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OUTLINES
IN
NATURE STUDY
FOR THE
PRIMARY AND INTERMEDIATE GRADES

BY
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MICHIGAN STATE NORMAL COLLEGE.

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NATURE STUDY

1911

PRIMARY AND INTERMEDIATE GRADES

BY

WILLIAM FITZELL SHEPHERD, PH.D.

EDUCATION OF ALL GRADES

MINNESOTA STATE NORMAL COLLEGE

THE MINNESOTA STATE NORMAL COLLEGE
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FOREWORD.

In the outlines here given definite form there are represented the observation, experimentation and deliberation of some fifteen years' connection with the Michigan State Normal College. They are the outcome of an attempt to discover the fundamental interests of the child, the subject matter of the Nature Course suggested by these interests and the principles underlying its presentation. Incidentally there is revealed the ideal relation to the Nature Work of the thought and expression subjects of the primary school, including the manual arts and domestic science. The course here presented has been nowhere given as now outlined, but nearly all the topics suggested have been successfully tried in many schools. If the course is found to possess anything of merit it is only because of the organization of material collected from many different sources and its adjustment to the interests and capacities of the child's mind. Acknowledgments are due to those authors whose works are cited in the various reference lists.

The continuous observation of typical children will convince any one that the mental powers and interests of individuals are unfolded according to a general law. This law appears to be the same as that which governed the development of the mental powers and interests of the race in its attempt to secure a mastery over Nature. The solution of the problem has necessarily followed evolutionary lines, and the steps in the reasoning are given in the first four chapters. The course of study outlined in the last two chapters differs markedly from those proposed by the followers of Herbart in that the basis of the work of the primary school is found in the Nature Study rather than in Literature and History. The expression of the race has been perfected and embellished by these last two subjects, but they themselves were the outgrowth of man's contact with Nature, and in the early stages of presentation to the child must acknowledge this relationship. Courses of study themselves are undergoing a process of evolution, and the author believes that in the preparation and presentation of this one he is, at least, *looking* in the direction in which such development is to take place. Lack of space has prevented the elaboration of the various topics proposed, so that rather full reference lists are given for the benefit of those teachers who may feel the need of help in outlining the actual lessons. An examination of the results to be secured will show that the work outlined is to reach the intellect as well as the emotions of the child, and be made to serve as a substantial basis for the elementary science of the grammar grades and high school. President Stanley Hall has aptly remarked, what so many teachers have felt, that Nature Study has suffered from *effeminization*.

CHAPTER I.—THE MACHINERY OF NATURE.

“Nothing perishes in this world, but things simply vary and change their form.”—*Pythagoras*.

As a preparation for the Nature Study of the elementary schools the teacher who would lay a reasonably solid foundation for her work along this line must acquire, first, certain fundamental notions concerning Nature's materials and processes. An elementary knowledge of *matter* and *energy* is of prime importance.

A.—Matter. This may be defined as whatever occupies space. A property of all known matter is that it has an attraction for every other particle of matter in the universe (gravitation). The *strength* of this attraction depends upon the amount of matter in the two masses and their distance apart. At the same place upon the earth's surface the *amount* of matter is proportional to its actual weight; that is, the strength of the attraction which the earth has for it. Consider the weight of bodies raised above the surface of the earth; transferred to other planets.

All matter is conceived to be made up of very minute particles termed *molecules*, of unknown shape and which even in solid substances are separated by wide intervals. These molecules are held in position by their mutual attractions (*cohesion*), such attraction being believed to be different from that of gravitation. What is *adhesion*? These molecules are regarded as indivisible by any mechanical means but are conceived to be made up of still smaller elementary particles known as *atoms* and held together by still another type of attraction known as *chemical affinity*. These atoms are the units that take part in chemical combinations but they are no longer believed to be simple in their structure. They are conceived to be aggregations of “*electrons*,” excessively small and in rapid motion. Radio-activity is believed to be due to the escape of these electrons. All matter may be classified under two main divisions; a. elements, b. compounds. The elements, of which there are about eighty different kinds, are those forms of matter which have thus far resisted all efforts to separate them into simpler substances. The compounds, of which the number is very great, are those substances in which the molecules are made up of atoms of two or more different elements. Most elements and compounds may exist under three different conditions, between which, however, no sharp distinction can be made.

1. If the molecules are held more or less rigidly in position, resisting somewhat any effort to displace them, the matter is a *solid*. If the molecules have a definite, orderly arrangement the solid is *crystalline*, but if no such order exists it is *amorphous* in its structure.

2. If the molecules are capable of moving freely over one another and still cling together more or less the matter is a *liquid*. The molecules of the same substance in the liquid condition are conceived to be farther apart than when in the solid condition, the molecules themselves probably remaining identical.

3. When the molecules of any substance are forced apart sufficiently by any agency cohesion is completely overcome and they tend to separate indefinitely, thus giving rise to a *gas*. Liquids and gases are grouped together as *fluids*. Cold and pressure are favorable for the production of the solid condition, while heat and lack of pressure give rise to the gaseous condition. Can gases have weight? Gases which are easily changed back to liquids are called *vapors*.

Matter can neither be destroyed nor created by any finite power. Either it has always existed or else it was created from *non-matter* by *DRIFT*. Matter may be made to undergo a great many transformations, but without any actual loss. Find illustrations. In a closed vessel a given amount of matter will always weigh the same, regardless of the changes that it may undergo. Changes in which the nature of the molecule itself is not affected are spoken of as *physical* changes. Those in which the composition of the molecule is altered are *chemical*.

Energy. Forces may be defined as that which gives any material agency the power to do work, or to overcome resistance. It can not be conceived of independently of matter but adds nothing to its weight. It does not occupy space and hence is not *matter*. Every conceivable activity in the universe takes place because the matter involved possesses energy in some form. Without it all matter would be absolutely cold, dark and lifeless. Energy cannot be destroyed by any finite power and neither can it be created. Either it has always existed or else it was created by DEITY. It can easily be made to undergo many transformations without any actual loss. The following varieties of energy are recognized:

1. **KINETIC ENERGY.** This is possessed by all masses of matter which are in motion. We may recognize mass kinetic, molecular kinetic and atomic kinetic energy. This energy must have been communicated to the moving particles from some outside source.

2. **POTENTIAL ENERGY.** This results from the relative position of bodies that have a mutual attraction for one another, as gravitation, cohesion or chemical affinity. If separate and free to move they will acquire motion and their potential energy will be gradually transformed into kinetic. Analyze the transformations in the case of a ball thrown vertically into the air; in the case of a swinging pendulum. Find other illustrations. We may recognize mass potential, molecular potential and atomic, or chemical potential. In the case of a bent bow or a compressed spring, the molecules are forced from their natural positions and will return when permitted. The atoms of carbon and oxygen, under favorable conditions, will rush together and form molecules of carbon-dioxide gas.

3. **HEAT.** This is a form of energy that we know only as a wave motion, transmitted through the mysterious medium known as the *ether*, which fills all space and penetrates all other matter. The molecules of ether may communicate their movements directly to those of other substances, or they may be made to vibrate by other means, as a blow. The faster the molecules of the body vibrate the higher is the temperature.

4. **LIGHT.** This is also a wave motion in the ether but a different type of energy from heat. They may differ possibly only in their wave lengths. Some bodies allow light waves to pass through them and are *transparent*. In opaque bodies the motion of the ether particles is communicated to their molecules and the light energy is thus transformed into heat. In green plants the light energy forces apart the atoms of carbon and oxygen in the molecules of carbon-dioxide gas. Give the transformations.

5. **SOUND.** This is a form of energy which manifests itself as a wave motion in the molecules of air. Trace the transformations in some musical instrument. In thinking of heat, light and sound we naturally think of their physiological effects, the impressions made upon our sense organs and our minds, instead of the physical effects noted. Besides these ether and air waves which we are able to perceive, a far greater number exist, known to us only by experiment.

6. **ELECTRICAL ENERGY.** In this we have a type of energy that has thus far defied all attempts to discover its real nature. That it manifests itself as a form of motion seems very probable, resident possibly in the "*electrons*" of which the atoms themselves are now conceived to be composed. Much of the industrial development of the present day is based upon the conversion of other forms of energy into electrical energy by means of the dynamo. Any material agent possessing energy, or having the property of attraction or repulsion, may impart motion to other bodies and may be called a *force*. Gravitation, cohesion, chemical affinity and magnetism are forces resulting from the *properties* of matter in which they reside. Wind, running water and moving ice are forces in consequence of their mass kinetic energy.

