aldebaran who will not leave his Hyades,
Capella, too, the yellow-haired and yon far planet Saturn, ringed in mystery.
These and a sweet host more, aye, vastly great,
Seen by my tulip-tree who lifts his head above the wood,
Canopus, monarch, king of suns, red-gloried, blazes, enormous, in the South.
And all we of the wood, who know that country wherefrom our gentle sun has but lately brought his own,
Wonder over that which was once in far-gone days, in the Land of the Sun's quit.
When all his little family were young,
Hot-hearted, ruddy-cheeked, with eyes aglow,
Hurrying by Sirius on our left, brilliantly dazzling in his then nearness,
And Canopus on our right, red-gloried, enormous, marvelous!
See how they have shrunk into little stars, whose names only they who love them call,
So many days, so long a way have we come!
But would I could see an hour of that wondrous time;
Know the youth of my earth, see her earliest face,
View her first offspring,
Learn what moods were hers in habit and in form, in the days of her childhood!
All this lies in the light beams, speeding ever into the infinite beyond.
And here under the Big Poplar, who sees so far,
I wonder whether some Eye, more wonderful even than his,
Catches the beams of the Past, till ages long dead live again,
Out, yonder, behind the Beyond,
Where that which was, is;
So far that Yesterday is Tomorrow.

CHAPTER VI.

OUR HOME IN THE HEAVENS

In all history there is nothing more fascinating than the tracing of the process of disillusionment through which mankind has been passing since it first came to consciousness of self and surroundings. Nothing, for example, could be plainer or more certain to an intelligent creature, not versed in astronomy, than the immovability of the earth. To early man the waves of the sea were ever restless, the forests bent before the storm, the clouds hurried hither and thither under orders of the gods, but the earth, itself, had not Jehovah laid its foundations so securely that it should not be moved forever? About it the sun, the moon and the stars circled their silent ways and only when the Lord laid earthquake-hands upon its pillars did it feel the faintest tremor. So mankind learned to speak of the eternal hills, of the immovable earth, of the motionless mountains.

Then came knowledge. We have already sketched the revolutionary discoveries. We have seen how the earth grew in size. Once it included only the valley of the Nile with its adjacent strip of fertile soil. The firmament rested upon mountains visible from Memphis or Thebes. The island of Crete was "behind the beyond." There is no evidence in all the stories of Homer that its author had ever been ten miles out of sight of the Greek islands and the coast of Asia Minor. So it was also in the Tigro-Euphrates valley, for the Fields of the Blessed were "at the mouth of the great rivers," the head of the Persian Gulf. It was a tiny little world and very solid and fixed which was the center of the universe to our ancestors.

How different is the reality! Could one imagine himself stationary in space along the pathway of the sun and his family he would witness what to mortal man would be the most sublime and appalling sight conceivable. A tiny point of light in the distance would grow into a brilliant star and then into a vast, flaming orb approaching the spectator at the unimaginable rate of twelve miles per second.

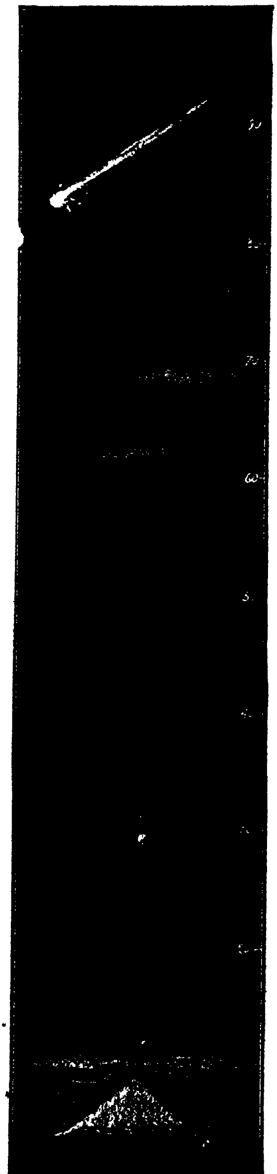
Eight smaller bodies, brilliant with the reflected light of the central sun, would be seen whirling around it at speeds varying from three to thirty-five miles per second. One of the number is our earth. While moving so swiftly through space, following the sun, she is whirling around him at a speed of eighteen miles per second and rotating on her own axis at a rate of 1,000 miles per hour measured at her equator. Nor are these three motions all. Like a dying top, spun by a school boy, she wobbles as she whirls and the very orbit that she pursues is unstable. Could one watch her motions long enough he would see that her orbit varies from almost a perfect circle to a marked ellipse though, of course, it is really a spiral and not an ellipse at all. Nor is her axis true and firmly set in its place but is tilted at varying angles to the path that she pursues. And even this is not all of the story. Her satellite, the moon, keeps tugging at her and each of the planets jerks her here and there. So is she tossed upon the sea of infinity by a thousand waves but ever hurries ceaselessly toward her destiny. The subject of a myriad varying influences (for we must remember that even the stars, to an infinitesimally small degree, influence her motions) she, nevertheless, has set her heart upon her lord and with him she speeds ever into the beyond. She is alive and athrob with mysterious magnetic influences which the skillful minds of men have not yet fathomed. For not one moment is she at rest. Not even her mountains are still. Not a stone upon her surface is quiet. Not a molecule, not an atom, not an electron but is hurrying ever onward toward something that is to be. Following her wake is another little world, her moon, whose diameter is slightly more than two thousand miles, whose surface area is about equal to that of the two Americas combined and whose weight is nevertheless as much as seventy-four quintillions of tons. The earth, herself, weighs eighty-one times as much, six sextillions of tons and her mighty lord whom she follows so constantly weighs some three hundred and twenty-four thousand times more than she, and is one million, two hundred and eighty thousand times as large.

Small though she is as compared with her sun, nevertheless as she approaches us her size becomes gigantic. In utter silence but with every fibre of her being aquiver she speeds by. All the power developed by a million Niagaras in a million years would not equal the energy expended by her in one second. Yet with his strong arm, the sun reaches out ninety-three million miles into space and draws her unto himself. Flammarion, whose treasure house of astronomical lore we herein rob at pleasure, tells us that if the hemisphere next to the sun were all one grass covered meadow and every blade of grass were a steel wire as strong as the wires of a piano binding her to the sun they would hardly equal the power of his grasp.

We note for a moment the principal motions of the earth. Most apparent of all is, of course, her rotation upon her axis which causes day and night. A person standing at the equator speeds with her approximately 1,000 miles per hour. Standing on her poles he is, practically motionless, with respect of rotation. The night is her shadow which is projected into space behind her like a vast cone to a distance of 744,000 miles. Into it the moon sometimes passes and is eclipsed. It is interesting to note that if the speed of rotation of the earth could be quickened seventeen times one would weigh nothing at the equator, for the centrifugal force would then exactly balance the force of gravitation. It is well known that there are 365¼ days in each year but perhaps not so well known that the earth rotates 366¼ times during that period. The extra rotation is, of course, necessary in order to offset a complete revolution around the sun. It is this motion of the earth that forms the basis of all measurements of time, which is chopped by mankind into so many periods of rotation or days and is combined with the period of revolution of the moon to form a moonth or month. And this again is quartered into weeks.

Second in importance to humankind is the motion of revolution around the sun. The earth's orbit, as stated above, is in the form of an ellipse, the sun being at one of the foci. When the earth is nearest to the sun, perihelion, it is three million miles nearer than when it is farthest away, aphelion. This makes a difference of about 1|15 in the amount of heat and light that she receives. But this is not the cause of summer and winter. The latter results from the fact that the earth does not sit upright in her orbit but is inclined from the perpendicular. At the present time this inclination is twenty-three degrees and twenty-seven minutes, but it, in turn, varies. The total amount of variation is two degrees and thirty-seven minutes. It can be easily seen that when the earth is tilted toward the sun her northern hemisphere receives the rays of the sun more directly than her southern. At present, the summer in the northern hemisphere occurs when the earth is farthest away from the sun. Thus the two influences counteract each other in part and, as a result, our summers are more moderate than those of the southern hemisphere, as also are our winters. The variation of the eccentricity of the earth's orbit affects her climate but not so vitally as the tilt of her axis. The period of her revolution is divided into twelve sections called months which at present are most unfortunately named, the twelfth, for example, being called the tenth, December. The fact that there is no synchronism between the rotation of the earth, the revolution of the moon around the earth, and the revolution of the earth around the sun, makes the formation of a perfect calendar a rather difficult mathematical problem. Not only does the varying eccentricity of the earth's orbit and the varying tilt of the earth's axis affect her climate, but as the earth moves through space she wobbles in her rotation. Thus the north pole of her axis is never for two seconds pointed at exactly the same spot in the sky. Yet so slowly does this motion take place that Alpha Ursæ Minoris, the brilliant pole star, has been such for 1,000 years and will continue to be for more than another 1,000. But as time passes, the pole of the earth describes a vast circle in the heavens. Six thousand years before Christ it pointed toward a little star of the fourth magnitude, Theta Draconis. For succeeding centuries it traced its circle through the same constellation. Twenty-seven hundred years before Christ the pole star was Alpha Draconis, which was known as such by the astronomers of the day in China and Egypt. It is interesting to note that the openings to the Egyptian pyramids which were built about that time are sloped at an angle of exactly twenty-seven degrees which was the exact altitude of that star. Thus astronomy enables us to determine with some degree of certainty the date of the dawn of civilization in the valley of the Nile. At the time of the birth of Christ there was no pole star, that is to say, no bright star located in that part of the skies toward which the north pole of the earth pointed. Polaris has occupied the throne since 1000 A. D. but about 3500 A. D. the pole will pass into Cepheus and about 10,000 A. D. will reach the bright star Deneb, Alpha Cygni. Eleven thousand five hundred years from now the axis of the earth will point almost in the exact direction toward which the sun and his family are moving. Vega will then be the pole star. In another 12,000 years the earth will have completed its circle, and Polaris will reign again. It thus takes about 25,700 years to embrace this lustrum. As the polar axis swings slowly around its circle, the very heavens change. Many stars of the southern hemisphere become visible to the dwellers under the northern skies. Thus a few thousand years from now any New Yorker may view the mighty Canopus and the Southern Cross. It will readily be seen that as this takes place the seasons will change with respect to the months. Our winter, which now occurs from December to February, while we are at perihelion, will occur from June to August, while we are at aphelion.

It may be well to contemplate for a moment the possible effect of the coincidence of extremes in the climate of the earth brought about by the variation in the motions referred to above. We must not forget, to begin with, that while the earth rotates in approximately twenty-four hours at the present time, it was not always so. Doubtless our days were once as short as those on Jupiter, ten hours, and perhaps they will some day be as long as those on Mercury, everlasting. It will readily be seen that when we consider geological epochs of millions of years a planet whose day is short will have a more equable climate than one whose day is long, other things being equal. As to the revolution of the earth, since our planet is three million miles nearer to the sun, at present, during perihelion than she is during aphelion and since this makes a difference of 1|15 in amount of heat received, the variation in the eccentricity of the orbit would be appreciable with respect of temperature in its influence on the earth's climate. Also, if there were no tilt to the earth's axis (and no eccentricity to the earth's orbit) there would be no seasons. This tilt varies as stated above. At present it is diminishing. Should it continue to diminish at its present rate, we would, in the course of time, have no seasons. This would take place in about 177,000 years. But, as stated above, it oscillates within a range of only two degrees and thirty-seven minutes. The amount of eccentricity of the earth's orbit also oscillates. A hundred thousand years ago it was 47|1000. Today it is only 17|1000. Twenty-five thousand years from now it will be at its minimum of 3|1000 which is practically a perfect circle. Then it will begin to increase. The influence of these variations upon climate is quite perceptible. It should be remembered in this connection that the sun is believed to be, within limits, a variable star, its earth-received heat varying as much as ten per cent. (10%). Perhaps there were also secular variations of solar heat during geological ages. It can readily be seen that a maximum combination of these effects would produce great changes in the climate of the



SECTION OF THE ATMOSPHERE UP TO 100 KILOMETERS.

Showing the mean elevation at which meteorites and meteors make their appearance. Below are shown the elevation of Mount Everest; the highest manned balloon ascent by M. Berson; the height of cirrus clouds; the highest free balloon ascent; and the elevation attained by the cloud of fire-dust ejected by the Krakatoa eruption in 1883. (From *La Nature.*) The average cumulo-nimbus cloud is something like 4,500 to 10,000 feet above the earth. Stratus clouds rise to a height of 10,000 to 23,000 feet. The fleecy cirrus clouds rise to an altitude of from 30,000 to 35,000 feet. Mount Everest is about 29,000 feet high. Kites reach an altitude of about 23,000 feet and balloons have gone as high as 35,000 feet. The altitude reached by aeroplanes is 39,584 feet. The highest tropical cirrus clouds are about 50,000 feet, or something like 10 miles. The highest sounding balloon has gone 21¾ miles and the highest pilot balloon to a height of 24 miles which is the altitude that the shell of the Big Bertha reached. Fire balls explode at an altitude of about 25 miles. Noctilucent clouds, (fine particles of suspended dust) are to be found at an altitude of something like 40 or 50 miles. Meteorites appear at altitudes of from 25 to 100 miles. The Aurora Borealis is to be found from 50 to 100 miles, and Stoermer has photographed a streamer which reached an altitude of 375 miles. The atmosphere of the earth gradually rarefies into space.

earth. All of these causes of climatic changes are largely subject to atmospheric control. For the earth is enveloped in gases (Nitrogen, 79%; Oxygen, 20%; water vapor and other gases 1 %) dense at the surface, rising to a height of hundreds of miles, eventually thinning into the rarefication of space itself. Into this atmosphere the earth has from earliest geologic days belched enormous quantities of volcanic gases and dust, the net result of whose presence in the atmosphere is to produce cloudy, cold and rainy weather. The air acts also as a cushion against the bombardment of the earth by millions of meteorites and as a blanket against its freezing in the cold of interstellar space.

The revolution of the earth around the sun causes the latter apparently to pursue an annually completed pathway among the stars. There is no evidence available to show that the men of the Old Stone Age were conscious of the stars above them. The first recorded primitive observations of the heavens were made in China and Egypt and date from the earliest part of the third millenium before Christ. Both Chinese and Egyptian records show that approximately 2,700 years before Christ, the sun, at the time of the Vernal Equinox, was in the constellation of The Bull, Taurus. The earliest astronomers associated the stars is groups, and their imagination sought out resemblances between these groups and earthly objects. Even today we speak of the Big Dipper, the Southern Cross, and the Northern Crown. Then, observers noted also that these constellations slowly revolved about the earth, that the stars of the summer night were different from those of the winter. Furthermore, the sun appeared to pass through the stars, making this complete circuit each year, and the stars along his pathway were grouped into twelve constellations. By observing the stars nearest the setting sun and preceding the rising sun he could easily be located in the heavens. This path with its twelve "signs" was called the Zodiac. It is well to remember the names of them, as follows: Aries, the Ram; Taurus, the Bull; Gemini, the Twins; Cancer, the Crab; Leo, the Lion; Virgo, the Virgin; Libra, the Scales; Scorpio, the Scorpion; Sagittarius, the Archer; Capricornus, the Goat; Aquarius, the Water Carrier; Pisces, the Fishes. All the sun-myths center about them.

In the chapters that follow we shall find of what tremendous importance to early religious thought was the awakening of life in the spring time. It was noticed at an early date that this occurred at about the time when the day and night were of equal duration. This exact point of time is called the Vernal Equinox. All early religious beliefs point to the assocation of the Vernal Equinox with the sun and the constellation of the Bull, leaving us to infer that when, for example, the religion of early Chaldea was formed the sun was, at the time of the Vernal Equi-

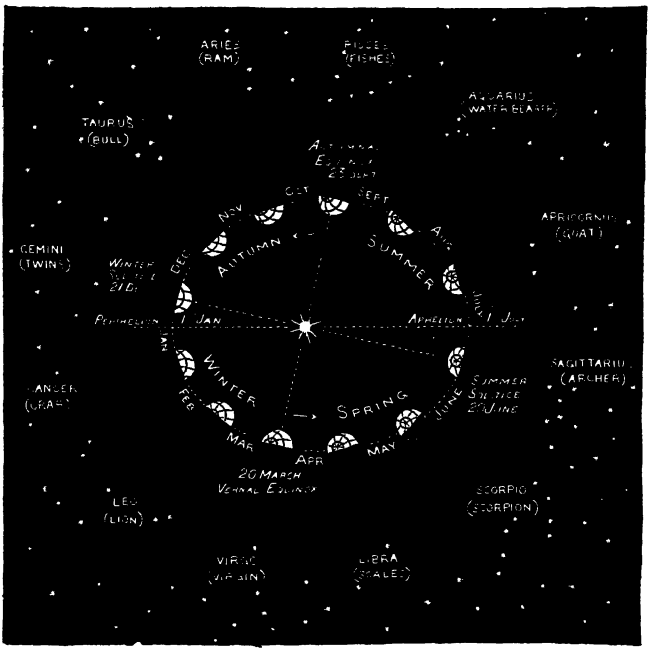


Diagram showing the orbit of the earth with relation to the seasons and to the constellations of the Zodiac. It will be readily seen that during the period of one year the sun appears to pass through each of the signs of the Zodiac in succession. (From *The Vault of Heaven*, by Sir Richard Gregory, courtesy of Methuen and Company.)

nox, in the constellation of the Bull, Taurus. From approximately 4300 to 2150 B. C. the Vernal Equinox fell in Taurus. At the beginning of our era it was in Aries. At present, it is in Pisces. Soon it will go into Aquarius. This is the "Precession of the Equinoxes."

Such are some of the chief motions of this quivering mass of matter, or shall we say of electricity, or power, or force, that we call the earth, the "immovable" earth?

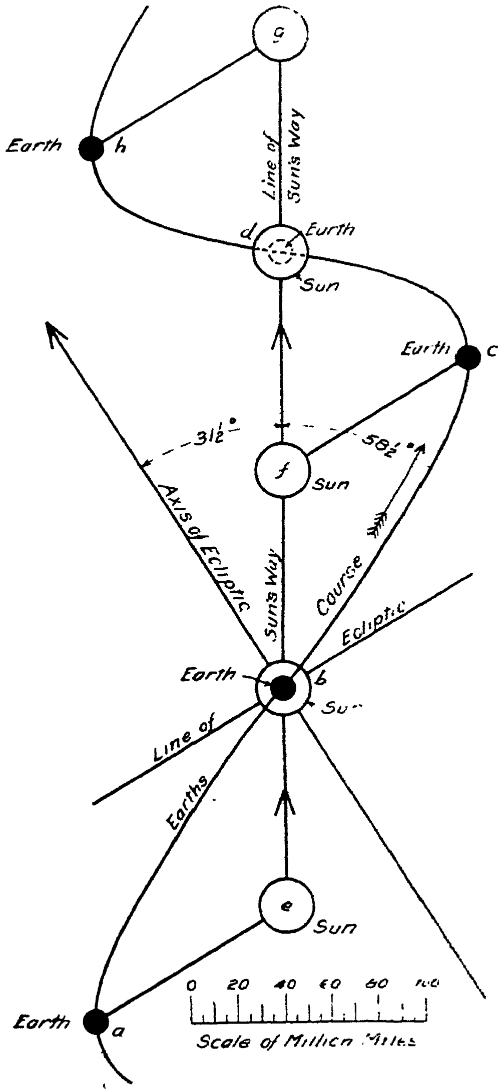


Diagram showing the pathway of the earth as it actually is. The direction in which the earth is moving is toward the constellation Hercules. The diagram is drawn on a scale of 100,000,000 miles to an inch. (Courtesy of the Mentor.)

And of her motions perhaps the most fascinating is that swift and strange and beautiful journey, her passage thru space, as she follows the sun toward Vega. Never was such a journey made in chariot or motor or airplane. No Gabriel nor Michael, nor Raphael nor Israfel ever knew such glorious flight. For since the day when our sun was begotten of the fiery mists of universal passion our little earth has followed him. First, the sun's pathway lay where peril was most imminent and star-stuff thickest. White-hot and young but with the slowly uncertain step of babyhood he began his wandering, stranger than the most thrilling adventure of Ulysses. Stronger and swifter, and surer but ever older and colder he swept out of the star-strewn galaxy into the open spaces and roomier and safer, followed by all earth's destinies. From careful observations of thousands of stars it appears that the Milky Way is the womb of our universe; that in it and out of its bright, irregular and comparatively motionless nebulæ the suns are born. Dividing the celestial sky into four zones from Milky Way to pole, Pickering has shown that over fifty per cent (50%) of the youngest type of star (helium) are within eight degrees of the galaxy and only five per cent. (5%) are found around the poles. In the next youngest (hydrogen) the proportion is thirty-seven to fifteen. Of the third (white-yellow stars) the proportion is thirty to twenty-one. Of the fourth (yellow) the proportion is twenty-nine to twenty-two. And of the fifth (red) the proportion is twenty-seven to twenty-two. This accords with the velocities of the various types of stars listed by Arrhenius as follows: irregular nebulæ, 0; helium stars, 2.8 miles per second; hydrogen stars, 6.8 miles per second; yellow stars, 9.3 miles per second; red stars, 11.5 miles per second.

It appears therefore that stars, like children, wander farther and farther away from home as they grow stronger and older. Faster even than the stars is the speed of the planetary nebulæ of which thirteen are known in our galaxy. They average 15.5 miles per second. They seem to have wandered into our system from the far depths of infinity, and are perhaps the result of some celestial collision. Fastest of all, some forty times faster than our own sun, speed the million spiral nebulæ, of which perhaps our own universe, two million light years across, with its stars young and old, with its four hundred irregular gaseous nebulæ and thirteen planetary nebulae, with its novae and star groups and comets and unnumbered planets and moons, living and dead, is one. And doubtless all of these million

Planetary nebula of which only a few are known to our universe. (Courtesy of Mt. Wilson Observatory.)

visible universes contain, like ours, billions of suns of all sizes and ages and speeds and inconceivable forms of living things and things higher and finer than our life and our lowly thought, and on out beyond the outermost of these universes doubtless lie others so far away that our little earth, though it already numbers the days of its life in millions of years, would be born and live and die before their light, speeding at 186,000 miles per second could reach us. Such are the companions of our journey. We are in the company of an innumerable host of worlds, going somewhere. We may picture, then, to ourselves, something like this as having happened: At the beginning of our journey in the long distant past, billions of years ago, our sun, young and white-hot, freshly born of the original nebula from which all of our galaxy was made, moved more slowly through space and nearer to the galactic plane than now and therefore in a region more thickly studded with stars. It was then that some other sun or meteor swarm, or perhaps a small, dark, burnt-out star, passed in his vicinity drawing after him the sun stuff of which our planets by a process of condensation and collision were later formed. Through the billions of years that have followed, the sun and his little family in their fall through space have drifted farther and farther away from the densely packed regions of the galaxy, and thus peace and quiet of sufficient duration has been furnished for the development of life on the planetary surfaces and in some cases for the whole planetary life processes to run their long course. In the meantime he has cooled and yellowed, and some of his attendant planets have chilled and died. Others of them, the larger, are yet warm and young. We are in the prime of our life biologically speaking and may look forward to millions of years of happy earth life, barring celestial accidents. Following the sun as he picks his way through space, we move ever outward into the celestial abyss. Our headlong flight has already reached the speed of twelve miles per second; but with age comes fleetness, and as our sun reddens and darkens until death comes very quietly and slowly and surely to all life upon all the planets, we shall doubtless fall more dizzily yet through space until we reach that final goal toward which his urge compels him. Then, in some fierce, mad hour of stellar catastrophe will come the ultimate crashing of worlds and thereafter, light, heat, power, another birth, another life, another sun with his other children.

It is not a difficult matter to calculate the enormous distance which our earth has travelled and will probably travel during the centuries to come. The distance traversed through space each year by the earth is some 378,000,000 miles. This is independent of the 186,000,000 miles around her orbit and the thousand miles per hour of her rotation. In the course of an ordinary lifetime, an octogenarian travels with her the inconceivable distance of thirty billion miles. During known history, a period of some 10,000 years, our planet has travelled approximately four trillion miles, and since a light-year is approximately six trillion miles, our planet is now two-thirds of a light-year from the point in space which she occupied when the foundations were being laid for the civilization of the Nile and Tigro-Euphrates valleys. Since the days of the Cro-magnon man, 25,000 years ago, the earth has travelled more than one-third of the way to the nearest fixed star, Alpha-Centauri. Since the days of Neanderthal man in Europe, 50,000 to 75,000 years ago, the earth has travelled from twenty to thirty trillion miles, or about five light-years, farther away than Alpha Centauri. But these are recent days. If we pass into geological epochs we pick up the Pithecanthropus erectus of 500 thousand years ago. The soil that he trod has travelled through space since that day two hundred trillion miles, approximately thirty-three light-years, or about as far as we are now distant from Vega. If we go back still further and deal with the periods of time required by geologists, let us say some five million years, our earth would, in that time, have passed over twice the distance that lies between us and the far away Arcturus and more than six times the distance between us and our present pole star. If, instead of five million, we speak of fifty million years, we find ourselves dealing with a distance of over 3,000 light-years, and in 500 million years which some geologists require, we would have travelled 33,000 light-years or half way along the shortest diameter of our solar system.

What strange adventures may not our far-borne wanderer have met on this long journey through the heavens? What vast conflagrations has she witnessed in the skies? Through what storms of meteors may she not have passed? From what peril of planet and sun and nebula has she fled? Astronomers tell us also that millions of years ago it is possible that our sun and his family were passing through the nebula of Orion, and while these nebulous masses are far more rarified than the rarest gas on earth, yet it is entirely possible that they may have influenced very greatly the temperature of the earth, and similar nebulæ may influence it again. Perturbations also may have occurred, due to the passage of the solar family near some other group of planets or suns. It is possible that our geologists may yet learn something from those astronomers who most accurately describe her pathway among the stars. And as there must have been a wonderful experience falling to her lot in the past, so shall there be in the future. Only in recent years has mankind larned how to write history and as the centuries pass the story of this great journey will be written. Many millenniums of quiet travel may be succeeded by centuries of peril. An adventure with a wild swarm of meteorites may be followed 100,000 years later by an almost fatal collision with a comet. Perhaps a million years thereafter the little earth will be passing with her sister planets through some dark nebula whose effects will be immediately felt in matters of climate, temperature, rain-fall, and most important of all, perhaps, in the constitution of the atmosphere itself. Then again, for other millions of years our astronomers may point out warningly how we are approaching dangerously near to another planetary system, and then, at last, when the hundreds of millions and perhaps billions of years have passed, will come the inevitable day of the unavoidable crash, and all the civilizations and the records thereof, of all the planets, shall meet their final catastrophe. But her end will be only a new beginning. Such is a second of Eternity.

THE APEX OF THE SUN

Fair Vega, is it indeed true that all our tiny fortunes move ever onward to thee?
To Thee shall we bring our little toy kingdoms and empires worn and broken?
Ah, the ages shall pass, and our dreams of eternal things with them, as we slowly approach thy presence.
Continents that we call vast shall rise from the waters and it shall be forgotten whether they returned thereunto,
E'er thou hast grown but a little brighter as we near Thee.
But even now we know that there is no lack of Centuries.
And some day, of such sort as we may be,
Our aged sun with his little family of planets shall approach thy furnaces,
And they who live upon thy worlds shall know us to have been long since dead.
And then, shall a new fire warm us?
Wilt thou kiss us into life again, as we join the family that moves about thee?
Or shall we haste hotly to thy bosom?
Oh, so long, so very long a while we shall have been rushing to thee,
How vast, how greatly vast shall be that blaze whereinto we shall then be plunged!
As the woodsman throws his dead stick upon his fire so shall One cast our little world into the flames;
And somewhere, off in the vastness of His night,
Someone, sitting by his own hearth shall look out through his window and say:
"A neighbor is kindling his fire in his home, out yonder in the distance,
I wonder how long he will sit by it with his loved ones around him;
I wonder if he is happy over the long pleasant while in which he will rejoice within the circle of its light;
The while he laughs and plans and dreams.
I wonder if the leaden ashes will gather as the embers burn,
Until the last passioned flame is dead, and then—
I wonder if—if—I wonder—"
So I pondered the problem of the End and found me an answer from the beginning,
There was a movement of the leaf I had been watching as if something stirred beneath it.
I bent over gently to uncover him who struggled under his burden,
And lo, a little heart-shaped bud of a tiny sweet, white violet.
The Spring-star had spoken to her and she know that voice from all others,
In the sure purpose of a certain faith she pressed upward to His heaven.
Nothing could stand before her, the earth uprose at her command, in reverence,
So reached she the last barrier across her path nor did she know of the eyes that watched it,
Nor of the hand that would so shortly be stretched forth to help.

CHAPTER VII.

FROM HEAVEN TO EARTH

There is a chapter in the story of our earth. as perhaps in the life of all planets, when the astronomer must cease to speak and the geologist begin. The astronomer has pictured to us the passage of two stars in the heavens and the disruption of the surface, at least, of one or both. He has told us of vast masses of sun-stuff thrown off into space. Such parts of this material as were moving at a speed faster than 378 miles per second would pass forever away from the control of the sun. A large proportion of the disrupted material would fall again into the sun. But there would be left a considerable mass revolving around the sun in the same plane as that of the approaching tramp star, and this sun-stuff, would, in the course of time, gather about certain nuclei and thus the planets would be formed. It is, of course, a matter of pure conjecture as to what was the original size of the earth or any of the planets. The broadly outlined facts would be that, in the first instant of disruption, the temperature of all the planet-stuff excepting the part contributed by the tramp-sun or the passing swarm of meteorites would be that of the sun itself—let us say not less than 5,000 degrees centigrade and probably higher. The smaller particles would cool almost instantly as they were flung out into space with its temperature of 273 degrees below zero, centigrade, and the larger particles would cool more slowly in proportion to their size. One would expect, therefore, that the asteroids would be the coldest and the larger planets the hottest and that is exactly the case. Such a spiral nebula would, of course, be a very tiny thing, astronomically speaking. Perhaps the Nova Persei of 1901 whose development of spiral arms (Lowell) has already been described throws some light on what happened to our system. It would not be distinguishable except by a certain increase in light, from the stars about us. The whole solar system, with a radius from Neptune to the sun, subtends from the nearest fixed star an angle of only one-half minute of arc. Such a little spiral as is predicated for the origin of our solar system would not be visible from the average distance of the stars even in our most powerful telescopes. It would, also, be but a temporary thing, astronomically speaking. The spiral would quickly cease to exist as the planet-nuclei, with varying periods of revolution, disalligned its contour. Such visibility as it would thereafter possess would depend upon the mass of meteoric material diffused throughout the system. If there were a sufficient amount of this material it would then appear as a small planetary nebula until the planet nuclei had swept up a large percentage of the meteor-stuff.

The asteroids which lie between Mars and Jupiter, some 800 of them telescopically visible, and countless myriads of them visible, combined with the meteorites which fall to the earth give us interesting suggestions as to the original event. It was by the impact of just such fragments varying in size from invisibility to 500 miles in diameter that the earth grew to her present size. These meteorites are in part metallic, composed largely of iron and in part stony and they are not spherical but rough and jagged nor are there any stones as yet discovered on earth of similar formation. They tell us of a dark body, disrupted, and of two types of rock that constituted its surface, the light stony material and the heavier metallic. It was in some such way as this that the little globule of sun-stuff which we call our earth came into existence and whatever its original largeness it doubtless continued to grow in size for countless centuries and is still growing daily in weight. So far, we are listening to the word of astronomy. The geologist cannot say more of the earth than that it was molten, based upon the evidence which he finds in the earth, itself. And the astronomer hands the book over to him to write just as the reader asks the question, how hot was the earth at the beginning? The logic of the astronomer's story points to a temperature that was very high.

On the other hand, the geologist also recognizes that the earth was originally molten, perhaps as it came from the sun, gaseous in part, so intense was its heat. The testimony of volcanoes, hot springs, and the increasing heat as we bore into the earth has already been mentoned. From all this we would imagine that to be the case which the astronomers predicted and the geologists discover, for underlying the soil and sedimentary rocks all over the earth is a crust of perhaps a hundred and fifty miles in thickness which is composed of solid stone with no evidence of sedimentation or of water action of any kind. The upper part of this crust is lighter than the lower and is generally granite. The lower, heavier part is basaltic. The lowest of all sedimentary rocks which, historically speaking, must have been the first to be deposited upon the cooling crust of basalt and granite is everywhere tilted, distorted, and crumpled, indicating that in the younger days of the earth vulcanism was much more frequent and that there must have been a long period of millions of years during which the crust was forming. At first it would only solidify in spots, to be fused again into the molten mass, but at last a thin slag-like film would remain, to be broken into at first very frequently and then at greater intervals by the molten material be-

The probable nature of a slice cut out of the earth from circumference to center. At the center of the earth there is probably a mass of iron alloyed with a little nickle. Outside this is a zone of mixed iron and rock. A relatively very thin layer on the surface represents the visible crust. This is composed, in the main, of rocks somewhat different from those farther below. (Courtesy of the Scientific American.)

neath. Nor would this tendency of the subterranean fires to break forth cease suddenly, but, as the geologists tell us, it would continue and, indeed, has continued up to the present time, for the crust of the earth is still thin nor are we far away from the internal fires.

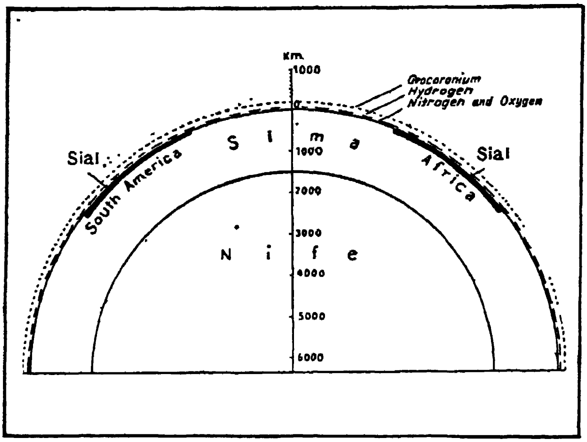
One must not think of the earth as liquid—nor would it be exactly true to say that it is solid any more than we could describe it as gaseous. Matter under the conditions which we believe to exist in the center of the earth is neither gaseous nor liquid nor solid. Under such pressures the firmest basalt would crumble if it could and under such temperatures the strongest granite would instantly melt. We can only think of the internal core of the earth as existing in a form of which we know nothing by experience. But we know that the earth as a whole is more rigid than steel and we suspect that its interior is so hot that were the pressure of the outer quarter removed it would instantly fuse into liquid and perhaps gaseous form.

The picture given, following Barrell rather than Chamberlin and Moulton, exhibits an earth, molten at its birth, and conforms in broad outline to certain well known facts. It fits in exactly with what we know of the tidal influences of the satellites and planets. The retardation of the rotation of the earth brought about by the tides is doubtless as variable as we find everything else in the universe to be. Today, as stated above, the earth is more rigid than if it were composed of pure steel and the effect of the ocean tides upon its rotation period must be very slight. It has been variously estimated from about twenty minutes per century to a second in five hundred thousand years. The complete rigidity of the earth would prevent any rapid lengthening of the day at the present time. In the earlier days when the earth was viscous the effect was much more marked and the tidal strains and stresses must not only have had a powerful effect in slowing down the axial spin of the earth but in breaking up the first attempts at the formation of the earliest crusts and in warping and crumpling the thicker ones that followed. Doubtless, could we view a cross-section of the earth, we would see that the first permanent crusts had been warped and twisted and plicated, and that the lowest and, therefore, earliest sedimentary rocks were similarly subjected to violent eruptive distortion and crumpling. And doubtless this was done myriads of times so that the process of acquiring its cooler shell was one which took our mother earth almost interminable centuries. Some geologists have assigned to geological time a length of one billion six hundred million years. This is the extreme estimate. But it is noteworthy that the geology of today requires a longer period than that of yesterday.

The tidal effect upon a viscous earth would be paralleled in other planets and satellites. The tides raised in the viscous moon by the earth and their effect in lengthening her earth-day would be much more marked and we would expect her to have a much longer day than the earth has. We, of course, know that her earth-day is eternal. Since the moon shows no signs of ever having had an ocean this must have been brought about by the tides when the moon was viscous, but as the earth and moon doubtless belonged to the same nebula-knot and passed through the same stages, the earth also must have been viscous. This accords with the fact that, roughly speaking, the bigger the planet and farther from the sun, the faster its rotation. The proximity of Mercury to the sun and, perhaps, of Venus, also, has brought about similar conditions there. The distant planets, Jupiter and Saturn, both by their size and distance have been protected from these influences and their days are short in proportion to their size, the one being slightly less and the other slightly more than ten hours. The oblateness of Uranus and Neptune point to similarly rapid rotations. All of these facts seem to indicate that the original earth was molten and the tidal effects correspondingly powerful.

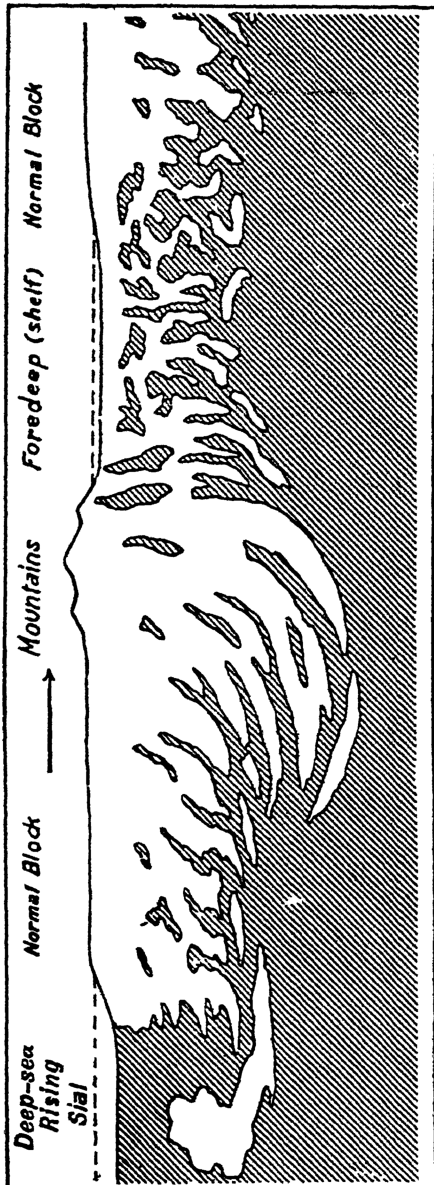
This argument is reinforced by the fact that careful calculation of the amount of salt in the ocean indicates that the earth acquired its waters when it was approximately its present size. Although 3½% of ocean water consists of salts of which 78% is common salt, yet the ocean is quite under saturated. Nine-tenths of ocean water must be evaporated before salt is precipitated. The amount of salt in the sea has been accurately calculated and calls for a period of accumulation of about a hundred million years. If collected, it would cover the whole United States to a depth of 1.6 miles. It figures out to be of about the same quantity as would be deposited from the erosion of just about the amount of land which geologists believe has been eroded. Twenty-three hundred feet over the whole earth and sixty-five hundred over the continental areas would have furnished all of it. The amount of salt in sedimentary rock is negligible.

The earliest book of earth-life may, therefore, be divided into two chapters. One of these covers that immensely long period when the earth was sufficient unto herself and needed no light nor heat from the sun or the moon or the stars. In this independent stage of her existence, she may be pictured as first a hot molten mass of sun-stuff, rendered so partly by her origin and partly by the enormous heat developed by the impact of colliding meteors. On this whirling orb vast fiery tides cast spray of liquid metals into the glowing gases of a superheated atmosphere. A gradual cooling process took place. The heavier ma-



THE CONTINENTS ARE RELATIVELY THIN
This cross section of the earth is diagrammatic; actually no such uniform conditions are believed to exist. (Courtesy of the Scientific American.)

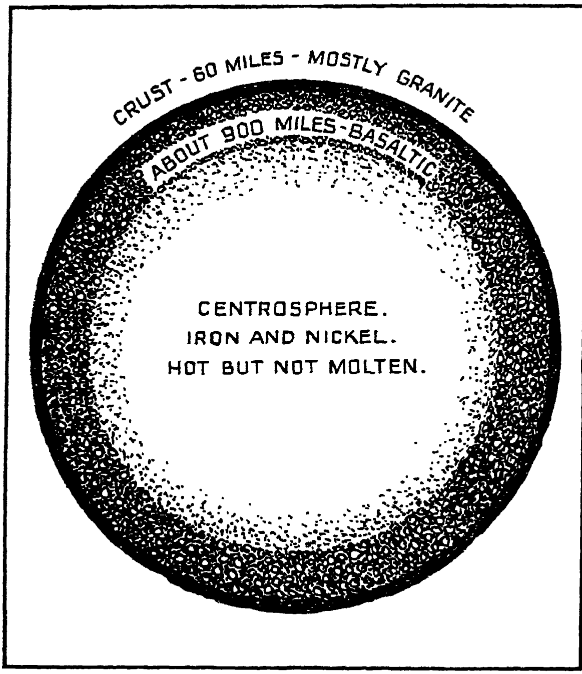
terials settled toward the center so that the core of the earth consists of the very heaviest metals. Probably nickel and iron (Ni and Fe) predominate and it is often therefore called Nife. On the surface the slag from the furnace collected. This represents the silicates, the lighter on top and the heavier beneath. The former represents the granites; Silicon (Si) and Aluminum (Al), commonly called Sial and the latter the basalts; Silicon (Si) and Magnesium (Ma) often referred to as Sima. This extreme outer crust of once molten now solid granite is perhaps 50 or 75 miles deep. Underneath it the basalt extends for a similar distance. It was, of course, all one molten mass, stratified by fractional crystallization or natural immiscibility, moved by the tidal action of the sun and of a moon nearer and more powerful than at present. The upper crust was penetrated with water-gas (by water-gas is meant super-heated vapor of water) much as the ocean is today penetrated by oxygen. It is known that granite fuses only under the intense heat of some 1,500 degrees centigrade but when water-gas is diffused throughout such molten granite it will remain a liquid until it reaches a temperature of 800 degrees centigrade. So that until that point in her temperature had been reached the surface of the earth was passing from a seething mass of liquid fire to a molten mass of viscous rock. Thereafter solidification took place and amid aeons



HOW THE SIAL OF THE CONTINENTS MAY ACTUALLY JOIN THE SIMA BENEATH

The transition is gradual and non-uniform. Note that the mountains indicate added thickness of Sial, required to buoy them up; while shallow under water areas require less thickness for support. This is according to the principal of isostasy. (Courtesy of the Scientific American.)

of commotion the crust of the earth was formed and broken, solidified and re-fused, its siliceous slag floating upon a molten interior, the subject of unspeakably vast eruptions, the child of immeasurable volcanic destructions. But millennium by millennium the surface of the earth grew more solid and steady until it reached the condition in which we find it today.



THE EARTH IN CROSS SECTION

The crust is relatively thin. Beneath it are heavier rocks. The earth's center is probably hotter than but not molten. (Courtesy of the Scientific American.)

So much for the formation of the lithosphere. What of the atmosphere and hydrosphere? In large part both the oceans and the gases that now constitute our atmosphere were in that surrounding body of gas which constituted the then atmosphere of the earth. At the original heat with which our earth left the sun the gases constituting water would doubtless be dissociated into hydrogen and oxygen, but as the earth gradually cooled they would exist under the form of super-heated vapor at the temperature of hundreds of degrees centigrade. With them in the atmosphere would be quantities of carbon dioxide and monoxide, with chlorine and hydrochloric acid, but little nitrogen and probably no oxygen. As time passed and the earth cooled there would come a moment when the first drop of water would be formed in the upper reaches of the air, only to be almost instantly dissolved again by the fervent heat around it. But others would follow, each falling a bit farther through the atmosphere to the more heated strata below. For a long while the rain storms of the upper atmosphere would never reach the earth but at last, as the cooling process continued, the day would come when the first patter of raindrops would fall upon an intensely hot surface of granite with here and there, perhaps, protruding basalt. Then disintegration of the stony surfaces would begin and our granite would begin to change into sand-stone and mud-stone. It is at that point that astronomy ends and geology begins. We have reached the first sedimentation though it be only so large as a square inch and from that moment the great sedimentary rocks begin to be deposited. It would be, of course, hundreds of years before the effect would be appreciable but the power of the geological agencies would be greater then than now.

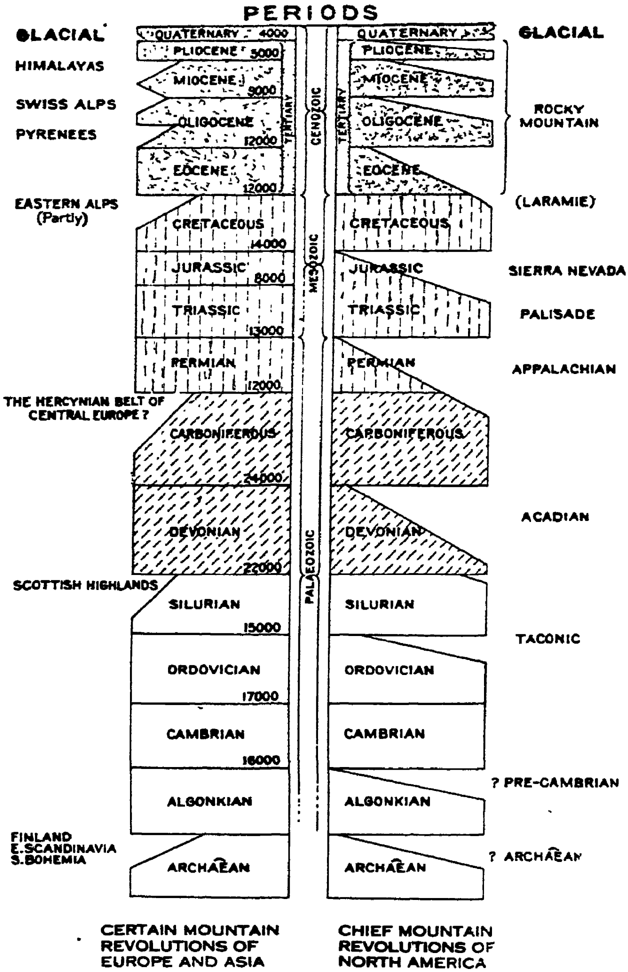
Nothing could be more dramatic than the picture which such geologists as Barrell draw of this earliest earth. Over its vast viscosity a dense, heavy atmosphere, dominated by water-gas and carbon dioxide and boiling with convection currents which turned its water-gas into great thunderheads when it came to the upper reaches of the atmosphere, hid the newborn earth from outside gaze or harm. Here and there over its quivering surface is a dull glow from an uncooled mass of molten rock. The sky is lurid above enormous volcanoes and the crust of the earth trembles beneath their explosions. In time, in the upper atmosphere, the super-heated water-gas becomes vast volumes of steam, and hot drops of acid-water which, falling into hotter atmospheric strata, are vaporized over and over again until, after millenniums the first drop reaches the intensely hot granite below. Thus a universe of cloud keeps perpetually arising first from hot continental cores of granite and then from the warm ocean. An unending downpour of hot acid rain continues for century after century. No sunlight has as yet entered nor is there a year nor a day. Ever and anon through the dense deep atmosphere there plunges a meteorite as large perhaps as an asteroid, penetrating with thunderous roar the thin crust of the cooler materials, and amid starry scintillations of incandescent outbursts buries itself into the masses of molten magma beneath. Unceasingly the electric storm proceeds with thunderous roar and unnumbered lightning flashes with fiery fingers gripping the clouds boiling up like thunderheads from volcanoes and molten seas and earliest hot-water lakes. Here and there a vast crack opens and over thousands of miles the heavy basaltic interior pours out over the lighter granitic crusts and slowly settles to form what, were there an end to eruptions, might be a permanent ocean basis. But slowly as the millenniums pass, the vulcanism diminishes and the power of the ocean and the air increases. Degree by degree the cooling takes place until at last the earth is no longer a tiny star but is ready for the life of a planet.

The rough outline of land and water possessed by the original earth may have been not unlike that which we know today. It should not be forgotten that the earth would be smoother than a billiard ball if reduced to such size and the difference of elevation between the lowest depth of the sea and the highest mountain top is therefore relatively slight. It is entirely conceivable that during the world wide alterations of the earth-crust large sections were covered by the heavy basaltic materials cast forth by vast volcanic eruptions which as they subsided elevated contiguous masses of lighter granitic material to form continents, their own surfaces being covered by the accumulating waters and thus forming oceans. This may explain the reason why the cores of our continents are of the lighter granite and the beds of our oceans are of the heavier basalt. Through all geological time such uplifted mountains have suffered a process of erosion in which storm and frost and ice and rain have played the leading roles and have thus been gradually lowered to approximately the level of the sea. Then would come another period of uplifted mountains, followed by another period of erosion, each having its definite effect on the climate and life-processes.

And such eruptions have had and even now are still having great effects upon the atmosphere. Into the original constitution of gas of water, carbon monoxide and dioxide, chlorine and hydro-chloric acid, there has been breathed enormous quantities of steam and volcanic gases. From the earth itself and from her living processes gases, particularly oxygen, have been constantly poured. From her sides also have flowed streams of living water increasing the content of her oceans. These waters are called "juvenile" and by their addition to the hydrosphere the total amount of the water in the oceans has probably been increasing during geologic time. As the mountains have been eroded their material has sunken as sediment into the surrounding ocean carried thence by torrent and river and distributed by wave and tide. This of course would raise the level of the oceans' surface which would then invade the land. It is calculated that if all the continents were by erosion to be distributed as sediment into the oceans of the earth it would raise the surface of the ocean about 650 feet so that all low-lying land would, in the absence of other counteracting agencies, be quickly overflowed in the process. And as the ocean increased in size and the land areas diminished the climate of the earth would change. Aridity and frigidity would decrease and the warm equable climate of the mid-ocean would tend to dominate the remaining lands. The effect of these climatic changes upon living organisms would be decisive. Floras and faunas would change with the centuries. Thus these periods of mountain formation would be critical hours in the geological history of the earth and more and more geologists are coming to so regard them.

Speaking broadly it is well to note the final word of admonition which astronomers give to geologists. It has to do with the gradual cooling of the earth from an almost incandescent sphere to its present state. It points to the first long period of geological history following the super-heated condition of the earth as being a period of darkness, warmth, moisture, and equableness. Such a time would be one in which life could exist from pole to pole, a time, indeed, such as we find the first hours of the oldest geological periods down to the palaeozoic to be. At a time like this plants and animals that seek darkness and moisture and warmth and that could stand little variability in temperature would flourish. It is in such an era that the transition from a super-heated earth to that in which we find it today would necessarily begin.

It is this transition which marks the change from the independent to the dependent stage in the earth's history. Up to this time she has been sustained by her own heat. From now on she must depend more and more for sustenance upon the sun. In some past hour of her life there



MAIN SUBDIVISIONS OF GEOLOGIC TIME

The subdivisions are not to the same scale. The notches at the sides of the scale represent chiefly the periods of mountain uplift in the northern hemisphere of the Old World (left) and of the New World (right.) From *The Origin and Evolution of Life*, by Osborn, Charles Scribners Sons, publishers. (Courtesy of the Author.)

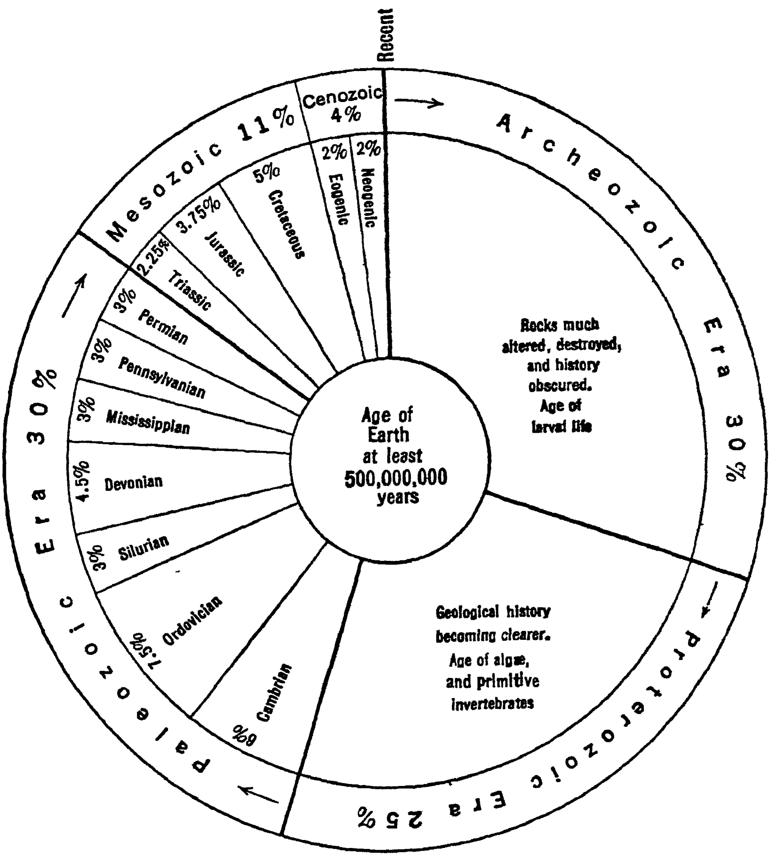
came a moment when through the ever decreasing density of cloud in her atmosphere, the sun peeped for an instant only to be swallowed up again among the thunder-heads. Many millenniums before that date an intelligent creature, had there been such on earth, could doubtless have guessed the existence of an outer radiance behind the thunder-clouds by the increasing light which must have grown century by century until it cast dim shadows such as we know upon a cloudy day. As the years passed, the moments of sunshine grew more and more frequent and more and more extended. Already the day had been dimly distinguished from the night as the clouds vanished and the sky cleared. The long waves of dark heat which had hitherto been kept in by the blanket of water-vapor and the carbon dioxide escaped into space. But in turn the heat of the sun was admitted. Investigations show that the earth would gain in total amount of heat by this clarification of the atmosphere which would thus let in more sun-heat than it would let out. At present about twenty per cent. (20%) of the sun's heat received by the earth succeeds in reaching the surface of the earth. Forty per cent. (40%) is deflected, principally by dust particles and about forty per cent. (40%) is absorbed by clouds and atmosphere. But radiation increasing correspondingly the crust of the earth continued steadily to cool and the climate of the earth on the whole to grow colder. Having in mind the heating effects of radio-activity and the climatic effects of other geological forces it is, nevertheless, on the whole true that the earth has not grown warmer but has doubtless grown colder during geological time.

And what of geological time, itself? How long has it been? The answers, shrewd and skillful as they are, can be no more than learned guesses. Yet there are certain definite limits that may be set. Arguments, too varied and intricate for discussion here, indicate a minimum of some sixty million years and a maximum of one billion, six hundred million. The difficulty lies in estimating the time that it would take to deposit the materials from which the sedimentary rocks were formed, not only, but also in estimating the gaps between the time of their deposition. The theory of uniformitarianism which recognizes that the vast changes through which the surface of the earth has gone were produced by much the same agencies that we know today working through illimitable time is now the one universally accepted. Yet we must not forget that these agencies were in many cases accentuated in the past.

And amid the shifting of mountain and plain and sea we discern the rivers bearing sand and silt to the ocean and depositing among them this or that animal that perished upon the banks to be preserved for future ages and studied as a fossil. Thus, as has been well said, nature packed her box much as a mother would pack a box she sends to her boy at college, the first objects being packed at the bottom and those at the top being packed last. So when we unpack nature's box we find that the upper sedimentary rocks contain the last chapter of her story and the lowest contain the first. And between the two there are many gaps showing where time and chance have torn out this page and that. But on the whole, it is possible to trace a steady process of growth, an evolutionary change from the lower to the upper strata and it is upon such a study of fossils that the science of palaeontology is based.

Also by them are the larger divisions of geological time distinguished. For example, we take a typical time-chart of earth-life with a total of sixty million years. We find the newer era, the Cenozoic, allotted three millions of years and divided into two unequal portions, the Quaternary (the latest) period, characterized by the appearance of man, and the Tertiary, characterized by the development of mammals. Below this age is that called the Mesozoic or middle life, featured by the overwhelming number and varieties of reptiles. To this middle era is allotted nine million years. Below it is the Palaeozoic covering eighteen million years in which life consisted first of invertebrates, then of fishes, and then of amphibians, and below these three are the Precambrian ages, embracing some thirty million years, characterized by unicellular life and the development of the invertebrates. These Precambrian days have been lately divided into two vast eras. The first in point of descent and, therefore, the youngest in point of age, is the Proterozoic, and the first in point of age and last in point of descent is the Archaeozoic. Likening all geological time to one hour then the total time length of all recorded history, five thousand years would equal a little less than a third of a second or about eight seconds out of a whole day.

Modern geologists usually allot to the entire time chart more than sixty million years. Their estimates are based upon the interminable periods necessary for the depositing of the sediments which year by year they more carefully discover and describe. If the various and different known sedimentary strata were to be superimposed on each other they would rise to a height of approximately fifty-three miles. It would take twenty ranges of mountains like the Rockies or Alps to furnish by erosion the necessary materials for them. If all the continental areas of the world



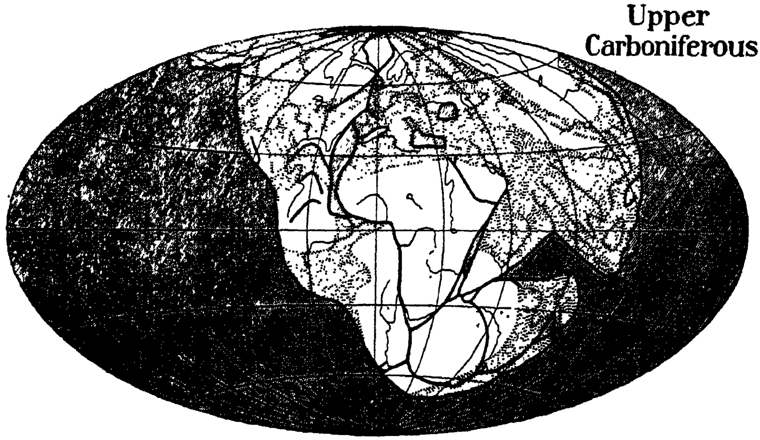
The geologic time table arranged in the form of a clock dial, with the duration of each time division given as a percentage of the whole.

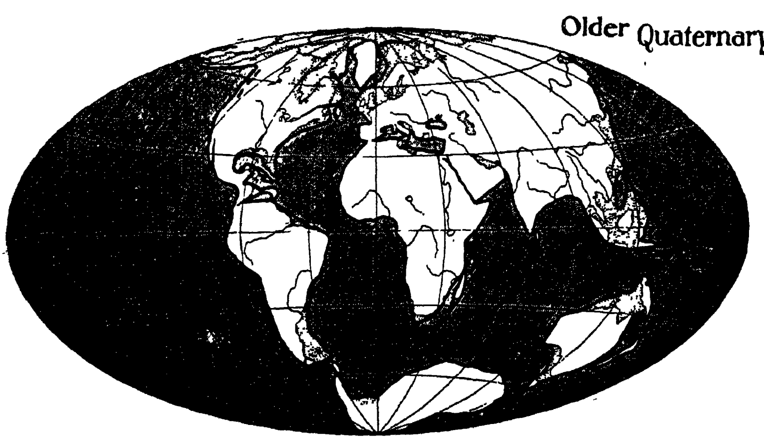
From *Pirsson and Schuchert's Geology.* (Courtesy of John Wiley and Sons.)

were denuded to a depth of 6.500 feet or the whole world to a depth of 2,300 feet it would about equal the amount of erosion since the beginning of geological time. These fifty-three miles of sedimentary rocks may be roughly divided as follows: To the Archaeozoic during which only unicellular life is believed to have existed, eighteen miles; to the Proterozoic during which multicellular life developed, fourteen miles; to the Palaeozoic, above described, eight and one-half miles; to the Mesozoic, eight and one-half miles; to the Cenozoic, four miles. From this the astonishing fact is developed that thirty-two miles of sedimentary rock comprising by far the greater part of geological life of the earth empty as they are of fossils, indicate that this enormous period of time was necessary for the development of the lowest unicellular and multicellular life up to the point where they had acquired a hard skeleton surface capable of evidencing their existence to future geologists. A study of geological time charts, presented on other pages, only accentuates the disparity existing between the ages as to time and emphasizes the extremely long while that it has taken to create the cell as compared with that required to develop the later forms of living things.

We shall see as we proceed how dependent the growth and development of life on earth has been upon the major geological changes of surface and climate. During the warm, moist, dark and equable, self-sustained age of the earth, before there was a day or a year, life was subject to few variations of temperature, but when the atmosphere cleared and the day and year had come, when the earth had become dependent upon the astronomical conditions which we have described in a preceeding chapter, and when these effects were combined with those resulting from the process of mountain-making, the real struggle for life began on earth. More and more the geologists are coming to mark the beginning and the ending of the geological ages by periods of mountain-making which seemed to have marked the critical points in the biological history of the world. Such a time, for example, occurred when the ancient Appalachian mountains were uplifted some 20,000 feet in the air at the close of the Palaeozoic and the beginning of the Mesozoic eras. Between such major up-lifts there followed a long period of erosion during which for countless centuries the mountains were being removed and cast into the sea. Gradually the climate became less and less cold. The snowy peaks covered with ice and heavy with glaciers were lowered to something approaching the level of the ocean. The warm moist equable climate of the seashore followed. The land was invaded by the waters of the ocean, more and more. Its area was contracted as that of the ocean expanded. The struggle for life on the continents became more and more terrific.

Those forms of living creatures which were best adapted for the new, changed conditions succeeded to the mastery of the world. As the towering mountains were slowly lowered into the sea by their merciless erosion, the principle of isostasy, equal pressure at equal depth, would eventually tend to re-elevate them and the lighter granite mountain mass would be pressed upward by the heavier basaltic ocean basins reinforced by millions of tons of eroded material. Under the shearing effect of this process the continental edges would melt, flow and recrystallize like the ice of a glacier and as this would happen on the fringes of the continent so there the cracks and heat and volcanoes and earthquakes would tend to discover themselves. So the mountains of today are not those of yesterday and while the continents are perhaps located much as they were in former days, yet time and time again their lower stretches have been invaded and covered by the ocean. Parts of North America, for example, have been beneath the waters of the sea no less than sixteen times. Europe is believed to have seen no less than four successive periods of mountain-making. Before the first there were doubtless others as there will be after the latest. Just where the first continents were, no one, of course, knows. Lothian Green conceives of the earth as having crystallized into the form of a tetrahedron whose four flat faces are covered by the Atlantic, the Pacific, the Indian and the Arctic Oceans, and whose jagged corners are represented by the continents. Wegener proposed a theory to the effect that the Americas and India and Australia were once snuggled up close to Africa and a part of that continent. Students of geography must have noticed how closely eastern South America fits into western Africa. The other countries named can be similarly replaced. Wegener believes that the Americas have floated westward much as Greenland is now floating away from Europe at the rate of fifty feet per year, their western edges crumpling as they went into the Andes and Rockies. Chamberlin maintains that the present contour of the continents was largely established as a result of tensional stresses due to rotational, gravitational, and tidal forces. Thus as the rotation of the earth slowed down under the effect of tidal action and its ever increasing weight, pressure on the equatorial regions would increase and on the polar regions would lessen. Thus the earth like the basaltic columns of the Giant's Causeway relieves this pressure by parting its "mass into three sub-equal parts radiant from the point of the greatest





THE ORIGINAL SUPER-CONTINENT 70,000,000 YEARS AGO
AND A LATER PHASE OF CONTINENTAL DRIFT
500,000 YEARS AGO, ACCORDING TO WEGENER.

Although the present continental outlines are roughly indicated on the upper map, these lines did not actually exist on the original super-continent. The lower map shows the comparatively narrow Atlantic Ocean of the early part of the glacial period. India, once twice as long as now, was "telescoped" into Asia, forming the Himalayas. (Courtesy of the Scientific American.)

stress . . . . by three fissure tracts radiating from the poles at angles of the general order of 120 degrees . . . . . . The effect would be to divide the circumpolar areas into three great segments of triangular form with their apices at the pole and their bases on the fulcrum zone . . . . . . at about thirty degrees North and South latitude." A glance at the map showing how the triangular ends of South America, Africa and Australia approach the South pole and how the mountain ridges thus originating, fork triangularly as they head for the equator seems to support his position.

WAS THERE ONLY ONE GLACIAL CAP?
When both continents are brought together, the outermost terminal moraines of the ice cap (dotted line) join up evenly. (Courtesy of the Scientific American.)

As we trace the story of life on earth in our later chapters we cannot, therefore, speak too dogmatically as to either time or space. But we do, beyond question, know the broad outlines of the subject and the general conditions under which life must have been originated and developed. We are ready to believe, for example, that at any time after the cooling process had reached a certain point, a condition of local glaciation would have been rendered possible by the up-lifting of mountains sufficiently high into the air to cause the necessary precipitation, and we know that the more moist the atmosphere the heavier would be the snow fall and the larger the glaciers. Inasmuch as glaciers depend as much upon moisture as upon cold, we would not be surprised to find sections of the world under ice far back in the world's history. Even today the Ruwenzori mountains under the equator are perpetually snowcapped and glaciated. As continents and mountains were successively made and eroded we would expect just such great climatic changes as we later find actually did take place, producing just such transformations of species and genera as the study of palaeontology discovers.

Thus far then have we come in the earth's process of cooling with its attendant chemical evolution. The blue-white heat of the hottest star has cooled through the yellow and the red and the dull glow of an encrusting earth. Parallel thereto the simplicity of the atom of hydrogen has changed into the complexity, first of the elements, then of the compounds, and now we are about to witness the development of the intricate complexity of protoplasm. Not at any single point may we place our finger and say: "here is something that has been introduced, different from anything that has preceded." Everything in the world is like everything else, the difference being only one of intensity and degree. Shall we find it otherwise when we enter the world of life?

We shall, in a future chapter take up in detail the effect of the general theory of evolution upon our conception of religion and God. At present, we are chiefly concerned to present the scientific story plainly and fairly. Yet, it may be well, just here, to frankly ask ourselves whether there is anything in the preceeding chapters, presuming that they comprise an accurate story of the origin of our earth, which need alarm a follower of Jesus and a worshipper of God. In essence what we have seen is exactly what the Master said: "My Father worketh hitherto and I work." The thoughtful reader must know by now that the forces of the Creator have never been cold or silent, that the equations of His physics and chemistry are incalculably abstruse and exact; that "as the heavens are higher than the earth so are His ways higher than our ways and His thoughts than our thoughts." Science, of course, interprets its sphere as that of the discovery and statement of the exact facts of the physical world. Consequently, pure science offers no explanation, other than physical, of the marvelous story heretofore outlined. But he who loves the thought of God, the Creator, the Preserver, and the Benefactor, as he reads that story, must find that his mind has been permanently stretched, that his idea of God has been broadened and deepened and illumined in proportion as the wonder and power and the glory of His creation has been grasped.

WHOSE BUILDER AND MAKER

This is the early Spring, worship, Jehovah hath made it;
Velvety carpet of green, softly, Jehovah hath laid it;
Breath of the apple bough; snow of the blossoms falling;
Song of the throstle's love; voice of the cardinal calling;
Splendor of pale-lipped plum; glory of pink-cheeked peaches;
Laughter of dogwood eyes; grace of the jasmine's reaches;
Holy, O Lord, our God—millions before you have prayed it—
Sing! It is Life, it is Spring; worship! Jehovah hath made it.

CHAPTER VIII.

THE UNITY OF LIFE

In telling the story of the origin and development of the earth and her inhabitants we are now arrived at what has seemed to many to be the great fixed gulf. Hitherto, we have spoken of suns and stars and planets; of stones and metals and gases; of molecules and atoms and electrons. These are words that have to do with matter. The things for which they stand are commonly described as inorganic and they are sharply distinguished from organic substances which latter, alone, have been supposed to be the product of living things. It is the magic word "life" that has separated the two worlds and still doth separate them in the minds of the multitudes. On the one hand are the things of which we have been writing; stars, moons, stones, matter, the lifeless inorganic world and on the other the world of living things from bacteria to men. Between them has stood the Great Divide. Before such an insuperable obstacle the flood of modern scientific facts has long paused but little by little the waters of knowledge have risen higher and higher until here and there at least a tiny rivulet has begun to flow quietly but surely over the barrier. So we turn to examine the whole world of the organic, wiser because of the experience we have gained in our explanation of the inorganic world and wondering whither the pathway will lead as we endeavor to follow the story of the origin and development of life. Its most striking aspect and the one which at once amazes and bewilders us is the multiplicity and heterogeneity of living things. Where we found a quarter million different kinds of inorganic things, we here find a full million different kinds of organic things. Our immediate task, therefore, is to discover whether there is any unity among them, any homogeneity, before inquiring whether the chasm separating them from "matter" is impassable. Our investigations will inevitably lead us to the problem of the origin of life.

There is a story told of a newly installed professor of

Biology in one of our Southern denominational colleges who sent some of his students to the library of the institution to make some original investigations as to the origin of life. They inquired of the librarian as to what volumes they should consult. She rather indignantly replied that there was just one book in the library which covered that subject and covered it finally and completely and handed them a copy of the Bible, pointing out to them the first two chapters of Genesis.

Now, however natural and proper her action may have seemed to some and however absurd to others, the simple truth is that the passages to which the students were referred contain the most priceless statement of the matter in the whole wide world of literature. They take us back to the hour of the first faith of the first thinkers of that far distant day concerning the origin of life which is still as fascinating and puzzling as it was then. The students would readily have noticed, had they read the accounts carefully, that they, while not contradictory, are, nevertheless, variant. One of them tells how Elohim on the fifth day of creation commanded the waters to swarm with swarms of living creatures and the birds to fly above the earth in the open firmament of heaven. Similarly, on the sixth day he said, "Let the earth bring forth living creatures after their kind." In the second account, the students would have read of a time when there was no plant of the field in the earth because Jehovah Elohim had not caused it to rain upon the earth, of how a mist went up from the earth and watered the whole face of the ground. Then follow some striking expressions: 'Jehovah Elohim formed man of the dust of the ground.' 'Out of the ground Jehovah Elohim formed every beast of the field and every bird of the heaven and brought them to the man to see what he would call them, and whatsoever the man called every living creature that was the name thereof.' 'But for man there was no companion and helpmert for him. Then Jehovah Elohim caused a deep sleep to fall upon the man and He took one of his ribs and closed up the flesh instead thereof, and of the rib made He a woman and brought her unto the man. Then the man gave her also a name. "She shall be called woman (Ishah)," he said, "because she was taken out of man (Ish)."

One cannot read this, which was until recently the most ancient of all written attempts to describe the origin of life, without being struck by the close association, in the mind of the writer, between life and the soil. It is out of the waters that the sea-life swarmed and out of the ground that the beasts of the field sprang. From the ground also came the man. The Bible story is probably not the oldest or the first attempt to solve this problem. Numerous stories of creation have been unearthed in the Tigro-Euphrates Valley, telling in various cases the tale of the origin of all things. Many of them either must be, or must spring from, traditions older than Genesis and belong doubtless to that body of beliefs which form the source of both. Of this we shall have occasion to speak fully later. Such a story is that in which Marduk mixes the blood of Kingu with the earth and forms the first man. Similarly, other tablets have been found recounting the creation of all living things, the fishes of the sea and the fowl of the air and the beasts of the field. One such story, translated from the cuneiform texts in the British museum, follows: (Italics ours.)

1. A holy house, a house of the gods, in a holy place had not been made.
2. No reed had sprung up, no tree had been created.
3. No brick had been made, no foundation had been built.
8. The deep had not been formed, *Eridu* had not been built.
8. The holy house, the house of the gods, the dwelling had not been made.
10. All lands were sea.
17. Marduk bound a structure of reeds upon the face of the waters.
18. He formed dust, he poured it out beside the reed-structure.
19. To cause the gods to dwell in the habitation of their hearts' desire.
20. He formed mankind.
21. The goddess Aruru with him created mankind.
22. Cattle of the field, in whom is *breath of life,* he created.
23. He formed the Tigris and Euphrates and set them in their places.
24. Their names he did well declare.
25. The grass, marsh-grass, the reed and brushwood (?) he created.
26. The green grass of the field he created.
27. The land, the marshes and the swamps.
28. The wild cow and her young, the wild calf; the ewe and her young, the lamb and the fold.
29. Gardens and forests.
30. The wild goat, the mountain goat, (who) cares for himself (?).

Compare with line 21, another account from the Gilgamesh Epic:

> The goddess Aruru, when she heard this,
> A *man like Anu* she formed in her heart.
> *Clay she pinched off and spat upon it;*
> Eabani, a hero she created,
> An exalted offspring, with the might of Ninib.

In each case, Babylonian and Biblical, life is represented as coming directly from the hands of Elohim or Jehovah-Elohim, or Marduk, or other gods, as the case may be. In each case, also, mankind is made in the image of the gods or has the blood of a god in his veins and possesses the physical body and features and organs of a god.

The close association of life with the soil in Semitic tradition is doubtless due to those first observations made by the earliest biologists of the way in which multitudes of humbler creatures seem to spring from the slime and mud of river banks and marshes. Many are the old traditions and beliefs and superstitions which have come down to us from earlier days, some of which are not yet outworn. The writer remembers very well the hour when he was confidently told, as a boy, by simple country-folk who believed it, that if a horse-hair were thrown into a still pool it would turn into an eel. In Egypt it was a common belief that insects and worms and even crocodiles sprang from the slime of the Nile, warmed by the rays of the sun.

It is not, therefore, surprising to find that in the beliefs of mankind for many ages there ran these two parallel lines of thought, one stating that all living creatures were made directly by the hand of God, and the other admitting that some of the humbler creatures, then, as still, sprang by spontaneous generation from the effect of the warmth and the light of the sun upon the commingling of water and soil in silt and slime. Side by side with these beliefs ran the faith of the average churchman for over a thousand years well expressed in the astonishing words of St. Augustine, "Nothing is to be accepted save on the authority of Scripture since that authority is greater than all the wisdom of the human mind." Centuries later we find Luther saying, "I hold that the animals took their being at once, upon the word of God, as did also the fishes in the sea." John Calvin declared that "all species of animals were created in six days, each made up of an evening and a morning, and no new species has ever appeared since." In general, the God of creation was pictured as either moulding with his hand or bringing into being with his word of command each species of living things which was thus different from every other species and which had not from the beginning changed. All these were brought by God to Adam to be named and two or seven of each of them were taken into the ark by Noah to be saved from destruction. It should be observed that these beliefs are a combination of the devout anthropomorphism of Genesis and the crude biology of the day.

As the knowledge of men increased, it became more and more difficult to believe in the traditional theory. Species after species unknown before were discovered until they numbered hundreds and thousands; entirely too many ever to have possibly been domiciled in Noah's ark. For a while the size of the ark was enlarged, but no possible mistake in figures was found sufficiently large to satisfy the ever increasing multitude of newly discovered animals. Other difficulties also arose from the great geographical discoveries in the fifteenth and sixteenth centuries when new worlds were found, teeming with new multitudes of living things. Never by the widest stretch of imagination could they have crossed the oceans after the flood from Mount Ararat. Nor could it be explained why in Australia, for example, the great majority of living things differed from those surrounding Ararat, not only, but from all the rest of the world. Likewise, it became more and more absurd to suppose that the Lord God Almighty had brought thousands upon thousands of species of animals to the Man for him to name them.

The old theory of spontaneous generation came handily to the minds of many as a solution, in part, of the problem and it was suggested that while the larger and more important creatures came directly from the hand of the Maker, the smaller and more insignificant creatures sprang from the soil. But as the numbers of species of "the larger and more important creatures" increased, that refuge also was forsaken. Then there came the hour of the discovery and interpretation of fossils. At first, the traditionalists described them as "models of his work, approved or rejected by the artificer or objects placed in the strata to bring to naught human curiosity." But as the years passed and the great science of Palaeontology developed, step by step the unity of life was shown to exist in time as well as in space. One of the most interesting phases of the discovery lay in the theory of the fall of man and its association with the evil in the animal world. White, from whose thesaurus of information on this and relative subjects we have borrowed at pleasure, tells us that for nearly 2,000 years the leaders of Christian thought taught in more or less positive form, that before the sin of Adam there was no such thing as death and, therefore, in the animal kingdom no such thing as poison or ferociousness. The great Augustine extended the argument to include the vegetable kingdom as well. Peter Lombard wrote "No created things would have been hurtful to man had he not sinned . . . they were created harmless and on account of sin became hurtful." John Wesley taught that before Adam fell "none of these attempted to devour or in any wise hurt one another; the spider was as harmless as the fly and did not lie in wait for blood." Even the serpent walked erect and talked before it was cursed by the Almighty. Of course, as the science of Palaeontology developed and an enormous number of carnivorous animals, devouring and partly devoured, were discovered, this belief also vanished and with it went the viper that could live in the fire and the salamander that the flames could not hurt and the cockatrice that "burneth leaves with its touch" and the dragon that fought everlastingly with elephants because it desired the coolness of their blood, and the phoenix that rose from its ashes, and the bees that sprang from the decaying body of a dead lion, and the birds that sprang from trees and were nourished by their sap and were born of rotting wood, and the basilisk that was able to kill human beings at a glance. The behemoth became an elephant, the leviathan became a whale and the unicorn became a rhinoceros. Sirens and griffins were no longer pictured as entering the ark. The conception of creation as having been a process wherein God devised certain definite and permanent species solely for the purposes of mankind became more and more discredited and finally was seen to be hopelessly untenable. Little by little it was made clear that it was not by means of tongue and throat and lips that living things came to be nor by fingers and arms and human-like muscles, nor was it a creation that was instantaneous and final but something infinitely vaster and indescribably more glorious.

It is one of the oddest facts in the history of science that just as this old theological theory of special creation was demolished and, therefore, just at the time when the ancient belief in spontaneous generation would come to be of genuine importance it was also shown to be wholly untenable. It had come to be a matter of great moment whether cheesemites, for example, sprang directly from the cheese or maggots from decaying animals or insects from the slime of the Nile. For, in the meanwhile, Darwin had come with the theory of evolution and the crux of the whole matter was the question of the origin of life. Little by little the unity of life had been shown by methods which we shall hereinafter describe. At this critical moment the theory of spontaneous generation, which in one form or another had been accepted for thousands of years, was suddenly attacked and disproven by methods of sterilization. Redi, Pasteur, and others showed to the satisfaction of the scientific world that life sprang only from life and thus once more by their motto "omne vivum ex vivo" (All life from life), caused mankind to revert to the old Platonic doctrine that life was so beautiful that it could not come from a thing so despicable as matter.

In that older view, life had been practically identified with self movement. It was plain, for example, that a stone was dead because it could not move itself and that an animal was alive because it could. But shortly was to come another break-down even in this hypothesis, for as chemistry and physics and biology came into their own it was very quickly seen that there is nothing from an electron to a solar system that does not move itself; that if life is self-movement, then the whole universe is alive. It may be said of all living things that they have this characteristic, namely: that throughout their entire bodies, whether they are but a single cell or billions of cells, there is motion perpetual. They are growing, living. They require food and this means a continual interchange of particles and influx of materials from the outside; a constant interchange of air and water and solid matter. Even in an unicellular creature this process is intricate and complicated. So that there is nothing more unstable or inexplicable than protoplasm although it is composed of the commonest elements, nitrogen, oxygen and carbon, with a little sulphur or calcium or silicon or phosphorus. Modern science, therefore, had arrived at a point where both of the old theories, that of anthropomorphic creationism and that of spontaneous generation had been demolished. At that exact moment the results of all of the great sciences converged to prove the unity of life. At this point, therefore, we enter into the proof of that unity.

Again we come to the same old story of disillusionment. What could be plainer than the vast unbridgeable chasms between the various species of plants and animals? It may be well to define the word species as used in natural history as meaning "a group, subordinate in classification to genus and having members that differ only in minor details," or as "a group of organisms with marked characteristics in common and freely interbreeding." To unobservant, untravelled, and unmicroscoped mankind there were not so many species but that one man could name them all when an industrious god had brought them to his attention. But as the years grew their numbers were enormously magnified. Although the task has not yet been finished, we now know some 10,000 species of protozoa, some 2,500 species of sponges, some 4,500 species of colenterata, some 50,000 species of flat worms, some 60,000 species of molluscs, some 400,000 species of insects, some 13,000 species of birds, some 3,500 species of reptiles, and some 3,500 species of mammals. Of plants we have listed some 1,500 species of algae, some 65,000 species of fungi, some 17,000 species of liverworts and mosses, some 4,500 species of ferns, some 25,000 species of grasses, and some 110,000 species of dicotyledoneae.

So, as we look out upon the world of life, we are confronted by the same system of illusory appearances as that which faced us when we first began the examination of the world of material things. The world of matter seemed to consist of some 250,000 different "things," yet upon examination their number lessened steadily until we found them to be composed of some ninety "elements" and these, in turn, when they were subjected to fiercer tests became fewer and fewer until at last, we had only the proton and the electron, electricity. So, now shall we find that all the myriad "species" of ilving things of which there doubtless are approximately a million will become fewer and fewer as we trace them to their origin? Will they also fade into genera? And will the genera fade into families, and the families fade into fewer and fewer orders and classes and phyla, until we find living things so diverse in form as an elephant, an oak tree, a fern, an eagle, all developing from germs that are indistinguishable from one another.

Hitherto these chasms such as those between species and chemical elements and especially this great one between organic and inorganic life have been sanctified by the apparent necessity of supposing that they were bridged directly by the hand of God. To some minds it seems nobler to require that direct interposition of divine power in nature, as if all nature were not divine power and as if the failure of nature to operate as a unit without flaw or defect of any kind were a compliment to its Creator. Whether this chasm likewise disappears as we proceed on our quest or not, let this be thoroughly understood, that from the point of view of religion the only question involved is whether God has so made his universe that his pictures melt into one another by indistinguishable gradations, as a cinema on the screen, or whether he presents it to us in disparate pictures like those of an album. The reader may take his choice both as to the facts in the case and as to the relative honor and glory to be ascribed to the Great Artist.

There are few more tragic conditions of religious thinking than the inability of the populace to worship God. To comprehend a Power such as modern science discovers is impossible to any one and to apprehend Him impossible to the masses. Their ability to worship is satisfied with the more easily conceivable; some with ancestors; some with a Mohammed or Confucius or Buddha; some with a Virgin Mary; some with a Jesus. Most human minds are simply too small to understand the meaning of the word, God, without limit in time or space or degree; infinitely exalted above our conceptions of personality and intelligence; as incomprehensible to us as we are to a worm. All the great teachers of humanity have suffered from this human unwillingness and inabilty to think; for the purity of their teaching has always been polluted by attempts of their followers to magnify and apotheosize them. Great men can be understood only by their equals. Anthromorphic idolotry still remains the only possible form of religion for the masses.

FIVE LITTLE PANES OF DUSTY GLASS

Five little panes of dusty glass
And an unmeasured universe await!
Yet, beautiful, O ye lovely forms I see.
And charmed voices—rapturing words I hear.
And odors winged with Heaven's breaths I smell.
And touch; O God what wondrous things are these I touch?
Five little panes of dusty glass;
O mist, O mystery!

And brief the time, ah me, so short the time
To taste, to smell, to touch, to hear, to look
Through such confused, dusty, dazed ways.
So long a while between the moments when,
One (a shadow dimly seen and heard)
Doth wipe away the smudges from the panes.

So many half-lit worlds to see,
So many muffled voices hear,
Such countless forms of things to feel,
Such breaths, breast-warmed of Heaven's draught.
Such untried sweets to taste of, but—
Only a momentary glance,
Through five tiny, smeared panes of glass!

Yet, O so beautiful,
The odor of them is a universe!
So fair their flavors, so entrancing sweet they seem.
So pleasing is their voice, so good the touch of all,
I crave one pane the more,
One crystal pane—and then—
O worlds, O Infinite, O God!

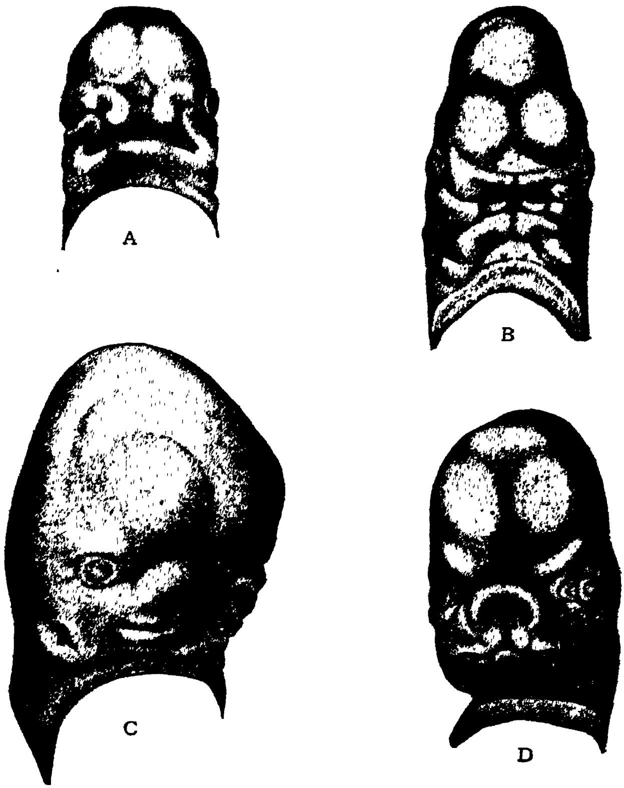
CHAPTER IX.

THE BONDS OF LIFE

The consciousness of the oneness of all living things has come very slowly to mankind. The story of its gradual discovery is one of fascinating interest, tinged with the excitement of the chase and pursued not without blood. To earliest man the difference between an eagle and a frog, between an elephant and a reed, seemed utterly unbridgeable. To multitudes of men today the chasm is still impassable. We reflect also that in the discovery of the bonds that unite all living things we have taken many steps in the very long journey toward the point of origin of life itself. In essence the problems are the same. He who knows where and how life originated can tell the whole story of the kinship of living things.

Perhaps the most astonishing feature of the story lies in the discovery of how unobservant men usually are of the things that lie nearest to them. Here is a man, for example, eighty years of age. He weighs 175 pounds, he is six feet tall, his hair is white, his skin is bloodless, his flesh is flabby, his muscles are lax, his step is tottering, his features are rugged, his pulse is low, his eye is dim, his eyebrows shaggy, his will is weak. It is the appearance of old age. Forty years ago the hair of the same man was black, his step was brisk, his features were virile, his eye was piercing, his will was strong, his flesh was firm, he had the appearance of vigorous health. He was quite a different creature entirely from the man of eighty and very few persons could recognize the two as being the same. Twenty years before, he bore still a third resemblance. He was younger, not only, but in every point, mental and physical, differed widely from what he would be at forty. Still more widely does his appearance diverge as we follow him back into his youth again until, at the age of ten, let us say, no person could possibly recognize the man of forty. At the age of five none could recognize the man of twenty, and at the age of one he bears no recognizable resemblances to anything that he had been or would be.

But the widest difference is still to come, for as we follow his life back towards its beginning there is revealed



DEVELOPMENT OF THE FACE OF A HUMAN EMBRYO.

(His.)