C.—Nature's Forces.

1. **WIND.** The sun's heat is communicated to the earth giving it molecular kinetic energy, and this warms the adjacent air, pushing its molecules farther apart and making it *lighter*. This mass of air now rises, being pushed up by the surrounding heavier air, which descends to take its place. Why? The mass potential energy of the colder air is converted into mass kinetic, which is simply transferred to the warmer, lighter air causing it to ascend. As it rises it gradually acquires mass potential energy with reference to the surface of the earth. This air in motion, particularly the horizontal currents, with its heat and kinetic energy constitutes the *wind*. Explain a lake, or sea breeze, by means of a diagram. At night the water is warmer than the land and gives rise to a land breeze.

Air movements upon a larger scale are produced by the excessive warming in the tropics, the expansion of lower layers of the atmosphere, the lifting of the upper layers and their flow polewards, while the colder and heavier air to the north and south moves towards the equator. Can you trace the transformation?

Seeing how the wind acquires its energy much interest attaches to the question of its expenditure. Distribution of heat and moisture over the globe, destroying rocks and artificial structures, the carrying and deposition of sand and dust, the production of water currents and waves with all their effects about the shore, the transportation of pollen and seeds and the assistance rendered in the distribution of plants and animals over the earth. Man may utilize the energy of the wind by means of windmills and in the case of sailing boats, balloons.

2. **RUNNING WATER.** The heat of the sun is communicated to bodies of water, driving the molecules apart and causing it to become vapor. This vapor, mixed with air, is *lighter* than the air alone and rises, for the same reason that the warmed air does and gives rise to winds. In thus rising it has mass kinetic energy and is acquiring mass potential with reference to sea level. In the cold upper regions it loses heat and condenses, forming clouds, which may be shifted over the land by the winds. The minute drops of the clouds unite and start to fall. Why? What transformation of energy now occurs? When the drops strike the ground they instantly lose their kinetic energy, thus doing work upon the earth or receiving a supply of *heat*. Being still above sea level they possess a certain amount of the mass potential energy which they had in the clouds. When collected into a lakelet or stream of water this potential energy may be converted into kinetic energy, in which form it is able to accomplish work.

The direct impact of the raindrops disintegrates and removes soil and rocks, lowering the general level of the land (rain erosion). In streams the water forms for itself a channel which it deepens and widens. The material is transported towards the lake or sea, being temporarily deposited upon the way as flood plains, bars, cones, deltas, etc., and being finally spread in sheets over the bed of the body of water into which it empties. Man may utilize this energy in transporting logs, rafts and boats, in turning fishing-wheels in the west, and various forms of water-wheels. Trace the transformation of the energy in the case of the great dynamos at Niagara, each dynamo being driven by a great water-wheel.

3. **MOVING ICE.** A glacier or great continental ice-sheet possesses mass potential and mass kinetic energy which has been acquired as in the preceding case, the only difference being that the vapor is congealed into snow. This snow accumulates in favorable places and by pressure and melting is compacted into ice. Owing to the attraction of gravitation this ice slowly flows to a lower level. Trace this kinetic mass energy to its source.

Glaciers expend their energy in making rock-basins, disrupting rock masses, in grinding much of it into powder, in removing former soils, in transportation of rock debris, in forming sheets of boulder clay, or "till," and in the making of moraines. One or more of these effects may be seen nearly everywhere north of the Ohio and Missouri rivers. The melting of extensive ice-sheets brought out from the ice much of the finer material and formed valley-trains, sand plains and out-wash aprons of sand and gravel. Man has not attempted to utilize the kinetic energy of glaciers.

4. **PLANT ENERGY.** The green coloring matter of plants (chlorophyll), using the *light* of the sun is able to separate the atoms in the molecules of carbon-dioxide gas, using the carbon to make starch by uniting it with a certain amount of water and throwing away the oxygen. Light is thus transformed into atomic kinetic and this into atomic potential energy, which may be thought of as residing in the carbon. The carbon-dioxide gas comes from the air and by this process the green plants get the carbon needed for their tissues and the energy which they must have for warmth and movement. This is to be thought of as a process of *feeding*. The carbon is loosely united with hydrogen and oxygen to make various plant products, but retains a certain amount of its atomic potential energy represented by its separation from oxygen alone. These plant materials may be stored in the root, stem, leaf, fruit and seed.

When these plants desire to liberate and utilize some of this stored energy the gas oxygen is taken into their tissues from the atmosphere (*external respiration*). Certain molecules containing carbon are broken down and this carbon unites with the oxygen forming carbon-

dioxide gas again (*internal respiration*). The potential atomic energy is first converted into kinetic atomic, as the atoms rush together, and this energy in turn is transformed into heat, or mass kinetic for the use of the plant. Plants *feed* in order to get materials for their tissues and also to get energy. They *breathe* in order to liberate energy which they already possess. Man may make use of the energy contained in plant tissue, such as wood, leaves, straw, moss, vegetable oils, resins, etc. When brought to a suitable temperature the carbon bearing molecules disintegrate, *charring* takes place, and the carbon unites with the oxygen of the atmosphere liberating *heat*. This heat is transformed sunlight. Many substances derived from plants, as alcohol, peat, coal, petroleum, natural gas, etc., still retain much of the plant's original potential energy, which may be set free and liberated as heat. Consider the transformations of energy that have taken place in our stoves, paraffin candles, kerosene lamps, artificial gas, machinery operated by steam engines. Plants without chlorophyll must get their energy just as do animals to be now described.

5. ANIMAL ENERGY. By a process of *feeding*, either directly or indirectly, animals take into their bodies those substances which have been manufactured by plants; chiefly starches, sugars, oils and gums. These contain carbon with its supply of potential atomic energy, representing so much transformed sunlight. Plants without chlorophyll must secure their energy in the same way. Animals feed in order to get materials for their tissues and to get their necessary supply of energy. Plant products are worked over into animal substances, of which carbon is the chief ingredient (*assimilation*).

All animals must have energy available for heat and movement, and in exceptional cases for sound, light and electricity. Certain molecules are broken down enabling the carbon to unite with oxygen, brought in by the process of *respiration*, thus setting free the energy that was potential. In the case of the oils, hydrogen also is available for similar union with oxygen, forming *water* and liberating energy. Animals respire in order to *liberate* energy. What animal energies may man directly utilize? Can you trace the transformations of energy from the light of a tallow candle back to the sun?

The "self-sustaining aquarium," a valuable adjunct of every schoolroom and home, can now be readily understood. It contains green plants and animal life so adjusted that the water does not need to be changed. Small quantities of food are periodically given the animals, thus supplying them with matter and energy. The oxygen dissolved in the water unites with the carbon of the animal substance, forming carbon-dioxide gas and setting free the energy. The carbon-dioxide gas is supplied the water and taken up by the plants. Using the light of the sun, this gas is separated into carbon and oxygen. The carbon is retained by the plant for its own use while the oxygen is thrown into the water again for the use of the animal life. Note that you supply the animal life with matter and energy, the carbon being passed over to the plant which is thus enabled to get a much needed material for its tissues and at the same time secure energy from the sun.

6. ENERGY NOT FROM THE SUN. In all the above cases the sun has been shown to be the source of energy. Where could it have gotten its tremendous supply? Can it last *forever*? In addition to the above we have other great manifestations of energy, which can not be traced directly to our present sun. The earth is moving forward in its orbit about the sun at the rate of about 18 miles a second, bringing us the change of seasons. It is rotating upon its axis at a maximum rate of over 17 miles a minute, causing the changes of day and night, influencing the oceanic and atmospheric currents, and causing the tidal waves. In addition to this mass kinetic energy, the outer crust possesses a great quantity of mass potential energy with reference to the interior, giving rise to subsidence in places and upheavals in others, often with accompanying earthquakes. The earth possesses a tremendous store of internal heat, causing volcanoes, geysers and hot springs. Minerals occur in the earth, such as iron, sulphur, etc., which have an attraction for oxygen and hence they possess atomic potential energy. According to the *Nebular Theory* of the origin of our earth all these forms of energy were derived from what constituted the sun at the time that the earth was separated from it. According to the other two theories of earth origin this energy came from outside our present solar system.

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CHAPTER II.—PROGRESSIVE CHANGE IN NATURE.

“Nature knows no pause in progress and attaches her curse to all inaction.”—Goethe.

A.—Origin of the Earth. Concerning the origin of our planet two views may be held. It may have *always existed* and presumably will never end, or it may have been *created*. If created it must have been by DEITY and two methods might have been employed. It might have been flashed into existence by divine command, illustrating the *special creation* method; or it may have been produced by slow *progressive change*. Scientific studies of the solar system and other portions of the universe have led to the belief that the earth was created by the method of slow progressive change and that it must necessarily come to an end. As to the manner of this creation three different theories have been held.

1. NEBULAR THEORY. Based upon the great nebular masses known to exist in the heavens this theory assumes that the entire solar system (sun, planets and satellites) existed in the form of a white hot gaseous mass. Gravitation gave the mass a spheroidal form and as it radiated its heat into space it contracted and a slow rotary movement was inaugurated. Further contraction increased the rotary movement and the gaseous matter was drawn somewhat from the *poles* and heaped up about the *equator*, where the motion was the greatest. Owing to the tendency of a rapidly rotating mass to move from the center (*centrifugal force*) there came a time when this tendency just balanced the gravitation in a *ring* of gaseous matter surrounding the equator. This ring then had its weight neutralized and became *detached* from the central mass as the latter continued to contract from its loss of heat. This ring of gaseous, or semi liquid matter, retained its mass kinetic energy but gave out its heat, cooling and contracting and finally breaking up into fragments all revolving in the same orbit about the great central mass. Because of mutual attractions and unequal velocities the larger masses *captured* the smaller and eventually all were united into a single rotating and revolving spheroid of solid matter, the planet *Neptune*. As the central mass contracted more and more its velocity of rotation continually increased and successively other rings were detached, each becoming a planet with diminished orbit, the sun representing what is still left of the central mass. According to this theory some of the planets themselves gave off one or more rings which became their satellites, our earth giving off but one. The source of the earth's kinetic and potential energy and internal heat is now apparent.

Through ages too long to be numbered in years the earth may be supposed to have passed through the gaseous, liquid and partially solid condition. The original crust formed in patches and may have been frequently remelted, until it finally became continuous. Eventually it became cool enough to allow the condensed water vapor to rest in the irregular depressions and the seas were started. How much of the interior of the earth still remains molten we have no means of knowing, but it is supposed that in spite of the heat, the tremendous pressure of the outer layers forces the molecules closely enough together to make a *solid* of the great central core.

2. METEORITIC THEORY. According to this theory the earth was formed from the accumulation of those wandering rock fragments in space known as *meteorites*. A large one would draw to itself the smaller ones coming within the sphere of its attraction and these in turn others, until a great central mass would be accumulated. The mass kinetic energy of the flying meteorites would be transformed into heat upon striking, and so the entire mass would become heated and possibly even liquified. The gases and vapors would be driven from the various meteorites and from the atmosphere and seas. From this highly heated spheroidal body the history of the earth would be very similar to that outlined in the preceding theory. The rotation of the earth upon its axis may be explained by assuming that the heaviest blows were struck upon the same side of the center. Its movement about the sun may have arisen from its *capture* by gravitation by that great body, in the same manner that the earth secured its moon.

3. PLANETESIMAL THEORY. This theory of earth origin gives promise of displacing the two preceding, but is itself still in its formative stage. It assumes that our present solar system was derived from an original gaseous mass (a *sun* and *star*) which was moving through space and revolving upon an axis. By the *close approach* of another great body this gaseous mass was partially *disrupted* by its own elastic force and the gravitation of the second body. The arms of matter shot out, containing variable masses (*knots*) and much finely divided matter (*planetesimals*), were twisted into a spiral similar to the spiral nebulae now seen in the heavens. The disrupted material from the central sun, constituting not more than one to two percent of its original mass, was given a motion about the sun in elliptical orbits. It soon passed into the liquid or solid state and some of it remained luminous, either because of heat or from some other possible cause. The minute planetesimals would slowly collect about the knots as nuclei, more from their overtaking one another than from gravitation. The energy of the collisions would be so slight and their accumulation so slow that no significant amount of heat would be added to the newly forming planet. In some such way is the earth supposed to have originated. As the spheroidal mass slowly grew in size the condensation of its internal portions by the tremendous weight of the outer layers would liberate *heat* and the interior of the earth became warmer and warmer. This heat and pressure forced to the outside the gases of which the atmosphere is composed as well as that which makes up the seas. The moon is supposed to have been formed from a neighboring *knot* of matter, but to have grown less rapidly than our earth and to be still too small to hold atmospheric gases by its gravitation. Hence it is practically without water and an atmosphere.

B. History of the Earth. The geological history of the earth may be assumed to have begun with the formation of a solid crust, providing the molten condition is accepted. Previous to this time it was simply a small *star* instead of a planet. According to the planetesimal hypothesis the earth may be assumed to have begun its geological history with the acquisition of an atmosphere. This has been computed to be when it had attained a diameter of about 4200 miles. The earth, from either of these stages, has attained its present features and forms of life by a process of slow, progressive change. The following stages may be recognized.

1. AZOIC ERA. This is the *lifeless* stage of the earth's history, made so either because of the excessive heat upon one hand or of the extreme cold and scanty atmosphere. According to the nebular theory the crust must cool from over 2500° F. to about 500°, when the water of the oceans might begin to condense under the great atmospheric pressure. According to the rival theory the earth continued to grow in size from the accession of planetesimals and to acquire heat from the compression of the interior. The rocks are mainly crystalline in structure and have been folded and crumpled by pressure.

2. EZOIC ERA. The name means the *dawn of life*, since we have indirect evidence that low forms of both plant and animal life had been introduced upon the earth. This evidence is supplied by beds of limestone, iron ores, and carboniferous shales produced to-day mainly through the activity of organisms. Direct evidence of life has been found in a few places, consisting of the remains (*fossils*) of simple representatives of groups of backboneless animals (invertebrates), which lived in the sea. We have no positive clue as to the source of this life. It may have been *transferred* from some other planet or it may have been *created* here. Some have held that the original life was created "*spontaneously*"; others that it was created by DEITY. If created by the latter, two methods may be conceived; viz., *direct creation*, by divine command, of representatives of the various groups of plants and animals; or such creation of only the simplest forms and their slow modification into higher groups, as the monotonous ages crept by.

3. PALAEOZOIC ERA. "*Ancient life.*" During this era conditions were much more favorable for both marine and land life and for its preservation in the sediments that were to be transformed into the firm outer layers of the earth's crust. Life made a great advance from the sluggish, segmented creatures that crept over the slime of the sea-bottom to the vertebrated animals that were able to leave the water and enjoy the forested and fern-covered banks. Four main divisions (periods) of the era may be recognized, each characterized by successively higher forms of life. The life forms of each period are related to those of the preceding, as well as the following period, but are sufficiently different so that the expert can distinguish them

readily. This may be explained by assuming that the Creator *annihilated* all life at the close of each period and then created new forms, closely resembling the old, by the method of direct, or *special creation*. It would be exactly as reasonable to suppose that he annihilated the earth itself at the same time creating it anew, because we find it somewhat different during each period. Just as the earth was slowly changed by the agencies described in chapter I, so scientists believe that the forms of plants and animals of one period were gradually modified into those of the next period, as rapidly as newer and better environments were prepared to receive them.

a. Cambrian period. Animal life during this period was abundant and varied, but confined to the invertebrates. The dominant type was the *crustacean*, to-day represented by the lobsters, crayfish and crabs. Marine plant life must have existed, but is known only by a few obscure imprints of sea weed. The continents and islands were of limited size and no traces of land life have yet been found.

b. Silurian period. (Ordovician and Silurian.) Upheaval of portions of the Cambrian sea bottom increased the land areas somewhat, but the sea was still of wide extent. The group of *mollusks*, represented to-day by the clam, oyster, snails and nautilus, became the *dominant* type. Fragments of their shells, mingled with the hard parts of corals, crinoids, etc., gave rise to great beds of limestone. Remains of marine plants are surprisingly scarce and related to the *algae* of to-day. Land insects have been found and traces of ferns. The concentration of inland seas by evaporation gave rise to beds of salt over certain areas.