From Prentiss and Arey, *Embryology*, by permission of W. B. Saunders and Co. (Courtesy of Yale University Press.)

to us the most astonishing panorama known to mankind. The great mass of human beings think of themselves as having begun their lives as little babies but, as a matter of fact, they began to live months before, and indeed, in one sense, they were eternal. As embryology tells the story of the chapters in our lives that precede our birth, we read a record so utterly full of mysterious wisdom that there are no words wherewith to describe it. There are, of course, immature births and monstrosities sufficient in number to indicate to even the average man something of the pre-natal growth, but the story of the earlier life of an individual is revealed to us entirely by our embryologists. They describe to us a form which disappears rapidly from that which we think of as human. Trace after trace of humanity vanishes as we go back into our pre-natal past until no lineament of the face, no outline of the body, nothing that we would call manlike remains. Little by little the body becomes smaller, not only, but attains a shape that no person would recognize as that of an infant until, at last, ever diminishing in size and changing in form, we view what we once were; just a little speck of matter that requires a microscope to be seen, and our embryologists tells us that even that is a product of millions of years of development. Even this is not the most astonishing part of the story. For as we sail back homeward, speaking biologically, as we come nearer and nearer to the port of the unicellular thing that each of us once was, looking out upon the sea of other living things returning homeward with us, we note that difference after difference is fading, that resemblance after resemblance is appearing, and that all those marks and characters which distinguish the tiger from the oak tree and the wasp from an eel are gradually disappearing until they, as we, become, also, little unicellular specks which the most skilled of biologists using the most powerful of microscopes, cannot distinguish one from another. The wildest dream of the most imaginative story-teller could never have pictured such an astonishing romance as this reality. Of all discoveries that mankind has made nothing is more utterly surprising.

To trace the parallelism in the embryological life of creatures so different in their natural forms as the human being, a frog and a chicken is one of the most amazing revelations that science offers. We know, of course, that as it was above with our man of eighty, of forty, of twenty, of ten, and of one, so it is with every other creature. The common fowl of the barn-yard, for example, offers us an equally striking contrast. What resemblance to the full grown cock with his flaunting feathers, his sharp spurs, his invincible fighting spirit, does the little one-day-old chick offer? And what resemblance to the one-day-old

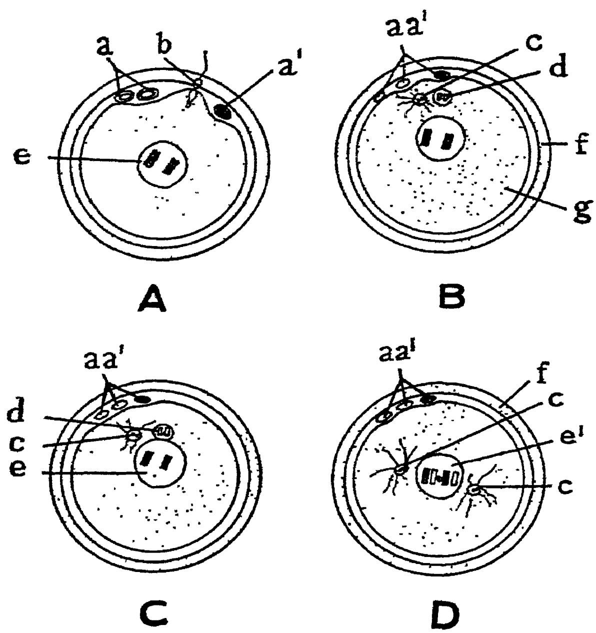
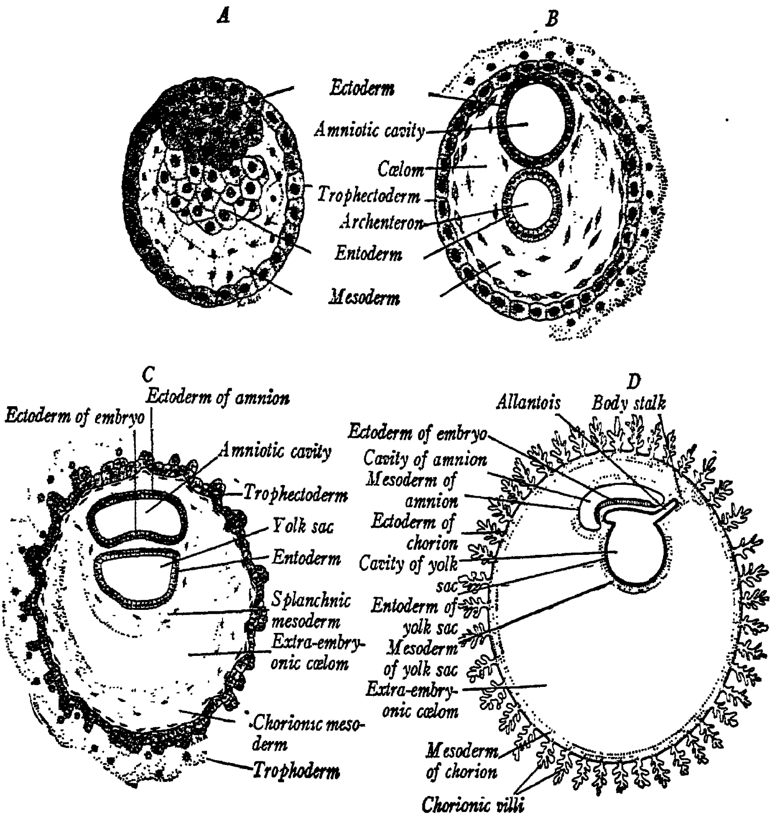


DIAGRAM SHOWING THE FERTILIZATION OF THE OVUM.

a—The mature ovum with a central nucleus, or, as it is termed, female pronucleus (e), containing the reduced number of chromosomes; the others have been given off into the first and second polar bodies (a). A—a single sperm (b) is entering the ovum. B—later stage in which the male pronucleus (d), with the two paternal chromosomes, has formed from this sperm. The sperm also brings to the ovum the centrosome (c), which is regarded as the dynamic division center. C—still later stage in which the male and female pronuclei are uniting to form, in stage D, the segmentation nucleus (e), which contains an equal amount of maternal and paternal chromatin. Following this the fertilized egg cell will divide by the complicated process of mitosis which insures the equal division of the chromatin material among the daughter cells. a—first polar body (divided into four parts); a—second polar body; b—sperm entering the ovum; c—centrosome (later divides); d—male pronucleus; f—cell wall; g—body of cell. Redrawn from Cunningham, *Anatomy*. (From *The Evolution of Man*, by Lull, Courtesy of Yale University Press.)

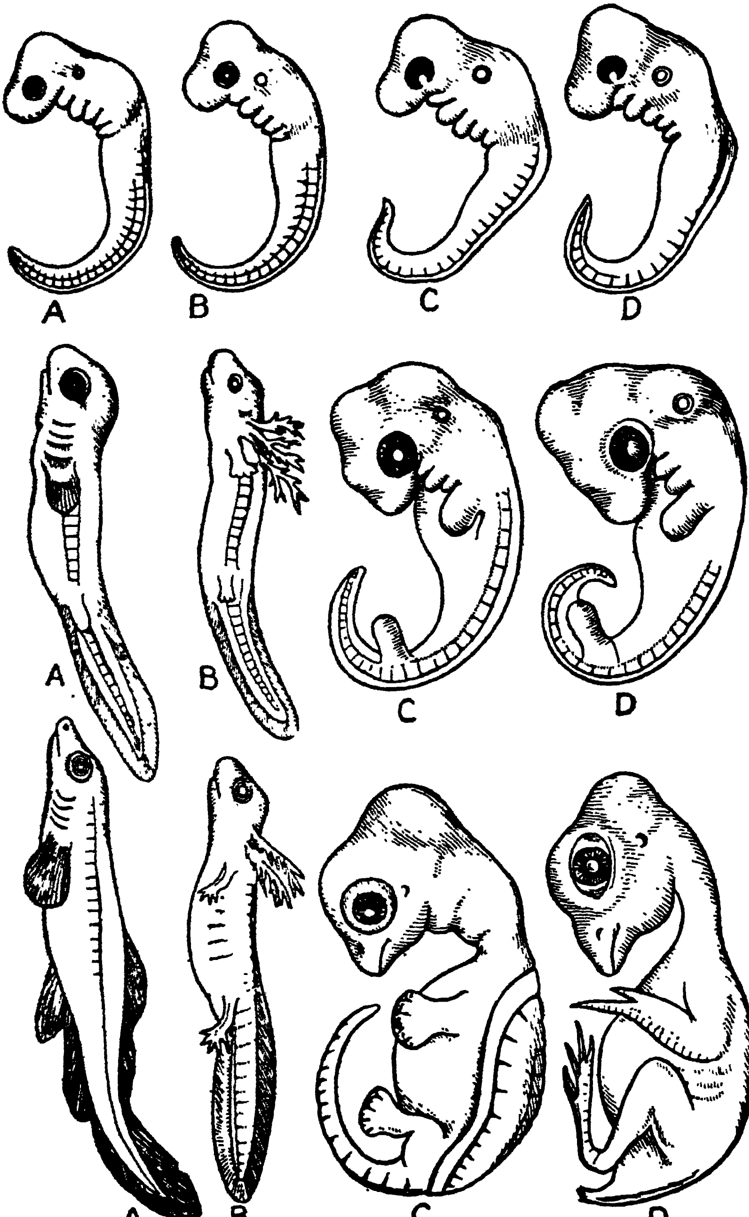
chick does the little spidery thing that appears after one week's incubation just outside of the yolk of the egg offer? Such contrasts appear in the life history of every living thing.



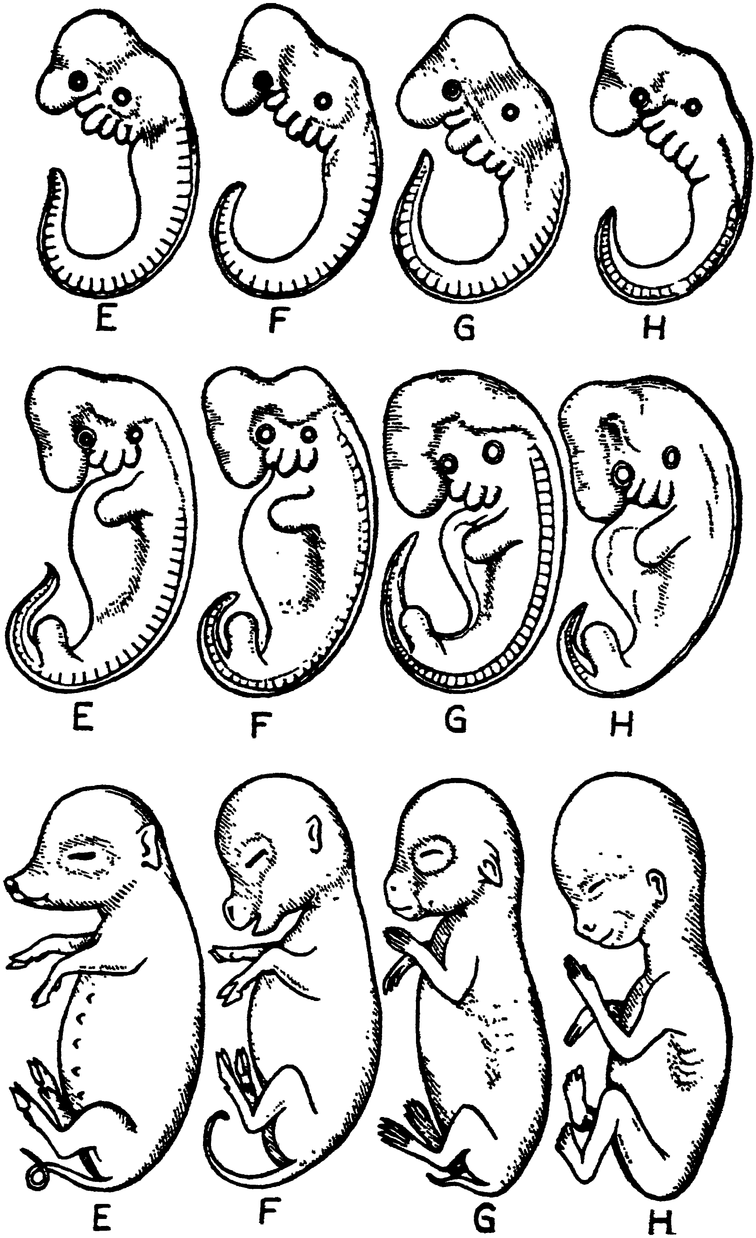
DIAGRAMS OF EARLY HUMAN EMBRYOS.

A—Hypothetical Stage; B—Bryce-Teacher Embryo (modified); C—Peter's Embryo; D—Graf Spee's Embryo. From Prentiss and Arey, *Embryology*, by permission of W. B. Saunders and Co. (From *The Evolution of Man*, by Lull, courtesy of Yale University Press.)

But it is not so much the contrasts that astonish us in embryology as the resemblances. Here for example are pictures of the embryo of a fish, salamander, tortoise, chick, hog, calf, rabbit and man at the same stage of development. None of the eight bears the faintest resemblance even to the newly born offspring of its kind. The human em-

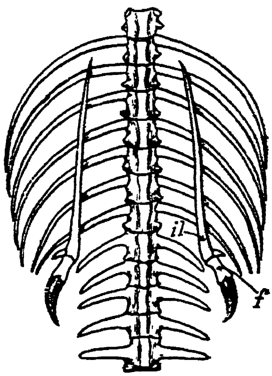


Series of vertebrate embryos at three comparable and progressive stages of development. A, fish; B, salamander; C, tortoise; D, chick
(Continued on next page.)



(con.)—Series of vertebrate embryos. E, hog; F, calf; G, rabbit; Human. (After Haeckel, from Romanes' ***Darwin and after Darwin.*** Copyright, Open Court Publishing Co.)

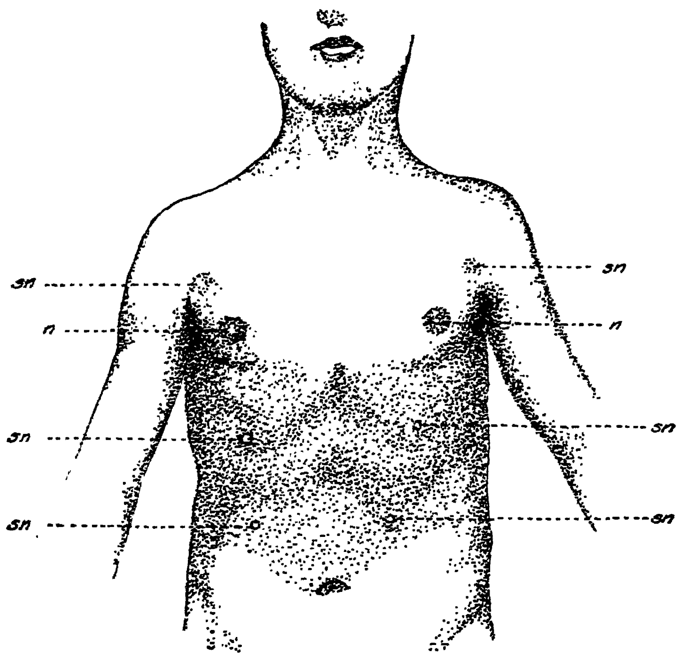
bryo is quite inhuman but it is strikingly like the embryo of all the others. Not a single line of what he is to be apparently is there. Yet plainly marked and visible are the gill-slits which tell us the strange story of the life his ancestors once lived and they are located just in the same position and have the same appearance as the gill-slits in the embryo of the fowl and the shark. In the mature man all of these slits except one have disappeared and that has been changed into the eustachian canal, still doing service by connecting the middle ear with the throat. It is, however, not so much the external resemblances of the embryos of different living things as their method of growth and development that identifies them as fellow-travelers along much the same road from those far distant shores. Every living thing begins with just one cell. Almost at once the paths diverge. Some remain unicellular. Some choose the road that leads to plant life, some take the highway to animal life, each learns how to add cell to cell much as mankind originally learned to add rom to room that he might build his greater house. Of the animals, the evidence goes to show that part remained in their home, the water, but many others learned to live on land, first as amphibia and later as purely land animals. These in turn diverged until we have the widely differing species of today. But all of this we shall sketch when we come to the subject of palaeontology. There are two words used in biology which perhaps carry with them as much meaning as any words of science. One is ontogeny, signifying the whole process of individual development. The other is phylogeny, covering the development of the species, the genus and the phylum. Now the interesting theory has been broached that the former recapitulates the latter; that, in other words, the story of the development of the human embryo is a story of mankind in palaeontology. The theory cannot, of course, be applied exactly and literally. One could hardly expect an egg of a chicken during its three weeks of incubation to fully reveal the life history of the birds. There would, of course, be a great amount of abbreviation and condensation to such an extent that many processes would be apparently eliminated and others subordinated. Then there are other cases where the embryo leads an independent life as, for example, the larvae of butterflies as caterpillars. This also would have to be taken into consideration. But, speaking broadly, the ontogeny of all vertebrates is strikingly similar, with such sign boards along the way as the gill-pouches. It is interesting to note, also, that the lungs seem to have been derived from swim-bladders. Countless structures like these plainly indicated in the embryo vanish before birth. The embryo of the whale, for example, which was once a land animal is coated with hair and the hind legs are plainly apparent although the adult whale, of course, has only its fore legs, flippers. Likewise, while the adult whale has no teeth its embryo has rudimentary teeth which disappear before birth. Oddly enough, even snakes in some of their species show embryo legs, and if one digs into the blubber of some species of whales he will find the hind legs still there but gradually disappearing. Such vestigial remains so far as mankind is concerned are indicated in the gill-slits, not only, but also in such examples as Darwin's point of the ear; in the ability, almost lost, of moving the ear; in the nictitating membrane of the eye; in the relic of a tail and the muscles for wagging it plainly visible, embryologically, and indicated in adult life; in the direction of the growth of hair on arms and body, showing that man had lived an outdoor life for an immensely long while; in the lanugo; in the appendix; in supernumerary nipples, in club feet which are really gorilla-like feet. There are more than a hundred such vestigial remains, each a sign-post pointing out the road through which mankind passed as he staggered up out of the night. Like his mother earth, he also has travelled far. What a vast distance he has come, whether we think of him in that long individual journey of the cell to the adult or in that longer but no more intricate journey from the cell of ages ago to the adult of today! From what abyssal depths, to what dimness of light! At how many partings of the ways would it not have been possible for him to have taken the wrong road, the road that would have led him to tigerhood or swine-hood, that would have kept him in fish-hood or vermi-hood. How many times he must have looked out, tempted to follow his then fellows, or have left the grip of circumstance binding him to a lower life. He



VESTIGIAL HIND LIMBS OF PYTHON.

f—Femur or thigh; il—, ilium or hip bone. (From Romanes' Darwin and After Darwin.) Copyright, Open Court Publishing Company. From Lull's *Evolution of Man*, courtesy of Yale University Press.

alone kept on while the vast mass of lower animals stopped. Or shall we say that they stopped? For there is every indication that many of them also are still developing both as to body and mind. But the firm fact stands fast that all of the diversities and differences of man and tree and beast may be and have been traced back and back and back until roots and limbs and hair and claws and bones



SUPERNUMERARY NIPPLES OF MAN

n—Normal nipple; sn—supernumerary nipple. Redrawn from Wiedersheim, after Ammon. From Lull's *Evolution of Man,* courtesy of Yale University Press.

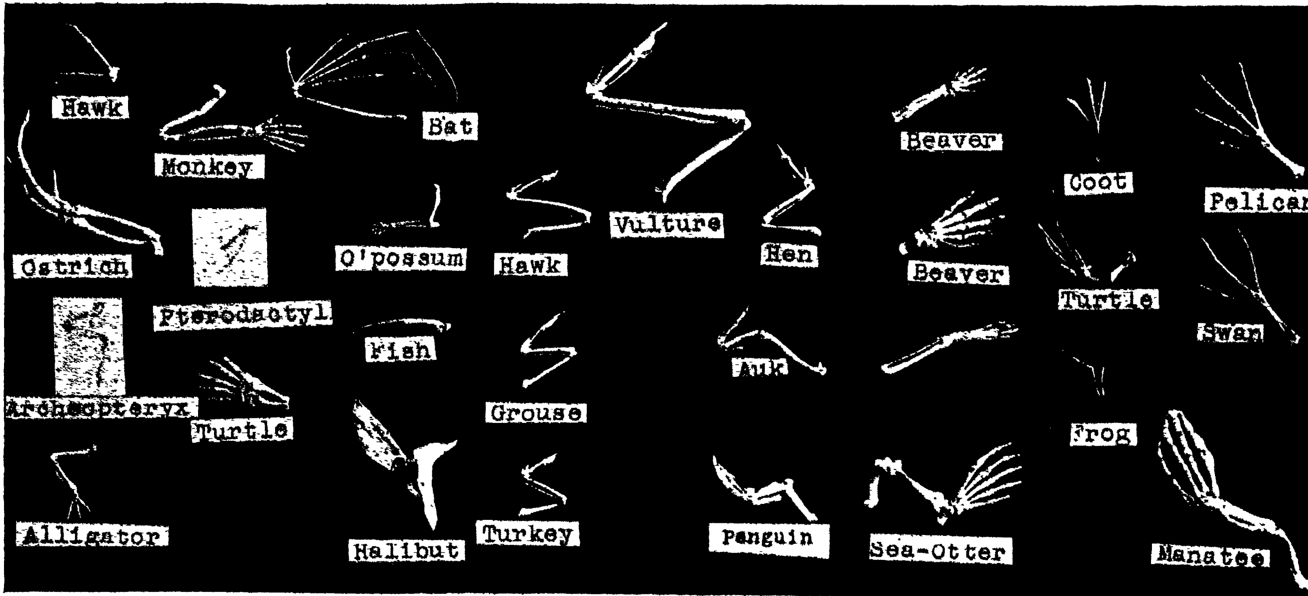
and flesh and muscles and blood all vanish into one infinitely complex globule of protoplasm, into a tiny cell. This is the amazing story of embryology. It constitutes an unbreakable bond binding together all living things in one common bundle of life.

And the kinship thus expressed in the very womb of nature herself is borne out in the recent discovery of the intimate relationships, shown by their blood which furnishes its common life-stream to them all. It seems that a common property has persisted in the blood of animals in proportion to varying degrees of consanguinity. The old saying "blood will tell" has thus received a modern accentuation. The method by which these results have been obtained is simple enough. Various attempts at the transfusion of the blood of one human being into the veins of another had already brought out certain personal differences of composition and result between individuals so that it was found to be dangerous to make such attempts without careful analysis of the blood contents. These differences were usually magnified when the transfusion became that of one race of mankind into the blood of a member of another race. They were even more generally magnified as between different species of animals. Experimentation was begun and some startling results were obtained.

If human serum, which is the white, watery part of the blood, be injected into another animal, a rabbit, for example, there would be developed in the blood of the rabbit an anti-body, a sort of anti-toxin, whose physiological use doubtless is defensive against the poison thus introduced. If, now, from the blood of the rabbit, the serum be taken, and if it be dropped into a weak salt solution of human blood, whether fresh or old, dried stains, there is formed a white percipitate. Oddly enough the reaction varies in degree as the species vary in relationship to man or, in case of anti-pig or anti-horse serum which can be made like the anti-human to the pig or horse. In other words, the more closely related the blood is to the "anti" serum, the denser the percipitate. Many tests of this sort have been made and the results correspond with results obtained in other fields as to the relationship of animal life. "Blood kin" has become more than a sentimental phrase. It defines biological relationship. It is another bond evidencing the ties that bind the fish of the sea, the fowl of the air, and the beasts of the field.

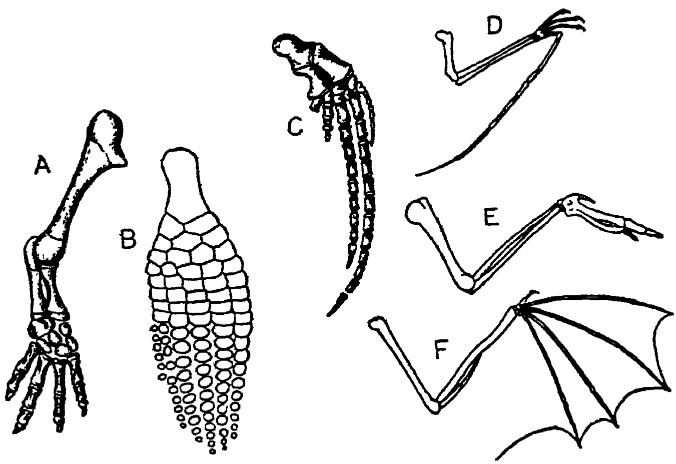
And there is also the bond of the body as evidenced in comparative anatomy. For unobservant man learns with astonishment that every bone of the body is crying out its witness to the unity of life. Here, for example, is the right arm of the great baseball pitcher, the anatomy of which is fairly simple. There is the humerus, the bone that joins the elbow to the shoulder; there are the ulna and radius, binding the wrists to the elbow; there are the carpals, the wrist bones; there are the metacarpals which form the body of the hand; and there are the phalanges, or fingers; nor should the finger-nails be forgotten as we shall shortly see. This seems so widely different from the fore-leg of a horse that one would only smile at the credulous fellow who associated them as to their origin, yet a careful examination shows that the horse also has his humerus, his ulna and radius which have ossified into one bone, his carpus, his metacarpals, and even his fingers and perhaps most important of all, one great finger-nail on which he walks. The fingers have all been welded into one, or perhaps it may be better expressed by saying that all except the middle finger and nail exist only as vestigial remains, the history of whose loss can be traced as we shall later see in our study of palaeontology. And if we take the foreleg of a cow we shall find but slight difference, the main one being that the cow has preserved two toes and enlarged two finger-nails instead of one.

Now the odd part of it is that such resemblances show up as being the greatest in the varieties of a species and less as the species vanish into genera but remain perfectly distinct as to such classes as mammals. Like everything else that we have found in the universe, when first seen the form of animals appear to be vastly different but as we examine into the matter we find that the vast differences are only the accumulation of little, tiny differences. For example, nothing would seem to be more different from the human arm than a bird's wing, but when we dissect it we find the bones all there, some shortened, some lengthened, some partly absorbed, but all there, discernible by sight or inference. Nor is it different with that strange object, the wing of a bat, which has its humerus, its radius and ulna, its carpus, even its fingers. And as to the flipper of a whale, it is a perfectly fore-shortened picture of the arm of a man, as is also the shovel of a mole. In short, amphibians, birds, reptiles and mammals are so self-evidently built alike that even the foreleg of a lizard tells the tale of the unity of their life by its resemblance to all others, including mankind himself. Each variety, each species, each genus, each family, each order, each class, each sub-kingdom by its form and shape when critically examined, gives the same witness. And the combined evidence, overwhelming and ever increasing, is another unbreakable bond that binds all living things together in one common unity of origin. It is, to use a fine and familiar illustration, as if one passed along a street where a great deal of loose dirt had been dumped into a little valley where a great oak stands, thus covering it with soil until at the



The forelimbs of various reptiles, birds and mammals, showing how function has modified form. (Courtesy of American Museum of Natural History.)

top only the twigs of the uppermost branches could be seen. Yet as one digs down into the ground the twigs are found to be joined together into limbs which by their union at last form the trunk of the tree. For the common center of life is as plainly indicated as the spokes that lead to the hub or the silken threads that point toward the center of the spider's web, or the constantly converging roads that all lead toward the great metropolis.



VERTEBRATE FORELIMBS (HOMOLOGOUS)

A—Necturus, a primitive salamander; B—Ichthyosaurus; C—Globicephalus, a dolphin; D—Pterodactyal; E—bird; F—bat, (after Wilder) from Lull's *Evolution of Man*, courtesy of Yale University Press.

Closely akin to these bonds is that the discovery of which led Lamarck and Darwin to accept the theory that all life had come from a common source. This is the fact that as the knowledge of men has increased it has become more and more impossible to define a "species." It will be recalled that both science and theology were founded for many centuries upon the dogma that God originally created a certain definite number of species which had remained unchanged and would remain unchanged, that these species could be distinguished by certain resemblances of form and shape and structure, that they were utterly distinct from other species as to their birth, their origin, and their life, that they would not and could not inter-breed with other species, or, if off-spring came from such a union, it was only as hybrid and sterile. Here, for example, is our common cat, Felis Domestica. It differs from the Felis Leo, the Lion, and from the Felis Tigris, the tiger, and even from the Lynx Rufus, the wild-cat, but with them and the puma and the leopard and the jaguar and the lynxes it is bound together in the family of the felidae and with mankind and the apes and the wolves and many others is classified as a mammal, and these in turn are joined with multitudes of animals other than mammals, in the sub-kingdom which, in turn, with the plants form the world of living things.* From this it will be seen that it is from the greater or less degrees of resemblance only that our classificationists derive their species and that as these resemblances vary, so vary the species. The great Linnaeus who above all other men did most to classify the living things of the world was until his closing years a believer in this which we may for the purpose of identification call the theological theory of the origin of life. But when Lamarck and Darwin came to study the problem and especially as there were constantly revealed increasing numbers of species, not only, but multiplying resemblances between them, the science of classification came to the point where the classing of an animal in this or that species was a matter of personal judgment in which great biologists differed from great biologists. So Lamarck and Darwin both forsook the old theory as have all their successors.

The evidence is simply overwhelming. At first great gaps and unbridgeable chasms existed between each species but step by step the gaps were largely filled. It is as if one wandered into a nursery and found on the floor two blocks, on one of which was the letter A and on the other the letter Z. A moment later one discovers another block marked B and another marked Y, and so on and on until twenty-six letters are revealed. Then one knows that he has not discovered twenty-six letters at all but an alphabet. So as the number of species has been increased while the information of mankind has been widening it has in many cases become impossible to distinguish them one from another. Our best scientists differ as to whether a certain group is a species, a sub-species, or a variety, and this is true whether they are speaking of birds or plants or animals. The science of classification simply arrived at a breakdown. Classificationists faced a law, not a list.

*K. P. COFGSI, will serve as an excellent "mnemonic" to aid the student in remembering the order: *K*ingdom; *P*hylum; *C*lass; *O*rder; *F*amily; *G*enus; *S*pecies; *I*ndividual.

Which is but another form of testimony to the unity of life.

It is really a matter of surprise that men had not already arrived at this conclusion with such a multitude of illustrations before them of the effect of domestication upon plants and animals. The very food that they ate on their tables kept screaming at them to recognize how form and shape and general characteristics vary according to environment. A moment's thought would have revealed to them the vast difference between domesticated wheat and wild wheat, between domesticated rice and wild rice, and so of each of the grains and berries and vegetables and fruits which mankind has first found and then fattened and by means of food and drink changed into something different from what it was. Even the pigeons in their cotes should have reminded them of the great difference between the wild pigeons and the tame. Any good biologist had he found in the woods the various types of modern pigeons would have classified them immediately as different species. And what shall we say of the greatly varying kinds of dogs, the spaniel and the bull dog, the poodle and the police dog which tell the same story as that of the difference between the pouter and the fantail pigeon. Then there are the fowls in the backyard, the gallus bankiva, the jungle fowl and its widely variant offspring. The little game bantam would seem to bear no kinship to the great langshan and what could be more different than the head, for example, of the houdan with its crest and beard and double-comb of two little horns and the white leghorn without crest or beard and with an utterly different comb. And as to the breeds and varieties of cows and sheep—when we mention sheep there comes to mind instantly the case of the ancon sheep, a short-legged variety derived from a "sport" or variation on an American sheep farm, from which there was bred an entirely new kind, or shall we say species, bearing that name. And there is the case of the Porto Santo rabbit, different in color and size and shape, and refusing to breed with other rabbits, which came from one doe and her litter set free on the island of Porto Santo in the early years of the fifteenth century. There are many similar examples showing what the effect of a change in environment, which, of course, carries with it a change in quality and kind of nourishment and life, can do to modify the appearance and general character of a living thing. So constantly we come upon the same result and the same evidence, the evidence of the domesticated wolf which appears in modern days as our friend, the dog; of the jungle fowl which we know best, perhaps, as the Philadelphia capon; of the domesticated pigeon which pouts at us and coos to us or helps us win our battles. All bear the same testimony, a frank and full statement of the unity of life.

Nor is this all, for when the matter is put to the test of location, the geographical distribution of life on the earth is a corroborating witness. The life regions of the world may be roughly divided in accordance with resemblances of living things within their borders, into, first Australia, whose fauna differs so widely from the rest of the world as to put her in a class by herself. Second is South America, of which almost the same may be said. The third is Madagascar, known as the Malagasy region. The fourth is Africa south of the Sahara, known as the Ethiopian region. The fifth, the southern peninsulars of Asia, the Oriental region. Sixth, the territory included in all of Europe and Africa north of the Ethiopian region and Asia north of the Oriental region, with Japan and all of northern North America, known as Holarctic region. And the last, the seventh, consists of the remainder of North America including practically all of the United States and known as the Sonoran region.

Now the point to be noticed is that these regions, differing thus from one another as to the form and shape and general character of their plant and animal life are able to offer certain definite reasons for such differences. If, for example, we imagine that Australia has been long separated from the mainland of Asia, so long that its animal life has had time to diversify in form and qualities, and if we suppose that there is a process of continual change or development or evolution going on in the life of the world, then we have the clue to the reason why the fauna of Australia are different from the rest of the world. As a matter of fact, the geologists tell us that this is the case and that Australia has probably existed as a disconnected body of land longer than any other large territory on earth. Its life, therefore, has been longer separated from all others and exhibits as an expression of that separation its great difference in general character. The same may be said to a lesser degree of Madagascar, and of South America, which, for a long while, speaking geologically, was not connected with North America. And

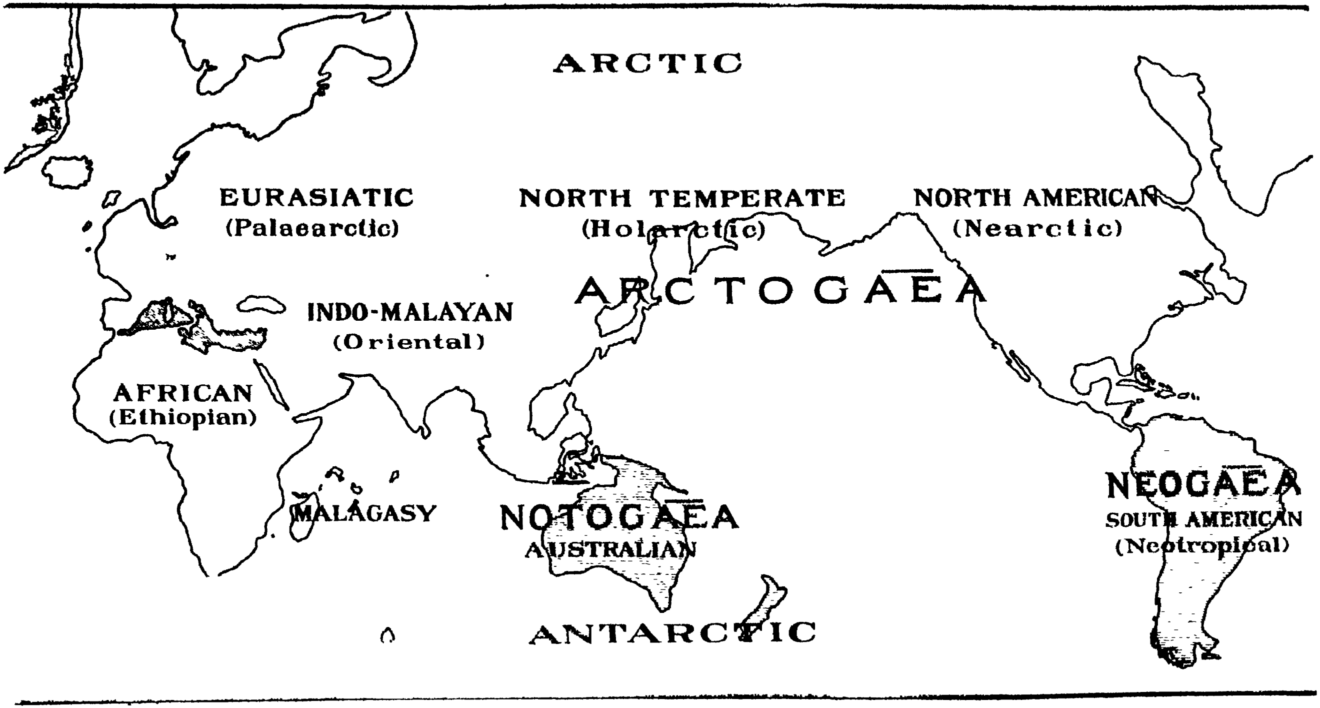


Diagram showing the principal life regions of the world. In addition to the above the territory of the United States is usually referred to as the Sonoran district. (Courtesy of the American Museum of Natural History.)

the other sections of the world embracing all the other regions have been and in many cases still are more intimately associated and physically connected. It is known, for example, that the island-hood of Great Britain is recent, that even while men of the Old Stone Age were living in Europe, Spain was connected with Africa at Gibraltar, Italy was connected with Tunis, Greece was connected with Asia-Minor. Also, in the past, North America has been connected with Asia, and in proportion as those physical connections have been numerous and recent, according to the testimony of our geologists, do we find the life in these regions the more closely resembling one another. The parallelism of physical connection and biological kinship is of great significance. The testimony of the islands of the sea is the same. Their life is that of the neighboring mainland, or in case of long separation it is proportionately variant. The life of the mountain-tops bears the same testimony. For the isothermal line—that is to say, the line of equal heat— is one of the most deadly barriers to animal and plant migration. Very few animals are able to pass through it with impunity but they cling to the temperature to which through long ages they have grown accustomed. Therefore, as the climate changes through geological processes which we have described many species are isolated, so to speak, on the mountain-side, so that there may be a species of plant on Mount Mitchell and the other high peaks of the Appalachians in North Carolina that is found no where else in the state but that is almost identical with plants growing to the far north along the same isothermal line. This, briefly, is the testimony of geographical distribution to the unity of life.

And following his usual custom to explore the secrets of nature wherever possible, man has corroborated, by experiment, what he has observed in the world at large. For the same sort of differences which justify the naturalists in segregating a group or a species, have been brought about in the biological laboratory. Domestication is indeed a sort of unconscious experimentation but under more rigid circumstances of observation astonishing changes have been wrought. The case of the salamander is mentioned by Dr. Scott in his remarkable little volume on the Theory of Evolution, of which we have taken frequent counsel in this chapter. Left alone in its wet forests it gives birth to some seventy gill-bearing larvæ in the water which are left in the water for months and finally change into air-breathing salamanders. When deprived of water, instead of bearing sixty or seventy larvæ it gives birth to a few little live salamanders resembling their parents. The off-spring of the second generation when allowed the use of water is a group of larvæ but not so many and much larger and they stay in the water a much shorter while, days instead of months. Water-fleas have been in the dark so long as to lose their sight, reminding us of what nature has done for the blind fishes of Mammoth Cave. The important point to notice is that such new characteristics thus developed are in many cases hereditary and are passed down from their parents to their off-spring. This, indeed, is the crux of the whole matter and it brings us to the wonderful work of Mendel in developing a basis for a practical theory of heredity. If, for example, a red flower of a certain species is crossed with a white flower, one-fourth of the off-spring will be white, one fourth would be red, and the other two-fourths a blending of red and white, or pink. In some cases one of the colors was found to dominate the other. For example, when white flowers were crossed with violet, the first generation was all violet but thereafter one-fourth was white, one-fourth violet, and the other two-fourths dominant violet—if we may so describe it. This opens up a broad outlook upon heredity which now appears to be a process of assortment of certain unit characters transmitted more or less separately as, for example, when a cross between the houdan fowl and a leghorn will in some of the progeny show the houdan's crest or the leaf-comb or the fifth toe either separately or together. Processes of experiment aim, therefore, at the suppression of certain of these factors, which determine the results of cross-breeding. Thus skillful men make new varieties of animals and plants, of berries and fruits changing their markings and characteristics much as a change in food modified the lunar moth transported from Texas to Switzerland. It is a very long and interesting subject but the thing to be remembered is that by experiment mankind has corroborated the testimony given him as above to the effect that all life is one. He has even broken down the imaginary partition wall between different species and in numerous cases has found their progeny fertile. Here, for example, is the turk-hen, a cross between a turkey gobbler and an ordinary farmyard fowl, dividing in its inheritance the characteristics of each and perfectly fertile, a new and inter-breeding "species." The "Kiwi" is the result of a similar cross between the New Zealand bird of that name and the domestic hen, a case of mating different genera whose progeny again are fertile. A cross between a zebu (Bos Indicus) and a gayal (Bos Frontalis) has been bred to the American bison (Bison Americanus) resulting in a calf that represented three distinct genera. Fertile crosses between the American bison and ordinary cattle (Bos Taurus) are common.

What a wonderful vision is thus offered us. We begin to realize what it means to be the heirs of all the ages. The whole past with its hundreds of millions of years is the story of opportunity that was lost or accepted, a story of dim ambitions and desires that were gratified or suppressed, of kindly or harsh environments that wrought their will, destroying or hardening this or that creature. It is a story of use or disuse of organs and limbs through countless ages, followed by its inevitable consequences of development or loss of that organ or function. And into it all is written in mysterious language, the story of a quest, a journey, a going forward, a mounting upward that has proceeded out of the darkness that lay behind the age of the mammal and before the era of the amphibian, that is deeper than the blackness of the haunts of the fishes and less conscious of light than the depth of vermian night. It is a long, long journey up through struggle and defeat and conquest and ambition and toil and infinite labor and patience, from a single cell to all that we now possess of civilization and religion and education. The story of how this was done as far as we are able to tell it will form the subject of succeeding chapters.

I.

I heard the mighty drum-beat of a million marching centuries.
I heard the tireless tides of countless ages pulsing softly on their shores
I heard the gurgle of ten thousand running streams.
I felt the strange tingling of many messages,
Speeding through distant lands, o'er many well-laid wires.
With every sense quickened, I lay listening.
Perhaps there might come a word from the vast within,
Advising me of the object of their tense and earnest struggle.
At first I heard only a confused murmur of many shouting voices.
The mighty bellowing of a million forges,
The toilings of great civilizations engaged in some tremendous enterprise.
Then—I began to hear the unending tramp of armies,
And through stranger than earthly canals
White navies sped from harbor to harbor,
That the fierce hand of some ruthless invader might be overcome.
I heard the call of artisan to mechanic,
As they rebuilt carefully the structures,
The bridges and culverts, the rails and wires, the houses and engines,
Worn and weakened by a day of toil.
And all this was—I!
Myriads of invisible intelligences, working incessantly, toiling interminably,
Building and ever rebuilding dynamoes, laboratories, factories;
Repairing ways of travel;
Replenishing fires;
Cleansing all avenues of poisons;
Consulting together that I might wake in the morning;
And all, of whom I was unconscious,
Ever conscious of me.
So that I could not even dream at midnight
But that every state of their empire heard it;
Until the vast machinery of their civilization was set in motion;
Every power plant quickened its motors;
All the belts were at tension;
The rivers of commerce hastened their waters;
And all the wires of intelligence were singing with messages.

CHAPTER X.

THE CONTINUITY OF LIFE

Perhaps the most surprising single feature of the world in which we live today is the variety and universality of life. And each new hour of discovery emphasizes the multitudinous kinds of living things, not only, but also their wide-spread distribution. From amoebæ to elephants, from algæ to sequoias, there is no gap wherein some variety of life does not appear. Nor does there seem to be any spot too cold or hot, too high or low for the habitation of living creatures. Under six miles of ocean waves life abounds as it does also in mountain snows. Hot springs that scald the hand are its dwelling place, yet rotifers have been found under sixteen feet of solid ice in the Antarctic regions. Whether the water is fresh or salt, life adapts itself to it, showing a wonderful initiative in the development of new fields of exploitation; constantly leaving or returning to the sea or the land, as the whale has done; so that today we have mammals living in the ocean, not only, but fish that climb trees and spiders that live in the water. The long polar cold they learn to conquer by hibernation, in the case of some animals, and by migration in the case of others. Every nook of the woods, every corner of the field, every breath of the air, every wave of the sea is full of life. And the astonishing fact about it all is that only a few kinds of the vast multitude of living things are visible. The larger animals and birds we see plainly enough, but they are few in numbers. Silently and quietly the multitudinous life of the invisible goes on unnoticed. Some of it is in the sky, some of it is beneath the sea. Some of it is in the soil, and a great mass of it within the bodies of larger living things. Between the larger and the invisible worlds of life lie some 400,000 species of insects. Indeed, this may be spoken of as the age of insects. About one-half of the total number of living species belong to that order. We cannot refrain from asking ourselves: Whence came all this life? Since there is a unity that binds it, is there a continuity also? Can they all be traced back in time to a common point of departure?

Certain general observations will be useful in guiding our thoughts as we take up the subject of the continuity of life. We do not fail to notice that whether we speak of things that live in the air or those that live on the ground or those that live in the water, they each and all depend upon the other two of those three worlds. For example, an animal that lives upon the earth, while it is of the earth earthy, nevertheless, literally and actually lives in water, and at the same time is dependent for its existence also upon certain elements of the earth for its food and upon the oxygen of the air, which it breathes dissolved in water. Likewise, the insect or the bird that lives in the air is dependent upon water and earth for its life. It gives us a little clue to what we shall find at the end of our journey as we trace life to its lair, for we shall find that all living things are equally children of the earth and sea and sky.

And there are certain general principles underlying life which, if clearly grasped, will aid the reader in following the biological story back into the past.

The first of these is commonly spoken of as the law of variation. It is the principle of individuality. Nothing in the world is exactly like anything else. Of all the myriads of grains of sand on the seashore no two are exactly alike. Of all the coins from all the mints of the world, no one is exactly like another. It is not surprising, therefore, to learn that of all the living things, vertebrate and invertebrate, that have lived through all of the centuries, none is exactly like another. No amoeba in reproducing itself by division is able in either of the progeny to duplicate exactly the parent-cell. Indescribable billions of protozoa have existed from remote time and do exist today, yet no two have been exactly alike. Of all the leaves on all the trees of all the forests of all the centuries, no two are exactly alike. When this is thoroughly grasped one can understand that nature inevitably gives birth to every possible life form and in so far as those forms accord with the environment into which they are born they live and develop.

The second law is commonly referred to as the law of heredity. It describes the custom which nature has of producing like from like. While it is true that no two leaves on a tree are exactly alike, it is also true that all of the leaves on a given tree are quite alike. There are individual variations in each leaf but there are also general resemblances. This law holds good with respect to all species.

The inheritance of variations is one of the mooted questions in biology commonly associated with the inheritance of acquired characters. It is probable that every living thing is more or less affected by every element in its environment. Just as the star feels the tug, though it be infinitesimal, of every other star in the universe, so each living thing feels the influence of its environmental factors, and these whether they be food or climate or others, by affecting the senses, affect also the body, and eventually the heredity chromatin. If deep enough and powerful enough and long continued enough, these effects accumulate until they become noticeable by man. Thus, as it is with planets and atoms, so it also is with living things. No influence is lost. It is not maintained, of course, that a slight environmental change will effect the heredity chromatin noticeably any more than the fall of a little meteorite would throw the earth out of its course, but doubtless the effect is there though the ultra microscope which can detect it has not yet been created.

The third law under which life seems to operate is commonly referred to as the struggle for survival. All animal life is enormously productive. Mr. Vernon Bailey of the U. S. A. Department of Agriculture has recently written a bulletin in which he tells us that one field mouse mothered seventeen litters of young in one year. Within the same year one of her daughters mothered thirteen litters, of four to eight in number. The progeny of one field mouse freed from the law of the struggle for survival would in one year number over a million. In a few more years the progeny would weigh more than the whole earth. But there is a limited amount of food in the world. It becomes, therefore, eventually, a question of who shall survive. Thus the fourth law, that of natural selection or the survival of the fittest comes into play. To illustrate this is simple enough to any one who has ever raised poultry or live stock. On an acre of ground there is, let us say, enough food for one cow to subsist. If others should be added and no more food given the effect would be immediately seen in the lessening of the strength and vitality of them all, but after so long a while the best fitted to survive would remain and the others would die. Thereafter, the survivor might return to her accustomed health and vitality for the food would be sufficient. To a given group of fowls in the backyard if a given amount of food is fed they will all flourish and in due course of time present their owner with an abundance of eggs. If the amount of food is reduced the eggs will be reduced in number until, as the food diminishes, the eggs will cease. If the process be continued indefinitely some of the flock will begin to weaken and then those least fitted to survive will die, until their number is proportioned to the amount of food supplied. The same thing is going on in nature everywhere. Anyone who walks through a forest cannot fail to notice the struggle for light and water and food. It is the law of survival for all living things whether plant or animal. It means that only those remain alive that can most successfully compete with other living things. It means, also, that any variation, however slight, that is of advantage in such competition will be, by the law of heredity, transmitted to the off-spring which thus survive. As these variations occur, in time intermediate forms disappear and only the most successful variations survive, just as the twigs of a tree that could not reach the light perish and only those survive that have been able to place their leaves above their competitors.

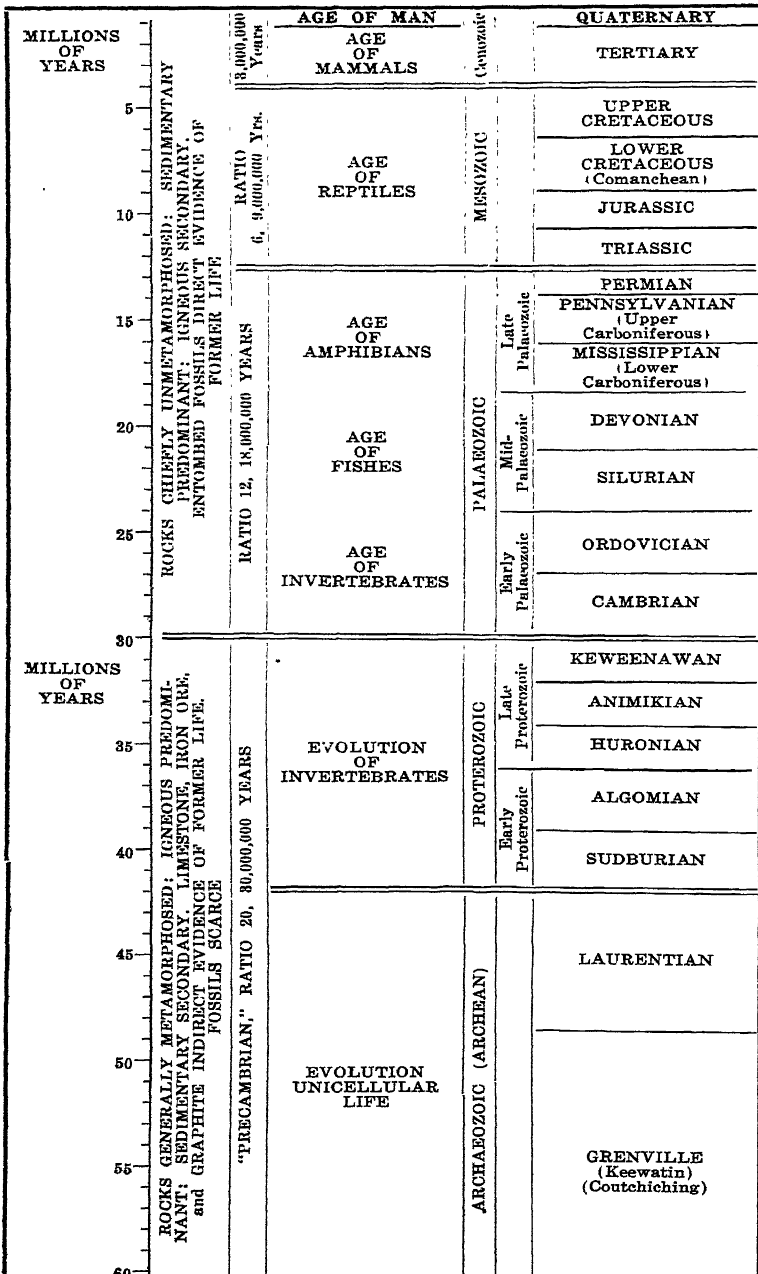
With these things in mind we begin to trace the continuity of life in time. We recall to our minds facts previously presented showing how the earth has existed for millions and millions of years. We look at the life upon her surface the unity of which we have herein before demonstrated and we wonder whether this same unity will be found to exist as we trace it back into the past.

That we are able to do this we should be grateful to wind and storm and rain. The illustration may be presented in its simplest form. Let us imagine that when the earliest crust was formed on earth there was a vast mountain chain that rose to a height, may we say, of many miles, and that from the beginning its surface has been in process of erosion. Its solid rock was first broken into tiny fragments of sand and mud and then washed into the sea. As this process is continued throughout the millenniums the top of the mountain range becomes the bottom of an immense mass of sediment, and when the process is finally finished the bottom of the range will be the top of the mass of sediment. If we can imagine this sedimentary material consolidated by pressure and recall that during all of these myriads of centuries whatever was living on the surface of the mountain range would have been washed down by the torrents and rivers into the sea and deposited in the sediment we have a fairly clear picture of what has actually happened. These living things thus preserved as fossils would tell us, and indeed they do tell us, the whole long story of life during the period in which our mountain chain was in process of erosion.

The period of time covered by the fifty-three miles of sedimentary deposits referred to in a preceding chapter has been divided by geologists into five great eras, and these eras are divided into periods, and the periods into smaller epochs. The duration of the eras is not, of course, accurately known. For purposes of discussion, let us say that the whole of this geological time is covered by sixty million years. This estimate is rather low. Some of our best authorities would say that six hundred million would be nearer the truth. The reader may, therefore, multiply the figures that follow by ten if he chooses, or by five, or two, as it may seem to him most probable.

Of the sixty million years, the first half is covered by the two eras, the Archaeozoic and the Proterozoic. In the first of these life, if it existed at all, was in the unicellular stage and left no trace of its existence except graphites, iron ores and marbles. The same is largely true of the second, the Proterozoic era. Only in the upper strata of this era is there evidence of life of the lower organisms. Thus thirty million years passed while life was only to be found in its humblest beginnings. Afterward, for about eighteen million years, came the Palaeozoic, and thereafter for nine million years the Mesozoic, and thereafter for three million years the Cenozoic, of which we are a part. Now the interesting thing and the fact which we must remember is that as we trace life back through the eras of the past we find that the structure of each individual species grows simpler, not only, but also that the number of varieties, species and genera and families and orders diminish. Approximately one million different species of living things are abroad today. They have taken possession of every nook and corner of the earth, and the abysses of the sea, the snows of the mountains and the poles, the winds of the air, the rocks and the soils of the earth. They have filled the world with beauty and color and perfume of flowers and with charm and grace of bird and beast.

If we could transport ourselves five hundred years into the past the world would already seem to be a bit different. The devastation that man has wrought on its surface would be less marked. In North America herds of buffaloes and clouds of wild pigeons so dense as to darken the sky would not have disappeared. But the grass and the trees and animals that live upon the earth



THE TIME TABLE OF THE AGES

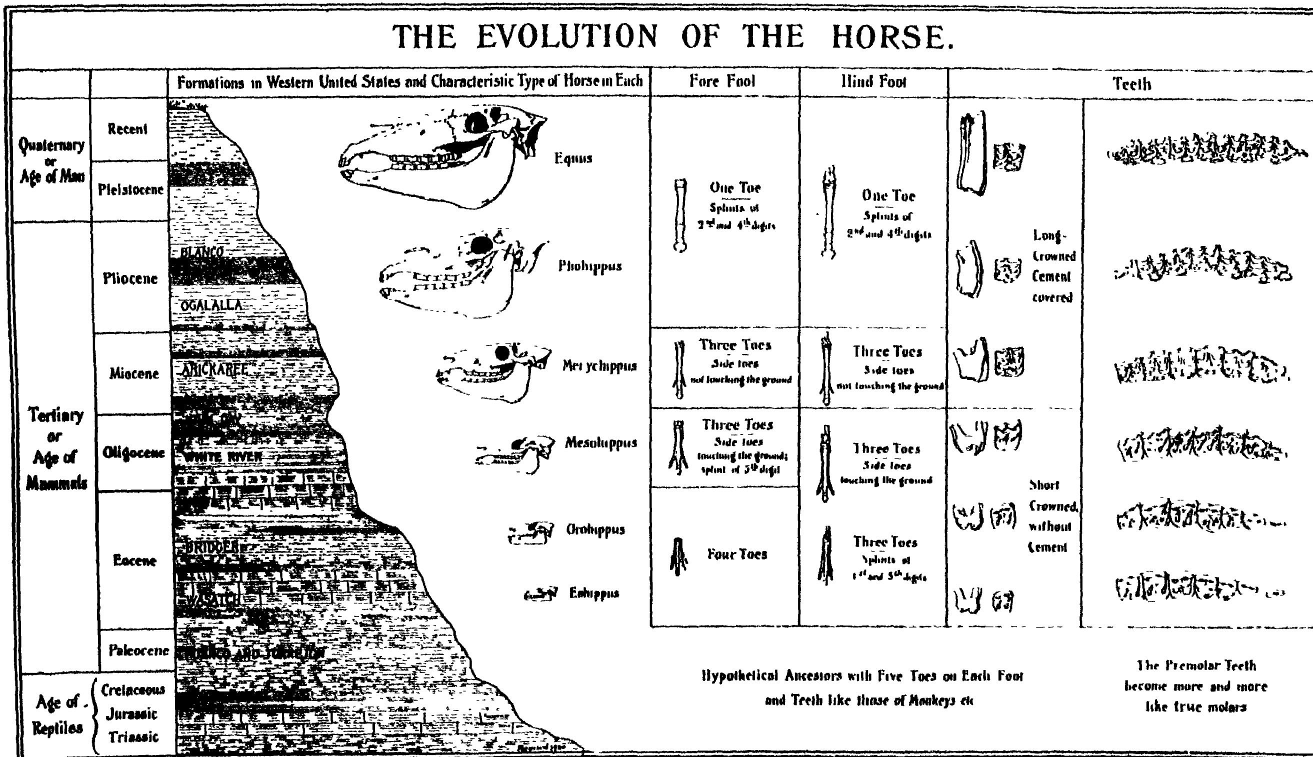
would be practically the same as today with only here and there some specimen like the moa of New Zealand that does not now exist.

Let us go back five thousand years. The principal changes that we then notice would be in such things as effect human life and civilization. Nothing of what we know by that name would we find on earth except on a little fringe of the river Nile or in the Tigro-Euphrates Valley or along the Yangtse and Hoangho in China, and perhaps at similar spots elsewhere. European and American civilization as we know it has long since disappeared. Alpha Draconis is the Pole Star and the men of Egypt as they build their pyramids, elevate their entrances to its level. But so far as the physical world is concerned we would perhaps notice only a slight difference of temperature. A little more chill to the atmosphere would constitute the principal difference in the climate. Some animals that were shortly to disappear would still be present. Kings of Babylonia are hunting tigers and lions from their chariots.

If we go back fifty thousand years the changes are more marked. We find the world just emerging from the last glacial epoch. Vast stretches of land which formerly emerged from the deep when enormous quantities of water were taken up into the ice of the polar and glacial regions are now slowly being submerged again. England is about to be separated from France, Spain from Morroco, Italy from Tunis, and Greece from Asia-Minor. The fauna and flora of Europe show differences when compared with today. Many of the then species do not now exist, many are altered. Perhaps in each species there would be the same unlikeness to its modern representative, at least in some degree, as exists between the Neanderthal man and the modern European—not so much, perhaps, but a detectible change.

Now let us go back five hundred thousand years. We find ourselves at the beginning of the ice ages, the Pleistocene epoch and the hour of the Pithecanthropus erectus. There are no "men," no cities, no civilization, no roads—only the paths through the forests beaten out by the beasts of the wood. The great ice period is about to come. For thousands of years at a time Europe is to grow colder and for thousands of years her climate will moderate, for some four or five times in succession. The fauna and flora will oscillate as the animals and the plants of the northern regions invade and then retreat from the south. A glance at the representatives of familiar species today would indicate marked differences. The modern horse, for example, is smaller than today, as is also the camel. Perhaps there still remain a larger number of representatives of the reptilian class. On the whole, however, while there would be a certain element of strangeness about the world, it would not be unlike the world of today. Wolves, lions, tigers, giraffes, camels exist with just about such trees as one would meet in the forests of the twentieth century.

But if we go back five million years, we find ourselves in quite a different world. The horse has become a little five-toed creature no larger than a rabbit. Two million years afterward he had three toes and was the size of a fox. Similar changes have taken place in the camels and other animals. The days of the Cenozoic pass and we find ourselves in the Mesozoic era. Great changes in plant life take place. As we go backward we find our flowering trees and shrubs gone and their places taken by cycads and conifers. The birds seem to be disappearing in numbers and species and their form is more nearly reptilian. Their tails are like reptile's tails, long but feathered and instead of beaks they have teeth. Mammals are less numerous and of them there are fewer kinds. The life of the world is comprised largely of multitudes of reptiles, some of them like the ichthyosaurs and plesiosaurs living in the sea, some of them like the great tyrranus rex, living on land, some of them like the pterodactyls, flying reptiles, living partly in the air, and with them the great gigantosaurus, over one hundred feet long, probably living in the marsh lands still moist and warm; for the climate is far more equable. While birds and mammals grow less numerous as we go backward, the life of the sea also becomes different. Modern fishes we find replaced by ganoids and sharks. Modern trees, oaks, hickories, beeches have disappeared from the forests. Bees and butterflies, grass and turf are disappearing. The story of the change from modern to Mesozoic times is fairly well represented in the names of the epochs of the Cenozoic era; the Pleistocene, 500,000 years ago most like modern life; the Pliocene, one million years ago, more like modern ilfe; the Miocene, a million and a half years ago, less like modern life; the Oligocene, two million years ago, resembling modern life a little; the Eocene, two and one-half million years ago, the dawn of modern life; and the Palaeocene, three


THE EVOLUTION OF THE HORSE.
Formations in Western United States and Characteristic Type of Horse in Each
Fore Foot
Hind Foot
Teeth
Quaternary or Age of Man
Recent
Pleistocene
Tertiary or Age of Mammals
Pliocene
Miocene
Oligocene
Eocene
Paleocene
Age of Reptiles
Cretaceous
Jurassic
Triassic
BLANCO
OGALALLA
ARICKAREE
WHITE RIVER
BRIDGER
WASATCH
Equus
Pliohippus
Merychippus
Mesohippus
Orohippus
Eohippus
One Toe
Splints of 2nd and 4th digits
Three Toes
Side toes not touching the ground
Three Toes
Side toes touching the ground; splint of 5th digit
Four Toes
One Toe
Splints of 2nd and 4th digits
Three Toes
Side toes not touching the ground
Three Toes
Side toes touching the ground
Three Toes
Splints of 1st and 5th digits
Long-Crowned Cement covered
Short Crowned, without Cement
Hypothetical Ancestors with Five Toes on Each Foot and Teeth like those of Monkeys etc
The Premolar Teeth become more and more like true molars

million years ago, showing the most ancient type of modern life. Before them, the Mesozoic, an entirely different life-world. The changes were doubtless closely associated with the climate. The Pleistocene epoch brought on the great ice age. In the Pliocene the climate was more like that of today. The Miocene was the age of mountain building and falling temperature. The Oligocene was more equable, and the Eocene and Paleocene were doubtless much warmer, shading into the warm, moist, equable climate of the Mesozoic. The Cenozoic is the age of mammals. The Mesozoic was the age of reptiles. During its nine long millions of years the ancestors of the mammals and birds were developing from their reptilian ancestors. The then world was warm moist, equable. Lowlands were dominated by dinosaurs and other reptiles. In its hard places, perhaps on the highlands where such easy conditions of life did not prevail but where it was cold and life was hard, certain creatures developed coverings of hair and feathers, both of which are specialized scales, so that when the day of Cenozoic cold came they were prepared. The meek inherited the earth and the mighty perished. It is a strange story that the palaeontologists tell us of how with seeming suddenness (geologically speaking) all this vast reptilian life disappeared. Only here and there a species of turtle or tortoise or crocodile remained when the curtain rose upon the newer, harsher days of the Cenozoic. Then the little forgotten creatures, too few and small to leave definite traces of their existence in the Mesozoic rocks as yet explored, but used to hardships and struggle and cold, found a whole world waiting them. They took possession. They began to increase and populate the earth. They increased in size of body. The whole animal world, perhaps from sheer necessity, increased in brain size and capacity also. The brains of modern mammals are from five to ten times the size of those of their earliest known ancestors. Among them was one whose brain outgrew the rest. One by one he conquered them. He rules the world today.

The reader will already have noticed that both the variety and range of life is less in this middle era, the Mesozoic, than it was in the modern, the Cenozoic. In the upper part of the Mesozoic, the strange reptile-like birds were becoming more and more like those of today, but as we go back to the earliest days of that era their variety decreases and, finally, there are no birds at all. The same is true of the many forms of mammalian life. It would seem strange, indeed, to be living in a world without men

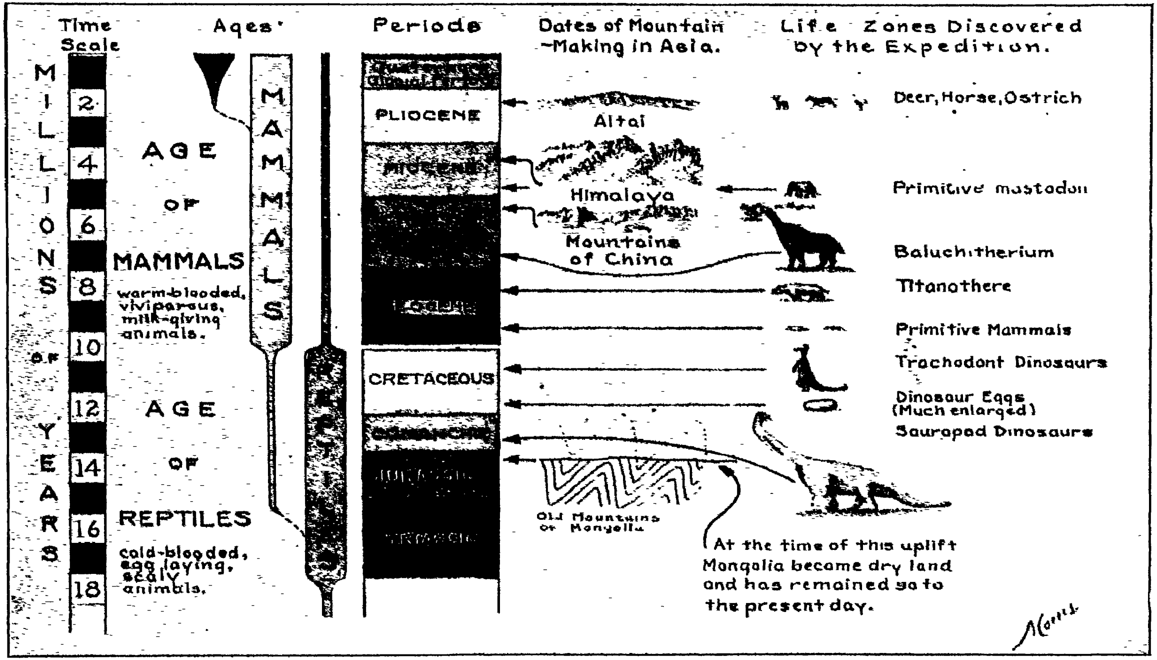


Diagram showing time scale, ages, periods, dates of mountain making in Asia and life zones discovered by the recent expedition of the American Museum of Natural History. The uplifting of the Himalayas is supposed to have had an important influence upon the climate of the central Asian plateau, creating an aridity that led to a wide human and mammalian migration. (See text.) From *The Chain of Life*, by Lucretia Perry Osborn. (Courtesy of the Author.)

or monkeys, without lions, tigers, cats, dogs or foxes, without bears, camels, bison, goats or sheep, without deer, hogs, elephants, whales or bats, without mice, rats, squirrels, opossums. Still stranger would it seem to have no blue-birds or robins, no tanagers nor bob-o-links, nor blue-jays, nor swallows, nor hawks, nor pigeons, nor chickens, nor turkeys, nor ducks. Of course the ancestors of these birds and mammals were there and it is believed that they belonged to some branch of the reptilian class, but of the many species of birds and mammals that fill the world with life today none is known to have then existed. Only fishes and amphibians and reptiles, among the vertebrates, are known to have constituted the then living world.

Between the Mesozoic and the preceding age, the Palaeozoic, there is a great gulf fixed. We shall have to go back some fifteen million years from today in order to find ourselves in the Palaeozoic world, and a strange world, indeed, it would seem. All modern trees and shrubs have vanished and there remain great forests of fern-like trees, lycopods and horse-tails. The land life was without flowers, or birds, or mammals, or modern insects. Life is found only in or along side of and partly under water. As we go backward into the Palaeozoic, grass and turf disappear but marshes, warm and moist and equable, are abundant. In the upper Palaeozoic, the sea is full of fishes and the first reptiles are developing. Also the first insects such as dragon-flies and flying cock-roaches abound, and life has learned to come out of the water to live partly in the air as amphibia. But as we go backward into the Palaeozoic even these diversified forms of the earliest reptiles and insects and amphibia become fewer and fewer until, in its earlier days, life is simplified into its least complicated forms of trilobites, shell-fish, and sea-scorpions, and just about such forms of living things as one would find in a lagoon or pool today. Invertebrate life dominates the seas where they exist in myriads of species and great numbers, but it is noticeable that their structure is simpler and less complicated than the structure of their modern descendants. The main point is that life in that day vastly differs from what it is today, not only, but that difference consists principally in the simplification of all forms and in the elimination of multitudes of species. When we get back to the beginning of the Palaeozoic we feel that we have excavated a great deal of the dirt dumped around the tree of life and have almost reached its trunk. Yet we have used only thirty of our sixty million years. Back behind the Palaeozoic are two vast ages, the first the Proterozoic, covering let us say, fifteen million years. It is believed that during this immense period life was developing from unicellular forms to the forms that we find existing in the first days of the Palaeozoic, the myriads of species of invertebrates with which the warm seas of that day swarmed. In the Proterozoic we find even the complicated creatures such as sea-scorpions, brachiopods and trilobites absent. Such vestiges of life as remain are those of algæ, the simplest unicellular plant life, of green scum, jelly-fish, and tracks resembling those of worms as they crawled in the mud. We are back, then, in our search beyond the day of hands and legs and arms and limbs and branches and leaves. The world contains no such thing as a claw or a fin or a nose. It is to all intents and purposes a unicellular world, or if multicellular in part, still with a structure so simple as not to remotely approach those of days that follow. We have, of course, therefore reached the point where the last track entering into the lair of life is so dim that we cannot pursue it further, for such filmy, delicate organisms left no trace of their existence, no skeletons, no shells. Only, here and there, the presence of formations of graphite or certain iron ore deposits indicate the possible presence of organic life. We have come to the point where the continuity of life and the unity of life meet in the simplest form in existence, the unicellular beginning, the original life-cell. We are ready to ask ourselves the question: What of the origin of life?

But, first let us see what the net result of our investigation concerning the continuity of life has been. We began with a view of the multitudinous forms of living things. We found they were divided into two great kingdoms, the "animal" and the "plant," vastly different in their appearances and qualities. We found the animal kingdom divided into further sub-kingdoms, phyla, the vertebrate and the invertebrate. We found the vertebrate sub-kingdom divided into a number of classes such as the mammals, and birds, and reptiles, and amphibia, and fishes. Taking up the class of mammals we found it divided into a number of orders such as the carnivora and the ungulate. Following the carnivora we found them divided into many families, such as the felidæ and canidæ and bovidæ. Following the family of the felidæ we found it divided into genera, and these into species. There was, for example, Felis domestica, the common cat, and Felis leo, the lion. In imagination we followed these sub-divisions of the animal and vegetable kingdoms, discovering a vast diversity of form and color and general characteristics. We traced them all back through the ages by way of the great geological eras, the Cenozoic, the Mesozoic, the Palaeozoic, and the Archaeozoic, until we found that one by one their differences disappeared and they gathered closer and closer in to the trunk of the great tree of life, becoming simpler in form and fewer in kind. First the varieties, then the species, and then the genera, and then the families, then the orders, then the classes, and then the sub-kingdoms, and finally the two great kingdoms themselves merge into one another until we can no longer distinguish birds from mammals, reptiles from fishes, plants from animals. We have reached the bacterial stage of life, a form so primitive that it is neither plant nor animal and yet so fundamental that it is claimed by eminent biologists to belong to both kingdoms.

Consider then this marvelous ascent of complexity; first the atom, composed of multitudes of electrons in orderly arrangement; then, the molecules, composed of multitudes of atoms in similar orderly complexity; then the cells, composed of multitudes of molecules in unfathomably complicated arrangement; then the metazoon, a honey bee, for example, composed of millions of millions of cells like some vast world government as yet only dreamed of among men, ordered perfectly, adapted perfectly, cooperating perfectly. In a hive of 50,000 bees we see an analogous organization. In a world of millions upon millions of dependent living things intimately and indissolubly conjoined to form a cosmos, we see a further analogy. In a solar system or a universe, we distinguish analogous stellar phenomena. Who would be so bold as to deny that universes themselves may constitute a super-organization, a universe of universes, or that an electron may be composed of similarly complicated and perfectly ordered being?

If we were correct in our story, then it has taken sixty to six hundred million years, perhaps more, for life to expand from this early bacterial stage, or something resembling it, into the myriads of kinds of living things seen today. But there is no lack of centuries and as we contemplate what we are pleased to call the beginning of life, we find ourselves face to face with the fact that it is, in turn, the product of millions upon millions of years of development. While life has become smaller with respect of the masses of matter that it controls as we go back into the past, yet we can hardly say that it has become less complicated. A tiny wrist watch, so small that we hardly see its hands, is just as intricately constructed as a great tower clock. In fact, it requires more skill and care in its manufacture. If, as we have supposed, the larger forms of living things have indeed grown up out of single-celled forms then it is deeply meaningful to reflect upon the inner construction of that supremely complicated organism that we lightly call a "simple" cell. But the point to which we are writing lies revealed. It is the continuity of life, the intimate connection of its various forms during the present time, not only, but through past time as well. As with the individual, so with the races. All forms of living things may be traced back to the tiny lair of life itself, the original life-cell. Shall we endeavor to discover what lies within and what behind this little globule of protoplasm whose name has become a synonym of mysterious complexity among the scientists of the world?

In a later chapter,, we shall discuss at length the bearing of the new science upon the old religion; but by this time, doubtless, the reader has been wondering where even a small place may be found for God in this story of life. What he seems to be confronted with is an elusive and ever vanishing phantasm as if the First Cause had been done away with in an unending chase after the origin of things. But after all, "canst thou, by searching, find out God; canst thou find out the Almighty unto perfection? It is high as Heaven, what canst thou do; deeper than Sheol, what canst thou know?" Have we not discovered "a Power which doeth great things and unsearchable; marvelous things without number?" It was an ancient proverb which said, "Whoso findeth Me, findeth life." Reversed, it is equally true: Whoso findeth life, findeth Me. Let us go further with the search.

TO THE KING OF THE MAY

Asaru-Osiris, Father of the blessed flowers,
Thou art with us again in Thy wondrous beauty
And a man may stretch forth his hands
And reap all Thy glories
From the boughs of any wild crab-apple tree.
Immaculate art Thou in May,
As Thou wert in the days of the milk-white blood-root,
When the little children gathered Thy white robes
From wooded dells and Thy sacred blood
Reddened their fingers with love.
For now the spotless glory of the gardenia
Is Thy mantle and, where Thy warm breath blows,
The meadows are matted with daisies.
Flushed with her pink joys,
The mimosa quivers to each tiny wind,
Who whispers of Thee,
And, at Thy miracled approach,
Even old grandfather grey-beard
Breathes the delicious scent of Spring
From his grey-green locks.
Amid all that is so wonderful,
We kneel with the violet in prayer
And with the sweet-shrub
We scatter incense before Thine altar.
And having seen Thine eyes in the dogwood,
And read Thy thoughts in the pansy,
We press the scarlet tiara of the woodbine
Upon our brows,
And remember the thorny crown
That made all things possible—
Amen.

CHAPTER XI.

UNITY AND CONTINUITY OF AWARENESS

The process of civilization has been largely a process of disillusionment, requiring in each case a long while for humanity to become accustomed to the new idea of existence. Particularly is this true of that broad world of facts that we describe by such terms as consciousness, intelligence, and reason. In that anthropocentric world which the human mind has painted for itself nowhere is human pride exhibited more vividly than in the exclusiveness with which we have arrogated to ourselves life in the realm of thought and claimed for ourselves, alone, such priceless assets as self-consciousness and the power of reason. It is almost the last step in the demonstration of the unity of the universe when we are shown that the highest and finest of intellectual powers find their origin in what we have, until, lately, esteemed to be humble sources.

There is a certain vivid awareness of his environment that characterizes man. More than any other living thing he is acutely conscious of the not-self, not only, but of the self as well. Furthermore, taking the information that comes to him through his senses he seems to be able to mould and multiply the forms into which such facts may be developed, weaving them into complicated forms of thought under rigid processes of logic. He is quite distinctly and undeniably the mental superior of all living things and it was but natural for him to suppose that no other creatures enjoy even to a limited extent the same kind of ability or the same quality of privilege.

Yet he was early reminded that it was only through five little windows that he knew anything at all, and that they are very dusty little windows, frequently begrimed. Through them, also, it is possible to see only a short distance through the fog and maze of the exterior, and through them he is privileged to look only an exceedingly short while. Nor is he allowed to forget that, even combined, they give him knowledge of but a tiny segment of the universe. With his eye he sees only those vibrations that lie between four hundred billion and seven hundred and fifty billion vibrations per second, seven colors out of seventy times seven that must exist. With his ear he catches the vibrations that lie below thirty-three thousand per second. Yet beyond this number lie musics that no human ear has caught. The same and even sharper limitations surround him as to taste and smell and touch. It it quite evident that from the beginning thoughtful men must have realized how possible it was for other living things to have developed faculties that men have not developed and, therefore, to live to a limited extent in a world in which he does not live. Perhaps the evidence of this fact gleaned by primitive men as a result of their close observation of the actions of other living things is at the base of that reverence and worship of animals which we find universally to underlie the ancient religious systems. So many of them could do things that men could not do. Even the humble Scarabeus could bring life from death. To the untutored primitive Egyptian it added glory to Thoth that he should possess the head of an ibis as also to Anubis of a jackal, and Horus of a hawk. How much of our modern civilization has come from discoveries made by other creatures is not sufficiently realized by most of us. The humble worm of the dust must be given the honor of showing how the Hudson terminals could be built. How to use the caves as a dwelling, how to weave strings into cloth, how to make music with his throat, how to swim, how to fly, all of these and many like them mankind could have learned and, perhaps, did learn from his fellow-creatures.

Now there are degrees of intelligence even in the individual. There are sluggish moments when one is scarcely so conscious as at others although he may consider himself to be wide awake. There are days and even years when one is not so aware of the meaning of life, of its haunting mysteries, of its fascinating problems and of its practical details as during other periods of time. From the beginning of civilization men have learned also that certain stimulants excite their consciousness to greater activity. Natural excitement is one of these. The public speaker knows that once he has begun his address his mind becomes more active and his thoughts embody themselves more vividly in words. There are drugs that artificially produce the same result. So one is not unprepared to learn how easy it is to reduce consciousness by varying degrees down from the most vivid awareness to dull, sluggish coma. Indeed, one does just that during his own lifetime. The old man of ninety whose mind is foggy and whose consciousness is dim may be traced back to the boy of twenty whose mind is alert and active and keenly sensitive to every element of his environment. This is the beginning of the law of unity and continuity of consciousness. For we can follow that same boy down into the years until he is a lad of ten or five or a babe of two years old and as we do so we can see his consciousness dimming, his intellect decreasing. We can follow him by the study of embryology back into the prenatal months, to the time when his mind is not that of man or youth or babe, not even that of bee or ant or elephant, until the processes within his brain have darkened into such midnight as abides in the natural processes of chemistry and physics, back to the original unicellular thing that he once was, a tiny speck of protoplasm, infinitely intricate and complicated in its structure but far below the beasts of the field and the fowl of the air and even the fish of the sea in intelligence.

It is essential that we should note that there is no break in this backward procession. There is no spot of time or space on which one can put his hand and say "here something different begins." It is a continuous degeneration of consciousness. It is an unbroken pathway into the darkness through which the embryologist leads us and it is out of this darkness that every man, woman and child who was ever born on earth has come. So as we look through our high-powered microscope at the little speck of protoplasm which represents the point of earthly origin of the greatest of human intellects we stand face to face with what is perhaps the greatest mystery that mankind has to solve, the mystery of the origin of life, physical, mental and moral. Also, there stands revealed the great law of the continuity of consciousness which teaches us that there is no break or chasm between the highest intellect known on earth and the mental process of unicellular creatures. If, therefore, a philosopher is to be admired or a great statesman reverenced, with what words of adoration shall we fall at the feet of this stupendous mystery that we call protoplasm, out of which there is continually welling up the throbbing life of the world?

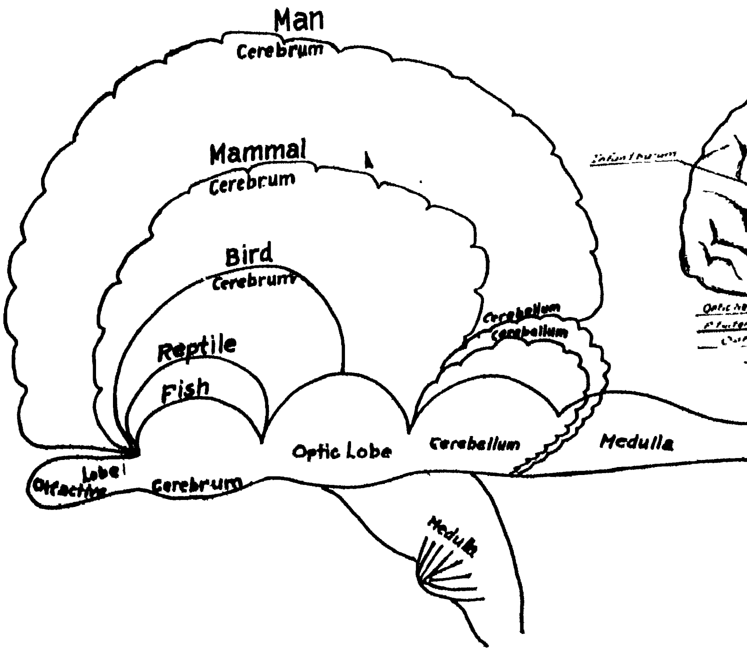
Side by side with these facts we place at once the thought that not only are there degrees of intellect in the life of individuals but that they exist also in the race. The modern device of intelligence tests advises us that 25% of the American people are mentally incapable of taking a high school education. A proportion of them are even incapable of taking a common school education, for the gamut of the human intellect ranges from the idiot through the moron to the genius. All men are not created equal either in size or intelligence. Furthermore, this difference is accentuated when race is compared with race. The quick and nimble wit of the highest type of Frenchman, German, Anglo-Saxon and related peoples is incomparably superior to the dull, sluggish mental process of the Australian aborigenes. Furthermore, the anthropologists advise us that the same difference in intellect, in power of awareness of their environment may be traced in the realm of his science. They tell us that the Neanderthal man, 50,000 years ago was, perhaps, a man of the same intellectual capacity as the lowest savages of today, and if their skillful conjecture is to be accepted the mind of the Pithecanthropus erectus, by the dimness of its light and the haziness of its atmosphere, suggests to us the very dawn of intelligence in man. So far the law as applied to mankind itself.

Now, as we go backward, tracing the obscuration of the human intellect in the past, we inevitably begin to compare it with the intelligence of other creatures living on earth today, and we wonder how far back it is necessary to go before we reach a point at which it can be said that mankind as it existed in that day was not so aware of his environment or so conscious of himself or so able to put two and two together as some of his fellow creatures of today. Here, for example, is a colony of bees, more perfectly knitted together than any commonwealth on earth is united, organized to the finest detail to suit the environment in which, through countless ages, its civilization has been developed. As one approaches the hive he sees guards armed with poisoned tips ready to defend the entrance. The hive itself is a vast city in which, let us say, some 50,000 individuals live. It is stored with food for the immediate present not only, but for the sterile months of the winter. The same foresight has caused them to fill every crack and crevice with propolis to shut out the biting north wind. Thousands of nurses are attending to the multitudes of new-born citizens who are nourished with indefatigable attention and reared into full citizenship by a system so perfect that none is neglected. Throughout the whole city every principle of sanitation known to modern science is observed. A perfect system of ventilation, produced by the untiring wings of skillfully placed toilers, keeps the city at an even temperature. In the winter time when the temperature sinks below 57° F. the fires are kindled and the house warmed against the icy blasts. At the portals of the city, thousands upon thousands of busy workers are sifting downward out of the sky, bringing a golden rain of wealth, each storing its tiny drop of nectar into the comb so marvelously manufactured by other laborers that the most skillful of human engineers can find no fault with the mathematical perfectness of its construction. From a score of different kinds of flowers this nectar is gathered each day under a generalship so faultless that no field is overworked nor any neglected. No lonely sumach bush in the remotest corner of the wood is forgotten nor any floret in the great clover field passed by. Secrets are open in this city that are not understood elsewhere, for the determination of sex is both known and practised. At her will the queen deposits a drone (male) or worker (neuter) egg in the cell and when they please the workers change the latter into a perfect female, the queen. And if the time comes when the population of the city is so overgrown that its limits must be extended, the mother of the hive joins the older citizens of the colony and by the aid of scouts sent out in advance they locate another site whereon another Troy is founded. And all of this is done without jar or discord or contention, in quiet, mutual understanding and appreciation and helpfulness, the like of which no human community has ever remotely attained. As it is with the bees so it is with the ants. Indeed, students of ant-life tell us that these tiny citizens of the soil exceed the bees in their intelligence, in their ability to plan for the future, in their power of bending the forces of nature to their purposes, and in the wisdom of their conduct. Not unlike their more haughty fellow-inhabitants of earth they, also, have learned to handle slaves, to wage wars, to plant gardens and to milk cows. Lull cites the little brown "herding" ant which for the sake of their honey dew gathers the young larvæ of the corn root louse in the autumn and keeps them safe until the corn germinates, then transports them to the roots of the growing corn till mating time in the autumn when they are allowed to pair and their offspring preserved as before. The slave-holding ant, Polyergus, is dependent upon its slaves for all work done in the colony. It can neither dig nor care for its young nor even keep itself from starvation in an abundantly stored nest without the aid of its slaves. And as it is with these tiny creatures, so it is with the larger. Horse-sense is a proverb. The intelligence of elephants is so widely known as to require no comment. Albert Payson Terhune whose life-long study of dogs adds weight to his words, writes in Harpers Magazine: "For the past thirty-odd years I have made an intensive study of dogs . . . but it has not taken me a tithe of that time to discover that they are our superiors in nineteen out of twenty things. Intellect, not intelligence, and the doubtful blessing of speech — in these two matters we are their betters. In a hundred others, in ceaseless loyalty, in forgiveness, in four-square honesty, in humor, in stamina, in adaptability, in conscience, in pluck, in sacrifice, in all five of the so-called senses (except vision) in normality and in many another fine detail they are immeasurably beyond us." The ability to build a downy palace of delight possessed by the humming bird, the knowledge of weaving which the weaver bird perhaps taught mankind, the reader in quite familiar with these and countless other evidences of intelligence among animals. Whole books full of them have been printed. There was recently published a remarkable story of a crow which was observed regularly carrying off part of the food which a lighthouse-keeper gave him daily. Curious to discover for whom the morsels of meat and bread were intended, the lighthouse-keeper investigated and saw the crow carry his load to a nest in which was, to his surprise, not a batch of young ones, but one old crow, bald with age and stone-blind. "Truly," adds Van Paassen, the narrator, "this black fellow had a white heart." Numberless illustrations could be cited to show that animals feel and think, love and hate, plan and devise. They play and dance. They love pretty things. They weave and sew and build houses suitable to their needs. They are loyal to their friends, they destroy their enemies, and they are, generally speaking, kinder to their females than are men. Their little candles illumine for them only a tiny sphere of the vast infinite. Their five little panes of dusty glass are more darkly besmeared than ours but that they can see and hear and smell and taste and feel and think, none will deny them.

A flood of light is thrown on this subject by a discovery of our palaeontologists to the effect that a careful comparison of the brains of creatures that have lived in the past, for example, the whole class of mammals, reveals

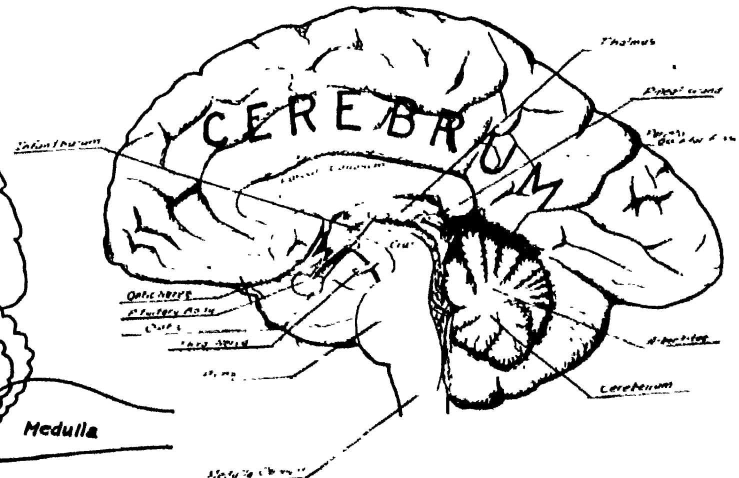
VERTEBRA BRAINS

RELATIVE STUDY.

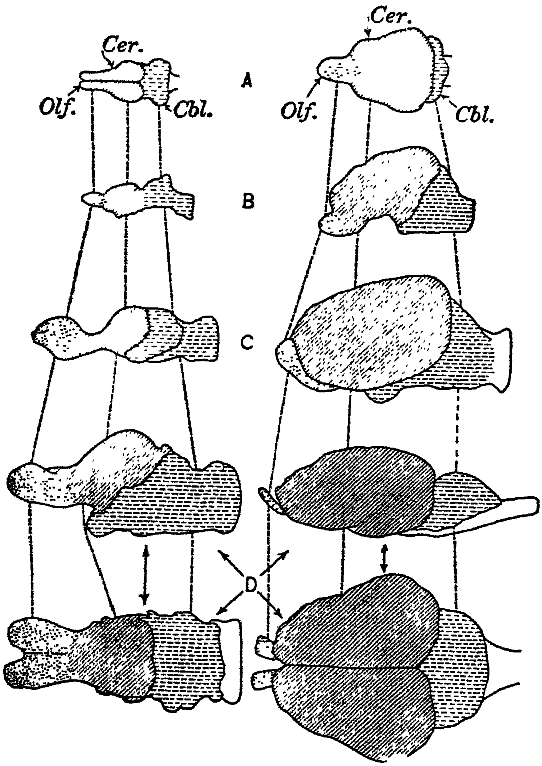


HUMAN BRAIN

VERTICAL MEDIAN SECTION



the astonishing fact that the brains of all mammals have been enlarging and therefore increasing in capacity for thought and consciousnes during the past geological ages. It is reasonable to suppose that they are still increasing and that along with man their intelligence and awareness of the universe will steadily grow finer and greater. Where man was once they are now. Perhaps some day some of them will be where man is now.



Brain proportions in archaic (left) and modern (right) mammals of similar size. *Olf.*, olfactory lobes; *Cer.*, cerebrum; *Cbl.*, cerebellum and medulla. A, *Arctocyon-Canis;* B, *Phenacodus-Sus;* C, *Coryphodon-Rhinoceros;* D, *Uintatherium-Hippopotamus.* From Osborn's *Age of Mammals.*

(Courtesy of John Wiley and Sons.)

But nowadays it is not so much the intelligence of animals to which attention should be called in order that the law of continuity of consciousness should be traced through the whole animal kingdom as it is in the plant world that an even deeper interest lies, forming as they do a sort of link in the diminishing chain of consciousness between animals and matter. Intelligence of plants is a subject of fascinating interest, and the conclusions which may be drawn from such a study are of equal importance. In speaking of the intelligence of plants one should not, of course, be understood to attribute to them the higher mental processes known only to humankind. Nor do they possess, so far as we know, the mental capacity of such creatures as the ant or the bee or the rat. We write, rather, of that awareness of their environment which constitutes in so far as it exists a consciousness, however dim, of the universe immediately around them.

When once we have entered the realm of plant-life we find differences existing in this consciousness comparable to those in the realm of animal life. There are some plants that seem to be acutely sensitive and others that are dull and sluggish. Perhaps the finest illustration of the highest process of consciousness in the plant-world may be drawn from the venus fly-trap. A sweet liquid exudes from the leaves of this plant which are spread temptingly in the sight of any passerby. On each side of the leaf are delicate threads that act like triggers of a trap which are sprung at the touch of its victims, the leaf closing instantly. The leaves themselves are provided with two sets of inter-locking bristles or fingers which look for all the world like the teeth of a steel trap and close upon signal almost as quickly, in less than a second, with the accompaniment of a slight electric discharge similar to that of an animal muscle, imprisoning their quarry beyond hope of rescue. If the insect is too tiny for its purpose it is at once released. If, by any chance, a scientist has placed a little pebble instead of an insect there, it also is released. But, if an insect of the kind desired has been caught, no release from its doom is possible no matter how desperately it struggles. The insect is imprisoned; soaked in a digestive fluid which is secreted in great quantity, and eaten by the plant which obtains from it the large proportion of nitrogen that it desires. This "most wonderful of plants," as Darwin once described it, is almost human in its sensitiveness. If one, desiring to experiment, should take an animal and touch its eye with the forefinger, it would at once close its lids for protection. If with his finger he touches the venus fly-trap it similarly closes. If, now, the animal should be etherized and the finger used again the eye of the animal will not close. If the plant be similarly etherized neither will its leaves close. Consider the sundew and decide whether it can be denied some form of "intelligence." On the rounded heads of its club-shaped leaves are from one hundred to two hundred tiny and similarly club-shaped tentacles whose tips exude a sticky liquid which glistening in the sun-light attracts the passing insect. When an insect, for example, a fly, lights on one of these tips, the others bend over and aid in imprisoning him. Indeed, the experiment has been tried of pinning a fly as far away from the flower as one-half inch. The tentacles bent over and captured him. Consider also the simple cunning of the pitcher plant which fills its little pitcher with an antiseptic digestive fluid; sets nectar upon the table of its rim; constructs a lid to shelter its precious liquid from the rain; waxes its slippery walls below and thus entraps and devours its unsuspecting visitors. "There is much feeling in plants," says Thomson . . . "Surely the beginning of memory . . . The animal is lurking in many a plant. . . . Whenever there is life there is some degree of mind even in plants." It is quite astonishing even to the one who is familiar with such matters to learn that there are no less than five hundred species of carnivorous plants. Each has its own way of specially adapting its leaves and its own laboratories for making its digestive fluids, and its own method of assimilating the victims of its skill. Thus some types of plant-life like the sundew and pitcher-plants and fly-traps and butter-worts and bladder-worts have become parasitic and learned to eat the animals which in turn live upon plants and each other. .

But vastly more illuminating than any particular illustration of man-eating trees and insect-eating pitcher-plants, and of wider significance even than the several thousand species of plants that maintain armies of ants for their defense by providing sugar for their food and boxes for the sentries are those more wide-spread and fundamental processes common to all plant-life that have to do with growth and reproduction. It is in this last sphere that plant-hood reaches in truth its flower. We find them using every conceivable agency in the perpetuation of their species. Some harness the winds, others the waters. Some use the birds of the air or the beasts of the field or even man himself to disseminate their seeds. To protect these seeds they adopt every imaginable defense; thorns, poisons, unpleasant juices, and multitudinous prickles. Some of them, which found it necessary to fertilize their seeds under water, have developed a pollen whose specific gravity is exactly that of water. Some of them have devised ways of discovering just when they must take the necessary steps to see that fertilization takes place. Here is the wild celery, for example. Below the surface of the water the male flower develops its pollen until it hears the call of the female flower which, elevated above the water, waits to be fertilized by its unseen lover. At the moment set by "nature" the wedding bells ring, the bridegroom rises, and binds his sepals into a love nest in which the life-giving pollen floats. Eventually the flowers, male and female, meet and thereafter the cunning bride withdraws to the safety of the waters beneath and in due course brings forth the seed of another generation. The foregoing and following are but a few of many thousands of illustrations pointed out by Showalter, Thomson, and other writers, of that perfect consciousness possessed by the whole plant-world of those elements in their environments which are necessary for their life and propagation. Some build airy thistle-like balloons in which to seek new worlds. Some expel their seeds as far as their powers permit. Some build runners and suckers. Some build grappling hooks by which their seeds may attach themselves to the desired object. Some develop a sort of glue for the same purposes, and there are even some that construct tiny flagella to propel them through the water. It is at this point that we find ourselves upon the border of plant and animal life but their differences have become so minute that we know not whether they are plants or animals and, indeed, they are often styled plant-animals or animal-plants. We face the unity of thought. "The plant," says Huxley, "is an animal confined in a wooden case and Nature, like Sycorax, holds thousands of "delicate Ariels" imprisoned in every oak. She is jealous of letting us know this and among the higher and more conspicuous forms of plants reveals it only by such obscure manifestations as the shrinking of the Sensitive plants, the sudden clasp of the Dionea or still more slightly by the phenomena of the Cyclosis."

To those who claim that all these adaptations came about only by a process of natural selection from countless variations one may easily reply: By what process other than those resembling consciousness does the plant or animal select the suitable variation and reproduce it in the next generation? And why do not plants continue to show innumerable variations today, specially adapted for other environments than those in which they now exist but not detrimental to them under their present living conditions.

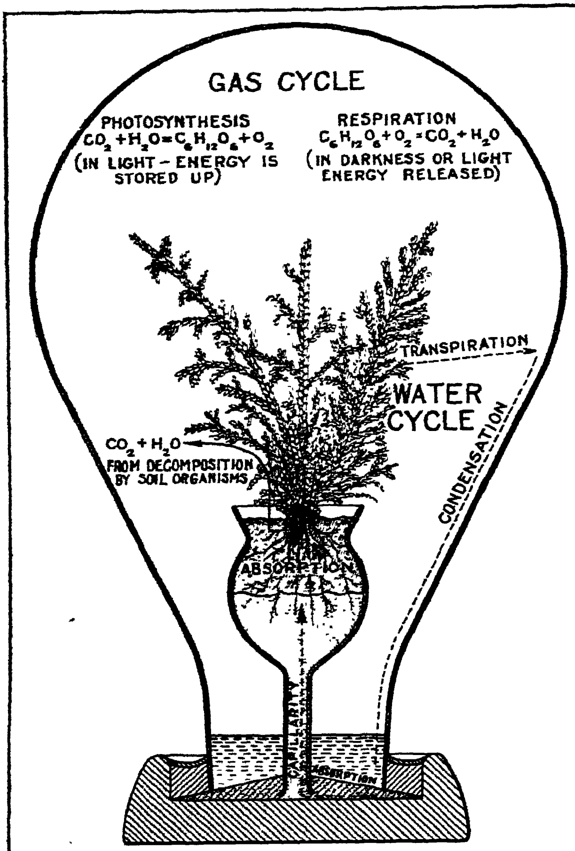
All of the illustrations given above whether drawn from plant or animal life, have to do with what may be called "corporate" consciousness and are designed to show that these large masses of bodily material constituting organisms known as animals or plants act as a totality so perfectly with respect to their environment that we speak of them as intelligent. While we are able to trace a long line of processes through the dimness and dullness of the lowest types up to the brilliance and quickness of the highest, yet they are all comparable to a set of machines intricately devised by man and delicately adjusted. What is our astonishment, therefore, when we find that these organisms are, themselves, composed of multitudinous entities, each a living thing and each exhibiting the same evidence of awareness of its surroundings that the larger organism exhibits. Whether it be plant or animal, man or matter, each is composed of multitudes of living creatures, each inhabiting a cell, a little room which it has built with its own hands. Their numbers, even in small organisms, run up into the hundreds of millions. Julian S. Huxley tells us that there are fifteen thousand billion red corpuscles in the veins of the average man. These living cells together with countless trillion more are so perfectly co-ordinated and related that in utmost harmony they develop and operate their intricate bit of machinery known as plant or animal. Could we enter the life of a plant and see with even the slight understanding of modern science the processes taking place therein, our astonishment would know no bounds. Things are happening there and results are there being brought to pass that the most skillful devices of the most learned scientists have not yet been able to fathom. In the leaf of any tree, for example, and that means in all the millions of leaves in all the millions of trees in all the millions of centuries, certain delicate chemical processes of manufacture are daily taking place the intricacies of which no human mind has yet traced. It is well known even to the beginner in the study of science that all animal life depends for sustenance in its final analysis upon plant-life, and all plant-life depends upon the ability to manufacture grape-sugar out of water and carbon-dioxide. In order to do this it is necessary for the leaf to dissociate the carbon and oxygen. Skilled chemists are able to do this by subjecting the dioxide to a temperature of some 1,300 degrees centigrade, produced by an electric current which uncontrolled would destroy the life of the chemist. Yet without heat, without noise, and without danger, each leaf performs this miracle constantly, reminding one of the cold light which plants and animals have been able to produce but which man has not yet succeeded in creating. The secret of this mystery is somehow involved with the grain of chlorophyll which plants manufacture and which in turn becomes an instrument whereby the violet and nearby rays are used to effect the dissociation of the carbon and the oxygen. By this means they manufacture grape-sugar, and other living proto-plasmic entities within the cell walls proceed further to the manufacture of starch and inulin and cellulose.

Nor is the plant organism a bit less wonderful than that of the animal. The marvelous mechanisms whereby it breathes and drinks and nourishes itself are astounding.* Like a vast community of unnumbered citizens these cells co-operate in a common purpose, each being in constant communication with the house of the other. From rootlet tip to tiniest leaf there is constant communication and complete community of interest. The throb of the bounding spring, the wealth of summer food, the glory of autumn color, the chill of winter's sleep, all are telegraphed from twig to root and from root to twig. Collaboration to a common end far surpasses among them any government among men. All that is useful to them they have learned to make. Delicious sugars and starches are their constant product. With resins and acids and many volatile oils they flavor their products, and with poisons they protect them.

* The idea that plants are as alive and sensitive as animals was presented by Sir Jagadis Chunder Bose, Indian botanist. He performed experiments which he claimed showed that plants react to cobra venom, cyanide and other poisons and to stimulants such as ether, chloroform and alkaloids, just like animals. The sensitive plant, he declared, is ten times as sensitive as the human tongue. Sir Jagadis says that the plant heart that propels its sap is a layer inside the stem, similar to the elongated tubular heart organ in lower animals, operating by expulsion. He showed an optical sphygmograph recording the "pulse" of a plant magnified ten million times by a reflected light beam. Plants, he claimed, have muscles much like those of humans, and that when tickled these are ordered to contract through the "nerves" of the plant. Sir Jagadis further stated that the stimulations of a plant are co-ordinated by a special brain-like tissue at the junction of stem and leaf stalk.

In breathless astonishment, botanists watched the pulse beats of a marigold translated into rays of light, thrown on a screen, and watched a drooping flower restored to vigorous life by a drug. Amid intense excitement, they watched the thrilling miniature drama of a snap dragon's struggle for life. A spotlight recording its pulse was thrown on the wall in a darkened room. Poison was administered to the plant. The spotlight moved to the left—toward death. Then, when almost at the point of death, the demonstrator asked, "Shall I let it die?" The answers being negative, ether was given to the plant. For several minutes the spotlight remained stationary while the forces of life and death met in combat. Then the light moved to the right—toward life. For the first time a plant has written the story of its own life for men to see.—Boston Evening Transcript.

THE LIFE CYCLE OF A PLANT



It has long been known that green plants carry on two processes. One process is respiration, by which plants break down stored food in the same manner as do animals, although usually at a much slower rate. The other process is photosynthesis, or the assimilation of carbon dioxide and water to form food. Since photosynthesis is the more vigorous reaction, being in some cases more than forty times as rapid in terms of gas exchange as is the respiration in the same individual, plants are able to accumulate a surplus of organic products such as carbohydrates, fats, et cetera. It is this excess in the plant world of food manufacture over food destruction that makes possible animal life in its various forms. During photosynthesis, exygen is continually given off, and it is this established fact that has probably given rise to the erroneous conception, commonly held by laymen, that plants "breathe" in only carbon dioxide and give off oxygen. In simple terms, respiration may be expressed as follows: Carbohydrate plus oxygen forms carbon dioxide and water; energy being released. Reverse the fomula, as follows: Carbon dioxide plus water, in the presence of light, forms carbo-we have the simplified formula for photosynthesis. (Courtesy of The Scientific American.)

They have devised pumps wherewith to elevate tons of water from the soil high into the sky. They have perfected the arrangement of leaf and limb so as to obtain the maximum amount of sunpower for their surface, diminishing their number in the desert, spreading them into lily pads on the water, filling them with tiny pores for breathing. They have learned how to attract such animal life as they care to entertain by enticing odors and nectars. When nitrogen is scarce in the soils in which they grow they have devised clever traps for insects. They have learned to live upon each other as parasites when in their opinion it is necessary, and some of them in what seems to us to be the upper realm of their intelligent life have become so sensitive to their environment that they resemble even man himself in their reaction to gases and contacts.

Now all this is noted in order that we may clearly perceive how universal, in nature, is consciousness, or awareness of surroundings. Beginning with the highest human intellect and descending to the lowest and paralleling that descent with a similar one from the most intelligent animals to the lowest and paralleling that descent with a similar one from the most intelligent plants to the lowest and taking each of these, man, animal and plant, and tracing them back embryologically, we find that intelligence or consciousness, like all the other elements, of nature with which we have dealt, possesses a distinct unity and continuity so perfect that no one is able to place his finger on any particular point and say, "Here is something absolutely different and distinct in kind." From the tiny bit of protoplasm in whose single house each of us began our life, exhibiting as it did no evidence of possessing an intelligence of a higher order than that of an amoeba, on to a Shakespeare, there is no break nor chasm. And side by side with this ascent or quickening of consciousness run the parallel lines of plant and animal life. In every case the record goes back to that most marvelous of entities of the universe, the unicellular house which all living things originally inhabited and which each living thing still originally inhabits. Not out in the sky, but within; in the infinitely little, not in the infinitely vast, lies that which is worthy of wonder and reverence and awe. It is the lair of life. It contains within its diminutive dimensions all the wonders and glories of the kingdoms. Like the atom in which we found compressed a power so great that one human breath could, if properly harnessed, propel a ship across the ocean, we find here compressed all the activities and powers of all living things. We are face to face with another of the great unities. The first that we sketched, as the reader will recall, is that of the physical universe itself, and from it we learned that nowhere in that scale of sizes and temperatures between a little speck of dust and the great star-cluster and between the cold of interstellar space and the blue-white stars of the heavens was there any place where there was a break or chasm. One merged into the other. First the dust, then the grain, then the meteor, then the asteroid, then the moon, then the planets, then the sun. As it was with them, so we found it also to be with matter, itself. One by one the 250,000 compounds diminished to some ninety elements and they decreased as their temperature increased until only hydrogen and helium and asterium and a few proto-metals remained in the hottest stars, and these we found breaking down into the electron and proton of the hydrogen atom until only electricity remained. Then we faced the unity of life and its continuity and gathered into one bundle all things that ever lived upon earth and now we find that as it is with them so it is also with consciousness, with thought and intelligence. And in each case, whether that of the astronomer or the chemist or the biologist or the psychologist, we found that the tracks of the long travelled path led back into the infinitely small, to the cell, the molecule, the atom, the electron. There the darkness grows so dense that our feeble lights can penetrate its blackness no further. As yet the mystery is beyond our reach. The most diligent study of the cell, of protoplasm, of nuclein, of chromatin, of all the factors into which cell-life can be divided fails to interpret the mystery. Life withdraws to its lair and we know no path by which to follow it.

Bearing in mind the thesis of this volume that between science and religion there can never be anything but eternal friendship, we ask ourselves, what is the effect of these findings on the old faith? Do they smother hopelessly the fundamental Christian teachings concerning life and especially concerning immortality? They do not. On the contrary all these facts march harmoniously with faith. Most Christians accept the apostle Paul as the greatest religious writer of all ages. Nothing that he ever wrote is superior to the latter half of the fifteenth chapter of first Corinthians. Nor on any subject did he ever write more profoundly than on this fundamental problem of immortality. Now note carefully his words and compare them with the findings of science which traces all life back past hand and eye and organ to protoplasm and chromosomes. See how he goes to nature for illustration and how skillfully he uses her great analogy. "But some man will say, 'How are the dead raised up? And with what body do they come?' Thou fool, that which thou sowest is not quickened, except it die: And that which thou sowest, thou sowest not that body that shall be, but bare grain, it may chance of wheat, or of some other grain: But God giveth it a body as it hath pleased him, and to every seed his own body. So also is the resurrection of the dead. It is sown in corruption; it is raised in incorruption: It is sown in dishonour; it is raised in glory; it is sown in weakness; it is raised in power; it is sown a natural body; it is raised a spiritual body. There is a natural body, and there is a spiritual body. As is the earthy, such are they also that are earthy: and as is the heavenly, such are they also that are heavenly. And as we have borne the image of the earthy, we shall also bear the image of the heavenly. Now this I say, brethren, that flesh and blood cannot inherit the kingdom of God; neither doth corruption inherit incorruption. So when this corruptible shall have put on incorruption, and this mortal shall have put on immortality, then shall be brought to pass the saying that is written, Death is swallowed up in victory. O death, where is thy sting? O grave, where is thy victory?"

And this incorruptible body of which he speaks, not flesh and blood, but spirit, have we found it at the end of that long reel of phenomena behind the flesh and blood which cannot inherit the Kingdom of God, behind the protoplasm, back behind the molecule, the atom, the electron, in energy, will, spirit, whence science tells us we have come? Each grain of wheat in the hands of Paul, who was wiser in his generation than some of our modern children of light in availing himself of the science of his day, tells the marvelous story of spiritual life. Intuitively, he likens the processes of the spirit to those of the body and in the analogy between protoplasmic evolution and spiritual development anchors his faith in the immortality of the soul. For he knew that his great teacher was right in saying that the Kingdom of Heaven is like a grain of mustard seed, like wheat sown by the farmer, like the microscopic yeast used by the housekeeper.

Verily the Kingdom of God is within.

TO HIM WHO NOW APPEARS

Spring again,
With her little wet violets and her daffodils,
From whose tender lips all the world claims a kiss.
Comes the tulip, with miracled cheeks,
And the woodbine, scarlet with shame,
Because every passer-by keeps staring at her loveliness.
Out, over the woods,
The rainbow has opened the gates of Heaven,
And all her incense is poured forth,
As any sweet-shrub can prove.
The dawn-chorus of the thrushes sounds again,
And the sunset antiphony of their music,
At vespers, thrills the vale.
The loveliness of maidenhood is gathered
In the petalled glory of the crab-apple tree,
And the flames of youthful loves are aglow
In the azalea's zone-wide conflagration.
Spring again!
If we love thee over-much,
Whom do we love but thy Dreamer?
If we pray thee to abide with us forever,
For whose presence do we long,
But for the Artist of the Jasmine.
And the Brush-Mother of the easter lily?
Spring again!
That we may see Thee,
Who art always with us.
Truly.

CHAPTER XII.

THE ORIGIN OF LIFE

From the birth of civilization men have wondered whence came this marvelous thing that we call life. At the beginning it was, as has already been said, identified largely with self-motion. The theory of spontaneous generation suggested by the apparent upspringing of life from the slime of the river valley offered the first workable hypothesis. The part that it played and the related developments have already been sketched. With this chapter we ask ourselves in the light of modern science, what do we know today concerning the origin of life? We know nothing. In fact, literally speaking, nothing has an origin: nothing begins. Everything merges into everything else. Everything begins in some other thing. But the intimations that nature offers concerning the point at which life first becomes perceptible as such are so fascinating that one cannot help endeavoring to frame some sort of an answer.

That life may not have originated on this earth at all, is, of course, quite possible. Spores of certain bacteria have been subjected to a temperature of some 120 degrees centigrade and have lived, and there appears to be no limit to the degree of dry cold which they can endure. Arrhenius, having this in mind, has suggested that the germs of life may have come to us out of space, either intercepted by the earth on its journey or driven to us by the pressure of light. Indeed, it is conceivable that interstellar space is thus inhabited and that life floats in the universe much as coconuts float upon the ocean, seeking suitable soil for growth. It will be recognized at once, however, that to accept this theory of the origin of life on earth is only to postpone the problem. Life must have originated somewhere, and scientists are not accustomed to evading the issue.

It is also possible that the conjecture of those biologists who have suggested that there is an undiscovered life element, some sort of "bion," may be true; for there are more things in heaven and earth than are dreamed of even by our modern biologists. Yet this too is a gratuitous assumption, comparable to those angels in medieval pictures who lifted the windows of heaven in order that it might rain.

Nowadays modern opinion seems to be converging upon some form of the theory that life is a condition of matter resulting from certain delicate actions, re-actions and interactions, a combination of physical and chemical forces. In this case, life would arise from a re-combination of pre-existing forces and would be one of the steps in a vast evolutionary process. This theory is based upon the presumption which we now know to be true, that the energy of motion can be and is constantly being converted into heat and that the energy of heat can be and constantly is being converted into motion, nor does this law fail in any realm from electrons to universes. It is certainly wise for us, as we ponder this unfathomable problem, to remember the vast and inexhaustible energy of the atom. We are so accustomed to think of power in association with moving masses approximately of our size or larger that it is very difficult to bear constantly in mind that the sum total of energy in the universe is largely contained in the atomic structures. When once we have fixed our eye upon the three elemental facts, that there is no lack of time, that there is no lack of space, and that there is no lack of power in the atomic world, we are prepared better to dream of the possibilities that lie within them.

When we consider also that most marvelous of modern discoveries, the breaking up of the atom in radio-activity, it occurs to us to wonder whether there may not be some constructive principle upon which atoms may work which is the reverse of the destructive principle of radio-activity. At any rate, we are now ready to take our last step into the lair of life and to listen to whatever echoes come back to us as we call for an explanation of its origin.

Let us get at this matter by placing side by side the simplest form of plant-life and the simplest form of animal life, comparing them as to their structure and life-process and endeavoring to interpret such indications as they offer in answer to our question. In each case it will be a unicellular creature comparable in size to those little one-room houses in which each living thing, plant or animal, originally lived. Let us take the animal first.

It is one of the ten thousand varieties of single-celled animals, a protozoon, just barely visible to the naked eye or perhaps even smaller. We magnify it some three or four hundred times, and we see beneath our microscope a mass of living matter called protoplasm. In its center is a material of somewhat different structure that we shall call the nucleus. Tiny vacuoles, in which its food is digested, may be seen here and there. Certain projecting cilia reveal their use at once as that of locomotion. There is an opening for food that we shall call the mouth and gullet, and as this little creature propels itself through the water there flow into this gullet certain smaller colorless growing things called bacteria, which may be found wherever animal or vegetable matter is decaying. At once the bacterial protoplasm is converted into the protoplasm of our protozoan. There are, of course, larger protozoa that live upon the smaller and, broadly speaking, this simplest form of animal life exhibits the quality which more than any one thing characterizes animal life, it lives upon other things. It cannot make its own food and would perish unless it were able to capture already organized complex chemical compounds. Its very being therefore points to pre-existing living things. From these it obtains its carbohydrates and fats and proteins. As to the rest, it is not different from the plant. Its respiration is like that of plants, and like plants it constantly changes its protopasmic content by combustion with the oxygen thus captured. It may be noted, also, that the animal keeps returning to the upper world compounds and elements used and robbed of part or all of their energy. Our protozoon reproduces itself by division or by fusion, according to the conditions of its environment. In the one case, the protoplasmic material divides into two parts, and in the other case two separate creatures unite into one. This, as we shall see, is not different from the way in which the simplest forms of plant life reproduce themselves.

Like the protozoon, the unicellular plant is barely visible to the naked eye. It also is composed of protoplasm, and about it is the cell-wall secreted by the inner contents and composed of cellulose. In its center is the nucleus and in the nucleus a net-work of chromatin which, whether, in plant or animal, is believed to be the center of those influences that have to do with heredity. While it exists in various forms its appearance is that of a net-work of little granules with here and there a knot of denser material. In reproducing itself this little unicellular creature proceeds by one of the two methods employed by our protozoon. In the one case it divides into a number of smaller parts, which then develop certain flagella which propel the cell through the water. When the cell has grown it again divides into smaller parts, and thus the cycle is completed. In the other case, the cell divides into a multitude of tiny cells or spores, each with its two flagella, and these, in turn, fuse or unite in pairs and, continuing to grow, eventually discard the flagella, becoming again mother cells of the same size as the original parent. In these processes of growth and reproduction a plant does not at all differ from an animal. But we come now to that unique and important distinction which is the principal basis in distinguishing plant from animal life. For our little unicellular plant does not feed upon other plants nor does it feed upon animals but it has the amazing power to manufacture its own food. This is done by a process of molecular disintegration which is so astonishing as almost to surpass belief. It is usually represented by the chemical formula 6CO2 plus 6H2O equals C6H12O6 plus 6O2. This means that the plant takes six parts of carbon dioxide and six parts of common water, and by breaking the molecules of each in pieces re-unites them so as to form one part of grape-sugar (glucose) or fruit-sugar (fructose) and six parts of oxygen. This is the underlying basis of life. The fundamental fact is that the class of objects known as plants are able to manufacture their own food, themselves, and in doing so they manufacture the food of all living creatures. The next step which they take is to change the sugar into starch, and thereafter into various delicate and complicated forms. They gather nitrogen and form proteins. How they do it no human being knows, but upon the fact that they do it our lives depend.

One thing we do know about it. Plants have the ability to manufacture a green colored material known as chlorophyll, the grains of which are the instruments whereby they capture the radiant energy of sun-light and, turning it upon the carbon-dioxide which they obtain from the air, they dissociate its two elements by such a perfect process that we count it "the highest achievement of modern science" to imitate it. Then by means of this marvelous material whose composition is most complicated, they manufacture all the elements of the food-stuffs, carbohydrates, proteins, fats, protoplasm complete. No animal can do this. It is the one permanent point of distinction between plants and animals. The plant world lies closer to the physical and chemical worlds in point of origin, evidently, than does the animal world, for animals are really motile parasite living upon food-stuffs already prepared. Plants take the inorganic materials of earth, and by power gathered from the sun's light build them into organic materials. This is the last known stathmos into the lair of life. The last thing that we see is a moving, living speck of protoplasm maintaining a delicate adjustment to its environment, capturing power from the sun, applying it to chemical compounds, thus working its will upon them and manufacturing more delicate compounds. It is thus a physico-chemical complex of surpassing intricacy. Its physical basis is matter existing in a colloidal condition, that is, intermediate between solid and liquid, and that matter is viscid, a little thicker than the white of an egg, without color, translucent. In it are little grains and certain empty spaces which we call vacuoles. It possesses the remarkable property of failing to mix with the medium shat surrounds it, and yet through a process of osmosis, interchange of materials is constantly going on with its environment. We distinguish its interstructure as resembling bubbles or fibres or a delicate net-work. When we examine it chemically we find that 99% of it consists of the commonest chemical elements, carbon, oxygen, hydrogen, nitrogen, calcium, and phosphorus, and yet when we have described everything that our microscope reveals we frankly admit that all of our information fails to tell us how this complex material we call protoplasm lives.

Consider its amazing properties. So delicate is it that in many of its forms it seems scarcely more permanent than a drop of oil floating on water, yet it is the one immortal form of life having under favorable conditions no known beginning or end, the nearest approach to earthly immortality. So complicated is it that no chemist can tell us its exact constituents. So invisible is its ultimate texture that our most powerful ultra-microscopes fail to resolve its structure. Into it are condensed all the organic powers of all living things, the power to move, to contract itself, to assimilate food, to re-act under irritation, to adapt itself to environment, to build up and tear down its multitudes of structures, to grow and reproduce its kind. All of these processes it hides behind a screen so dense that no human eye can see nor human mind perceive their method or motive. Into what unfathomable depths of the infinitely small does the path of life's secret lead! Verily no man by searching can find Him out.

Of one thing we are certain. Every living creature, whether plant or animal, as the price of its existence must maintain an exquisitely delicate adjustment to its environment, and of another thing we are sure, that self-movement, which we found playing so large a part in primitive biology, arises from those immeasurable atomic powers beyond the reach of the microscope which reveal themselves in the slower motion of larger masses. Nor should we overlook what is perhaps this most remarkable fact. Of all the billions of cells constituting living things, whether of unicellular or multi-cellular creatures, no two are exactly alike. Each tiny speck of protoplasm lives its own life, whether it is a complete creature all of itself, or whether it is one of countless billions in some larger organism.

With these two, the simplest single-celled plant and the simplest single-celled animal we compare another unicellular creature which is either plant or animal or both, the bacterium. If bacteria are shaped like rods we call them bacilli. If they are shaped like little balls we call them cocci. If they are spiral-shaped we call them spirilla. They are so small that some of them pass through porcelain filters. Fifty thousand of their kinds may be placed side by side to cover the length of a single inch and their breadth is still smaller. They live everywhere, in the air, in water, salt, fresh or hot, in ice, in soil, in plants and in animals. They possess no clearly defined nucleus, the chromatin being diffused throughout the cytoplasm in the form of little grains. They also develop flagella and reproduce themselves by cell division, which sometimes occurs as frequently as twice in an hour. Were it not for them the world would be one vast cemetery. They break up the chemical compounds of all dead things, restoring to circulation the precious chemical constituents of protoplasm by processes which we call decay. It is through their agency that nitrogen, that most priceless constituent of protein, is captured and fixed for the use of living things. They are the active agents in the production of many foods such as the many delicious sorts of cheese and of many enjoyable drinks. They contain no chlorophyll but are actually colorless plants closely resembling animals in certain features. And, like the green plants, there is at least one group of them that possesses the power which green plants possess, that of disrupting carbon-dioxide and utilizing it as the green plants do. Possessing no chlorophyll, they do this by utilizing chemical energy captured by oxidation. As distinguished from photosynthesis, this process is called chemosynthesis. It reveals to us what may be a clue concerning the origin of life on earth. For such bacteria may have prepared what we are pleased to call the lifeless earth for the habitation of other living things.

It is interesting to note that life has not made use of the rare earths, but of the common elements of air and water and dirt. We can picture to ourselves, a lifeless earth slowly cooling, a lifeless ocean still warm, and a lifeless atmosphere. At any point where these three met every life element could be found. It is evidently logical therefore to suppose that life began where these three, earth, air, and water, met. They meet at such points as the seashore and river banks and marshes and water-soaked top soil. It is at just such points that the original colloidal material forming the basis of protoplasm could have combined with such postulated physico-chemical reagents as were necessary to initiate primitive unicellular existence. Or shall we look upon life as a sort of symbiosis where "spirit" made common table with "matter" developing the latter into more and more complicated forms and ever building a more and more intricately designed body for itself. It remains only to suppose that in or out of that unfathomable well of being that we call the atom there lay or developed a will for organization. What steps were taken to bridge the vast chasm that must have been crossed before the bacterial stage was reached we do not know and we cannot guess, but doubtless the bacterium with its indescribable complexity of structure is as far from the electron as it is from mankind. When we speak of the bacteria and similar unicellular creatures as representing the origin of life on earth we can only mean that the point they occupy in the evolution of life is at present the most distant that we are able to discover. Back of them lie countless milleniums of evolution comprised in those geological eras known as the proterozoic and the archaeozoic which we have already learned constitutes one-half of geological time.

Thus far science, which dares only to believe what it can see or feel or taste or hear or smell. But the believer in

God asks at once, What, who, is this "will for organization?" The scientist can only answer, "I do not know." If this seems to lose us in a misty maze of ignorance just when we are most anxious to see clearly, let us remember that science, as it enlarges the circumference of its little circle of light, finds the circumference of the encircling darkness of the unknown correspondingly increased. But surely none will fail to observe that the final conclusion of the new science as to the origin of life opens wide the door for the theist. It is as if the new knowledge beckons to the old faith to bring its light. In the beginning, God! Thus the apparent controversy between the new science and the old religion vanishes, becoming simply a question of terms and names, of how much of God's work is "nature" and "law" and therefore common and known, and how much is super-natural operated by unknown laws and therefore "holy." It is not a question of who made the world, God or evolution, but of how He made it, how far back to the original point of its initiation we can trace that process of development which we know as "evolution." "How did life originate?," we ask of the scientist, and he answers, "I do not know the first cause." Of the theist we ask it and he answers, " I do know the First Cause." That is the full length, and depth, and wideness of the supposed conflict between the new science and the old religion.

If our supposition is at all correct, and the earliest known form of life on earth is represented by the bacterial phase in which from inorganic materials these invisible unicellular creatures transformed a part of the lifeless world into organic materials, then it is not unreasonable to suppose that the green single-celled plants, such as we have already described, followed and that they, in turn, gave rise to algae and the protozoan stage of animal life. Thus, from the very beginning, living things began to feed on living things and parasitism developed. It is worth remembering that heat seems to be of more importance in the life of bacteria than does light which is fatal to them and this again points to the primitive conditions of the earth as being such as have already been described.

Text books on the origin of life, which are largely as yet pure speculation, generally speak of the process as being an assembling of the life elements, carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, potassium, iron, calcium, magnesium, and silicon in a colloidal or gelatinous state in the presence of catalyzers, that is, of substances which, without being themselves changed are able to produce changes in others. The newly discovered enzymes, antigens and anti-bodies are supposed to have played their part in the game. Special chemical compounds are suspected of having taken the leading role by some, but, when all is said, we can only marvel at the smallest living things, for example, the fertilized ovum of men which is just one one-hundred and twenty-fifth of an inch in size, constituting as it does an unfathomable mystery, more complicated than the adult of the species, and containing within its microscopic contents, in the form of atomic energy, resources of power sufficient to account for all of its later developments.

Answering, then, the question, what of the origin of life? We can only say that it is to be sought in the unfathomable well of being from which come the molecules and the atoms, the protons and the electrons. Of it come all things; in it we live and move and have our being. For, as the poets of earth have always said: "We also are his offspring."

Perhaps some day man will be able to make life. Already he is able to build up artificial cells "that grow and crawl and feed themselves and stick out feelers and subdivide very much like living cells." As we write these words, Dr. Baly announces that he has made sugar and formaldehyde from water and carbon dioxide by using ultra-violet light. Is the wall between life and death imaginary? Is life inherent in "matter" needing only the proper adjustment to become perceptible?

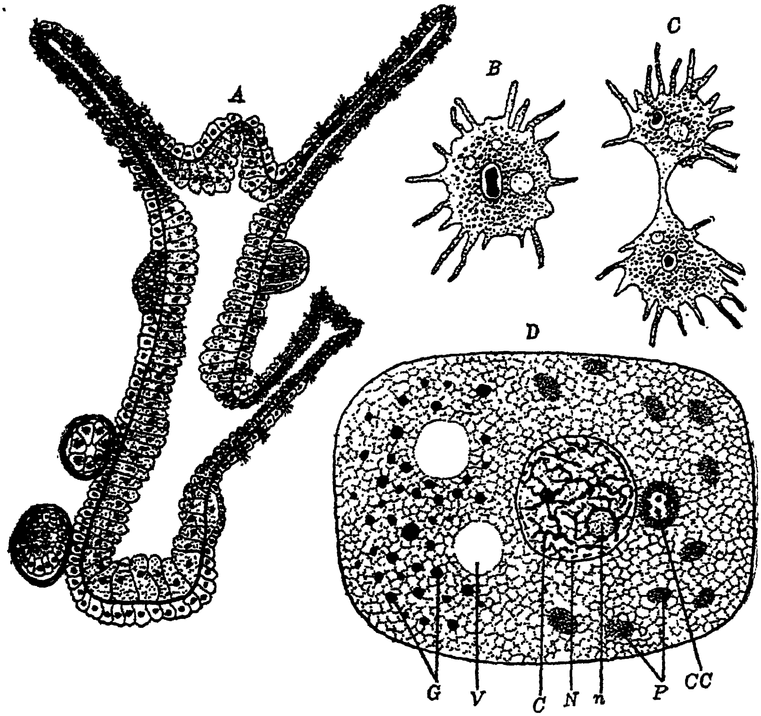
Let us leave the facts and appeal for a moment to imagination. If the earth were reduced to the size of a globe forty feet in diameter, ten thousand human beings could lie within the space included in a lower-case o. Living things on earth are, of course, (whether large or small) composed of matter, and matter is composed of protons and electrons. Fournier D'Albe says that if one could imagine himself standing on an electron in an amoeba which is about the size of a human blood corpuscle (three thousand to an inch), the sky would not seem very different from ours. Every object and every hour would be ten thousand trillion times shortened. A year, there, would be a thousand billionths of one of our seconds, within which latter countless generations would live and die. The suns and planets (electrons and protons) would possibly seem a bit nearer, for the density of our universe is more that of a gas, but there are doubtless star clusters and star clouds in the milky way of about the same density. We know that all life processes consist of the action, re-action and inter-action of protons and electrons. Our imagination hesitates to go further. Is it possible, then, as D'Albe suggests, that our universe is a living thing? Is it possible that within living things, ourselves for example, this electronic life proceeds? Of how many of the myriad life processes within us are we conscious? How many of them do we control? Then who does control them? Is it intelligent control? Whence then the intelligence? Are the bridges built over the fractures of our bones similar to those that bees build to connect fractured comb and that men build over fractured bluffs? If protons and electrons are the ultimates of the universe, where is the universal intelligence that guides with uniform perfection the chemical, physical and biological processes of earth? Does it also come up out of the infinitely little where its perfection is most evident and necessary? Is an amoeba a vast empire of worlds controlled as we shall some day control the worlds of our solar system? Thus do we lose ourselves before we start on our journey between the infinities.

Here on earth we know moving masses that we call "living" of sizes varying from 60,000 to the inch, an infusorian spore, to an elephant or whale. Within them and part of their vital processes are billions of microscopic bacteria of which they are unconscious. Still further within, life vanishes into the infinity of littleness. And above us, what of our universe? Is it alive also, and are its motions such as to show intelligence? Does it feed on star clusters? Does it throb with gravitation? Do its nerves tingle with electricity? Has it also a purpose—a living purpose? Or is it but a lens-shaped leaf or ring of smoke in some upper totality from whose purposes we are as far away as an electron is from ours? Is there an end to the heavens of Anu?

Let us reflect for a moment. We have seen in how small a segment of time and space we live. Our eyes see only a few colors. Our ears hear only a few sounds. If it grows either too hot or too cold, we perish. Our vision is only of the things immediately around us. Our measure of them is either large or small, near or distant, depending upon our measure of ourselves and of our earth. And in this world we find nothing permanent. Everything is in motion not only, but eventually that motion is disruptive. Sooner or later the form and color and temperature of all things change. There are no fixed stars. There are no immovable mountains. There is no steady earth. There is no immortal reputation. There is no imperishable civilization. Everything changes, everything perishes, except two things. One is the positive and the other the negative charge of the hydrogen atom. So far as we know nothing earthly or heavenly can effect their permanence. They are eternal. Amid the fires of stellar Molochs they remain unaltered. In the deadly chill of interstellar space they are ever the same. Here, then, is immortality—so far as the earth is concerned. If we were as small as they and constituted as they are constituted, our life also would be immortal.

Now let us dream a moment. Suppose it were possible that there should be some form of passage of power or life from the eternal world of the electron into the temporal world of the earth. Suppose that that inscrutable entity which we call the human soul or self or personality were such a power and had come to its present state through such a passage. Is it necessary to be large in order to think? Does size determine the capacity of the soul? Indeed, has the soul, the self, the ego, any size at all? Flammarion tells us that the brain of an ant, which is probably next to man the most intelligent creature on earth, weighs less than a tenth of a milligramme. What a curious and instructive light the science of embryology throws on this question. In any good text on biology one may read the statement that the human infant at birth is just one billion times larger than the egg from which it grew. And that egg? How mank billion times larger is it than the atomic nucleus from which it grew? In short, as we trace life back, we find it diminishing in size from adult life, through youth to infancy, past the embryo to the egg. We see it vanish into tiny bars of chromatin, hidden away in a protoplasmic nucleus. We note that it veils itself in chromosomes and disappears into the infinite littleness of the molecule and the atom. Our reason follows it to the proton and the electron. Its tracks are lost in the dim obscurity of our ignorance, and our hopeful pursuit temporarily ends. But who knows out of what eternal depths of the infinitely small may come these larger creations that are born and live and die?

THE LAST STEP TAKEN, SO FAR, INTO THE LAIR OF LIFE.



Cells and cell structure. *A*, a longitudinal section through the body and two tentacles of a fresh-water *Hydra*, to show the cell structure of a metazoan animal. Greatly magnified. *B*, a single-celled animal, *Amœba;* *C*, the same dividing into two individuals. Greatly magnified. *D*, diagram of cell structure and its meshwork or linin. After Wilson. Very greatly magnified. *C*, chromosomes; *CC*, centrosome; *G*, granules; *N*, nucleus; *n*, nucleolus; *P*, plastids in the cytoplasm: *V*, vacuole.

(Courtesy of John Wiley and Sons.)

To those who interpret the universe in terms of God, there is something vastly heartening in all this. For it is nothing short of an amazing fact that when the biologist is asked, "Whence comes life?," his answer is in essence the same as the answer of the astronomer to the question, "Whence comes the universe?" The one goes back to protoplasm, ultra-microscopic, unanalyzable, immortal; the other, to protons, to electrons, to ultimate quanta of power, ultra-microscopic, unanalyzable, immortal. The theist quickly interprets these as themselves only sign posts along the pathway which leads to that fundamental unity which underlies the organic and the inorganic worlds. Thus the ultimate word of modern science as to the source of life and power inevitably postulates a Cause of Causes, invisible, inaudible, intangible, who doeth His will among the armies of Heaven and among the inhabitants of the earth and whose hand no man can stay and of whom none may ask, "What doest Thou?" Are we, then, come upon that great and fundamental postulate of religion, the fatherhood of God? Having traced all things, organic and inorganic; all phenomena, mental moral, physical; all facts, religious, historic, scientific, back to energy, power, vibrant will, are we suddenly and clearly brought face to face with our divine sonship? Surely the theist has a right to say so. All the great seers of earth have said it. For this first stage in the evolution of all things is certainly as much spiritual as it is material. No wonder Goethe declared: "Es ist der geist der sich den koerper baut." What we have discerned is that the universe is in essence, spiritual; that it either is, or controls, the energy of electron and atom; that it appears "asleep in the stone, adream in the animal, and awake in man;" that it is ever tirelessly experimenting with forms of "matter," its function always dominating its form; that, in short, all things visible and invisible are manifestations of what, for lack of a fitting term, may be called Will, without bounds in space, without end in time, and without measure in degree, which, if traced to its ultimate source, vanishes ever into some new transformation of power.

Thus, do our little minds, just awaking to the consciousness of the universe, marvel over the depth and the riches both of the wisdom and the knowledge of God. How unsearchable are His judgements and His ways past finding out. For of Him and through Him and to Him are all things; to Whom be glory forever. Truly.

WHEN?

There is a tiny planet in the sky,
That circles round a modest, yellow sun,
Midway between worn Mars whose seas are dry,
And staring Venus, whose love-days are done.
Around her moves a pallid, lifeless face,
Her breathless Moon, whose graceful youth has fled.
While, fixed and rigid, his regard betrays
Yon dusty-sandaled Mercury, long dead.

An aging planet, but beyond the count
Of millioned miles lie days that are to come,
Where ruddy Jove guards then De Leon's fount,
And Saturn rings his more abiding home.
There Herschel's star and Neptune's figured place
Entice Earth's poet to a clearer sight
Of life begun in slime to end in grace,
Of paths that lead through darkness into light.

A minor planet, with her sisters seven,
(And yet one more who could not come to birth)
All swiftly speeding through God's boundless heaven.
To some far destiny! One lonely Earth,
One unnamed sun's small family, a-swing
Round what vast circle in a universe
That plummets space upon what magic wing?
Toward what abyss of blessing or of curse?

And on this tiny ant-hill hurled through space,
On lines dividing nation's clod from clod,
Men kill to win this great grain for their race;
For that vast beetle shed each other's blood.
And when the slaughter slackens, on the way
Most-frequented, their highest statues rise
To him who most successfully could slay,
That all may look and learn where greatness lies!

So short a distance have they come from that
Warm ocean's shore where atoms learned to love,
And, fellowshipping rudely, first begat
A larger vision of a world above;
Till, at millennial cost of toil and pain,
One wondrous day a cell, completed, lay
In lap of mother Time; till gain sired gain
Past fish, amphibian, reptile—till today!

So staggered they, up out of ancient night;
So fought their way past fin, and fang, and claw;
Enamoured of a dim and flickering light;
Impelled by some deep-moving nameless law.
And ever those who marched a pace ahead
Would draw the struggling masses to their side;
But those, o'er-eager, who too swiftly sped
Were crowned with thorny wreaths and crucified.

O planet, red of hand and bloody-skirted,
By all that thou hast known of weal and woe,
By vermian night, by ichthian heart-blood spurted,
By vertebrated billions' scarlet flow,
By sloped brows of myriad Trinil rivers,
By countless caves Cro-Magnon, by the thin
Set lip of Faith that never, never quivers,
The light shall conquer and the Cross shall win!

CHAPTER XIII.

THE ASCENDING PATHWAY

We have now come to the wonder of wonders. It is the long, long journey of man up out of the invisible, the intangible, the inaudible, the infinitely little, to his present state. It has to do with the most astonishing thing in the universe, the germ of life, the original cell from which individuals and races come. No man can tell the story completely. Many of its chapters will not be written for ages. Doubtless, many will never be written, but we can read enough of it to know that it is perfectly fascinating.

We begin with the simplest known form of life, that of the colorless plants, the bacteria. Apparently, they have none of the marks that distinguish man, no eyes, no ears, no limbs, no brain. Yet all the great human organ systems such as those of digestion, respiration, contraction, are theirs in embryo. Their size, beginning at approximately 1|230th of a millimeter in length and 1|10th that size in width, vanishes into the invisible. The influenza bacillus is from 1|2 to 1|5 of a micron in size, and therefore may just barely be distinguished by a microscope. Still smaller are other bacteria which are so tiny that they cannot be seen but can be detected by ultra-microscopes. Some of these are so small that they have been known to pass through a porcelain filter. Doubtless there are others smaller still, bacteria of bacteria. Perhaps some of the new, strange diseases which affect mankind from time to time come up out of this unknown world of the immeasurably small, whose dimensions do not greatly exceed those of a large molecule of starch. Perhaps such life is still being born from such sources and in the course of ages developing. Over this fascinating speculation the veil of mystery is drawn. We only know that there are living things so small that with our most powerful microscopes we cannot see them, and that these living things are different from higher and more elaborately developed living things in possessing only such features and constitution as are common to all protoplasm. They are not plants, they are not animals. They either are, or are closely related to, that original trunk of life from which the limb of the plants on the one hand and of the animals on the other hand later branched.

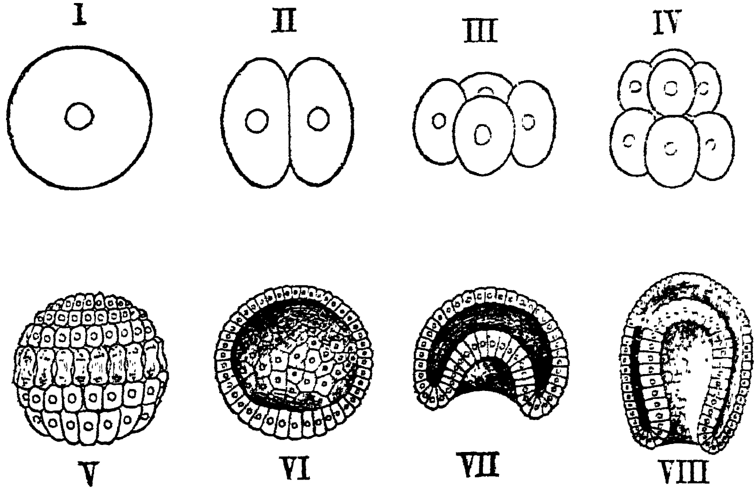
We are struck with amazement, as we examine this world of bacteria, at the tremendous creative power that they contain within themselves. First of all, they have learned in some way, in many cases, to live from inorganic material by the method previously described as chemosynthesis. Each of them is a little blast furnace in which energy is captured from the chemical substances ammonium sulphate, for example, and devoted to the purposes of the organism. It is generally believed that these bacteria represent the first surviving state of life on earth and that their activities prepared the lifeless world for later organisms. Their capacity for reproduction is astounding. Woodruff, one of our most careful and distinguished biologists, tells us that a single paramecium has the power to reproduce itself at the rate of 3000 generations in five years and that all of its descendants preserved alive would constitute a volume of protoplasm equal to ten thouand times the volume of the earth. By the 9000th generation the mass of protoplasm descended from the original pair, supposing all descendants to have lived and bred normally, "would exceed the bounds of the known universe and the rate of growth would be extending its circumference into space with the velocity of light", 186,000 miles per second. (Lull). Lull further tells us that if all the progeny of an oyster survived until her great, great grandchildren, these would number sixty-six quadrillions of quintillions and the heap of shells would be eight times the size of the earth. They remind us of the calculation by Flammarion of the amount that one penny invested at compound interest at the birth of Christ would come to by 1924. If a mass of gold as large as the earth were to fall from the sky every minute for seventy-five thousand years, it would equal the amount. Sometime ago the papers contained the story of how Dr. Charles E. Mitchell, President of the National City Bank of New York, had purchased a tiny toy bank unearthed at Carthage containing some copper coins worth about six cents. He had his experts calculate the sum to which this little deposit of a Carthaginian child 2500 years ago would have amounted at 5 ½% compound interest by the year 1925. The figure, if expressed in dollars, would come to 36, followed by 59 zeros. It would equal a gigantic planet 62½ billion times larger in diameter than our earth, made of solid gold. Such multiplication of life must, necessarily, be curtailed by other laws and hampered by environment, and it is this contest for the materials of living that constitutes the struggle for survival which is at the basis of development.

Remembering our chart of geological time it should be observed that the development of unicellular life seems to have taken place in the Proterozoic era. The second step of advance was the discovery of a way in which to capture the energy of sun-light by means of the green coloring matter known as chlorophyll. Some of the bacteria learned it and others did not, or shall we say that one bacterium learned it and that the discovery was of so great importance to his progeny as to enable them to multiply and survive in the struggle for life. In this stage, therefore, we find the world divided into two types of single-celled creatures. One of them which we now call plant obtained its energy from the sunlight, and the other by feeding upon other existing organisms, bacteria and the plants themselves. These latter we call animals. And here is a point that we should never forget; countless bacteria "stayed put." And as they were then so they are today. Through countless milleniums many of them have changed but imperceptibly. Many of them have, doubtless, not changed at all. This is a feature of evolution that we will find always present. The new discovery does not come to all. The new power comes to the individual and is appropriated, at first, by only a few. If it is good and useful, those who had it prosper and multiply, but at each stage in the onward march, as each opportunity is presented, there are some who fail to take advantage of it and whose punishment is that they simply remain what they were.

The next advance in the development of man consists in the pathway chosen by animal life as it separated from the plants. Back in the earlier day there seemed to be no difference between them except that one had discovered the use of the chlorophyll and the other had not. Each could move at will through the water. Each was conscious, though dimly, of its surroundings. Each was able to make a choice as to its conduct, each knew the pangs of hunger and the twinges of pain. In each, therefore, was found the rudiments of those upper faculties that we call memory, will, consciousness and habit. Then their paths diverged. One did not need to move from place to place. It learned to settle down in a convenient spot and to harness the sun to work for it. After a while it had discovered how to make a "hold-fast," to anchor it in a specific spot, then it learned to sink roots into the soil, to gather moisture and the chemicals of earth. Eventually it learned to spread out its hands more widely and perfectly to receive the gifts of the sun. It stored up enormous quantities of food-material and pursued its various pathways of adaptation to its surroundings. Today we know it as the vast world of vegetation, a marvelous world of throbbing life which has availed itself of every niche and corner possible for its growth. It is still the foundation upon which animal life is built, and in perfectness of structure and exquisite adjustment to environment it is not surpassed even in the animal world. In short, it illustrates that marvelous principle of the radiation of life wherein we see protoplasm adopting no one pathway, but following every road and occupying every possible field of development, and doing it all with infinite perfection.

The animals chose the other fork in the road. They did not learn how to harness the sun by means of chlorophyll, but they quickly discovered how to devour those plants that had found out so fine a secret. They learned also how to live upon other animals, the weaker, and thus laid the foundation of their being, motile parasitism, which general principle of conduct they have preserved to this day. We, therefore, find the animal world one of intense struggle, perfectly illustrative at all times of the Darwinian principle of the survival of the fittest, and it is from the necessity of developing ways of protection and methods of offense and means of subsistence that the animal bodies which we know have been created. As in the plant world also we find animal life radiating into every available pathway, into the air, aerial; into the trees of the wood, arboreal; into the rivers, fluviatile; into the marshes, paludal; into the shallow waters, littoral; and into the deeps of the sea, abyssal; and into the earth itself, fossorial.

The next great step in the progress toward manhood was the development of the multi-cellular animal. The long ages of the Proterozoic passed with their infinitude of tiny battles and then one day two cells learned to live together, and then three and four, until a colony had been formed. Again we find that there are still in existence just such creatures as are thus described. In many of them the individual cells performed their accustomed functions. Here for example, is a colony of single-celled creatures, every one of them performing its individual functions of nutrition and reproduction. In other cases, some of the cells specialized in the part that they played, some being set aside for reproduction or for locomotion or for similar services.



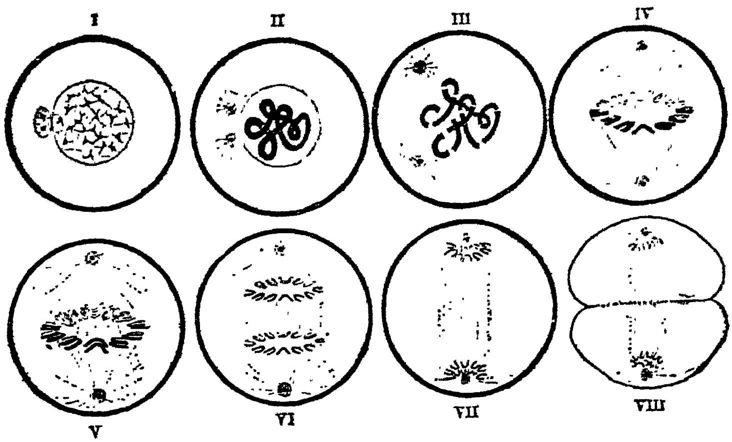
DIAGRAMS REPRESENTING NORMAL MITOSIS

Early Metazoan development; typical. (After models of *Amphioxus* by Hatschek.—I, the egg. II, III, and IV, cleavage stages. V and VI, blastula: in VI, which represents a somewhat older stage than V; one-half has been removed. VII represents the beginning of the gastrular invagination, and VIII is the completed gastrula, both sectioned as in VI. (From *History of The Human Body*, by Wilder. Courtesy of Henry Holt and Co.)

After so long a time we find animals composed of cells shaped like a hollow sphere commonly called a blastula, and then a little later we find this sphere invaginated, forming a shape something like a sack with an opening to the exterior. Then begins a series of succeeding changes by which this latter gastrula stage is changed into a tubular form, and then still later into a tube within a tube. According to this latter figure all modern vertebrates are formed. Now the fascinating fact about this process is that on the one hand we find alive today animals whose form still illustrates each of the successive changes of single-celled, multi-cellular; many celled, without specialization of some cells for special service; many celled with specialization of some cells for special service; blastula shaped as a hollow sphere; gastrula shaped as an open-mouthed sack; single tubed; and double tubed: and on the other hand, we find that the individual human being in its embryonic development passes through each and every one of those stages. This is the law of recapitulation which, while it cannot be pressed to extremes, is, nevertheless, good for broad outline. So when our unicellular plant discarded its flagella and abandoned locomotion, and our unicellular animal perfected its system of locomotion and adopted the colony plan, the whole broad vista of the two great kingdoms was opened up. Soon the cells of the animal were, by processes of cell-division involving differention of structure and function, developing various kinds of tissue, for example muscular, created to perform certain definite functions. Later, these tissues were organized into organs, for example, the heart. The liver, is such an organ. It is composed of billions of cells, each a complex universe containing, according to Bechold, 225 thousand million water molecules, 29 hundred million crystallized molecules, 166 million fat molecules, 53 million protein molecules. The many organs are united into organ-systems, for example, the digestive system, so that an animal today is a co-operating organ-system.

We find, therefore, this interesting fact to be true of the human body not only, but of all animal bodies, that they are wonderfully organized and adapted systems of organs for the capture, storage and release of energy. All such parts of the body as hands, claws, talons, beaks, fangs, eyes, legs have been developed in order to capture power. The internal organs have been largely developed for the storage of power. Other organs such as the muscles serve a double part. All animal bodies both in shape and function have been determined by the necessity of getting food and drink and from them of securing the energy necessary to life.

Following therefore the progress of the animal body, which of course means also of the human body in its early stages in evolution, whether in embryology or in palaeontology, we find ourselves passing rapidly through the various stages named. The single celled comes first, developing, by the process of mitosis, into the multi-cellular stage, followed rapidly by the blastula, then the gastrula stages. Afterward comes the tubular stage represented by the earth-worm, and thereafter the tube within the tube of which all vertebrates are illustrations. Then, in rapid succession, the line of march passes through the fish, the am-



In I the nucleus is "resting"; the centrosome is seen by its side. In II the spireme appears, which in III becomes separated into chromosomes. In IV the centrosomes have become placed at opposite poles, while the chromosomes form an equatorial plate midway between them. Each chromosome divides longitudinally in V, and in VI and VII becomes drawn to the two opposite poles. In VIII the cell divides into two.

Stages II—IV are spoken of as the *Prophases* of the Mitotic process; Stage V, where the chromosomes split, is called the *Metaphase;* Stages VI and VII, which effect the separation of the two sets of chromosomes, constitute the *Anaphase*; and the final phenomena, beginning with VIII, where the new cell-wall is forming, and ending with the massing together of the separate chromosomes of each of the daughter cells, and the loss of individuality of the separate chromosomes, are the *Telophases.* (From *History of The Human Body*, by Wilder. Courtesy of Henry Holt and Co.)

phibian, the reptilian stages to the birds and mammals. To enter into a technical description of this process in detail would take us beyond the scope of this volume. We are rather concerned with the more fundamental questions that underlie the process. Here, for example, is the whole wonderful problem of how the animal form has been developed. They are so many and so various. How different is the eagle from the elephant and the humble frog from the proud Nordic! How did it come to pass that the flipper of the whale, though it contains just the same bones as the foreleg of other mammals, has been so fore-shortened, while the leg of the horse has been lengthened?

Few biological problems are surrounded by more difficulties and uncertainty than this subject of the inheritance of acquired characters or more plainly the inheritance of change in the body of an individual brought about

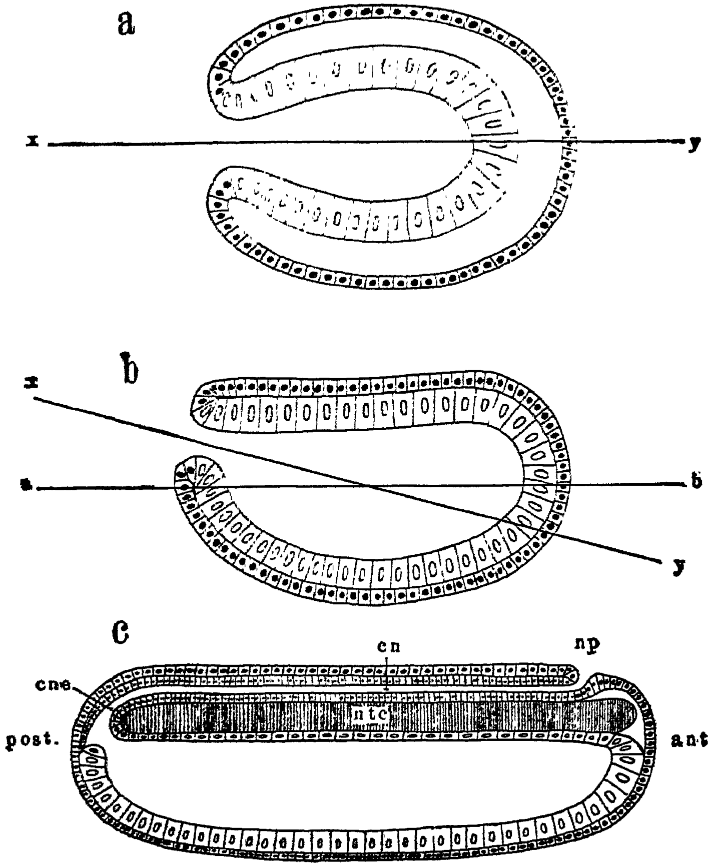
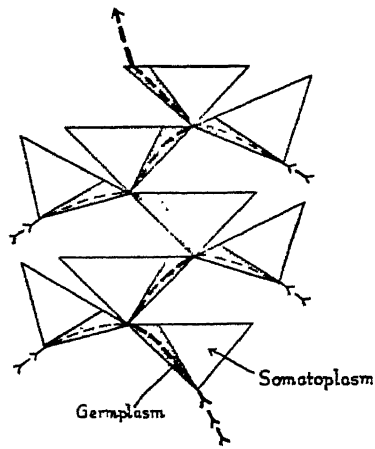


Diagram of the gastrulae. [Based on models of *Amphioxus* by Hatschek.] (a) Typical gastrula, as VIII, but differently placed, for comparison with the others. (b) Early gastrula of Amphioxus, a probable ancestor of the vertebrates. (c) Later embryo of the same. *xy*, primary axis, *i. e.*, that of the gastrula; *ab*, secondary axis, that of the adult *Amphioxus; cn*, neural canal; *cne*, neurenteric canal; *np*, neuropore; *ntc*, notochord. (From *History of The Human Body*, by Wilder. Courtesy of Henry Holt and Co.)

by environmental causes. Since the days of Weissmann who showed how even in sexual reproduction the life stream of the germ plasm is kept separate from the body plasm, many of the most learned and distinguished scientists have been inclined to doubt the possibility of the transmission of somatic changes by heredity. Broadly speaking there are three clearly defined groups of theories on this fascinating problem. One, commonly spoken of as the Neo-Darwinian, of which DeVries and Weissmann are the principal expositors, holds that the origin of variations and changes and adaptations of bodily shapes and functions is to be found in the heredity chromatin. According to this view the chromatin by varying combinations is to all intents and purposes trying out various experiments. Those that succeed would naturally be the ones to survive, and in proportion as the experiment was needed by the organism it will be continued in the next generation. It calls for endless chance variations culled and modified by natural selection. The second postulates directional variation or orthogenesis entirely independent of environment, exhibiting phenomena known as parallelism of developmental variations in different species and overdevelopment of variations and needless and even harmful variations in others. The third type, that of Lamarck, Spencer, and Cope, holds that the heredity chromatin of the germ cells is invariably affected by the bodily organs and that such physical and chemical changes as take place in the bodily organs influence the determiners of the germ plasm, genes, to the end that each organ is



SCHEME TO ILLUSTRATE THE CONTINUITY OF GERM PLASM.

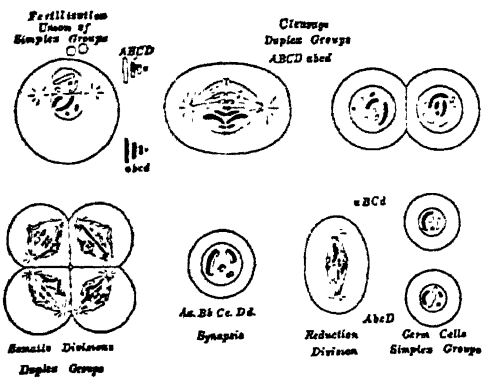
Each triangle represents an individual composed of germplasm (dotted) and somatoplasm (clear.) The beginning of the life cycle of each individual is at the apex of the triangle where both germplasm and somatoplasm are present. In biparental (sexual) reproduction the germ plasms of two individuals become associated in a common stream which is the germplasm and gives rise to the somatoplasm of the new generation. This continuity is indicated by the heavy broken line and the collateral contributions at each succeeding generation by light broken lines. (From Walter). (From *The Evolution of Man*, by Lull, courtesy of Yale University Press.)

changed. Under this theory the chromatin invariably inherits the experience of the bodily organ. Conversely, the atrophy, for example, of the eye of the fish in Mammoth Cave, brought about by disuse, would be "inherited" by the heredity chromatin which in the next generation would tend to reduce the health and vision of the eye. It is based on the same general principles as the doctrine of heredity itself and is buttressed by a thousand facts. The simplicity of its appeal may be seen if we consider a child begotten by a man, let us say, at the age of thirty. This child is the living image of his father thus specially illustrating the principle of common heredity. But which father? He of thirty or of twenty-five or of fifteen or of one? Plainly, by all; even of the potential embryo. He has inherited of his father up to date. All the changes in the ancestral line accruing since mesozoic or even archaeozoic times he has inherited. Now all of these either are or may be explained as adaptations to various kinds of palaeontological environment and conditions of life brought about by natural selection. Furthermore, as it is with man so is it with birds and reptiles and insects and all living things. It takes an enormous amount of credulity to believe that all the forms of all living and fossil creatures, so plainly the results of adaptation, are not inherited but are the results of chance in each individual case or of uncalculating, uninformed directional variation. The inner cause of variation must have been advised in some way of what was happening on the outside. And this argument is buttressed by such analagous, homologous and causative facts as the prenatal influences of the maternal emotions and experiences during pregnancy, the inherited effects of paternal debauchery, the atrophy of organs from disuse, the dwarfing of races of dogs, and bantams, and other animals as well as trees by changing their nutrition and other environmental conditions and the continual inheritance of these modifications after environment is changed as for example, by Shetland ponies, dwarfed silkworms, etc. The morphological likeness of limb and organ in animals subject to the same environmental influences transmitted through countless generations, the whole science of line-breeding for eggs, flesh, speed, fruit, etc.; the atrophy of parts no longer useful as the eyes of cave-fish; the modification of whole species under circumstances plainly due to environmental conditions such as dwarf elephants, rabbits, etc.; these and similar facts strew the pages of palaeontology, comparative morphology and anatomy and indeed of all biology. Striking analogies fill the whole of nature. Lull cites the common begonia plant which propagates by seed. Yet from any cutting of its stem, even a leaf, a complete plant can be grown, and this plant so grown bears seeds which continue the life circle as before, plainly showing that either the heredity chromatin is distributed through the tissues of the plant, or perhaps each body cell has retained its portion of hereditary characters, neither of which is possible under the Weissmann theory. Of planarian flat worms, Dorsey says: "Life processes in planaria are naturally highest at the head and diminish toward the tail. Cut one into three pieces: the head part grows a tail, the tail grows a head. Normally, a head will grow at the end of the middle piece which was toward the head, a tail at the other end. But Child can reverse this! He can so alter the life process that a head will grow out from the tail end, a tail from the head end. The net result is the same: from one old worm, three new worms. With no more 'conjugation' or 'fertilization' than a scalpel." The case of the flounder born a normal compressed fish whose eyes and some of whose bones remove from the under to the top side of its body when it begins to lie flat upon the ocean floor is similarly difficult of other explanation. The essential question seems to be: If the germplasm is as Weissmann claims unaffected by the experience of the body which acts only as its carrier during life, how could any change in offspring come about at all? Would not each generation be exactly like its parents? No, is the answer, for the law of variation, chance or directional, would operate. Yes, is the reply, but how then could those variations ever possibly show such perfect and multitudinous adaptations to environment. If the germ plasm goes on its way unaffected by its carrier's experiences, on what principle of chance or directional variation could the young flounder's eyes and adjacent bones ever change their positions from the under to the upper side of the flounder's head? Even Weissmann admitted the inheritance of acquired characters in the lower orders of plants, in protozoa and lower metozoa, which all animals and plants once were, and all embryos still are. "How," wisely questions Henry Fairfield Osborn, "could so valuable an ability be lost by natural selection?" Osborn has probably more nearly approached a working solution of this problem in his statement of the case. On the one hand he believes that the Lamarckian view to the effect that the adaptation of the body cells invariably precedes similar adaptive reactions in the chromatin is not supported either by experience or observation. Such precedence he believes to be occasional, and even frequent, but by no means invariable On the other hand. he points out that in the genesis of many characters there is a direct evolution of the chromatin toward adapted ends. Answering then the question as to how single characters originate, he holds that under normal conditions an organism will tend to reproduce its normal ancestral character, but if a new physico-chemical intruder enters the environment it may produce a new visible character. The part that chemical messengers, the hormones, chalones, ferments, and enzymes play in this drama is doubtless important. He believes that these chemical accelerators, balancers and retarders of body-cell development also affect the germ. Surely, in some way the experience of the individual becomes the heritage of posterity. Hidden somewhere within the germ plasm is the recorder of each occasion when fathers eat sour grapes and the children's teeth are set on edge. Doubtless we shall eventually find that it is here as it is everywhere else in nature that every impression, every sensation, every experience, even the slightest and least noticeable, has its effect on the present mind and body not only, but on the future as well; that in some way unknown and by degrees imperceptible these impressions accumulate and intensify until they become apparent; that acquired characters differ only in their faintness, softness, evanescence from the clearest, hardest, most permanent phylogenetic characters, a difference in degree, not in kind. They are the soft, pliable, living crest of the coral reef, which hardens below into fixed and unchangeable rock. As the invisible grain of dust grades into the meteorite, asteroid, planet, sun, star cluster, universe; as the invisible bacterium grades into the worm, fish, amphibian, reptile, bird, mammal; so doubtless the faintest impression grades into the hardest hereditary character. That natural selection is constantly operative, we know. That variation is constantly taking place, we know, but we do not know why. That heredity includes the inheritance of all characters acquired up to date from archaeozoic to psychozoic, we presume, but how the recent experience of the past is impressed upon the germ plasm whose life current Weissmann has shown never to become a common stream with the somatoplasm we know no more than how one mind can read the thought of another though they be separated by a brick wall. Back of

Weissmann's Biophores and determinants of the germ plasm is the same thing, "Nature," "Law," "Will," that is back of the molecule and atom and electron, invisible, intangible, inaudible. Let us not be afraid to say with Herbert Spencer, "We are ever in the presence of an infinite and eternal Energy from which all things proceed." Perhaps these congenital variations happen somewhat like this: Nature throws out upon her table, the fertilized ovum, a double handful of small dice which are of varied size, color, etc. (There are some who believe that all the dice are loaded and that the thrower knows exactly what numbers will be uppermost.) Each mark upon the dice is a unit character determining the color of an eye, the curve of a chin, or the length of a limb. With each throw the uppermost units change. This is the law of variation. Biparental parentage may or may not in doubling the number also double the variety, color, size, etc., of the dice or unit characters and consequently may or may not increase the variations. Further variation in the environment still further diversifies the result. All of these causes are far below the limits of visibility but their effects accumulate until they become visible to our microscopes and eyes, sometimes suddenly as in the progressive mutations of Waagen or contemporaneous mutations of DeVries. These jumps or saltations appear as "sports" such as the short legged Ancon ram. If the thrower of the dice allows only those dice to remain on the table that match the woodwork or the furniture of the room, we see natural selection at work. The results obtained in each room would vary as in nature with the environment. The variations in the size, shape, color and other qualities of the dice themselves take us back to the original equipment of the chromatin and cytoplasm, back to variations of molecules and atoms and electrons and vibrant quanta of energy or will, back to ever receding mystery. Life's variations like life itself well up out of the world of the infinitesimal where the ultimate secret dwells.

Although, in the whole wide universe, there is really nothing more wonderful than anything else, yet here we face one of the most amazing discoveries ever made by mankind. A tiny speck of protoplasm enclosed by a little cell-wall with some bars of chromatin in it, contains within its invisible empire energies, powers and wisdoms exceeding the wildest imagination of the romancer. Beginning as a little one-celled creature, it lays up its experiences as in some strange library. It develops means of locomotion, of respiration, of nutrition, of reproduction, and remembers how it was done. It companies with other cells and divides with them the labor of construction a norganism. Of its own contents, by division, it learns to build a colony. Exentually this colony grows into billions of cells, in the case of man, twenty-six trillion, and the instruments which they develop to effect their purpose become so intricately complicated that the wisest biologist of today with his most powerful microscope is unable to understand them. Step by step, also it learns how to reproduce all of these experiences far more quickly than it acquired them so that by processes of reproduction experiences of a thousand years can be concentrated and abbreviated by the heredity chromatin into a few hours or days. Thus it stores up in these chromatin bars the skill and training of the past until, for example, an egg through an embryological development of three weeks passes through stages that it took the birds perhaps a hundred million years to traverse.

The Cellular Basis



(Courtesy of American Museum of Natural History.)

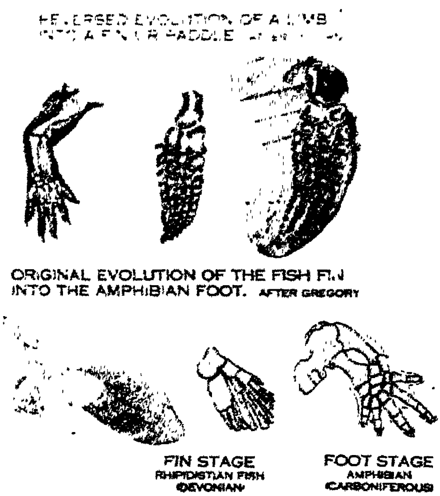
It is as if a young student of music first picks out slowly on the piano a difficult composition, pausing to find each note on the key-board. But after many repetitions the student finds that he is able to play in three minutes a composition that it took him three laborious weeks to learn. Singularly enough also in embryology we find that the earlier stages of development are most quickly covered. A view of embryonic development is not unlike that which one gets from an observation car of a limited train. The immediate track is normal in size and appearance, but as one looks along the fast receding rails he sees them converge and congest more rapidly as the distance increases.

And the final touch of wonder is added to this strange story which our scientists tell us by the fact that the hand which accomplishes these miracles is utterly invisible. That such powers should be compressed into microscopic specks of protoplasm, that the experiences of the whole human race, for example, whether as primate or mammal or reptile or amphibian or fish or what not could be stored up in little microscopic genes, so that even the color of the eye, the texture of the hair, the shade of the skin should be a thing predetermined by their unknowable powers is marvelous enough, but when we add thereto the uniform accuracy and perfectness of most intricate operation, all done invisibly, noiselessly, and purposefully, we are astounded. It is as if one went to a cinema and saw upon the screen a vast forest. Then slowly the chips begin to fly from the trunks, the trees fall, the limbs are chopped off, and the logs move concertedly to a nearby river. Upon its waters they float until they reach a mill by the side of the stream. There they stop, approach the bank, are drawn up into the mill, are sawed into plank, are stacked in the yard. Then with one accord they place themselves on cars, and when the cars have been filled they whisk themselves away to a great city, and there silently move into trucks. No human hand has touched them apparently, nor can any one see the cause of their action. Then, when they have reached the spot that they choose, one by one, they take their positions, each in his own place, until a foundation, then a frame-work, then a roof is visible, and finally a house is completed. It is done, so far as we can see, without intervention, without cause. The trick of the whole movie has been to present the drama with man eliminated. Are we then face to face with a trick of the creator who is invisible, intangible, and inaudible, in this marvelous series of biological changes that we call evolution?

Through all these changes from tiny to large, from amoeba to man, there runs a significant thread of purpose as if "Nature" had an end in view from the very beginning. And it may be well to notice here that it is this intention in nature that constitutes the cement between the new science and the old religion. If the hundred and sixty thousand words of this book were all jumbled together into a meaningless mass the result would not be unlike nature without evolution; multitudes of facts with no meaning, no intention. For example, see how fundamental and ancient a thing the human family is. For milleniums, the world contained only unicellular creatures that reproduced by dividing themselves into two parts. Just there began the interesting struggle which each animal structure must face between its surface and its mass or weight. For if the dimensions of an animal, its length and breadth and thickness be multiplied ten times, its mass or content will be multiplied one thousand times. This means that its lungs must inhale one thousand times as much air, its digestive apparatus absorbing one thousand times as much nourishment, and its muscles and bones must move and support one thousand times as much weight, although the animal grows to be only ten times as large in size. A normal man, for example, having one hundred square yards of lungs, if he were to increase his size ten times, would have to develop a million square yards of lungs, and his body which would not be proportionately stronger than before, would flatten under the weight of a thousand times as many pounds. So the first lesson learned by earliest plant and animal life was to divide before the time came when, increasing in size, it could not longer supply its needs for nutrition and respiration. This being the first step in reproduction was also the first step in the founding of the family. Then some of these unicellular creatures began to set aside portions of their body while still protected by the cell-wall of the mother cell, freeing them later as spores. Still later, carefully devised eggs containing food supplies were furnished to the germ to aid it in its struggle with an unfavorable environment. By this time, we have reached the stage of the fish and amphibian and reptile. Then in some of the reptiles the process of egg-laying was retarded, and the process of incubation, which for example, in the case of the domestic hen has already passed its initial stages when the egg is laid, proceeded internally until they became viviparous, bringing forth their young alive. The case of the salamander, deprived of water wherein the larvæ might develop, which in that case brought fourth a reduced number of live salamanders, illustrates the progressive change. Each of these changes made motherhood more important by prolonging the period when the life of the offspring depended upon her care. Later some amphibians which had developed hair from scales, as the birds developed feathers, learned to nourish their young from mammæ thus separating themselves from the other amphibians who were notoriously careless of their eggs, becoming a class of mammals. This still further accentuated the importance of motherhood. Perhaps their primitive method was that of the two remaining archaic and viviparous mammals, the echidna and the ornithorhynchus, which furnish to their egg-hatched young a nutritive fluid from glands distributed generally over the mother's body. Later these glands were localized into mammæ, as doubtless the original sensitiveness of the skin to light was localized in the eyes, the number of the mammæ being proportioned to the number brought forth in the litter of young. Thus another tie between mother and child was forged, and the family became a necessity. Thus also the altruism of religion sinks its roots deep into the past for "the struggle for life of others" is co-eval with "the struggle for life."

It is well to notice that we are confronted again with the same strange paradox that faces us everywhere in nature; what seems to be so widely different reveals, upon closer examination, its intimate relationship to a succession of preceding forms. Perhaps the greatest wisdom that embryology teaches is in presenting us with that marvelous reel of moving pictures wherein we see form melting into form so slowly, so subtly, that we cannot at any point see where the change took place, yet at one moment the form is that of a sphere, at another it is that of a worm, at another it is that of a fish, at another it is that of a reptile, at another it is that of a primate, and at another it is that of a man. We cannot, of course, in palaeontology discover so perfect a succession, but those pictures that come to our hand, when they are placed in series, clearly indicate their foot-prints in the line of progress to which they are fitted.

Here, for example, are two forms, that of an invertebrate and that of a vertebrate. There seems to be an impassable chasm between them. Yet, as we study the world of nature, we find that it is bridged by a form still existing known as the amphioxus or lancelet, whose shape is that of a fish, but whose back-bone is simply cartilaginous tissue. Later, as lime salts replace the cartilage, the backbone which distinguishes all vertebrates is discovered. Again, it seems a far cry from the worm without legs or fins to the fish. Yet any one may take up his palaeontology and see there the picture of the cladoselache whose fins in opposite pairs were fitted with supports of cartilage, shaped like rods, and whose exterior structure evidences its origin from folds of skin, not unlike the way in which the flying squirrel has developed its parachute. All that it is necessary for us to do is to vision the skin-folds separated into five parts and the cartilage ossified into bones, and we have the five-fingered limbs character-



CHANGE OF ADAPTATION IN THE LIMBS OF VERTEBRATES

The above figures represent (lower) the theoretic mode of direct original evolution of the bones of the fringe-fin, of a *Crossopterygian* fish—the *Rhipidistia* type of Cope—into the bony, five-rayed limb of an amphibian of the Carboniferous Epoch (after Gregory); and (upper) the secondary, reversed evolution of the five-rayed limb of a land reptile into the fin or paddle of an ichthyosaur (after Osborn.) (From the *Origin and Evolution of Life*, Osborn. Charles Scribner's Sons publishers, courtesy of the Author.)

istic of all reptiles, birds and mammals. Again to the novice the difference between fish and amphibian and bird and mammals seems utterly impassable, yet "a fish is an aquatic back-boned animal which breathes by means of gills and moves by fins. An amphibian is a fish which early in life, after the tadpole stage, discards its gills, develops lungs, substitutes five-toed limbs for fins and lives on land.

A reptile may be described as an amphibian which has left the tadpole stage behind in the egg and has emerged with limbs and lungs. Birds and mammals may be regarded as derivatives of the reptilian class which have transformed the scales of the reptile into feathers and hair, respectively, and have developed a special care for their young; the birds by incubation of the eggs and the mam-

FOUR EVOLUTIONARY STAGES IN THE HYPOTHETICAL FOUR-WINGED BIRD. [After Beebe.]

(From *The Origin and Evolution of Life*, Osborn. Charles Scribner's Sons, publishers, courtesy of the Author.)

mals by retention of the young, essentially as parasites within the body of the female, until birth occurs." (Woodruff.) Than the difference between the complicated processes of human child-birth and the simple division of an amoeba what chasm would seem to be more unbridgeable? Yet see how simple are the steps by which nature has crossed it: The following are the principal developmental stages in this process:

1. Simple division where the unicellular creature divides into halves.

2. Multiple division where the original cell divides into more than two parts.

3. Multiple division within the body of the original cell for purposes of protection, thus creating spores which will later be set free.

4. Multiple division of certain special cells within the original body, the balance of the cells remaining unchanged (Volvox.)

5. Multiple division of certain other cells into rod-like bodies with whiplash tails (spermia) which conjugate with (4) (compare other species of Volvox) thus producing the first impregnated ovum in nature (ovum comparatively large, perhaps one-hundredth of an inch in diameter, supplying food; spermia comparatively small, about one 100,000th of an inch, supplying no food.)