c. Devonian period. During the Silurian and at its close much more land was added to the continents. This land was forested with trees of a primitive type, with an undergrowth of ferns and rushes. Insect and land mollusks are known to have lived. In the water especially marine, the group of plants known as *rhizocarps* flourished in countless numbers. Their spores accumulated in the mud rocks (shales) and gave rise to much oil and gas. The most remarkable advance was in the animal life of the ocean and bodies of fresh water. The lowest class of backboned animals—the fishes—had come into great prominence from their numbers and size. These are vertebrates adapted to an aquatic mode of life by gills and fins. They are usually covered with scales or plates, have a single auricle and ventricle and are cold blooded.

d. Carboniferous period. (Carboniferous and Permian). A further great expansion of the land occurred, much of it standing near sea level; a warm, moist climate extended well toward the poles and the air was highly charged with carbon-dioxide gas. In many regions conditions were most favorable for the growth of moisture loving plants. The *lycops*, represented today by the ground-pine, shot up into magnificent forest trees, mingled with which were tree ferns and gigantic rushes. Much vegetable matter accumulated in the swamps where, out of contact with oxygen, under the pressure of later deposits, with some internal heat of the earth, it was finally converted into coal. Dr. Winchell poetically referred to this substance as "*Solidified sunlight*." The fishes, modified from the Devonian forms, were rulers of the sea, preying upon one another and upon the invertebrates. In the fresh waters of the land a higher type of vertebrate had appeared;—the *amphibian*, represented to-day by the mud-puppies, salamanders, frogs and toads. They were numerous and grew to much larger size than at present. Can you find any reason why? This class of vertebrates has typically a smooth skin and no claws and breathes, in the adult stage by lungs. Fore and hind limbs are present. They are cold blooded and have two auricles and one ventricle.

4. MESOZOIC ERA. During this "middle life" of the earth's history there occurred a marked advance in the continents and their surface features, as well as in the plant and animal life. It is usually divided into three periods which may not be here recognized. The dominant type of plants was the *cycad*, a tree which combined characteristics of the conifers, the palms and the ferns, only a few representatives of which are still living in the tropics. The next higher group of vertebrates;—the *reptile*, had appeared and in enormous numbers and almost unbelievable size dominated the seas, land, trees and air. The reptile is a tailed, cold blooded vertebrate, with fore and hind limbs, generally present, covered with plates or scales and provided with claws. It breathes by lungs and has two incompletely separated ventricles (lizards, crocodiles, turtles, snakes, etc.). During this era conditions in the sea were

favorable for the growth of certain microscopic organisms, whose shells gave rise to extensive beds of *chalk*.

5. CENOZOIC ERA. "*Recent life*." Further advances in the continents and seas, in their plant and animal life brought the earth still nearer to that of to-day. In the west there was great volcanic and mountain making activity during the early half of the era, while in the latter half the ice-sheets formed in Canada and invaded the United States. Similar events were occurring in Europe and elsewhere in the world. The modern genera of trees were introduced early and some of those now growing in our southern states extended northward even to northern Greenland. It was the age of higher flowering plants; the *dicotyls*, including the deciduous trees. The two highest groups of vertebrates, the *birds* and *mammals*, reached their fullest development simultaneously. Scientists believe that they were each derived independently from certain groups of Mesozoic reptiles, as the result of their adjustment to new environments. They attained great size and numbers under the favorable conditions that prevailed before the glacial period. Man slipped in quietly, as the highest type of mammal, and, in Europe if not in America, saw the great ice-sheets slowly invade his native forests.

6. PSYCHOZOIC ERA. This, the "*age of mind*," may well be separated from the preceding, although no line of demarcation can be drawn between the two. Human reason has gradually displaced brute force and man is gaining the ascendancy over Nature and compelling her to do his bidding. Dangerous plants and animals are being exterminated, useful ones have been preserved through domestication and their usefulness still further increased through artificial selection. The waste places of the earth are made to blossom as the rose, the energies of Nature are being garnered and time and distance annihilated.

General Summary of Earth Development.

STAGES IN EARTH HISTORY.		DOMINANT PLANT TYPE.		DOMINANT ANIMAL TYPE.	
6.	Psychozoic Era	Flowering	Domesticated Plants	Vertebrates	Man
5.	Cenozoic Era		Dicotyls		Birds and Mammals
4.	Mesozoic Era		Cycads		Reptiles
3.	Palaeozoic Era	Flowerless	Lycopods	Vertebrates	Amphibians
			Rhizocarps		Fishes
			Algae	Invertebrates	Mollusks
			Algae		Crustaceans
2.	Eozoic Era		Problematic		Lower invertebrates
1.	Azoic Era		No life		No life

C. Present Day Changes. Through the operation of the *forces* described in chapter I constant changes in the earth, plants and animals are in progress to-day. The rapidity and amount of change depends upon the rate of activity of these various forces. At great depths in the ocean, the conditions of which may be readily imagined, changes occur with inconceivable slowness, while upon the land, elevated more or less, relatively rapid changes are constantly in progress. In both land and water the plants and animals are directly and strongly affected by their immediate surroundings (*environment*). Some of the more important changes will be briefly outlined.

1. LAND. Through the internal energies of the earth changes in elevation of the surface are in constant progress, the crust of the earth being subject to upheaval and subsidence. The activity of the wind, water, ice and plants leads to a constant readjustment of levels, cutting here and filling there. These forces are all engaged in continually changing the character of the soil. For reasons not so clearly understood slow, progressive changes in climate occur. In a great variety of ways plants and animals must adjust themselves to their

changing environment, in case they do not migrate or perish. Protective coverings must be taken on, or discarded, changes in the structure, size and form of the various organs must occur in order to adjust them to their new conditions. If these changed conditions are favorable an increase in size and numbers will result, but if unfavorable the size will be reduced and the number of individuals diminished. A *barrier* in nature is any physical feature that tends to keep the forms of one region separate from those of another, as a mountain range, desert, body of water, etc. When such a barrier is broken down by any of the above mentioned agencies forms of animals and plants are allowed to mingle, the biological equilibrium is disturbed and an entire readjustment is demanded. Unwittingly man has helped plants and animals over these natural barriers to his sorrow. Illustrations are furnished by the English sparrow, the gypsy moth, the San Jose' scale and the Russian thistle in America; the mongoose in Jamaica and the rabbits in Australia.

2. **WATER.** In the ocean and other large bodies of water changes in the depth may occur through oscillations of the bottom or variations in the level of the surface. Wind, running water, ice, animals and plants often conspire to lessen the depth of lakes and seas. Climatic changes upon land, the shifting of winds and currents may materially change the temperature of the water in any particular region. The water may become more or less charged with sediment, salt or some other ingredient of sea or lake water. The average amount of oxygen or of carbon-dioxide may be the subject of change, the amount of light may vary and the character of the sea bottom may be slowly or rapidly changed. In all cases plants and animals become adapted to certain average conditions and as these change the animals and plants, that do not perish or migrate, will also change in their efforts to adjust themselves to their new environment. It seems probable that the fresh water plants and animals were derived from marine forms that were isolated in separate bodies of water, the character of which was gradually changed by streams. Barriers also occur in the water consisting of depths and shoals, cold or warm currents, streams of fresh or muddy water, bodies of land, etc. The breaking down of these barriers may occur through the operation of agencies already discussed, leading to the same results as upon land. The opening of the Panama Canal will partially destroy the barrier which has kept the Atlantic and Pacific forms apart and allow a commingling of forms with results difficult to predict.

D. Natural Selection. Many of the changes referred to above as occurring amongst plants and animals take place through the operation of four principles, known as the "principles of natural selection." Other principles are also operative but these are so fundamental and important that they should be understood by all. Through their operation the plants and animals have been many times changed during the long earth history, those that survive being the merest "handful to the tribes that slumber in its bosom."

1. **PRINCIPLE ONE.** No two individual plants or animals are exactly alike. Where they *seem* to be alike a very little observation will show that they are different in every respect. For every difference that man may detect with his special senses we may be certain that many others exist which he is unable to recognize. We may go still further and say that no two parts of the same individual are exactly alike; no two leaves, blades of grass, flowers or seeds. Try to disprove this statement by finding two things that really are alike.