6. Multiple division as in five (5):

(a) Sometimes cast out into water (for example, fish. amphibian eggs);

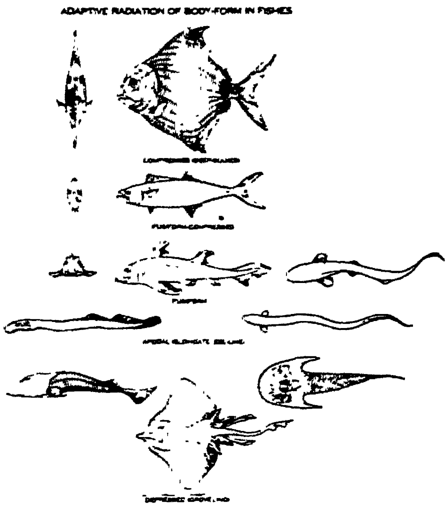
(b) Sometimes furnished with impervious cell and supplied with food, yolk, floats as embryo in water but breathes through shell; air conveyed by allantois; deposited externally, as an egg. Compare reptile and bird.

(c) Allantois (breathing apparatus) develops into placenta and umbilical cord furnishing breath and food to embryo in uterus of mother, no yolk needed or supplied. Incubation of the eggs of birds, initiated before "laying," is further retarded (as by some amphibians at will when removed from water), and finally young are born alive but still helpless and unable to care for themselves. Compare man and mammals.

(d) Young still further developed in utero until when born they are fully able to run and feed themselves (compare horse, deer, calf, etc.)

In each of these cases the amoeba, fish, amphibian, reptile, bird or mammal, is perfectly adapted to the conditions of its life. In its process of radiation life found an empty spot where energy was going to waste and at once developed a means of capturing it.

And it is one of the most fascinating tasks of science to discover and describe these marvelous processes of adaptation which are thus developed as the world of living things broadens into earth and sky and sea. Here, for example, in the abyssal depths of the ocean, under many atmospheres of pressure, are delicate, flimsy things which die if brought into our world, and which exhibit the most marvelously intricate and filmy forms. There, also, where darkness is eternal may be found many species of fishes, each of which has independently discovered a way to light the blackness of the paths of the sea, developing its own phosphorescent organs. Countless, also, are the means of defense adopted as life ascends. Among the fishes the forms arising from the nature of their life are distinctive and interesting. Some, whose safety lies only in flight, are shaped for speed along the lines of the modern submarine. Some, which found security in silent immobility, in lying flat and depressed upon the bottom of the sea, have bodies that tell the whole story of their habit. Where the former are lithe and graceful as flight itself, the latter are depressed, groveling. At the other extreme are those deep-bodied forms, compressed to such an extent that the width of the body is scarcely more than 1/6th of its height, and between these extremes are all possible connecting forms. Interesting also is the way in which the reptiles and birds and mammals have solved the same mechanical problems in the same way, or shall we say that the strange wisdom which lies within the heredity chromatin has adopted the same solution to the same problems. As it is with fishes, so also it is with the others. Those that have no way of defense except in flight are built for speed — like the gazelle, the horse, and the humming bird. Those that develop some form of armorial covering, whether fish or reptile or beast, are all slow moving, having found it unnecessary to flee. Witness, "Brer Tarrypin." As it is in the modern contest between the projectile and the armor plate, so has it been in nature. As soon as the heredity chromatin has developed for one animal a tooth like a sabre, the heredity chromatin of the other animal has developed an armor. As multitudinous as are the species themselves, so innumerable are their adaptations to their environment. Perhaps the most remarkable illustration of this appeared when, as life proceeded upward there came a time when some living forms left the water. Vast indeed were the changes necessary in order that life might adapt itself to the air. Yet perhaps in those olden days there was not so great a difference between the sea and the land, or between their temperatures and degrees of moisture as we find today. The transition may not have been such a difficult one to imagine as it would be today, but it was certainly difficult enough, and the changes that came over those creatures which were perhaps driven out of the deep on to the land because of the difficulty of obtaining a living in the sea are among the most astonishing that palaeontology reveals, nor does the heredity chromatin offer anywhere in all its history a finer illustration of its ingenuity and wisdom. Here is the fish, cold-blooded, the temperature of the water in which it swims. The new life takes it and of its fins develops limbs such as the arm of a lizard or man, with humerus and ulna and radius and with carpus, meta-carpals, and fingers, with cleverly devised sockets and ligaments and muscles and a perfected system of nerves, and above all that most astonishing and intricate series of balances whereby the temperature of the body subjected in the air to the wider ranges of heat and cold is kept at exactly one-point, 98 2|5 degrees, which thus adopted, remains the temperature at which for the most part all mammals live. And so perfect is it that even in these days of skilled physicians the surest sign of illness is the slightest variation above or below that normal. Wonderful also was the change which took place

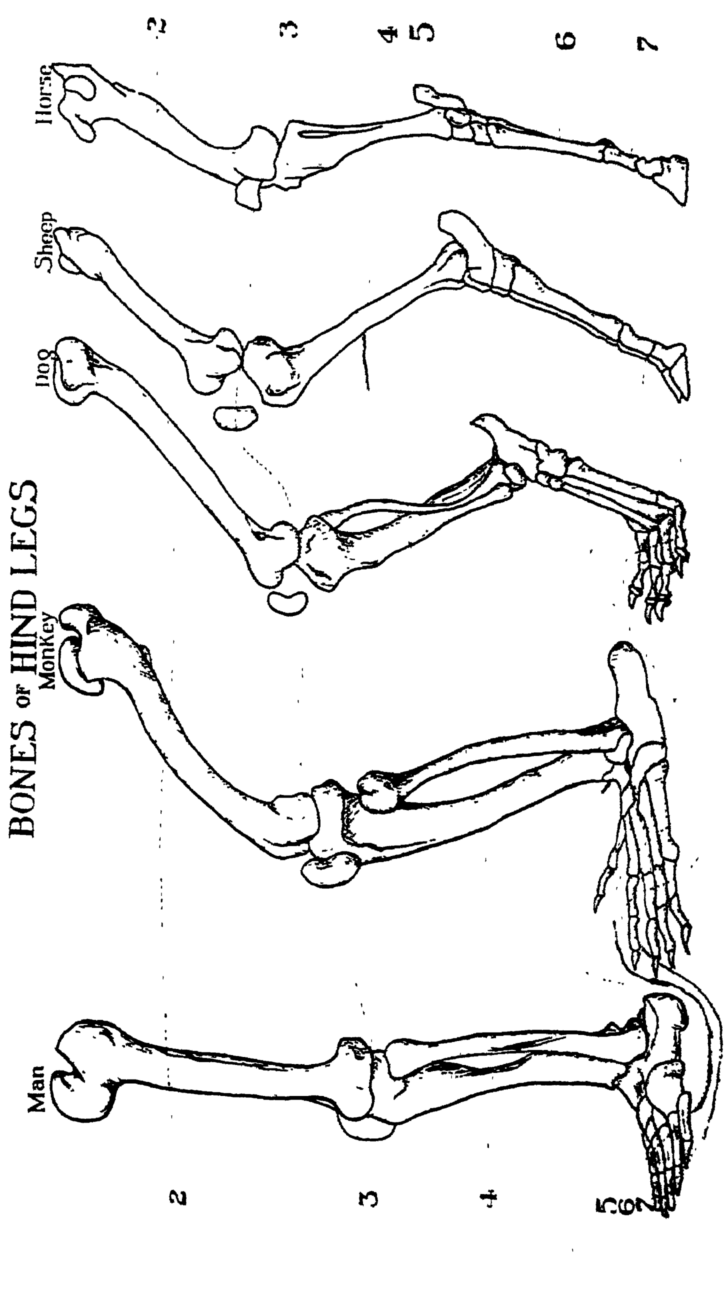


THE FIVE PRINCIPAL TYPES OF BODY FORM IN FISHES.

These begin with the swift moving, compressed, fusiform types which pass, on the one hand, into the laterally compressed, slow-moving, deep-bodied types, and, on the other, into laterally depressed, round, bottom dwelling, slow-moving types, also into elongate, swift-moving fusiform types which grade into the eel-like, swift-moving, bottom-living types without lateral fins. These five types of body form in fishes arise independently over and over again in the various groups of this class of vertebrates. Partially convergent forms subsequently appear among amphibians reptiles, and mammals. Prepared for the author by W. K. Gregory and Erwin S. Christman. (From *The Origin and Evolution of Life*, Osborn. Charles Scribner's Sons, publishers. Courtesy of the Author.)

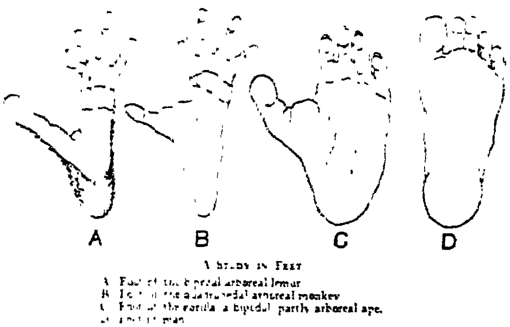
in respect of the new medium, the air, in its effect on the body. Down in the sea where oxygen is scarce, it must be obtained by the constant laving of the delicate gill structures in the water. There life, as a consequence, was sluggish. But in the air, when once the lungs had been devised, were vaster treasures which when captured gave vaster power. Thus was life quickened and energy intensified. The new upper world, into which doubtless the philosophers of those days would have said that no creature could come and live, offered untold advantages over the old. Soon the amphibian changed into the reptile and the reptile into the bird and mammal.

If one wishes to pass an interesting evening he could do nothing better than to take such a book as Osborn's "Origin and Evolution of Life" or Lull's "Organic Evolution" and sketch the various ways in which life has adapted itself to the varying environments offered by time and space. This law of adaptation has been well-stated by Osborn as follows: "Each isolated region, if large and sufficiently varied in its topography, soil, climate, and vegetation, will give rise to a diversified mammalian fauna. The larger the region and the more diverse the conditions, the greater the variety of mammals which will result. From a primitive stem-form radii go out in four diverse directions, the adaptations being mainly those of limbs and feet, also of teeth, but that of the teeth and feet do not necessarily parallel." The pages of books on evolution are full of fascinating and oftentimes amazing facts. Consider the diversity of difficulties which have faced living things during the ages of the past and the spaces of the present. And the reader should not overlook the meaning of all these facts, for they bring him face to face with the resourcefulness of life, a resourcefulness which, if we are not willing to call it "intelligence," is equally as capable of solving problems. Consider the widely different types of organization called for by such widely different environments as the air, the sea, the desert, the marsh, the river, the mud, with varying temperatures, polar, temperate, and torrid. In reading the examples which follow, remember also that the fundamental conditions of existence for living things are food and safety, and these two conditions dominate and modify every function and the form of every organ and limb. For example: consider how the bodies of all animals living upon the surface of the earth are modified by the two necessary conditions named above. In order to obtain food they must have muscles for springing upon and carrying, and claws for catching and holding, and teeth for wounding and tearing. So we have the muscles of the tiger and the claws of the leopard and the saber tooth of the smilodon. Other animals not having other methods of defense must flee for life. So we have the development of form and muscle exhibited by the gazelle or the horse. These necessities modify particularly three organs, the feet, the teeth, and the brain. Those animals that do not have to flee for life may walk upon the soles of the feet (plantigrade). Such is man, but even man when he wishes to run does so on his toes, and temporarily becomes like the wolf or the dog (digitigrade.) Others have developed speed to the point where they run on the tips of their toes so that it is as if their toe nails had developed into hooves. Such are, for example, the horses (unguligrade.) Beginning with a quadrupedal, plantigrade, unspecialized form, terrestrial animals have sought out every possible environment, and their bodies have been modified accordingly. Some have taken to the trees, like the flying squirrels (arboreal.) Others have taken to the water in part, like the beavers (natatorial, amphibious) or entirely to the water, like whales (aquatic.) Others, like the dogs and horses mentioned above, remain upon the surface of the earth, attaining speed for either offense or defense by running upon their fingers like the wolves, or upon their hooves like the deer. All of these examples are from the mammalian world, and the modification of their form produced by the different environments is nothing short of astonishing and finds its completest expression in the feet. Yet the teeth, also, are permanently changed to suit the type of food upon which the animals live. Beginning with an insectivorous ancestor some chose to feed upon grass, others to browse and others to feed upon fruits. Ther teeth therefore are formed according to the distinctly herbivorous type. Others fed upon fish and flesh, and their teeth are immediately distinguished as of the carnivorous type. Others, oddly enough, confined themselves to living on ants. This, of course, reduced their teeth in size and number, and they are recognized as belonging to a still different type, the myrmecophagous. Others adapted themselves to all knds of food, and their teeth are distinctly those of the omnivorous type. The third organ upon which life is and was chiefly dependent is the brain, and it is interesting to note that the brains of all mammals have from the beginning been in process of enlargement. Intelligence was found early to



Man and monkey, plantigrade; dog, digitigrade; sheep and horse, unguligrade. (Courtesy of the American Museum of Natural History.)

be essential to safety, no less a prize than life itself being its reward. It has proven to be, in the case of man, an all sufficient guarantor both for food and safety, and it is to be hoped that no modification of civilization will ever decrease the penalty imposed upon those who lack it.



A STUDY IN FEET.

(Courtesy of American Museum of Natural History.)

Now we view briefly the amazing ways in which life has adapted its form to suit its environment, to protect itself from its enemies and to obtain energy and power for continued existence. More detailed descriptions may be found in such volumes as Lull's "Organic Evolution" from the store of whose material we draw at will. At the very beginning the various ways in which life has used the silver sunbeam astonishes us. Nature has taken haemoglobin, a red iron compound and haemocyanin, a blue compound responsible for the color of the blood of the octopus, and colored the skin of some of her children so that they resemble exactly and at will the environment in which they are placed, thus protecting themselves from their enemies or disguising themselves in the search of food. Such is the custom of the chameleon. This protective coloration or mimicry of nature is used for the above two purposes not only, but by other creatures to attract unwary food supplies, or by copying the color of poisonous species to protect themselves from attack and in various other ways. What could be more astonishing, for example, than the dead-leaf butterfly so exactly resembling a dead leaf even in its veining, stem and all, as to be indistinguishable except to informed scrutiny? Nature is full of such examples running down to the way in which the American opossum disguises his deliciousness by appearing to be dead.

Consider also that rather surprising development adopted by many forms of life known as gregariousness (helping one another without division of labor), communism (helping one another by means of division of labor), commensalism (where animals feed together from the same table), and symbiosis (when they render mutual benefits to one another by life association.) The enormous southern herd of American bison was estimated to number three and one-half million. The association of such large numbers would, of course, be of great benefit in protecting the individual from its enemies. Other creatures, for example the beaver, combine for civic enterprises such as the building of dams across available waterways. The pelicans form a military line to drive schools of fishes into shallow water. The marvelous intricacies of life in a hive of bees is elsewhere described. Ants, which rank next to men in intelligence and exceed in numbers all other terrestrial animals, surpass even the bees in their social organizations. The little brown ant collects the larvæ of the corn-root louse in the autumn, protects them from their enemies until the spring and nourishes them upon other plants until the corn germinates and herds them there upon the roots of the growing corn until mating time in the autumn when they are allowed to pair and their offspring are preserved as before. Sometimes life finds a quiet corner where it may apparently obtain both safety and food without effort. Such was the case of the crab parasite, sacculina. It is well to note how this case illustrates that remarkable characterization of the over-prosperous human: "In that same night shall thy very self be required of thee." Thomson describes this process as follows: "The animal is at the nadir of parasitic degeneration. Its life history shows how far it has fallen. Its larvæ, with three pairs of appendages, the food canal and a median eye . . . feed and grow and molt and pass into a second stage. These fix themselves like barnacles . . . to the back or limbs of young

Dead-leaf butterfly, a remarkable illustration of protective coloration. (From *Organic Evolution*, by Lull. Courtesy of MacMillan Co.)

crabs, finding a soft place at the base of the large bristles . . . all but the head region is cast off; the structures within the head contract: eyes, tendons, pigment, and the remains of the shell are all lost; and a tiny sac sinks into the interior of the crab . . . the cuticle of the crab softens beneath it." The little rootlets from the parasite ramify all over the crab's body even to its eyes. The parasite itself degenerates until it is nothing but a tumor. Similarly strange and in each case different, are the adaptations of other parasites to their hosts. Such are the malaria germs, the trachina and many others.

More easily grasped and not less interesting is the way in which life has adapted itself to the varying environment of earth, air, tree and desert. See, for example, how beautifully the ancient principle of self sacrifice is illustrated in the various methods of reproduction that nature has adopted. The simple one-celled creature living in an environment uniform and temperate simply divides itself. The next stage is that form of internal division where the spore or the seed is protected within until it is ready to be cast out to live its own life in the world. In the next stage the mother furnishes her offspring with a supply of nourishment to meet what has evidently become a dangerous environment. Such is the egg of the amphibian, the reptile and the bird. A little higher, we reach the mammals of which we find one part, the monotremata, laying eggs but nourishing their young at the breast, another part bringing forth their young alive but carrying them in a pouch for protection, abandoning both of the former initial stages for the methods used by such creatures as the cats and primates. And as with the process of reproduction, so every other activity of life is modified by its environment. We have already mentioned the way in which necessity for speed has brought many animals up from the soles of their feet to the tips of their toes. Still others have learned to walk and run upon their hind legs, freeing their forelegs for other uses and almost invariably causing them to be reduced in length and size. It was probably the increased activity made necessary by increased danger of death or hunger that developed warm blooded animals from cold blooded ones. Not only has the contour of the bodies of living things been modified to suit the nature of their lives, but such special parts as the tail, the eyes, the ears, the paws, and the cheek pouches have been developed or reduced for similar reasons. Thus the mole has practically lost his tail and his eyes, but he has specialized his hands and his nose. Those creatures that have taken to the water have developed air bladders wherewith to raise or lower themselves in the sea. Others living in pools or streams that dry up during the summer's drouth have learned to breathe through these air bladders. Nowhere better than in the water are we able to see the way in which the shapes of creatures are modified by their method of life, or vice versa. Compare the flounder flat upon his back with the elongated eel.

The sizes which life has adopted form an interesting story. From the infinitesimally small we find living things of all shapes, weights and sizes up to the great sulphur-bottom whale 87 feet long, weighing 87 tons. The famous "Jumbo" elephant was 11½ feet high but weighed only 6½ tons. Other African elephants have been reported as 13 feet high. The Tyrannosaurus rex is usually considered to have been the largest strictly terrestrial dinosaur. Its length was about 47 feet and its weight about 20 tons. The Brontosaurus was about 66 feet long and weighed about 38 tons. The Diplodocus was about as long as the whale, 87 feet, but doubtless did not weigh as much. Perhaps the heaviest of all the saurians was the Brachiosaurus from east Africa, which was about as long as the whale and the Diplodocus and whose weight must have approached 80 tons.

When life ascended into the trees and thence into the air, it still further changed the already existing forms so that we find such diverse organs as the pronged tail of the chimneyswift, the prehensile tail of the chameleon, the rapier-like beak of the hawk and the pick-like beak of the woodpecker. For flying, we find the flying squirrel developing the folds of its skin into a patagium, the bat spreading that skin between its fingers as a wing and the bird modifying its reptilian scales into that marvelous instrument of flight, the feather. Also the birds have hollowed out their bones that they may contain more air, and have added to their lightness by air sacs in many portions of their bodies which aid them in breathing and still further lighten their weight. The bats being blind have developed their uncanny tactile sense in a marvelous fashion. Even some of the fishes have learned to fly for considerable distances above the water, as have also certain frogs and lizards following the ancient custom of the pterodactyl, the insects, and the reptilian birds.

Nowhere is the marvelous adaptability of life to the conditions which it must meet more beautifully illustrated than in the caves and the oceans where for the most part there is no light and the temperature is uniform. Changes necessary for cave life are well illustrated by the proteus anguinas, (the German Olm) whose habitat is in the eternal darkness of the great caverns. Of it, Gadow says, "Their total length is scarcely one foot. The whole body is white, occasionally suffused with a slight fleshy, rosy tinge, while the three pairs of gill-pouches are carmine-red. They are easily kept in captivity, and live for many years, provided three conditions are strictly adhered to, viz., fresh and clean water, an equable low temperature of about fifty degrees Fahrenheit equal to ten degrees Centigrade, and darkness. The question of food is not so very important, since specimens are known to have existed for years, although they refused to take any nourishment. How far darkness is an absolute necessity is not known. Anyhow, the white skin is almost as susceptible to light as is a photographic plate. If light is not absolutely excluded the white skin becomes in time cloudy, with grey patches, and if kept exposed to stronger light, the whole animal turns ultimately jet black." (Compare the human skin.) To this, Lull adds, "While totally blind, these creatures are nevertheless annoyed by the approach of a candle flame, showing that the body is sensitive to light. They are guided to their prey mainly by the vibrations which its movements give rise to, possibly also by the sense of smell." Eigenman also mentions an eyeless cave-fish of Mammoth Cave which is totally blind but has terminal buds scattered all over its body used as organs of taste. It finds its food by a remarkable tactile sense whereby it detects vibrations in the water. It is also able to perceive light through its sensitive skin so that we almost have here a perfect illustration of the way in which original protoplasm, having differentiated and localized the five senses in higher types of creatures, seems to be able to scramble them again, for the skins and bodies of these cave and deep sea forms may almost be said to see and touch and taste and hear and phosphoresce and electrify and even drink; and, had the brain also been scrambled, perhaps to think.

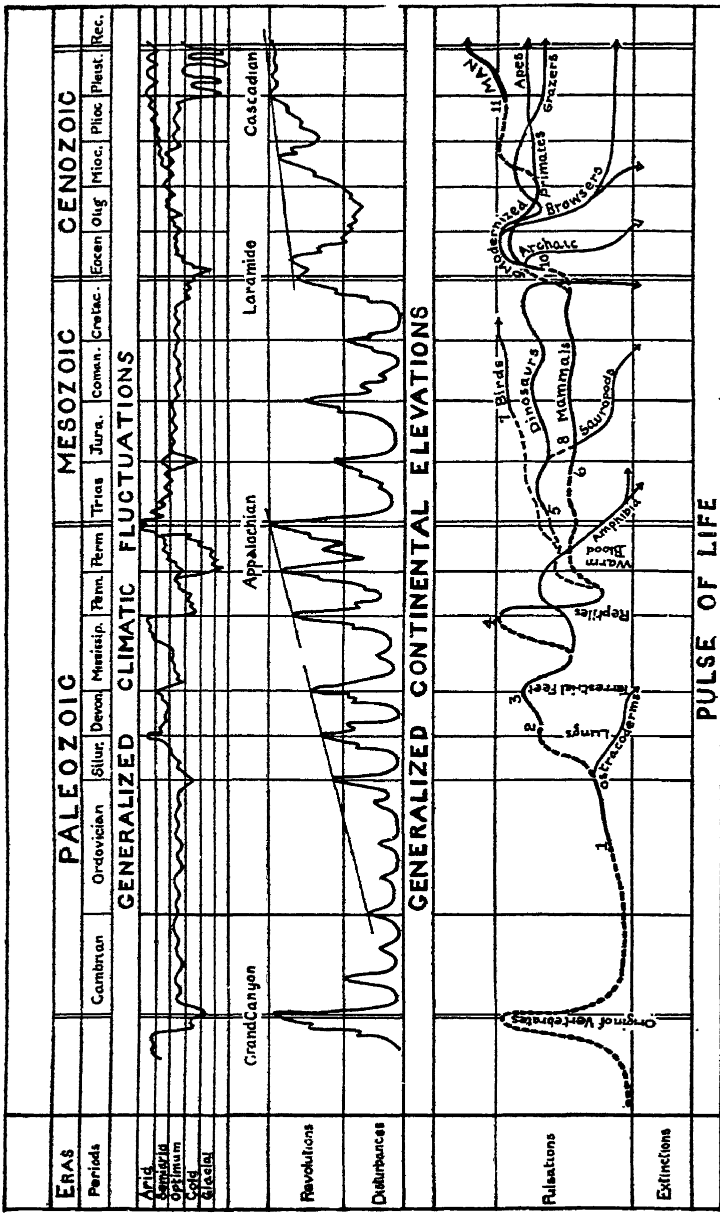
Deep sea life offers likewise remarkable illustrations of the adaptability of life. There where the darkness is absolute and the cold, below 3000 feet reaches 37 degrees Fahrenheit and even goes as low as 32 degrees Fahrenheit, in the greater depths, where the calm is complete, the most terrible storms reaching only a few hundred feet and average tides only a few thousand, where the pressure grows at the rate of one ton to every square inch for each 1000 fathoms, where food is comparatively scarce and of limited composition, we find many migrants, all, geologically speaking, but lately come, since palaeozoic days and of many species and genera. We do not wonder, therefore, that the creatures found therein have discarded vivid colors and enormous size, nor that they have developed telescopic eyes or eyes like concave mirrors in order to absorb what little light could be found, or else have discarded them altogether and in lieu thereof have developed organs for detecting the slightest vibration in the water. For light (blue and ultra-violet rays) penetrates even in the tropics only about 3000 to 5000 feet while the red, orange and yellow rays descend only some 600 feet. (Schuchert.) Others finding that protoplasm furnished them with the ability to light the depths of the sea paths have developed phosphorescent organs and still others, finding food is so scarce that they must subsist on decaying ooze, have lost their power to masticate food. Yet even to the very bottom of the 26,000 feet, five miles, life is to be found exquisitely adapted to its environment. Some fishes have even adapted their fins to crawling on the bottom of the ocean. In the land without day or season, in the unending sameness of eternal night, life abounds, exquisitely adapted to its environment.

Nor is it different in the desert stretches of the world where the struggle for survival is perhaps the severest in all the earth. Lull tells us that in tropical countries desert conditions develop if the average rainfall is under fifteen inches a year and in temperate regions under ten inches. Yet life obtains its water, sometimes by sinking roots amazingly deep into the soil, seventy-five feet or more, sometimes by collecting the slight moisture in the superheated atmosphere, condensing it upon hairy filaments, sometimes by absorbing it as occasion may offer, like the lizard described by Willey which "absorbed water like a blotting paper" when put into it. Other plants store the water that they can collect during the rainy season in under-ground reservoirs, taproots expanded like turnips; others, like the cacti, discard leaves and develop their trunks into great masses of watery pulp so that men have learned to obtain their water from them. This secret has also been learned by some animals, notably the camel, which stores water in little tanks to be used between oases. It is a common trick among desert plants to avoid the development of leaves or else to reduce their surfaces to a minimum, also to defend themselves by spines and prickles, by poisons and by cathartic and emetic liquids and by disagreeable tastes and smells. As "Nature" has learned to color polar creatures like the polar snows, so she colors desert creatures like the desert sands, protects their nostrils by complicated valves (snakes and camels) or reduces them to the finest pinholes. More remarkable still, in the lower eyelid of some of them, she has built a transparent window through which they may still see though the sands of the desert drive fiercely. Swiftness she has given to all of them; to the lizard, the ostrich, the gazelle, the jack-rabbit; even domestic cattle have adapted themselves to desert ranges, and to them she has also given a quickening of sight and hearing and smell and intelligence. It is well known that the wild camel is mentally exceedingly alert though the domestic camel seems but a silly, senseless creature. In short, it looks as if life were able to abound almost anywhere; that the limits to its possibilities can hardly be set; and that it can adapt itself to almost any circumstances. And as it is in the present so it has been for countless years. Shuchert tells us that if we would obtain the number of species which have existed during all geological time, we must multiply the number of present day species (which he estimates at about four million including insects) by 200 geological units. After exploring about 1/15th of the exposed rocks, we have described some 100,000 of them, "the skimmings of the pot of life," as Huxley expressed it. What is back of this amazing resourcefulness of life; what name shall we give to the power that teaches atoms and molecules to think and feel and purpose? Shall we call it "Nature" or "Law" or "Natural Selection" or "God?"

In no part of this strange and beautiful story does deeper meaning lie than in its evidence of the truth that it is through hardship and struggle that what we call the excellencies of life have developed. The old adage "in union there is strength" was not first thought out by man. When the first cell associated itself with another and multi-cellular life began, that truth had been discovered. In fact, it is entirely possible that a still earlier symbiosis occurred when the protoplasm that we call chromatin associated itself with the outer cytoplasm to form the first cell. It was in the necessity of earning their bread by the sweat of their brows that animals first learned to solve the problem of locomotion. It was again doubtless because they were driven to it that certain forms living in the shallow waters in order to avoid the demons of the deep, learned to invade the land. Thus from a few congested blood vessels supplying a primitive lung-bladder came, first a little more ability to endure in times of drought, then more and more as the arid days lengthened and finally lungs, the foundation of all land life were developed and the priceless storehouses of life-giving oxygen were opened. Now, as we already know, the whole Palaeozoic era was the day of invertebrates, but in the Mesozoic the reptiles were the rulers of earth. As in countless numbers they multiplied, they finally took possession of all the choice spots for themselves. So again it was the marginal type, the creature that was driven outside of the then garden of Eden which learned to endure the hardships of the winter, to develop coverings of hair and feathers, which was able, when winter came in the chilly hours of the Cenozoic era, to withstand the frost and, surviving, to inherit the earth. It is a striking fact that as the conditions of life on earth have become harsher and more difficult the quality of life has become higher until, in the extremest hour of ice and cold of the glacial epochs, we first find definite traces of man.

So, throughout all this agelong process of development there throbbed the Pulse of Life. Continents rose and sank; mountains were uplifted and cast into the sea again; volcano and earthquake, frost and tornado, sea and glacier, each played its part in altering biological conditions, especially heat and aridity, and the nature of the struggle for life. Ever the Will kept rearranging the letters of the alphabet. Ever they seemed to spell something higher and finer. Lastly, He has caused them to form the word Man. Perhaps there are still greater words in His vocabulary.

What an indescribably weird and glorious march has been this march of mankind, and how utterly silly and obtuse do those seem who describe the theory of his evolution as atheistic and accursed. Out of the night, out of nothingness, but ever trailing clouds of glory we watch him come. The words herewith we describe his progress fit equally well into the stages of his embryological life and the partly conjectural stages of his palaeontological life. If we could



FOR EXPLANATION SEE BOTTOM OF NEXT PAGE.

see deeply enough we would find ourselves back in the world of atoms and electrons. Out of the indescribably complicated mysteries of protoplasm there comes a single cell. Soon to it is united another and another, each dividing with its brother the labor of the group. Larger and larger, but never more wonderful than at first, the organism grows, storing its experiences into the mysterious complexity of the heredity chromatin. Born in the water it fills the seas of earth and spreads out upon the shore. It conquers even the air, for all the great branches of the animal world in turn and separately have solved the problem of flight, whether pterodactyl among the reptiles or bat among the mammals or insect or bird. And in watching this strange cinema of varying forms, adapted to varied environments, we note this strange thing, that each stage of progress attains to some new height. Each of the various forms through which mankind has passed from the primitive protoplasmic speck to the 20th century has added its increment to the whole. At one stage milleniums are required to develop the intricate loyalties of a multi-cellular creature. Another era discovers a way to invaginate the blastula. Perhaps a million years pass while the

---

EXPLANATION OF CUT ON PRECEDING PAGE.

CHANGING ENVIRONMENT DURING THE PAST FIFTY OR MORE MILLION YEARS.

Theoretic correlation of climatic, continental, oceanic, and life phases. This chart shows the maximum and minimum periods of coal formation, of limestone formation, of aridity and of humidity; also the theoretic and actual epochs of glaciation in the northern and southern hemispheres preceding the final glaciation, periods of maximum continental depression and oceanic invasion, and periods of mountain revolution.

Diagram of the pulse of life. Climatic line: minor jogs merely indicate climatic oscillations; doubling of lines, climate zones where aridity and cold are differentiated, single line, uniformity of conditions the world over. Continental elevation line: up-slopes mean rising diastrophism; down-slopes, periods of erosion before continents are low enough to have mantles of sediment spread upon them, i. e., the intervals. Tangential lines show gradual rise culminating in great revolutions. Whole Cenozoic has about the time valuation of the Permian; is all a period of revolution, and its compression to uniform scale would give the tangent to the peaks about the same slope as in the Upper Palaeozoic. First records on the life line: 1, vertebrates; 2, lung-fishes; 3, footprint; 4, reptile; 5, dinosaur; 6, mammal; 7, bird; 8, sauropod dinosaur; 9, archaic mammal; 10, modernized mammal; 11, man. Modified from Huntington after Schuchert. From *The Origin and Evolution of Life.* (Courtesy of Yale University Press.)

problem of segmentation whereby the bodies of the lower forms are divided into segments and a later consolidation of these segments in the head, thorax and abdomen is effected. To perfect the system of tube within tube whereby the alimentary canal and its many out-pocketings were created took century upon century. Other milleniums brought from struggle and effort the fin of the fish and the first crude leg of the amphibian. Through what depths of anguish and pain and strain of utmost power the wing of the bird, the fleet limbs of the antelope, and the sabre tooth of the tiger were developed, who can say? But certain it is that mankind today is profoundly and sublimely the heir of the ages. Into his physical body, and much more into his spirit and intellect, the anguished cries of all earth's bloody path find voice and expression. Today, with his almost newly arrived and ever increasing consciousness and knowledge of the universe, he stands upon the fallen forms of an eternity of struggle and reaches his hands imploringly forth as has been his custom from the beginning, up toward the stars, ready and waiting as ever before for the agonies of each future cross that each coming age may plant. For he knows that there is no lack of centuries; that this, also, is but a geological epoch, that neither time nor advance has ended; that as there have been milleniums of progress in the past, so there shall be milleniums of progress in the future. Backward into that past he looks for wisdom, but not for ideals. It is of the future that he dreams, the future that has called him up out of the vermian night. The tug of the infinite beyond still lures him onward. He is not afraid to judge the future by the past. He puts his confidence in the wisdom and the power and the purpose of that "infinite and eternal energy from which all things proceed," and he believes that "Eye hath not seen and ear hath not heard, neither hath it entered into the heart of man to conceive the glories which are laid up for those that trust Him."

Now the thoughtful theist, having read this volume up to this point, must have observed that while the content of science has been vastly enlarged and the form changed by modern discovery, nevertheless the mysteries before which primitive man bowed in reverence still remain. For though the scientists have proven a thousand first causes, one after another, to be only effects, yet they have not removed the necessity for the first cause. And though they have defined a hundred laws governing the marvelous results of evolution, they have not defined the force that has directed those laws. Thus the double-deep mystery remains; the origin of things and the direction of things. To trace the quarter-million inorganic compounds back through ninety-two elements to the primal unity of electric vibration involves a vast multitude of discoveries and labors; but having arrived at that point the physico-chemist advises us that he can penetrate no further into the mystery of the origin of matter. Even when he shall have found a key to that door there will be behind it a veil past which he cannot see. Thus it is also with the origin of life and with the origin of everything else in the universe. None of them can be explained except in terms of God.

But the most important contribution of modern science to the cause of theism and religion springs from the universally admitted need of postulating a directive power in all the processes of evolution as we have pointed out elsewhere. No thinking man much less a scientist can conceive of this universe of ours, so full of marvelous development in any other similitude than that of ordered progress. Science is simply the way God looks as He goes about His daily toil. Science does not deny; it demands God. "I had rather believe," said Lord Bacon, "all the Fables in the Legend, and the Talmud, and the Alkoran, than that this universal frame is without a mind. . . . A little philosophy inclineth a man's mind to atheism, but depth in philosophy bringeth men's minds about to religion." The laws of science are generalizations concerning His habits. Every one of its hourly processes requires His activity just as necessarily as the original moment of origin of all things. While science can not include philosophy and religion within its sphere, its every presupposition calls for the Creator and its every corollary leads to the Immanent Energy. It is as Whitman said:

> "I find letters from God dropped in the street and every one is signed by God's name,
> And I leave them where they are for I know that wheresoe'er I go,
> Others will punctually come forever and forever."

TO HIS PROPHET

And now, at the birth hour of Spring,
Though the Winter be not yet overcome,
I have found thee, my milk-white bloodroot,
So wise, so brave, so pure!
All the abiding interests of Almighty God are in thee.
Up through the leaves of fallen faiths thou hast beaten thy way,
Casting aside, in thy bravery, the broken laws of little dead limbs.
The discourteous winds could not chill thine ardor,
Nor the groaning of sleet-laden branches turn back thy faith.
Through the whole mouldy past of the matted forest floor,
With a martyr's haste to achieve a new world,
Hast hurried to defy all the creeds
Known in a wood, terrorized by the Winter.
Yet many shall follow thee,
O prophet of a new day
And of an age so wonderful!
Already the news of thy deed is spread abroad through the wood,
And multitudes, cowed by the ice and the storm,
Are moving restively beneath their burdens.
Soon a million graves will open
To the green blades whom thou hast led to battle.
He shall blow his breath from the land,
Whence his star returns,
And the cheek of the azalea shall redden with anger at the oppressor.
Then shalt thou hear the shout of victory
From the grave of the forget-me-not,
Who would add her paean to thine.
Even old grandfather graybeard
Shall burst the shackles of his outworn forms,
And spread his creamy streamers to airs of a new hour.
White-lipped though thou art,
As alone thou dost call for That Which Is to Be,
Yet all the Will of God shall toil to accomplish that end,
Whereof He hath sent thee, to prophesy.
O speak, my pale apostle!
By what word didst thou take hold of His mystery?
Learn thereof for me the season that next shall come on my earth,
Whisper me my message that shall thrust me forth,
Into the new life, awaiting me above,
Higher than the dead forms last worn by the world.
O miracled messenger, whose red blood stains the fingers
That plucked thee because thou wast first;
Symbol of all those who did and do and will forever die
In the cause of That Which Is to Come;
Flower to lay upon the breast of the martyred dead;
To pin above a mother's heart, who died
With the cry of her infant in her arms,
Token of the Mighty Seer;
Flower to place reverently in the hand of a Christ,
Dead until tomorrow;
O little flower;
O God!

CHAPTER XIV.

THE INFANCY OF MAN

If these processes of paleontological development from amphibian-like, reptile-like creatures up to the mammalian form, may be likened to the foetal life of man. then a time must have come in his paleontological story, as in his embryological, when he ceased to be an embryo and became an infant. Perhaps from this hour of his infancy we may learn many facts to guide us in determining the direction from which he came and the direction in which he is going.

It is exceedingly difficult for one who knows only our modern civilization to realize the conditions under which earliest man lived, just as it is difficult for a man of forty-five years to imagine his own psychology at the age of two. Modern civilization, as simple as it will seem to men of future ages, is, nevertheless, already a vastly complicated affair. Man has learned to work his will upon the earth and he is changing it to suit his pleasure. He is swimming with the fishes, flying with the birds, and running with the gazelle. One by one the mysteries of the earth yield to his searchlight. To one who is accustomed to the rumble of his locomotive, the purring of his giant dirigibles, the marvel of his submarines, and the height of the great structures that he rears upon the hills and plains of the earth, it seems absurd to suppose that there was ever a time when none of these things were.

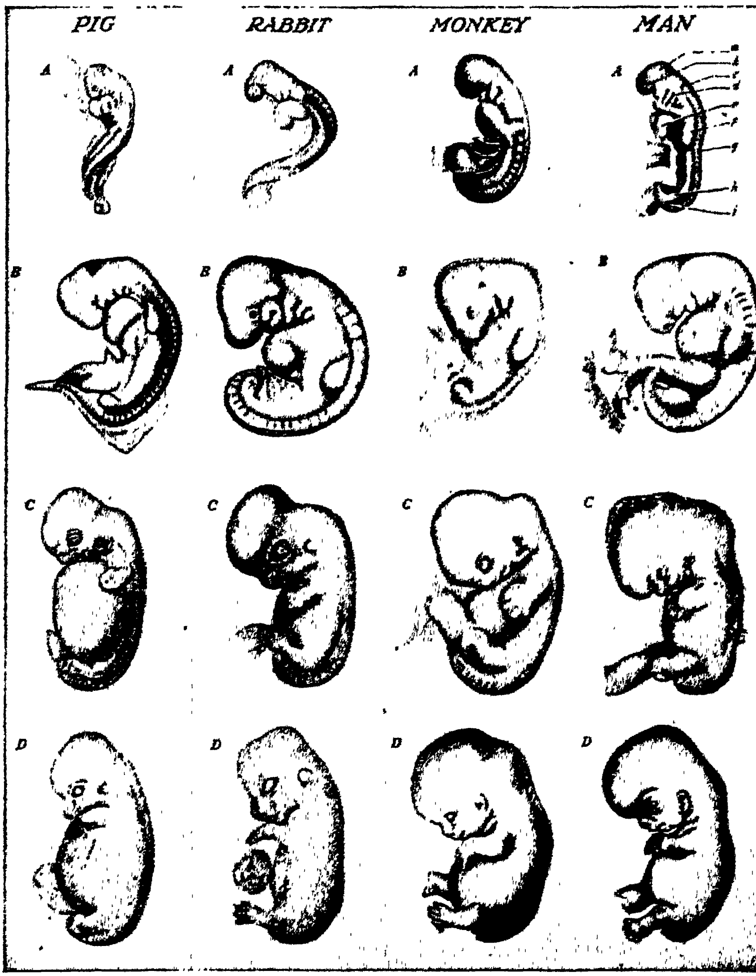
Yet the first word of the historian as he takes us backward into the past warns us that they are the things of yesterday and that some of them are the children of today. One hundred years ago the city in which these words are being written, now numbering in its shopping district one-third of a million people, had no hut upon its site. Two hundred years ago the great American nation of the United States had not yet been thought of. Three hundred years ago a few lone white settlers had just landed on the American continent. Five hundred years ago there was no

America, in the historical sense, and Europe differed so widely from the Europe of today as to constitute quite a distinct world. A few more centuries take us back through medieval days to the hour when there were none of the modern European nations, and during a thousand years more we would pass backward to the days of Rome. Still another thousand years, which from the point of view of the geologist are but as yesterday when it has passed and as a watch in the night, would place us in the days before Assyria had waxed mighty, and a few more milleniums would take us to the hour of the founding of the civilizations of Egypt and Babylonia. And these milleniums, constituting all recorded history, comprise but ten seconds of the geological day. Nor is this all. Discoveries, which we shall shortly discuss, carry us back further and further toward the youth of mankind, until at last — let us say one-half million years ago — we find him in his infancy.

Now it is a most interesting fact that, whether we speak of the infancy of the individual or the infancy of the race, a careful emamination of the dust and clothing of their journey reveals to us many facts concerning the whence and whither of their pathway. Let us look at the infancy of the individual first. We have traced his embryological story in the past chapters and now as we look at the child just born we find that he is ticketed toward his destination and from his point of departure. It is true, as another has said, that man is a walking museum of paleontology.

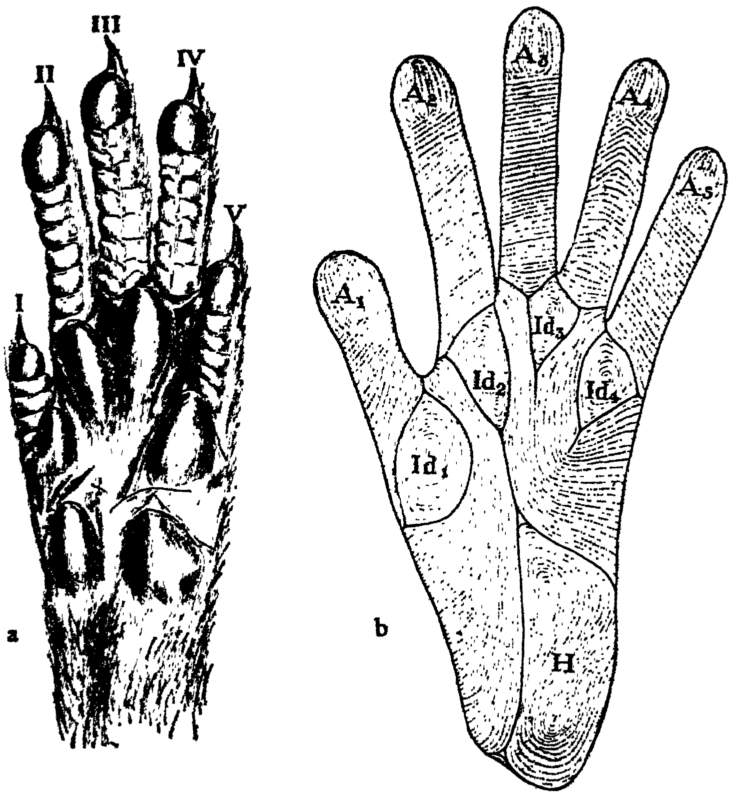
Let us begin at the top of his head. It is covered with a soft down. The body is naked otherwise, yet our embryologists tell us that at a certain point preceding his birth it was covered with long dark hair known as the lanugo. We are reminded of a similar hairy covering upon the embryo of the whale from which embryologists have always been led to believe that the whale was formerly a hairy land mammal which took to the sea. And suspicion is at once raised in our mind that perhaps man, also, in his racial infancy, was likewise possessed of a covering of long hair over his body and face, its loss being due to the lengthening of his period of gestation which is about two months longer than that of the great apes.

The direction in which the hair grows on the arms is also significant. From the wrist it points toward the ground. To us this suggests the position of the arm during countless ages when the only protection from rain and cold was the hand and arm gabled over the head. And as we



Embryos of the pig, rabbit, monkey and man. Comparison at corresponding stages of development. The embryos of each animal are arranged in the vertical columns according to age, beginning with the youngest stage at the top. Stage A of the human embryo is fully labelled, and the corresponding structures in the other embryos can be noted. a, head region; b, eye; c, ear; d, gill slits; e, heart; f, fore limb; g, primitive muscle segments; h, hind limb; i, tail region. Slightly modified from K. Guenther, after Keibel. From *The Evolution of Man.* (Courtesy of Yale University Press.)

examine our infant we notice that he has a remarkable power of grip which must have come from somewhere. The experiments made by Dr. Louis Robinson have become



Ventral surface of anterior chiridium of an insectivore and of a primate showing correspondence between relief and arrangement of friction ridges. [After Miss WHIPPLE (Mrs. H. H. WILDER).]

(a) *Crocidura caerulea* (shrew-mouse). Fore paw showing walking-pads enclosed by triangular folds of skin. (b) *Macacus* sp? (Old World monkey). Hand, covered by friction edges, the arrangement of which corresponds to the relief (a). The pads are represented by concentric circles, and the triangular folds by triradii. These latter features are here designated by heavy lines, although in the real object they are not more conspicuous than the others. From Wilder's *History of The Human Body.* (Courtesy of Henry Holt.)

famous. In the sixty cases of infants, all under one month of age, one-half of whom were less than one hour old, all except two could support themselves from a rod or finger from ten seconds to two and one-half minutes. Does this point to a time when such a power of grip was developed as an essential in the struggle for life? The very lines and relief ridges of the palms of his tiny hands bear silent witness to ancient insectivore days. And then there are the gill-slits, evident in every embryo and occasionally constituting a malformation of most startling nature in those infants which are occasionally born with the opening to the exterior unclosed. In fact, all children before birth are club-footed and even at birth the soles of their feet are turned both inwards and upwards very much as is the foot of the adult gorrilla. This also is significant. Occasionally infants are born with more than twelve pairs of ribs and it is note-worthy that in the embryonic state they have thirteen or fourteen. Nor should Darwin's Point be overlooked, the little tubercle which is all that is left of what was once probably the pointed ear of our ancestors. And the ability to erect the ear still possessed by some, does it also point to the hour when all sub-men and sub-women could and did erect their ears to catch warning sounds as do the wild animals of today? The muscles are still there though they are rarely used. Then there is the nictitating membrane, a third eye-lid, possessed by birds and amphibians, of which only the remnant may be seen in the inner corners of the eye. As we look at the infant we note with astonishment that his upper and lower extremities are of about the same length; that his legs are short, that his nose is broad, and that he has an astonishing power in the grip of the toes of his little inverted feet and that he does not possess the same cervical and lumbar curves in his spinal column that he will possess in later years, but his curves are more like those of man of 50,000 years ago and of the apes of today.

There are certain curious retrogressions that should be noticed. He cannot, for example, smell as acutely as most animals do. His olfactory organ and part of the brain which corresponds thereto are proportionately atrophied, and if we were to observe his life long enough we would find that his teeth, when they come, tell the same story, for they indicate a reduction in the size of the human jaw, especially if they should be irregular and misplaced, as the teeth of many are becoming, as the jaw has grown too small. The full story would tell how man has probably discarded twelve out of his original forty-four teeth, and how the contraction of the jaw has developed a chin which earliest man did not possess, caused by the shrinkage of that part of the jaw which contains the teeth.* Occasionally an infant will be born with four molar teeth instead of three which is, perhaps, another reversion to earlier conditions. Our child should be sitting up when six months old and creeping on all-fours when ten months old and walking by the time he is fifteen months old. Is this progression from four feet to two, in line with his racial history?

And the most astonishing of all are the three to five vertebrae which form the coccyx or rudimentary tail of all human beings. In the embryonic condition it is much longer than either the arms or the legs and possesses muscles for wagging itself. After birth they have become bands of fibrous tissue, but some cases are known where the muscles themselves have persisted during the entire life-time. It is an interesting fact that among the vestigial habits of the infant above described there is one which perhaps more than any other throws a clear light upon the days of the long, long ago. At about the age of ten months the baby is learning to crawl on his all-fours which he continues to do until some five or six months later when he learns to walk. This simple period of transition is full of meaning. The physiologist observes it and explains how both the anatomy and physiology of the man points to the time when the human creature was a quadruped. There are many things about his body that convinces the thoughtful observer of this truth. They may be found summarized in almost any of the excellent works on evolution. There are, for example, four curves in the human backbone, of which one that is in the small of the back is bent toward the front-side of the body. In doing this it is compelled to encroach upon the abdominal space occupied by vital organs of the

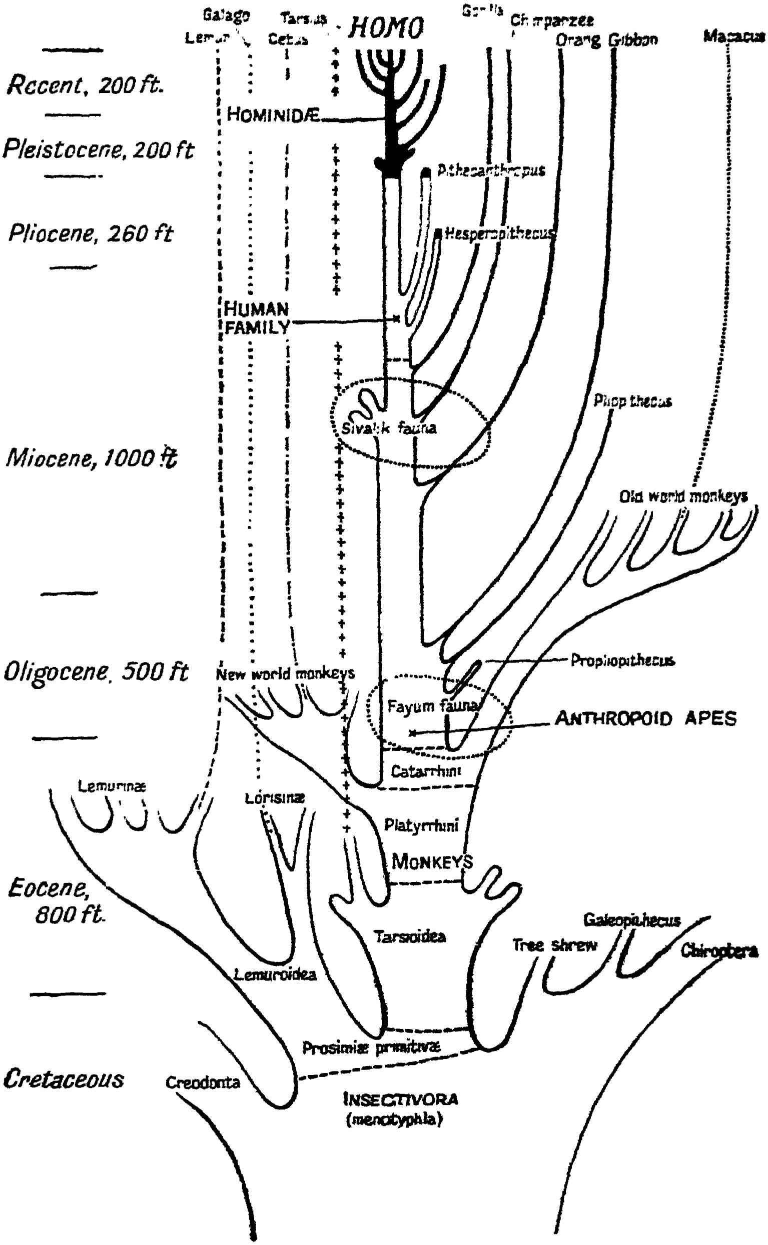
Human embryo in early stage of development. Note the gill slits, tail, etc.

* See illustration on page 260.

abdomen much to their detriment and this. as any physician well knows, is a source, in civilized man, of many troubles. The upright position has also necessitated the enlargement of the hip bones which has narrowed the birth portal of the human being whose females are thereby subjected to a pain at parturition greater than that of any other living creature. The fact that the erect position is not yet quite natural with men is fully exemplified by the difficulty which they have in maintaining for a long while a standing attitude, whereas a quadruped may maintain a stable position almost indefinitely. Many men actually faint when in army formation if they are compelled to stand at attention for a great while. This is due to the unnatural strain on the muscles required for the balancing of the body, especially those that have to do with preventing the head from falling and the abdominal muscles that keep the body from toppling over. One of the universal complaints of mankind is fallen arches which have not yet adapted themselves, in the human being, to the extra strain put upon them. Almost every organ of the body could tell some similar story. Who does not know that in his sleep his eyes tend to roll upward as do also the eyes of the dead? Any oculist will advise his patient to relieve the eye-strain by frequently looking up which was long ago the natural attitude of the eye. Hernias, varicose veins and many ailments of the generative organs, not to mention such simple things as indigestion, stomach gases, and such like are in many cases due to the dropping down of the heavy internal vital organs such as the kidneys into the lower part of the abdominal space. In the old quadrupedal days these organs were better supported by rib and muscle. So that when the little child begins to lift his body and walk upright he is doing within a few months a thing which represented a racial transition occupying thousands of years, and in each case there are both disadvantages and compensations. In the old days, by doubling the height, it became possible to see much further and, therefore, to obtain a greater safety. It also released the forelegs and especially the hand for other purposes and formed largely the psychological basis of our present civilization, but the human body is still in process of adapting itself to what was a serious change.

These are some of the indications which tell us the whence and whither of mankind. Of such vestigial remains biologists have enumerated one hundred and eighty. Many of them play an exceedingly important part in human life such as the degeneration of the human appendix which was probably once useful to the human being as it is still to many other animals.

Nor is the story a different one that we read of the infancy of the race. The process of his creation is an ancient process and it has lasted a long, long while. When we see him he is never what he is today nor what he was yesterday but the slightest study shows that he is going somewhere, that he is involved in a mighty process of becoming. None of the great structures which he will later rear are about him in the beginning. No temples, no palaces, no pyramids, not even a house or a single room that he has built with his own hands. His only home is a cave or the leafy shelter of the forests. He has no machines to do his work for him, not even a polished flint or a chipped arrow-head. We can trace him back to the days when he had not harnessed the lightning or the waterfall or even the fire. He was then little more than a walking ape that had learned to use his hands and feet more cleverly than the other animals, that had developed the opposable thumb and so could handle implements better than other animals, and that was emerging in tribal groups from the forests. And, most important of all, the thing was coming which would distinguish him from every other creature. He was learning to think, to plan and to purpose. In the years to come he would see the dismal darkness of his damp and chilly cave changed to the comfort of palace and hall. He would see his pointed stick and jagged flint fade through successive evolutions into tempered steel and massive cannon. After a while he would learn to control fire and with it would come the mysteries of steam and the powers of the gas engine and the wonder of the electric motor. The skins captured in the chase would soften into silks and his ever present hunger be satisfied by the trade of all continents. As the time passed, he would learn to speak and to write and call forth music from reed and string, but with none of these things did he begin. In the day of his infancy he differed from his fellow-creatures mainly in a few slight anatomical changes and in an increased brain capacity. He was just an animal among other animlas. Perhaps his most distinguishing feature was that he was disturbing the world more than any other animal. He was less content to leave the world as he found it than they. He was never so speedy as the deer nor so strong as the lion nor so terrifying as the mammoth. He possessed no claws like the tiger nor tusks like the ele-



A tentative scheme of the relationships of the Order of Primates. From Smith's Essays on *the Evolution of Man*. (Courtesy of Oxford University Press.)

phant, nor poison like the snakes, nor impervious hide like the hippopotamus. So for claws he learned to use sharp, jagged pieces of flint and sharp-pointed sticks that the storm made in the forest. And sometimes when they were not quite pointed enough or sharp enough he pointed and sharpened them for himself. Perhaps he watched the bird build her nest and imitated it for his own young, or the chimpanzee could have taught him how to build a little hut in the forest. Such things as these constitute the beginning of civiliztaion. They probably preceded the harnessing of fire by thousands or even hundreds of thousands of years. The principal point to note is that he, more than any other creature, began to change his environment, to sharpen sticks, to chip flints, to crack nuts, to probe and to dig.

It would be a very wonderful thing if science possessed the information necessary to tell the complete story of mankind from the old quadrupedal days to the present hour but this is not possible. She does know, however, that the primates had emerged from the mammalian stock, by the beginning of the Eocene epoch. They are known at that time to have existed in North America and in northern Asia. From such points they probably migrated into southern Asia, South America and Africa. It is believed by many that the primates were themselves descended from an insectivorous ancestry, passing through the primitive prosimians and the Tarsioidea to the primeval apelike anthropoid. It is probable that in the original home of mankind there was brought about great continental elevations producing the aridity which is supposed by many competent authorities to have had large effect in inducing pre-man to adopt land rather than tree life. This made him a hunter and led, doubtless, also, to the beginning of communal life, the adoption of the upright position and the claiming of such natural shelters as he could find and of such clothing as he could obtain from the chase. It has become an adage that man did not make society but that society made man and if the above line of reasoning is true then it was the cold hard fact of hunger which in the struggle for survival developed community life. His manner of life then as now made man.

"Italian missionaries in the backwoods of Erythrea," runs a recent newspaper article, "have discovered a tribe of beings who dwell in trees and who eat their own dead. They are dwarflike in stature and swing from limb to

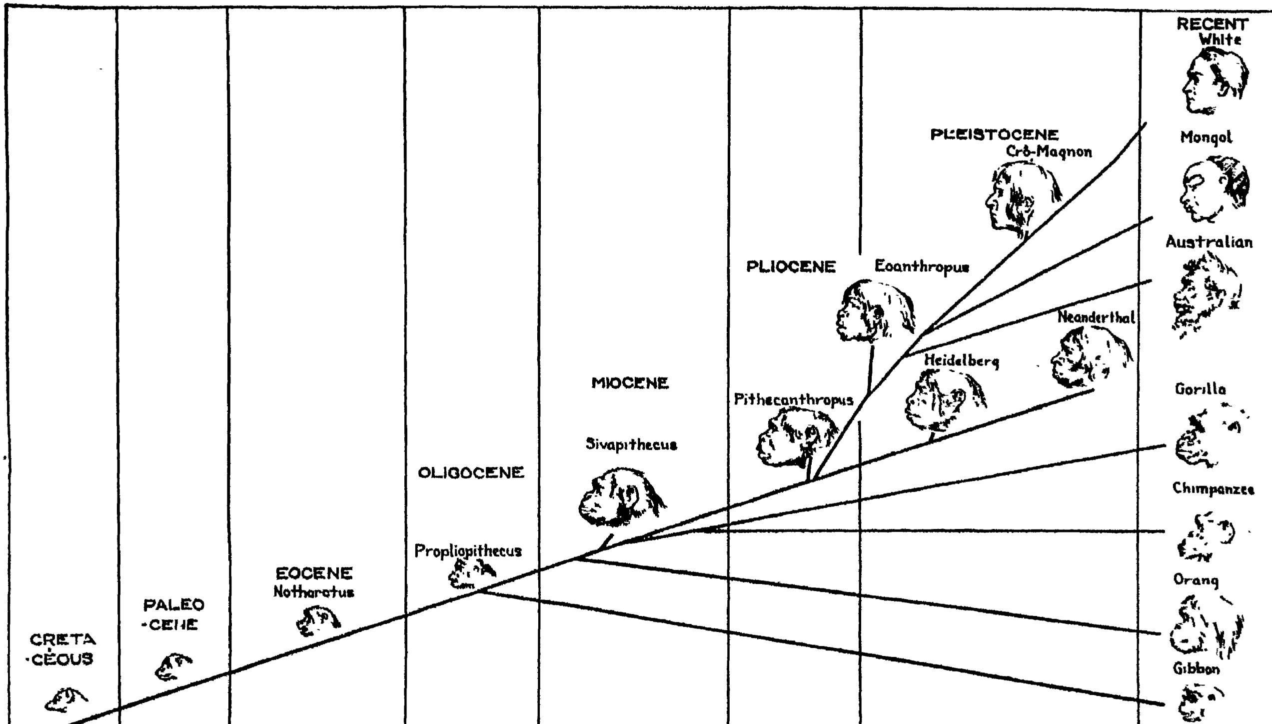


Diagram showing the development of the face of man since Cretaceous days. (Courtesy of the American Museum of Natural History.)

limb in the trees. Like the natives of which Stanley speaks in his book "Zanzibar," they would not believe that outside their gigantic forests there were fields and meadows and open skies. With melancholy earnestness they moved their arms in answer to the protestations of the missionaries. "It is all like this, trees, trees and again trees." The same writer, Van Paassen, continues: "In 'De Tropische Natur'," a Dutch publication, J. Van Herwaarden tells of a singular experience he had on a small island near the coast of Sumatra. While hunting wild boars he saw a creature walking in an open clearing in the jungle. Its arms were long, but did not have the length of those of the orang-outang. Its head was covered with long, flowing hair, but the face was bare. It had a nose that resembled a Zulu's, regular teeth, and quiet, steady eyes, not the shifty, nervous kind of an ape. When Van Herwaarden leveled his gun at the creature it wailed, but presently made off, making a hissing sound. Anthropologists the world over are excited over the possibility that the Dutchman has stumbled on the "missing link" that is to connect man with ape-like ancestors. The governor general of the Dutch Indies has ordered a detachment of troops to investigate the strange creatures and bring one of them to Batavia in captivity." Neither of these reports may be accurate but both illustrate possible stages of prehistoric human progress.

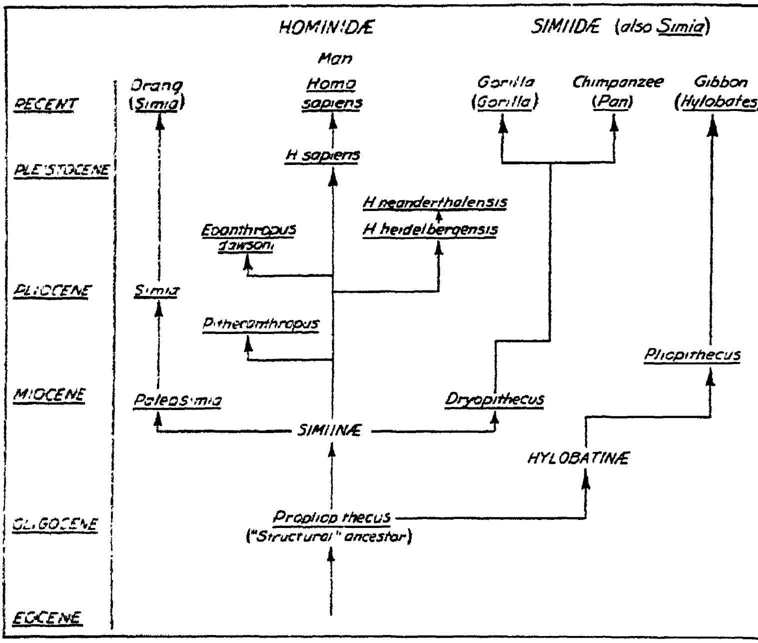
Some shrewd guessing has been done by such men as Tyler as to the reason why and the place where and the time when men descended from the trees to begin their long career on land. The period of arboreal life following the quadrupedal days had vastly modified pre-human man. His body had become strong, muscular, adaptable. His brain had developed, especially in the centers associated with vision, nor had his body been over-specialized by its arboreal life. The foot was different from the hand, which had become ready for tool-making and handling. Then gradually man descended from the trees to the ground, forsaking the pathway trodden by other primates excepting the baboons which inherit caves and cliffs. Why and when and where?

Setting three million years as the time occupied by the tertiary period, we recall the epochs; Eocene, Oligocene, Miocene, Pliocene, Pleistocene, each containing about six hundred thousand years. The Eocene was warm, and fairly moist. Many apes abounded along with the arboreal progenitors of mankind. The climate of the Oligocene was colder and of the Miocene colder still with increasing aridity. In Asia, the original home of mankind, as the climate grew more arid and trying during the Miocene and Pliocene days, the central plains dotted with forests and river valleys offered a veritable Garden of Eden for man and beast. Slowly the Pleistocene with its ice ages approached. Aridity had increased as the Alps and Himalayas, had been uplifted in the Miocene, the latter robbing the southern winds of their moisture and turning the central Asian Eden into a desert. The forests and their inhabitants passed. Followed dry steppes and grassy plains. Apes and pre-humans migrated southward into India, Africa, East Indies. New food sources must be sought amid changed surroundings. Followed the descent to the plains and the adaptation to and conquest of the land. Again, as so often in the past, the pinch of necessity had driven man out of Eden only to set him down in a broad place of greater opportunities and swifter progress.

Although it could be clearly inferred from what has already been said, yet it is well to state that the theory of evolution does not include any statement to the effect that man is descended from modern apes, though they probably descended from the same original progenitor. While it is true that the orang, the gibbon, the chimpanzee and the gorilla offer to mankind the closest physical resemblances in all nature, yet there is a wide disparity between them. The very way in which they walk is distinct, man principally using his heel and great toe while the apes walk on the side of their

Showing the way in which the human forehead has been lifted. (Courtesy of American Museum of Natural History.)

feet and their middle toe. Apes still live in the forest and are expert climbers of limb and tree. Mankind must, for countless ages, have lived upon plain and steppe. He is a good runner, a poor swimmer, and a still poorer climber. This would point to land-life as having been his environment perhaps as far back as the Mesozoic days.

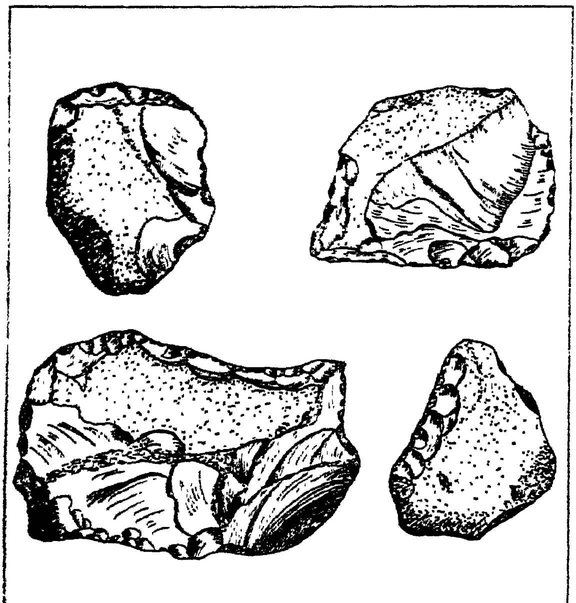


Provisional Phylogeny of man and the anthropoids. (Courtesy of Yale University Press.) From *Men of The Old Stone Age*, Osborn, (Scribner's.) Courtesy of the Author.

As we go into the more detailed story of earliest man, it is with a feeling of solemn reverence. There is nothing ludicrous about that fierce and bloody battle through whose lone watches by day and night our ancient progenitors fought their way up toward the light. Through what strange conditions of environment they must have passed before they obtained the mastery over all living things! To sympathize with that struggle it is necessary for us to rob man of all his weapons, all his tools, all his defenses, to disrobe him, to take away even his rudimentary knowledge of science, to put him back into the place from which he came, an animal among animals, fighting against the poison of the snake, the paw of the bear, and the fang of the saber-tooth. It was an unspeakably glorious struggle and it was won cleanly and fairly by wit and mind against brawn and muscle. It was an indescribably wonderful battle producing every great thing that yet abides in the hearts of men and women, forming the foundation of every permanent structure erected by civilization. No man need be ashamed of his ancestry for every page of palaeontology is resplendent with the glory of his achievements, so that today the climax of all appears as we find him, king of living things, master of the destinies of the world. It is a question as to whether his future, no matter how wonderful it may be, can ever be quite so wonderful as his past.

The simple facts, so far as anthropology knows them, of the life of earliest man cluster around a limited number of discoveries of human remains and artifacts. In each case, the time element is of supreme importance. There is a fourfold method whereby the date of such relics can be determined. One is that set by geology, wherever the geologist can state the age of the stratum in which the remains are found. Another is that set by paleontology which gives the date of such animal bones and remains as are associated with finds. The third is that set by the artifacts, such implements or weapons as indicate the handiwork of man, associated with his remains, and last of all, the evident stage of development of the remains themselves, judged by their likeness or unlikeness to existing man.

The oldest known evidences of man on earth are certain roughly flaked flint-objects so nearly resembling some chance bit of stone that it is exceedingly difficult to determine whether they show that the hand of man has changed them or not. They are called eoliths and belong to the sub-human days of the Pliocene epoch, a half-million or more years ago. They occur from that time on, associated with human remains until their shapes have changed so definitely that they merge into the implements and tools and weapons of the Palaeolithic days. Silent witnesses they are of the hour when man was first beginning to change his environment, to the time when he could not find enough sharp flints and subtly planned to sharpen a flint for himself. And yet, what a wonderful voice is theirs! They speak to us from days of five hundred thousand years ago. They tell of that earliest hour when man, having noticed that some stones were sharper than others and thus better fitted to his purpose of defence or attack or other use, by accident, perhaps, learned to increase their sharpness or by fracturing to render them pointed. It was the same trick he had played with the stick found in the forest. Only the flint was superior to the stick. He could cut with it, bore with it, scrape with it. No other animal could do it. So the Age of Wood passed and the Age of Stone arrived. Upon it he built his civilization so that the stone age would rank with the bronze and



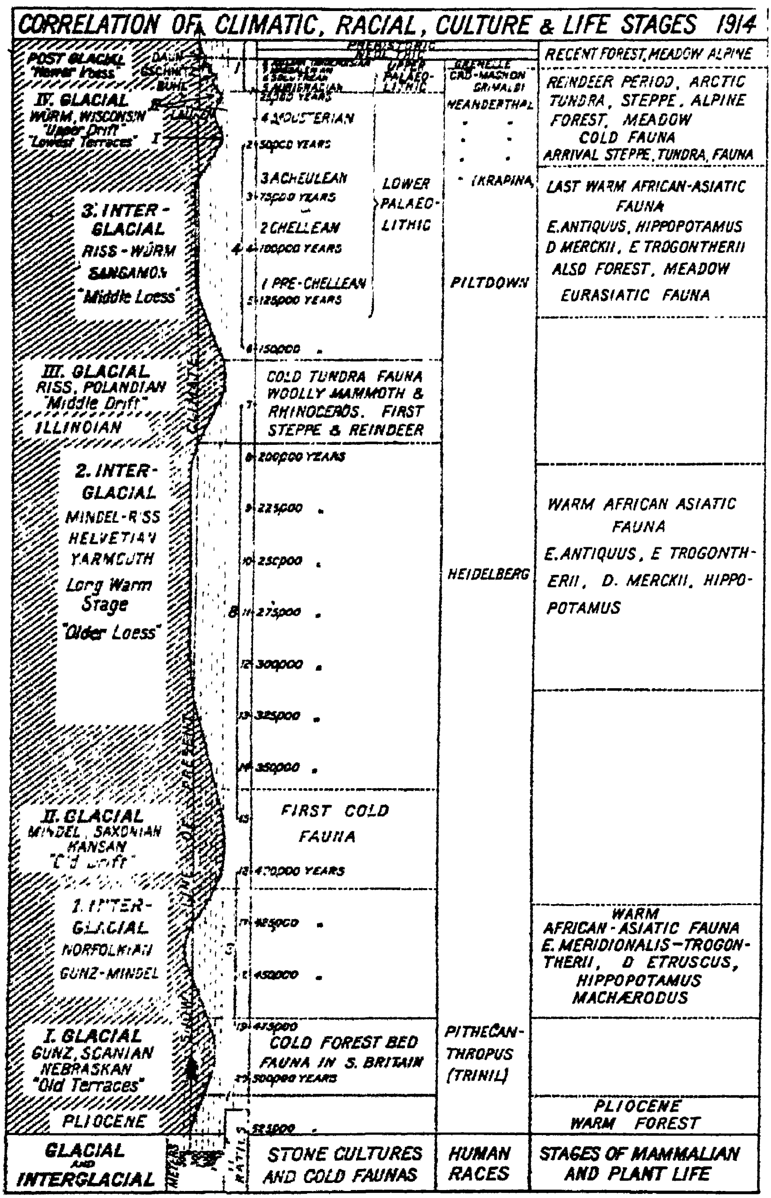
Earliest implements of man, roughly flaked by human hands. Age, pre-glacial to glacial. (Courtesy of Scientific American.)

steel ages as one of the great stages of human progress. It was one of the epochal discoveries ranking with the harnessing of fire, the domestication of animals, the use of the wheel, the manufacture of bronze and steel and the capture of the powers of electricity and gas. What strange, dimly exultant emotions must have surged through the mind of that first unknown benefactor of mankind as he realized that he had made something no animal or man had ever made before—a tool. The wonders to which it would lead he knew not. He was like the little child who discovers his hands.

The kind of man who did this is revealed to us by the find of Dubois in 1891 in Trinil, central Java. Only his skull-cap and thigh-bone and three teeth were found,* but an anthropologist is able from such relics to build up a head and body with reasonable certainty. When this had been done, it was not an easy matter to decide whether this tentative man was a gibbon or a pre-human ape or a primitive human being. His height was about five feet seven inches, which is about an inch lower than the average for man of today. He was flat-footed and possessed great supra-orbital ridges from which hung beetling eyebrows. His brain capacity was about 900 c. c., perhaps half-way between that of a simian and a man. The island of Java on which he lived was in his time a part of the Asian continent. The climate of Europe at that time was mild and pleasant, resembling that of southern Georgia today. He had probably come from Asia and the animals with which his kind were familiar were mastodons, rhinoceroses, sabertooth tigers, hyenas, antelopes and innumerable apes and monkeys and other varieties of tentative men. At that time there were land bridges connecting Europe via Sicily with Africa and via the Dardanelles with Asia. The first glacial epoch was about to begin, to be followed by a climate warmer than that of today. He was extremely dolicocephalic, (long-headed) unlike all apes hitherto known, which are broad-headed, or brachycephalic. His brain, which weighed about 28 oz., had a capacity of about 900 c. c., and was most highly developed in the rear sensory centers. This may be compared with the largest simian brain capacity, estimated to be about 600 c. c., and with that of modern man which averages about 1,500 c. c. His weapons were probably sharpened sticks and clubs and rocks for missiles, and those

Reconstruction of the face of Pithecanthropus erectus by J. H. McGregor. (Courtesy of American Museum of Natural History.)

* The Associated Press has just reported a find of a complete skull of the Pitheeanthropus erectus.


CORRELATION OF CLIMATIC, RACIAL, CULTURE & LIFE STAGES 1914
POST GLACIAL "Newer Loess"
DAUN
GSCHNITZ
BUHL
IV. GLACIAL WÜRM, WISCONSIN "Upper Drift" "Lowest Terraces"
LAUFEN
4 MOUSTERIAN
50000 YEARS
3 ACHEULEAN
75000 YEARS
2 CHELLEAN
100000 YEARS
1 PRE-CHELLEAN
125000 YEARS
150000
UPPER PALAEOLITHIC
LOWER PALAEOLITHIC
GRIMALDI
NEANDERTHAL
KRAPINA
PILTDOWN
RECENT FOREST, MEADOW ALPINE
REINDEER PERIOD, ARCTIC TUNDRA, STEPPE, ALPINE FOREST, MEADOW
COLD FAUNA
ARRIVAL STEPPE, TUNDRA, FAUNA
LAST WARM AFRICAN-ASIATIC FAUNA
E. ANTIQUUS, HIPPOPOTAMUS
D MERCKII, E TROGONTHERII
ALSO FOREST, MEADOW
EURASIATIC FAUNA
3. INTER-GLACIAL RISS-WÜRM SANGAMON "Middle Loess"
III. GLACIAL RISS, POLANDIAN "Middle Drift" ILLINOIAN
COLD TUNDRA FAUNA WOOLLY MAMMOTH & RHINOCEROS. FIRST STEPPE & REINDEER
200000 YEARS
2. INTER-GLACIAL MINDEL-RISS HELVETIAN YARMOUTH Long Warm Stage "Older Loess"
225000
250000
275000
300000
325000
350000
HEIDELBERG
WARM AFRICAN ASIATIC FAUNA
E. ANTIQUUS, E TROGONTHERII, D. MERCKII, HIPPOPOTAMUS
II. GLACIAL MINDEL, SAXONIAN KANSAN "Old Drift"
FIRST COLD FAUNA
400000 YEARS
1. INTER-GLACIAL NORFOLKIAN GUNZ-MINDEL
425000
450000
WARM AFRICAN-ASIATIC FAUNA
E. MERIDIONALIS-TROGONTHERII, D ETRUSCUS, HIPPOPOTAMUS MACHÆRODUS
I. GLACIAL GUNZ, SCANIAN NEBRASKAN "Old Terraces"
475000
COLD FOREST BED FAUNA IN S. BRITAIN
500000 YEARS
PITHECANTHROPUS (TRINIL)
PLIOCENE
PLIOCENE WARM FOREST
GLACIAL AND INTERGLACIAL
METERS
STONE CULTURES AND COLD FAUNAS
HUMAN RACES
STAGES OF MAMMALIAN AND PLANT LIFE

rudely shaped but sharp-edged flints called eoliths which were to develop later into knife and hammer and razor. He stood upright, as a careful study of the femur shows. He was certainly not an ape, and yet it is hard to recognize him as a man, although he differed less from modern man than does the infant from his father. Without lese majeste we may call him a cousin of the gorilla, especially since they had in common that extreme prognathism which characterizes almost all specimens of earliest man. He was a walking ape-man as the name given to him by scientists, Pithecanthropus erectus, indicates. His was a wonderful age, in which a higher intelligence was beginning to dawn, in which man was first setting himself to the vast problem of making over the earth and utilizing it for his own purposes.

We must skip a quarter of a million years before we come to the next authenticated find. In doing so we pass to Europe, where on account of evident circumstances anthropology has been developed farther than in any other part of the world. The days of the first glaciation had passed, to be followed by the first inter-glacial period, with its warm Africo-Asiatic fauna of elephants, rhinoceroses and hippopotami. After it followed the second glacial epoch, 400,000 years ago, and then during the warm inter-glacial days that came afterward, when the warm Africo-Asiatic fauna was still to be found in Europe, hippos, rhinos, and elephants, we find the Heidelberg man. We know him only by his jaw, perfectly preserved and full of teeth. As we look at it we see at once that it possesses no chin, that it is very massive and yet so narrow that it would seem difficult for its owner to have possessed the power of fluent speech. It was found eighty feet below the surface of the soil in 1907 by Schoetensack in the Mauer sands near Heidelberg, and with it were those significant eoliths which tell of the primitive industry still persisting. In the same strata are found the remains of bison and elephants and rhinoceroses and horses and moose. It was the day when the lion was spreading over Europe, but saber-tooth was declining in numbers. It was at the very beginning of what was known as the Chellean flint industry, noted partly for the size and massiveness of its implements. With a fair degree of exactness we may locate in time the Heidelberg man, low-browed and sub-human, somewhere between 200,000 and 350,000 years ago.

After his day the geologists tell us there came a third glaciation when Europe was occupied by a fauna from the

Sabre-toothed tiger, ancient enemy of early man. Pliocene epoch. Note the Scimitar-like upper canine teeth. (Courtesy of Scientific American.)

cold tundra regions of the north such as the woolly mammoth, the woolly rhinoceros, and the reindeer. When something like 50,000 years had passed there came the third interglacial period when the warm Africo-Asiatic fauna returned, and it is about this point in time to which the famous discovery at Piltdown, Sussex, England, is referred. These remains consisted of a whole skull exceedinly thick, with a brain capacity about half-way between that of modern man and the Pithecanthropus erectus. Nearby was found a jaw-bone and some teeth. A careful study of the former showed that it was even less like that of a human being than was the Heidelberg jaw but the teeth were not unlike those of human beings. So different did the jaw seem that most anthropologists refused to believe that it belonged to the same being that had furnished the skull and it was supposed to have been the remains of some anthropoid ape which it resembled closely, but the later discovery of another specimen of the Piltdown man at a point not far removed, and having quite the same general characteristics, has set all doubt at rest. Oddly enough the skull lacked the beetling brows of almost all types of sub-men, possessing a smooth forehead but an ape-like jaw which is more slender than that of the Heidelberg man and an ape-like chin — that is to say, no chin at all. The fact that the brain seemed to have been far more human than the jaw suggests the very evident fact that the changes in the lower part of the human face have followed tardily the brain development of the race. Originally man was quite ape-like in appearance and manlike in reality. The brain capacity of the Piltdown skull is estimated at 1,300 c. c., which may be compared with that of the lowest type of human brains today, that of the Australian aborigines, approximately 1250 c. c. The fact that the Piltdown skull shows no supra-

Reconstruction of the head of the Piltdown man by J. H. McGregor. (Courtesy of American Museum of Natural History.)

Photographs showing the development of the human chin caused by shrinkage of the upper half of jaw resulting from the reduction in the number of teeth, probably brought about by their disuse due to a change in food and manner of life. Compare with faces of men and Anthropoids. (Courtesy of American Museum of Natural History.)

orbital ridges is believed by most anthropologists to point to a wide differentiation of the human race existing at this time, comparable to the number of species of other animals. In some respects, the Piltdown man was nearer the man of today than any of the other of ancient types. He is supposed to be the most ancient of human beings, the shape of whose head and the size of whose brain is definitely known. The discovery was made by Dawson in 1911, and is located in time between 125,000 and 300,000 years ago — before the days of skillful flaking of flints, for again we find eoliths associated with the Piltdown man. These eoliths are of the most primitive type and might easily be mistaken for natural bits of jagged flint. The shape of his skull would suggest the possibility of his having been a stage in the ancestral line from which modern man developed. He doubtless possessed all of the rudiments of human life and the same rude emotions as those possessed by modern savages with whom he would see face to face. It is worth noticing in this connection that in early life the forehead of the modern ape is round, not unlike that of the

Piltdown skull, and that their supra-orbital ridges develop later. All this was in the third interglacial period which extended from 150,000 to 300,000 years ago.

Followed the fourth glaciation, the reindeer period, characterized by a cold fauna of tundra and steppe, with alpine forests. At this time we come upon the days of the Neanderthal Man. The animals from the south have vanished, though certain large carnivora such as tigers and lions remain. From the north the reindeer have come in great numbers, and the cave-bear disputes possession of the natural shelters from the ice. In one cave alone over 800 skeletons of the cave-bear have been found, and the cave-lion and cave-hyena and cave-leopard are everywhere. The arctic fox and the arctic hare and ptarmigan have come down from the north, and the ibex is to be found upon the mountain-side. The moor-hen and steppe-horse are on the steppes and in the forests are the stag, the wolf, the giant deer, and the fox. Wild cattle and bison are plentiful upon the meadows. Such are some of the animals familiar to European men of 50,000 years ago. Many discoveries have been made of skeletons possessing the Neanderthal physiognomy. The original discovery was made in 1856 in the Neanderthal valley near Dusseldorf and consisted of what was probably a complete skeleton, parts of which were later scattered and crushed. The Neanderthal man is distinct and important. Again we find the heavy, over-hanging, supra-orbital ridges with a brow that is pressed down and receding. The general outline of the face is distinctively less intelligent than that of the lowest human beings today and is quite narrow and long-headed. As reconstructed by the best anthropologists the Neanderthal man was of low stature, averaging perhaps five feet three inches with a frontal angle of perhaps 60 degrees. He was very heavily built and had great beetling eye-brows and interestingly

Reconstruction of the face of the Neanderthal man by J. H. McGregor. (Courtesy of American Museum of Natural History.)

enough seems to have been unable to stand absolutely upright. His skull-cap was flat and his face was extremely prognathous, strongly resembling that of an anthropoid ape. All Neanderthals possessed a deeply receding chin. It it worthwhile noting that his supra-orbital ridges not only projected from above the eye in sockets but extended from the temple to temple like over-hanging eaves of a house. The Neanderthal jaw was not so massive as that of the Heidelberg man, and his canine teeth are less conspicuous and more human in appearance.

Perhaps the most interesting of all facts known about these sub-human people is that they buried their dead ceremonially, placing about them an assortment of precious weapons and implements and probably food supplies, laying them out in an east-and-west direction, as if in that early day men dimly hoped for a hereafter or, at least, were so uncertain of a permanent death that they wished to supply their loved ones with the necessaries of life should their sleep have its awakening. To these characteristics should be added the fact that he had not yet perfected the use of the opposable thumb, that he was long-armed and evidently was accustomed to squatting as a normal position, that his body possessed an exceedingly thick trunk and above it was set an enormous head. To vision the life of the Neanderthal man, it is necessary to understand that he lived entirely in the open as a hunter, or at the best a trapper, finding protection in the caves from which he drove out the bear and the hyena and the lion. He possessed the use of fire which he built at the mouth of the cave, his home being rather its entrance than its interior. He probably could construct pit-falls and knew the use of the javelin. If his strength was that of his cousins, the chimpanzee and the gorilla, he was a powerful creature amply able to defend himself. Living in communities he was the more to be dreaded as a group which with missiles and clubs and fire and superior wit would be able to vanquish any living animal. It was this communal life which was fast making him and his contemporaries all over the world the master of field and forest although he still could only assume a stooping posture and could not hold his head erect, although he was chinless, and perhaps could not even talk, although his teeth differed from those of men and his jaw-bone seemed more like that of an ape. Taking him as a type of sub-men everywhere, we may say that he was fighting the great battle of humanity toward the things of the upper world. He had learned a great deal more than men knew before him about how to chip flints. and he was making some remarkable implements by skill and patience. His civilization is known as the Mousterian industry and he was an adept in the manufacture of scrapers and borers and "points" with sharp cutting edges, beautifully chipped but never polished. He was laying the foundation of the exqusitely polished flint arrow-heads and knives of later ages from which he was not so far removed as from the days when men only used natural flakes or,

Skull of Neanderthal man. (Courtesy of Yale University Press.)

at most, smote them into eoliths. As it was with the implements, so it was with his brain case. Through countless years of struggle and thought and anxiety his brain had lifted its vault. He was a greater man than the man of Heidelberg or the man of Trinil. His brain was bigger. He thought more about things and pondered more. He had harnessed the fire and was learning to cook his food and perhaps most important of all to keep back the enemies of the forest by means of its glare. He had not yet built a house unless it may have been some rude covering of leaves like that of the chimpanzee, but he had occupied the caves, beating back his enemies to do it. He knew nothing as yet of the tools of modern civilization but all of them he was making possible in the remarkable productions of his handiwork, and most important of all

One of the earliest battles for progress and civilization. Cave men fighting cave bears for the possession of a desirable home.
(Courtesy of American Museum of Natural History.)

he was almost the only animal in the whole world that was disturbing the course of nature. His house was not so beautifully constructed as that of the bird, for he had nothing but a smoky cave, but he had already started on that long course of action whereby he would work his will upon the face of the earth, changing it as he pleased and harnessing all of its powers as he wished. The Neanderthal man is not believed to have been the ancestor of Homo sapiens, modern man. Within a few thousand years he had completely disappeared from Europe, probably driven out by a superior race about which we shall shortly tell. His heavy massive ape-like form probably covered by long black hair, was far below the type of men who succeeded him. Indeed, it is possible that he furnished the historical basis for the legends of ogres and gnomes which have come down even to our days. But it was through some such stage as his that mankind must have passed on to the day of that great battle whose stake was the conquest of the earth.

It is a fascinating task to attempt to visualize the past world changes which affected Europe during and following the days of the Neanderthal man. First of all, one should remember that at the time there was no North Sea, England being connected with France by a beautiful fertile valley. Great ice-caps had formed in the Scandanavian peninsula, over Scotland and along the Alps, thus locking up immense masses of water in the form of ice. Since this was contemporaneous with the glaciation of North America and other parts of the world it is entirely possible that it affected the sea-level, causing a still further apparent elevation of the lands. Especial interest attaches to the effect of the melting of those enormous masses of ice upon the level of the Mediterranean Sea which at that time probably consisted of two inland lakes divided by the land-bridges between Italy and Tunis. If as has been suggested the rising waters eventually broke through the land-dam of Gibraltar a deluge of such gigantic proportions as is called for by the flood-legends of all peoples would certainly have occurred. The fountains of the great deep would indeed have been broken up. Many believe that the Sahara was not then a desert of shifting sands but a land of wooded hills and well-watered valleys. In an atmosphere that was cold and chilly at all times Neanderthal man hunted his game, sometimes taking them unawares at awkward crossings of bogs and rivers, sometimes capturing them by hidden pitfall or when wounded by other enemies, taking back their marrow bones to his cave to be cracked at his leisure. We can picture him as always anxious that the fire should never go out, valuing the warm skins of other animals as his greatest treasures unless a finely chiselled flint should be esteemed more highly. It was a perpetual camp-life, void of any modern comfort, an unending process of exposure to the elements, to the rain, cold and ice and heat.

What would not one give to be able to go back to those early days and feel as primitive man felt, see as he saw and live as he lived? The wanderlust of youth is perhaps a dim memory of that hour, the love of the wild, the fascination of forest and river and meadow, felt most deeply by the young. And what a wilderness of tangled impressions his mind must have contained. It was in the first hour of logical thought, when he was just beginning to put together cause and effect. Ten thousand things that we thus quickly relate must have been to him not unlike what they are to shrewd animals today. He leaned over into the quiet pool and saw his own image in it, but it must have been to him something remotely resembling the image of what a wild animal sees under similar circumstances, without fully recognizing it as himself. What breeder of game cocks cannot tell the story of how his favorite bird has smashed a mirror in striking at his own image. And the echo from the neighboring hillside, and unseen crickets beneath the rock, and the thousand invisible voices that spoke to him from hollow tree and matted forest floor, what and who were these? He saw the swelling of the tides, the coming of the floods, the anger of the shooting star, the disappearance of the moon and the sun under eclipse, and pondered over them, and his solution of the mystery was a simple one. Evidently there were two classes of objects, those that moved themselves and those that did not. The former were living things, the latter were dead. It was but natural, therefore, that all changes involving motion involved to him life. And there were many things that moved. Most magnificent of all was the sun, ineffably glorious. No wonder he stands at the head of all objects to be reverenced, wondered at and worshipped. And the ever changing moon over whose waxings and wanings primitive man never ceased to marvel. And among the stars were five, Mercury, Venus, Mars, Jupiter and Saturn, of which the quick eye of the first man early discovered the wanderings. Then there were the fierce comets and flaming meteors and the terrible anger of the lightning whose zigzag pathway among the clouds resembled nothing so much as a fiery snake, that ancient and fearsome enemy, which may explain the strange reverence for and worship of serpents, characteristic of the brown-white civilization, whose natural habitat was so subject to violent thunderstorms. Then there were the flowing rivers and bubbling fountains with their "living waters" and the wind and the ever restless sea. Nor should the surrounding animals be forgotten, almost as shrewd and cunning as man himself, and in many ways his industrial, social and physical equal. No wonder we find the worship of animals playing so large a part in the earliest history of mankind! And to these could be added the unaccountable voices of nature, the inexplicable words from hidden sources of wood and field and river, none of which he understood at first. What a herculean task it was to conquer these myriads of fears and to stagger through all these shadows upward, onward, ever losing his way, ever retracing his steps, but ever mindful of that undeniable urge which compelled him to go forward. And as age by age his forehead deepened and his overhanging brows uplifted, we see the light dawning upon his soul. Dimly it came and dim it is still. At length the day must have dawned when man knew himself to be the master. It was not always so. Away back in the Mesozoic era his progenitors, whatever they were, had trembled before the great terror of the Tyrannosaurus rex or cowered driven and afraid before gigantic dinosaurs, lords of creation. It was only yesterday that he had learned how to conquer the mammoth. Perhaps the secret of his widening mastery lay largely in his communal life, for then as now the "strength of the pack is the wolf and the strength of the wolf is the pack". An army of howling, hungry humanoids, hurling clouds of missiles with unerring aim and great force, a forest of clubs and sharp pointed sticks — in this way combined with his fellows, he was invincible. Thus also wit sharpened wit, each sharing in the new discovery, learning the new word, practicing the new trick, until the bundle of the family or tribe was too strong for the elephant or lion or tiger. By this might he took what he wanted, winning the caves from the bears and the drinking places from the wild beasts. No such fight has ever been or ever will be again. From among a billion species of creatures that had struggled for it, one hand, mightier than any other, grasped the earth's greatest prize. Not by might nor by power but by his spirit he won. He whipped a whole creation into submission. Mastodon and mammoth, lion and leopard, simian and serpent, he beat them all to their knees. He was to rule the world!

But there were still the invisible powers of pestilence and pain and ill fortune and death. Surely these lived also and must be pleased and placated. And beyond his power of conquest were sun and moon and stars, and the lightning-snake, and the sea and the power of seedtime and harvest. Each and many more he feared and reverenced in his own time and way. Some of them were good spirits and kindly. Some of them were evil spirits, malevolent and dangerous. Such were the devils of sickness, physical and mental, of which so many men were possessed. Some had this name, some had that, each with his or her separate manner of propitiation or praise. For the pain that he suffered must have been caused by some living thing within him that made him suffer. Thus he came to a belief in invisible powers and presences which vitally effected his life. Even his shadow must have given rise in his mind to the thought of another self which was his and his dreams were plainly experiences through which he passed while asleep in which he met the dead, passing again with them through the experiences of the chase and battle, and thus laying the foundation for a belief in the invisible powers and persons and perhaps in that conviction of immortality, common to the rudest races, which led primitive man to supply their dead with all the weapons and necessaries of life. And of the world itself he had learned

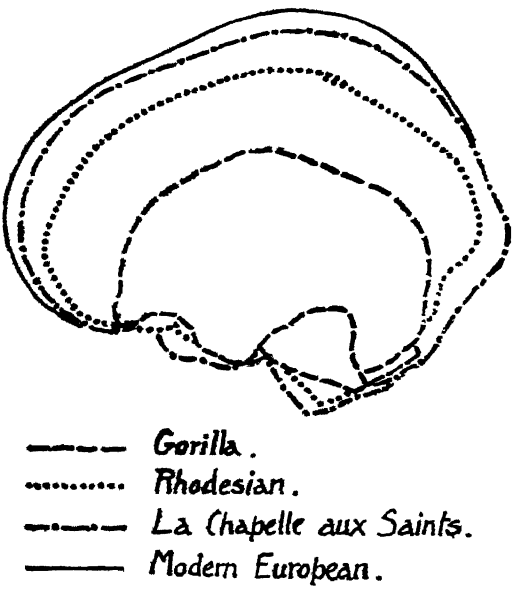


Diagram showing relative sizes and shapes of the brains of the gorilla and three types of men. (Courtesy of Oxford University Press.)

much, laying deep the foundations of modern science. He had noted how, whenever he removed support, a thing would fall to the ground; how some things sank while others floated; how water turned to ice; how, after the snows came the flowers and then the fruits and then the sun went away southward; how the fire lived in the flint and how to call it forth; how to tell wholesome from poisonous berries; how to dive for and catch fish; how to track and conquer game; how to mimic and attract this bird or that; in short, how to live in and master the wild. But many great mysteries he could not solve. Who was the sun? Whence came the wind? Who was his shadow? Who answered him back from the neighboring hill? What made the river angry? Whose hand entered into his body and made him gripe in agony? What did the rustling leaves say to one another? Who were the clouds? Was his recent misfortune caused by the hooting of the owl the day before? And did his child die be-

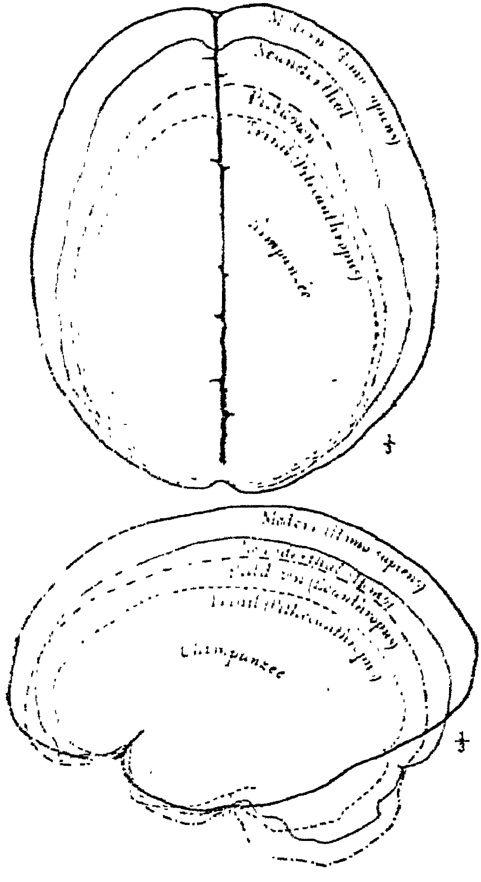


Diagram showing the relative sizes and shapes of the brains of men and chimpanzee. From Osborn's, *Men of the Old Stone Age*, Scribners. (Courtesy of the author.)

cause he failed to pick up that curious stone by the pathway? These were mighty questions and it took him a long time to form his answer.

And then, too, bad luck came to him sometimes just after he saw a rabbit run across his path, and in his mind the old error of "post hoc ergo propter hoc" took immediate form. The next time when he saw the rabbit he performed some special anti-motion and the ill-luck did not occur. Thus superstition was founded simply upon inability to relate cause and effect. As we think of him so dazedly endeavoring to reason out the laws of nature and to interpret the happenings of life, we smile at his ignorance much perhaps as men 100,000 years from now will smile at us who know so little and to whom it is so impossible to explain the hazy pathways of nature. For we are still wondering whether there is a sort of "behavior" in the universe. Do there exist habits of conduct in "Nature," dependable habits, of such sort that a man may test them, try them out, explore them? Are they favorable to certain elements of his own conduct, the moral element for example? Does the Power, the Will of the All really "make for righteousness." Does it respond to lesser wills? Is that what Lincoln really said when he remarked that he was not so much concerned about God being on his side as his being on God's side? Is it what Jesus meant when he said of any man who opposed the Will that it would grind him to powder? How sensitive is it to the wills, the purposes, the prayers of men? As sensitive as electron to electron, as cell to cell, as sun to sun? Is that action and reaction instantaneous, inevitable and exactly proportional, recording and punishing here and hereafter with unthinkable exactness? Now, as then is science leading us into the very presence of God?

At least in one point the men of the Old Stone Age were far ahead of modern man; the sensory part of his brain was much better developed, the part that had to do with quick, skillful physical reactions of sight and hearing, of nerve and muscle. He knew far better than man of today where nature set her table and supplied her eggs and fruits. He was often times fooled by his senses, he was not unlike us who are similarly deceived. But his knowledge of the laws of wild animals and birds, his sense of kinship with other living things, many of them almost as intelligent as he, which existed everywhere, and his knowledge of the secret things of all animate nature were far beyond that of his descendants of today. For it would be well for us to remember, as we contemplate primeval man, confused and wondering over what seems to us the simplest matters, that we also are in similar case. As it was with the stars and life and consciousness, so it is here. Ignorance merges into knowledge infinitely. As there is no end to one, neither is there to the other. We are only relatively wiser than they. As is the earth among the universes, so are our sciences and theologies among the truths of God. Absolutely, though not relatively, we are as ignorant as they. Those who come after us in the glacial or interglacial ages of the future will say so. While we have enlarged the tiny, lighted circle of knowledge, we have in no wise decreased the infinite expanse of the blackness of outside ignorance, to fully enlighten which is the task of eternity.

THE PATHWAY

There was a little path, my boyhood's path,
That led me o'er the stream, beyond the vale;
Beyond the mighty poplar and his wood;
A tiny, timid path, oppressed of stones,
With here and there a thornbush enemy.
The wild-tongued weed made threat of choking death;
The burly oak stood squarely in the way;
The gnarled pine root rose affrightingly;
And oft, the fallen limb her barrier placed.
Ah, tiny, timid, humble path, yet thou
Didst work thy will around the burly oak
And o'er delaying pine-knot; past the thorn;
Around the greedy weeds; aye past the love
Of wetted violet eyes; past daisies' tears;
Beyond the trailing, prone, arbutus' prayers;
And ever, in thy going thou didst say:
"I am thy Little Path, and, unafraid,
I lead thee o'er the Stream, beyond the Vale."

CHAPTER XV.

HOMO SAPIENS ARRIVES

Such is the cinema of earliest man that anthropologists picture to us. In it we see unrolled the whole long pathway of progress whereby our kind staggered up out of the night. Its facinating, disolving pictures melt from form into form until a creature that none would call human becomes the modern man.

The thoughtful student will observe at once that the story as it has been told is largely a European story. With the exception of the Trinil Man, of Java, all of the pictures have been thrown upon a European canvas. It is in the caves of France and Spain and the river valleys of England and Germany that we have been able to read the history of sub-men. There are, of course, very good reasons for this. One of them lies in the fact that Europe has been studied more carefully and exhaustively both by geologists and anthropologists than any other section of the world, it having been for the longest while the home of scientific research. To this should be added a second reason. It is possible in Europe to synchronize events almost perfectly, due to a most careful study of the whole Pleistocene epoch with the various retreats and advances of its ice sheets. Unfortunately, however, even a careful study of European anthropology reveals to us the fact that Europe was not the original home of mankind but that it was subjected in the earliest, as in the latest days, to a series of invasions from the east. It was from the east that the modern races who inhabit Europe came as did also those who preceded them, Cro-Magnon, Neanderthal, Piltdown, and Heidelberg alike. All of which raises in our minds the question: where did the human race originate?

It is interesting in this connection to review briefly some important finds made in other parts of the world. Notable among these is the remarkable discovery at Broken Hill Mine in Northern Rhodesia, about 300 miles south of the Zambezi. It consists of a skull with part of a lower jaw, a sacral bone, a tibia, two ends of a femur, and a collar-bone. Fortunately, also, the upper jaw of another individual of evidently the same species was discovered under similar conditions. Interestingly enough the teeth of the latter gave signs of suffering from caries. The face of the Broken Hill man is spoken of by competent anthropologists as the most primitive and brutal human face known to their science. The eyebrow ridges were like those of a gorilla, almost equally enormous, and the face showed no groove on the side of the nose to distinguish its boundary from that of the face, but the nose and face seem to merge. The palate and the teeth were enormous. His cranial capacity lay somewhere between a modern European and a skull such as that of La Chappelle. He seems to have walked erect. He is believed by at least one competent anthropologist to have branched from the human stock somewhere between the Heidleberg and Neanderthal man. This is the only important anthropological find that comes to us from Africa.

In America a number of important discoveries have been made. There is, for example, the Calaveras skull, discovered in the auriferous gravels of California whose age may be safely dated as Pliocene, and there are discoveries of human remains in the Trenton gravels, in the loess of Nebraska (Omaha), and the remains that have been uncovered at various points such as Lansing, Vero and at Rancho La Brea, and in the sand-pit near Dallas, Texas, and to these should be added the remains of a mastodon found by Dr. Clarke a foot above some pottery and charcoal which lay in undisturbed clay. Although, as Dr. Lull says, all of these finds exhibit the usual evidences of age required by careful anthropologists such as their discovery in ancient strata, their association with ancient animals, their similar degree of fossilization, yet they do not differ as to their bodily characters from the modern American Indian. They have not, therefore, been considered up to this time as of very high antiquity but Dr. Lull follows Sir Arthur Keith in inclining to the belief that they may be in part of the genuine Pleistocene age, in which case it is quite evident that the type of man from which the American Indian sprang was very ancient indeed.

And there should be mentioned a similar find in South America, at Lost Hope Inlet, Patagonia, evidencing the association of man with the ground sloth, now extinct, under circumstances that lead scientists to believe that either

GEOLOGICAL RELATIONSHIP OF HUMAN HISTORY

CENOZOIC	QUARTENARY		1927 A. D. Age of Man. A. D. 11 B. C. Iron Age Bronze Age	Holocene	Age of Man 500,000 yrs.
			New Stone Age Neolithic, or upper Palaeolithic Old Stone Age Or Lower Palaeolithic Dawn Stone Or Eolithic	Pleistocene Europe, Asia, Glacial Period America.	
	TERTIARY		Pliocene Miocene Oligocene Eocene Palaeocene	Himalayas Swiss Alps Pyrenees Rocky Mts. Eastern Alps	3,000,000 yrs. Age of Mammals
MESOZOIC		Early Mesozoic Late Mesozoic	Upper Cretaceous Cretaceous Jurassic Triassic Permian —————— Carboniferous	Glacial Period South Africa	10,000,000 yrs. Age of Reptiles
PALAEOZOIC			Devonian Silurian —————— Cambrian	Scottish Highlands	15,000,000 yrs. Invertebrates
PRE-CAMBRIAN		Archaean Archaeozoic ——————		Moulds Algae Bacteria Earliest Living Things	30,000,000 years Origin of Life

these creatures were domesticated or else worshipped not unlike the Egyptian apis. Inasmuch as there do not seem to have been in America any types of sub-men, it would seem that the original home of the human race was not in America but that mankind probably came to the Western hemisphere as an immigrant. All of this leads us to ask again the question: What land was the birth-place of mankind? The greatest mass of evidence points toward Asia. This vast continent is suited to this answer from every standpoint: its location; the variety of its climate; its fauna and flora; its general life and conditions; its vast extent; the ease with which passage is possible from it to all the other continents; the fact that the highest types of organic life find their home there; the fact that most of our domestic animals and plants originated there; the fact that all of the oldest civilizations were located there; the fact that the story of the climatic changes of Asia correspond with the circumstances under which the anthropologists believe the human race to have been evolved; and finally, the fact that the early wanderings of all the races of men may be most easily explained upon that theory; all of these point to Asia as the original home of mankind.

If these suppositions be true, then we may, with some trepidation, lift the veil that hides us from those faraway days by imagining somewhere, let us say in central Asia, at a point not far distant from the spot where the expedition of the American Museum of Natural History made its famous find of dinosaur eggs, a land of forests and rivers and pleasant meadows, enjoying a climate that is temperate and invigorating. The time set for the drama is millions of years ago, back let us say in the Miocene epoch. In this forest live the ancient progenitors of man, leading largely an arboreal life, feeding upon nuts and eggs and tender buds and a hundred other such natural foods easily found. Slowly but with that inevitable certainty with which geologic changes come, the climate grows more arid; the rivers fail, the vegetation diminishes, the food supplies decrease. "The brook dried up." Little by little, through a period of centuries, the ancestors of mankind found it necessary to seek subsistence on the ground. They emerged from the forests in family groups and tribes and adopted the running posture and spread over meadow and steppe, farther and farther afield, tending ever southward toward moisture and warmth and food. Chief among their powers were the advantages incident to communal life. It has been well said that man did not make civilization but civilization made man. It was this striking of wit against wit and this combined power of union which made these humanoid tribes the terror of the whole world. As they widened their geography they also broadened their food supplies until at last they became the animal which probably of all others enjoys the greatest variety of food. All this was in the Miocene epoch, from one to three million years ago. It is probable that by the time Pleistocene days had come these humanoid creatures very closely resembled modern men. An extremely interesting find was made by Mr. H. J. Cook in Nebraska in 1922 which dates from the lower Pliocene period. He describes it as "a molar tooth that very closely approaches the human type, found associated with other typical fossils of the Snake Creek and mineralized in the same fashion" which seems to take the story of mankind in America, also, a long way back. It is entirely conceivable that for a million or more years various species of human beings have been wandering over the world, following their food supply, flourishing or being extinguished, as the case may be and as the case has been with every animal, notably the horse, which, after flourishing for millions of years in America, disappeared entirely and had to be re-introduced from abroad. But, so far as modern men are concerned, it seems highly likely that earliest homo sapiens reached his highest point of development somewhere in Asia and that climatological changes forced him to become a wanderer so that he spread beyond the confines even of that vast continent into all other lands and, notably, by a series of invasions, into Europe.

It was one of these invasions which supplanted the Neanderthal race in Europe. For about 25,000 years ago the man whom G. Elliott Smith describes as "uncouth; repellent, short, thick-set, coarse, with a half-stooping slouch; with short, powerful, half-flexed legs; with thick neck; broad shoulders; massive, flattened head, protruding forward; forming an unbroken curve of back and neck with heavy over-hanging eyebrow ridges; retreating forhead; great, coarse face; large eye-sockets; broad nose; receding chin; with a shaggy covering of hair; short arms; large hands; and no co-operation of thumb and fingers;" this Neanderthal man suddenly vanished from the European horizon and in his place there appeared, just as suddenly, as fine a physical type of humanity as the world has ever known.

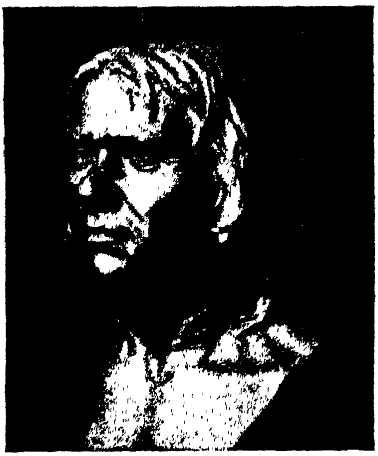
These Cro-Magnon supplanters evidently had followed their food supply which in turn had followed the receding ice sheets. They were hunters and trappers, feeding largely upon the fruit of the chase, though they were fishermen also and doubtless availed themselves of such supplies as the vegetable world might offer. They followed great herds of horses and reindeer and bison and other animals, and these, in turn, sought the flora and the fauna which slowly followed the retreating ice. Evidently they succeeded and possibly they drove the Neanderthal men before them, occupying their flint mines just as a modern invader would possess himself of our iron and coal mines. Yet in no nearby burying ground do we find the two races mingled, nor is there any evidence of a half-breed form indicating an intermixture of blood. It is as if the Neanderthal race was so widely different from the appearance and quality of the invaders that they could only be treated with aversion and, indeed, may have given rise to the tradition of ogres common among European races. Thus not only were the men either driven out and destroyed but none of the women seem to have been kept and incorporated in the victorious tribe.

The story of Cro-Magnon man has been beautifully told by many writers but by no one in greater detail or with clearer insight than H. F. Osborn. Placing the advent of Cro-Magnon man in Europe as about 25,000 years ago in the post-glacial days, just as the ice sheets were melting, he reasons that they must have come from Asia, possibly via Phoenicia and North Africa, bringing with them their Aurignacian culture which is not found in central or eastern Europe but stations of which are distributed along the North African coast and in Asia Minor. This is the same route as that along which we will later find the brown-white peoples coming.

The characteristics of the Cro-Magnon race are markedly modern, their brain capacity is fully equal to that of modern man, and the weight of the Cro-Magnon brain which averaged perhaps 54 oz., was slightly greater than that of modern man, usually given at about 49 oz. These may be compared with the estimated weight of the Piltdown brain, 43 oz., of the Pithecanthropus, 28 oz., and of Simian brain, 20 oz. The forehead and fore-brain were highly developed and quite modern and as we shall see later the Cro-Magnons exhibited high artistic development. It is possible that they were aided by superior weapons, the bow and arrow, in driving out the Neanderthal men. They brought with them their own method of chipping flints and using them, quite distinct from the Mousterian culture of the Neanderthal man. With the Neanderthalers, vanished the fauna associated with the last glaciation. While the climate was still cold and becoming increasingly dry until

Skull of Cro-Magnon man. (Courtesy of Yale University Press.)

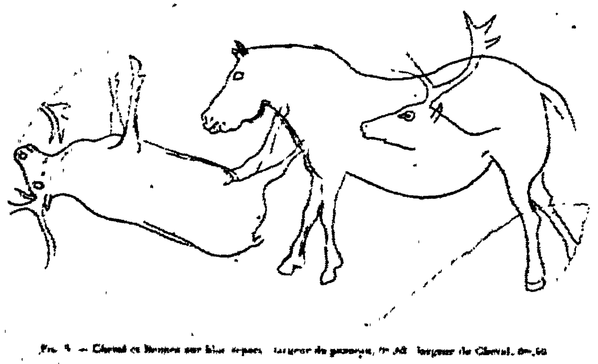
great dust storms were depositing the newer loess, the Cro-Magnon man arrived, seeking such shelters, grottos and caverns as he could find. He found France connected by a broad and beautiful valley with England and his climate tended to become genial, dry and stimulating. He followed great herds of reindeer and wild cattle. "He ate much horse." Around the open air camp at Solutre the bones of 100,000 horses have been found. His life was that of a hunter and trapper and he was a tall, broad-shouldered six-footer with prominent nose and big brain. He spent his life largely in the open, watching and stalking his prey, and drawing pictures of the wild animals who were his contemporaries upon the walls of his caves. He must have known everything that mankind has ever known about the habits of wild creatures. Gradually his climate ameliorated and he found it less necessary to live in the caverns. He may have learned how to build himself a hut, at least certain tectiform drawings suggest it. As the climate grew milder his flint workers returned to the "open" stations. At first the fauna and the flora were quite arctic in character. Even the northern lemmings were in the land when he came. The arctic hare and the arctic ptarmigan, the musk-ox, the steppe horse, the deer, bear, wild-cat, wolf, fox, bison, wild cattle, cave hyena, and the cave lion were his animal neighbors. Innumerable reindeer have given their name to this period. The Cro-Magnon man himself in addition to being an almost perfect physical specimen possessed a broad face and long head (dis-harmonic) and an unusually large brain capacity, high, broad cheek bones, aquiline nose, with a rather small space between the eyes and a massive chin, thick and strong.



Reconstruction of the face of Cro-Magnon man by J. H. McGregor. (Courtesy of American Museum of Natural History.)

His average brain capacity was about 1590 c. c. and his average height was about 6 feet, 1½ inches. He possessed a great chest. His arms were short compared to his legs. His shoulders were exceptionally broad, he was "one of the finest races the world has even seen." It is interesting to note that Cro-Magnon man possessed a deep reverence for the departed and a probable faith in immortality. With his dead he buried his treasures, beautiful shells, often as perforated necklaces; fine flint implements and ornaments; treasured weapons; with a food supply which indicated belief in survival after death. Grottos and shelters were used for burial and oddly enough it is quite possible that the bodies of the dead were painted.

His stay in Europe is generally divided into three cultural periods, each named for some typical location where his remains have been found. The first of these is the Aurignacian (Aurignac), the second Solutrean (Solutre), third Magdalenian (la Madelein). Each is marked by its own peculiarity of life, artifacts and art. Inasmuch as the periods cover in time from approximately 25,000 to 10,000 years B. C., there were also large variations in climate and consequently in fauna and flora. When Cro-Magnon man reached Europe he found the arctic fauna and flora named above. The climate was cold and the many limestone caverns and grottos which he found in southwestern Europe were seized just as quickly as he could drive the cave-bear, and the cave-lion, and the cave-hyena out of them. In fact the fauna of his newly adopted land was not unlike that which it had been during the fourth glaciation. The Aurignacian age was characterized by excellently made implements, many statuettes and frequent cave pictures and paintings. Thus Cro-Magnon man evidently brought with him the art of drawing in outline, but only in profile, never fore-shortened. As time passed he etched his drawings on ivory and horn and chiselled them upon the walls of caves. With them he painted fingers in colors, using brown, yellow, white and black. Redochre was especially useful to him. Beautiful polychrome paintings followed later, notably the famous drawing of the bison on the ceiling of Altamira. Among the most frequent subjects which he chose for his art were the mammoth, the reindeer, the woolly rhinoceros, the horse, the bison, and the stag. Sometimes he grouped his pictures, as a well-known group of horses, deer, bison and wild boar at Altamira or the mastodons of the Gallerie des Fresques reveal. When he came to Europe, while it is possible that he tamed the horse, yet it is quite doubtful, and it is practically certain that he had not domesticated cattle or swine or sheep or dogs. Neither did he have any agriculture of any sort, nor gardens, nor cereals. He knew nothing of weaving but tectiform drawings indicate that he may have built huts or tents, probably with the use of skins. During the age that followed, the Solutrean, he still further improved his flint implements until some of them were as thin and sharp almost as razor blades. This Solutrean culture was spread largely over the entire world. Those marvelous flint knives with which, for example, the Aztec priests cut the hearts from the victims offered to their gods, were of Solutrean type. It is probable that there was a slight softening of climate during this period but it remained dry and cold, permitting however a probable increase in the possibility of a life spent in the open. It was during the Solutrean age that the flint industry reached its culmination of excellence. It is possible that this increase of open-air life had some effect upon the art of Solutrean times which seemed to have lacked some of the excellence and richness of Aurignacian days. Followed the Magdalenian period at about 16,000 years B. C., evidenced at once by a revival of the arts.



Finely engraved outlines of the Celtic horse and of the reindeer, in the Grotte de la Mairie, near Teyjat, Dordogne. After Captain and Breuil. (Courtesy of American Museum of Natural History.)

Also the industry of this period seems to have little in common with the Solutrean age. It is as if the Solutrean culture were not antochthonous but had been intruded between the Aurignacian and Magdalenian by culture-invasion perhaps, the latter having many points in common, both in art and industry. It was probably during Magdalenian times that the bow was introduced. The high development of the manufacture of bone implements was another of its distinctive characteristics, accompanied by a decline from the exquisitely chipped flints of Solutrean days. The climate was largely cold and arid, driving the men of the times back into the caverns which may account for the rapid development of art. As one looks through the volumes on the subject he is astonished at the drawings and paintings and bas-reliefs which date from this period. There are drawings of bison and mammoths and many similar wild animals on the walls of the cave. There are engravings, realistic and charming, of the heads of horses and stags and chamois and grouse on horn and ivory. There are polychrome paintings of wolves and reindeer and bison of which the masterpiece is that already referred to on the ceiling of Altamira. Some of them, like the beautifully engraved fore-part of the bison, in the cavern of Marsoulas are engraved only in outline, but others are filled in with appropriate colors. Stags, lions, salmon, horses, wild cattle, royal stags, appear singly or in procession. These evidence the keen form perception of the reindeer men. They also are the first known sculptors and much of their work remains to this day. Sometimes we find, as in the cave Tuc d'Audoubert, two beautifully modelled clay figures, a male and female bison. Sometimes we find a horse carved upon the tusks of a mammoth or on the antlers of a reindeer. There has been discovered also the sculptored head of a woman with a coiffure resembling that of ancient Egypt and also female statuettes of baked clay like those of the Nile valley. So it was that they wrote themselves among the first known races in laying the foundation for the arts of drawing and sculpture and painting. "These people," exclaims one writer, "were the Palaeolithic Greeks!"

During all this period of from 10,000 to 20,000 years during which Cro-Magnon man occupied Europe, he was without such simple things as cooking implements, pottery, arrow-heads, oats, wheat, corn, vegetables, wooden buildings, domesticated animals, even dogs. He was simply a "naked and painted savage living on the open steppes." Upon the walls of his caves he drew outlines of his hands with fingers mutilated perhaps superstitiously. Yet he was not without some of those finer sentiments which adorn human history. That he possessed a sense of awe and wonder and held immortality as a hope in his heart is clear from his burial customs. With his dead he placed carefully away the best of his implements and the finest necklaces of perforated shells. Slowly as the forests covered the steppes he disappeared from Europe before a higher culture, the Neolithic. Perhaps he followed his prey, the reindeer, by Behring straits to America along his isothermal line that steadily tended northward. Perhaps there still remains, here and there in Europe, a bit of Cro-Magnon blood, notably in the Dordogne, and not far away is the most primitive language in Europe, the agglutinative speech of the Basques. Of this no man may speak certainly. Gradually as the centuries passed and the

Female bison lying down with the limbs drawn beneath the body, so that only the horns and tail project beyond the convex surface of the limestone boss on the ceiling of Altamira. After Breuil. (Courtesy of the American Museum of Natural History.)

ice sheets receded his land changed from tundra with its reindeer through steppe with its wild horses, to a land of meadow and forest with its deer and bear. Hunter of tundra and steppe, the coming of the forests drove him on, and other men filled his place.

TO RAMMAN OF THE RAINS

O Raindrops,
What precious thing is this ye are seeking,
That ye rush so hurriedly on?
Out of the fathomless sky above us,
Storm-driven, wind-misted,
Ye are ever falling, falling!
Each tiny, new-born drop leaps downward,
As if impelled by some mighty urge.
Your innumerable company flood the air, the grass, the streams.
Is it the heart of all things ye seek so earnestly?
Is the throne of Ramman there?
Is that the call that drives you down hill and vale,
On, by the way of the great river,
That ye may be a little nearer the goal?
Gladly, then, would ye tell of duty performed?
Eagerly, would ye seek new missions?
Oh, little drops, prophets,
Seers of that which lies in the depths,
Great is your wisdom!
We, also, move ever onward by the way of the Long River
Sent on His messages,
Bent on our tiny missions.
We seek the Heart of All Things.
Our path is ever toward the Far Sea,
Ever leads us nearer to the Harbor,
Where the Great Main restlessly tosses,
Await!

CHAPTER XVI.

THE DAWN OF CIVILIZATION

One must not imagine, as we begin now to speak of Neolithic times in contradistinction to Paleolithic, that there is a sharp break between them, some sort of anthropological catastrophe. Writers on the subject usually speak of a transition period between the two eras, testifying again to the law which we have found to be so universal, that everything is like everything else and that every movement merges into every other movement. During this transition period, whose industry is commonly referred to as the Azilian-Tardenoisian, appear those strange little objects, the painted pebbles, with the fascinating problem of their purpose and origin. One cannot view them without wondering whether this is the beginning of numbers and writing. As the years pass we gradually come upon a different sort of living, accompanied by a change from chipped to polished flints. It is the New Stone Age, the Neolithic. While it is possible that Palaeolithic man had domesticated the dog and had learned to build a tent-like shelter, it is not believed that he had domesticated any other animal or had made any beginning in agriculture. He was a hunter and a trapper. Nothing else was necessary. The world was full of food. Fish swarmed in the lakes and rivers and he had become an expert at catching them. Birds in countless multitudes, comparable to the immense flocks of pigeons that used to so burden their roosting places as to break the limbs of the forests of America, doubtless filled the woods and the meadows. The finest of wild game was at their disposal, reindeer, horses, bison, wild cattle, animals of every description. So their manner of life was not unlike that of many tribes who have followed it to this good day. They went and abode where the hunting and the fishing was good. Thus for countless thousands of years mankind was a wanderer upon the face of the earth. No wonder that the historian tells us that there is no tribe or race but has the tradition of having come from somewhere else. None are indigenous, none are autochthonous. They all come from some other place. Their traditions always point to some other where as their place of origin.

Just how the change was made that ushered in the new manner of living, it is impossible to say with exactness, yet we know that all the vast farming interests of today must go back to that pre-human hour when some ancestor discovered that a little grain of wheat or of barley or of rice was edible, that it tasted well and that it nourished and strengthened the body. Already, doubtless, they had learned the same thing of nuts and berries and many minor foods. Perhaps they had seen other wild animals eating these foods first and had noted how the birds settled down upon the ripening grain. In their hunger they had followed the example and advice of their fellow animals. Milleniums afterwards the day came when the tribe must move onward. Perhaps the fish and the game were growing scarcer at their camping place. Perhaps some woman of the tribe who had been gathering the wheat, disliked the abandonment of the grain fields, decided to take some with her and plant it in the new camp. It was in such a way that agriculture began. Perhaps it was by the accidental dropping of grain near the home and the noticing that it sprang up and flourished.

In a similar way doubtless began the domestication of animals. Some youth of the tribe brought home a young wolf or a jackal or the chicks of the gallus bankiva and noted with pleasure that there grew up an attachment between their captives and the camp. Thus one by one the dog and the horse and the cattle and the sheep and the swine were taught to serve mankind. Thus year by year he pursued that distinctive policy of interfering with the running of the universe by adapting its animals, its cereals and tubers, its powers and resources to his own purpose. So as we uncover the mounds that reveal to us the contents of the vanished kitchen-middens or delve into the remains of the ancient Swiss lake dwellings, we find ourselves in a new world that has grown out of an older one. Inventiveness had done its work. Where Paleolithic man drank directly from the stream or from an empty skull, Neolithic man had learned to take clay and work it with his hands to make a pot or a drinking vessel. Insensibly we find ourselves drawing nearer to the days of history. We begin to speak now of animals and races that we know, whose names are familiar. We find, for example, the two great types of domesticated cattle, the short horn and the long horn, sprung from two different varieties of wild cattle. We find ourselves speaking of the apple although it is only a crab-apple, of raspberries and strawberries and hazelnuts, of the different types of dogs that perhaps came from three different sources of tamed jackals and wolves and coyotes. We find men building their little homes, some 20x30 feet in size, about forty or fifty of them to each large Swiss lake, on piles in the water for protection and perhaps for sanitation. In short, we find Europe gradually merging into its present conditions.

And while this has been happening to the industries of man new physical conditions have arisen on the continent. The forests have gradually crept up from the South, bring-

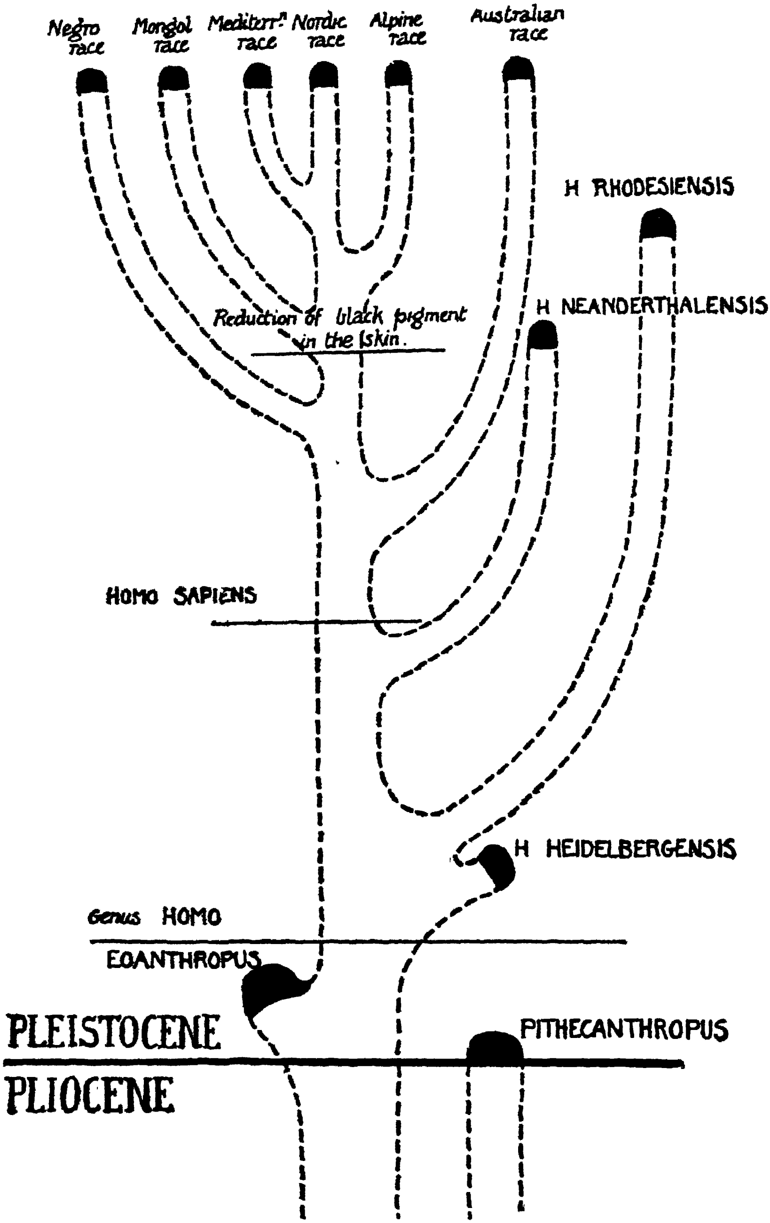
Swiss Lake Dwellings, Neolithic age. (Courtesy of the American Museum of Natural History.)

ing with them a change in fauna and flora. The reindeer have vanished and the hunting life has ended. The Cro-Magnon type of man has disappeared. Either he has been driven out by invaders or has followed his food supplies northward, or perhaps some pre-historic pestilence has decimated his numbers. In his place we find the Azilians, with their painted pebbles, and then, as the centuries pass, the curtain lifts upon misty forms of new and unnamed races pressing into Europe, probably from the East. Then almost suddenly comes the use of copper, destined slowly to supplant the polished flint instruments that characterized the Neolithic age. The date of the use of copper is usually set at about 5,000 or 6,000 years B. C. Some 2,500 or 3,000 years later bronze, an alloy of tin and copper is found. Whether its discovery came about by skillful experiment or whether by the accident that tin and copper are often found in the same mine and were smelted together we shall never know, but in one or the other way men learned that one part of tin mixed with nine parts of copper made a substance harder than either, more durable and more useful, holding a sharper edge and better fitted for implements of peace and war. This was about 2,500 years B. C., and then perhaps 1,000 years later some other man learned to smelt iron and thus with an ever decreasing interval between them mankind has passed through the milleniums of the Eolithic and the Palaeolithic ages and through the centuries of Neolithic, copper and bronze, into the age of iron.

There is nothing very strange about the manner of life of the Neolithic peoples. It is just about such a life as was lived in central Europe up to the days of the Renaissance, the Reformation, and the times of modern discoveries and invention. There were little farms on which wheat and barley and other crops were raised. Hoes, made at first of pronged sticks or reindeer antlers, were used for tilling the soil. Man had pactically all of the domesticated animals that we have today. His axes were of stone and his vessels of pottery. He had become an adept at making bone instruments and weapons. Flint was his steel and the finest masses of it dug from mines as deep as forty feet were bartered throughout wide areas. Perhaps he was already using salt and bartering it. He had learned to make beautiful necklaces and was beginning to use gold. The wheeled wagon or cart did not arrive until the bronze age so that his roads were doubtless simple paths through the forests and over the meadows. He had no adequate way to fell these forests so that it is no wonder that as they marched northward the Cro-Magnon man disappeared before them. Men of the Neolithic age followed the river valleys and settled around the lakes. They doubtless first learned to use a tree trunk for navigation, then a raft, then a hollowed tree trunk, then a boat in which quite early they must have passed from island to island. It was an easy matter to make these dugouts with axes and fire. There is evidence to show that trade routes had already been established so that flint and pottery and amber and trinkets and all sorts of precious things including perhaps woven cloth, rare seeds, precious shells and rings, and many such things were exchanged over wide areas. There was almost certainly in the bronze age a heavy trade in amber and a regular trade route between the Mediterranean points and the settlements on the Baltic. Perhaps the earliest known case of mutual exchange of precious commodities was that whereby the copper of southern Europe was bartered for the amber of the Baltic, which furnishes an early illustration of the civilizing power of such commodities. This power was later very beautifully illustrated by the little mussel which by its drop of royal purple led the Phoenician galleys along the shores of the Mediterranean.

Nor were the habits of dress and home life of the Neolithic peoples very different from that in some sections of Europe today. They knew how to spin and weave and dye, and the heavy oak coffins of the bronze age remaining to us in Scandinavia have preserved clothing of that period which may have been not very unlike that of the Neolithic times immediately preceding. Their dress was probably at first a rough flaxen cloth which was no great improvement on skins of wild animals but doubtless these last were becoming rarer as the population increased. When copper and bronze were discovered there immediately followed many types of ornaments and it was at about the bronze age that tables and stools came into use.

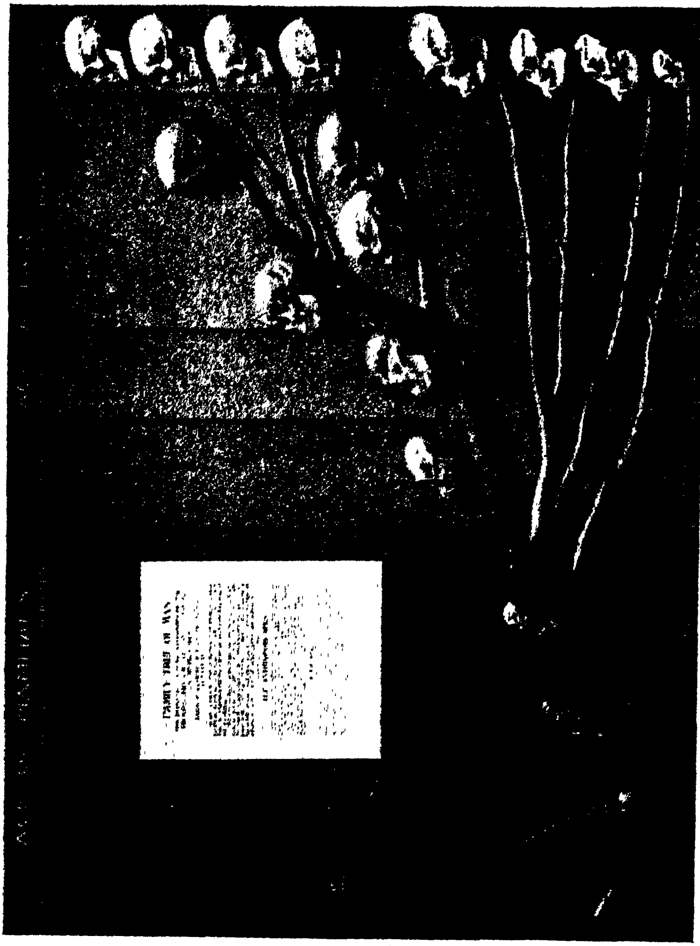
We are now almost come to the days of history. In that twilight zone of which we are speaking we can dimly trace the movements of certain great migrations of peoples who are pressing into Europe. A glance at the map will show three principal migration routes from the east. One of these leads through Asia Minor, southwestward by way of Phoenicia, northern Egypt and northern Africa, crossing into Europe by the land bridge then existing between Italy and Tunis or that connecting Spain with Morrocco at Gibraltar. By this route there had entered Europe perhaps as early as Magdalenian days, while Cro-Magnon man was still in the land, certain peoples who are marked by a dark complexion, black hair, long heads (dolichocephalic), rather small bodies, and who had developed a higher degree of civilization than any other races who had entered Europe at that time. Perhaps some of their tribes had also got to Greece and Italy by way of their second migration route through Asia Minor and the Dardanelles. To the north of them certain broadheaded races had driven a wedge through central Europe as far west as Belgium. This race is also characterized by black straight hair but is distinctly broad-headed (brachycephalic), short and stocky. To the north of them came the Nordics, long-headed, fair-haired, blue-eyed. Speaking broadly, these three great types of races exist in Europe at the present time but it must be remembered that there



A tentative scheme of the relationships of the different genera, species, and races of the human family. From Essays on *The Evolution of Man*, by G. Elliott Smith. (Courtesy of Oxford University Press.)

are as many breeds of men on this continent as there are of chickens in America. We see them as the curtain of history rises, partly settled, partly wandering here and there, driven by hunger and thirst or any of a score of necessities, interbreeding frequently and giving rise, therefore, to many types of people. Last of all, in historic times came the Aryan peoples, the Dorian and Achaean, the Oscan and the Umbrian, to lay the foundation of the Greek and the Roman empires. Here the current of our story narrows and we turn over to the historian the task of acquainting our readers with the further facts of these fascinating days.

But there is one feature of Neolithic life which perhaps transcends all others in interest, of which it is fitting that a word should be spoken. It has to do with the burial of the dead and its association with religion. All over the world there have been found in practically every country certain mounds or barrows, long if the work of the brown-whites, round if that of their Keltic successors, in which excavators find relics of the dead, skeletons, implements of warfare, and in many cases vessels which evidently contained food supplies. The form which these mounds take are various but in every case they were evidently of vast importance to the people who built them. Sometimes they are simple dolmens, little roofed huts of stone a little longer than a man and a little wider. Sometimes great menhirs, standing stones, are set in special lines about them. Sometimes these stones are arranged in circles as cromlechs. The simplest form would reveal what to all intents and purposes is a grave with great stones set about it and roofing it, in which one or more skeletons with associated implements and vessels are found, and this simple form sometimes grows into the great marvel of Stonehenge or Avebury, in England, or the Pyramids of Mexico and Egypt. A shrewd guess would suppose that some chieftain had died and that a mound had been erected over his body to mark the spot with great stones and to protect it from the wolves and hyenas. The shallowness of the mounds would doubtless be due to the imperfect implements for digging possessed by Neolithic man. There appears early in the story a tendency to orient these mounds, to associate them with the movement of the sun and the stars and the planets. Attention has already been called to the fact that the earliest burials even of Neanderthal man are in an east and west direction. Evidently as man became conscious of his surroundings one of the first



THE FAMILY TREE OF MAN.
Explanation on Following Page.

THE FAMILY TREE OF MAN

The evolution and relationships of the principal branches of mankind and apes based on a careful weighing of various lines of evidence.

As yet we know but little of the direct fossil ancestors of man, but the fossils represented by stages 1, 2, 3, 4, 5, 6, 7, of this "*Family Tree*" are important milestones along the immensely long road of man's evolution.

Man's ascent from the lower primates has been a struggle upward toward better brains, better intelligence and better morals. Through the improvement of the frontal lobes and other parts of the brain, in the later stages of his history, Man is slowly overcoming his selfish impulses and awakening to the vast possibilities of advanced thought, of mutual tolerance and helpfulness.—William K. Gregory, 1924.

THE ANTHROPOID APES

Among all living animals the anthropoid apes, especially the gorilla and chimpanzee, come the nearest to man, not only in general appearance, but also in the peculiar anatomical characteristics of their skulls, teeth, backbone, of the muscles of the face, back and limbs, as well as in the form and arrangement of various internal organs. Moreover, in the mode of reproduction and in the course of development within the body of the mother the anthropoid apes reveal the most unmistakable marks of close relationship with the remote ancestors of mankind. They are also the only animals which show the beginning of human intelligence and their brains, while distinctly inferior to those of the lowest existing races of man, are superior to those of all other mammals. For these and many similar reasons the existing apes are recognized as man's nearest surviving relatives, or to put it in another way, man and the various existing anthropoids are regarded as the diversified descendants of a long extinct group of primitive anthropoids.

KEY TO STAGES

1. Primitive Primate (*Northarctus osborni.*) Fossil skull and jaw, slightly reconstructed, of Eocene age, Wyoming, U. S. A. Original in American Museum of Natural History, New York.

2. Prototypal anthropoid. Reconstruction based on fossil jaw (*Propliopithecus haeckel*) of Oligocene age. Egypt. Original jaw in Stuttgart Museum, Germany.

3. Primitive anthropoid. Reconstruction based on fossil jaws (*Dryopithecus frickae, etc*) of Miocene age, India. Original jaws in American Museum of Natural History, New York.

4. Trinil Ape Man. Reconstruction based on fossil skull-top (*Pithecanthropus erectus*) of Upper Pliocene or Lower Pleistocene age, Java. Original in Teyler Museum, Haarlem, Holland.

5. Piltdown Man. Reconstruction based on fossil skull and lower jaw (*Eoanthropus dawsoni*) of Pleistocene age, England. Original in British Museum (Natural History,) London.

6. Heidelberg Man. Reconstruction based on fossil jaw (*Homo heidelbergensis*) of Lower Pleistocene age, Germany. Original in University of Heidelberg Museum, Germany.

things to catch his eye was the sun. The thing goes back even further than that, to the law of cause and effect which probably sprang from the consciousness of effort on the part of man himself in accomplishing anything. Men putting forth effort moved themselves not only, but other objects. They noted that other things moved themselves not only, but other objects. It was natural and inevitable that they should attribute to objects which, like themselves, moved themselves or other objects the same kind of existence as that of which they were conscious. They thought, therefore, and spoke of them as living things. Such were the tiger, the mastodon, and the sun, and the greatest of all was the sun. Upon it everything depended. Its presence was light, its absence was darkness. Its presence was warmth, its absence was cold. Its presence was food, its absence was hunger. Its presence was safety, its absence was danger. And this was true in a double sense. Early man must have been impressed with the day not only, but with the year also, and each was like his own life. As the sun rose in the morning, attained its full strength at noon and wasted away in its old age toward the west, so did man likewise, and as the sun began coming northward again after the winter solstice, growing stronger and stronger until the summer solstice and weakening unto its death as the winter once more approached, so did mankind, likewise. This comparison was striking and inevitable and gave rise as we shall see to two great types of myths, one the solar having to do with the daily and annual sun-path, and the

---

7. Neanderthal Man. Fossil skull and jaw slightly restored, of the Old Stone Age, Europe. Originals in Paris Museum of Natural History.

8. Cro-Magnon Man. Fossil skull and jaw, slightly restored, of Late Palaeolithic age, France. Original in Paris Museum.

9. Australian black-fellow. One of the most primitive of existing human races.

10. Hottentot. Representing the Negro group of races.

11. Chinese. Representing the Mongolian group.

12. American. Representing the Caucasian group.

(a) Gorilla, Africa; (b) Chimpanzee, Africa; (c) Orang-utan, Borneo; (d) Gibbon, India.

Reconstruction by J. H. McGregor (Nos. 4, 5, 6, 7, 8,) M. Roigneau, (No. 2) and O. Falkenbach (Nos. 1, 3.)

Prepared by the American Museum of Natural History, New York, for the Museum of Oglethorpe University, Atlanta, Georgia.

other the chthonic, having to do with the year and the changes through which the earth passes during the year. Probably there has never been any more beautiful chapter in literature spoken or written than that which tells the story of the earth-mother and the sun-father, of Venus and Adonis, of Ishtar and Tammuz.

It may easily be seen, therefore, how burial became intimately associated with religion. Avebury and Stonehenge on the one hand, like the pyramids and their adjoining temples in Egypt became centers of worship. And the graveyard still clings to the church as it did milleniums ago. It is intersting to note again that, with the dead, his weapons, his favorite implements and ornaments and his food supplies were buried. Just what thoughts were associated with these facts in the minds of Neolithic men we can only conjecture. Perhaps the deposit of food may have arisen from the custom of leaving a food supply with the decrepit, the sick and the wounded as the tribe moved onward under the compulsion of necessity. Perhaps from the sick and the wounded left behind some survived to rejoin the tribe. Perhaps early man was never quite certain whether his dead were really dead, either as to this life or the next. At any rate, we may be sure that as many as 50,000 years ago this dim foreshadowing of belief in immortality was controlling the thoughts and the lives of our ancestors.

More than once we have called the attention of the reader to the fact that the story of anthropology is still largely an European story and at every turn of our pathway we have noticed that Europe did not create its men but that they came from elsewhere, probably from the east. Wave after wave of migration which should, doubtless, be better named and more accurately imagined as a slow penetration or infiltration came westward from Asia. It is a question of intense interest to ask, whence came these peoples and especially whence came this Neolithic culture which was the foundation of our modern civilization.

Now we can follow the track of it almost as clearly as the Indian stalks his prey, having already been given the clue of the general direction from which it came. We note that long before Europe was civilized there were states and nations in Asia; that every new advance of civilization, whether it be of Paleolithic or Neolithic culture or the use of copper and bronze, came from Asia. We look backward, therefore, to find the earliest settled civilization that history knows. We discover it in the valley of the Nile and in the valley of the Tigris and Euphrates. There is every reason to believe that 5,000 years B. C., there was settled civilization along the shores of the Persian Gulf and northwestward, comprising the ancient cities of Ur and Eridu and Larsam and many others, a civilization which could not have originated quickly but which points backward to a long antecedent period of development. We find that still further eastward at Anau there was a civilization in existence 8,000 years B. C., that corresponds to that of the lake dwellers of Switzerland which may be roughly set at from two to three thousand years B. C. We find that at Susa, perhaps the most ancient known seat of civilization in the world, there existed, some 18,000 years B. C., a similar Neolithic civilization. We combine with these facts this other, that our domesticated cattle and sheep and swine are of Asiatic origin and that the Mesopotamian plain is the only spot where wheat is known to grow wild. We recall that even our modern beliefs and traditions which have to do especially with religion have come out of Asia and we very naturally conclude with most anthropologists that the origin of the Neolithic culture was somewhere in Asia, probably not far from the Iranian Plateau. It is, therefore, with intense interest that we ask ourselves what were some of the fundamental conceptions possessed by the men of Ur and Eridu, trasmitted to them perhaps, from the men of Anau and Susa and in turn transmitted to them by others who lived while the Cro-Magnon man was in possession of Europe and the Paleolithic culture was all that Europe knew. Shall we find in such an investigation how deep some of our beliefs are imbedded in the past? As the brow of man has lifted and his circle of knowledge widened, we have found that he has modified old structures for new uses. If his body is a walking museum of Paleontology, what shall we say of his science and his religion? Let us, with that earnest reverence which it deserves, endeavor to reconstruct the universe as it was conceived in the minds of those men of Babylonia who laid for us the foundations of our astronomy, our cosmogony, and our theology. Have these also staggered up out of the night?

SUCCESSION OF PREHISTORIC AGES IN EGYPT AND IN EUROPE

FROM THE CLOSE OF THE OLD STONE AGE UPWARD

N. C. NELSON, 1921

DATE	Egypt & S. W. Asia	Southeast Europe	Northwest Europe
1000 A. D.			*HISTORIC AGE*
0		*HISTORIC AGE*	IRON AGE
1000 B. C.	*HISTORIC AGE*	IRON AGE	BRONZE AGE
2000 B. C.		BRONZE AGE	COPPER AGE
3000 B. C.	IRON	COPPER AGE	
4000 B. C.	BRONZE		
5000 B. C.	COPPER AGE		*NEW STONE AGE (Neolithic)*
6000 B. C.		*NEW STONE AGE (Neolithic)*	
7000 B. C.			
8000 B. C.			CAMPIGNIAN
9000 B. C.	*NEW STONE AGE (Neolithic)*		*TRANSITIONAL* TARDENOISIAN
10000 B. C.			AZILIAN
11000 B. C.			
12000 B. C.		*TRANSITIONAL*	MAGDALENIAN
13000 B. C.			
14000 B. C.			SOLUTREAN
15000 B. C.			*OLD STONE AGE (Palaeolithic)*
16000 B. C.	*TRANSITIONAL*		
17000 B. C.		*OLD STONE AGE (Palaeolithic)*	AURIGNACIAN
18000 B. C.			
19000 B. C.	*OLD STONE AGE (Palaeolithic)*		
20000 B. C.			

OVER THE PORTAL

Great Anu, Bel and Ea, all have fled.
Ra, Amon, Thoth are with the Mighty Dead.
Zeus lies at rest, for Thor no altar glows.
And shall our modern Lords find no repose?

No man is ever greater than his God.
Up from the night the self-same path they trod.
One moves not farther than the other can.
No God is ever greater than his man.

Lo, we have made our God more grand, more vast
Than those our fathers made within the past.
So shall our children build, more vast, more grand
Than Him whose measure shows our wingless hand.

For they who made our Lords their witness give,
That Gods must ever grow if they would live;
That Gods must ever live if they would grow.
All those who made our Lords have told us so.

And though what skilful artist toil till late
The God that I have formed to duplicate;
Yet there remains some difference, some flaw;
The Face that I have drawn none else can draw.

While heretics among the faithful dwell,
Though idols sicken, yet the Gods keep well.
But when the Gods are finished, tagged and dried,
They change no more, for all alike have died.

So, o'er the temple gate where enter those
Who in unchanging faith would find repose;
In steadfast creeds the holy ancients gave;
This trembling truth by flickering light I grave:

To all the broken Gods of yesterday;
To One, our Present Lord; to Him whose sway
And power tomorrow's mightier hour will yield;
Revealed, Revealing, and to be Revealed.

CHAPTER XVII.

THE BIRTH OF THE GODS

Through the dimness of that marvelous dawn, while the light of intelligence was growing stronger and stronger, we have traced the footprints of the human race with some assurance, yet with great uncertainty, from his Miocene home in central Asia almost until the white light of history reveals him as a civilized human being. From these Asiatic plains, growing more arid and less habitable each year, the human race is supposed to have scattered to the ends of the earth. Those who were to be the black men wandered southward into the East Indies and India and Africa. Those who were to be the yellow men went eastward into China and Japan. The red men constitute a problem in themselves but they are generally believed to be closely related to the Mongolian tribes and to have wandered into America by way of the land-bridge of the Aleutian Islands. Those who were to be the white men of today, classified with more or less correctness as Semitic, Hamitic, and Japhetic, for the most part went westward, following one of the three principal migration routes, the first being via Phoenicia and North Africa into Europe over the land-bridges of Tunis to Italy and Morocco to Gibraltar; the second being via Asia Minor and the Dardanelles and the Danube Valley; and the third being north of the Caspian and Black Seas into central Europe. The sun of civilization, therefore, as it rose, shone first upon those countries, the original home land where mankind passed through the tutelage of Paleolithic and Neolithic times, whose gray light gradually brightened into the dawn of historic culture. For that reason, we are not surprised to learn that the oldest Neolithic culture which the study of archaeology has as yet revealed to man comes to us from Anau and Susa on the plateau of Iran. There, among the hills, at a time when the ice-sheets covered the greater part of Europe and in a climate which was doubtless more moist and better suited to life than it is at present, the men of Iran laid the foundation of modern civilization. There indeed their thunder god, Enlil, had planted for them a garden in which he had made to grow every tree that is pleasant to the sight and good for food, every grass that their cattle required, and every kind of game that their hearts might desire. To such a land they came as they wandered in the east and there they founded the most ancient civilization known to history. Years passed and the moisture withdrew until the Aral and Caspian seas became separated and mankind again was forced westward by the growing aridity of its habitat. Directly in their pathway lay the rich and fertile valleys of the Tigris and Euphrates.

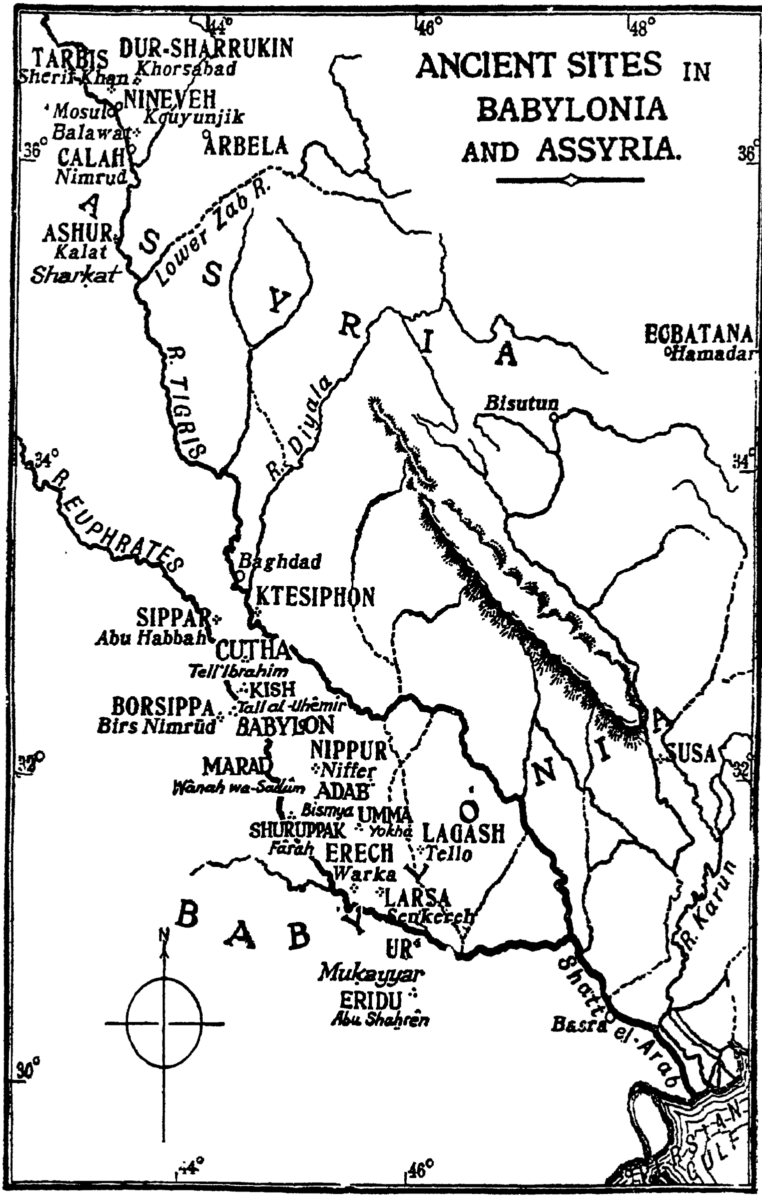
So the curtain of history lifts and we behold a vast level plain, lush with grasses, studded with palm trees, ribboned with irrigation canals and supported by two great rivers. It is Kengi, the lower half of Babylonia. Dotted here and there are little cities, of what size and population we do not know exactly. Each is a cluster of houses gathered about a temple-tower (ziggurat), and one, the palace of the priest-king, is larger than the others. This ziggurat consists of three, five, or seven quadrangular masses of brick set one above the other, each upper story smaller than the one below it. It represents, perhaps, the hill-tops on which primeval man, the ancestors of these settlers in the valley, had been accustomed to worship their gods. Perhaps also they served for points of vantage for observation of the stars, primitive observatories, though this is by no means certain. One irresistibly guesses that these people who have thus appeared in a full stage of civilization as inhabitants of what will later be known as Chaldea are a part of that belt of brown-white peoples who, during prehistoric days, spread practically around the world, following their isothermal line. Most anthropologists recognize as true that such a racial diffusion is at the bottom of those similarities which appear in the civilizations of countries so wide apart as Egypt, Babylonia, India, China, Mexico and Peru. These were the people who built the long barrows, the dolmens, as distinguished from their Keltic successors of the round barrows. They also buried their dead where their successors cremated them. Their culture is supposed to embrace such singular customs as the couvade, the putting to bed of the father as well as the mother upon the birth of a child, which may have originated at the time of the first discovery that men were really necessary to conception. The erection of megaliths also was one of their distinctive characteristics, and massage, and the swastika

Map to illustrate the broader lines of dispersal of the principal races of man. Modified from Matthew. (Courtesy of the Yale University Press.)

was a symbol which they seemed to have created. Among other customs characteristic of their culture were mummifying their dead, artificially deforming the skull by bandages, tattooing the body, the association of the sun and serpent in worship and the erection of great megalithic monuments. The Mediterranean races were typical examples of their stock; rather small of statue, dolichocephalic, dark-haired brunettes.

Whether they were the first settlers in Mesopotamia or whether they found the Sumerians already established in the valley is still a matter undetermined. These Sumerians, who spoke an agglutinative language, seem to have been of Mongolian stock. At the earliest moment of recorded history we find these two breeds of men mingling in lower Babylonia, with a settled civilization five thousand years or more before Christ. That there was an important substructure of brown-white Semites as a basis of Chaldean civilization seems clear.

The first scene of the drama reveals to us certain of these little city-states struggling for supremacy. Perhaps the very oldest of them was Nippur which, with Eridu, were the Mecca and the Medina of Babylonia. For religion chiefly was Nippur famous in the first years of history. Eridu, like Ur of the Chaldees, was a sea-port of the Persian Gulf. Both of these cities are now 160 miles northwest of the Gulf. It is a well known fact that between the years 325 B. C., when, in the time of Alexander, Spasinus Charax was founded and 1835 A. D., forty-six miles of new land had been formed from the mud deposited by the rivers, approximately 100 feet per year. A simple calculation shows us that Ur could not have been a sea-port later than 6,500 years B. C., nor Nippur, whose early religious prestige suggests a greater age and more ancient glory, one later than 10,000 B. C. It is interesting to note that sea-shells are found as far north as the site of Babylon. Eridu was the center of the worship of Ea, god of the waters, and Ur of Sin, the moon god. Some 30 miles away was Larsam whose patron deity was Shamash, the sun, and again only twelve miles distant was Uruk or Erech, the center of worship of Ishtar, (Venus), the evening star, goddess of love. And not far away were two other ancient cities, Mar and Lagash, while in the northern part of Babylonia were Kutha, where Nergal was worshipped, and Sippar, loyal to Shamash, and Agade, the famous capital of Accad. These represent the elder towns of Babylonia.



Sites of the principal city-states of the Tigro-Euphrates valley. (Courtesy of the British Museum.)

Such cities as Babylon and Borsippa and Nineveh were of later growth. While civilization was beginning in Babylonia it was doubtless also rising on the banks of the Nile, but northwest of Kengi were only nomadic tribes, while the Bedouin roamed in the west. Primitive Neolithic settlements were to the north, and to the east was Elam, overshadowing and often interfering with the city-states of the valley. It is perhaps from Elam that the early Sumerian settlers came, and it was probably from Arabia that the brown-white Semites arrived. At the time when history begins her story civilization is well advanced and organized in Kengi. The marvelously fertile soil of the valley, famous for the amount of potash and phosphorus and nitrogen that the overflowing waters of the two great rivers had deposited annually for many centuries, was doubtless occupied originally because it furnished so richly the necessaries of life to early man. There were grass for the cattle and water and wild grain and multitudinous animals and birds and fish. After a while the settlers learned to control the annual inundations by building a complete system of dams and dykes parts of which have lasted until this day.

When we come upon these men they are no longer hunters and trappers with only a few chipped flints, with no domesticated animals, and no agriculture, nor are they merely in the first stages of the Neolithic culture, but they are busy building cities, codifying laws, surveying garden plats, irrigating farm land, leasing properties, establishing courts of justice, building temples, and worshipping their gods. For the great part, they are engaged in agriculture. There are many gardeners raising fruits and vegetables for the market. Some of them are shepherds, others are herdsmen. They have carpenters and metal workers, smiths and dyers, weavers and brick-makers, vintners and leather-workers. Woollen clothes have supplanted the raiment of skins. They are trading with their neighbors not only, but at the very beginning of the record their priest-kings are importing rare products from far distant places, such as cedars from Lebanon, great building stones, rare spices, with gold and copper from Egypt and Sinai. In their earliest hour they have slaves, though the free laborer and the tenant farmer are also present. We read of properties passing from generation to generation of the more prominent families, showing that they had already developed a firm respect for the rights of private property. In their houses which are built of brick they have learned to use furniture; chairs and stools and rugs are on the floors. Their bed is a mat, and while the flint knife is still to be found, the metal knife is supplanting it. Beautiful pottery is universal and their principal food is grain and meat. The principal person in the city is the patesi, the priest - ruler. So early is religion associated with government. Indeed, even in the earliest time, these priests - kings claimed to be gods and prefixed the divine symbol to their names. Verily, the distinction between gods and animals and men grows dimmer and dimmer as we go back into the past.

Babylonian map of the world showing the ocean around the world (The Bitter River) and marking the position of Babylon on the Euphrates as its center (the rectangle lying across these lines near the large central black dot.) It also shows the mountains at the source of the river, the land of Assyria and the swamps at the mouth of the Euphrates. One of the districts is marked "The Sun cannot be seen." (Courtesy of the British Musuem.)

And this earliest civilization had already begun to express itself in its distinctive architecture not only, but in literature as well. First came poetry both narrative and lyric with stories of gods and heroes expressed in rhythmic measure and strophic arrangement. Step by step some of these stories were woven into the great national epic of Gilgamish with its twelve books, the Babylonian Odyssey. As our readers will later see, the thoughts and ideas of this national epos and its mythological conceptions lay at the foundation of the religious lore of the Greeks and the religious beliefs of the Hebrews.

And even at their earliest hour we find that they have laid a tentative foundation for medicine by prescribing certain medical herbs upon occasion, though the great mass of their medical lore consisted of exorcisms and magic formulae. They had made a start in mathematics and had written for us our fundamental tables of weights and measures and distances, using the hand breadth as the basis. They had put into use the duodecimal and sexagesimal system, counting by sixes and dozens. Their year had twelve months of thirty days each, with an extra month intercalated as needed. Their day had twelve double hours and each hour had sixty minutes. Their circle had 360 degrees, and the path of the sun through their heavens was divided into twelve compartments or Signs of the Zodiac, the whole circle being divided into six parts of sixty degrees each. As we shall see, they had twelve principal gods which have come down to us under another sky as the twelve gods of Olympus. Twelve was the foundation of their arithmetic. Their ner consisted of six hundred dozen. Their century was therefore like that of the Chinese, a period of sixty years. Thus they had already taught us to buy our eggs by the dogen and to expect twelve ounces in our pound, and in accordance therewith we still have twelve pennies in our shilling and sixty seconds in our minute. Their week they divided into seven days, each named for one of the principal gods. Sunday was the day of Shamash, the sun; Monday of Sin, the moon; Tuesday of Nergal, the planet Mars; Wednesday of Nebo, the planet Mercury; Thursday of Marduk, the planet Jupiter; Friday of Ishtar, the planet Venus; and Saturday of Ninib, the planet Saturn. They had written tables of stars and eclipses and had learned to begin their year at the Vernal Equinox. Their day began at sunrise and they marked its hours by means of the sun and the clepsydra. They had already established a Sabbath, or Shabattu, which they observed "to assuage the wrath of the gods," and they paid especial attention to their list of lucky and unlucky days. This Shabattu, or seventh day, quite clearly was associated with the changes of the moon which, though imaginary, still influence the more superstitious of mankind, advising the farming class of all nations when to reap and sow. On the Shabattu, as on Friday, 13th, of today, men feared to begin important matters or to undertake work or to offend the gods.

Nor were these people of 8-10,000 years ago unacquainted with art or agriculture. They were also makers of excellent brick with which they constructed hut and palace and temple. They had invented the keyed arch and they used tile for excellent systems of sewèrage. They had learned to decorate their walls and build slender columns. They were expert designers and builders of temple-towers, ziggurats. Their art was as art should be, realistic and forceful. Their animals were real animals and their gods were real gods, depicted in the form of the highest known type of animal, the human being, in which form they were destined to continue to exist until the Hebrews and Zoroastrians and the Buddhists and the Christians taught the world better. Their kings were liberal patrons of libraries. Sargon of Agade made Erech the "city of books" by his liberality to the library of her priestly college nearly 4,000 years B. C. And 3,000 years later Asshurbanipal followed his example in the creation of the royal library of Nineveh. It was this same Sargon of Agade who perhaps first told of himself the story that has adorned the childhood of many great kings and leaders of the earth. For among the cuneiform texts of the British Museum is the following legend of his birth:

Sargon, the mighty king, king of Agade am I,
My mother was lowly; my father I did not know;
The brother of my father dwelt in the mountain.
My city is Azupiranu, which is situated on the bank of the Euphrates.
My lowly mother conceived me, in secret she brought me forth.
She placed me in a basket of reeds, she closed the entrance with bitumen,
She cast me upon the river, which did not overflow me.
The river carried me, it brought me to Akki, the irrigator.
Akki, the irrigator, in the goodness of his heart lifted me out,
Akki, the irrigator, as his own son . . . brought me up;
Akki, the irrigator, as his gardener appointed me,
And for four years I ruled the kingdom.

Such were the social and political organizations and such the intellectual life of the Tigro-Euphrates valley, this mixed race of Accadians (highlanders) or Semites and Sumerians probably of Mongolian race, who like mixed races in all ages, where the types are not too divergent, have developed the highest cultures. But the thing that fascinates us about these people is not their art nor their architecture nor their libraries of baked brick, nor their irrigation canals, nor their kings of Shumer and Accad, but the fact that they, of all men whom history knows, stand farthest away from us and nearest the unlighted gloom of that remote past through which, by his interminable pathway of struggle, mankind staggered up out of the night. On their right was history, on their left were the vast tracts of time comprising the territory of anthropology. As we have records of them, so they had records of the past of man. His traditions, his legends, his myths, these are the dim and misty forms that move on the background not only of their religion, but of their social and civic life. We get a little glimpse of the hour of his coming to these Babylonian plains in a tablet discovered by Pinches in 1883, reading: "South is Elam, north is Accad, east is Suedin and Gutium, west is Phoenicia. On the right is Accad, on the left is Elam, in front is Phoenicia, behind is Suedin and Gutium." Thus were his ziggurats orientated with their corners apparently to the four cardinal points, but if one turns his map to correspond with the above directions he finds that they were orientated inexactly but in accordance with the accepted directions of north, east, south and west among men who had evidently come down southwestwardly from the hills. They brought with them, as most hill tribes do, their god of thunder storm and the lightning. Perhaps this is the reason why Nippur, the city of Enlil the thunder storm god, was at the very beginning of Babylonian history without a peer as a center of religious influence.

In comparing the new science and the old religion we are thus come to an interesting moment. We are to look upon the real "old time religion" the "most ancient faith of our fathers" the "old fashioned faith" of our ancestors. For we must not forget that our beliefs come to us via Europe and Rome and Jerusalem, from the city of Terah and Abraham, Ur of the Chaldees. Our Christian theology of today is founded upon the Old Testament as well as the New. It therefore embodies almost intact the early Hebrew faith and this was of course largely, with respect of the creation and primitive life of mankind, the faith of the ancient peoples who lived between the great rivers. Compared with that faith Protestant and Catholic and Jew and Mohammedan and Buddhist and Confucianist are all new comers into the world. As part of an infallible book this faith has formed the basis of systematic theology from the days of Paul to the present. Now all of these accounts, found in the early chapters of Genesis come to us from that vast body of Semitic tradition, first and fully expressed in ancient Chaldea. They antedate Heber and Abraham by thousands of years. They come to us out of the twilight zone of pre-history, out of the land of myth and legend. The Hebrew prophet took them, stripped them of all their polytheistic crudities and handed them over to our theologians to be abused and misinterpreted for centuries. They are ineffably precious. If they are studied carefully and sympathetically, they are revealed as a worthy foundation for faith. If they are interpreted literally, as a divinely inspired statement of exact scientific fact, as they have been for so many years, the results with respect to science are tragic. The story of the relationship between the new knowledge and the old faith would not be complete without an explanation of their contents. All who have made a careful study of theology know it is founded on the first few chapters of Genesis. There are the "fundamental" stories of the creation of the world, the creation of men and women and animals, the institution of the Sabbath, the temptation of Eve in the garden of Eden, the tree of life and of the knowledge of good and evil, the fall of man, the promise that the seed of the woman shall bruise the serpent's head, the early genealogy of the holy family from Adam who was the "Son of God," the tower of Babel, the flood and many another story which has entered into the fundamentals of our religious beliefs. Whether interpreted by an infallible church or interpreted by creeds founded upon a scientificially inerrant and infallible Bible they constitute the foundation of theology from Paul to Hodge. Taken literally they can be harmonized with scientific truth only by gross distortion. Are we compelled then to deny either our reason or our religion? We are not. There is a better way. Let us see what it is.

In this strangely fascinating past of these ancient peoples, we have come upon a stage of human thought that is full of wisdom. It is the age of myth, and after all what is a myth but the telling of the truth in terms of spirit and life rather than of substance and matter? If we accept the usual definition of a myth as an interpretation of phenomena in terms of personality, while we may satisfy our intellect, our heart still tells us that a myth is, as one of our students recently said, a truth that is lost. To early man whatever moved itself and other things was a living thing and of all the things that moved themselves and living things, two were of supremest importance. One of these was the earth and the other was the sun. Now the activities of these two primal lives or spirits or powers or gods could be readily sub-divided or classified. There was the day and the year, and both of them, especially in equatorial countries, where torrential rains opened the windows of heaven for months at a time during the rainy season, flooding everything with their outpour of waters, and where during the dry season all was parched and dry and dead, were one eternal fight between light and darkness, between life and death, between plenty and hunger, between chaos and order. Thus there came about in the minds of earliest men certain great primal myths or interpretations of the universe in terms of spirit and divinity. These myths are, first, the creation myths, whose terms equally describe the creation of the world, the creation of the year, and the creation of the day. Second, the solar myths whose terms describe the daily pathway of the sun through the sky, and the annual pathway of the sun through the constellations that constitute the signs of the Zodiac. And lastly there is the chthonic myth whose terms describe the birth and the death of the children of the earth, and therefore of earth herself, and the vital changes through which the earth passes, from winter through spring to summer and autumn, from death through life to disease and death again.

And in a most astonishingly beautiful way did these first philosophers and scientists and ministers of the gods work out the problem of human life, for each of these myths was evidently from the beginning taken and made a symbol of the life of human beings. If, when all was dead, some strange voice and powerful availed to call the flowers from their tombs and the birds from the distances beyond, why should not such a voice call man from his dolmen? If when all was night some vast power prevailed to conquer the darkness and disperse the clouds, why should not that same power cause the light of life to shine again for men? If, when his long pathway toward the south had led him to the weakness of the winter solstice the sun heard a voice calling him backward to power and strength once more, why should not that voice call mankind backward again from their weakness when life ended? Thus all sun-myths were associated with that same strange hope which was in the heart of the Neanderthal parents who buried their boy with his head upon his arm and placed by his side his best loved implements and his most precious treasures 50,000 years ago. The same hope had led the Neolithic mother to bury her infant beneath the floor of her cottage as if, while others might be buried further from a mother's care, the little child might call in the night again. Nor has this passion for life, possessed of old, lost its power. These same wonderful myths, having done their work in Babylonia, have spread literally to the ends of the world, having been learned by the Greeks and the Romans and the Hebrews and having been adopted as part of the Christian faith. It is with a reverence unspeakable that we learn and tell their story and meaning.

For worship, like all other great growths of earth, begins humbly, in admiration and respect and reverence. So it was with early man. For the great mass of material things that could not move themselves or other things he did not have great respect or admiration or reverence. For the humbler animals which could neither hurt nor harm him he had little more. But for those creatures which by their cunning or by their power were able to endanger his life or to surpass his prowess, he entertained a profound respect which merged into worship. Perhaps that is the reason why the earliest civilization, in blind struggle to attain unto a conception and understanding of other spirits, conceived of the gods as having animal forms: But as knowledge increased and science flourished, step by step there came to be those who discovered that there were certain moving, living things higher and stronger and greater than men or animals. One of them had been known from the beginning, the sun, as indeed another, also, the moon. After a little while, keen observers noticed that while the vast number of stars in the heavens were fixed and immovable, yet there were certain of them that evidently possessed life, that moved themselves and presumably other things, and so keen were their eyes and so complete their investigation that among the 3,000 or more stars visible to them they picked out five and called them the planets, the wanderers, and they recognized them as living things, as gods. So it comes to pass that the first known name for god among men was Ilu, a star, shining one. It is the same as El, Allah, Elohim, which last will be instantly recognized as the god of the first chapter of Genesis. Soon to the sun and the moon they added the quick darting Nebo (Mercury), the messenger of the gods, and the beautiful evening star, Ishtar (Venus,) and the red and bloody Nergal (Mars), and the great stately Marduk (Jupiter), and the leisurely far away Ninib (Saturn). Whether before or after the deification of the planets we know not but very early in the first chapter of their theology they grouped the great triad, Anu, the heaven, Enlil or Bel (the same that is known as Baal, Lord), the earth, and Ea, the waters. This Ea, whose nearest home was the turbulent deep of the Persian Gulf, is the same as he who, as Oannes, taught the first settlers of the valleys the art of civilization. With this primal triad there were early associated Ramman, the thunderer, the god of the storms and the upper air, and Belit, the lady, consort of Bel, who in the minds of her worshippers represented that eternal principal of fertility, of motherhood which parallels fatherhood in all nature. Such were the twelve great gods, and in service of them civilized man lived his earliest life. It will be noted that they fall naturally into threes or fives or sevens. So the temple-towers, the ziggurats, were composed of three or five or seven successive towers, one upon the other. There was, for example, that wonderful temple of the seven spheres, at Borsippa (Birs-Numrud.) Its basement was black with pitch over masonry, dedicated to him who walked in the distant darkness, Ninib. The second story was of orange-colored bricks, dedicated to the golden Marduk, Jupiter. The third story was of blood-red, half-burnt bricks, dedicated to the fiery Nergal, Mars. The fourth story was overlaid with thin plates of gold and dedicated to Shamash, the yellow-haired sun. The fifth story was a pale-yellow brick and dedicated to Ishtar, Venus. The sixth story was of azure created by the vitrifaction of the clay into a sort of blue slag and dedicated to Nebo, Mercury, and the seventh and last story was covered with silver plates and dedicated to Sin, the moon. It fronted northeast, the sacred direction, the country in which lay the cradle of their race, the land of the great Mount of Assembling and the paradise of the gods, where grew the sacred tree of life and tradition called its ruins the tower of Babel.

Around these temple towers clustered the religious life, the political life, and no doubt the social life of each city-state of Babylonia, and under the hand of priests and kings there grew up three great bodies of doctrine. One of these was the science of astrology, the rabbis of which were the stargazers or astrologers who believed and taught that the destinies of men and nations could be read in the movements of the heavenly bodies. Second were the dogmas associated with incantation, the rabbis of which were the magicians and sorcerers. The third was the science of divination, the rabbis of which were fortune-tellers and the soothsayers. Such were the wise men of the east, the Chaldeans. Their word for wise man, mag, (Sumerian, imga), magus, magician, interprets to us rabmag, great priest or perhaps head conjurer, and like many other things Babylonian their belief in sorcery and fortune-telling, and witch-craft, passed over into Europe to curse for many centuries the civilization of the west.