2. **PRINCIPLE TWO.** There is a constant struggle in progress amongst plants and animals. This arises from their imperfect adjustment to their environment and from the fact that more individuals are produced than can be accommodated upon the earth. Plants are struggling for room, food, moisture, and sunlight, against plant and animal enemies, often against unfavorable climate and soil and to secure cross-pollination and distribution for its seed. Animals are struggling for food and water, against plant and animal enemies, to protect their young and often against unfavorable climatic conditions. Only under exceptional circumstances do they struggle for room and air.

3. **PRINCIPLE THREE.** In general, those forms which are *best fitted* for the particular environment that they are called upon to occupy are the ones that *survive*. If the struggle is sufficiently severe all others are exterminated. Those characteristics that "best fit" any organism for this struggle will depend upon the structure, habits and environment of such organism. For the plants rapidity of germination will often be an advantage; a type of root development that will best anchor the plant and enable it to most successfully wrest from the soil its mineral foods and moisture; a growth above ground which best enables the plant

to secure the most favorable amount of sunlight and at the same time successfully resist unfavorable climatic conditions and enemies. The question of plant survival often hinges upon the most effective methods of securing cross-pollination and seed distribution. In regard to animals success in the struggle for existence may depend upon rapidity of development, acute senses, strength of limb and fleetness, favorable coloration, ability to adjust themselves fully to climatic conditions, parental care, effective weapons of offense and defense, mental power, etc. The result of the operation of principles one, two and three is the "elimination of the unfit" and the "survival of the fittest," so far as the plants and animals of a single generation are concerned.

4. **PRINCIPLE FOUR.** There is a tendency to transmit by *heredity* to the next generation those characteristics (with others as well) that have enabled the organism to attain success in this life and death struggle. This is admitted to be true by all, providing these favorable characteristics were themselves *inherited*. In case these characteristics were *acquired* during the life of the individual, biologists are not agreed in regard to the possibility of their transmission. Use and disuse of organs by individual plants and animals may greatly affect their state of development. If continued through a series of generations it seems to the writer that such characteristics will have a tendency to become *fixed* and *transmissible*. Luther Burbank has stated that all characteristics that are now *inherited* must have been at some time *acquired*. Through the operation of the entire four principles we may account more or less satisfactorily for the remarkable adaptation of plants and animals to their environment. Illustration of the application of these principles will be taken up in class.

5. **ARTIFICIAL SELECTION.** Making use of the above described principles man steps in and by eliminating the struggle and doing the *selecting* himself, induces Nature to produce modifications that she would not otherwise make. The principles made use of are, first the tendency towards variation, which may even be increased by man, and the transmission of inherited characteristics. The wonderful productions of Luther Burbank, such as the thornless cactus, have been produced by careful selection, intelligent cross-pollination and the most skillful treatment of the plants and their descendants. From a *weed* growing along the shores of the Baltic (*Brassica*) there has been produced the turnip, kohlrabi, cabbage, Brussels' sprouts, cauliflower, etc., depending upon the storage of plant substance in the root, stem, leaf or flower stalks. Beginning back in prehistoric time the domestication of animals and their selection for special purposes began and is still in progress. Thus have originated our various breeds of horses, cattle, sheep, dogs, cats, fowls, etc. How could man produce a blue rose, a gold-fish or a white robin?

E. Evidences of Development. There remains to be presented some of the strongest evidences that the groups of plants and animals living to-day have been produced from the slow modification of related groups that lived in the Cenozoic era, rather than that they were produced by the method of special creation. These ancestral groups were in their turn derived from still more primitive ones owing to the slow, progressive change in the environment. This method is what scientists understand by *development*, or *evolution*, which is simply the gradual unrolling, or unfolding of a magnificent scheme of creation which comprehends the earth itself and all that it contains. There are certain evidences that are best explained by assuming that the CREATOR used this method in getting the present groups of plants and animals upon the earth. Taken together they have the force of a positive demonstration.

1. **EVIDENCE FROM STRUCTURE.** Microscopically plants and animals show a striking similarity in structure, consisting of single *cells*, or aggregations of cells and products produced thereby. Within the various groups there is strong similarity in the general plan of each organism and in the more detailed plan of the various parts. A good illustration is furnished by the fore limbs of the great group of vertebrates, consisting of fishes, amphibians, reptiles, birds and mammals. This similarity in coarse and microscopic structure strongly suggests *blood relationship*, the derivation of one group directly from another. It is like finding strong similarity in the alphabet, words and grammar of two languages which is accepted as positive evidence of direct relationship. These facts of similarity may be reconciled with the special creation theory by assuming that the CREATOR simply desired to use the same plan throughout his great groups, regardless of the environment that they were to occupy. This, however,

would be like an architect using the same general plan for a dwelling, business block, church or school-house.

2. EVIDENCE FROM CONNECTING GROUPS. Forms are known which occupy an intermediate position between two other groups having characteristics common to the two. Most of the forms of plants and animals that lived in the past are of this nature, while those of to-day may connect these ancestral forms with those that are still to appear upon the earth. These connecting forms appear to bridge the gaps between related groups and strongly suggest that there was an actual passage from one to the other. They may be harmonized with the special creation theory by simply assuming that the CREATOR saw a place for these forms and created them directly without reference to the preceding, or the following groups.

3. EVIDENCE FROM GEOGRAPHIC DISTRIBUTION. All closely related groups (species) occupy regions of geographic proximity upon the earth. Their distribution over the earth is most satisfactorily explained by assuming that they all originated from a single ancestral group, in a single locality and spread from this as a center. The direction of migration and the distance that they were able to make depended upon various geographic factors, climatic conditions and their powers of locomotion. A single illustration will serve to show the bearing of this evidence upon the doctrine of development. The humming-birds are confined to North and South America, being most abundant in individuals and varieties in the northern portion of South America and diminishing in all directions. This seems to imply that the group originated in this region as a center, that they were somewhat modified by getting into different environments and gradually migrated in every direction favorable for their distribution. Without the necessary powers of flight they have not been able to leave the continent. Had they been made by methods of special creation it would seem that they would have been distributed more or less uniformly over the earth in those environments suitable for them. The full force of the evidence can be appreciated only when one makes a careful study of the distribution of a large number of plants and animals.

4. EVIDENCE FROM THE GEOLOGICAL RECORD. From a study of the table given upon page 10 it is seen that the lower groups of life were introduced upon the earth first and that these were followed by higher and higher forms successively, the highest of all being the last to appear. This is just the order in which these groups should have appeared providing a slow, gradual, progressive development had taken place, so that the theory receives this additional support. Under the special creation theory this would have been a natural order of creation, providing the various groups were not all created at the same time, but since no change in the forms can be assumed, we are compelled to believe that at the close of each successive period practically all the animal and plant life of the earth was annihilated. With the beginning of the next period entirely new forms, but closely resembling those that had just been destroyed must have been created by divine command. The improbability of this method may be seen when we consider any single form, such as fossil horses, which gradually grew in size and lost their digits during the Cenozoic era.

5. EVIDENCE FROM RUDIMENTARY STRUCTURES. In the bodies of plants and animals there occur structures that appear to be merely the *vestiges* of organs that were once functional and presumably well developed. The two miniature stamens in the Salvia, the "splint bones" of the horse, the wings of the penguin and Apteryx, are illustrations. According to the theory of development these structures furnish evidence that the forms have *changed* as the result of a changed environment and these are the remnants of organs originally useful. Their elimination takes place with extreme slowness. Under the special creation theory we are compelled to believe that these structures really have a use, yet undiscovered, or else that the CREATOR put into animals and plants structures without use, say for the purpose of carrying out a regular plan.

6. EVIDENCE FROM INDIVIDUAL DEVELOPMENT. A study of the life history of individuals shows that they pass through a series of stages which represent, in a general way, the same stages through which the group to which it belongs must have passed providing it had been developed. A familiar illustration is furnished by the frog which begins life as a single cell, which divides and subdivides, forming a solid sphere of cells (*morula*), a hollow sphere with a single layer of cells (*blastula*), a spheroid with a double layer of cells (*gastrula*) which elongates and acquires the foundation of a *vertebral column*. From this stage the embryo has all the essential characteristics of a *fish*, in which stage it lives for a year, when it sprouts two

pairs of legs, passes into the *salamander* stage having all the characteristics of an amphibian, finally absorbing its tail and passing into the adult frog stage. The toad goes through a similar series of stages but much more rapidly than the frog. The salamander passes through the same stages, up to the salamander stage, when its development is completed. This peculiar development seems to indicate that these three amphibians have all had a common fish-like ancestor, which was derived in turn from certain special forms of invertebrates. It is but typical of the general development of animals and possibly plants. It is interpreted as meaning that the individual has to be developed in the same manner, because of Nature's uniformity. If the group of frogs had been produced by special creation then this life history of the frog of to-day is unintelligible. Individual frogs should now be produced by divine command, or, if produced through the agency of eggs, these should contain the perfected frog in miniature.

If we accept the statement of Mill, that "uniformity in the course of Nature must remain as the ultimate major premise of all inductions," then this slow, progressive development of the frog from the single-celled egg to the adult means that the group of frogs was produced by the same process. With unlimited time for the changes from stage to stage to take place, the passage from an invertebrate to a fish, or a fish to an amphibian, is far less wonderful than that which we behold before our eyes to-day. To annihilate each group successively and re-create a higher would be exactly the same as destroying each individual at the close of each stage and creating it anew upon a higher plane.

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CHAPTER III.—THE DEVELOPMENT OF THE RACE.

"Whence our race has come ; what are the limits of our power over Nature, and Nature's power over us ; to what goal are we tending—these are the problems which present themselves anew and with undiminished interest to every man born into the world."—*Huxley*.

A. Origin of the Race. Concerning the origin of the human race upon the earth it is possible to hold but two views ; either man was *transferred* to this planet from some other, or else he was *created* here. It is seriously held by some that the planet Mars supports life of a more advanced character than that found upon the earth. If this life includes human beings, the miraculous intervention of the CREATOR would have been required to convey them to the Earth, and to adjust them to the supposedly different conditions that here prevail. So far as the writer is aware no one has ever seriously proposed such a view. We may then consider the different ways in which he might have been created here ; the method of special creation or that of slow, progressive change from certain higher groups already in existence. If the method of special creation had been employed man sprang into existence by divine command, or was, as many crudely imagine, moulded from a lump of clay as an artist makes his statue. Having made the earth and its various life groups by the method of development in past time, making all individual animals and plants to-day by this same method, the *presumption* is that the CREATOR would not discard this method when it came to His highest creation—*man*.

As the result of scientific study it seems more plausible that the progenitors of our race were derived by gradual changes wrought upon a certain group of man-like brutes, which found themselves in an environment requiring the fuller use of *brain* and less of *muscle*. The evidences of such an origin may be briefly outlined here.

1. The general plan of man's body and its microscopic structure relates him closely to those higher mammals that are especially adapted to tree-climbing. The bony system, the muscles, circulatory, respiratory, digestive and excretory systems are essentially identical. The nervous system is the same, differing only in the size and complexity of brain development.

2. The physiological processes that take place in his body are identical with those in some of the lower animals. He acquires his energy and liberates it in the same way. The same diseases may affect them very similarly, indicating not simply a superficial but a fundamental relationship.

3. There occur in the body of man a large number of rudimentary structures ; comprising muscles, fragments of bones, glands and portions of various organs. The most serious of these is the vermiform appendix, for which no use has yet been found and which is a constant menace to life. The only reasonable explanation of these structures is that they hark back to a state of development when they were useful in the organism. They are evidence of *change* in structure due to change in habits.

4. From the geological record we learn that man appeared upon earth as the *last* of the series of great mammal creations. He has made his way to those portions of the earth only that could be reached through his own efforts.

5. In the years 1891-2 Dr. Eugene Dubois found upon the island of Java fragments of the skeleton of an animal that originally occupied an intermediate position between the lowest type of man and the highest known brute. To this creature has been given the name *Pithecanthropus erectus*, meaning the "erect ape-man." It appears to be one of a group of forms that bridges the gap between man and the lower animals.

6. Careful studies upon the embryonic development of the child shows that it passes through the same general set of stages as do those of the higher mammals, suggesting most strongly actual relationship. This series of stages includes all those through which the frog may be observed to pass and, in addition, those stages belonging to reptiles and mammals.

We seem to have here an epitome of the entire animal creation, most suggestive in the light of development, but otherwise without meaning.

B. Early Stage of Culture. Whatever view is held concerning the *origin* of the race, but one view can be maintained concerning its earliest stage of culture. All the scientific evidence thus far available points to the fact that earliest man was in a very low stage of culture, lower than that of any savage tribes of the present day. When we consider that if directly created he might as well have been started upon the plane of civilization, this low stage of culture furnishes further evidence of his lowly origin. The development method, however, necessitated that he begin at the first round of the ladder and that he work his way laboriously to the top. At least four lines of evidence of his low culture stage may here be cited.

1. **CONFORMATION OF SKULL.** A study of the most primitive skulls known, such as the Neanderthal and Spy, shows that their possessors had a full muscular and sense development, but combined with little intellectuality. The heavy supra-orbital processes are suggestive of struggle and combat. The human character of the first of these skulls was for a time questioned but it is now conceded that the skull is typical of very early man and that it marks him as a very low savage.

2. **UTENSILS AND IMPLEMENTS.** So far as known the implements of primitive man were crudely chipped from stone and showed no specialization, the same article serving a variety of purposes. They were such as some of the lowest races of to-day, the Bushmen of South Africa, are still using. Had man been civilized he would not have been satisfied with such utensils but would have used the metals and invented special forms for special uses. There is reason for thinking that before man had learned to fashion even such crude articles, he used simply those that Nature had already shaped for him, selecting those that seemed to best answer his immediate purpose. The gradual development of man's mind is clearly seen in the series of implements, more and more improved and specialized, that mark the stages in his upward progress.

3. **ABSENCE OF RELIGIOUS BELIEFS.** All savage tribes of to-day have more or less religious sentiment and some form of worship. Our American Indians firmly believed in the "happy hunting grounds" and buried with their dead warriors their favorite weapons of war and chase. The Mound Builders who preceded them held elaborate burial ceremonies and left behind certain evidence of their belief in the life beyond the grave. As we peer farther and farther into the dim past we find less and less evidence of such religious, or superstitious sentiment. In the case of the most primitive type of man, whose remains are known, we have no evidence that he ever buried his dead, held any form of religious observance, made an idol or erected any kind of monument. The evidence is entirely negative in character but it stamps primitive man as standing very low in the scale of culture.

4. **ARBOREAL HABIT.** A comparison of the bones of earliest known man with those of the present day shows that they possess characteristics which can be explained only upon the supposition that primitive man was a *tree-climber*. This inconvenient mode of life was forced upon him because of his inability to cope with the fierce Cenozoic animals with which he was surrounded. Had he been even partially civilized he would have invented suitable weapons and united with his fellows in a fierce war of extermination. That he did not do so at once is evidence that he lived upon a low culture plane. The skeletal evidence of his tree-climbing habit is shown in the relatively greater length of arms; the "perforation of the humerus;" the shorter, curved legs; the "flattening of the tibia;" the narrow, elongated pelvis; the curvature of the spinal column and the position of the head upon the spinal column. With his dwelling established upon the ground there was less and less climbing done and these characteristics have been slowly eliminated from the human skeleton.

C. Stages in Race Progress. Starting with man in this low culture stage it is now a matter of interest and importance to follow him in his heroic struggle for existence, to see how the four principles of selection have helped along those individuals and races that were most worthy of such help and have eliminated those that might retard progress towards the highest goal. Nature, the relentless enemy of the many, selected as her favorites those *most fit*, either by endowment or acquisition, and for these she has opened her bountiful hand.

The point is that the development of the child is a continuous process and cannot be broken down into separate stages. The child's development is a continuous process and cannot be broken down into separate stages.

3. Early Stages of Learning It is important to note that the child's development is a continuous process and cannot be broken down into separate stages. The child's development is a continuous process and cannot be broken down into separate stages.

4. Theoretical and Practical The child's development is a continuous process and cannot be broken down into separate stages. The child's development is a continuous process and cannot be broken down into separate stages.