It is a characteristic of all peoples of the past that when, telling the story of their origin, they have rehearsed their memories and their history, they traverse the land of legend before they reach the mysterious country of myths. "And it came to pass in those days when men began to multiply on the face of the ground and daughters were born unto them that the sons of gods saw the daughters of men that they were fair and they took them wives of all that they chose. The giants were in the earth in those days and also after that when the sons of God came in unto the daughters of men and they bear children to them, the same were the mighty men that were of old, men of renown." Such were the demi-gods, the half-deities, the off-spring of gods and mortals. Hercules was among them and Perseus and a thousand other famous demi-gods. And as it was with Greece and Rome, so it was in Babylonia. They also had traditions of heroes and demi-gods. This free cohabitation and interbreeding of gods and women and indeed the very beasts of the field which appeared possible and reasonable to early man finds a rather complete illustration in their great national epos, wherein Gilgamish, (two-thirds god and one-third man) and Eabani, (half-man and half-bull), are the principal actors. Farthest back of all was the day when Oannes, the man-fish, came up from the Persian Gulf to teach the dwellers of Ur and Eridu the beginnings of arts and sciences. He it was who gave them a book treating of the origin of all things, and by his counsel and wisdom laid the first foundations of civilization. Two hundred and fifty-nine thousand years after Oannes there came a long line of ten antediluvian kings whose reign continued for 432,000 years, combined. This is according to Berosus who wrote shortly after the days of Alexander, some 300 years B. C. The last of these kings was Xisuthrus, Tsitnapishtim or Ut-Napishtim, he who dreamed the flood at the whisper of father Ea. Here again the power of Kengi asserts itself, sending this same tradition throughout the Semitic world to reappear as Hebrew tradition in the ten antediluvian patriarchs. The story of Tsitnapishtim, chief hero of the great epic was first deciphered by George Smith of the British Museum. The story of the flood in which he figured so largely is the eleventh of the twelve chapters or tablets of that epic. The twelve chapters complete constitute the first great solar myth, describing the wanderings of the sun in its annual path through the heavens. In studying it we are launched upon the description of the two other great primitive myths, the chthonic myth and the creation myth. The solar-diurnal myth does not appear in great prominence in Babylonian literature.

These ancient myths—interpretations of Nature (God) in terms of personality—together with certain legends hardly less hoary, taken over into the sacred writings of the Hebrews constituted for centuries one of the most difficult hurdles that civilization had to leap. Verily it is easy for the blind to stumble over the dead. For in them the long arm of the dead reached out to oppose scientific progress. Yet in themselves nothing could be more beautiful. Only interpretation fathered by ignorance made them appear as the enemies of light. Accepted in blind literalness by devoted believers, they have been used to drive the enlightened and educated from the courts of the Lord upon the plea that they are the very "Word of God" inspired, exact, inerrant statements of plain facts. One must believe, "as the Bible teaches" that the world was created in six consecutive days of twenty-four hours each; that man was created in perfect purity and holiness, without biological antecedents; that woman was made from his rib while he slept; that the serpent spoke, tempting them in Eden; that the flood covered the whole world destroying all living things except such as Noah took into the ark; that the diversity of languages originated in an attempt on the part of terrified humanity to secure themselves against another flood by building a tower so high that it would reach heaven, an attempt that would have succeeded had not God become alarmed at its progress; one must believe all these and many more such naive efforts to explain the universe as sober statements of plain facts or deny the inspiration, the inerrancy, the truthfulness of the Bible. Now obviously, faced by such a necessary disjunctive educated men would take that horn of the dilemma which leads away from the church. A better path is indicated herein. It is in order that the reader may see the beauty and truth and fathomless religious meaning of the principal primitive myths, comparable to the parables of Christ and to the dramas and lyrics and short stories of the Old Testament and equally true and meaningful that they are given in such fullness of detail. They are in one sense the foundation stones of both the new science and the old religion. They cluster around the father of all gods, the radiant heaven, the sun.

the most evident manifestation in nature of that beneficent life and light and power which from earliest times men have recognized as God. The annual journey of the sun through the heavens being perhaps the most widely diffused, is the first of the primal myths to be examined.

A PSALM TO THE SUN

O Sun,
Father of worlds,
Face of the Infinite,
Lord of the destinies of men,
Ilu, El, Allah, Elohim,
The Shining One, Star of Heaven, Divinity,
Asaru-Osiris, who died and rose again,
Who from Tiamat, the Primeval Deep,
From Tehom, the Abyssal Chaos,
Didst bring forth the bright firmament,
And establish the stars in their places,
Teaching the gods their abodes:—
Anu in his heaven above,
Bel and Belit on their earth beneath,
Ea in the waters that are under the Earth,
And thunderbolted Ramman to lighten the storm;
Appointing Dumuzi as shepherd of the clouds,
And Nannar as the queen of the night,
Rivalled only by sweet Ishtar,
Star of evening, princess of love,
Appointing Nibiru to be shepherd of days,
Directing distant Ninib in his lonely path,
Crowning Nergal king of the dead in Arallu,
And instructing swift Nebo as the messenger of all:—
O Sun, who hast heard the millenial adoration of mankind,
To whom the dying of all ages have turned their faces, in hope,
Planning to rise again, with thee, in the east;
Whom the staring eye-sockets of the dead follow toward the west,
Their bony fingers still grasping bow and hunting knife,
And tress of once-loved hair, entombed in faith;
Thou who didst mix the wise blood of a god with their clay, in the beginning,
Creating him, Eabani, the man of Ninib, thy companion;
And through the love of Ukhatu, priestess of Ishtar,
Didst separate him from the beasts of the field,
Enticing him into walled cities,
Teaching him to love and dream and aspire;
O Sun, Gilgamish,
Who shines forth among the valiant?
Who is glorious above all men?
Gilgamish shines forth among the valiant!
Gilgamish is glorious above all men!

CHAPTER XVIII.

THE GREAT ANALOGY

The story, in narrating which we follow largely the translation and description of E. A. Wallis-Budge, of the British Museum, opens in the far distant past, in the storied land of Shinar (Shumir,) and in its ancient capital Erech. The first of the twelve tablets narrates the greatness of the hero Gilgamish, (the sun god,) he who saw everything, understood everything, learned everything, who searched the hidden mysteries of all wisdom and could tell the story of everything that had happened before the flood. He was the far traveller, the doer of mighty deeds, all of which he had recorded on tablets of stone. He it was who built "walled Uruk" with its mighty temple. He was two-thirds divine and one-third man, but he was an oppressor of his people who cried out against him, beseeching the gods for deliverance. Harkening to their cries they bade the goddess Aruru to create an opponent for Gilgamish. Taking clay, she spat upon it and made a person in the image of Anu, the god of the heavens. His name was Enkidu (Eabani) and, perhaps, he represented primitive manhood. He was covered with long hair and was clothed with leaves, living in the forests of the mountains with the wild cattle, eating grass like an ox and herbs like the gazelle. He was of enormous stature and immeasurable strength and had mastered all the inhabitants of meadow and forest. Now a trapper found one day that his snares and nets and pits had all been broken or filled, and discovered Eabani loosing the wild animals that they had caught. The story of it was told to Gilgamish who advised the sending of Ukhatu, a hand maiden of the goddess Ishtar, that she might entice the wild man. When Eabani saw woman for the first time his curiosity grew into delight and for six days and seven nights he left his beasts for her company. Using all her arts of persuasion and praise, she finally induced him to come to "walled Uruk," the city of Anu and Ishtar that he might become a friend of Gilgamish, "perfect in power, surpassing men in strength, like a mountain bull." "In the wisdom of his heart Eabani recognizes a companion," a helpmeet for him, and follows Ukhatu to Erech, for the wild beasts had forsaken him who had thus been so quickly refined by a woman's influence.

The second chapter tells us of how Eabani was further civilized by the society that met him in the city. Soon he was eating bread, wearing clothes, drinking beer and anointing himself with ointments. After a while he was himself a trapper and hunter, slaying panthers and snaring gazelles. So his reputation as a mighty hunter and a good shepherd grew. After a while he became a great friend of Gilgamish whose admiration for his enormous size and mighty virility was unbounded, especially after a violent struggle between the two in which Eabani was the victor.

In the third chapter Eabani recites to Gilgamish the story of a fateful dream which had visited him. In the midst of thunder and earthquake a creature of horrible countenance had seized him with its eagle-like talons and compelled him to descend into the subterranean world, the dominion of Irkalla. "He who visited this land never came out and he who travelled along that road never returned. He who dwelt there is without light, the beings therein eat dust and feed upon mud, they are clad in feathers and have wings like birds, they see no light and they live in the darkness of night." There shadowy figures of former kings presented offerings to the gods. It was a "land of darkness and the shadow of death, where the light is as darkness."

In the fourth chapter the two friends undertake a most dangerous expedition against King Khumbaba, monarch of dark and gloomy forests of mighty cedars and cypresses, sacred to and protected by the god Bel, who had appointed Khumbaba as their guardian. The roar of the storm was his voice and his breath was like a gale of wind. Eabani, dismayed by the darkness of the wood and terrified by its dense shadows, entreated Gilgamish to forsake their perilous adventure, but in vain. With that sureness of victory with which the sun has ever shot his arrows, they forced the shadowy palace and slew Khumbaba.

The sixth tablet tells us how, crowned with this new glory, Gilgamish returned to Erech only to find himself confronted with a new danger in that Ishtar, the goddess of love is enamoured of him, having seen the brightness of his armor and noted his freshly dressed hair and cleanly garments, his crown and his fillet.

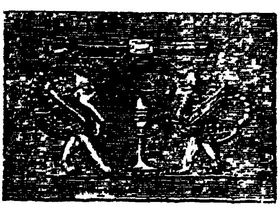
"Then the eyes of the majesty of the goddess Ishtar lighted on the goodliness of Gilgamish (and she said).
Go to, Gilgamish, thou shalt be my love.
Give me thy (love)-fruit, give to me, I say.
Thou shalt be my man, I will be thy woman.
I will make to be harnessed for thee a chariot of lapis lazuli and gold.
The wheels thereof shall be of gold and the horns of precious stones.
Thou shalt harness daily to it mighty horses.
Come into our house with the perfume of the cedar upon thee.
When thou enterest into our house
Those who sit upon thrones shall kiss thy feet.
Kings, lords and nobles shall bow their backs before thee.
The gifts of mountain and land they shall bring as tribute to thee.
Thy . . . and thy sheep shall bring forth twins.
Baggage animals shall come laden with tribute.
The (horse) in thy chariot shall prance proudly.
There shall be none like unto the beast that is under thy yoke."

So would the loves of spring entice the sun-god hero to abide with them forever. But Gilgamish was not to be enticed. Instead, he reminds her of how others, trusting her love, have been destroyed. He reminds her of Tammuz slain by the wild boar in the deep, dark forest of Eridu, and of the sparrow-hawk who cries still in the forest. "Oh, my wings! my broken wings!"; of the stallion that she destroyed and the mighty lion she rent in twain. "Dost thou love me?" he cries, "and wouldst thou treat me as thou didst them?" Enraged at his scorn she persuades Anu to create a great fire-breathing bull to destroy Erech and its people, but Gilgamish and Eabani break its neck and kill it. "Who is splendid among men, who is glorious among heroes?" cries Gilgamish. And his people reply, "Gilgamish is splendid among men. Gilgamish is glorious among heroes!"

In the seventh tablet or chapter, the goddess Anatu, the mother of Ishtar, strikes down Eabani unto sudden death and lays upon Gilgamish a terrible illness resembling leprosy. Terrified by his own illness and increasing weakness, and deprived of the counsel and the comradeship of his departed friend, he broods long over the dire fate of men and the inevitable necessity of death. Then he forms a great plan in his heart. He would seek out that immortal sage, "the distant one" who dwells by the mouth of the rivers, Tsitnapishtim, or Hasisadra (the sun of life or the morning sun,) the son of Ubaratutu (the glow of sunset.) He is the same mighty hero who was warned by Ea of the impending flood and who was, with his wife, translated to the blessed island beyond the waters of death.

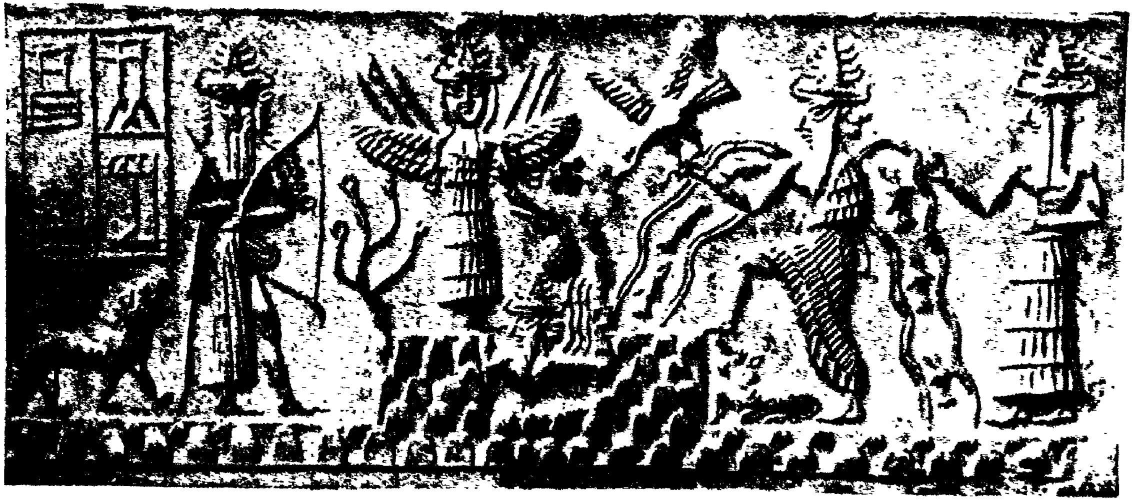
The laments of Gilgamish over the death of Eabani fill the eighth tablet. "What kind of sleep is this which hath laid hold upon thee? Thou starest out blankly and hearest me not," he exclaimed. From the body of his dead friend he turns away roaring like a raging lion and like a lioness robbed of her whelps.

It is in the ninth chapter or tablet that he makes his great resolve. Impelled by his earnest desire to escape from death and remembering that his ancestor Tsitnapishtim, deified and immortal, dwelt happily at the mouth of the great rivers, he set out to find him that he might also learn the secret of immortality. He turns his face westward to the land of the setting sun, fighting his way against man and beast (over the terrible wastes of the Arabian desert,) until at last he arrives at Mount Mashu, whose back reached to the gate of heaven and whose breast reached down to Aralu, where strange scorpion men guarded the cavern of the setting sun. He was terrified at their aspect. Before the glance of their eyes great mountains collapsed. But one of the scorpion men cried out to his wife, "The body of him that cometh to us is of the flesh of the gods. Two-thirds of him is god and the other third is man." Receiving Gilgamish hospitably they recited to him the dangers and difficulties of his future way, but under the great urge of his longing for immortality Gilgamish pressed onward. Undismayed by the statement of the scorpion men that no man had ever passed through the eternal blackness of their mountain which took twelve kasbu or double-hours to traverse, he set his face forward into the darkness whose denseness increased each hour. He struggled on and on until, at the end of the twelfth hour he arrived in a region of brilliant light where was a beautiful garden set with trees loaded with jewelled fruits, and in this garden he saw the "tree of the gods."



The Scorpion men. From Smith's *Chaldea.* (Courtesy of G. P. Putnam's Sons.)

The tenth tablet tells us that not far away from this wonderful garden was the palace of Sabitu who sat upon



Shamash, the Sun God, setting on the horizon. In his right hand he holds a tree (?) and in his left a knife with a serrated edge. Above the horizon is a goddess who holds in her left hand an ear of corn. On the right is a god who seems to be setting free a bird from his hand. Round him is a river with fish in it and behind him is an attendant god; under his foot is a young bull. To the right of the goddess stands a hunting god with a bow and lasso and a lion. From the seal-cylinder of Adda, the scribe, in the British Museum. About 2,500 B. C. (Courtesy of the British Museum.)

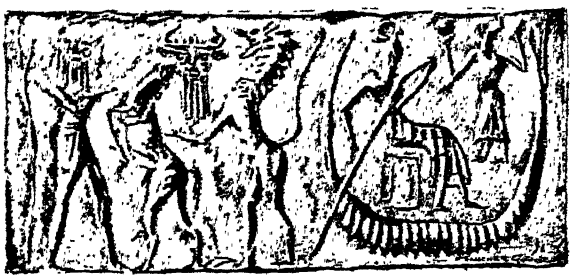
a throne by the side of a great sea and watched this weary, travel-stained wanderer, clad in ragged skins of wild animals, as he approached her fortress. Though she closed her door against him Gilgamish demanded audience, threatening to smash the bolt and break the door. Before he could enter he must needs tell her the story of his friend Eabani, panther of the desert, with whom he had traversed mountains and overcome Khumbaba in his mighty cedar forest, by whose aid he had slain the Bull of Heaven and mastered the mighty lion, his companion through many difficulties. "I wept over him for six days and nights before I would let him be buried."

"I was afraid of death, and therefore I fled through the country.
The fate of my friend lieth heavily upon me
Therefore am I travelling on a long journey through the country.
How is it possible for me to keep silence about it?
How is it possible for me to cry out (the story) of it?
My friend whom I loved hath become like the dust.
"Enkidu, my friend whom I loved hath become like the dust.
Shall not I myself also be obliged to lay me down
And never again rise up to all eternity?"
Gilgamish (continued) to speak unto Sabitu (saying):
"(O) Sabitu, which is the way to Uta-Napishtim?
What is the description thereof? Give me, give me the description thereof.
If it be possible I will cross the sea,
If it be impossible I will travel by land!"
Then Sabitu answered and said unto Gilgamish
"There is no passage most assuredly, O Gilgamish
And no one, from the earliest times, hath been able to cross the sea
The hero Shamash (the Sun-God) hath indeed crossed the sea, but who besides him could do so?
The passage is hard, and the way is difficult
And the Waters of Death which block the other end of it are deep
How then, Gilgamish, wilt thou be able to cross the sea?
When thou arrivest at the Waters of Death what wilt thou do?"

From Sabitu Gilgamish learned that Ur-shanabi (Arad-Ea,) the boatman of Shamash was near by at his wharf and she added "If it be possible cross with him and if it be not possible come back." Directed by Ur-shanabi, Gilgamish, with his axe cut down from the forest some poles sixty cubits long and entering the boat of Ur-shanabi journeyed with him. After a long month's travel they reached the limit where the waters of death mingled with the world stream which like a girdle surrounded the whole earth. Ur-shanabi warned Gilgamish not to touch the waters with his hand. As they approached the other side they found Tsitnapishtim who had discovered the approach

Shamash, the Sun God, rising on the horizon. Flames of fire ascending from his shoulders. The two portals of the dawn, each surmounted by a lion are being drawn open by attendant gods. From a Babylonian seal-cylinder in the British Museum. (Courtesy of the British Museum.)

of their boat and come down to the shore to see who they were that had passed safely through so fearful a journey. To him Gilgamish explained the cause of his coming, how he had traversed mountain and forest, passing through desert and darkness in his search for the secret of immortality. Unfortunately, there is a break in the text covering the opening lines of Tsitnapishtim's reply but in his closing words he reminds Gilgamish that there is nothing on earth that abides permanently and that no



Gilgamish and Arad-ea navigating their vessel. From a Chaldean intaglio in the British Museum. (Courtesy of D. Appleton and Co.)

one save the god of destiny had power to protect men from death, for so long as men build houses, so long as brothers quarrel, so long as enmity exists none may know the day of his death and none may escape his end.

The eleventh tablet or chapter contains the story of the deluge. It is so full of interest and importance to the purpose of this volume that it is given in full. The reader would do well to consult the story of the flood as given in the Bible, by way of comparison.

Gilgamish had just said to Uta-napishtim, the remote:

I am looking at thee, Uta-Napishtim
Thy person is not altered; even as am I so art thou.
Verily, nothing about thee is changed; even as am I so art thou.
(Moved is my) heart to do battle
But thou art at leisure and dost lie upon thy back.
How then wast thou able to enter the company of the gods and see life?

It is in answer to this question that Tsitnapishtim or Uta-Napishtim tells the story of the flood as follows:

Uta-Napishtim said unto him, to Gilgamish:
"I will reveal unto thee, O Gilgamish, a hidden mystery,
And a secret matter of the gods I will declare unto thee.
Shurippak, a city which thou thyself knowest,

On (the bank) of the river Puratti (Euphrates) is situated.
That city was old and the gods (dwelling) within it—
Their hearts induced the great gods to make a windstorm.
Their father Anu.
Their counsellor, the warrior Enlil,
Their messenger En-urta (and)
Their prince Ennugi.
Nin-igi-azag, Ea, with them (in council) and reported their word to
the house of reeds.

(First speech of Ea to Uta-Napishtim who is sleeping in a reed hut.)

"O House of reeds, O House of reeds! O Wall, O Wall!
O House of reeds, hear! O Wall, understand!
O man of Shurippak, son of Ubara-Tutu
Throw down the house, build a ship,
Forsake wealth, seek after life,
Abandon possessions, save thy life,
Carry grain of every kind into the ship.
The ship which thou shalt build,
The dimensions thereof shall be measured,
The breadth and the length thereof shall be the same.
. . . . . the ocean, provide it with a roof."

(Uta-Napishtim's answer to Ea.)

"I understood and I said unto Ea, my Lord:
(I comprehend) my lord, that which thou hast ordered,
I will regard it with great reverence, and will perform it.

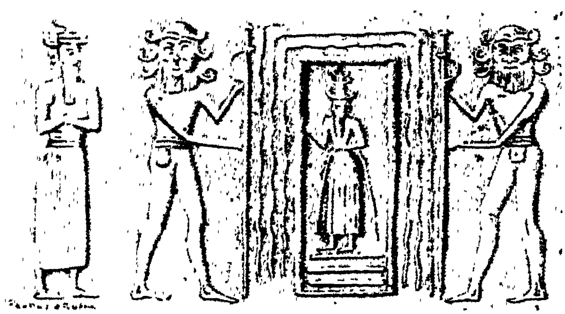
(The building of the ship.)

As soon as (the dawn) broke . . . . . .
(lines 49-54 broken away.)
The weak (man) . . . bitumen,
The strong (man) . . . brought what was needed.
On the fifth day I decided upon its plan
According to the plan its walls were ten Gar (120 cubits) high.
And the circuit of the roof thereof was equally ten Gar.
I measured out the hull thereof and marked it out (?)
I covered (?) it six times.
Its exterior I divided into seven,
Its interior I divided into nine,
Water bolts I drove into the middle of it.
I provided a steering pole, and fixed what was needful for it.
Six sar of bitumen I poured over the inside wall,
Three sar of pitch I poured into the inside
The men who bear loads brought three sar of oil,
Besides a sar of oil which the offering consumed,
And two sar of oil which the boatman hid.
I slaughtered oxen for the (work) people,
I slew sheep every day.
Beer, sesame wine, oil and wine
I made the people drink as if they were water from the river.
I celebrated a feast- day as if it had been New Year's Day
I opened (a box of ointment,) I laid my hands in unguent.
Before sunset the ship was finished.

(The loading of the Ship.)

With everything that I possessed I loaded it (the ship)

With everything that I possessed of silver I loaded it.
With everything that I possessed of gold I loaded it.
With all that I possessed of living grain I loaded it.
I made to go up into the ship all my family and kinsfolk,
The cattle of the field, the beasts of the field, all handicraftsmen I made them go up into it.
The god Shamash had appointed me a time (saying)
The Power of Darkness will at eventide make a rain-flood to fall:
Then enter into the ship and shut thy door.
The appointed time drew nigh;
The Power of Darkness made a rain-flood to fall at eventide.
I watched the coming of the (approaching) storm,
When I saw it terror possessed me.
I went into the ship and shut my door.
To the pilot of the ship, Puzur-Bel (or Puzur-Amurri) the sailor
I committed the great house, (ship,) together with the contents thereof.



Uta-Napishtim shut into the ark. From a Chaldean intaglio, Smith's *Chaldean Account of the Deluge.* (Courtesy of D. Appleton and Co.

(The Abubu (Cyclone) and its effects described.)

As soon as the gleam of dawn shone in the sky
A black cloud from the foundation of heaven came up
Inside it the god Adad (Rammanu) thundered,
The gods Nabu and Sharru (Marduk) went before,
Marching as messengers over high land and plain,
Irragal (Nergal) tore out the post of the ship,
En-urta Ninib) went on, he made the storm descend.
The Anunnaki brandished their torches,
With their glare they lighted up the land.
The whirlwind or, cyclone) of Adad swept up to heaven.
. . . the land . . . as . . . had laid it waste.
A whole day long (the flood descended) . . . .
Swiftly it mounted up . . . (the water) reached the mountains
(The water) attacked the people like a battle
Brother saw not brother.
Men could not be known (or, recognized) in heaven.
The gods were terrified at the cyclone.

They betook themselves to flight and went up into the heaven of Anu.
The gods crouched like a dog and cowered by the wall.
The goddess Ishtar cried out like a woman in travail.
The Lady of the Gods lamented with a loud voice (saying)

(Ishtar's Lament)

"Verily the former dispensation is turned into mud,
Because I commanded evil among the company of the gods.
When I commanded evil among the company of the gods,
I commanded battle for the destruction of my people.
Did I of myself bring forth my people
That they might fill the sea like little fishes?"

(Uta-Napishtim's story continued.)

The gods of the Anunnaki wailed with her.
The gods bowed themselves, and sat down, and wept.
Their lips were shut tight (in distress) . . .
For six days and nights
The storm raged, and the cyclone overwhelmed the land.

(The abating of the storm.)

When the seventh day approached the cyclone and the raging flood ceased:
—Now it had fought like an army.
The sea became quiet and went down, and the cyclone and the rain-storm ceased.
I looked over the sea and the calm had come,
And all mankind were turned into mud,
The land had been laid flat like a terrace,
I opened the air-hole and the light fell upon my face,
I bowed myself, I sat down, I cried.
My tears poured down over my cheeks.
I looked over the quarters of the world—the open sea!
After twelve days an island appeared.
The ship took its course to the land of Nisir.
The Mountain of Nisir held the ship, it let it not move.
The first day, the second day, the mountain of Nisir held the ship and let it not move.
The third day, the fourth day, the mountain of Nisir held the ship and let it not move.
The fifth day, the sixth day, the mountain of Nisir held the ship and let it not move.
When the seventh day had come
I brought out a dove and let her go free,
The drove flew away and (then) came back;
Because she had no place to alight on she came back.
I brought out a swallow and let her go free,
The swallow flew away and (then) came back;
Because she had no place to alight on she came back.
I brought out a raven and let her go free.
The raven flew away, and saw the sinking waters,
She ate, the pecked on the ground, she croaked, she came not back.

(Uta-Napishtim leaves the ship.)

Then I brought out everything to the four winds and offered up a sacrifice;

I poured out a libation on the peak of the mountain.
Seven by seven I set out the vessels.
Under them I piled reeds, cedarwood and myrtle (?).
The gods smelt the savour,
The gods smelt the sweet savour.
The gods gathered together like flies over him that sacrificed.

(Speech of Ishtar, Lady of gods.)

Now when the Lady of the Gods came nigh,
She lifted up the priceless jewels which Anu had made according to her desire, (saying)
"O ye gods here present, as I shall never forget the lapis-lazuli jewels of my neck.
So shall I ever think about these days, and shall forget them nevermore!
Let the gods come to the offering,
But let not Enlil come to the offering,
Because he would not accept counsel but made the cyclone.
And delivered my people over to destruction."

(The Anger of Enlil (Bel)

Now when Enlil came nigh
He saw the ship; then was Enlil wroth
And he was filled with anger against the gods, the Igigi (saying);
"What kind of a being hath escaped with his life?
He shall not remain alive, a man among the destruction!"

(Speech of En-Urta)

Then En-Urta opened his mouth and spake
And said unto the warrior Enlil (Bel):
"Who besides the god Ea can make a plan?
The God Ea knoweth everything."
He opened his mouth and spake.
And said unto the warrior Enlil (Bel),
"O Prince among the gods, thou warrior,
How couldst thou, not accepting counsel, make a cyclone?
He who is sinful, on him lay his sin,
He who transgresseth, on him lay his transgression.
But be merciful that (everything) be not destroyed;
Be long-suffering that (man be not blotted out)
Instead of thy making a cyclone,
Would that a lion had come and diminished mankind.
Instead of thy making a cyclone
Would that a wolf had come and diminished mankind.
Instead of thy making a cyclone
Would that a famine had arisen and (laid waste) the land,
Instead of thy making a cyclone
Would that Urra, (the Plague god) had risen up and (laid waste) the land.
As for me I have not revealed the secret of the great gods.
I made Atra-hasis to see a vision, and thus he heard the secret of the gods
Now therefore counsel him with counsel."

(Ea deifies Uta-Napishtim and his wife)

Then the god Ea went up into the ship,
He seized me by the hand and brought me forth,
He brought forth my wife and made her to kneel by my side

He turned our faces towards each other, he stood between us, he blessed us (saying),
"Formerly Uta-Napishtim was a man merely,
But now let Uta-Napishtim and his wife be like unto the gods, ourselves.
Uta-Napishtim shall dwell afar off, at the mouth of the rivers."

(Uta-Napishtim ends his story of the deluge.)

"And they took me away to a place afar off, and made me to dwell at the mouth of the rivers."

Such was the remarkable story of the flood deciphered by George Smith from the tablets of the royal library of Asshurbanipal. It forms the greater part of the eleventh tablet of the great Gilgamish epic. In the closing part of the tablet, when Tsitnapishtim had finished the story he takes up the healing of Gilgamish. For six days and nights he slumbered in magic sleep and on the seventh day he woke suddenly and, fearful of remaining longer in the waters of death, begged of Tsitnapishtim once more to reveal to him the secret of immortality. Then Tsit—(Ut- or Pir—) Napishtim commanded his lieutenants saying:—"This man is covered with boils; leprosy has annihilated the charm of his body. Take him to the place of purification. In the waters let him wash his abscesses pure as snow." Then "his boils washed he in the waters pure as snow. His leprosy he cleansed. The sea bore it away. Sound became his body." Then spake the wife of Tsitnapishtim to her husband: "Eabani has come, rested, refreshed. What will you do that he turn back to his land?" Then Tsitnapishtim opened to Eabani the marvelous secret of the gods, by advising him of a certain plant which grew at the bottom of the sea which would give him immortality. Weighted with heavy stones, Gilgamish lowered himself through an opening in the floor of his boat and reaching the bottom of the sea, saw and plucked the plant and ascended with his heart's desire. The name of the plant of life was "the old man becometh young again." "I shall eat it," exclaims Gilgamish, "in order to recover my lost youth!" He planned to take it home to "walled Uruk" but while he was bathing in a pool on his way home to Erech a serpent (dragon) discovered the plant by its odor and swallowed it. Then Gilgamish sat down and wept. He cursed aloud over his useless struggles and the vain efforts of his months of toil. A weary and disheartened wanderer he at last reached Erech.

The twelfth and last chapter comes to us in only very fragmentary form with many gaps but we may still learn from it that Gilgamish did not abandon his plan and hope of finding the secret of immortality. Having wandered all over the world in its search he now endeavors to discover it in the kingdom of the dead. Advised by the priests of the temple, he beseeches god after god to open the ground that his friend Eabani may come back to him and tell him what sort of life they lived who had passed beyond.

Then Gilgamish raises his voice in his distress: "Eabani has descended from earth to Aralu. It is not the messenger of Nergal, the implacable, who has snatched him away. It is not the plague which has carried him off. It is not consumption that has carried him off. It is the earth which has carried him off. It is not the field of battle which has carried him off. It is the earth which has carried him off!" So staggers he from the temple of Bel to the temple of Sin until he cries to Nergal, god of the dead: "Burst open the sepuchral cavern, open the ground, that the spirit of Eabani may issue from the soil like a blast of wind." Nergal the violent, caused the spirit of Eabani to issue from the earth like a blast of wind. The Gilgamish anxiously asked him what the state of the dead in Shualu is. "Tell, my friend, tell, my friend, open the earth and what thou seest tell it." "I cannot, I cannot tell thee, my friend. I cannot tell it thee. If I could open the earth before thee, if I were to tell to thee that which I have seen, terror would overthrow thee, thou wouldst faint away, thou wouldst weep." "Terror will overthrow me. I shall faint away. I shall weep, but tell it to me." Then Eabani describes the sorrows and sufferings of the underworld, where only those shades know happiness who have fallen in battle with arms in their hands, and who have been solemnly buried after the fight, those neglected by their relatives succumb to hunger and thirst.

"On a sleeping couch he lies, drinking pure water,* he who has been killed in battle."

---

* Compare Luke X:21, 24 XLI:24: And in Hell (Hades) he lift up his eyes lying in torment . . . and said . . . "Send Lazarus that he may dip the tip of his fingers in water and cool my tongue." Compare also Koran, the Chapter of the Inevitable:

These are they who are brought nigh,
In gardens of pleasure!
A crowd of those of yore,
And a few of those of the latter day!
And gold-weft couches, reclining on them face to face
Around them shall go eternal youths, with goblets and ewers and a cup of flowing wine; no headache shall they feel therefrom, nor shall their wits be dimmed!

"Thou hast seen him?" "I have seen him: his father and his mother support his head and his wife bends over him wailing." "But he whose body remains forgotten in the fields—thou hast seen him?" "I have seen him: his soul has not rest at all on earth." "He whose soul no one cares for—thou hast seen him?" "I have seen him, the dregs of the cup, the remains of a repast, that which is thrown among the refuse of the street, that is what he has to nourish him." (Maspero.)

Such is the story of the first great analogy. It is the most marvelous myth of all, the interpretation in terms of human life, of the spirituality of the universe. Even upon its very surface it carries its own explanation. Gilgamish, like all of his manifold followers, is the brilliant young sun-god and the story of his wanderings is that of the great star through the twelve months of the year. Beginning with the Vernal Equinox, March 21, and the month Nisannu, Nisan, the story leads us in a manner not unlike the many myths of succeeding ages through the waxing of his power and glory until it reaches its peak in the passionate joys of spring, thence through the slow decrease of power and strength until the enchanted sleep of the winter solstice and thence through the eternal process of purification and re-birth unto full resurrection and power again. The very calendar of the Babylonians, and ours as well.

And fruits such as they deem the best;
And flesh of fowl as they desire;
And bright and large-eyed maids like hidden pearls;
A reward for that which they have done!
They shall hear no folly there and no sin;
Only the speech, 'Peace, Peace!'
And the fellows of the right—what right lucky fellows!
Amid thornless lote trees.
And tal'h trees with piles of fruit;
And outspread shade,
And water out-poured;
And fruit in abundance, neither failing nor forbidden;
And beds upraised!
Verily, we have produced them a production.
And made them virgins, darlings of equal age (with their spouses) for the fellows of the right!
A crowd of those of yore, and a crowd of those of the latter days!
And the fellows of the left—what unlucky fellows!
In hot blasts and boiling water;
And a shade of pitchy smoke,
Neither cool nor generous!
Verily, they were affluent ere this, and did persist in mighty crime; and used to say 'What, when we die and have become dust and bones, shall we then indeed be raised? Or our fathers of yore?'

marks the chapters of the legend and the correspondence is so beautiful that we must state it somewhat in detail. At the present time our sun is in the constellation Pisces, the fishes, at the time of the vernal equinox. But 2,000 years ago he was in Aries, the Ram. Two thousand years before that, when the ancient calendars began, he was in Taurus, the Bull, and it is a striking fact that the beginning of life in the spring of the year is associated in all the ancient calendars with this month called in the Accadian calendar "the month of the propitious bull," when the man-bull Eabani came to "walled Uruk." "Canst thou bind the sweet influences of the Pleiades?" In the following month, our May, (Gemini), the Accadian "month of the Twins," the intimate friendship of Gilgamish and Eabani is formed. In the third month, our June (Cancer), the Accadian "month of the boon of the seed (compare the pomegranate seed of Proserpina), the sun begins its retrograde movement. This month is believed to have been sacred to Dumuzi, the weakening winter sun. Nevertheless, in the fourth month, our July (Leo), the Accadian "month of fire," the heat of the sun is, as we well know, still growing in intensity. So that the sign in this month is that of the lion, anciently synonymous with fire, as that of the preceding month is the sign of the cancer or the crab who seems to go backward as he progresses. It is in the fifth month, our August, the Accadian month of the message of Ishtar, whose sign is the Virgin (Virgo), that the beautiful goddess entreats the departing sun to remain with her as her lover. But the eternal urge is upon him who must press forward perpetually in his fixed path. Ever westward he tends during the sixth month, the weary wanderer searching for the secret of immortality, weakening as he goes. In the seventh month, our October, the Accadian month of the scorpion, (Scorpio), he reaches Mount Mashu, pictured elsewhere as marking the limits of the super-heated wastes of the Arabian desert, thick with serpents and scorpions of the wilderness, the kingdom of the dead, guarded by scorpion men. In the eighth month, our November, the Accadian "the cloudy month," he is passing over the waters of death guided by the pilot of Shamash. In the ninth month, our December, the Accadian "month of the cavern of the setting sun," with the winter solstice (December 21) as in nature, he reaches the goal of his journey and Tsitnapishtim stands revealed. In the tenth month, our January, the Accadian "month of the curse of rain," a time of violent storms, floods and downpours in the lowlands of Mesopotamia, Ut-Napishtim recites the story of the great deluge. In the eleventh month, our February, the Accadian "month of the fishes of Ea," he turns his face homeward again over the waters, purified and strengthened. And then, in the last, the twelfth month, closing with the vernal equinox, March 21, called in the Accadian calendar "the month of the altar of Bel," whose sign is the ram, a fit sacrifice on the altar of Bel, he offers up his tribute of thanksgiving to the gods even as his great ancestor had done at the end of the flood.

In a thousand forms this wonderful myth has permeated the religion and literature of all peoples of all succeeding ages, not that it is the mother myth of them all but that it is found by the archeologists at a point of time nearest the original myth-spring of tradition. As it is the oldest, so it probably represents most clearly and fully the original form of the great primal solar-astral myth as it existed before the separation of the white peoples from their original home in Asia. How far back it goes, who can say? Are its roots sunk into the folk-lore of Neolithic days? Did Cro-Magnon man tell it to his child? Did the boy who was buried with his face to the west by his Neanderthal mother 50,000 years ago understand its meaning?

THE DEATH OF DUMUZI

Dingir, Ilu, El, all are gone.
Shamash, Elohim, Baal, are at rest with Ra and Aten.
Yet by Thee, who wert they, are our days still numbered.
With Thee we begin our year: in our youth
We offer our vernal sacrifices upon the Altar of Bel.
In April's Taurus we lift half-bestial manhood
Into companionship with the gods.
Twin comrades are we in May.
And though, in solsticed June, Thou dost begin to pale,
Yet in the Lion's strength of July is our power triumphant
Over every tyrant Khumbaba.
Comes the Month of the Message of Ishtar,
She of the broken loves—
Of Allala, the spotted sparrow-hawk
Whom she loved, and who now cries in the forest—
"Oh, my wings, my broken wings!"
Of the mighty lion whom she loved,
And caused to be rent to pieces;
Of the splendid stallion driven to exhaustion by hunger and thirst;
Of the shepherd Tabulu, transformed into a leopard;
Of Ishullanu, whom she turned into a dwarf—
The month of Ishtar, who loved Dumuzi,
He who weakened as the winter sun,
Dumuzi shepherd of the clouds,
For whom the whole world wails; saying:
"Ishtar, beautiful Ishtar is gone
To the land without return,
For Dumuzi, her lover is dead;
The wild boar has slain him
In the deep, dark forest of Eridu,
Into the heart of which no man has penetrated,
By the black pine,
That marks the center of the earth;
Stern Allat has taken him
Ruler of the Great City,
Queen of the House of Darkness,
And now all love is ended;
Earth has ceased to bring forth children.
But we know that fair Ishtar shall enter
The dwelling place of Irkalla,
Over the waters of death will she pass,
Through the seven gates and their watchers,
Till, stripped of her jewels and naked,
She stands before Allat, her sister,
Demanding the Waters of Life
That spring from the threshold of the palace.
Though smitten of Namtar the mighty,
With sickness of eyes and heart and head,
Yet shall she force the fierce Namtar,
Before the golden-throned Anunnaki,
To sprinkle her, queen of all lovers,
That Dumuzi, her lover may live."

CHAPTER XIX.

THE MESSAGE OF THE MOTHER.

Who of us is there that has not read with delight the ancient story of the sleeping beauty, the lovely daughter of a beautiful mother's prayer, whose destiny it was, at the age of maturity, to enter the fateful chamber of the palace and there, pricked by the point of a spindle, to sink into her long repose, from which she could only be awakened by the kisses of Prince Charming. Her sleep is as the sleep of the Great Mother who dreams in icy peace, the snows and the sleet of the long winter upon her, whose slumbers none may interrupt until the yellow-haired sun breaks through all obstacles, and with the kiss of spring, awakens her again to the renewed joys and life of another year. As it is with the Father Sun, whose year-long pathway we have traced in the preceding chapter, so it is with Mother Earth below, each day of whose life is a counterpart of his footsteps on high. Nor did early man fail to grasp the meaning of this parallelism. It was as if they, in their earliest consciousness, understood that there is a certain spiritual quality in the world about them, a definite moral order of the universe. And in the dimness of their groping their hands touched, at the beginning, the solution of the mystery, that the universe is one; that its unity is its meaning; that as it is with one of its parts so it is with all; that the lives of men and earths and suns are in essence the same; that Father Sun could not move in the sky, nor Mother Earth wait anxiously below without conveying to their children the solution of the mystery of their own struggles. It is not a matter of wonder, therefore, that we find such legends as that of the sleeping beauty in all the literatures of the white race, whether Semitic, Hamitic, or Japhetic. But of them all the one that is the most ancient and that represents probably the nearest approach to the original earth-myth as it was told on the plateau of Iran or the heights of Pamir before the separation of the white peoples, is that of the Descent of Ishtar. Tammuz, the weakening winter sun, has been slain by the tusks of a wild boar, perhaps in the deep, dark

Nergal, god of the Chaldean under world, Shualu, and husband of queen Allat. His face is shown on the reverse side of this tablet, page 341. From Maspero's *Dawn of Civilization*. (Courtesy of D. Appleton & Co.)

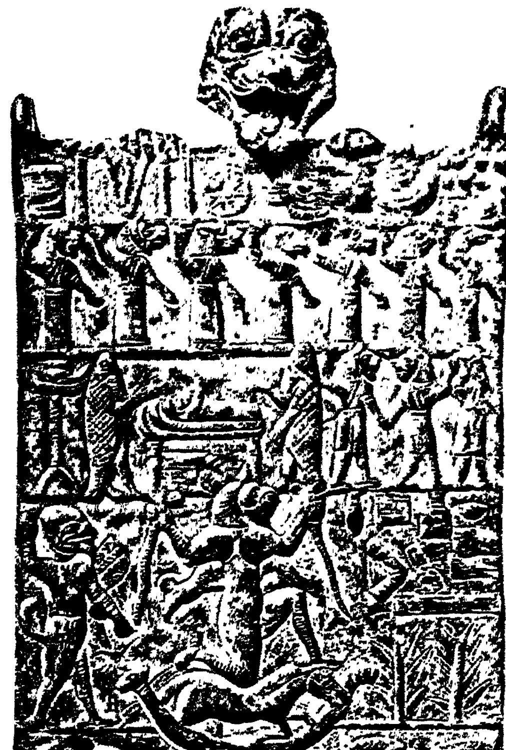
forest of Eridu near the great pine which marks the center of the earth. In her distress, Ishtar determines to seek her lover in the land of the dead, whose queen is Allat and whose king is Nergal, her husband, that she may bring him back to the upper world and to life and happiness again, so,

"To the land without return,
Directed Ishtar, the daughter of the moon god, her mind,
To moon god's daughter directed her mind
To the home of darkness, to the dwelling place of Irkalla.
To the house whose entrant comes out nevermore,
To the path whose entrance does not lead back.
To the house whose inmate is deprived of light,
To the place where dust is their nourishment, where their food is dirt,
The light they see not, in darkness they dwell,
There they are clad as birds, in feathers for clothing
Upon door and threshold thickens the dust.

"When Ishtar to the door of the land without return had come
She spake to the watchman of the door; "Watchman of the waters, open thy door
Open thy door, enter will I!
If you do not open and I cannot enter,
I will shatter the door, the threshold destroy.
I will shatter the sills, tear up the door posts.
I will lead out the dead, that they eat and live.
To the living shall flock the dead!"
The watchman opened his mouth to speak
To announce the exalted Ishtar:
"Desist, my queen, destroy it not.
I will go and thy name announce to Queen Allat."
The watchman entered, spoke to Queen Allat,
"These waters has thy sister Ishtar traversed"
. . . .
When Queen Allat heard this
Like the cutting off . . . . . of trees,
Like the tearing of reeds, sank she down and spoke:
"Like to the over-flowing of a deluge, like the rushing waters of a mighty flood
Will I weep over the men who their wives have left
Will I weep over the women who from the loins of their husbands are taken
Over the little children will I weep who before their time are snatched away;
Go, watchman, open to her thy door
Do to her according to the ancient law."

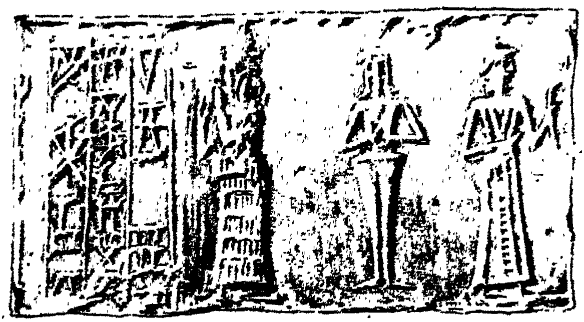
The watchman went, opened to her his door
"Enter, my Queen, may the underworld shout with joy
May the palace of the land without return delight in thy arrival."
He bade her enter the first door, disrobed her, the great tiara taking from her head.
"Why, O watchman, takest thou the great tiara from my head?"
"Enter, my Queen, for these are the Earth-queen's commands."

He bade her enter the second door, disrobed her, the jewels taking from her ears.
"Why, O watchman, takest thou the jewels from my ears?"
"Enter, my Queen, for such are the Earth-queen's commands."
The third door he bade her enter, disrobed her, the chains taking from her neck.
"Why, O watchman, takest thou the chains from my neck?"
"Enter, my Queen, for such are the Earth-queen's commands."
The fourth door he bade her enter, disrobed her, the ornaments taking from her breasts.
"Why, O watchman, takest thou the ornaments from my breasts?"
"Enter, my Queen, for such are the Earth-queen's commands."
The fifth door he bade her enter, disrobed her, taking the girdle of precious stones from her hips.
"Why, O watchman, takest thou the girdle of precious stones from my hips?"
"Enter, my Queen, for such are the Earth-queen's commands."
The sixth door he bade her enter, disrobed her, the spangles taking from her hands and feet.
"Why, O watchman, takest thou the spangles from my hands and feet?"
"Enter, my Queen, for such are the Earth-queen's commands."
The seventh door he bade her enter, disrobed her, the shame cloth taking from her body.
"Why, O watchman, takest thou the shame cloth from my body?"
"Enter, my Queen, for such are the Earth-queen's commands."
When, now, Ishtar had gone down to the land without return and looked upon Allat, she began to rage
Ishtar, beside herself, rushed towards her . . . .
Then Allat opened her mouth to speak, to Namtar, her servant, to make known the command
"Go, Namtar, open my . . . . . and
Lead them out . . . . . the queen Ishtar
With sickness of the eyes strike her
With sickness of the hips strike her
With sickness of the feet strike her
With sickness of the heart strike her
With sickness of the head strike her.
Upon all her person . . . ."
After Ishtar, the queen (had departed from the Earth)
The ox does not bend over the cow nor the ass bend over the she-ass
Over the maid of the street does not bend her lord,
Papsukal, the servant of the great gods, scratched his head before Shamash
Clad in garments of mourning . . . .
To Shamash he went, before Sin, his father, he wept
Before Ea, the king, came his tears.
"Since Ishtar has descended into the land without return the ox does not bend over the cow, nor the ass over the she-ass,
Over the maid upon the street her lord does not bend."
Then created Ea in the wisdom of his heart a man-like being
He created Uddusunamir, the servant of the gods.
"Hasten, Uddusunamir, to the door of the land without return direct your countenance
The seven doors of the land without return must open for thee;
Allat must see thee, thine arrival to welcome.
After her heart is rested and her spirit is refreshed



The goddess Allat queen of the under world passes through Shualu in her bark. The face of Nergal, her husband is shown above. From Maspero's *Dawn of Civilization.* (Courtesy of D. Appleton & Co.)

Then enchant her with the names of the great gods.
Lift thy head toward the spring, direct thy mind and speak
"O, my Queen, the spring must not remain barred; from the water therein will I drink."
When Allat heard this,
She struck her hips, she bit her finger and spake;
"Thou hast asked of me an impossible request!
Forth, Uddusunamir, I will shut thee up in the great prison.
The slime of the street shall be thy nournishment,
The gutters of the street shall be thy drink,
The shadows of the wall thy dwelling,
The sill thy habitation,



Ishtar disrobed of her garments in Shualu. From *The Dawn of Civilization*, Maspero. (Courtesy of D. Appleton & Co.)

Prison and dungeon must break thy power!"

. . . .

Allat opened her mouth to speak
To Namtar, her servant, she made known her command;
"Go, Namtar, shake the eternal palace,
Destroy the posts, upheave the sills,
Lead the Annunaki out,
Set them upon a golden throne,
Sprinkle the goddess Ishtar with the waters of life"

Namtar went, shook to pieces the eternal palace, destroyed the posts so that the sills upheaved;
The Annunaki led he out, set them upon a golden throne;
The goddess Ishtar sprinkled he with the waters of life and led her forth.
Through the first door he led her out, gave her back the shame cloth of her body.
Through the second door he led her out, gave her back the spangles for her hands and feet.
Through the third door he led her out, gave her back the girdle for her hips set with precious stones.
Through the fourth door he led her out, gave her back the ornaments for her breasts.
Through the fifth door he led her out, gave her back the chains of her neck.

Through the sixth door he led her out, gave her back her jewels of her ears.
Through the seventh door he led her out, gave her back the great tiara of her head.

It is very interesting to compare this Shualu which accompanied Abraham from the Ur of Chaldees with the Hebrew Sheol or underground abode of the dead. Some of the other names applied to it by the sacred writers are Abaddon, Destruction; Bor, the Pit; Dumah, Silence. Sheol, itself, is probably derived from a root meaning "to

Dumuzi (Tammuz), rejuvenated on the knees of Ishtar. From *The Dawn of Civilization*, Maspero. (Courtesy of D. Appleton & Co.)

be hollow" just as our own hell, (hoehle, hollow) is derived. An adequate description may be gleaned easily from a cursory reading of the scripture: It was the "land of the shadow of death, without any order where the light is as darkness." (Job 10-21.) "There the wicked cease from troubling and the weary are at rest." "They that are deceased tremble beneath the waters and the inhabitants thereof." (Job 26-5). "The dead goes to the generation of his fathers; they shall never see the light." (Psalm 49-19). It is "in the lowest pit, in dark places, in the depths." Like Aralu, it is also a land of dust. "For thou shalt sleep in the dust and thou shalt seek me in the morning and I shall not be. Thou shalt go down to the bars of the pit, when once there is rest in the dust." (Job 17-16). Like Aralu this "house appointed for all living" is possessed of gates and bars. "In the noontide of my days," exclaimed Hezekiah, "I shall enter the gates of the grave." And Job adds, "Thou shalt go down to the bars of the pit when our rest together is in the dust." These are the bars that closed over recreant Jonah at the bottom of the mountains.

We may well imagine that the Hebrew like the Babylonian pictured it as the distant land. "Whither shall I go from thy spirit," exclaimed the Psalmist, "Or whither shall I flee from thy presence. If I ascend up into heaven, thou art there. If I make my bed in Sheol, behold, thou art there." Nor could any man escape from "his long home." "What man is he," asks the Psalmist, "that shall deliver his soul from the land of Sheol?" It is as if Uta-Napishtim was speaking in Ecclesiastes: "No man hath power over the spirit to retain the spirit, neither hath he power over the day of death." And Job adds, "So man lieth down and riseth not up. Till the heavens be no more, they shall not awake nor be raised out of their sleep."

We get a fascinating view of this popular belief in the appearance of Samuel to the witch of Endor upon the petition of King Saul. The prophet came up out of the earth clothed in his same old cloak and asking, "Why hast thou disquieted me to bring up?" We can hear the author of Ecclesiastes adding, "For there is no work, nor device, nor knowledge, nor wisdom in Sheol whither thou goest." "Death shall be thy shepherd," continues the Psalmist, "and thy beauty shall be for Sheol to consume." To which Job adds: "There the prisoners are at ease together. They hear not the voice of the task-master. The small and the great are there and the servant is free from his task-master." Perhaps the finest description in the whole Bible of the popular conception of the land of the dead is contained in the fourteenth chapter of Isaiah which pictures the entrance of the king of Babylon into Sheol. In it we see the shades of all the dead gathered by nations unto their fathers, emasculated, comatose, shadows of their former selves. The last sentence suggests the words of Eabani: "The dregs of the cup, the remains of a repast, that which is thrown among the refuse of the street, that is what he has to nourish him."

"The whole earth is at rest, and is quiet; they break forth into singing. Yea, the fir-trees rejoice at thee, and the cedars of Lebanon, saying, Since thou art laid low, no hewer is come up against us. Sheol from beneath is moved for thee to meet thee at thy coming; it stirreth up the dead for thee, even all the chief ones of the earth; it hath raised up from their thrones all the kings of the nations. All they shall answer and say unto thee, Art thou also become as weak as we? Art thou become like unto us? Thy pomp is brought down to Sheol, and the noise of thy viols: the worm is spread under thee, and worms cover thee. How art thou fallen from heaven, O day-star, son of the morning! How art thou cut down to the ground, that didst lay low the nations. And thou saidst in thy heart, I will ascend into heaven, I will exalt my throne above the stars of God; and I will sit upon the mount of congregation, in the uttermost parts of the north; (This is equivalent to the Babylonian "Mount of Assembling, in the far North, E har sag gal kurkura, the dwelling place of the gods," and to the Greek Olympus). I will ascend above the heights of the clouds; I will make myself like the Most High. Yet thou shalt be brought down to Sheol, to the uttermost parts of the pit. They that see thee shall gaze at thee, they shall consider thee, saying, Is this the man that made the earth to tremble, that did shake kingdoms; that made the world as a wilderness, and overthrew the cities thereof; that let not loose his prisoners to their home? All the kings of the nations, all of them, sleep in glory, every one in his own house. But thou art cast forth away from thy sepulchre like an abominable branch, clothed with the slain, that are thrust through with the sword, that go down to the stones of the pit; as a dead body trodden under foot."

Equally vivid in its revelation of the way in which this myth permeated the literature of all the white races is the striking story told in the 16th chapter of Numbers concerning the rebellion of Korah, Dathan and Abiram, judgment upon whom Moses pronounced as follows: "If these men die the common death of all men or if they be visited after the visitation of all men, then Jehovah hath not sent me, but if Jehovah maketh a thing and the earth open its mouth and swallow them up with all that appertain with them and they go down alive into Sheol, then ye shall understand that these men have despised Jehovah." "And it came to pass, as he made an end of speaking all these words, that the ground clave asunder that was under them and the earth opened its mouth and swallowed them up and their households and all men who appertained unto Korah and all their goods. So they and all that appertained to them went down alive into Sheol and the earth closed upon them."

Such are a few of the numerous references to the underground world of the dead to be found in the Bible. Such phrases as "goeth down to Sheol," "deeper than Sheol," "hide me in Sheol," "the bars of Sheol," "Sheol is naked before God," "in Sheol who shall give praise?" "the cords of Sheol," "deliver my soul from the lowest Sheol," "thy beauty shall be for Sheol to consume," "the pains of Sheol gat hold upon me," "her guests are in the depths of Sheol," "Sheol and Abaddon are before Jehovah," "Sheol and Abaddon are never satisfied," "jealousy is cruel as Sheol," "Sheol hath enlarged its desire," "your agreement with Sheol," "O Sheol where is thy destruction!" "out of the belly of Sheol, cried I" (Jonah)—these and others are familiar to the readers of scripture and the myth to which they refer is common to all the white races of the world.

Through what long and hazy pathway this Sheol-Shualu myth had come and what had been its history up to the time it was reduced to writing thousands of years before Christ, we may only guess. It represents the last stage in the process of personification of the universe, and is based upon the principle that mankind interpreted that which was about him in terms of that which was within him. He thought and felt and willed, and his thoughts, emotions and deeds did not seem to him to be, nor indeed were they, very different from the thoughts and emotions and deeds of the animate world about him. Furthermore, the thoughts, feelings and actions of the animal world sank by invisible gradations into the vegetable and thence into the inanimate worlds. As has been well said, there was to him no supernatural because he did not know what nature was. Nor had he measured the intelligence of other living things about him. He did know that there were many of them mightier than he, who overcame him easily by their power, and especially he knew that some strange force was constantly at work reducing even the mightiest of men and the greatest of plants and the most powerful of animals, aye even the supreme ruler of them all, the sun, to weakness and death. His theory was that all powers are spiritual. We speak of sickness, he spoke of demons possessing the body. We speak of death, he spoke of a spirit that had driven out the spirit of the man and taken possession of his body. We speak of the howling of the wind in an impersonal way, but the very words witness to that earlier faith which ascribed to the storm his voice in the same way as to the man.

With all this in mind, we can interpret this wonderful message of the Mother Earth which they had read and understood. It is the crystallization in words of the earliest of all faiths and one of the most beautiful of all analogies. If everything is alive; if the stars and the trees and the birds and the beasts also think and feel and do; then how full of meaning must be the life of the mother of men and what depths of wisdom must lie in her life-story. How like she was to the beautiful maiden, united to her lover in the spring, and what must have been the terror in her soul as she saw her husband losing his strength day by day until he was powerless to protect her from the chilling winds and the icy sheets of winter. And as it is with women, so it was with her. She resolved to find her lover slain by the tusks of the wild boar; to follow him into the great hollow (hoehle, hell) unto the nethermost part of the earth, in order that she might strengthen him with the waters of life and restore him once more to the power and beauty of his youth. As we read the story of her descent to Aralu we are reminded of Ceres who followed her daughter Persephone to the underworld only to find that she had eaten the pomegranate seed proffered her by her lord Pluto but who was, nevertheless, able to win Jovian consent for her to spend one-half of the year in the bright world of her love above. Also we see the Sibyl guiding Aeneas through Tartarus unto the Elysian fields, bathed in their purple light, where the blessed of the gods reside (for Virgil has here consolidated the Fields of the Blessed with Aralu). There, like another Gilgamish, he found his father with the other departed great in the beautiful laurel grove, amid feasting and music. Nor do we forget the love of Venus for Adonis, nor a hundred other beautiful explanations of how the maiden-Eearth, snatched away in all her rapturing beauty or desperate over her dying lover, descends to a vast underground Shualu, Sheol, Aides, Tartarus, Hoehle, Hell, there to discover the secret of the daily and annual rebirth of the sun and the annual resurrection of earth life; to find the waters of life. That very expression, "the waters of life," how it has come down the ages to comfort and strengthen the hearts of men in every clime and of every faith. By its power, Gilgamish was purified, and for its mysterious magic Ponce de Leon explored a continent. It springs from the same source of hope as that from which all men who have thought deeply about the universe have drawn their inspiration. If we can forget the impersonalities of our science long enough to remember that we do not ourselves know the source of power; that we can only conceive of it in terms furnished by the constitution of the human spirit; that we have deprived nature of that richness wherewith earliest man filled it; that they had no terms with which to speak of the world around them except terms of thought and emotion and deed, in short, of life; and that it still remains a question as to whether they or we are nearest the truth; we will begin to understand how much this message of Mother Earth may mean to us. At any rate, by it we are brought sharply face to face with the fact that, from the beginning of their thinking, when men sought to answer the riddle of the universe, and especially the riddle of life and death, they, as we have sought to find out what it is all about, what it is for. They answered it in terms of volition and spirit and we answer it in terms of force and law. Yet, day by day, there arise among us those who find their highest wisdom in sympathy with these earliest conceptions. Surely there was no greater in his generation than Herbert Spencer, who summed up his knowledge in these words: "We are ever in the presence of an infinite and eternal energy, from which all things proceed." "Of what I call God and fools call Nature," Browning explains. Nor among those who most clearly understood the philosophy of history has there arisen a greater than Matthew Arnold who unlocked the story of men with this key: "There is a power, not ourselves, that makes for righteousness." No one has expressed it more finely than Camille Flammarion: "There is an incommensurable power which we are obliged to recognize as limitless in space and without beginning or ending in time and this power is that which persists through all the changes in those sensible appearances under which the universe presents itself to us." The ancient Omar spoke of Him

> Whose secret presence through creation's veins,
> Running quicksilver-like eludes our pains,
> Taking all forms from Mah to Mahi and
> They change and perish all but He remains.

And among the seers of these latter days who have grasped the newest discoveries of science in one hand and held on to the oldest of faiths in the other, there is Tennyson who speaks to us almost in ancient Babylonian phrases when he writes:

> The sun, the moon, the stars, the hills, the seas, the
> plains,
> Are not these, O soul, the vision of Him who reigns;

Speak to Him thou, for He hears, and spirit with
spirit can meet,
Nearer is He than breathing and closer than hands or
feet!

Thus again the science brings the golden plunder of a mighty day of toil and lays it at the feet of religion, repeating as it were those fine words of the ancient Hebrew proverb:—

My son, if you heed my words,
And store my commands in your mind,
Attentively listening to wisdom,
Applying your mind unto reason,
If you will but seek her as silver,
And search for her as for hid treasures,
You shall then understand true religion,
And gain a knowledge of God.

WHITHER, LORD SUN?

And after the Message of Ishtar,
When the sun declines to September.
Still follow we Thee to the Scorpion Men,
The flaming Cherubim of Shamash,
Who guard the gate of the mountain,
The mighty mountain of Mashu,
Still follow we Thee, pale Dumuzi,
Who daily approachest thy cavern.
Through the month of the Clouds, then, thou leadest,
Of clouds and increasing darkness,
That shadow the way to the Islands,
And still do we follow Gilgamish,
Through the Cavern of the Setting Sun,
Nor turn we back from thy footsteps,
Leading into the blackness beyond,
To the shore of the mighty river,
That girdles the earth as an ocean,
There to meet kind Sabitu's mercy,
Arrived in her marvelous forest
That borders death's ultimate waters,
And the pilot of God, Arad-Ea,
Who guides only Shamash thereover,
Through billow and tempest to follow
Through darkness, the path to the westward
Till, lastly, the Isles of the Blessed!
Nor turn we back from thy footsteps
In the month of the Curse of Rain,
When floated above the high temples,
To land upon sacred Mount Nisir,
The ark of the wise Pir-Napishtim
Whom thou, O Gilgames, found, also,
Transported by Ea, immortal,
Near the Fountain of Youth that springs ever,
Afar, at end of the world,
In the west, on the Isles of the Blessed.

O Sun,
Thou who givest us light, warmth and power,
Who dost glow in the fire,
Sparkle in the lightning,
And muscle the mighty river;
From whom cometh all joy,
All songs that the mummer knows,
All perfumes that the flowered meadow spreads,
All colors of the jewels of Ishtar,
The grace of all loved and lovers,
And Eabani's bull-like might;
Toward whose elusive abode,
In thy golden sunset palace,
The steps of men have pressed, westward,
Seeking the secrets of Thy glory
As their aureate hoard of promise
Beneath the bow of Ishtar's necklace:
We follow Thee, lord Sun,

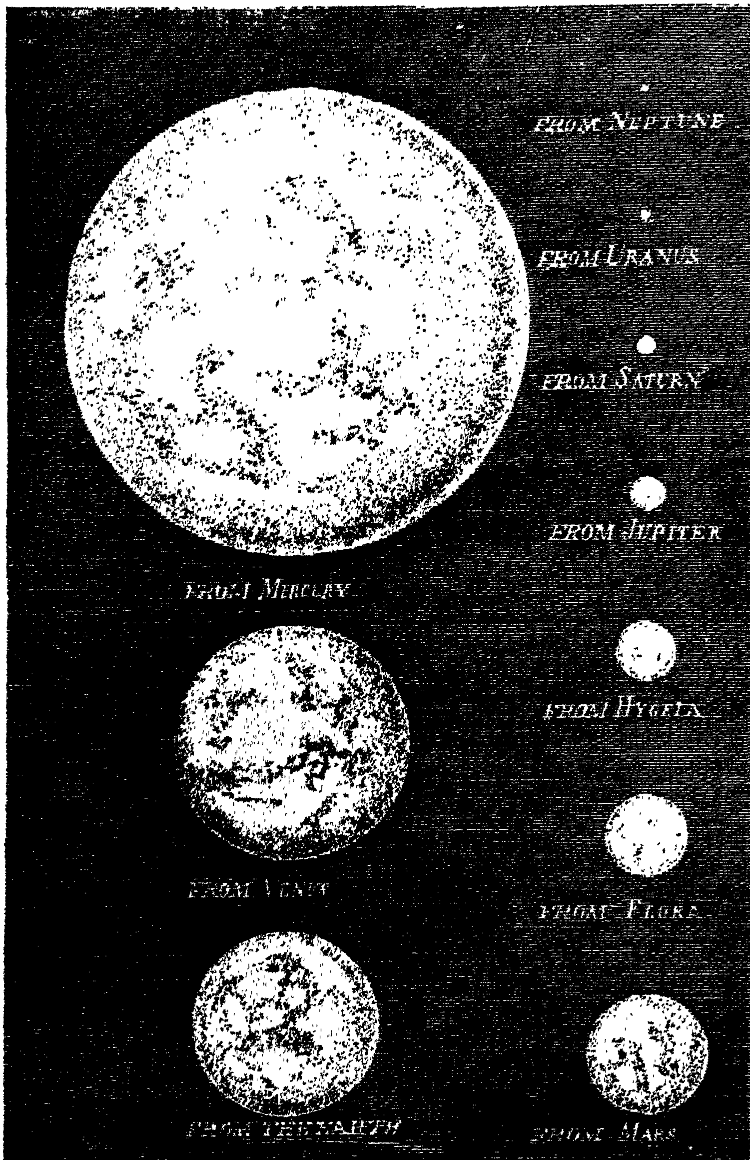
CHAPTER XX.

THE ETERNAL STRUGGLE

The fundamental fact of the apparent universe is darkness. Night dominates space. Only about the hearthstone of each little star is there radiance and warmth. Even near the suns some of the planets share but slightly in the light. Neptune, for example, enjoys only 1·900th of the amount of light and heat that we enjoy, and a traveller through interstellar space need go but a single light-year before he knows himself to have reached the outer darkness. There the most brilliant light visible would be scarcely more radiant than our own Sirius or Capella. Throughout the universe night is the law, day is the exception. Early man seems to have been more conscious of this fact than his sophisticated descendants of today. To him it was a vital thing that the sun should rise, nor was he any too sure of its continued beneficence. The one great idea which conquered his imagination and dominated his thought was that of the solar radiance. That is the reason why, in all early religions, light is divine. Ilu, El, Allah, Elohim, all of these are derived from the

---

Into the abysses of space
Past the Isles of the Blest,
That lie at the mouth of the great rivers;
To the far, far west
We follow Thee,
Whither, lord Sun?
O far borne wanderer, Gilgames,
Thou face of the hope eternal,
Thou stricken and ever resurgent;
By all of the faith of the ancients,
By all of the blood of their altars,
By all the death cries of thy millions,
The sun-sacrificed of all ages,
May we, with the fishes of Ea,
Who mark the last stage of Thy journey,
Come forth with thee, strong and triumphant,
Exalted, aglow, resurrected,
As after the storm shines the sun comes forth,
As after the darkness comes morning,
As after the winter the spring wakes!
Into the light of the morning,
Into the joys of spring,



Sizes of the sun as seen from the planets. From Flammarion's *Popular Astronomy*. (Courtesy of D. Appleton & Co.)

Semitic root which means to shine, and our own Aryan tongues tell the same story. Div, Deva, Dyaus, Deus, Zeus, Theos, even Tues-day and perhaps also Odin, Goudan, Gott, God, go back to the same sanskrit root that means to shine. Even the ex-gods remind us of their former glory. When the negro mammy warns her little boy that the "booger-man" (bogie-man) will get him, our students of language explain to us that the root-stem of bogie leads us directly back to Bog, Bhaga, Bagaios, holy symbols again, of the divine light. The very daemons testify, similarly to their royal descent, for they also once were gods before mono-theistic Zarathustra deposed them. The very devil, him-self, as we all know, was once an angel of light as his name signifies. Jupiter, himself, is but a combination of Zeus-pater, Dyaus-pitar, the great father of the radiant heaven. It is quite evident to those who know most of the subject that the shining firmament, the life and light of day, was the fundamental religious idea of all nations.

See how completely the world is girdled with this thought. When the Indo-European travellers reached this country they brought with them one of the most beau-tiful of all the myths of the sun-illumined sky. It was the story of Oedipus, the sun, whose father, Laios, the night, had been warned that he would die by the hand of his son. In order to avoid this terrible catastrophe, the little babe was exposed on the hillside, just as the early rays of the rising sun are always exposed on meadow and mountain. A kindly fate, however, rescued him from death just as Romulus and Remus and a score of other solar di-vinities were rescued. On his way to the city of Thebes, in his later days, he met an old man, and after he had slain him discovered that he was his own father, Laios. At Thebes he was told of the sphinx whose terrible rid-dles none could answer and who was destroying the land by drought. Oedipus interpreted the riddle and was crown-ed king. He took as his bride Iokaste (the beautiful violet-tinted clouds at dawn and sunset), his own mother. Death came to Iokaste in her bridal chamber and Oedipus who had blinded his eyes "fled to the grove of the Eumenides where, amid flashing lightning and peals of thunder, he died." This story would have been understood by all white peoples of the world as the daily journey of the sun through the heavens, bound under the orders of fate, like Herakles, to perform his predestined task; to slay his own father, the night; and to wed again in the evening the beautiful sunset colors that had borne him in the morning.

Now when they reached America these Aryans met a people probably of Mongolian descent who had circled the remainder of the world and had established themselves upon the Atlantic seaboard. In the western mountains of North Carolina, in the land of the Cherokees, they found a mountain named Attacoa. Concerning its name they heard this beautiful Indian legend; that many, many aeons ago, before there were any rivers to run quietly to the sea or green grass to grow, while the earth was yet a watery waste, a woman named Ataensic looked down from a rift in the clouds. Touched by the desolation that she saw, she leaped through the rift to make with her own hands a pleasure spot on the face of this watery chaos. Little by little she built the earth and it became an abiding place for her children. There was given her a daughter surpassing fair. The Dawn she was, and her name was Attacoa. The Sons of Attacoa were Ioskeha, the Fair One, and Tawiskara, the Dark One. Ioskeha was kind and good. Around the earth he travelled, calling forth the joyous springs and the green grass, planting the beautiful trees and herbs and giving light and life to all he looked upon. Tawiskara, the Dark One, tried always to undo the deeds of his brother. He made his home on the crest of Attacoa and from thence sent forth his storm clouds and hurled his thunderbolts. Even when he slept his hoarse voice could be heard, muttering and rumbling in the depths of the cavernous rock. When he issued forth he covered his giant form with a mantle of darkness which spread over all the earth. In the heart of Attacoa Tawiskara built castles for his demons of darkness and the ruins of some may still be seen, rising like towers from the south side of the rock, so that men call them the Chimneys.

One morning, borne on the wings of his mother Attacoa Ioskeha came speeding toward the crest of the great rock. There the conflict between the two brothers joined. Fast and furiously they fought. The storm clouds gathered and the lightnings played around their heads. Gods and demons came to witness the contest. At last when the battle raged fiercest and each brother was sore wounded and bleeding, the mother heart of Attacoa (the Dawn) could bear no longer to watch the fierce passions of her sons wreaking ruin each upon the other, and her own white breast she bared and interposed between them. This was the undoing of the peaceful Dawn, for the fury of the combatants compassed her about and, mortally wounded, she fell, expiring, into the arms of Ioskeha (The Morning

Sun). As Tawiskara (the Night) fled, a terrific thunder-peal summoned the subterranean powers and the rugged mass of rock was split in twain. That part upon which the feet of Tawiskara had been planted was rent asunder, forcing into the rock a great crevice. Thereinto the Dark One fell, but step by step he cut his way upward, sending before him his clouds and his mantle of darkness. When he reached the top, spent and worn by his labors, Ioskeha and his shining legions drove him far, far away to the West, the Land of Eternal Night, where he still holds his gloomy sway, and where the beams of the bright sun are ever devoured by his demons of darkness.

And so at sunrise when the Dawn dies in the arms of the Morning, the Cherokees used to bring their offerings to Attacoa, and still when the autumn comes tiny drops of her blood may be seen on the ground and are drawn up into the galax leaves formed into the shape of her heart, and redden them, too, that the children of the forest may be reminded of her who died that light might cease its conflict with darkness. To this day the bloody galax leaf is called the Heart of Attacoa; to this day men descend the perilous steps cut in the face of the rock by the mighty hand of Tawiskara. And to the mystic mountains of which it was a part the Great Manitou comes in the autumn to prepare for his winter nap, composing himself with a last pipe, whose smoke he blows over the Tarquoee valley, and men call it Indian Summer. There, too, as in the days of old, he gathers his white blankets about him and lies prone upon his bare bed, the great Tolista Ridge, sleeping under the white mantle of winter, till the flowers come in the early springtime at the call of Ioskeha to meet him on the brow of Sunahlee, Mount of the Morning. Then the Great Manitou wakes from his magic sleep and lifts the mighty fingers that have kept the winter rains and frosts away from the Eseeolas, protecting the snowy mantle, which has covered him during the winter, and summons the feathery clouds of the springtime, and looks in vain to find Tawiskara, that he may slay him. For Tawiskara, fearful of the bright arrows which Ioskeha was wont to shoot in the summer, has fled far, far away to the land of darkness, and his giant footsteps may be still traced across the mountains. Ioskeha and the Great Manitou allow no flowers to grow on them, and the green grass is there forever forbidden to spring, so that they are still bare and bald, and men have learned to call them Devil's Footsteps. Such is the story of Attacoa, the mystic mountain, reverenced because there Attacoa, the Dawn-Mother, bared her white breast that the morning might break for men. It is easily recognized as identical in thought with the story of Oedipous.

With what amazement and awe earliest man must have observed the sky, so full of every wonderful thing and especially of ever-changing clouds! Who were these creatures that kept forming and dissolving again, shaped now like a dragon, now like a scorpion-man, now like a horse or sheep or cow? Occasionally, too, they would have the head of one animal and the body of another. Earliest legends and literatures are full of such descriptions. Shapes of things unknown on Earth were there, too, of strange, fantastic creatures, and all of them were at war with the sun, all sought to obscure the light. They were the destroyers, the darkeners, the demons who must first be overcome before there could be a cosmos or a springtime or a day. To overcome them in the beginning was the first great task of the gods. Nor should we forget that greatest of all terrors, when in bright midday the sun, overcome by some dragon of darkness, was devoured by the night. Dim memories of these awe-inspiring eclipses are preserved in myth and legend adding their own chapters to the wars of the gods. To this day the hearts of unlettered men are terrified by their uncanny mystery.

So we are not surprised to find that as it is with the Aryan and with the American Indian, so it is also with all peoples. Perhaps the first and certainly the fundamental fact in their science and religion was the consciousness of the eternal struggle between light and darkness. See how the stories are all full of its meaning. There is Perseus, born of the golden shower of morning light, who with his invisible sword of piercing sun-rays, slays the starry night, Medusa, who must ever die at the coming of the sun; there is Bellerophon who rode Pegasus into high heaven and falling became the lonely and sullen wanderer over the desolate plains of the west; there is Heracles, who labored long in the service of the humanly weak Eurystheus but found at last the golden apples in the garden of the Hesperides afar in the west; there is Theseus, slayer of the Minotaur who descended into the underworld sleeping all winter upon the enchanted rock at the palace gate of Aides until released by the mighty Heracles; there is Oedipous who, wedding the violet-tinted clouds of sunset, the same who as his mother bore him in the morning, tore out his own eyes for shame; there is

Achilles sulking in the cloudy tent for love of the fair-haired Briseis; and there is Odysseus, who left his twilight bride for ten long hours of conflict with the powers of Darkness, and having conquered them, wandered among the dreamy clouds in the land of the lotus-eaters, outwitted the formless monsters of the vapory ocean, heeded not the siren calms of heaven's sea, slept his appointed time in the cave of Calypso behind some black thunderhead of the sky and then from the bright fields of the Phaeacian land with their immaculate maiden-clouds, laden with gifts from his adventurous toil, he was borne again to Penelope who ever weaves the rose and purple fabric of the sunset. All these there are and a bright host more who have battled for the light. And there are a thousand virgin mothers, beautiful dawn maidens who are forsaken or murdered as the sun fills the sky under the resistless decree of destiny; lovely Didos, faithful Penelopes, weaving the fair fabric of filmy violet clouds which can never be finished. There are lovely Ioles and Oinones and Iokastes and Attacoas with their rose and silver tints of morning and evening clouds. And there is loyal Antigone, "she who is borne opposite" the gegenschein or delicate glow in the east that ever faces the setting sun. And then there are those who steal the solar radiance which is represented as a lovely maiden or golden fleece or virgins in bondage or cloudy cows. Sometimes the cows or the maidens are stolen in the day time by the thunder storm, sometimes at night by the darkness. Under these clouds the sun sulks at times like Achilles or Meleagros, and with the robbers he is engaged in bloody battle. Their names come down to us from the ages; Cacus or Caecius, the darkener, elsewhere Orthros or Vritra, stealers of the celestial kine, who hide them in the caves of the east. Ahriman also is among them and Satan. Thus our sphinx becomes a storm demon and the rock upon which she sits becomes a rain-cloud where she imprisons the rain. Such are all the terrible medusae and chimairae and the dragons and serpents of darkness. Such was the snake sent to strangle the baby Hercules. Nor should we forget the grove of Erinnys which after all is likewise the garden of the Hyperboreans, and of the Hesperides, the same that Gilgamish found in the region of eternal life bearing jewelled fruit near the palace of Sabitu on the brink of the outer world-stream.

And then there is the terrible night who is both the parent of the sun and his victim, Ahriman, the serpent, the dragon, Tawiskara, the darkness. These are the Panis, the night demons, the devils, dragons, serpents, whose ever impending terror hung over the lives of men. In alliance with them were all the mighty children of darkness. Hear Tawiskara as he summons his legions to battle:

> "The voice of deeptoned Tawiskara:—
> "Come forth, ye Senoyahs, to join me;
> Ye Mountains of Night, come and join me.
> And Estatoe, drowner of Maidens.
> Dark Estatoe, killer of daughters;
> And come Agasiyah, come Hunger,
> And bring Konnassaywee, your arrows,
> Aye, bring ye your bundle of arrows,
> And bring Klamahaw, the black bat bring;
> And call ye Ellowah, the thunder;
> And so shall we end this Ioskeha,
> This man who must ever be smiling,
> And hang up his scalp with the others,
> His red, bloody scalp, Ostahneega."

It is characteristic of the human heart which has been from the beginning full of faith and hope that the sun never loses his battle. Odysseus fails not to draw his bow, nor does Achilles cast his spear in vain. As John Fiske of whose labors we have herein availed ourselves freely, long ago pointed out, the swords of Perseus and Sigurd and Roland are always as invincible and certain as the arrows of William Tell, all being equally solar weapons, so that the sun, though sorely wounded by the poison-shirt of the cloud-fiend, Nessos, eventually is crowned with western glory and cometh like a bridegroom out of his chamber in the east, rejoicing as a strong man to run his race. Though he labors at the bidding of others like Herakles, or wanders lonely through the skies as Odysseus, yet he comes safely home from the Phaeacian Land to find his faithful bride weaving the violet tints of her cloudy fabric. With all this in mind, we may the more readily appreciate the marvelous story told among men of Shumir and Accad which had to do with that great discovery, greater than which no man has made.

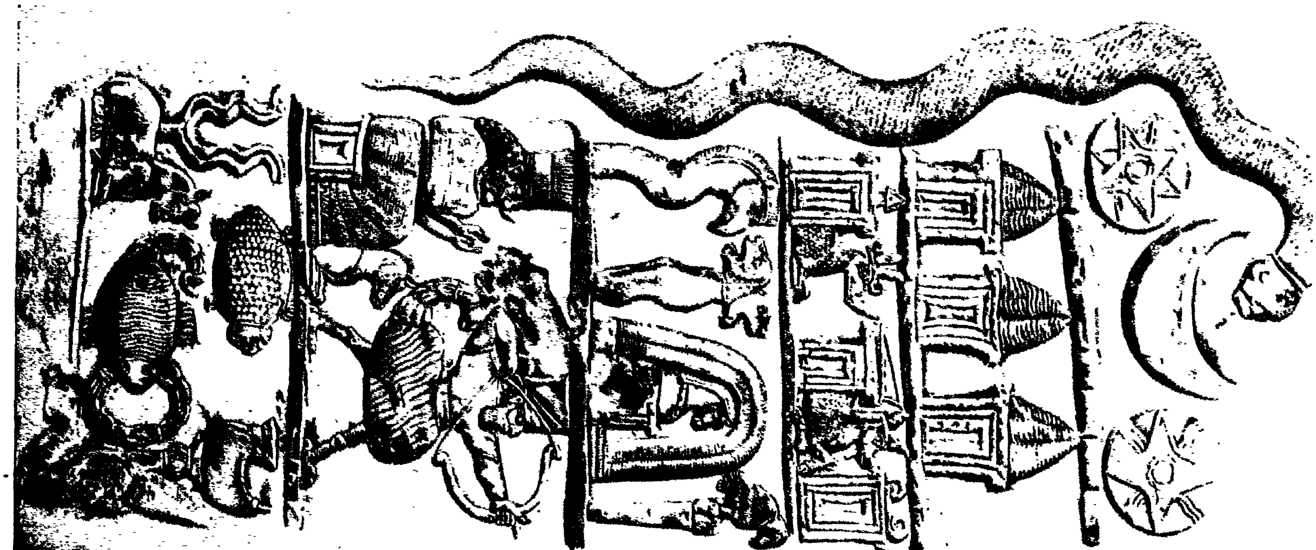
In all these sun-myths of which the languages and religions of mankind are full, there is to be found the finest wisdom that the ages have distilled for humanity. These early men quickly identified light and might and right on the one hand and storm and darkness and wrong on the other, and they believed that in the innermost shadow the great power stood watching over his own. They saw what our modern scientists see, that life was an eternal warfare and an interminable struggle. They read the story if it in the life of the sun, the birth of the dawn, the voice of the tornado. They watched the three great victories of the solar radiance, his victory over the thunderstorm, his victory over the night, and his victory over the darkness of the winter, and with that singular keenness of perception which was one of their chief characteristics they reasoned that the first coming of light and life could not have been widely different. Just as order and life emerge again when the storm has passed, or the night has gone, or the winter has ended, so doubtless they came forth from a similar state in the beginning. Just as chaos and terror rule while the black storm passes or the shadows of night are thickest or the darkness of winter deepest, so all must have been terror and chaos before the light came. Thus, doubtless, the creation myths were born in the hearts of men. In the beginning all was primeval chaos and darkness, a vast waste of waters, the supreme terror to men who dwelt in the deluged plain between the great rivers, inhabited by every demon of darkness. This was in the day before the gods were born. But for the rest, let the great creation myth taught to the children of Babylon milleniums before Christ speak for itself.

The translations of E. A. Wallis-Bridge and George A. Barton are followed. Certain words and phrases are italicised that their significance may not escape the notice of the reader.

TABLET 1.

When the heavens above were yet unnamed,
And the name of the earth beneath had not been recorded,
Apsu, the oldest of beings, their progenitor,
"Mummu" *Tiamat,* who bare each and all of them—
Their waters were merged into a single mass,
A field had not been measured, a marsh had not been searched out.
When of the gods none was *shining,*
A name had not been recorded, a fate had not been fixed,
The gods came into being in the midst of them,
The god Lakhmu and the goddess Lakhamu were made *to shine,* they were named.
The confraternity of the gods was established.
Tiamat was troubled and she . . . their guardian.

At that time Apsu, the progenitor of the great gods,
Shouted out and summoned Mummu, the steward of his house, saying
"(O) Mummu, my steward, who makest my liver to rejoice,
Come, to Tiamat we will go."
They took counsel together about the gods (their children)
They formed a band, and went forth to battle to help Tiamat.
They were exceedingly wroth, they made plots by day and by night without ceasing,
They offered battle, fuming and raging.
They set the battle in array, they uttered cries of hostility,



The accompanying illustration, which is reproduced from the Boundary Stone of Ritti-Marduk (British Museum, No. 90,858), supplies much information about the symbols of the gods, and of the Signs of the Zodiac in the reign of Nebuchadnezzar I, King of Babylon, about 1120 B. C. Thus in Register I, we have the Star of Ishtar, the crescent of the Moon-god Sin, and the disk of Shamash the Sun-god. In Register 2 are three stands (?) surmounted by tiaras, which represent the gods Anu, Enlil (Bel) and Ea respectively. In Register 3 are three altars (?) or shrines (?) with a monster in Nos. 1 and 2. Over the first is the lance of Marduk, over the second the mason's square of Nabu, and over the third is the symbol of the goddess Ninkharsag, the Creatress. In Register 4 are a standard with an animal's head, a sign of Ea; a two-headed snake—the Twins; an unknown symbol with a horse's head, and a bird, representative of Shukamuna and Shumalia. In Register 5 are a seated figure of the goddess Gula and the Scorpion-man; and in Register 6 are forked lightning, symbol of Adad, above a bull, the Tortoise, symbol of Ea (?) the Scorpion of the goddess Ishkhara, and the lamp of Nusku, the Fire-god. Down the left-hand side is the serpent-god representing the constellation of the Hydra. (From *Babylonian Legends of the Creation*. (Courtesy of the British Museum.)

Ummu-Khubur, who fashioned all things,
Set up the unrivalled weapon, she spawned huge serpents,*
Sharp of tooth, pitiless in attack (?)
She filled their bodies with venom instead of blood,
Grim, monstrous *serpents*, arrayed in terror,
She decked them with *brightness*, she fashioned them in exalted forms,
So that fright and horror might overcome him that looked upon them,
So that their bodies might rear up, and no man resist their attack,
She set up the Viper, and the Snake, and the god Lakhamu,
The Whirlwind, the ravening Dog, the *Scorpion-Man*.
The mighty Storm-wind, the Fish-man, the *horned Beast* (Capricorn)
They carried the Weapon which spared not, nor flinched from the battle.
Most mighty were Tiamat's decrees, they could not be resisted,
Thus she caused *eleven* (monsters) of this kind to come into being,
Among the gods, her first-born son who had collected her company,
That is to say, Kingu, she set on high, she made him the great one amongst them,
She gave him the *Tablet of Destinies*, she fastened it on his breast.

TABLET 2.