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8. Theoretical and Practical The child's development is a continuous process and cannot be broken down into separate stages. The child's development is a continuous process and cannot be broken down into separate stages.

1. ARBOREAL STAGE. The evidence that primitive man spent much time in and about the trees, and presumably had his crude home there, is shown in the characteristics of the skeletons of his more immediate descendants. According to the development theory his *body* and probably his *mind* had been derived from a tree-climbing creature that lived in some tropical, or sub-tropical forest region. In the light of our present knowledge we may select the islands immediately south of Asia as the most likely cradle of the human race. Inheriting then the necessary structures and instincts it is to be supposed that he simply continued the life of his ancestors, after he had risen to the human plane. Surrounded by the powerful and ferocious beasts of the later Cenozoic time and greatly *inferior* to them physically, he was never safe upon the ground, even in his waking moments. His method of climbing is supposed to have been similar to that now practiced by the higher apes and some savage peoples; placing the soles of the feet against the side of the tree and holding the upper part of the body at arm's length. Clothing and shoes were unnecessary and would have seriously impeded his movements. His body was protected by a light covering of hair. His food was vegetable in large part and uncooked, he not yet having domesticated fire. Language probably consisted of inarticulate calls and cries by which were expressed simple wants and ideas. Weapons only of wood were probably at first used and discarded when no longer needed. These were very ineffective against the large mammals of the time and kept man in a continual state of fear. He was biding his time! Darkness brought to him terrors both real and imaginary and his *bete noire* was probably the terrible boas and pythons that could follow him to his very shelter, as the dog family and larger cats and bears could not do. Of high winds and the lightning's flash he stood in wholesome fear. He acquired a sufficient knowledge of plants to enable him to select those suitable for food and to leave alone those that were unfit or poisonous. His knowledge of animals was limited mainly to knowing how to escape their fangs and claws. By long residence under these arboreal conditions the human eye became adapted to the color *chlorophyll green*. The social unit was the family, plus or minus the father, the care of the children devolving mainly upon the mother. The younger children were carried upon her back in order that her arms might be free for climbing. Those unable to cling sooner or later lost their lives by falling, leading to a survival of those best fitted to this mode of life. It seems likely that crude cradles of vines, or tough bark, were eventually invented by which means the children could be swung from the branches, or more conveniently carried upon the back. Under this strenuous life parental care must necessarily cease at a relatively early age and the young then became largely dependent upon their own efforts. Egoism was in the ascendency. No region could support much of a population and as the numbers increased the weaker individuals were crowded into the surrounding regions, more or less unfavorable, and demanding adjustment of habits to new conditions. Upon the ground this type of man was unsteady, walking more largely upon the outer edge of the foot and probably securing more perfect balance by placing the hands upon the ground.

2. HUNTING AND FISHING STAGE. Through a combination of circumstances probably, rather than to any one, certain individuals, or groups of individuals, gradually gave up their arboreal habit and lived more fully upon the ground. This may have been brought about by the discovery of the use of stone for weapons and the advantages of co-operation in fighting enemies. The "taming of fire," so that it might be employed in man's defense against wild animals, may have been an important factor in this forward step of the race. In part, it may have been forced upon man by his inability to find suitable trees for homes, the scarcity of food or the necessity of obtaining clothing in those less congenial regions into which he had been crowded. This change in environment called at once for new habits of living, necessitated new structures, or rather the modification of old ones. In order to wield his newly discovered weapons he must stand erect and secure stability and fleetness. This called for a readjustment of muscular and skeletal development and alterations in the various proportions of the body; changes which are still in progress in the body of civilized man.

With certain divisions of the race this stage of mankind has continued to the present day (American Indian) and in the long time involved, migrations, impossible in the preceding stage, distributed man over the greater part of the habitable globe. The most marked improvement took place in every direction now that his mental powers were fully aroused. Had he been superior physically to the animals about him his mental development would have been greatly retarded, if not absolutely checked. Beginning with stones shapen only by Nature he learned

to chip them into shape by striking the two together. At first all his tools and weapons were combined into a single type shaped like an almond and used on the point. Presently he made tools and weapons separately, of special designs and materials and polished some of them. In regions where caverns abounded these were utilized as homes, in other regions crude shelters of bark, sod, or leaves were constructed. As the population of a region increased the game was soon killed off, or frightened away and must be followed, necessitating a *portable* home. This was made of vegetable material, such as birch bark where this was available, or of skins of animals. This type of home, the wigwam or tepee, assumed the most favorable form for such a house, that of a cone. Can you discover all the advantages?

Co-operation in war and chase was found highly advantageous and this was possible only by a more complete language. Man now became a gregarious and social creature. With success came confidence in himself; with this confidence came physical bravery and eventually love of the approbation of his fellows. In the field the leadership of the strongest, bravest, most skillful and shrewdest was unconsciously recognized, either because he forged ahead or the others slunk behind. In camp they admired and respected his ability and the office of chief was established. Success in hunting brought them abundant food, of the most nutritious character, materials for homes, clothing, various weapons and utensils. At first eaten raw the advantage of cooking meat was discovered probably by accident. Roasting and broiling over the camp fire was first done and boiling by means of hot stones considerably later. Skins used for clothing were at first simply dried, after the flesh was removed, and became hard. Wherever they rubbed the body uncomfortably it would seem natural to pound such portions in order to soften them and tanning was discovered, to be later experimented with and improved upon. Those people having access to bodies of water would learn how to capture fish by various devices. Beginning with a floating log they devised the light canoe.

During this stage the specialization of the work of man and woman began. The man being naturally the stronger assumed the duties of the war and the chase, the protection of the home and the securing of game. To the woman was entrusted the care of the younger children, the preparation of food, the making of clothing and the making and erection of the tepee. The gathering of available vegetable food in the immediate neighborhood of the camp, the making of baskets, or pottery, to hold such was left also to the woman. With some peoples it is probable that a little elementary agriculture was carried on about the camp, as far as the nomadic life permitted, this work being also entrusted to the women. In case the slaughtered game was accompanied by young that refused to escape, these would be taken to camp alive and turned over to the women and children for their entertainment. Most animals would thus lose much of their wild nature and the idea of domestication of animals was well started. In the hunting stage the dog and the horse were the most serviceable animals and these were early domesticated and shared the fortunes of primitive man in his wanderings.

In the evenings camp fires were lighted for the sake of the warmth when needed, to cook the evening meal and very often to frighten away savage beasts, with which the fear of fire is *instinctive*. The narration of the day's experience was natural, furnishing instruction and entertainment. The meager language of the time permitted only imperfect accounts of the varied happenings of the day and gesture and pantomime supplied what the language failed to depict. When participated in by several, and accompanied by the chant, the rattle, tom-tom, or drum, we have the starting of *music* and the *dance*. Attempts to explain phenomena that they could not fully understand led to the *myth*. The happenings in the world about them and the deeds of their greatest warriors furnished the basis for their legends and folk-lore, from which were developed literature and history. From this imperfect knowledge of their region and its plants and animals arose geography and science, attempts to express *how much* and *how many* led to the development of number. The earliest known drawings are representations of wild animals. From the days' necessities and the evenings' pastimes were started the thought and expression work of the present day.

Private ownership extended to the home and its meager equipment, articles of clothing, adornment, weapons and utensils, the few domesticated animals, etc. The fields, forests, streams and lakes, with their game and fish, were all held in common by the tribe in possession of the region. The impulse to live was the controlling motive in the breast of every individual. Self-preservation must be secured at all hazards, after this the preservation of family and friends. In order to secure food deception and trickery must be practiced upon the animals.

Man must lie in hiding, entice the animals to their doom by false calls, dig pit-falls, set traps, bait hooks, etc. Sympathy for wild life had not yet shown herself upon earth. Other men who were strangers were simply more dangerous animals, to be disposed of with the utmost expedition, and with never a thought of mercy or fairness. The type man of this stage was selfish, cruel and blood-thirsty, impulsive, deceitful and with but little respect for property rights. These traits of character he had inherited from the past and his existence depended upon their retention. They are not entirely unknown to-day amongst peoples professing civilization. Look over the morning's paper for illustrations. Primitive man, however, is not to be judged by ethical standards of the present day. He secured for him and his, personal safety, comfort and, as far as possible, happiness. According to the philosophy of Herbert Spencer he did *right* and his conscience approved.