Tiamat made solid that which she had moulded,
She bound the gods her children with (evil bonds).
Tiamat wrought wickedness to avenge Apsu.
When . . . . had harnessed his chariot he went to meet Ea,
Ea harkened to his story,
He was sorely afflicted and abode in sorrow,
The days were long, his wrath died down,
He went his way to the dwelling of Anshar, his father,
He went into the presence of Anshar, the father who begat him,
Whatsoever Tiamat had devised he repeated unto him.
When Anshar heard that Tiamat was stirred mightily
"Thou hast slain Mummu and Apsu
But Tiamat hath exalted Kingu—where is the one who can meet her?"
Anshar was distressed, he looked down upon the ground,
He turned pale; towards Ea he lifted up his head.
All the Anunnaki assembled at their posts.
They shut their mouths, they sat in lamentation.
(They said), "Nowhere is there a god who can attack Tiamat.
He would not escape from Tiamat's presence with his life."
The Lord Anshar, the Father of the gods, (spake) majestically.
He lifted up his heart, he addressed the Anunnaki, (saying)
"He whose (strength) is mighty (shall be) an avenger for (us)
The . . . . . in the strife, Marduk the Hero."

TABLET 3.

"Marduk, your son, the envoy of the gods, hath set out.
His heart is stirred up to oppose Tiamat.
He opened his mouth, he spoke unto me, (saying):
Should I as your avenger

* The lightning-snake, feared from the beginning by all inhabitants of tropical lands.

Slay Tiamat, and bestow life upon you.
Summon a meeting (council), proclaim and magnify my position,
Sit down together in friendly fashion in Upshukkinaku,
Let us issue decrees by the opening of my mouth, even as ye do,
Whatsoever I bring to pass let it remain unaltered.
That which my mouth uttereth shall neither fail nor be brought to nought.
Hasten ye therefore, issue your decrees speedily
That he may go to meet your mighty enemy.

All the great gods, who issue decrees.
They entered in, they filled (the court) before Anshar.
Brother (god) kissed brother (god) in the (divine) assembly,
They held a meeting, they sat down to a feast,
They ate bread, they heated the (sesame wine),
The taste of the sweet drink confused their . . . .
They drank themselves drunk, their bodies were filled to overflowing,
They were overcome by heaviness (of drink), their livers (spirits) were exalted,
They issued the decree for Marduk as their avenger.

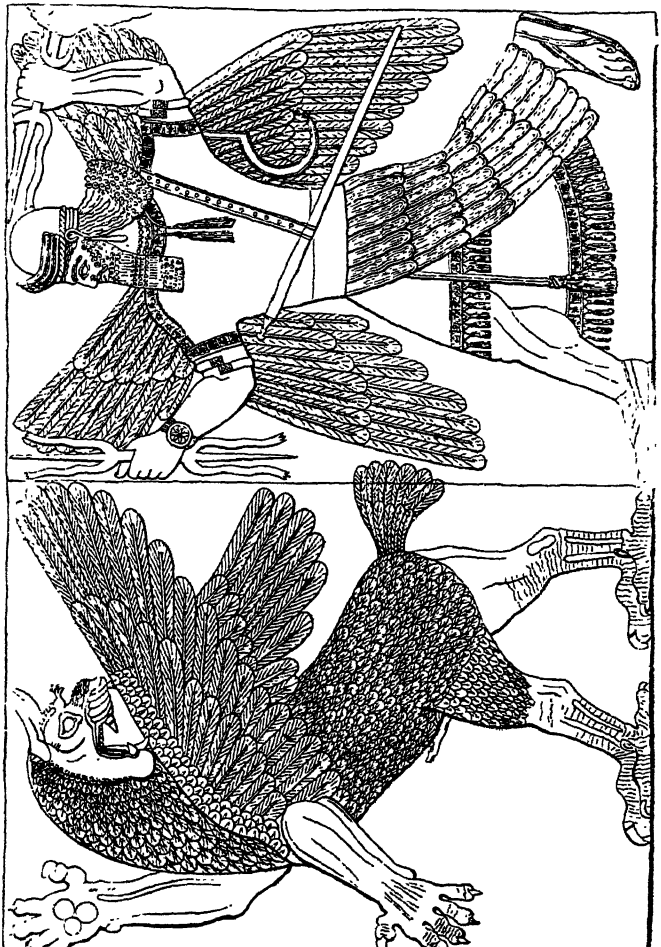
TABLET 4.

Then a cloak (literally, one cloak) was set in their midst,
They addressed the god Marduk their first-born (saying):
"Thou, Lord, shalt hold the foremost position among the gods.
Decree thou the throwing down and the building up, and it shall come to pass.
Speak but the word, and the cloak shall disappear,
Speak a second time and the cloak shall return uninjured."
Marduk spoke the word, *the cloak disappeared,*
He spoke a second time, *the cloak reappeared.*
When the gods his fathers saw the issue of the utterance of his mouth
They rejoiced and adored (him, saying), "Marduk is King."
They conferred upon him the scripture, the throne, and the symbol of royalty (?)
They gave him the unrivalled weapon, the destroyer of the enemy (saying):
Go, cut off the life of Tiamat.

He strung (His) bow, he set ready his weapon (in the stand)
He slung his spear, he attached it to (his belly),
He raised the club, he grasped it in his right hand.
The bow and the quiver he hung at his side.
He set the lightning in front of him.
His body was filled with a glancing flame of fire.
He made a net wherewith to enclose Tiamat.
He made the four winds to take up their position so that no part of her might escape,
The South wind, the North wind, the East wind, the West wind.
He held the net close to his side, the gift of his father Anu,
He created the 'foul' wind, the storm, the parching blast,
The wind of "four," the wind of "seven," the typhoon, the wind incomparable
He despatched the seven winds which he had made,
To make turbid the inward parts of Tiamat; they followed in his train.

The Lord raised up the wind storm, his mighty weapon.
He went up into his chariot, the unequalled and terrible tempest.
He equipped it, he yoked thereto a team of four horses,
Pawing the ground, champing, foaming (eager to) fly,
. . . . . (the odour) of their teeth bore foetidness.
They were skilled (in biting), they were trained to trample under foot.
. . . .
. . . .
. . . .
His brightess streamed forth, his head was crowned (thereby),
He took a direct path, he hastened on his journey.
He set his face towards the place of Tiamat, who was . . .
. . . .
. . . .
At that moment the gods were gazing upon him with fixed intensity,
The gods, his fathers, gazed upon him, they gazed upon him.
The Lord approached, he looked upon the middle of Tiamat,
He searched out the plan of Kingu, her husband.
Marduk looked, Kingu staggered in his gait,
His will was destroyed, his motion was paralyzed.
And the gods his helpers who were marching by his side
Saw the (collapse of) their chief and their sight was troubled.
Tiamat (shrieked but) did not turn her head.
With lips full of (rebellious words) she maintained her stubbornness
(Saying), ". . . . .that thou hast come as the Lord of the gods, (forsooth),
They have appointed thee in the place which should be theirs."
The Lord raised up the wind-storm, his mighty weapon,
(Against) Tiamat, who was furious (?), he sent it, (saying):
(Thou hast made thyself mighty, thou art puffed upon high,
Thy heart (hath stirred thee up) to invoke battle
. . . .
(Thou hast exalted Kingu to be (thy) husband,)
(Thou hast made him to usurp) the attributes of Anu
. . . . . . .thou hast planned evil.
(Against) the gods, my fathers, thou hast wrought evil.
Let now thy troops gird themselves up, let them bind on their weapons.
"Stand up! Thou and I, let us to the fight!"
On hearing these words Tiamat
Became like a mad thing, her senses became distraught,
Tiamat uttered shrill cries again and again.
That on which she stood split in twain at the words,
She recited an incantation, she pronounced her spell,
The gods of battle demanded their weapons.
Tiamat and Marduk, the envoy of the gods, roused themselves,
They advanced to fight each other, they drew nigh in battle
The Lord cast his net and made it to enclose her,
The evil wind that had its place behind him he let out in her face.
Tiamat opened her mouth to its greatest extent,
Marduk made the evil wind to enter (it) whilst her lips were unclosed.
The raging winds filled out her belly,
Her heart was gripped, she opened wide her mouth (panting)
Marduk grasped the spear, he split up her belly,

He clave open her bowels, he pierced (her) heart,
He brought her to nought, he destroyed her life.
He cast down her carcass, he took up his stand upon it.
After Marduk had slain Tiamat the chief,
Her host was scattered, her levies became fugitive.
And the gods, her allies, who had marched at her side,
Quaked with terror, and broke and ran
And betook themselves to flight to save their lives.
But they found themselves hemmed in, they could not escape.
Marduk tied them up, he smashed their weapons.
They were cast into the net, and they were caught in the snare,
The . . . .of the world they filled with (their) cries of grief.
They received (Marduk's) chastisement, they were confined in restraint,
And (on) *the Eleven Creatures* which Tiamat had filled with awfulness,
The company of the devils that marched at her. . . . .
He threw fetters, he. . . .their sides.
They and their resistance he trod under his feet.
The god Kingu who had been magnified over them
He crushed, he esteemed him (as little worth) as the god Dugga. (as a dead god?)
Marduk took from him the Tablet of Destinies, *which should never have been his.*
He sealed it with a seal and fastened it on his breast
After he had crushed and overthrown his enemies,
He made the haughty enemy to be like the dust underfoot.
He established completely Anshar's victory over the enemy,
The valiant Marduk achieved the object of Nudimmud (Ea),
He imposed strict restraint on the gods whom he had made captive,
He turned back to Tiamat whom he had defeated,
The Lord (Marduk) trampled on the rump of Tiamat,
With his unsparing club he clave her skull.
He slit open the channels (arteries) of her blood.
He caused the North Wind to carry it away to a place underground.
His fathers (the gods) looked on, they rejoiced, they were glad.
They brought unto him offerings of triumph and peace,
The Lord (Marduk) paused, he examined Tiamat's carcass
He separated flesh (from) hair, he worked cunningly.
He slit Tiamat open like a flat (?) fish (cut into) two pieces,
The one-half he raised up and shaped the heavens therewith,
He pulled the bolt, he posted a guard,
He ordered them *not to let her water escape.*
He crossed heaven, he contemplated the regions thereof.
He betook himself to the abode of Nudimmud (Ea) that is opposite to the Deep (Apsu),
The Lord Marduk measured the dimensions of the Deep,
He founded E-Sharra, which he made to be heaven.
He made the gods Anu, Bel and Ea to inhabit their (own) cities.
He appointed the Stations for the great gods,
He set in heaven the Stars of the Zodiac which are their likenesses.
He fixed the year, he appointed the limits thereof
He set up for the twelve months three stars apiece.
According to the day of the year he. . . .figures.
He founded the Station of Nibir (Jupiter) to settle their boundaries,
That none might exceed or fall short.
He set the Station of Bel and Ea thereby.
He opened great gates under shelter on both sides.



Fight between Marduk (Bel) and the Dragon. Drawn from a bas-relief from the Palace of Ashur-nasir-pal, King of Asyria, 885 B. C., at Nimrud. (Nimrud Gallery, Nos. 28 and 29.) From the *Babylonian Legends of the Creation*. (Courtesy of the British Museum.)

He made a strong corridor on the left and on the right.
He fixed the zenith in the heavenly vault (?)
He gave the god Nannar *(the Moon-god) his brightness* and *committed the night to his care.*
He set him for the government of the night, to determine the day,
Monthly, without fail, he set him in a crown (dusk) (saying):
At the beginning of the month when thou risest over the land,
Make (thy) horns to project to limit six days (of the month)
On the seventh day make thyself like a crown.

. . . .
. . . .
. . . .

TABLET 6.

Marduk, the word of the gods, when he heard it,
His heart was stirred, he formed a brilliant plan.
He opened his mouth, to Ea he spoke,
What in his heart he had conceived he offered as a plan:
"Blood will I bind, bone will I fashion,
I will produce a man; "man" is his name;
I will create the man "man";

Then Ea answered him and said a word to him;
"One among your brethren must be given up.
Him I will appoint, the people prepare.
The great gods must assemble together;
This one must be given up; ye must persuade them."
Marduk assembled the great gods, he entered and delivered the decision,
He opened his mouth, to the gods he spoke:
"Truly the former things we told you are verified;
True things with myself as an oath I have sworn.
Who is it that has created the strife,
Brought about the uproar, united the battle?
He who has caused the strife shall be given up.
I will make him, verily, I will cause him to bear the curse 'to destroy the garment'."
Then answered him the Igigi, the great gods;
"O king, god of heaven and earth, counsellor of the gods, their lord,
Kingu it was who caused the strife,
He led the rebellion and brought on the battle."
They bound him and brought him before Ea.
Then a curse he laid on him; his blood burst forth from him.
From his blood he made mankind for the service of the gods.
But (the other) gods he let go free.
After man had been created, Ea laid on him the service of the gods.
Marduk, king of the gods, *stationed twenty Anunnaki above and below,*
He delivered unto Anu the charge to guard. . . the post.
The Anunnaki . . . . approached. . . . . . .
To Marduk their father they spoke:
"O divine guardian of the earth, lord, who has wrought our release,
How do we cling to thy presence!
Oh, we will make a sanctuary the naming of whose name is
'Sanctuary-wherein-we-may-take-rest!'
Oh, we will found our sanctuary as our dwelling!
On the day when we take possession, we will rest in it."
Marduk, when he heard this,

His face like the day appeared exceedingly bright:
"Like the founding of Babylon with walls, be the joy of its founding.
Let an enclosed city be built, a district of land surround it."
The Anunnaki presented the strength of the mountain as the glory of its foundation.
The second year came around, the enclosure of Esagila was founded on the breast of Apsu,
They built the temple-tower till it touched the celestial ocean;
For Marduk, Enlil, and Ea they raised it as a dwelling;
With the glory of their presence they entered in.
From its foundation Esagila exhibited its two horns
From Esagila they made its double;
The Anunnaki the double (?) of their sanctuary set up;
The Anunnaki placed by the side of the deep their temple (?);
In a large garden which they created was their dwelling.
Divine fate at the great gate of the beloved dwelling was established.
When their goddess was taken away—their Ishtar,
Men forgot their god; verily there was ruin!
Their pride (?) became great; their sanctuaries were desecrated (?)
Verily they grew mighty; the black-headed race rose up,
Sanctuaries (?) as many as they had commanded to build they destroyed.
They (the gods) named it (the black-headed race); 'Terror' was its name.
Ruin verily increased; it was terrible! Verily it was thus!
It was Marduk whom, on account of its devastation, Anu, his father called.
Making a pit as a tomb, in full splendor he went down to it
Who, *by his weapon the deluge,* had taken captive those who rebelled (?)
The gods, his fathers, he preserved from tribulation.
Surely it was his counsels (?) for which the gods called him!
In his brilliant light, they walk continually.
The bones, which he had made, a living creature became;
The service of the gods he established; them he pacified.
Mankind (?) was created (?) again;
Verily favor was restored; they looked on them with compassion—even them.
The divine son was imprisoned, Ea (spake thus ?) concerning the son;
"He gave joy to the hearts of the Anunnaki. . . . .
The divine Son was slain and might overcame (?) him. .his . .
Him shall indeed the people of the lands praise . . . .
The divine Prince, mighty, and strong, and broken. . . . .
Broken was His heart; dishonored His body!
As divine king, god of heaven and earth, whose name our assembly named,
(By) the word of their mouth, even theirs, above the gods his fathers—
Verily above the gods of heaven and earth all, of them—
As king on his throne (?) the gods verily said (?) they would seat him (?)
The brilliant god, the king of heaven and earth is his name, who, removed from the mountain, the place of the gods
Of heaven and earth, has been overthrown. Our dwelling is in distress!

Between the Igigi and the Anunnaki the place is divided."
With his name the gods verily recorded his stewardship in the dwelling:
"*Asaru*, whom Anu his father named is its saviour;
He verily was the light of the gods—their battle-axe
Who, like the powerful guardian, Ishtar, is dead!
By a mighty battle he delivered his dwelling from distress."
Two mighty ones called the god Asaru, who is the perfect god, *unto life again.*
"It was he who by his act gave might to us, the gods who had perished!
He is the lord who, by his holy death, made the dead gods to live!
There perished the heirlings who hated him. . . . !
Verily he is the one whom his fathers named the brilliant god!—
Verily, *he holdeth the beginning and the end of them*, verily. . .
Saying, "He who entered into the middle of Tiamat resteth not;
His name shall be 'Nibiru,' the seizer of the middle.
He shall set the courses of the stars of the heavens.
He shall herd together the whole company of the gods like sheep.
He shall (ever) take Tiamat captive, he shall slit up her treasure (variant, life), he shall disembowel her."
Let (these words) be heard without ceasing, may they reign to all eternity.
Because he made the (heavenly) places and moulded the stable (earth)
Father Bel proclaimed his name, "Lord of the Lands."
All the Igigi repeated the title,
Ea heard and his liver rejoiced,
Saying, "He whose title hath rejoiced his fathers
Shall be even as I am; his name shall be Ea.
He shall dispose of all the magical benefits of my rites,
He shall make to have effect my instructions."
By the title of "Fifty times" the great gods
Proclaimed his names fifty times, they magnified his going.

The reader has not failed to observe the strangely revelatory nature of these astonishing tablets. There is good reason to believe that the story originally centered around Bel or Enlil, the thunder-storm god, of the ancient city of Nippur, and that when Babylonia became the dominant power in Mesopotamia their god Marduk was substituted. This would not, however, change the general tenor of the myth. The startling resemblance between the story and that told in the first two chapters of Genesis is revealed at once. "In the beginning the universe was without form and void and darkness was upon the face of the deep." This deep is in Hebrew "Tehom" and in Babylonian "Tiamat." The Babylonian then elaborates. In the darkness dwelt all evil things, dragons, demons and every hideous imagination. Contrasted with these were the gods who had human forms and who were born from but struggled against the mother-darkness who possessed the Tablet of Destinies or the Book of Fate in which the destiny of every living thing was written, no syllable of which can fail nor can piety or wit cancel half a line of its decrees. Followed the great battle between the gods and the demons whose purpose was to conquer the light. The gods were represented by the stars of the heaven, the sun, the moon, and the planets, while Apsu or chaos and all of his demons are deifications of evil and darkness and night. At first the original chaos is triumphant over the gods who then called for a hero to defend their cause. Tiamat, the boundless deep and watery chaos, whose husband, Apsu, has been slain by Ea, caused to be created new allies, storm and cloud and fog and mist and whirl-wind, and all the destructive agencies known to early man. To this devilish brood she summoned the aid of the powers of the air and the stars above and "set up" her eleven helpers, who, with herself, constitute the twelve signs of the Zodiac: the viper, the snake, the god Lakhamu, the whirl-wind, the ravening dog, the Scorpion-Man, the mighty storm-wind, the fish-man, and the horned beast, the invincible weapon and Kingu. The names of some of these eleven helpers, such as the horned beast and the Scorpion-Man, remain to this day. This Kingu is perhaps synonymous with the night sky. Appointing Marduk to be their champion, the gods eagerly watched the contest. Having tested his magic powers by effecting the appearance and disappearance of a cloak, Marduk took his bow and spear and club, set the lightning before his face, carried with him a net in which to catch Tiamat, bade the four winds accompany him, created great and tempestuous winds as helpers and grasping thunder-bolts in his hand, ascended his chariot, the mighty storm, and riding upon the wings of the wind, went out to slay his enemy. He "entered into the middle of Tiamat," caught her and all her eleven allies in his net, took the Tablet of Destinies from Kingu's breast and placed it upon his own. This he did as the personification of light. All this conquest of darkness is canvassed in one single sentence in the book of Genesis, "and God said let there be light and there was light." Then it was that Marduk began his work of creation. He divided the body of the great chaos, Tiamat, into two parts. Of the upper part he made the firmament, pinning it carefully back so that the waters that were above would be held back, and out of the other half he built the abode of Ea, "the waters under the earth," setting them over against Apsu, the deep. Out of the water he made the dry land to appear and set apart the dwelling place of the great trinity, Anu, the heaven above, Bel, the earth beneath, Ea, the waters that are under and around the earth. Then he set in heaven the stars of the Zodiac, "gave the moon-god his brightness and committed the night to his care," fixed the month and year and constructed the world as a going concern.

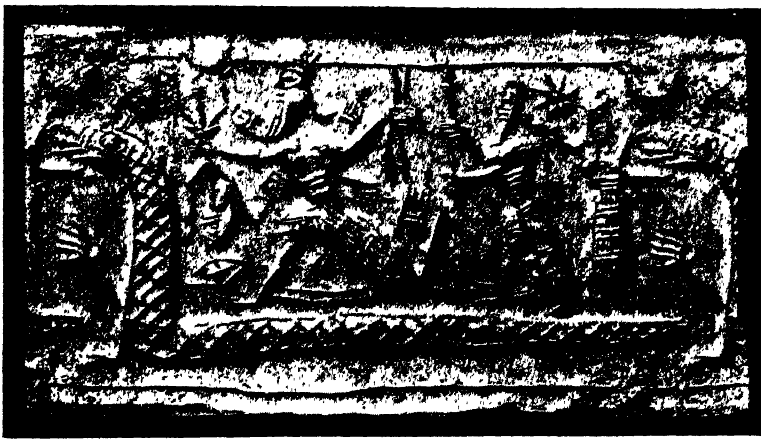
Then comes the astonishing story of the creation of man. As told in the dramatic words of the text, man is made in the image of God, and indeed, of his very blood, and from the beginning he was charged with the worship of the gods. "In a large garden which they created was their dwelling." To guard this Eden, "Marduk, king of the gods, stationed twenty Anannuki." Also the enclosure of Esagila, the great Temple of Babylon or Tower of Babel was founded on the breast of Apsu, the deep. "They built this temple-tower until it touched the celestial ocean." Then comes perhaps the most astonishing part of the myth. "Men forgot their god. Verily there was ruin." "The wickedness of man was great in the earth and every imagination and thought in his heart was only evil continually." "Their pride became great, their sanctuaries were desecrated. Ruin verily increased. It was terrible." Oddly enough, there is a sexual element in this great apostasy as there was in the temptation and the fall in Genesis. Then Marduk for the second time came to the rescue of the gods. As he had made him, so now he re-made them, "making a pit as a tomb in full splendor he went down into it." "Mankind was created again." "The divine Son was slain, broken was His heart, dishonored was His body." Then "two mighty ones (angels), called the god Asaru (Osiris, Ashur, names of Marduk) who is the perfect god unto life again."

What a wonderful paean of triumph the gods sing in his praise! Robbed of its polytheism, it is translated by Barton:

> "He is the god who by his holy death makes the dead to live.
> There perished the hirelings who hated him.
> Verily he is the god whom his father named,
> The holy god who makes pure all of us."

So here we have it, the deep, light, the firmament, the earth, the waters that are under the earth, the lights in the firmament, the creation of man, the garden of Eden, the serpent, the cherubim, the flood, the tower of Babel, the temptation and fall of mankind, and combined with them a remarkable addition, the re-creation of man by the death and resurrection of a god called back to life by two mighty ones, angels.

The angels of the Babylonians were also the messengers of the gods and the man-headed bulls, the Cherubim, were their defenders. Demons of monstrous shape also there were. These all passed over to the Hebrews via Abraham of Ur and other contacts. With them came Tiamat and Kingu, Rahab and Leviathan. A reminiscence of the ancient conflict comes to us from Job (26-13): "By his understanding he smiteth through Rahab. The bars of heaven fear him. His path hath pierced the swift serpent." Elsewhere, he exclaims, "The helpers of Rahab do



Marduk destroying Tiamat, who is here represented in the form of a huge serpent. From a seal-cylinder in the British Museum. (No. 89,589). From *The Babylonian Legends of the Creation.* (Courtesy of the British Museum.)

stoop under him." (9-13). "Thou didst devour the sea by thy strength," says the Psalmist (74-13). "Thou breakest the head of Leviathan in pieces." "In that day," prophecies Isaiah, "Jehovah with his hard and great and strong sword will punish Leviathan the strong serpent and Leviathan the crooked serpent and the monster that is in the sea." St. George and the dragon are a modern echo of this ancient struggle and the sea-serpent still lives in the deep. A very fine illustration of the use to which this primal myth may be put is found in Revelation 12-9 f.f.: "And there was war in heaven. Michael and his angels fought against the dragon and the dragon fought and his angels and prevailed not. . . .and the great dragon was cast out, that old serpent called the devil and satan which deceiveth the whole world." "And . . . . . laid hold on the dragon, that old serpent which is the devil and satan and bound him one thousand years and cast him into the bottomless pit and shut him up and set a seal upon him that he should deceive the nations no more till the one thousand years should be fulfilled. And after that he must be loosed a little season."

Now when the spade of archaeology dug up these Palaeontological forms of some of the most cherished religious stories of our childhood, it was inevitable that some pious souls should immediately exclaim against this supposed challenge to the inspiration of the Bible and the truth of the first chapter of Genesis. To them the "truth of the Bible" was at stake. How patently absurd! Is Esther less true because we now know that other short stories were written before its date? Is the book of Job less true because older dramas have been discovered? When will the world learn that the truth is never in danger? That marvelous library of books that we call our Bible written by scores of people during more than 1,000 years, contains every type of literature that a modern library contains. Part of it is poetry, part of it is drama, part of it is allegory, part of it is history, part of it is law, part of it is correspondence, part of it is parable, part of it is myth. Step by step the modern Christian has learned to appreciate and love each type of literature represented therein for what it is, excepting the last named. There are still those who think that to say that a part of the Bible is founded upon myth is to insult the faith of believers. Surely such should be advised that with the single exception of the words of Jesus Christ himself, there is no class of literature in the holy book that can compare in its solemn meaning or ancient wisdom with those parts that are founded upon the great myths. A lyric poem like one of the Psalms is the figment of a single writer's mind. A short story, such as Esther, reveals the world as seen through a single human eye. Even the majestic drama of Job is written from a standpoint of one man. History at its best is but the "accepted fable." But the primal myths, written in the blood of the race, products of infinite toil and anguish, the creation of deepest contemplation, colored with the sweetest of human dreams, these are composed of substance ineffably holy. So when the writer or writers of the first chapters in Genesis, bearers themselves of the ancient traditions that came from Ur of the Chaldees, summed up the wisdom and aspiration and philosophy of their day in this story of the creation, the temptation, and the fall from the paradise of God, they were writing words which for preciousness excel all other words ever written on earth except those of Jesus Christ himself. What does it matter that we now know that Sheol, in which all the patriarchs believed, is the same as the Babylonian Shualu so vividly described in the descent of Ishtar and the ascent of Samuel? What does it matter if we now know that there are not "four corners of the earth," nor "waters under the earth," that the sun does not "rise," nor "set," and that the moon and the sun that were stayed by the hand of Joshua were not really moving at all through the heavens? Has the truth of the Bible been impugned? Is Job less true because it is a drama, or Esther less true because it is a story, or the Psalms of David less true because they are poems? These things came from the minds of men, but the primal myths came from the deeds of God. There is an eternal battle between light and darkness, between night and day, between life and death, between good and evil; and light, as always will win as it has always won, whether it be called Marduk, or Odysseus or Ioskeha or Elohim. This knowledge, this faith, this sun-myth if you please, which has fired the hearts of men from the beginning, what is it but that light which lighteth every man who cometh into the world?

If one would know the supreme heights to which this ancient conception of the battle of Light with Darkness may be lifted; if he would realize the utter holiness of the thought of the immanence of God in Nature, in sun and star and sky, let him read Kent's translation of the introduction of the Gospel of John which recites once more the marvel of creation illumined by the Gospel of Jesus:

"In the beginning was the divine Wisdom, and the divine Wisdom was God. He was in the beginning with God; through him all things came into being and without him nothing which existed came into being. In him was life and this was the light of men. The light shone in the darkness, and the darkness did not overcome it.

There was a man sent from God whose name was John. He came to bear testimony to the Light, that through him all might believe. He himself was not the Light, but came to bear witness to the Light. The true Light, which enlightens every man, was coming into the world. He was in the world, the world which came into being through him, but it knew him not. He came to his own, and his own received him not. But to as many as acknowledged him he gave the right to become children of God, even to those who believe on his name, who are children not by physical descent nor by human desire nor by the will of man, but of God.

The divine Wisdom became flesh and lived among us, and we beheld his glory, the glory as of a father's only son, full of love and truth. John testified to him and cried aloud, "This is he of whom I said, 'He who is coming after me has preceded me because he existed before me.'" And we have all received from his overflowing love gift after gift."

The reader who is bearing in mind the relationship between the new science and the old religion must by this time have thoroughly disabused his mind of fear for the Ark of God. For to the heaven-sciences and the earth-sciences, and the man-sciences this last testimony of the science of comparative religion is added, advising us that the foundation of our faith in the Eternal Goodness is as fundamental as creation itself. The new science does not destroy the foundations of the old religion and then mockingly inquire, "Now what can the righteous do?" On the contrary it lays a firmer foundation, deeper, more indestructible, more abiding for every religious essential. It shows how the very universe itself has no meaning without the postulate of a super-intelligence and super-power to create and preserve its ordered progress. It shows how invincible is the logic of the fatherhood of God and how certain the possibility of communion with him. It asserts the comradeship of man and God in the development of civilization and the evolution of character. It demonstrates the inevitableness of religion in the nature of heredity and environment and the terrible struggle for survival. It lays the foundation of the hope of immortality in a thousand analogies and similes chiefly the great three: the death and resurrection of the sun; the death and resurrection of the earth; the death and resurrection of Light in its eternal struggle with Darkness. And for all the gracious processes of salvation it offers in the vastness of its visions a far surer guidance than that of the obscurantist who darkeneth counsel by words without knowledge. No man can think in light years or micro millimeters, can contemplate his universe of stars or electrons, can consider the mysteries of mind or protoplasm without exclaiming: I have heard of Thee by the hearing of the ear, but now mine eye seeth Thee. Wherefore I abhor myself and repent in dust and ashes.

For as the astronomer tells us of the misty infinitudes of space, and the geologist of the illimitable vistas of time, and the biologist of the hazy mysteries of protoplasm, and the chemist of the impenetrable secrets of matter, each confessing in his own way frankly and wisely his inability by searching to find out either end or beginning; it is as if they were speaking for the great Alpha and Omega, himself, and saying: "Where was I when He laid the foundations of the earth; when the morning stars sang together and the suns of God shouted for joy? Who shut up the sea with doors saying hitherto shalt thou come but no further and here shall thy proud waves be stayed! Who commands the morning and causes the dayspring to know his place? Who enters into the springs of the sea and walks in the paths of the deep? Who opens the gates of death and closes the doors of the shadow of death? And where is the place where light dwelleth and as for darkness where is the place thereof?"

In short, when we contemplate the universe, atomic, protoplasmic, sidereal, we seem to hear a voice like the sound of many waters ascending from all things living and dead, in soil and sky and sea crying: The Lord is in his holy temple, let all the earth keep silence before him!

THE ISLAND OVER-SEAS

An hundred hours a-wing and, still, no shore
Since vanished for Alaska's snowy peaks;
Only the vast Pacific's billowy floor;
Nor yonder anywhere, the home she seeks;
No path beneath; the silent blue above her;
What prophet's wing is thine, my golden plover?

Some dawning, ruby-lit for coming day,
Uprising from the unmeasured sea of night,
The palms shall pierce, at last, the misty gray
And thou at morn, a migrant, shalt alight
With those who followed to the final lea
The lure that led them o'er the lonely sea,
There, where the summer calls to all who love her;
Is this thy so great faith, my golden plover?

An hundred hours a-flight and, all the while,
The little island in the boundless sea
Thy goal! But whose the sight, through mile on mile.
To pierce the mists that hide this tiny lea?
This atom island lost upon the main;
Yet, ere the winter, thou art come again!

So quickly as the iron horse I made;
Unerring, as my needle points the star;
Against her all the ocean's might arrayed.
Whom time and space and night her goal would bar;
Lo! lightly o'er yon silver beach doth hover,
By right of dream, a queen, my golden plover!

O Winged Will, wait one who tarrieth,
So shall I go, as that within me saith;
Trusting a hope of land beyond the sea,
Heeding a Voice that will not let me rest,
On pinions weak, tho strong the storm winds be,
Faith-blown unto the Island of the Blest,
Wait, Winged Will, while winter tarrieth:

Then, swiftly, for the autumn cometh fast
And, surely, for the winter maketh sure;
With such an urge within me as thou hast;
With such a voyage before me to endure,
Though cloud and storm and night my way should cover,
My dawn shall lift her palms, O golden plover!

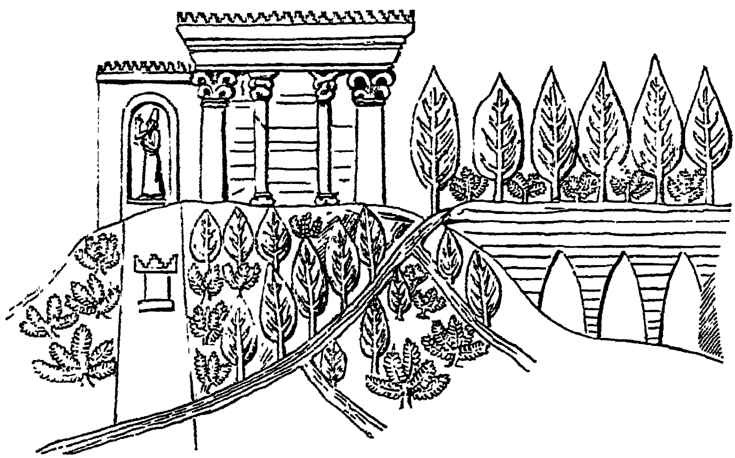
CHAPTER XXI.

UNIVERSAL LIFE

There is a little cylinder, in the room of the British Museum containing the relics of Babylonian civilization, about which a group of visitors may be seen gathered at almost any hour. In the center of the cylinder is a seven branched tree, each branch showing twigs and leaves. Below them are two other branches, each seeming to bear fruit. On one side of the tree sits a man with his hand outstretched to the fruit. On the other side sits a woman. Her hand also stretches forward as if to reach the fruit of the tree. Standing behind the woman, as if in a whispering attitude, is a serpent. It is known as the Adam and Eve cylinder and is supposed to represent the temptation and fall of man.

Adam and Eve cylinder, supposed to represent the temptation and fall. (Courtesy of British Museum.)

Yet it is only one of many beliefs held in common by nations that have ascended the scale of civilization, having to do with reverence for and worship of the "Tree of Life." Often, as was the case with the Sumero-Accadians, the tree stands in a beautiful paradise or park in the sacred direction which, in the case of the inhabitants of the Tigro-Euphrates valleys, was toward the northeast. There they located their Mountain House of Lands or Mount of Assembling, unto whose lofty pinnacle Isaiah declared that the king of Babylon had sought to exalt himself. From this paradise, fed by its bubbling springs, beautiful rivers flowed forth unto fertile valleys. Each ziggurat of Babylonia testified by the very meaning of its name, "Mountain Peak," to the holy memory of high places upon which their ancestors used to worship, of lands flowing with milk and honey, of mountain springs and brilliant, transparent sky. In such a land as this so intelligent a race must have noted with reverence and awe as also with delight and hope that here and there among the trees of the forests there were some which did not yield to the frost; which were not terrorized by the ice and sleet of winter. These were the evergreens, the cedars, the pines, the hemlocks. They were the trees of life and symbolized doubly to primitive



TEMPLE AND HANGING GARDENS AT KOYUNJIK

(British Museum.)

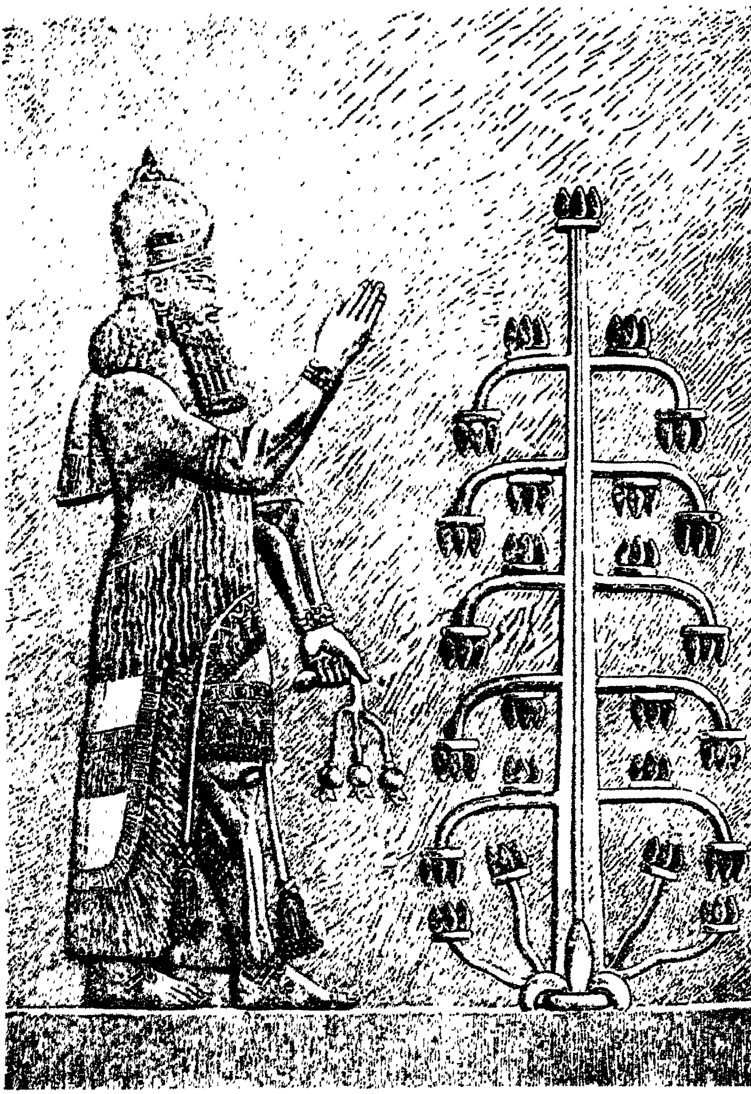
Temple and hanging gardens at Koyunjik. From *Chaldea*, by Ragozin. (Courtesy of G. P. Putnam's Sons.)

men the eternal principle of living things. As early man was impressed with the power and the agility and brute force of the animals, so he must likewise have been impressed with the dignity, the strength and longevity of the great towering monarchs of the forests which drew their power and strength from unseen sources below and stretched unceasingly their palms toward the unseen powers above. Especially would his reverence center upon those trees which seemed never to die but whose leaves were eternally green and which, therefore, must have symbolized to him the principle of unending life. Constantly roving over the earth he would not know whether they ever died. Also, he would beyond question have observed and pondered over the fact that the fruit of some trees was poisonous while that of others gave health and strength.

So, in endeavoring to explain to themselves how sin and death and pain came into the world, more than one race of early men associated it with the failure of man at some time in the past to eat of the mystic fruit that grew upon the tree of life, or else they explained the coming of evil by his eating of some forbidden fruit which brought death and disaster into the world. Here, for example, is the curious story of the fall of Adapa (Adam?), a story doubtless well known to Abraham when he left Ur of the Chaldees. We quote directly from Barton's translation of the Babylonian inscription (italics ours):

Wide intelligence he (Ea) made perfect for him, the destiny of the country to reveal.
Unto him wisdom he gave; eternal life he did not grant him.
The road to heaven he (Ea) made him take and to heaven he ascended.
When to heaven he ascended, when he approached the gate of Anu,
Anu saw him and cried:
. . . .
Food of life
Bring him, that he may eat." Food of life
They brought him; he ate it not. Water of life
They brought him; he drank it not. A garment
They brought him; he clothed himself. Oil
They brought him; he anointed himself
Anu looked at him; he wondered (?) at him
"Come, Adapa, why dost thou not eat nor drink?
Now thou shalt not live; men are mortal (?)." "Ea my lord
Said: *Thou shalt not eat, thou shalt not drink."*
Take him and bring him back to earth.
As now Adapa from the horizon to the zenith of the heavens
. . . . . . .looked, he saw his terror . . . . (the terror he inspired.)
Sickness (shall come,) his disease be violent,
. . . . *.destruction shall fall upon him,*
(In) *good sleep he shall not rest,*
. . . . .shall overturn (?) the joy of people's hearts.

Here we have in Abraham's neighbor-city a man who had possessed himself of knowledge and wisdom not unlike that ascribed to the gods and so great that with it he could break the wing of the south wind. It was a knowledge not unlike that of Adam and Eve who "would become like God knowing good and evil." Yet it did not impart immortality. On the contrary, Adapa's friend, the god Ea, who had caused him to be perfect in wide intelligence was evidently afraid that he might also possess himself of eternal life—just as Jehovah feared that Adam "might put forth his hand and take of the tree of life and eat and live forever." To avert this disaster, Ea played false with Adapa, instructing him guilefully as to his actions when he



Sargon of Assyria before the sacred tree. From *Chaldea*, by Ragozin. (Courtesy of G. P. Putnam's Sons.)

entered the presence of the Supreme Anu. Had Adapa (and Adam) been able to eat of the food that was almost in their possession they might have become immortal as the gods. Each, falling, was punished with disease and death.

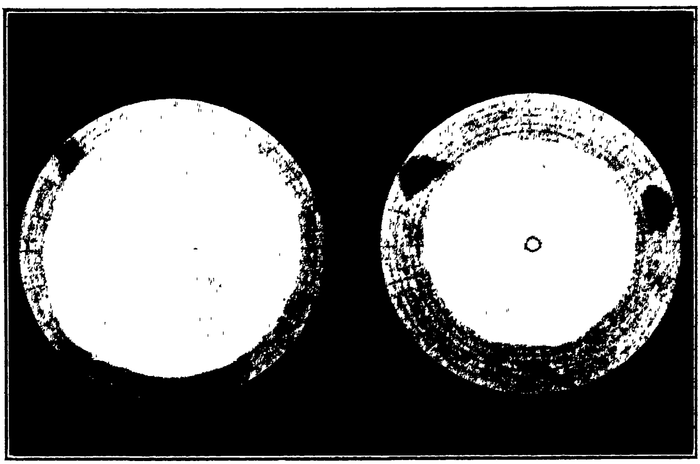
So it seems that from the earliest times men have been as restricted in their view of life as in their view of time and space. It was as if they were afraid that at any time the little candle might die out. They took it as a temporary thing, to be treasured indeed, but a thing that would surely be quenched in the blackness of Sheol. But as the passing years have lifted the vault of heaven and lengthened the days of time, so likewise has the kingdom of life been widened. At first it was but a temporary thing confined to a little river valley and a few outlying districts, a thing created a few years ago and expected almost momentarily to perish in some deluge or other natural catastrophe. But as the years passed, men have begun to wonder whether life is not just as universal as the universe, itself, and just as eternal as time.

On the earth, we see life in every available niche and corner. So long as the temperature lies beneath ice and steam, for part of the year, so long as water is present, and so long as there are carbon and oxygen and nitrogen and hydrogen, and a few other of the life elements, there living things abound. Nor does it matter whether it is in the heavens above or the earth beneath or the waters that are under the earth. And in the sea, life varies in size beginning with creatures of microscopic size up to enormous whales. There are diatoms, the grass of the sea which like the bacteria of earth transform inorganic matter into a form available for larger sea life. Dr. Mann describes a hake whose stomach he found filled with herring, which were gorged with water fleas, which were full of diatoms. Down in the fathomless depths of ocean, in utter blackness and icy cold, under a pressure equal to the weight of one hundred railroad locomotives, where by the wildest imagination, life could hardly be supposed to exist, there dwell multitudes of beautiful delicate living things which, when they are brought up into the air where we live, are scorched and blinded by the heat and light of our sun and suffocated by our atmosphere. In hot springs, in fleecy snowbanks, everywhere, between the limits noted above, life may be found on earth. Taking these as the conditions of life elsewhere, we view the universe as we know it, asking ourselves whether our kind of life is to be found on planets other than ours.

Nearest us is our companion, the moon. Its small mass with the consequent weakness of gravitation on its surface, has allowed its water and atmosphere to be almost entirely dissipated. Its temperature varies far beyond the limits of ice and steam. Yet there have come to the notice of the keenest observers among our modern astronomers certain signs on the surface of the moon that suggest change and movement, perhaps filmy wreaths of smoke, which would indicate moisture and atmosphere and warmth. Even on our little companion planet, in some deep valley or cavernous hollow some form of life like ours may exist.

Reminding ourselves, again, that a planet ages in proportion to its smallness, just as a smaller ball of iron would cool before a larger one, and that life on each planet as it cools must originate and disappear while the temperature for part of the year lies between steam and ice, and that life as we know it is built around the element carbon combined with the other life elements, we turn to our sister planets. Nearest the sun is Mercury with his face eternally toward his lord. He seems to have an appreciable atmosphere, but such moisture as exists must long since have been consolidated into ice on the dark and cold side of the planet. Since the recent invention of the thermocouple it has been possible to measure with a fair degree of accuracy the surface temperature of the planets. We find that on Mercury it rises at noonday as high as six hundred degrees Fahrenheit. The dark side, doubtless approaches 273 degrees below zero, Centigrade, the temperature of inter-stellar space. But ·in the little margins between these two, where the phenomenon known as libration causes the sun to rise a certain height into the eastern sky and then return eastward again to set and similarly to rise and set in the west and where some surface is therefore alternately heated and lighted by the sun, we might, possibly, find conditions which would support life as it is known on earth. There may still survive a fauna and flora remaining from the earlier days of the planet's youth.

If we turn to Venus we find a planet not unlike our own, but the astronomers have not yet definitely determined whether the clouds of Venus consist of moisture or of dust or whether the days of Venus are eternal or much like ours. The logic of events would seems to teach that tidal friction, acting more powerfully upon this planet than upon the earth, on account of its closer proximity to the sun, would have retarded her rotation and lengthened her day, and this may have proceeded far enough to have caused her rotation period to equal that of her revolution. On the other hand, it is possible that the clouds of Venus are real clouds and that the day of Venus is a real day not greatly different in length from ours, in which case we may be fairly sure, since the same chemical constituents



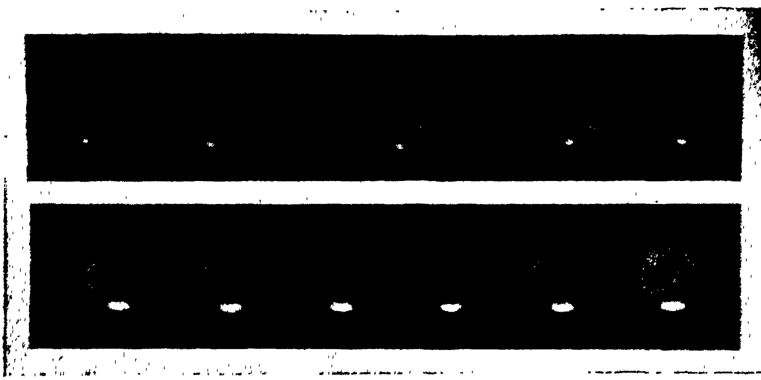
MARS.

NORTH POLAR CAP
At Maximum—full extent of white.
At Minimum—inner circle

SOUTH POLAR CAP
At Maximum—white.
At Minimum—nothing.

From *The Evolution of Worlds*, by Lowell. (Courtesy of MacMillan and Company.)

and physical laws prevail there as here and since, as to size and other characteristics, she is almost our twin, life in some form may exist on Venus. Recent measurements by thermocouple indicate the radiation of dark heat waves from the unlighted portion of the planet's surface resembling those emitted by earth surfaces at night and differing as between the north and south poles. This, if confirmed, points to at least a slow rotation and a day, though perhaps one of great length and to a polar tilt similar to ours. Although Venus receives practically twice as much heat from the sun as we do, we must not overlook her exceedingly dense atmosphere nor forget that only twenty per cent of the heat received by our atmosphere from the sun ever reaches the surface of the earth. Even if the reported temperatures of 120 degrees to 140 degrees Fahrenheit be surface temperatures, life such as we know it would flourish abundantly on Venus. The combination of heat and water doubtless produces a universe of cloud resulting in such conditions as existed in our Palaeozoic days. Even today the temperature of the cloudless desert of Sahara goes as high as 175 degrees and 180 degrees Fahrenheit.



Two sets of photographs of the same face of Mars taken 75 days apart, showing melting of the south snow cap and the coming out of the dark blue-green areas of the southern hemisphere with the advance of Martian summer. The growth of vegetation. The Martian dates are May 10th and June 29th respectively. By E. C. Slipher. (Courtesy of Lowell Observatory.)

Beyond us, in the outer distance, is Mars, smaller than the earth, and therefore astronomically speaking older than the earth. His water is almost gone though there is enough left to condense into an occasional cloud and to gather as polar ice-caps in the winter. His atmosphere is almost gone, being much thinner and rarer than ours, yet it is distinctly perceptible. His "canals" seem to indicate the possible presence of intelligent creatures on his surface as they darken with marginal vegetation in the springtime and redden with each coming autumn. His temperatures are easily within the range of adaptation of living things. The noonday temperature of Mars at the Equator as indicated by radiometric measurements runs as high as sixty to seventy degrees Fahrenheit, a little too warm for a football game on earth, and although the night temperature seems to fall to minus 150 degrees Fahrenheit and in winter even to minus 200 degrees Fahrenheit, we know surely by now how easily life, even our earth-life could adapt itself to such conditions. It would seem a simple problem by the side of the problem of lighting the icy pressures of sea-depths. Under similar conditions men would burrow beneath the surface and live in and not on their planet. At the Martian poles the climate would be more equable affording six consecutive months of daylight and comparative warmth. At our own poles while the win-

Drawing of Mars by Lowell, showing the canals and oases. From *The Vault of Heaven*, by Gregory. (Courtesy of Methuen and Company.)

ter night falls as low as seventy degrees Fahrenheit, the summer heat reaches 110 degrees Fahrenheit, in the shade, and the superabundance then and there of both animal and plant life is well known. Certainly all the fundamental conditions of life as we know it on earth exist on Mars.

With the outer planets, Jupiter, Saturn, Uranus and Neptune, the case is so different that it becomes harder and harder to prophesy. There is reason to believe that Jupiter has not yet cooled sufficiently for life, as we know it, to exist on his surface. The dull cherry glow of the great red spot tells us perhaps of a super-heated interior and of a crust as thin as that which lay upon the earth once, perhaps a billion years ago. As we go further from the sun, the planets become lighter and lighter, Saturn, whose radiometric measurements indicate a temperature approximately equal to that of Jupiter, is about as light as cork. In their atmospheres a new element appears of which we know nothing on earth. We find ourselves staring at this guess: can life be organized around some element other than carbon, and could it exist, so organized, in temperatures per-

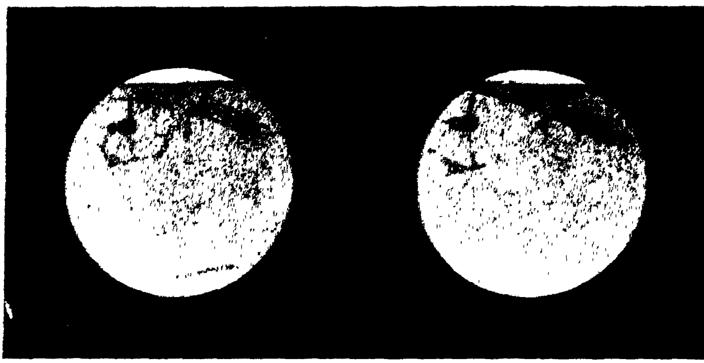
Photograph of Saturn by E. C. Slipher. Note that the ball of the planet shines through the outer part of the ring system. (Courtesy of Lowell Observatory.)

manently hotter than steam and colder than ice? Certainly, it would not be our kind of life, but could it be conscious life and intelligent life?

Our kind of life seems to be as natural to our universe, given certain chemical constituents and temperatures, as matter itself. It seems to be as inevitable as thunder clouds or ocean waves or wind storms. Therefore, when any heavenly body reaches the life stage in its process of cooling, life should appear. It is as if life were waiting everywhere at all times ready to bubble up when conditions make it possible. Life, for example, on our moon probably was born, ran its course for millions of year, and disappeared before the earth became cool enough for life to begin here. The way of the heavens is opposite to that of the earth. The grandchildren, the satellites, die first. The children, the planets, follow. And last of all die the parents, the suns. The lifetime of a solar system begins with the smaller satellites and, e'er they have died, life flowers on the smaller planets, then on the larger, until the autumn comes to this garden of the gods, as death falls upon some giant Jupiter. Afterward the last strange life appears upon the warm but cooling body of the father sun himself, runs its course of ages and disappears in the darkness and chill of death. Then the relics of memoried worlds sweep silently on through space, blinded and darkened until, with a blaze of glory, they are born again in the frenzied clasp of crashing suns.

And what shall we say of life out among the stars of God? Taken all in all, dead and live stars alike, there are perhaps a billion and a half suns in our galaxy. Eliminating those that have long since been darkened and accepting the hypothetical figure of 500 million as the number of living suns, and presuming that only one in five of them is the father of a system of planets like ours, we would still have 800 million planets in the heavens above. And supposing that, of that number, the same proportion of habitable planets holds as the number that the solar system contains, and presuming that matter is the same everywhere and that the same physical and chemical laws hold everywhere as here, there would then exist upon 300 million planets living creatures in approximately the same stages of development as in our solar system. And if we reduce the proportion to just one habitable planet instead of three in each solar system, we still have one hundred million earths, in our galaxy, where conditions, physical, chemical, geological and biological would resemble ours very closely. How many must there be in all the innumerable galaxies of the limitless abyss?

But we must not forget that life as it is organized on earth is a resultant of a multitudes of forces: gravitation, density, heat, light, relative proportions of chemical materials in delicate balance and adjustment. All these and many others have determined the kind of living things that the earth has. In short, while each of the 100 million planets may be inhabited by living, sentient creatures, it is not at all likely that on a single one of them a creature exactly like man would be found dominating his world. Just as no two geological ages on this earth have offered the same types of life, so doubtless no two planets in the universe offer the same types of life. In form, in size, in constitution, in senses, in everything they doubtless differ. It is entirely conceivable, for example, that living crea-



Early winter snow storm in the northern hemisphere of Mars, 1907 (north at the bottom). Martian dates, October 22; left hand drawing. From drawings, July 20, and 22nd before and after the event. From *Mars as the Abode of Life*, by Lowell. (Courtesy of MacMillan and Company.)

tures on Mars, if they have eyes at all, may not know colors from violet to red but may be conscious of other vibrations of light or perhaps conscious of such vibrations as X-rays or radio-waves which we must turn into other waves before we become conscious of them. That wild dream of the ancient philosopher who spoke of the "music of the spheres" may be just as real to some creatures as the light of the spheres is to us. In short, there is nothing that the wildest imagination of mankind can picture that may not exist in the heavens above. The principle of life, adapting itself to a hundred million types of conditions, would produce 100 million types of results.

When human life is at its best, with youth, health, power, beauty, love, dreams—it is a boon unspeakable, and nowhere in the heaven pictured by the prophets can anything so desirable be found. And mankind, as the centuries pass, has enjoyed it and doubtless will continue to enjoy it more and more, as his capacity for enjoyment increases. Furthermore with each year the transcendent possibilities of life in the galaxy, in the universe of galaxies, ever widens before him as he comes to know more fully the plans and dominions of God. Increasing wisdom draws him nearer and nearer to his Maker.

Have we not here a clue to the purpose of evolution? Does it not mean that with each passing year, with the lifting of each misty veil, with the opening of each door of scientific discovery He is drawing us more intimately into his presence until finally we shall see Him face to face? What fears should the old religion have of the new science when all that it asks is the privilege of revealing with each new discovery the wisdom and the power and the glory of God not only, but also his beneficent purposes and his intimate comradeship? It is upon this beneficent purpose that theologians may well place our hopes for continued progress and ultimate immortality.

Which of us has not at times longed for eternal life, here on earth, blessed by perfect health and power and joy and love? Which of us would not, under such circumstances like to live to see the milleniums of transformation and development that await our little planet and its inhabitants? Life like an absorbing drama is so interesting that it is finished before we are aware. Yet here also we find the same strange law that we have met everywhere in the universe. As it was in heaven from star dust to galaxy, as it was on earth from compounds to electrons, as it was with living things from bacteria to man so it is with our life term. There is no chasm or break, everything grades into everything else. From the Ephemeridae whose life-span lasted only between suns, life durations lengthen until nearly three centuries is reached by some reptiles. Through a succession of trees the figures pass to the Sequoia sempervirens which lives for three milleniums. Races, species, genera, families, orders, classes, phyla, kingdoms, enjoy life-terms of millions of years enduring as long as the planets themselves. The planets number their years in thousands of millions. The suns number theirs in millions of millions. How long galaxies endure before they become globular star-clusters and how long globular star-clusters endure before they become—?, only their Creator knows.

Does not this same strange law apply to intelligence? Between amoeba and man, embryo and adult we have discovered no impossible chasm, does the progress stop with man? Is it not quite probable that there are higher intelligences? With no lack of years and no lack of centuries is it not logical to suppose that intelligent creatures exist in our as in other galaxies to whom our intellectual attainments are what the amoeba's is to us? And with no lack of galaxies and no lack of milleniums may we not hope that he who gave us, unasked, so pleasant a thing as life, has prepared for us, whom he has taught to desire it, something else equally as good? Galaxies are continuous from nebula to nebula, matter is continuous from electron back to electron. May not life be continuous from God back to God? If our present life, so wonderful, so enjoyable, so precious, was given to us as a gracious surprise may not other equally beautiful surprises await us? If life is a fairy story, as it is, may not death be also?

And if life is so beautiful and time is so long and the universe is so big, why should man have to die? It is the ancient problem, the question of questions which, coming down to us out of the ages, has remained unanswered. Life has been such a lovely thing for us when it has been lived in accordance with natural laws, when the body has been healthy and spirit has been high, that contemplation of death brings to normal men and women a sense of horror and despair. From remotest times the human heart has longed for immortality, and as the horizons of knowledge have widened and the labors of men have made the world more and more liveable and comfortable, the sense of depression at the contemplation of leaving such happiness and loveliness has been accentuated. Men are just learning how really interesting life is, what joys are to be found in the pursuit of truth and beauty and goodness. The intricacies of social and political life have just begun to intrigue the human spirit so that it seems that we have only begun to appreciate what a great gift it is simply to live and to learn more and more about the marvelous cinema that the Creator is daily and eternally presenting to us. In short we have just arrived at the point where life has become so interesting that the prospect of its termination is a tragedy.

And this tragedy is deepened by the fact that normally life is immortal. Cultures of unicellular creatures, kept under suitable conditions, have demonstrated the fact that protoplasm is inherently immortal, knowing no death so long as its environment continues unchanged. It is only when cell is added to cell and the multi-cellular creature is formed that death appears. It seems that the by-products of life cause the trouble. These by-products, cast off by the individual cell as poisons must be eliminated from the multi-cellular organism and if this is done imperfectly, as it always is, the other cells are poisoned and eventually die. Thus death is the price that we pay for the intensification, the specialization of life. It is an old law in logic that as you increase your intension you decrease your extension. Any cell of one's body can live alone forever if furnished a suitable environment but their union as a body is mortal. In this case, as life is deepened and widened and intensified it becomes more and more complicated and therefore more and more subject to death. The amoeba is immortal, but man perishes. The by-products of the chemical reactions of a single celled creature may be easily eliminated whereas nature has not yet devised a system either to eliminate them perfectly or to neutralize them perfectly in a multi-cellular organism. But, man who is already among the longest lived of animals, at any rate, comes as near to such a goal as any animal on earth, although some birds and reptiles as well as a few mammals have been known to live more than one hundred years. Yet as it is with Professor Woodruff's paramecium which is still alive after having produced approximately 10,000 generations, so it is with many multi-cellular organisms. Fruit and other trees are and presumably may perpetually be propagated from cuttings or even from shoots growing out of stumps. If every peachtree in the world except one were destroyed including all peach kernels the earth could and would be promptly re-supplied by cuttings grafted on other stocks. The germ cells of human kind are, of course, similarly immortal so that each of us carries in his body cells that are as old as life itself. It is only the soma, the body cells that they create and of which our brains and consciousness are parts, that perish. Thus to die is geologically speaking, a new thing on earth and an abnormal one brought about by the inability of the individual cell to resist the poisonous by-products of the others. Experiment has proved that body cells of, for example, the heart and nervous system of a chicken embryo will, in the proper environment, grow indefinitely even when removed from the living body. Tumors are a visible demonstration of the immortality of certain cells which have in some way developed an immunity to somatic poisons. Death is not inevitable. It is not natural. It is the result of imperfect adaptation. Man by his control of natural processes has begun to substitute his will for natural selection. He will doubtless learn how to conquer all diseases, to preserve all vital processes and to prolong life indefinitely. While the last enemy to be destroyed will be death, yet it is not unthinkable that man will some day be able here and now to taunt him, saying "O Death where is thy sting? O Grave where is thy victory?" As life has become conscious of its own wonder and joy it has become more conscious of its brevity and sorrow. Death is the price we pay for development. Nature has not yet devised a physically immortal, specialized organism.

Yet we cannot help asking ourselves whether she is in process of doing so. If this is the case the effort certainly must be associated with the human brain, for there would seem to be no need for extending the lives of men or animals beyond their present length unless she has in her mind some purpose other than physiological because the perpetuation of the species is already adequately insured by the present life period. But the brain of man that has already changed so many things on earth may also find a way to bring immortality to earth. The all-powerful influence of the mind over the body suggests an ultimate control of the life period much more complete than at present. Imaginary states of mind have been known to produce death on the one hand and irrisistible power on the other. Hypnotized children have been transformed into bars of steel. The ability of faith to heal and to create surpasses the belief of those that are not thoroughly acquainted with the subject, and now for the first time in the history of the world intelligence is directing its efforts to the problem of immortality. The whole medical profession is engaged in solving the problem of lengthening life. It is entirely possible that the duration of human life, that has been lengthened by a quarter of a century in a few hundred years, may be lengthened for another half century by the simple but regular observance of hygienic laws. What the physiological chemist can do with the problem when he really attacks it in earnest and has time for experimentation, will be one of the most interesting problems of the coming centuries. The two hundred year man may come much sooner than we expect. It is largely a matter of producing the proper chemical reactions in the human body. On this earth we know only two immortal things, one of them is the unicellular creature when living in a suitable environment; the other is the electron whose superiority to change and decay we have shown in a previous chapter. Real immortality, that is a life that will last longer than the earth itself, should it, for example, be involved in some celestial catastrophe, would of course eliminate all protoplasm so that the only truly immortal things known on earth today are the constituent elements of an atom, electrons. As we have already found, it is out of electrons that the human being has come and if Goethe was really right when he said that it is ever the spirit that builds for itself a body, then we may have found a clue to our problem. We shall have to think of the human soul or spirit, not as an immaterial body but as something whose life is beyond space and time. We shall have to think of space and time as being perhaps temporary forms of thought of the human mind or its equivalent. We shall have to conceive of ourselves, that is our souls, our spirits, as having built for themselves bodies and as having begun to do this not in the realm of the visible and the tangible and the audible nor even in the world of molecules and atoms but in that newly discovered land of Power and Will and Spirit where protons are suns and electrons are planets. At any rate if we have made such a journey this glorious cloud has trailed our footsteps, that we hope for and believe in the immortality of the human soul.

Already there are some signs that we are approaching a solution of the problem so that it is not necessary for us to sorrow as those who have no hope. Man has not failed to note how, from the beginning, there has sprung up in the hearts of every race, under every clime, a faith, dim at first, but ever growing in intensity, that He would not leave our souls in Sheol. And he has learned that the great indispensable truths, permanent and fundamental, have come to him slowly through the ages, not by sudden revelation. So, whether in Egypt or Babylonia, in China or Australia, in Mexico or the isles of the sea, as men have appeared, the immortality-hope has appeared with them. This ethnological assurance throws the argument directly up to the Creator. "If the Lord had meant to destroy us would He have shown us all these things?"

Nor have men ceased to note that resurrection is as common as death. We have already traced the ancient sun-myths and the message of mother earth, advising us that:

"Again the burdened bough shall bend with blooms of
sweetest breath.
Ah, mystery of mysteries, the life which follows death!"

This cosmological assurance has ever made a compelling appeal to the hearts of men.

And side by side with these two we have learned to trace the historical assurance. We have noticed that species and genera and races and nations all die but that they are always resurrected in other forms, that there has been a steady evolution of all creatures and peoples upward, a march of mind and a soul toward God. We have learned that

"Still the new transcends the old
In signs and tokens manifold."

It is as if each new forward- going spiral bears us nearer to a future life as the present life is enlarged. We not only live thus again but we live more.

And then there is the teleological assurance. A fine old man who is about to die says, "I am not afraid to go for I am ready to die." Now the interesting part of it is that what he really means is that he is at last ready to live. Men pass through decades of study, of labor, of toil and defeat and triumph and then, ripe with wisdom and experience, they come to the point when they are prepared to enjoy life and to use it, to understand it, to grasp some little part of the meaning of the universe. Shall it be that hundreds of millions who are thus ready to live will be destroyed? Will the great manufacturer scrap the finished product of his factory?

And then there is a certain psychological assurance which springs from the bottom of the human heart.

"Like the tide on the crescent sea beach when the moon
is new and thin,
Into my heart strange yearnings come surging and welling in.
Come from the mystic ocean whose rim no foot has trod
And some men call it longing and others call it God."

It is difficult to believe that the great Creator would make millions of beings who long to live, who expect to live, and who are fitted to live forever and then destroy them. It is as if a father had taught his little boy to expect a beautiful Christmas present and then had given him nothing. If it were not so he would have told us.

And surely no one can read this volume without thinking of the astronomical assurance of eternal life. What mean the stars? Was Herschel really right when he said that he had been reading the thoughts of God after him? Surely there are enough heavens now for all of us since Galileo and Copernicus have come. The Father's house stretches to all infinity and lasts to all eternity. In it there are indeed many mansions. We found, on earth, that the individual is part of a family, the family is part of a city, the city is part of a country, the country is part of a race, the race is a part of an earth, an earth is part of a solar system, a solar system is part of a universe, a universe is part of a supra-universe, and everywhere, all is God. And God is life.

Among the strangest and most wonderful discoveries of modern science is that of the Millikan rays, fifty times shorter than gamma rays which themselves number some 250,000,000 to the inch. Sinking his instruments into the waters of a mountain lake fed by melted snows where they would be free from earthly vibration and open to those of heaven, Millikan found that those rays do not seem to originate on earth nor on the sun but come from everywhere, from the night sky or from the day sky, from the ether. Of almost infinite smallness they betoken activity in the world of electron and ultra-electron where matter is being born of "nothing." More nearly than any known radiance they spring from the throne of eternal Being. They remind us that we are immersed in God; that myriads of influences play upon us of which we are ignorant; that the real world is the invisible, inaudible, intangible, the world of phenomena being an infinitely small segment of it. Now the most striking feature of the whole universe, to those who consider it most carefully, is the perfect order and sureness of step with which everything moves. There is no confusion, no hesitation. From electron to star cluster, from paramecium to man everything acts as if a super-intelligent power controlled all. "To an astronomer the most remarkable and interesting thing about the part of the physical universe with which he has become acquainted is not its vast extent in space, nor the number and great masses of its stars nor the violent forces that operate in the stars, nor the long periods of astronomical time, but that which holds him awestruck is the perfect orderliness of the universe and the majestic succession of the celestial phenomena. From the tiny satellites in the solar system to the globular star clusters, the galaxy, the exterior galaxies, there is no chaos, there is nothing haphazard, there is nothing capricious. The orderliness of the universe is the supreme discovery of science!"—(Moulton.)

So the final wisdom of science searching for the origin of matter, of energy, of life delivers to us the ultimate source, invisible, inaudible, intangible, omnipotent, omnipresent, eternal, creator, preserver, destroyer. With her marvelous key, evolution opens to us her remotest door and we view the Infinite Being, the Eternal Becoming. Of "Him" all things are born, by "Him" all things are preserved and developed and unto "Him" all things return. "He" is law and purpose. Heredity is "His" and variation and the struggle for survival also. Of "His" essence we know less than the amoeba knows of the universe yet toward "Him" we steadily march. And as we are borne further forward with each new discovery we realize more clearly how tiny a part of the real universe is the visible, tangible, audible world. All the important advances of science will, in the future, be made outside of the "material" world and will be brought into it only at large cost of skill and thought. Science is already walking by faith, not by sight. The kingdom of the unseen has come! Until we can get a better name, let us continue to call "Him" God. So wherever God is, there also is life and light and love. And so when the true believer looks at the problem of death from the "materialistic" standpoint of the evolutionits, he finds naught to dread therein. Science points out the fact that human death is the result of specialization. The amoeba in a proper environment never dies. Death is the penalty for development, differentiation, complexity. The germ cells from which we come, barring accident and change of environment, are immortal. That means since we were those germs, that could we return to our prenatal size and condition retaining the plunder of life's experiences and could our environment remain unchanged, we would never die. Now may we so return? Evidently death means the dissolution of every cell in the human body. But if we, our bodily selves, came from a thing so small as a single microscopic cell, one-billionth our adult size, may not we, our kinetic selves, really come up from an infra-cell, so small as a billionth of an ordinary cell, and may we not retire to that infra-cell at death. In fact, may we not always abide therein? And as a cell is immortal, barring accident, so may not such infra-cell be even more permanent, independent of environment of all kinds. All this may be only dream stuff but surely the direction to which it points is fundamentally correct, even if it is only an analogy. Evolution has taught us a profound respect for the invisible, the infinitely little. The query of the mediaeval scholastics; "How many angels can dance on the point of a needle?" may not be nonsense after all.

Science then consists of the things men know, events whose causes they have explored and measured and found to be proportional to their effects. Magic consists of imaginary causes falsely believed to produce desired effects. Out of magic many ritualistic observances have grown. Representing the phenomena of the universe by a large circle and science by a very small one at its center, the realm of magic would be the whole field within the larger circle and outside the smaller realm of science. As knowledge increases the content of the realm of magic decreases. Gradually science will absorb the realm of magic and theology in proportion as the knowledge of man increases until we shall know even as also we are known. But not ever, until he has become God Himself, will man's comprehension and worship of and sense of dependence upon the Supreme Being which is the essence of religion be embraced in the tiny circle of science. On the contrary, outside of both circles is that of religion which includes both what we know and what we believe, both pistis and gnosis. Magic and theology and faith shall tend more to be resolved into knowledge as men learn to see him face to face and to realize that the very dirt on which they stand is holy just as holy as that on which the angels stand. Perhaps the immortality hope may some day become the immortality fact of science. Perhaps we shall some day discover it just as Lief Ericsson discovered America. In the meantime it is safe to leave it within the larger circle of religion.

Also, there is ever the possibility to be reckoned with that we would not care to live longer than our allotted time if we knew what the hereafter offers. Perhaps life is like a cinema which, having once been seen, we would not care to view a second time, especially if we knew of another and more attractive one which we could see. Ours is indeed a beautiful little planet and certainly no heaven painted by saint or seer can remotely compare with life upon it when it is at its very best, offering as it does:

Instead of the noises of heaven
A thrush, and the setting sun.
Instead of the marbles of heaven
A green where the bluets hide,
Th'azalea's pink cheeks freely give,
A cardinal, calling his bride,
Cloud shadows o'er meadow waves driven
And the woman I love by my side.

Who is sure that earthly life at its best would attract him by the side of that which is to come? Perhaps our longing for immortality is as that of the child who would not leave his toys; as if the embryo desired ever to be an embryo, refusing to grow up to the heritage of adult manhood. No stranger fact faces the philosopher than that which puzzled old Omar:

Into this universe and why not knowing,
Nor whence, like water willy-nilly flowing;
And out of it like wind along the waste,
We know not whither, willy-nilly blowing.

Yet perhaps this also is wisdom. Who would want to stay if he really knew that there was something far finer to be obtained by so simple a method as dying?

Among the finest of the old Scandinavian myths was the story of the mighty evergreen tree, Ygdrasill, which bears up the whole universe. Out of the body of Ymir, the Frost of Death, he rose, sending his three enormous roots into three undying springs. One of them was guarded by the three Norns, the Past, Present and Future, goddesses of fate. In another were hidden the mysteries of all knowledge and learning, while the great adder, Darkness, drank eternally from the third. In the branches of the Tree are the dwelling places of gods and men. The sun, the moon, and the stars are borne on his boughs. The winds feed upon his leaves unceasingly, and eternal darkness gnaws at his roots. Yet he lives, forever!

Has myth again become our seer? Is the universe indeed the tree of life? At its roots does there forever flow as a river the living waters, clear as crystal, proceeding out of the very throne of God himself? And on either side of the river does there tower eternally the Tree of the Gods, bearing twelve manner of fruits, yielding her fruit every month, as his symbol passes from sign to sign on his journey through the heavens, and shall the leaves of the tree be potent forever for the healing of the nations? And is God back of and Father of compounds, organic and inorganic, of elements known and unknown, of protons and electrons, of ether and energy and all, is He the Source from which eternally keeps springing this perpetual resurrection and this irrepressible life, rising unceasingly from the frost of death. And is His the omnipotent Bosom into and unto which all things tired, fall to renew their strength so that they can again mount up with wings as the eagle? Is he, speaking scientifically as well as spiritually, the alpha and omega, the beginning and the end, the first and the last, and those who do His commandments, are they the ones who have the right to the tree of life?

Then, indeed, behold, the tabernacle of God is with men and there never has been any death. Perhaps we shall find it to be the last great illusion.

THE URGE OF BUSH RIVER

Rippling thro' the wooded wild
    Where the mint and minnow meet.
Mindest thou thy former child?
    Feelest still his feet?
O little Pastor of my Dreams,
    The years have gone, but thou art here,
And still thy hurried current seems
    To say: "He waits me there!"

Heeding not the shadowed wood,
    Hardening toward the thrush thy heart,
Suffering ill the angler's cord,
    Fain with peace to part,
O luring, unallured stream,
    Wilt whisper to me, pondering here,
The mystery of thy zeal? Thy dream?
    The joy? "He waits thee there?"

Rememberest then the Bosomed Form
    On which thou sleepedst e'er thy mist
Awoke amidst the thunderstorm,
    By rainbows kissed?
Ah! this the urge that drives thee on,
    In rudeness to the lily, fair,
To kneeling violet left alone
    In purple rage: "He waits thee there."

O wander-wisdom, weather-won,
    Thou mindest me, thou mindest me
Of bosom-dreams in aeons gone,
    On distant sea;
Of currents ever homeward bound,
    Of breathings in the untracked air,
Of hurried lights and glory round
    The One who waited there,

Behind the infinite Beyond
    Where new-born universes spring,
At touch of misty, spiralled wand,
    While swarming star-clouds sing;
Mid fiery clutch of orbed bliss
    As myriad cindered Vegas meet.
And clustered suns throng thick to kiss
    The world-dust from his feet;

Within the infinite Within,
    Of elements that change and fade
Till each its varying form may win
    Of that whence all is made,
Amidst the vast unbelted power,
    Which ioned suns in atoms ties
Where in one earth's short hurried hour
    Their world is born and dies.

Ah, little brook, thy waves and mine
    Break ever toward the open sea,
Nor stone may bar, nor wading kine
    A hindrance be.
We beachward bear our portioned sand,
    The boom of breakers in our ear,
O harbor of the Father-land,
    He waits us there.

CHAPTER XXII.

THE UNITY AND CONTINUITY OF BEING

In one of his inimitable lectures, delivered in this case to the graduates of the Hartford Theological Seminary, Woodrow Wilson, himself the son of a Presbyterian minister and the nephew of that Dr. James Woodrow* who was dismissed from the Presbyterian ministry by his brethren because of his belief in evolution, told a most interesting story. After endeavoring to persuade them that "the man who shall mediate between our spirits and our knowledge, who shall be our guide to tell us how we shall thread this

"I heard a very pathetic story told the other day about a poor woman, a simple, uneducated woman, in one of our cities, who had by some accident got hold of one of Darwin's books—I don't know whether it was the 'Origin of Species' or not—and who had found, even to her unlettered mind, a great revelation in the book, a revelation of the processes of physical life and of the plan of physical existence. She told a friend that it had taken out of her—in her expression—"all the kick that was in her." She said: 'I don't find anything in the preaching that I hear. It listens good, but it is so soft. It doesn't seem to give me anything to chaw on. It doesn't enable me to understand what happens to me every day any better than I understood it before. It doesn't even put bread in my mouth or in my children's mouths. But I read that book and I saw that there was something doing. I saw that there was something going on of which I was a little part, and it has taken all the kick out of me.' I believe that her experience is typical of the modern intellectual situation. We are infinitely restless because we are not aware of the plan. Just as soon as we are aware of the plan and see that there is 'something doing,' something definite, something to which we are related, even if by mere inexorable necessity, we at least know that it is futile to 'kick', that it is inevitable that the processes of the gods should be ground out, and that therefore, the whole operation of life is something to which we may properly relate ourselves if we choose, but must relate ourselves in some fashion whether we will or not. How arid, how naked, how unsatisfying a thing, merely to know that it is an inexorable process to which we must submit! How necessary for our salvation that our dislocated souls should be relocated in the plan! And who shall re-locate them, who shall save us by enabling us to find ourselves, if not the minister of the Gospel?"

*At one time professor in Oglethorpe University, from whom Sidney Lanier (class of 1860) said that he received the finest impulses of his intellectual life.

intricate plan of the universe and connect ourselves with the purpose for which it is made, is the minister," he said:

It is an ancient faith, this conviction that the universe is personal, that it has a purpose and plan, that it is directed by a will and a mind. "Concerning the gods," said Epictetus, "there are those who deny the very existence of the Godhead; others say that it exists, but neither bestirs nor concerns itself nor has forethought for anything. A third party attribute to it existence and forethought, but only for great and heavenly matters, not for anything that is on earth. A fourth party admit things on earth as well as in heaven, but only in general, and not with respect to each individual. A fifth, of whom were Ulysses and Socrates, are those that cry:—"I move not without thy knowledge!" As we read these remarkable words of one of the greatest moral philosophers of all time, we are perhaps more pleased by the tremendous advance which they represent over the earliest thought than by their ultimate perfection. The various conceptions that men have of the universe may be divided into even fewer classes than Epictetus names. After all, one is conscious of self and of not-self. Most thinkers, therefore, have divided the universe into these two divisions. There remains the question as to what the not-self is and its relationship to one's conception of God. Is God identical with the not-self or does He exist apart from it and over it, ruling both it and self? Most ordinary Christians would answer the last question affirmatively because most everyday Christians are deists. They think of God as sitting upon a throne, somewhere up in the heavens, surrounded by angels and principalities and powers, who convey his commands and messages, or if they have advanced sufficiently far in philosophy to conceive of God as a "spirit, infinite, eternal and unchangeable in his being, wisdom, power, holiness, justice, goodness and truth," they still think of Him as a person who is contending for righteousness and is opposed by the devil who is contending for evil and, in general, raising a rough-house wherever He can. They have a supreme contempt for the materialist who maintains that the whole universe, self, not-self, Satan and God are one and that they may be all of them defined and explained in terms of matter. The present day materialist is quite different from the type that Berkeley demolished because he has exhibited matter in its ineffably glorious nature. He has shown that nature and power and electricity are all one and the same thing; that there is nothing unclean in itself, that the very dirt upon which one treads is holy. Whenever he reaches that point in his argument he meets the pantheist who began at the other end of the universe by holding that all is mind or spirit, that matter does not really exist as a coarse, common thing, and that God and the angels and mankind and matter are all really divine. Between the pantheist and the modern materialist there is really no difference. They are both identical in that they are monists, believing that all that is in the universe is of one kind. The modern materialist has so exalted matter that the pantheist can take it to his bosom as consisting, in essence, of that spiritual thing of which he always believed the universe to consist. Both are different from the deist who separates quite sharply between coarse, common matter on the one hand and "spirit" on the other and who divides equally sharply the personality of God from the personality of men. The acme of such definitions is reached in that famous statement, "There are three persons in the Godhead, the Father, the Son and the Holy Ghost; these three are one God, the same in substance and equal in power and glory."

Now, if we could be perfectly sure that there is nothing in heaven or earth that is not dreamed of in our philosophy we would know at once that the pantheist and modern materialist were both quite right in maintaining that the universe is just electro-magnetic spirit-matter. But the fault of both the pantheist and materialist is that each limits God to the thinking capacity of the human mind. Existence is not certainly synonymous with the universe nor is it comprehended in time and space. May there not be billions of extra-conceptional universes? We easily and quickly reach the limits of our thinking power. Beyond lie the infinities of God. God is greater than the material universe. God is greater than the spiritual universe. When we define Him in terms of personality we can only mean that we yet know no higher form of existence. We cannot conceive of universes beyond time and space and causation, yet billions of them may exist. Let us not forget that even our thought is "of the earth, earthy." From some such universe we may have come; to some such existence we may go. Between such and ours there would scarcely be intelligible communication. Memories of them like the memories of our embryonic days are lost. Forms of existence, like forms of wave vibration vanish at each end into infinity. Who can say but this individuality of consciousness which we know as personality is but one element in the unity of Being, intricate plan of the universe and connect ourselves with the purpose for which it is made, is the minister," he said:

It is an ancient faith, this conviction that the universe is personal, that it has a purpose and plan, that it is directed by a will and a mind. "Concerning the gods," said Epictetus, "there are those who deny the very existence of the Godhead; others say that it exists, but neither bestirs nor concerns itself nor has forethought for anything. A third party attribute to it existence and forethought, but only for great and heavenly matters, not for anything that is on earth. A fourth party admit things on earth as well as in heaven, but only in general, and not with respect to each individual. A fifth, of whom were Ulysses and Socrates, are those that cry:—"I move not without thy knowledge!" As we read these remarkable words of one of the greatest moral philosophers of all time, we are perhaps more pleased by the tremendous advance which they represent over the earliest thought than by their ultimate perfection. The various conceptions that men have of the universe may be divided into even fewer classes than Epictetus names. After all, one is conscious of self and of not-self. Most thinkers, therefore, have divided the universe into these two divisions. There remains the question as to what the not-self is and its relationship to one's conception of God. Is God identical with the not-self or does He exist apart from it and over it, ruling both it and self? Most ordinary Christians would answer the last question affirmatively because most everyday Christians are deists. They think of God as sitting upon a throne, somewhere up in the heavens, surrounded by angels and principalities and powers, who convey his commands and messages, or if they have advanced sufficiently far in philosophy to conceive of God as a "spirit, infinite, eternal and unchangeable in his being, wisdom, power, holiness, justice, goodness and truth," they still think of Him as a person who is contending for righteousness and is opposed by the devil who is contending for evil and, in general, raising a rough-house wherever He can. They have a supreme contempt for the materialist who maintains that the whole universe, self, not-self, Satan and God are one and that they may be all of them defined and explained in terms of matter. The present day materialist is quite different from the type that Berkeley demolished because he has exhibited matter in its ineffably glorious nature. He has shown that nature and power and electricity are all one and the same thing; that there is nothing unclean in itself, that the very dirt upon which one treads is holy. Whenever he reaches that point in his argument he meets the pantheist who began at the other end of the universe by holding that all is mind or spirit, that matter does not really exist as a coarse, common thing, and that God and the angels and mankind and matter are all really divine. Between the pantheist and the modern materialist there is really no difference. They are both identical in that they are monists, believing that all that is in the universe is of one kind. The modern materialist has so exalted matter that the pantheist can take it to his bosom as consisting, in essence, of that spiritual thing of which he always believed the universe to consist. Both are different from the deist who separates quite sharply between coarse, common matter on the one hand and "spirit" on the other and who divides equally sharply the personality of God from the personality of men. The acme of such definitions is reached in that famous statement, "There are three persons in the Godhead, the Father, the Son and the Holy Ghost; these three are one God, the same in substance and equal in power and glory."

Now, if we could be perfectly sure that there is nothing in heaven or earth that is not dreamed of in our philosophy we would know at once that the pantheist and modern materialist were both quite right in maintaining that the universe is just electro-magnetic spirit-matter. But the fault of both the pantheist and materialist is that each limits God to the thinking capacity of the human mind. Existence is not certainly synonymous with the universe nor is it comprehended in time and space. May there not be billions of extra-conceptional universes? We easily and quickly reach the limits of our thinking power. Beyond lie the infinities of God. God is greater than the material universe. God is greater than the spiritual universe. When we define Him in terms of personality we can only mean that we yet know no higher form of existence. We cannot conceive of universes beyond time and space and causation, yet billions of them may exist. Let us not forget that even our thought is "of the earth, earthy." From some such universe we may have come; to some such existence we may go. Between such and ours there would scarcely be intelligible communication. Memories of them like the memories of our embryonic days are lost. Forms of existence, like forms of wave vibration vanish at each end into infinity. Who can say but this individuality of consciousness which we know as personality is but one element in the unity of Being, bearing a relation to pure Being, similar shall we say to that which gold and hydrogen bear to pure matter.

Let us reexamine with some care the modern scientific view of "being" or "matter" and see if from it religion has anything to fear. Perhaps it would be well to quote some representative exponent of the new knowledge fully: In his recent Lowell lectures (1925) Alfred North Whitehead, fellow of Trinity College in the University of Cambridge and professor of Philosophy in Harvard University, has summarized the matter thus: ". . . . .One of the most hopeful lines of explanation (of matter) is to assume that an electron (its ultimate known constituent) does not continuously traverse its path in space. The alternative notion as to its mode of existence is that it appears at a series of discrete positions in space which it occupies for successive durations of time. It is as though an automobile moving at the average rate of thirty miles an hour along a road, did not traverse the road continuously: but appeared successively at the successive milestones, remaining for two minutes at each milestone . . . . . These electrons, with the correlative protons, are now conceived as being the fundamental entities out of which the material bodies of ordinary experience are composed. Accordingly, if this explanation is allowed, we have to revise all our notions of the ultimate character of material existence. For when we penetrate to these final entities, this startling discontinuity of spatial existence discloses itself. There is no difficulty in explaining the paradox, if we consent to apply to the apparently steady undifferentiated endurance of matter the same principles as those now accepted for sound and light. A steadily sounding note is explained as the outcome of vibrations in the air. If we explain the steady endurance of matter on the same principles, we shall conceive each primordial element as a vibratory ebb and flow of an underlying energy, or activity. Suppose we keep to the physical idea of energy; then each primordial element will be an organized system of vibratory streaming of energy. Accordingly there will be a definite period associated with each element; and within that period the stream-system will sway from one stationary maximum to another stationary maximum,—or, taking a metaphor from the ocean tides, the system will sway from one high tide to another high tide. This system, forming the primordial element, is nothing at any instant. It requires its whole period in which to manifest itself. In an analogous way, a note of music is nothing at any instant, but it also requires its whole period in which to manifest itself . . . . . . We first must ask whether there is any evidence to associate the quantum theory with vibration. This question is immediately answered in the affirmative. The whole theory centers around the radiant energy from an atom, and is intimately associated with the periods of the radiant wave-systems. It seems, therefore, that the hypothesis of essentially vibratory existence is the most hopeful way of explaining the paradox of the discontinuous orbit . . . . . . Light consists of waves of vibration in the electromagnetic field. After a complete wave has passed a given point everything at that point is restored to its original state and is ready for the next wave which follows on. Picture to yourselves the waves on the ocean, and reckon from crest to crest of successive waves. The number of waves which pass a given point in one second is called the frequency of that system of waves. A system of light-waves of definite frequency corresponds to a definite colour in the spectrum. Now a molecule, when excited, vibrates with a certain number of definite frequencies. In other words, there are a definite set of modes of vibration of the molecule and each mode of vibration has one definite frequency. Each mode of vibration can stir up in the electromagnetic field waves of its own frequency. These waves carry away the energy of the vibration; so that finally (when such waves are in being) the molecule loses the energy of its excitement and the waves cease. Thus a molecule can radiate light of certain definite colours, that is to say, of certain definite frequencies. You would think that each mode of vibration could be excited to any intensity, so that the energy carried away by light of that frequency could be of any amount. But this is not the case. There appear to be certain minimum amounts of energy which cannot be subdivided . . . . It has been the basis of the materialistic theory, that the happenings of nature are to be explained in terms of the locomotion of material. In accordance with this principle, the waves of light were explained in terms of the locomotion of a material ether, and the internal happenings of a molecule are now explained in terms of the locomotion of separate material parts."

"What," asks Arthur James, Earl of Balfour, "are we to say about a universe reduced without remainder to collections of electric charges radiating energy through a hypothetical ether? . . . . . . it seems that in the present state of our knowledge or (if you prefer it) of our ignorance, we have no choice but to acquiesce provisionally in an unresolved dualism. Our experience has a double outlook. It brings us face to face with such objects as electricity, mass, motion, force, energy, and with such manifestations of energy as ethereal radiation. The second is spiritual. The first deals with objects which are measurable, calculable, capable (up to a point) of precise definition. The second deals with the immeasurable, the incalculable, the indefinable and, (let me add) the all-important. The first touches the fundamentals of science; the second is intimately connected with religion. Yet different as they seem both are real. They belong to the same universe; they influence each other; somewhere and somehow they must be in contact along a common frontier. But where is that frontier to be drawn? And how are we to describe the relation between these two continuous provinces of reality?"

This all-important question which the Earl of Balfour fails to answer may find its solution in this thought: that these final units of the universe, these "electric charges vibrating energy'" are themselves only phenomena perceived by us through our senses. That Reality whcih is behind them, their Ding an Sich, we do not and cannot perceive. All that we know of them may be and doubtless is but a billionth part of what they are. Why should it be thought a thing incredible for mind to be compressed into electrons any more than for legs to be compressed into microscopic cells, at least until we know what an electron is? The last stathmos in our analysis of "matter" leaves us in the house of mystery viewing discrete discontinuous quanta of vibrant energy, pulsating by waves that appear to us as jumps. Quite evidently they are the birth units of sensible phenomena ascending from the infinite well of unperceivable Being. What is to hinder any man who so chooses from calling that Being, God?

Doubtless some of our more philosophical readers, as from time to time they have looked up from the pages of this book, have reflected upon this great and final illusion of human thought. Once to all men, as now to the vast majority, our little world seemed to be the sum total of the universe, the center of all things around which the sun and moon and stars revolved and to which all the hosts of heaven paid homage. Yet it was not so. Solid and immovable seemed that earth founded upon the seas and established upon the floods, as eternal as the great mountains that would stand forever. Yet it was not so. In that day and for a long time after, the world of things seemed composed of multitudinous, disconnected, essentially separate objects whose number the learned men of the day counted by the hundred thousand and affirmed to be composed of some eighty or more irreducible elements. Yet it was not so. Once also, all living things, seemed so separate and distinct that their species were immutable, their only connection being that all had left the hand of the Creator perfect and unchangeable forever. Yet it was not so. Once also between man and all else that God had made there was a great gulf fixed, an impassible barrier of intelligence and consciousness and mind, so that he alone was made in the image of God with the blood of Kingu in his veins. Yet it was not so. In each and all of these various spheres we found an underlying unity, a definite oneness so that, as one merged into the other no man could at any point say: here or there entered a distinct element of new kind and quality. And now having discovered this unity in the worlds of matter and life and consciousness we turn to the world of Being and we ask ourselves: Are these apparently vast differences between matter and mind and gods many and lords many also illusions? Is there a fundamental Unity of Being?

Let us inquire into the significance of this question. When men first looked thoughtfully upon the universe they took it for what it quite evidently was, a vast aggregation of disparate things. These were quickly divided into two great classes, those which like themselves moved and grew, the living, and those which did not, the dead. Of the former there were certain tremendous powerful uncontrollable moving things like the sun, the moon, the lightning, regarded with special fear and respect. These were the gods. To these were added those unseen forces, spirits, ghosts, the souls of men and later the unseen gods and God. To early man these were all permanently separate. It has been the task of modern science and philosophy to point out their essential unity. As it was with the inorganic world of two hundred and fifty thousand things and the organic world of a million species of living creatures and the world of multitudinous consciousnesses so it is also with the world of gods. Dyaush-Pitar, Zeus-Pater, Jupiter, the heaven-fathers are one with Anu and Ra and Unkulunkulu and the great Manitou. Ilu, Allah, El, Elohim, Bel, Baal, Ishtar, Ashtoreth, Venus, Yahwe. Ormuzd, Law, Nature, Chance, Heaven, Providence, Brahma, Necessity, God—all are one. Each is the conception in whole or in part of the purpose and power behind the universe. As men have grown in wisdom and knowledge the gods also have grown, each nation and each generation creating the god whom it deserved. We are no better than our gods—nor worse. Therefore, the new conception which we are now come upon is that of the unity of being of gods and men and things, seen and unseen. It is the key to all the doors of the universe. It is this Unity of Unities into which the sciences and philosophies and religions of men are fast gathering up the worlds of the inorganic and organic and spiritual and the divine which constitutes the chief glory of human achievement. No one man has done it. It is a creation of the thoughtful toilers in science and religion and philosophy during milleniums. It is based upon a new conception of the universe and yet one of which the seers of the past did not fail to prophesy, a conception which recognizes the temporal differences of thing from thing, of life from life, of mind from mind, so plainly apparent in the universe but perceives also that fundamental oneness which unites them in the unity of unities which for lack of a better term men will doubtless continue to call God. "We are but framents torn from God," cries Epictetus, and out of the Bacchae Euripedes answers:

"O strength of God slow art thou and still
Yet failest never!
Is it so hard a thing to see
That the Spirit of God, whate'er it be,
The law that abides and changes not, ages long,
The eternal and nature-born, these things be strong."

"Surely the Lord was in this place and I knew it not!" exclaims Jacob;

"All are but parts of one stupendous whole,
Whose body nature is and God the soul,"

Pope explains. "Work out your own salvation with fear and trembling," admonishes Paul, "for it is God who worketh in you both to will and to do his good pleasure." And an ancient bacchanal continues:

"Till life, through the trammelings
Of laws that are not the right,
Breaks clean and pure and sings
Glorying to God in the height."

"To God Unknown" the Athenians graved on their monument. Hear the Apostle to the Gentiles as he interprets its meaning:

Whom therefore ye ignorantly worship Him declare I unto you. God that made the world and all things therein . . . . . He giveth to all life, breath and all things . . . . .hath made of one blood all nations of men for to dwell on the face of the earth. That they should seek the Lord if haply they might feel after Him and find Him though He be not far from any one of us, for in Him we live and move and have our being. For we are His offspring. Forasmuch then as we are the offspring of God, we ought not to think that the God-head is like unto gold or silver or stone."

"Fetch me from thence a fruit of the Nyagrodha (fig) tree," said the ancient father in the Upanishads to his son. "Here is one, sir," "Break it." "It is broken, sir." "What do you see there?" "These seeds almost infinitesimal." "Break one of them." "It is broken sir." "What do you see there?" "Not anything, sir." The father said: "My son, that subtle essence which you do not perceive there, of that very essence this great Nyagrodha tree exists . . . . . It is the True. It is the self and thou, O Svetaketu art it."

And deeper and finer than them all are those great words of Him who felt more vividly than any other son of Man this marvelous Unity of Unities in God: "I am in the Father and ye in me and I in you. . . . I came forth from the Father and came into this world. Again I leave the world and go to the Father . . . . As Thou, Father, art in me and I in Thee that they (who shall believe in me) also may be one in us . . . I in Thou and Thou in me that they may be perfected into one." And as if he were one of his disciples, Epictetus adds: "He that hath grasped the administration of the world, who hath learned that from God have descended the germs of life, why should not such an one call himself . . . a son of God?"

And so in the last analysis we discover that all the wordy battles between the anti-evolutionists and the scientists might well have been saved by a little deeper insight on the part of both. Again, as often before, the fight is over a shield both gold and silver. In essence, all religions are true, all creeds, all gods. And all are precious. God, he that abideth of old, the high and lofty one who inhabiteth eternity lived in them all. As a vesture he has changed them for He only hath immortality. He alone lifts up His hand to heaven and says: "I live forever!" Yet the invisible things of Him from the Creation of the world are clearly seen in them all being understood by the things that are made. The whole earth is full of his glory. They all—Marduk, Osiris, Ioskeha, Allah, Ormuzd, are but forms of One God and Father of all, who is above all and through all and in them all. "Why asketh thou after my name," he warns us, "seeing it is secret?" It has ever been the glory of God to conceal a thing, for he pleases to do great things past finding out, yea, and wonders without number. The Lord has always said that He would dwell in the thick darkness. His way is in the sea, His path in the deep waters and His footsteps are not known. Verily thou art a God who hidest thyself!

Thus it is as Cleanthes sang:

"Chiefest glory of deathless gods, Almighty forever,
Sovereign of Nature that rulest by law; What name shall we give Thee?
Blessed be Thou, for on Thee should call all things that are mortal,
For that we are Thine offspring; nay all that in myriad motion
Lives for its day on the earth bears one impress—Thy likeness—upon it.
Wherefore my song is of Thee and I hymn thy power forever."

So when the outraged fundamentalist anxious for the Ark of God accuses the "materialistic" scientist of atheism because though he casts out devils "he followeth not after us," each may renew his confidence in the other's faith upon thee foundation of the Unity of Unities.

"Do you mean to say that I am an atheist simply and a teacher of Atheism?", asked the immortal Socrates of his accusers.

"I mean the latter, that you are a complete atheist," replied Meletus.

"Do you mean that I do not believe in the God-head of the sun or moon which is the common creed of all men?"

"I assure you, judges, that he does not believe them; for he says that the sun is stone and the moon earth . . ."

"I do believe that these are gods and in a far higher sense than that in which any of my accusers believe in them. And to you and to God I commit my Cause."

Thus it is that the deepest thinkers of all ages have united in a hymn of praise to God, each interpreting Him after his own fashion and according to his own knowledge each perceiving Him as through a glass, darkly, each weaving around Him the knowledges of his day and each perceiving but not comprehending the infinite reality of the Unity of Unities. Perhaps no one of them all has ever expressed this thought in a more masterly way than that ancient Egyptian author of the "Hymn to the One God" written milleniums ago: (translated by E. A. Wallis Budge.)

"God is One and Alone, and there is none other with him.
God is the One, the One who has made all things.
God is a Spirit, a hidden Spirit, the Spirit of Spirits, the great Spirit of Egypt, the divine Spirit.
God is from the beginning, and has existed from the beginning.
He is the primeval One, and existed when as yet nothing existed; He existed when as yet there was nothing, and whatever is, He made it after He was. He is the Father of beginnings. God is Eternal. He is everlasting, and without end, Perpetual, Eternal. He has endured for endless time, and will exist henceforward forever.
God is hidden, and no one hath perceived His form, no one hath fathomed His likeness, He is hidden in respect of Gods and men, and is a mystery to His creatures.
God is the Truth, He lives by Truth, He lives upon the Truth, He is the King of Truth.
God is Life, and man lives through Him alone.
He bloweth the breath of life into their nostrils.
God is Father and Mother: the Father of fathers, and the Mother of mothers.
God begets, but He is not begotten: He gives birth to, but is not given birth to.
He begets Himself, and gives birth to Himself: He makes, but is not made. He is the Creator of His own form, and the fashioner of His body. God is the Creator of Heaven and earth, the deep, the water, and the mountains. God stretches out the heavens, and makes firm the earth beneath.
That which emanates from His heart is performed immediately, and when He has once spoken, it actually comes to pass, and he is the progenitor of all deities.
God is compassionate to those who fear Him, and hears those that cry unto Him. He protects the weak against the strong. God knows those who know Him.
He rewards those who serve Him, and protects those who follow Him."

THE WILL OF WILLS

There is a voice that calls me on and on;
    There is an urge compelling me to go;
There is a hand that beckons me, alone,
    To whispered secret which I fain would know.
O God of Dreamers, thine the tug that draws
    Our faltering footsteps toward the purple hills,
Till all that we have sought we find, because
    We dared not disobey the Will of wills.

CHAPTER XXIII.

THE NEW KNOWLEDGE AND THE OLD FAITH

Through earth's unhappy maelstrom of opinion and doubt, the stroke of modern science is sure. Master minds from all the fields of discovery; astronomy. geology, biology, palaeontology, embryology, anthropology, and from many others are united in their confession of faith which is embraced in that superb generalization called "evolution." In the warm sunshine of its radiance old traditions and dogmas disappear like the ice-floes in the Gulf Stream. But with them the very foundations seem to be destroyed until the righteous exclaim "What shall we do?" The theory is assailed by some of the best of living men as "damnable heresy," not only, but as "rotten morals" and as conducive to every terrible and evil result. It is described as a cancer eating at the vitals of pure religion and as the mother of unbelief and godlessness. In some sections of the country for a minister of the gospel to refer to the theory of evolution favorably in a sermon would mean immediate attack on the part of the majority of the membership of his church and his instant resignation or exclusion from the pulpit. This union of blind religious devotion and blind scientific ignorance is absolutely deadly. An address delivered in Atlanta as this chapter is written epitomizes this attack stating that "Evolution as a theory is paganistic in its origin, atheistic in its character, beastialistic in its science (sic) and has no place in the scientific world." Even state legislatures have outlawed this "atheistic hypothesis" while school boards and boards of directors of colleges and universities have unseated members of their faculties who "teach and sanction this form of Paganism." And yet so far as we know, there does not exist in the world any great astronomer who does not believe in stellar evolution. So far as we know, there does not exist on earth a great geologist who does not believe in the evolution of the physical form of the earth. So far as we know, there does not exist in the whole academic world a half-dozen distinguished biologists who do not accept as true, in some form, the general theory of the evolution of life as originally propounded by Alfred Russell Wallace and Charles Darwin and modified by the opinions of such men as Lamarck, Weissman, Huxley, Mendel, DeVries, Osborn and others. So far as we know, there does not exist a single palaeontologist in the whole world who does not believe in the palaeontological evolution of the present forms of earth-life. And so far as we know, there does not exist, anywhere, a modern master of human embryology who does not believe in the evolution of the individual human body from a microscopic cell.

Pertinent to this anti-evolution agitation two remarks may be made. The first is that while men have become wise enough to consult experts on problems of medicine, dentistry, war, agriculture, etc.; these anti-evolution agitators prefer to use their own judgement on this subject although it involves a multitude of abstruse and technical details. The other is that the situation is still further most unhappily embarrassed by the fact that, generally speaking, scientists do not regard religion as within the sphere of their expert training or within the proper field of their discussion and, although they are in many cases deeply religious men, their professional silence on the subject which they consider necessary creates in many minds the impression of indifference or opposition to religion. They further resent the invasion of their special field of investigation by ignorant blunderers and are apt to apply terms, which, however, appropriate, are nevertheless harsh to those who thus proclaim their unfitness to engage in an argument on a subject which would seem above all others to require expert training, exact knowledge and a dispassionate weighing of evidence. Fortunately there remain a few who love both science and religion and who endeavor, as is being done herein, to mediate between these two equally important branches of human interest. After all this "conflict" is, when properly understood, highly gratifying. For we must never forget that if the world is to go forward some must necessarily precede. He whom God honors by imparting to him the new truth must tell it to others. First he wins a dozen disciples then seventy, then a whole world. But if his discourse have anything to do with religion from the day on which he steps out of line he is a marked man. Sometimes it is a cup of hemlock, sometimes a shower of stones, sometimes epithets and anathemas, sometimes a cross. Both before and since the day when the greatest iconoclast of all was called Beelzebub, no man may go far in advance of his fellows. They will follow him a few steps but a great distance—never. Thus every age, in proportion as it is progressive is distinguished by discoveries, heresies, argument, conflict. Just at present our age is engaged in tearing down all our previous structures in order to examine their foundations. Some are already rebuilding. Of such are those who would save all that is good in the Old Faith and illuminate it with the New Knowledge.

It is because the point of emphasis of science in respect of religion is so distinct from that of theology that much misunderstanding has arisen. The devout theologian emphasizes as fundamental certain dogmas about Jesus; his virgin birth, his divinity, his miracles, his vicarious atonement for sin, his resurrection from the dead in the flesh and bodily ascension to heaven and as the basis of them all the inspiration of the Scriptures and the fall of man from an original state for pristine purity. The devout scientist emphasizes the order of the universe, its marvelous perfection amid mystifying complexity, the necessity of a source of its infinite and eternal energy, the evidence of super-inteligence and super-purpose directing its progress. The virgin birth of Jesus seems to him distinctly inferior in wonder to that which he finds ordinarily in nature. Nor does interference with the majesty of law by means of miracles impress him half as deeply with a sense of divinity as the perfection of immutable law. The thing that does constantly impress him is what the theologian calls the providence of God, the Will of the universe. This Will seems to be eternally engaged in an unending process of creation. The scientist calls this continuous process evolution and labors to understand and explain it. Its direction-on-the-whole he calls progress. He knows by what interminable warfare and fathomless suffering its each tiny increment has been won. He keeps constantly wondering what addition he or his generation will make to the sum total of assets heretofore accumulated by the race. With all the earnestness of his soul he desires to see this evolutionary process continued especially in the case of man. He judges every thought, every feeling, every deed, every law, every custom of individual or society by its effect in setting forward or retarding this Will. The prayer that Jesus taught His disciples expresses the religion of the modern devout scientist exactly: "Thy Will be done on earth as it is in the heavens." Such problems as those having to do with whiskey, the family, dissipation in all its forms, the misuse of wealth, the misuse of the

Sabbath, educational ideals—of them all he asks, will it set forward or retard the progress of mankind? Nothing that opposes the Will is desirable. Anything that is in line with it is to be approved. To a man holding these modern scientific views Jesus would at least have said, "Thou art not far from the Kingdom of Heaven" for in identifying the law of evolution with providence our scientist has laid the foundation for a complete rapprochement between the New Knowledge and the Old Faith. Here, for example, is Dr. Henry Fairfield Osborn. than whom there are few more authoritative exponents of modern science, saying: "If you will examine our exhibit in the Hall of the Age of Man, you will see that it demonstrates very clearly not that man has descended from monkeys, or from the ape, but that he has a long independent line of ascents. The argument is that creation is continuous, every phase of which we are to accept as an act of God." And here is Dr. Millikan, discoverer of the Millikan rays. and winner of the Nobel prize for the isolation of the electron, saying: "Every one who reflects at all believes, in one way or another, in God. From my point of view the word 'atheism' is generally used most carelessly. unscientifically, and unintelligently, for to me it is unthinkable that a real atheist should exist at all. It seems to me as obvious as breathing that every man who is sufficiently in his senses to recognize his own inability to comprehend the problem of existence, to understand whence he came and whither he is going, must in the very admission of that ignorance and finiteness recognize the existence of a something, a Power, a Being in whom and because of whom he himself 'lives and moves and has his being.' That power, that something, that existence, we call God." Vernon Kellogg, Secretary of the National Research Council, puts it this way: "Religious leaders may welcome every new advance of science; some do. Science may be truth and so may religion. Science and religion co-exist. Both are realities in human life. They should not be looked on as antagonistic or as displacing each other. They should be looked on as complementary. A full human life includes both, depends on both. The cause of things may be called God; the manner of things, science." Nor do they stand alone in giving such testimony. On the contrary. the great mass of modern scientists stand unequivocally today on the side of a moral interpretation of the universe. on the side of God. Now these men are only stating in scientific terms what our Christian poets have long ago taught us, in words permanently interwoven with our finest religious sentiment. In what detail is their belief different from Whittier; singing:—

"I know not where God's islands lift
Their fronded palms in air,
I only know I cannot drift,
Beyond His love and care."

Or from Bryant's faith:

"There is a power whose care
Doth guide thy way along this pathless coast,
The desert and illimitable air
Lone, wandering, but not lost."

Or from Carothers' interpretation:

"A fire mist and a planet
A crystal and a cell,
A jelly-fish and a saurian
And caves where cave men dwell.
Then a sense of law and beauty,
And a face turned from the sod,
Some call it Evolution
But others call it God."

Or indeed from the fine words of the old Scotch song:

"Confide ye aye in Providence, for Providence is kind;
And bear ye a' life's burdens wi' a calm and tranquil mind.
Tho' hemm'd and press'd on every side, hae faith and ye'll
win through,
For ilka blade o' grass keps it's ain drap o' dew."

Or from those familiar words, difficult to improve, by Pope:

"Safe in the hands of one disposing power,
Or in the natal or the mortal hour,
All nature is design unknown to thee;
All chance direction which thou canst not see;
All discord harmony not understood;
All partial evil universal good."

No wonder that Lowell exclaimed:

"I take great comfort in the thought of God."

and that Theodore Monod requested that his epitaph should be: "Here endeth the First Lesson,"
For it is this meticulous care which Divinity exercises over all creation from electron to universe that philosopher, theologian and worshipper may find common ground for fraternity and co-operation. No one has expressed this fundamental conception of evolution as the Will of God revealed in the providence of God better than Browning:

"God smiles as He has always smiled
E'er suns and moons could wax or wane,
E'er stars were thunder-girt or piled
The heavens God thought on me His child,
Ordained a life for me, arranged
Its circumstances, every one, to the minutest;
Aye, God said this hand this head should rest upon
Thus, e'er He fashioned stars or sun."

Why ma ynot all God-fearing men, evolutionists and theologians alike, unite upon this formula of the Divine Will in nature and forget their non-essentials, their adiaphora? To such a happy consummation the pathways of both science and theology are constantly tending. The scientist, on the one hand, should remember those fine words of John Oxenham:

> "Not what, but WHOM. I do believe,
> That, in my darkest hour of need,
> Hath comfort that no mortal creed
> To mortal man may give:—
> Not what, but WHOM!
> For Christ is more than all the creeds,
> And His full life of gentle deeds
> Shall all the creeds outlive.
> Not what I do believe, but WHOM!
> WHO walks beside me in the gloom?
> WHO shares the burden wearisome?
> WHO all the dim way doth illume,
> And bids me look beyond the tomb
> The larger life to live?—
> Not what I do believe,
> But WHOM!
> Not what,
> But WHOM!"

And on the other hand, the ultra-fundamentalist will find food for thought in Edward Bulwer Lytton's reflection that really,

> "There is no unbelief;
> Whoever plants a seed beneath the sod,
> And waits to see it push away the clod,
>   He trusts in God.
>
> Whoever says, when clouds are in the sky,
> "Be patient, heart; light breaketh by-and-by"—
>   Trusts the Most High.
>
> There is no unbelief;
> And day by day, and night, unconsciously,
> The heart lives by that faith the lips deny—
>   God knoweth why."

The whole teaching of evolution points to a "divine, far-off event toward which the whole creation moves," something compared to which our individual lives are as nothing, for in the consideration of this matter we should not forget that our consciousness is as if we were looking at our own lives through a magnifying glass. And should the lens be lifted from above us we could see how disproportionately large we seemed compared to the universe. For just as the principal thing to a flower is the seed, so it is as life bearers that we find our importance in nature. When viewed sub specie eternitatis, the individual is infinitessimal in space and time and importance. Compared with the race, divine wisdom may say to each of us as was said to Abraham, "Look now toward heaven and tell the stars if thou be able to number them—so shall thy seed be." Each of us is but one link in a chain so long that it is unthinkable. As we have had billions of ancestors, so we shall have billions of descendants. We have but two fundamental duties—one to transmit unimpaired the life that we received, the other to transmit it improved by something we have individually fought for and won and added, as our tiny increment to the common treasure. Thus and thus only may we set forward the evolution of the Will of God.

But the scientist is apt to smile at the theologian when he is asked to believe that the earth was created in six consecutive days of twenty-four hours each; that woman was made from Adam's rib, literally; that man fell, tempted by a walking and speaking serpent, from a state of primitive purity and sinlessness; that the immature and outgrown cosmology, geography, biology, astronomy and palaeontology of the Bible is to be accepted verbatim, et scribatim, et punctuatim, et seriatim, et literatim, as scientific truth. Even among our theologians there are those who see this clearly. "Listen to old Father Inchofer in 1631," writes Fosdick, in the current Harpers, "as he pours out of a pious heart his outraged sense of sacrilege at the idea that the earth moves: 'The opinion of the earth's motion is of all the heresies the most abominable, the most pernicious, the most scandalous; the immovability of the earth is thrice sacred; argument against the immortality of the soul, the existence of God, and the incarnation, should be tolerated sooner than an argument to prove that the earth moves.' Nevertheless, Father Inchofer was wrong and Father Inchofer's successors today are wrong for the same reason. They have let their sense of sacredness run away with them. Their feeling of sanctity has unintelligently attached itself to all sorts of things that are not integral parts of vital religion. A stationary earth is not sacred; a whimsical universe where miracles, not law, are the order of the day is not sacred; creation by fiat is not sacred. Religion has no inherent dependence on such outgrown ideas. Yet all these things, along with many others from the use of anaesthetics in operations to acceptance of the law of gravitation, have been bitterly opposed in the name of religion as though the old science to which the religious imagination had clung, around which it had entwined itself, were a holy thing. There is no peace in sight between science and religion until religion recognizes that the sense of sanctity is too valuable an article to be misused in holding up scientific progress. Once many Christians were scandalized at evolution: they called it "a dark art," "dangerous and disreputable," "a forbidden province," "an awful invasion of the testimony of Revelation." How long shall religious people go on making this lamentable blunder which always reacts disastrously upon the fortunes of religion itself and in the end can do nothing against the new truth? Always the outcome has been the same: the scientific view of the world at last has triumphed and the seers of the spirit have found the new truth a nobler vehicle than the old for the experiences of the soul."

If the theologian insists upon the gospel about Christ as essential there is nothing to be done but for each to present his views to the informed opinion of the educated public and let the world take its choice. For the only real fundamental is a conviction that the human mind will eventually distinguish between truth and error and will prefer the truth. This is religious toleration, theoretically a common-place, actually, a rarity. It is the court of final appeal in all religious impasses. Only a consciousness of the weakness of his cause or a lack of love for the truth as distinguished from his conception of it could possibly prevent either scientist or theologian from accepting that solution. In the meantime, let brotherly love continue.

Thus what science is now doing is confirming the absolutely fundamental foundation of religion by asserting the immanence of God in nature and in man while brushing away a lot of excrescences and rusty accretions of theology. The new science is burnishing and polishing and causing to shine with a new lustre the gospel of Jesus Christ. The new religion is simply the old religion restored. It has again become as it was upon the lips of Jesus, a way of life, a special kind of personal conduct based upon a definite relationship to the Will, a process of promoting its purposes. Fundamental to such co-operation is respect, admiration, reverence, love for the Will. The fundamental law of life thus becomes, "Thou shalt love the Lord thy God with all thy soul and with all thy strength and with all thy heart and with all thy mind" and the second is like unto it, "Thou shalt love thy neighbor as thyself." Likened unto the highest relationship on earth it appears as the fatherhood (and motherhood) of God. To great spirits co-operation with the Will becomes the chief purpose of life. Such men are seers of the Will, apostles from the Will, prophets for the Will. All the incidents and purposes of their lives are absorbed into its current. Thus the object of the incarnation, the life, the death of Jesus Christ stand revealed: "To do the Will of Him that sent me." To that end he came into the world; to that end he toiled in the world; and to that end he died, that the Will of God might be done, that His purpose might be set forward. Thus the Cross becomes logically and rightfully the law-center, the life-center and the love-center of the Gospel, the inevitable outcome of fearless leadership and unwithholding service. Furthermore, any man who would come after Him and take part in the salvation of the world may and must likewise take up his Cross and follow Him. Of such a gospel faith would inevitably be the essence. How else could man guide his footsteps in the right direction, how else become conscious of the immanent Will? This spiritual coming-to-consciousness is so like the physical that it may be likened to a re-birth nor can man so much as see the Kingdom of God until he has been born again. Once conscious of the Will and its purposes his own will and purpose tend to add their tiny bits to the progress, the evolution, if you please, of the world. Jesus praying, "Not my Will but Thine be done" is Jesus revealed doing exactly this thing. Thus he who endeavors to do the Will of God, to show forth in his personal conduct the attributes of God, is the righteous man, for he that doeth righteousness is righteous. On this basis all the sciences worship, offering their gold and frankincense and myrrh unto the Babe representing as He did and does the future, the progress, the salvation, the evolution of the world. God still remains as "Our Father who art in Heaven." Sin is still revealed as "any want of conformity unto or transgression of the Law (Will) of God and Jesus still came not to destroy but to fulfill that Law. Consciousness of the Will may be intensified by the concentration of the attention upon its presence. This is the communion of prayer and gains added meaning upon reflection that the Will must be infinitely more conscious of us than we could ever be of it. Prayer, itself, becomes a part of the plan of the Will including the original yearning, the consequent petition and the subsequent answer.

The story of civilization has been that of a running fight between old faith and new truth. Each newly discovered fact necessarily modifies the interpretation of all preceding beliefs. Therefore, as the world goes forward, the timid are perennially fearful of the effect of the new truth on the old faith, and each new discovery has met with ridicule, persecution, and often with death. It is an old saying that science commits suicide when it adopts a creed. The same is largely true of churches. For it seems to be a particular delight of Providence to shatter all fixed things such as mountains and creeds. A group of able, pious and learned men confer for months together, and after vast effort, formulate a statement which is the last word of science and philosophy and theology in that day. And if it were not for the wonderful evolutionary process which we call progress such a creed might last indefinitely. But the Will proceeds with its purpose, and bit by bit the science of the creed becomes obsolete and its philosophy ages. The faster the world advances the more rapidly the creed becomes senescent. Some new discovery makes a "fundamental" ridiculous. In the meantime, however, a multitude of holy memories and loyalties have clustered about the tradition of the old-fashioned religion. A terrible battle ensues between the new truth and the old faith, the adherents of the former being "heretics" or "atheists" or "infidels." Finally, the heretics win and slowly become prophets or martyrs. The crudities of obsolete science are smelted out of the creed and to the astonishment of the faithful the sanctities of religion remain unharmed. Thus there has never been a fight between science and religion, but there has never ceased to be a fight between science and theology. The ancient Greek philosopher who once stated that the sun was as large as the Peloponnessus would have been exiled but for the intervention of Pericles. Giordano Bruno, who expressed the belief that the sun was a star, was burned at the stake in Rome. Galileo was forced to recant his faith in the rotation of the earth. Copernicus dared not have his book, on the evolution of the earth around the sun, published until after he was dead. There was a time when to say the sun did not rise, or that there were not four corners to the earth, or that there were no waters under the earth, was to run the risk of death.

After all, the matter is simple enough in spite of all the noisy confusion brought about by contending parties. Let us remember that concerning the facts of religion there is not, will not be, and never has been any doubt. Human beings are as incurably religious as they are social, nor can their hearts any more than that of St. Augustine "find rest except in Thee." Religion is very simple and easy to understand and universal in its appeal. It consists of all those thoughts, feelings and deeds which arise from a consciousness of the existence of a power other than ourselves upon whom we are dependent. Science also is simple, consisting of the orderly arrangement of the things that we have learned through our five senses of sight, hearing, touch, taste and smell. Religion is permanent and abiding but science, infinitely restless, is constantly changing with each new discovery.

Between the two and composed partly of each is theology. Theology is an alloy of religion and science. The human mind endeavors to understand God by interpreting his universe in terms of divinity. Thus theology is born. Therefore, also, as the science of each age changes into that of its successor, its theology must likewise change. Sometimes it does it easily and gradually, but more often it has crystalized into forms so holy and hard as to be indistinguishable in the mind of the average worshipper from religion itself, so that the churches of the day defend the alloy of theology as if it were the pure metal of religion. Thus the stress increases and the tension grows until, like some mighty earthquake, there is a sudden collapse and many theological castles crash to their ruin. It will readily be observed that the more rapidly an age increases its scientific knowledge the more certain are these theological earthquakes to come. The Renaissance brought the Reformation and the last most wonderful century of all has brought our modern struggle.

The well-informed student of the Bible knows that there has been a constant evolution of Biblical theology from the beginning to the present time. We should never forget that the Bible was written by scores of writers during a period of almost two milleniums. Consequently, the theology of Genesis bears little resemblance to that of Jesus, and the theology of the book of Judges has little in common with that of Paul. Each writer has taken the science and the philosophy of his age and alloyed it with his religion, so that the metals that they have created are in most respects different. Nor did the process end when the canon was closed and all the present books of the Bible separated from all other literature as being sacred and inspired. Followed the theology of the middle ages and the changes of the Reformation, and now has come the reconstructive processes of the modern hour. In no case has religion suffered but combined with a new science in each case it has produced a new alloy. All this seems plain enough to the thoughtful but unfortunately men do not so much think about their religion as feel about it. Once they have identified their religion with their theology they are ready to defend the alloy with words, not only, but with deeds and lives. Hence, the eternal warfare between science and theology and the eternal friendship between science and religion.

Comes Jesus, the Christ, to preach His wonderful gospel to an age pharisaical, legalistic, hypocritical. Asked what is the essence of religion, He replies "Thou shalt love the Lord thy God with all thy heart, with all thy soul, and with all thy mind. This is the first and great commandment. And the second is like unto it: Thou shalt love thy neighbor as thyself. On these two commands hang all the law and the prophets." Asked what is the essence of the law and the prophets, He replies: "All things whatsoever ye would that men should do to you, do you even so to them, for this is the law and the prophets." Such is the gospel of Jesus Christ. It is somewhat amplified in the Lord's Prayer and in the sermon on the mount and in various other discourses. But the heart and essence of the gospel of Christ is as He Himself stated it in the words given above. Yet no sooner had He gone than His followers created a brand new thing, a gospel about Christ. Who was this wonderful personage? Why had he been born? Why did he die? Where had he gone? In answering these questions they began with the creation of the world in six consecutive days of twenty-four hours each; in the creation of man, perfect and pure and holy; in the creation of women from the rib of the sleeping Adam; in the fall of man from his pristine purity to a state of utter depravity, into which situation all of his descendants fell likewise, having sinned with him and fallen with him in his first transgression. From this beginning, through a series of covenants, redemption of the world took place, climaxing in the vicarious death and atonement of the Son of God, followed by his ascension into heaven, still imagined as immediately above the earth. To obtain this salvation one must believe and be baptised, thereafter being justified, adopted and sanctified, and finally, after death, being glorified. This system called for a final judgment; for a heaven above the earth and a hell beneath it, and for various other surroundings and circumstances mentioned elsewhere and commonly understood by the ordinary Christian. Now all of this, whether it be false or true, is not religion but theology. It is an alloy of religion with astronomy, anthropology, history, philosophy, and other sciences. The quality of these sciences thus mixed with religion depends inevitably upon their age so that the older they are the cruder they are, and consequently the older the theology the cruder it is also. Having identified all this with religion any man who doubts part of it as for example, the verbal inspiration of the Bible, the creation story of Genesis, the miracles of the sun and moon that stood still is considered a heretic and infidel, an enemy of the faith; although he may practice the gospel of Christ far better than his accusers. Yet the God of providence seems to bless these heretics. Their numbers grow. Their influence is enlarged. At last they succeed in rubbing the ancient theological tarnish from the pearl of great price and religion, clean and pure, leaps forth, and sings, glorying to God in the height. If ordinary christians could only be shown that the gospel of Christ is essential and eternal and the gospel about Christ non-essential and evanscent, an enormous amount of friction and discord and evil-speaking could be saved the world. But this has never been possible in the past nor is it possible at present; they have identified their religion and their theology too closely. They have written long creeds which they change with greater difficulty than they revise the Bible itself. They have established theological seminaries where men are specifically trained in polemic theology and of such strongholds of intellectual inertia it is a proud boast that they have not advanced a new idea in centuries. When the new discovery comes, upsetting some fundamental of their theological faith, it is first doubted, then ridiculed, and then attacked as atheistic. But truth has a way of moving like the great glacier, slowly, but with crushing force, and as Castelli said, "Nothing that can be done can now hinder the earth from revolving." So the old theologies, amid protests, anathemas and prophecies of utter calamity, vanish. "They shall perish, but thou shalt endure; all of them shall wax old like a garment. As a vesture shalt thou change them, and they shall be changed. But thou art the same and thy years shall have no end."

In his remarkable "Life of Jesus of Nazareth" Klausner points out the impossibility of the Jewish people accepting the teachings of Jesus because to them religion consisted of religion, not only, but of law, and social customs, and history and science, and medicine, and religious observances and traditions of rabbis and of high priests and elders. Jesus isolated religion separating it from science and philosophy and jurisprudence and politics. "Render unto Caesar the things that are Caesar's and unto God the things that are God's," was to the patriotic pharisee the saying of a disloyal slacker. To Jesus it was of the essence of religion that it should be free from state and philosophy and science and theology. The strict scholarly theologians of that day rejected His teachings as "tending to infidelity" and rejected Him as a glutton and a winebibber and blasphemer and sabbath-breaker just as the strict scholarly theologians of today reject those who accept and defend the same principle. Theological intolerance is in essence the monopolization of God. Follows the ossification of God. Now when gods cease to grow religion decays. It is the duty also of each generation to outgrow gods, else, its descendants having done so will laugh at them. After all, what is religion? Is it not the will to live by the noblest ideal, regardless of consequences? The goal of science is this ideal, truth; the goal of theology is a creed. The hope of science is a new discovery; the hope of theology is the old faith. Theology treasures the thing that was believed yesterday. Science treasures the thing that will be believed tomorrow. The scientist had rather be wrong obeying the truth than right disobeying her. The scientist is ever mindful of the wonder of the usual. Unmindful of it the theologian has thought it necessary to add every species of thaumaturgy to prove religion divine as if a change in the universal harmony could indicate the presence of God. One of the least fascinating of national stories is that of the Jewish people yet so clearly did they see God in their most ordinary affairs that the civilized world today thinks of them as the chosen folk, the peculiar people. They chose themselves—by seeing the Supreme. They were peculiar in that they heard a Voice whispering in every mulberry tree. The Greek saw Form, the Romans saw Order, the Hebrews saw God. And so today we follow Greek art, Roman jurisprudence, and Hebrew religion. And follow them we shall so long as their vision is superior to ours. But our subservience reveals the more clearly the three fundamental errors of Fundamentalism: 1. That men were once better than now. (Eden, the Fall of Man.)

2. That God was once nearer than He is now. (Prophets, Miracles) 3. That books were once holier than now. (An inerrant, verbally inspired Bible.) Now if the supreme object of religion, of education, of civilization is to equip man with higher thoughts, nobler emotions, and finer principles to the end that he may understand and enjoy and take more excellent part in the universe, then blessed above all the sons of men is he who can better Greek art or Roman law or Hebrew religion. This was anathema to the rabbis who listened to Jesus as He taught the people: "Ye have heard that it was said by them of olden times, but I say unto you." Trusting God's future for men he promised that those who came after him would do greater works than he did. That they have done so, science affirms and theology denies. But whether one is right or the other, religion remains unaffected.

Now the section of scientific knowledge which causes the most concern is the theory of evolution. The theory of evolution is the greatest and highest scientific generalization that the mind of man has conceived. It enlarges our vision of God, of the universe, of space, and of time. It is the finest compliment ever paid to its Creator by the mind of man. As it is undeniably true, so it is immeasurably illuminating. It has given mankind their first real grip on the meaning of the divine Will. Properly taught and interpreted, it illumines the Bible and inspires all men to march further forward to our divine destiny. No man can do a more dangerous thing than to teach the populace that religion and modern science constitute a necessary disjunctive. The church should be made safe for intelligence. The well-educated should not be driven from its doors. Science enlightens religion and religion sanctifies science. The issue, therefore, is fairly and squarely joined. There can be no doubt but that the new discoveries in all scientific fields have had and are having an effect upon religious thought and belief perhaps greater than the effect of the Renaissance and Reformation, combined. We are in the presence of the greatest forward movement that religion has known since the days of Jesus Christ. Just as we have reconstructed the old fashioned method of dentistry, the old fashioned method of government, the old fashioned lunatic asylum and the old fashioned method of farming, so we must again, as many times in the past, reconstruct the old fashioned religion. For the world is going forward now as heretofore. We, also, live in a geological age. Progress is eternal and the great lesson that evolution teaches, the fine contribution that it makes to the progress of mankind is its insistence that "there is a power, not ourselves, that makes for righteousness," not only, but for all other things that are good and true and beautiful. Evolution has taken hold of our conception of God, our conception of religion, our conception of man, himself, and is transforming all of them before our very eyes. What then has evolution done for God?

The writer recalls that during the first year of his student life at Princeton there appeared in a paper that came to the reading room a never to be forgotten cartoon; a drawing of a youth, puzzled, not unlike himself, as he sat at his desk, reading a book by Darwin. On his table lay an open Bible. The countenance of the student was troubled as if great anxiety had taken possession of his soul lest he might lose the old faith and hope as he read the strange new revelation that evolution was making. But underneath the drawing the cartoonist had written this legend, "It is I, be not afraid."

Possibly some reader of this volume, also, is questioning its import, similarly. "If," says he, "the face of the deep was that of Tiamat; if there is really no firmament and the world was not created in six consecutive days of twenty-four hours each, if woman was not really taken as a rib from the side of sleeping Adam and the serpent did not literally whisper his words of temptation to her to the end that mankind lost its chance of immortality, falling from purity to total depravity; if Cain must have wedded a woman who was not a descendant of Adam and Eve and the story of the flood was a tradition or myth, ancient and hoary before Abraham was born; if the "bow in the cloud" was Ishtar's necklace and the tower of Babel not the source of philological differences among the peoples of the earth;—then, and in that case, what becomes of the inspiration of the Bible and, indeed of the very truth of the Scriptures? Answer: "the inspiration of the Bible" is made intelligible and the "truth of the Scripture" accentuated. Here is a man who has lived a long life of usefulness, inspired by the memory of a noble mother. Here is a world that has been inspired for ages by the teachings of a wonderful book. Does it destroy the value of the man's sacred memory to learn that his mother believed that the world was flat? Does it destroy the value of the Bible or Shakespeare or Milton to learn their authors believed that the sun revolved around the earth? And as to the "truth" of Scripture, are the parables of Christ true? Are the Psalms true? Are the Biblical allegories true? What is there in all the world so absolutely and finally true as the great primal myths? Are the statements of modern science more true? In a decade new discoveries will make them largely obsolete. Are the creeds and theologies of the churches more true? Each year they become more senescent. Whether there be prophecies they shall be done away; whether there be tongues they shall cease; whether there be knowledge it shall pass away. But the unfathomable meaning and charming imagery of the great myths remain as true to us as they were to former men and as they will be to those who will come hereafter. When man was a child he spake as a child, he felt as a child, he thought as a child. Now that he has become a man, let him not too quickly put away all childish things, lest he should fail to see the Kingdom of Heaven.

There was a time when the eternal and ever living God sat in high Heaven, his dwelling place, attended by His holy angels, exalted above the heavens of the sacred seven and the fixed stars, beyond the prime mover, in the empyrean, issuing commands to His subordinates, and governing the earth much as imperial Caesar governed his empire below. Underneath the earth lay hell, with its unspeakable tortures, to which were consigned the persons of all who violated His will which was authoritatively and definitively revealed in the holy Scriptures. Tintoretto has made immortal this conception of heaven in his great painting on the walls of the ducal palace in Venice. * The wall is covered with cloud-like masses of the holy saints, with harps and cymbals eternally hymning the praises of the eternal One and His divine Son. In the same place Civetta has drawn for us his picture of the infernal regions * where abides every conceivable torture by which the unrighteous are being burned or quartered or boiled or baked or beaten. All of the horrors conceivable to men below was hell and the supreme joy of cathedral worship above was heaven. Such were the limits of the imagination of the old fashioned religion. Then astronomy took hold of the story with its theory of evolution which revealed the development of earths, not only, but of the solar systems and universes through countless ages; which smashed into little bits all the crude science of the day; which took hold of the very throne of God and hurled it into the abyss of space; which

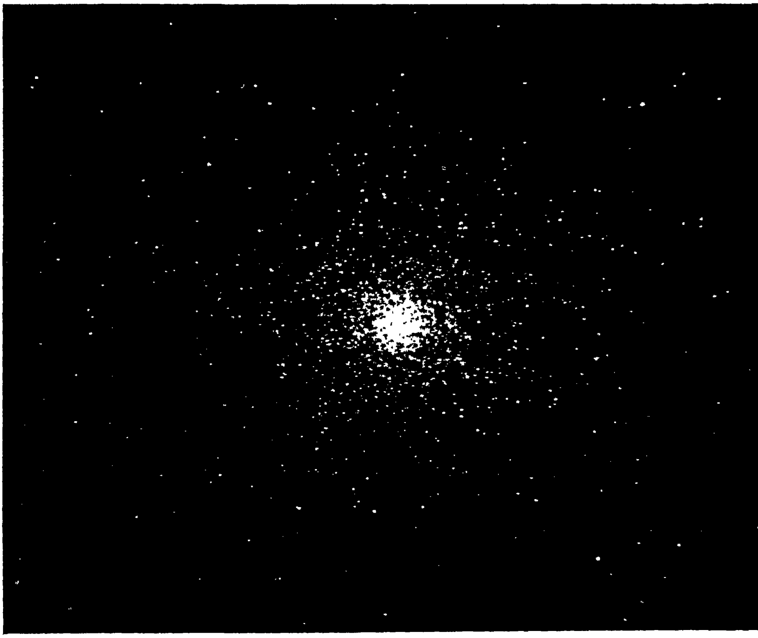
---

* See Chapter I.

illumined the darkness of the nether world with celestial light. Men who loved God and the church trembled as they saw every sacred tradition and every firm religious conviction which had been precious and dear throughout the ages shattered by this rude iconoclast. Yet when it was all over and the dust of hell had settled and the fragments of the seven spheres been removed it was seen that the new heaven and the new earth were infinitely superior to the old. The kingdom of God had been extended. No firmament, a trifle higher than the tower of Babel, could longer confine the God that men were to worship. Out, in the infinite reaches of space, on, beyond the realms of Nebo and Ishtar and Nergal and Marduk and Ninib, on farther and farther and infinitely farther away stretched the new empire that evolution had won for God, and through it all there pulsed the mighty creative power, unresting, unending, unabating. Ever from sun to cinder, from incandescent droplet to lovely earth, and from cinder to sun again this ceaseless panorama of creation and re-creation was revealed as the task of that father who worketh hitherto even as the Master worked.

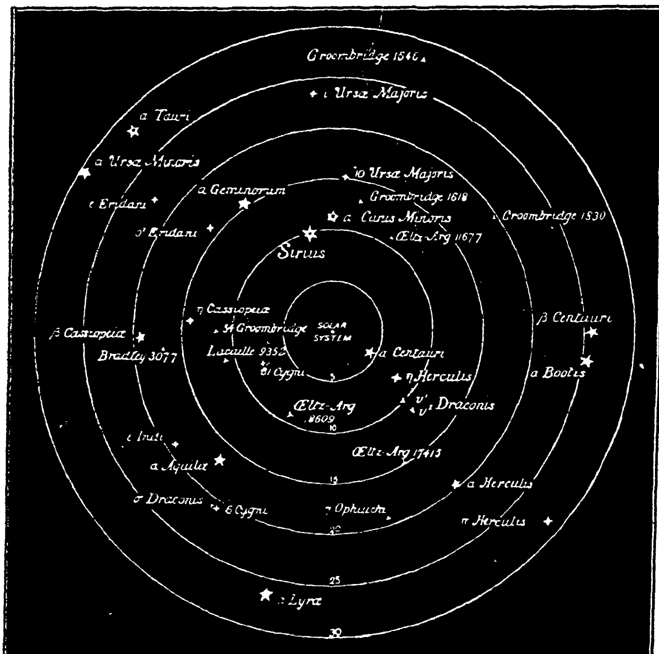
Then evolution proceeded to lengthen the reign of God. It was not enough that our little earth should have been created 4,004 years B. C., on the twenty-third day of October, at nine o'clock in the morning, even though so great an exegete and ecclesiastic as Bishop Lightfoot insisted that it was so. The Ancient of Days seemed to modern geologists under such circumstances to be but a youth, so they called for millions of years, and yet more millions, and gave them all to God. They traced his footsteps backward in an unending path until the things that are were no more. Heaven dissolved into heaven and earth into earth, throughout successive evolutions, becoming more and more beautiful. When the story of earth was done, comprising its thousands of millions of years, they took up the story of the solar system and then the story of the universe, and then the story of other universes, until they had taught the world, in a way that it will never forget, that there is no end, nor was there any beginning to the regnancy of the Almighty. Thus in time, as likewise in space, they stretched the mind of the world permanently and filled it with the glory of God.

And then evolution set to work to clarify the law of God. It had been well said by those of old time "Be not deceived. God is not mocked, whatsoever a man soweth that shall he



Globular star cluster M. 13 in the constellation Hercules, containing 100,000 suns all of the larger ones radiating a thousand times as much light as our own sun. "Yet they are so remote that the entire cluster appearing like a faint fuzzy star is on the very limits of visibility with the unaided eye. The average distance between adjacent suns, even in the very heart of the cluster is something like 100,000 times the distance between the earth and the sun. There is abundant room for planets to revolve about them in families much greater than that belonging to our own sun. The dynamics of globular star clusters has been compared to the dynamics of a gas. Molecules moving in our atmosphere at the speed of 1,500 feet per second meet and rebound from other molecules 250,000 times in going an inch. More than a million years are required for a single circuit of a star into the interior of a globular cluster and out again; and the distances between the stars are so great that on the average a star approaches another star only once in thousands of circuits. The dynamical evolution of our own galaxy has not yet proceeded to the steady state that is found in the globular clusters. Its great swarm of stars still surge and mingle throughout periods of time limited in millions of millions of years. While this dynamical evolution is in progress the sun will make wide excursions in the galactic empire, now winding its way for hundreds of millions of years through the thickly populated deep interior and then approaching for a time the shores of the empty regions beyond, only to be pulled back by the gravity of millions of suns before it drifts forever away into the night of space."—Moulton. Photograph of the star cluster in Hercules, (M 13) taken by Dr. J. S. Plaskett, with the 72-inch reflector of the Dominion Astrophysical Observatory Victoria, B. C., Canada. (Courtesy of Methuen & Co.)

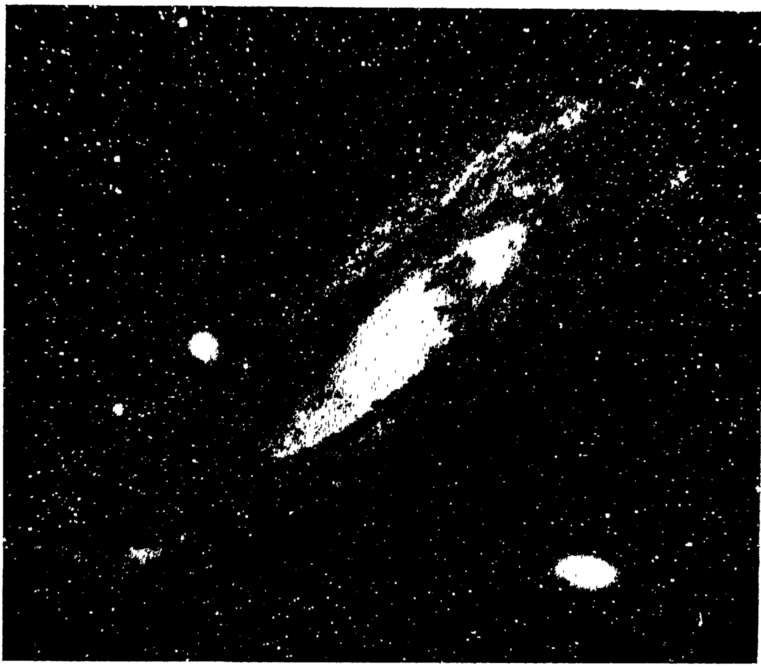
also reap," and in ancient wisdom another had added "the wages of sin is death." But the foundation of declaratory law, of ipse dixit decree, upon which these statements rested needed to be strengthened, and so Darwin and men like him came and they took up the stones out of which the world is built; they examined the birds that filled the air, the fishes that swam in the sea. They talked with the trees and the grasses and the flowers and covenanted with



A TINY CORNER OF THE KINGDOM—
OUR NEIGHBOR STARS.

The numbers on the circles represent "light-years" (six million, million miles, and show their distance from our sun and his family. (Courtesy of Methuen & Co.)

whatsoever passes through the paths of the seas. When they had done with it they wrote certain eternal laws as being the decrees of God; the law of heredity, whereby are transmitted the blessings and curses of God from father to son; the law of variation whereby the providence of God creates and improves and develops the new and better out of the old; and the struggle for life, whereby the muscles and minds of men are strengthened and the weak and worthless are eliminated. When, having read his thoughts after Him, they had found out what God was doing in nature so certainly that the whole scientific world was agreed and so wonderfully that they had loosed the sandals from their feet conscious that they stood upon holy ground, these evolutionists turned to every man on earth and said: "Go forward or die! It is the law of God for you and yours. What contribution are you making to the pro-



ONE OF HIS "ISLAND UNIVERSES"
Photograph of the great Nebula in Andromeda, taken by Mr. G. W. Ritchey, with the 24-inch reflector of the Yerkes Observatory, University of Chicago. Billions of suns like ours. (Courtesy of Methuen & Co.)

gress of the race? What will you add to the inheritance of the ages?"

And then they set to work to multiply the power of God. There had been a time when men had believed in the ability of other spirits to resist the decrees of the Almighty, some devil being thought powerful enough to withstand him and by storm and disease and temptation to defeat his purpose. Then the physicist took up the work where the astronomer and geologist and the palaeontologist had left it. He measured the muscles of God and compassed His sinews, until, astounded, he gasped some tiny syllable of the infinite, immeasurable power of Him who doeth His will among the armies of heaven and among the inhabitants of the earth, whose hand no man can stay and of whom none may ask, "What doest Thou?" As he spoke of such power as none had ever dreamed of, in universe after universe, men stood agape with wonder. He was no longer Enlil or Ramman hurling His little thunder bolt at the rainbow of Ishtar. The very heaven of heavens could not contain Him.

And then the chemical evolutionist undertook with startling success to illustrate the presence of God. No longer could men say concerning the God-head that He cared only for heavenly matters and not for anything on earth, for as microscope surpassed microscope in unveiling the infinitely little: as dirt and dust were revealed scintillant with glory; as atom yielded up its secret and electron revealed its purpose and as the story of evolution from atom to molecule, to amoeba, to man was told, that became true which another had prophesied; that not in the earthquake, nor in the whirlwind did God abide, but in the still, small world which is within. So it came to pass that the evolutionists taught us that the whole earth, rock and dirt and muck, is full of His glory, that there is nothing too small for His attention, that the paths of each protozoon and the music of each electron is to Him a precious thing. Then, at last, the world began to know what it means to say that in Him we live and move and have our being.

And then the evolutionist who worked in the field of palaeontology brought his contribution, giving us quite the finest interpretation of the providence of God. Perhaps the very wisest statement that had ever been made on this subject by the old fashioned religion was that beaten out by the divines of the great Westminster Assembly: "The providence of God is His most holy, wise and powerful preserving and governing all His creatures and all their actions." But the palaeontologists said: "That is not enough." The providence of God is wider and broader than that. He not only preserves and governs all His creatures and all their actions but He develops them. His is not a static world, nor are His creatures like a flock of sheep to be led and driven only. They, like everything else in the world, are going somewhere. There is a purpose and an object in that journey. Nothing happens to any of them that does not develop, accelerate or retard this or that organ or function, for the Shall of Evolution is the Will of God. "The greatest thing," said the evolutionist, "the greatest thing in the whole universe, the key to the universe, is this Will of God which is eternally driv-

IN ONE OF HIS UNIVERSES LIKE THIS OUR SUN IS A FLECK OF LIGHT.

Spiral nebula in Andromeda, photographed at the Mount Wilson Observatory by Mr. G. W. Ritchey. The nebula is seen edgewise, and the photograph shows dark matter obscuring part of the bright centre. (Courtesy of Methuen and Company.)

ing every created thing forward. The whole universe; atoms, mountains, planets, solar systems, is in motion, going somewhere." Whether one passes among the electrons or out among the stars of God, He

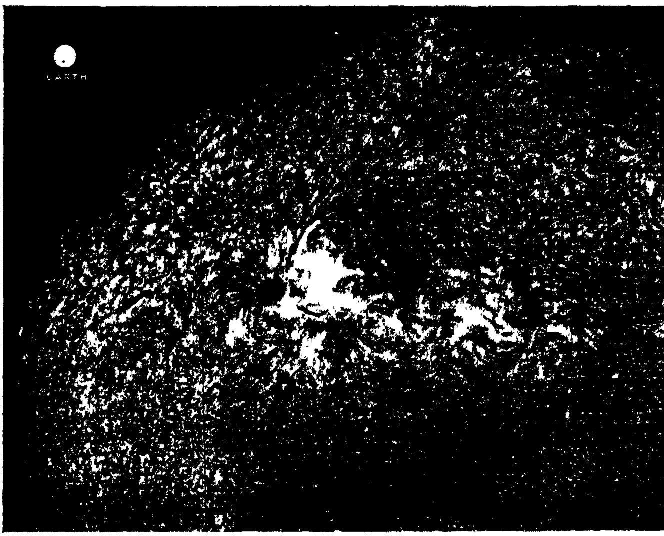
> "Hears at times a sentinel,
> Who walks about from place to place
> And whispers to the worlds of space
> In the deep night, that all is well."

Now the palaeontologists digging wisdom out of the earth, discovered there also the process of evolution at work creating species after species, each going somewhere, until at last man appeared, conquerer and the ruler of them all. Then they turned to the theologians, saying: "Man is also going somewhere and the direction of his journey is determined by the same power which determines all other things." The evolutionist is like the little blind boy on the streets of the village, in the spring time, when the March wind was high. The little blind lad had heard the shouts of his friends flying their kites in the gale and he had gotten himself a kite and sent it up into the sky. Then a stranger passed and asked him what pleasure he got out of flying a kite he could not see, and the little lad, wiser than many men, replied: "I love to feel the tug of the thing as it goes higher and higher." That is just how the evolutionist feels as he watches the lower form melt into the upper, the inferior brain develop into the better. He loves to feel the tug of the thing as it goes higher and higher.

And then the anthropologist came and showed how the evolution of mankind had glorified the worship of God. No longer were the hymns and readings of temple and cathedral to be called impositions of priest-craft. All forms of worship, as indeed the spirit of worship itself, he traced back and back and back until he saw that they were born as man was born, so deeply imbedded in his heart as to be part of his very being. He found men hoping for immortality 50,000 or perhaps 100,000 years ago. He saw men revering, fearing and worshipping as they reeled forth from the darkness of the past. He watched them as they discovered God and sang of His presence everywhere. With his pick-axe and shovel he dug these holy things out of the ground, and handing them to the ecclesiastics, said: "The worship of God is an eternal thing. It comes up out of nature, out of matter, itself, if you please, out of that infinite and internal energy from which all things proceed."

As it has come to pass, thanks to the scientists, that our God is a bigger, better, finer God than the God of our fathers by just so much as human ideas are bigger, better and finer today than yesterday, so also, He will continue to grow as long as mankind grows. As our vision shall be still further enlarged our God will be magnified. The world is strewn with broken images of outgrown gods, nor will those untiring iconoclasts, newly discovered truths, cease their work unless humanity should falter in its progress; until evolution should cease.

And so, working hand in hand, though separated from one another, in the far different fields of various sciences, these men to whom the theory of evolution is the explanation of a thousand mysteries have magnified beyond the wildest dream of human imagination the kingdom of God and the reign of God and the law of God and the power of God and the presence of God and the providence of God and the worship of God. Yet there are still found those who have failed to avail themselves of this mightiest of all



One of his numberless suns with the size of the earth shown for comparison. It is "less than a spark of His fire or a moment's mood of His soul." Photographed with the Spectro-heliograph at Mount Wilson Observatory, Pasadena, on January 5th, 1917, by Mr. E. Ellerman. (Courtesy of Methuen and Company.)

tributes to God which scientists pay to their creator. They command the ministers in their pulpits to preach "that Adam's body was directly fashioned by Almighty God, without any natural animal parentage of any kind, out of matter previously created from nothing; and that any doctrine at any variance therewith is a dangerous error inasmuch as in the methods of interpreting Scripture it must demand and in the consequence which by fair implication it will involve it will lead to the denials of the doctrines fundamental to the faith." One could easily despair of the hope that the church would be made safe for scientific progress if one did not remember that the great founders of our modern churches. Luther, Calvin, Wesley, and others all stigmatized the Copernician theory as "atheistic and infidel." White tells us that Cardinal Bellarmine asserted that the doctrine of the incarnation depended upon the retention of the Ptolemaic astronomy; the scholarly Danzius taught that the very continuance of religion depended upon the divine origin of the Hebrew punctuation; Peter Martyr believed that everything sacred depended on the literal acceptance of Genesis; Bishop Warburton insisted that Christianity absolutely depended upon a right interpretation of the prophesies regarding Anti-Christ. John Wesley insisted that the truth of the Bible depended on the reality of witch-craft; Bishop Wilberforce insisted that the truth of the incarnation depended on the Mosaic statements regarding the origin of man; Liddon insisted that Christianity itself depended on a literal belief in Noah's flood and the transformation of Lot's wife and in the sojourn of Jonah in the whale, and the scholarly Pusey insisted that Christianity must stand or fall with the early date of the Book of Daniel. None of these insistances have, as they have disappeared, "vitiated the plan of salvation," nor will the new method of interpreting the universe upon the principle of growth, development, evolution do aught but add glory to God.

For, after all, who are the great sciences and who is evolution? Our natural philosophers have abandoned Nergal and Marduk and Ishtar and have adopted gravitation, electricity, radio-activity and a multitude of other divinities. But who are they all? It is just here that the evolutionist renders his greatest service. He speaks to us of the immanence of God in all things. He tells us that side by side with the struggle for life there has been developed the struggle for the life of others. He reminds us that the first tendency of mankind was to see personality in everything, just as a little child to whom all things, dolls, tin soldiers, comets, live. He reminds us that they quickly associated benevolence or malevolence therewith so that they spoke of the good sun, the pure Artemis, the lovely Venus, the bloody Mars, the swift Mercury, the stormy Neptune, the sweet influences of the Pleiades. But a stone's throw away were fear and love and worship. Then came the birth of modern science and natural laws pushed personality farther and farther back. Gravity supplanted the hands of the angels and electricity was the new name for thunder bolt of Jove. And yet as science went further and

One of the green, gaseous, amorphous nebulae in which the whole solar system would be lost. From such gigantic masses of cosmic material it is supposed that suns are formed by a process of condensation. This nebula is believed to be more tenuous than a vacuum in the chemist's laboratory and represents the first known stage in stellar evolution. In it we see the process of which the ancient writer spoke: "In the beginning, God created the heavens and earth." (Courtesy of MacMillan Company.)

further abroad, she was ultimately baffled by the impossibility of reaching finality, anywhere in space or time. Hence came the postulate of an ultimate personality, in all phenomena whether smaller than the atom or bigger than the universe. To call it a personality, is, of course, inexact. The word is used because we think of no higher form of existence, material or spiritual. So we come again upon the mistake made by both the materialist and the pantheist who, as Dr. Hibben trenchantly observes "equate God and the universe, without remainder." There is a remainder, though it be unthinkable and in the realms that the mind of men cannot reach. Just as there are colors beyond the violet and within the red, and just as there are ether waves shorter than X-rays * and longer than those of the radio, so there are doubtless forms of existence outside of the physical or mental beyond the realms of matter or mind. This reminds us that from the beginning of time no two people have ever worshipped the same God. The so-called denominational ties and the acceptance of creeds and symbols as marks of unity among worshippers cover a multitude of diverse images. And not only is this true but it is also true that no person ever worships exactly the same God during two successive days. The God of one's childhood is recognized at once as being widely different from the God of one's maturity. The ultimate essence of Divinity is, of course, incomprehensible to us but in degrees varying according to time and circumstance each endeavors to apprehend "Him." And the consequent image which we carry in our mind and call God is never exactly identical with the image we had of Him yesterday, the reason being, of course, because we, ourselves, are changing every moment of every hour. So it comes to pass that a man and his God are always of exactly the same size. They come up out of the night together, out of the embryological night leading through the days of childhood and youth; out of the historical night leading through days of barbarism and superstition; out of the palaeontological night leading through the days of mammal and protozoon. Someone once said, very truly, that "in the beginning men created their Gods, in the image of man created they them, male and female created they them." Witness Marduk and Ishtar, Zeus and Aphrodite, Osiris and Isis. And no man ever made a God greater than himself. Even if a man can imagine that there is a God greater than he can imagine,

* Since this sentence was written Millikan has discovered them!

yet he cannot imagine what sort of a God he is. Thus our own mental capacity sets the limits of the God whom we worship. Thus, also, God (meaning, of course, our comprehension of God) keeps growing. Men keep making and remaking God just as they keep making and remaking heaven. Each age, if it progresses at all, must take its God along with it and He must change and grow with the new age; hence, religious reformations. Surely this should teach tolerance, to conservative and liberal alike. On earth the Ultimate Truth has never expressed himself in a form higher than personality, but who can describe the forms under which he exists elsewhere?

Such are the corollaries of evolution, which ever whispers to us of a future that is indescribably glorious; of days that are to come as much finer than the days that are, as those days are finer than those that have been. Evolution shows us that "from God have descended the germs of life" and argues that "each of us is a fragment torn from God." Evolution tells us that no dream that man has ever had is too full of wonder and beauty and glory to come true. Evolution bids us to judge the future by the past, to have faith and courage and hope in our hearts and to fight eternally forward, knowing that it is by these qualities that we have hitherto won the victory. Evolution points us forward to an hour when we shall think greater thoughts, feel deeper feelings, do bigger things than we are thinking, feeling or doing now. Evolution keeps insisting that we are going somewhere and that that somewhere is onward, forward, upward. Evolution tells us to plant our feet firmly upon the wonderful things that God has done for us in the past and to believe them to be but tiny foretokens of glories that are to come. Its face is the face of hope; its heart is the heart of faith; its voice is the voice of God.

AFTERWARD

O wonderful, wonderful world of God,
    When thy wonders all are seen;
Ah, beautiful beautiful universe,
    When thy beauties all have been;
When all of the thoughts of all of the years
    Have shed their light and gone;
When all of the tears and all of the fears
    With all things felt have flown;
What stage will he set for the play He will get
    When all of His worlds have gone?
    When time and space have gone?
    What stone to what tinder strike
    When suns are cinder-like
    And Life and Love have flown;
    When thought and will have gone?
    What stone to what tinder
    With no worlds to hinder
    When God is left alone,
His song in His heart His own.
    Ah blessed is he who the reaper may be
Of the seeds his God hath sown.
    Thrice blessed is he who the bearer may be
Of the harvest no hand hath strewn.
When the story is penned to the very end,
    To the denouement none hath known,
(Save the author, the author alone,)
When the sins of the world, to oblivion hurled,
    With oblivion shall atone,
    With midnight for their own,
    Dead midnight all their own,
What wonderful note from what wonderful throat
    With what wonderful impulse blown,—
    In the ultimate darkness blown,—
Shall He strike for what audience, in what strange gaudience
    Hearing His voice, alone?
Shall He strike for what listeners to what new bliss in airs
    Never by mortals known?
What new light then shall He be for what strange eyes to see,
    Shining where stars were strewn?
    Alight and alove, alone!

CHAPTER XXIV.

THE END OF THE WORLD—AND AFTER

We have come almost to the end of our journey. Guided first by astronomers, then by geologists, then by palaeontologists, and anthropologists, with the advice and counsel of biologists and embryologists, we have at last reached the day when archaeology has been turned into history and we find the stream of our story so vastly widened that its breadth and length are too great to be included in a single volume. We have endeavored to explain as well as human limitations allow the way in which mankind came to be. We have tried to tell his story in the light of modern science, thus furnishing to our readers a species of orientation which cannot but be of vast advantage to them in contemplating the whence, the why and the whither of life. We commend to our readers, most earnestly, the endeavor to trace for themselves in history the paths through which the earliest beginnings of human life have developed to their present enlargements, begging them to remember all the while that the present is, indeed, the child of the past, and the mother of the future. Before we close our volume we cannot but ask ourselves the question, what of the future of this little earth, how long will it last, and what is to be its destiny?

It took a long, long while for mankind to form any adequate conception of the length of time. Just as their imagination was baffled by distance so it was also baffled by time. Just as they felt it possible to build a tower that would reach to heaven, so they thought of the earth as having been created a few years ago and as coming to an end after a few more years had passed. It is a curious fact that early man expected, almost momentarily, the end of the world. He could not conceive of it as lasting into the ages. He expected it to end shortly. The history of this widespread delusion is both interesting and instructive. Such summaries of its history as that by Flammarion in "Omega" which we shall use at will find a strange parallel in modern times.

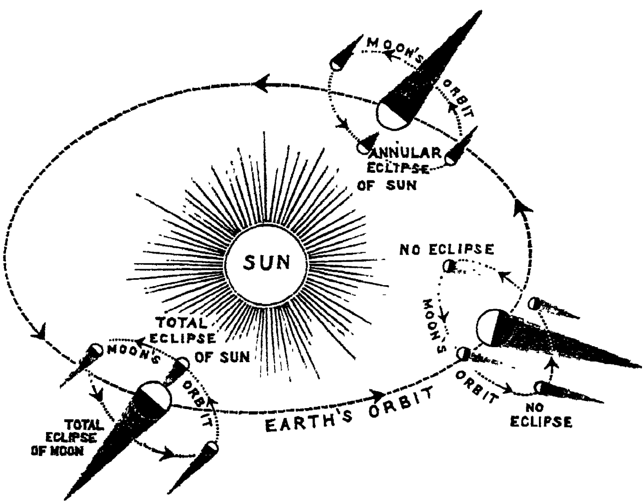
This limitation of imagination was especially emphasized upon the founding of Christianity. The prophecies of Jesus as recorded in the Gospels seemed to indicate the near approach of the great catastrophe. The years 64 to 69 of our era seemed especially appropriate for the close of the age. Nero's terrible persecution, in which Peter and Paul are supposed to have perished, was under way following the burning of the city of Rome. Strange and inexplicable things were happening. Reports of prodigies, flaming swords in the heaven, showers of blood were min-

On account of the pressure exerted by light upon extremely fine particles, the tail of a comet is always directed away from the sun. Such were the flaming swords in the heaven, emblems of divine wrath. From Gregory's *Vault of Heaven.* (Courtesy of Methuen and Company.)

gled with earthquakes, comets and eclipses while famine and pestilence devastated the empire. The terrible slaughter of the Jewish war and the destruction of Jerusalem was only one among many horrors and cruelties. There was an astonishing array of catastrophes at about this time. In 63 Pompeii had been destroyed by an earthquake and in 79 Vesuvius belched forth her fiery death. Verily, the Lord was at hand! Every one expected the world to end. But the terrible days passed. Peace came with Vespasian and Titus and afterward there was a great calm. Yet men still expected the end of the world to come shortly, and when Rome fell it is impossible to describe the effect upon the mind of the whole earth. This was, indeed, the end of the world. The great Augustine who witnessed it took it to be the first act of the final drama. Every unusual natural phenomenon, each earthquake or widespread misfortune was taken to be a forerunner of the final destruction. If an unusually large meteor appeared it was the herald of the ultimate cataclysm. Comets were the special terror of the populace. But as the years passed and the earth swept on serenely, little by little the minds of men began to look forward to the year 1,000 as being the date which scripture set as the final hour of earth-life. "And when the thousand years have expired Satan shall be loosed out of his prison . . . and the sea gave up the dead that were in it and death and hell gave up the dead that were in them and they were judged every man according to his works . . . and I saw a new heaven and a new earth." So thoroughly did the belief that the last days had come control the actions of men that we even find some of the charters of the period beginning "Termino Mundi Appropinquante." Leading monks such as Bernard of Thuringia announced the exact date which he chose as that when the Annunciation fell on the same day as holy Friday which occured in 992. Druthmar, monk of Corbie, set March 24, 1000. On that date, multitudes fled to the churches offering supplication before the saints for their safety. The years between 980 and 1040 were terrible years. The invasion of the Huns, 910 to 945, terrified Europe and had been followed by a horrible season of pestilence and famine. For three successive years there had been a most unusual downpour of rain, preventing or destroying all farm work. So unspeakable were the conditions that cannibalism became common, and even little children were enticed into the woods and were slain and eaten. Many cases were known where the children had devoured their parents, and at least one where human flesh was exposed in the market place for sale. It was a time of unutterable woe, of suffering and devastation and robbery. In 1033 there was a total eclipse of the sun. Everybody believed that the end of the world had come. Thousands gave all that they had to the churches so that from this time the wealth of the church increased, and it is to this period that Europe owes many of her greatest cathedrals. But the end of the world did not come. Better times arrived.

In the twelfth century there occurred a conjunction of all the planets in the constellation of the Scales. Then, as often thereafter, this favorite source of alarm for the prophets of evil occasioned immense consternation. Again the populace was terrified, the cathedrals crowded with refugees and the churches enriched. In 1524 another conjunction arrived and a German astrologer, Stoffler, predicted a general deluge. Real estate situated by the seaside or in the river valleys sank so low to be unsalable. Again was repeated, as so many times in the past, the universal terror—the end had come at last! In 1572 the beautiful Nova appeared in Cassiopeia. "It is the star of the Magi," cried thousands. "Christ returns!"

Each century has seen the frequent recurrence of this popular delusion. Twenty-five times the world was about



Orbits of the earth and the moon, showing the cause and character of the eclipses which for so long a while terrified humanity. (From Gregory's *Vault of Heaven*. Courtesy of Methuen and Company.)

to end during the 19th century. Each case is based on some prophecy of Scripture definitely proving the date selected. In the 20th century, during the great world war, multitudes believed that the end had come. Yesterday the largest auditorium in the southern states was packed to hear that "millions now living will never die." But the little planet keeps sweeping silently and swiftly and safely around the sun, in spite of the terror awakened among the ignorant by comet and pestilence and war.

Yet the end of the world is sure and her death is inevitable. Indeed, from the hour when she reached her heat pinnacle she began to die. In that mighty moment she contained the countless resources from which in the millions of years that followed she spent her fortune so lavishly. From the moment that she began to cool she began to die. Indeed, all life on earth is but an episode of that death. As her temperature has fallen from thousands of degrees centigrade to the present point, she has slowly lost her vigor and vitality, and as the milleniums pass she will continue to lose it until at last, like all other planets, she will speed through space a ghost of her former self, dead and forgotten.

And already, as she fights the germs of death which have taken hold of her body, the signs of old age have appeared. As the rain falls drop by drop and the frosts prize particle after particle from the mountain side and the sea detaches mass after mass from the cliff, her lands are being levelled like the lands of Mars, and although many times again they may be raised as mountains to the sky, yet as the earth becomes more rigid the hour must some day arrive when all the mountains shall be cast into the sea and such as are left shall be levelled to the bosom of the ocean. The rivers of the earth carry each year into the sea one ten millionth part of the land mass. Combined with the other equal forces of erosion it would take, then, only about five million years to complete their task.

And the water, in turn, will doubtless disappear. Year after year it will descend into the earth to be lost among its hollows or to enter into chemical combination with its constituents. Though the level of the ocean may rise from temporary reasons, yet eventually there shall be no more sea on earth than there is on Mars or the moon, and when the water is gone, life, as we know it, must go, for 70% of the human body is water and a similar percentage holds for all organic substances. In fact, it is not impossible already to see the signs of age gathering on the face of the earth. Even within our day the arid belt has widened and the deserts have spread. Once, in the days of Carthage and before, the Sahara was a land of rivers and meadows. Petrified forests are found beneath its sands and its rivers fed the aqueducts of Carthage. The Dead Sea, Salt Lake, and the Caspian, all of them cut off from mother ocean and slowly evaporating, witness the former wider spread of the waters. And as the water goes, the aqueous vapor of the atmosphere will go. It is well known that our air consists of about 79% nitrogen, about 20% oxygen. Roughly, one-half of the remaining 1% consists of water-vapor, yet this water-vapor is largely responsible for the retention of the sun's heat in our atmosphere, preventing its immediate radiation and thus it really makes the world inhabitable. In fact, a molecule of water-vapor is about 16,000 times more powerful than a molecule of dry air in radiating or absorbing heat. Now as the ages pass, the chemists tell us that according to the Kinetic theory of gases, this water vapor, not only, but our whole atmosphere will vanish into space. We have already learned that the pulling power of the earth is about seven miles per second. This means that if any object moves faster than seven miles per second it would leave the earth for the infinite reaches of space. Many molecules of water-vapor and of the other gases of the air are doing this and, doubtless, we are now losing gradually our atmosphere. That we have not already done so entirely is partly at least due to the size of the earth. Of our smaller neighbors the moon, whose pulling power is much lower than ours, has long since lost her atmosphere, and Mars has almost lost his. With the loss of our air and its elements, life, as we know it, ends on earth.

In yet another way the end of the world is coming. If our astronomers speak wisely, the time will come when tidal friction will so retard the rotation of the earth that there will be no more sunlight on one side of the world and no more night on the other, when, in other words, the earth will, like Mercury and perhaps like Venus, stare eternally at the sun, her periods of rotation and revolution being the same, just as they are with our own moon and with all other satellites of the solar system whose rotation periods are known. When this happens to a planet it means that one side of it is eternally baked and the other side eternally frozen. All the water, therefore, if any remains, collects in the form of ice on the side opposite the sun. Life as we know it would disappear excepting perhaps on the thin line dividing the heat from the cold.

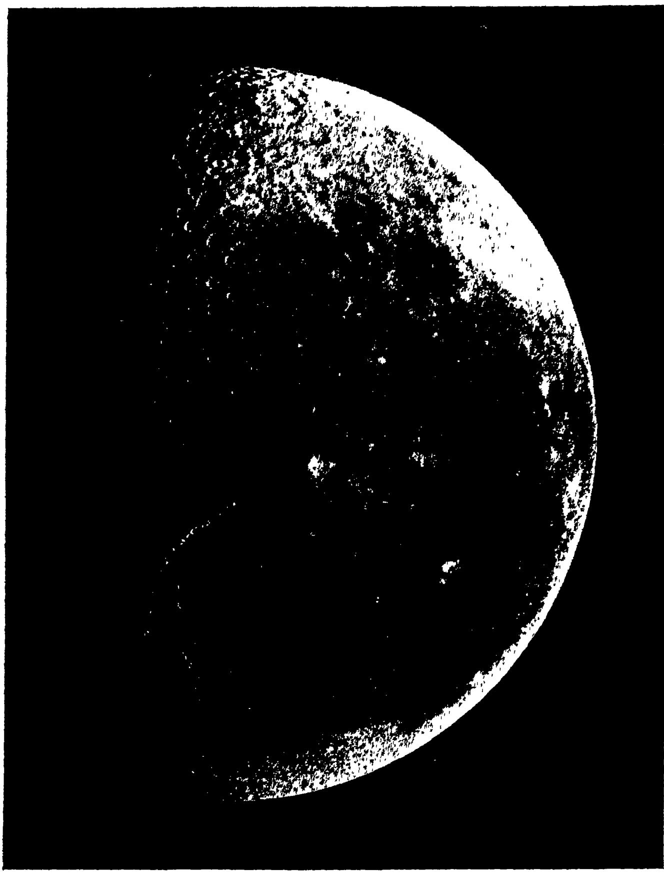
In one of the above ways the earth may die and by one of them she certainly would perish were she a self-sustained little universe all her own, but her dependence upon the solar orb is so great that the question naturally rises, will the earth outlive the sun or will she perish when her lord dies? How long, then, will the sun live? He who knows most about the great day star can answer that question with least exactness. There was a time when astronomers believed that the sun could not last longer than

20 or 30 million years. Its heat was supposed to be supplied from the incessant fall of meteoric material and from its own contraction and, undoubtedly, these are sources of an enormous heat supply. A ton of coal, falling into the sun, would produce from its arrested motion, 6,000 times as much heat as it would produce by burning. The sun could hardly last more than 5,000 years were it composed of solid coal, producing its heat by combustion. Since the discovery of radium and the study of radio activity, astronomers have recognized the fact that there, doubtless, exist incalculable resources of power and energy and heat in the sun beyond our power to know. Recent estimates indicate that the stars, of which our sun is one, may live for billions of years. How aged our sun is at present we can only guess. It is perhaps billions of years old. If the end of the world depends upon the death of the sun, she will have a long, long while to live.

It is interesting in this connection to see how other earths have died. There is a little world just above us that has become pallid and cold long before her land was levelled by erosion. Long before the light of her sun had gone out our moon died of drouth and loss of her atmosphere. She had also lost her earth-day perhaps before life on her surface had ended. Her story is a transcript of that which is happening to us and that which happens to all other moons and planets. The little planet Mercury, for example, has long since lost her day and now keeps eternal vigil gazing into the face of the sun. In the case of Mars, distance from the sun has kept her days long, but her lands are more level than ours and her water and atmosphere are almost gone. The satellites of Jupiter, one of which is almost the size of Mercury, have doubtless already had their day in the heavens also.

There is still another way in which planets sometimes die. As here, so there accidents will happen in the best regulated families. As the billions of years pass, the billions of stars, with their attendant satellites, occasionally pass too near to one another. Follows a terrible catastrophe involving a whole solar system. So it may be with us. This would usher in a new lustrum. Our beautiful little planet with its seven sisters would vanish from the heavens. New worlds would take their places, a new family circling our father-sun. Perhaps we, ourselves, are children of a second marriage or a third or more.

"The average period between the birth and destruction of planets," says Moulton "the period during which they grow and evolve and in some cases support life that, too, evolves, is one that can be easily determined. It follows



Photograph of the moon obtained at the Paris Observatory on September 12, 1903, by Dr. P. H. Puiseux. (Courtesy of Methuen & Co.)

from the volume of the galaxy, the number of stars it contains, and their average velocity that on the average for many successive near approaches (of sun to sun) the period is of the order of 1,000,000,000,000,000." A million billion years is a long, long while. In that time even great Jupiter would have ample years for the running of his course. Whether it is long enough for notable progress to be made in the development of our galaxy from a spiral nebula to a globular star cluster (if such is really the order of our march) is a matter of fascinating contemplation. At any rate with such semi-eternal lapses of time in prospect it would seem most probable that our little planet would die as most other planets do.

Through the long ages that will intervene between that hour and this, what strange transformations will be those through which our little earth will pass! Nothing is more difficult than for the human mind to imagine what will be, but surely it is not unreasonable to suppose that the same forces and processes which have worked their will in the past will continue their labors in the future. The earth of today differs from the earth of yesterday. The world of the 20th century would be scarcely recognizable by one who knew it in the Paleozoic or Mesozoic eras. The danger is that we shall forget that we also live in a geological era: that changes just as sure and just as inevitable and just as noteworthy are taking place today with equal rapidity as those which took place in Eocene days. The forces of nature are affecting the life of man today just as powerfully as they affected the life of Palaeolithic man. The world has not stopped because men have begun to write history and to discover the mysteries of science. So we may safely say that all things will continue to change. Could we abide indefinitely on earth we would see continents slowly eroded and later covered by the waters of the ocean; we would see mountains born and islands disappear and peninsulas submerged; we would see continents change their form and lakes dry up and rivers reverse the direction of their currents. Slowly we would see the land levelled and the water absorbed and the air dissipated into space. As the countless ages passed, we would note that the heat of the sun was becoming less dependable, less intense; we would notice that the earth was becoming colder and less inhabitable. If the calculations of the physicists are correct, when ten million years had passed a day on earth would be 110 hours long instead of 24, and when one hundred fifty million years had passed the earth would present the same side to the moon and her days would be 5¼ to the year, and as these changes took place on earth mankind would be modifying its former life. Again, as often in the past, life would adapt itself to its environment. If the light of the sun faded the eye of man might be modified until it could even perceive rays that are now dark because they are beyond its range of perception. As the final cold came, men could live in the earth as they did in the beginning, rather than on its surface. As the air became rarer the lungs would adapt themselves by enlargement and the body by reducing its necessities. As the water disappeared into the rocks human ingenuity would learn how to take it out again. As the air was dissipated into space, human inventiveness would learn how to increase its amount. As every living thing finally perished man would learn how to make his own foods chemically, and as the power of sun and coal and tide and water-fall perished in the chill of the final death, man would learn how to control the power that lies elsewhere, as, for example, in the atom. Thus, for countless ages, he would and doubtless will fight with cosmic forces for the preservation of the life of his earth. But as it is with individuals, so it will be with the planets; some day the fight will be lost. If it comes by cold arising from the loss of the heat of the sun, the final state of the earth will be a rigid, frigid mass, the water being frozen, not only, but the atmosphere lying as a liquid sea enveloping the world. If it comes by loss of water or air, we shall present an appearance not unlike that of the moon or of Mercury, both of which are prophesied by the present state of Mars. If it comes by accident, we shall again be raised to the supreme pinnacle of incandescent power and mingling with the matter of another sun our traditions will perish with those of other earths as a new heaven and new earths are born. In any case, long before the final catastrophe has occurred the world will be unrecognizable to its present inhabitants. With the changing continents will disappear all that we now call civilization. In so short a while as 100,000 years from now, perhaps in 1|10th of that time, all of the present organizations known as the nations of the world will doubtless have perished. None of our present institutions excepting only perhaps the family will exist. The names of all of our present churches will have been forgotten. As a vesture shall He change them and they shall be changed. If it takes only ten years for an encyclopedia to become obsolete, it will certainly not take 10,000 years for all of our present knowledge to become what the knowledge of the Neanderthal man is to us. Long before that hour our libraries will have become museums and we ourselves, our bodies, our buildings, our social customs, our institutions, all that man has as yet done upon earth, will seem as far removed from real civilization as the Pithecanthropus erectus is from the modern philosopher. And, whatever else may be in doubt, of this thing we may be certain, that it is not within the power of the most vivid imagination which the earth has ever produced to picture the future of the human race on this little planet. As that wonderful principle of progress that we call "evolution" or the "Will of God" proceeds with its purpose; as the minds of men develop and their forward stride becomes surer, there will remain undone on this earth no good thing. Disease and wretchedness and woe will pass. God will wipe away all tears from all faces. Slowly but surely that which is bestial and brutal in human nature, as heretofore, will be modified into that which is divine. The good, the true and the beautiful will prevail. Murder and war and crime will disappear, although we, who are just emerging from the days of beast-hood can scarcely imagine that hour of world-wide righteousness. Knowledge wrung from the sciences, experience wrung from the past, and courage wrung from successive evolutionary victories will combine to eliminate the dross and scum of the human race. What living conditions will then be we can no more picture than could the Cro Magnon man draw upon the wall of his cave his vision of the sky-line of New York. Of the future of man, its blessings, its glory, its joy, we only know this, that it will be finer and nobler and better than the dimmed intellects of present day dreamers can imagine. Already we are reaching our hands up into the heavens, grasping for the stars. Who knows but that we shall some day pass from planet to planet as we now pass from continent to continent? Who knows but that we shall some day talk with the spirits of unseen worlds just as now neither sea nor mountain can stay the voice of our radio? Who knows but that we shall discover the future life much as Leif Ericson discovered America? Who knows but that some day we shall stand face to face with God?

INDEX