The study of Nature was a marked advance over that of arboreal man. It was one thing to keep out of the clutches of the man-eating beasts, but quite another to be able to capture and eat them. The herbivorous animals were shy and wary and must have their habits well understood in order to be successfully hunted. The capture of wild fowl and fish taxed man's shrewdness to the utmost. Roving from place to place man had to become acquainted with a wider range of plants in order to select those suitable for food and to let alone those that were poisonous. Real or imaginary medicinal qualities of plants were discovered from time to time. In order to select suitable material for his weapons and utensils primitive man must study the minerals and rocks and make a search for them. To plan for successful expeditions of war and the chase, to protect himself most fully against the rigors of the climate, he must be able to predict the weather. The fullest success in his warfare against animate and inanimate Nature demanded that he know his "home geography." In all cases this Nature knowledge was acquired not because man had developed any students' instincts, but because it was essential to his existence. Those unwilling, indifferent or incapable of such study were displaced by others more fit. The method, in the main, was direct contact with Nature in field and forest and the effect was robustness of body, symmetrical development of the muscles and motor centers, the fullest possible development of sense organs and sense centers, the strengthening of associative memory and imagination. The mathematical and reasoning powers received scant training.

3. PASTORAL STAGE. With the discovery that the wild nature of some animals could be, in a large part, overcome through domestication certain groups of individuals gradually acquired sufficient numbers of such animals to demand their attention. From these flocks and herds they found that they could procure food, clothing and materials for shelter and that the supply was adequate, more conveniently procured and always at hand. The natural increase of their flocks required that more and more time be spent upon their care and protection, leaving them less and less time to devote to the chase. With all their wants provided there was little inducement now to hunt and in regions where game was scarce the hunter became a herder. The change was brought about independently by various peoples, the details of which varied with the region and the type of the domesticated animal. In the mountainous districts the sheep were domesticated, upon the plains horses and oxen, in the far north-land the reindeer. In most cases the dog was found to be of much service in the care and protection of the herds and in guarding the camp. He was made a part of the family and by unconscious selection various varieties were started.

Since the animals would presently exhaust the pasturage of a region it was necessary to maintain the nomadic habit in order to secure food and water. This necessitated a portable house, with its limited supply of conveniences. The animals could be utilized for purposes of transportation of the camp. In the early stages the tepees were made of skins; later, in the case of certain people, of cloth. In order to better care for and protect their stock several families lived together holding the animals in common. So long as all went well there was enough for all and to spare. This less strenuous life was favorable for sociality and story-telling, dancing and singing were further developed. The various expression subjects; language, drawing, numbers, music, etc., were advanced beyond their position reached in the preceding stage. The "picture-writing" of the hunting peoples had become more symbolic and a step made towards phonetic writing and the alphabet. Amongst certain people the art of spinning and weaving was discovered, suggested probably by the basketry or fishing-nets of the hunting stage.

The complete welfare of these people depended upon their providing favorable conditions for their herds and flocks. Good water, suitable and sufficient food must be found; they must be protected against the rigors of climate and from the wild beasts of the region. The result of this constant oversight and care, as pointed out by Miss Dopp, was to develop sympathetic relations between man and his animals. When they suffered, he suffered. Individual members of the flocks were sacrificed only when actually needed for food or clothing. That which we voluntarily care for we soon learn to love, whether it is a house-plant, a dog, cat or only a homely toad. The blood-thirsty savage of the previous age, delighting in the slaughter and torture of all animal life, was being transformed and humanized. Gentler relations with his fellows were established, the sick and aged no longer must be murdered, or abandoned to their fate, upon the march. A closer bond between children and parents sprang up because no single individual could separate himself from the group and long maintain himself. The maternal care of the Apache mother ceases when the child can pluck a certain kind of fruit and, by its own efforts, capture a *rat*. So long as their most valued possessions were *upon legs* and could be driven away there was great inducement for plunder. These pastoral people were in almost constant danger of attack and must hold themselves in readiness for such an emergency. Woe betide the group that forgot or neglected the arts of war! Bold, full of energy and daring in the face of danger, but not without sympathy toward strangers whose good intentions were assured. They could even afford to be generous and hospitable. Altruism was being born.

4. AGRICULTURAL STAGE. The use of plants for food had continued from the arboreal stage; first, to supplement the occasionally meager supply of game and fish and second, to furnish desirable variety from the carnivorous diet. Roots, leaves, stems, berries, nuts, seeds and the inner bark of trees were thus utilized. The collection of such foods was left mainly to the women and children. Simple attempts at agriculture were begun by the women of the hunting people and continued by those of the pastoral when they were favorably located. The idea that plants, as well as animals, could be *domesticated* and, under favorable conditions made to yield abundantly, was not entirely new. Favorite plants were probably transplanted in small plats, or started from the seed, and there kept free from weeds. The advantage of stirring the soil was accidentally discovered and digging-sticks and stones were made use of. It would seem that the use of fertilizers was dimly understood by even the hunting people, since the Indians are said to have informed the early settlers that burying a dead fish in a hill of corn would increase the yield.

With a knowledge of the simple methods and advantages of agriculture it seems likely that the transition from the pastoral to the agricultural stage was brought about by the stress of circumstances. It was started when the men began to turn their attention to what, at first, must have seemed beneath their dignity. The life was so much more laborious and so free from excitement that it does not seem that it would have been undertaken voluntarily. The loss of their flocks by disease, cold or plunder would compel a group either to fall back upon the chase, or to seek out a favorable location and wrest a livelihood from the soil. In certain mountainous regions, where relatively few cattle, goats and sheep could be supported in a given area, it was possible for small villages to spring up in the valleys, where conditions were favorable for limited agriculture. Portions of the population would devote themselves during the summer mainly to the care of the animals, while others would raise hay and grain for their winter use, along with vegetables and other food stuffs. In this way the change from the pastoral to the agricultural stage was a gradual one and, with the discovery that a rather limited area could be made to support a large population, more and more land would be brought under cultivation.

In order to care properly for the crops some kind of permanent home, within easy reach, was necessary. The nomadic habit must be given up and for the first time in its history the race became sedentary. There was now an incentive to build a larger and a better home, provided with crude articles of furniture, such as beds, tables, stools and benches. The fire was brought indoors and, at first, served for cooking, heating and lighting. The materials of which the house was constructed varied with the people and the region, being made of sod, sun-baked clay, rough stone, bark or logs. It was quite possible and desirable often to group them into small villages and the necessity for some social organization arose. Grains, berries, fruits and vegetables were cultivated, along with grasses for the winter use of the few animals

still retained for food and beasts of burden. The first digging stones were replaced by stone hoes with handles, and strong, sharpened sticks drawn by animals became plows. All the various handicrafts and inventions that had been started in the hunting and pastoral stages underwent a rapid and fuller development during the agricultural stage, because of the greater opportunity and necessity. The mortar and pestle for cracking and grinding grains and seeds, were replaced by heavy stones turned one over the other, first by hand power and then by animals. The grains first gathered and threshed by hand, were cut with knives, threshed by flails, and later by animals. Owing to the inconvenience of transporting it in the nomadic stages, the industry of making pottery could not flourish until the permanent home was secured. Cooking vessels, water jars and various dishes were devised and elaborately ornamented. Methods of cooking underwent a corresponding development from the simple roasting and broiling over the camp fire. Various peoples have devised ingenious methods of getting fire, the most primitive of which was probably that of striking together two pieces of chert or flint. In chipping their crude implements the sparks were observed and when alighting upon the skin they were found to be hot. Either by accident, or deliberate intent, their effect upon a very combustible substance was discovered. The heating effect of friction was discovered and made use of in a variety of ways for getting fire, different people using the fire-plow, the fire-saw and fire-drill. The various industries required for the manufacture of clothing were perfected by the women and garments of special design and materials produced, adapted to the season.

This manner of life was so arduous that it exhausted the surplus energies of a community; so free from excitement that it eliminated the wild, boisterous spirit of the shepherd and cow-boy. With his main treasures in *land* which could neither be carried away, nor utilized by hunting and pastoral man; in crops or stores of grain not easily transported; the agricultural people did not invite attack. They gradually lost the warlike spirit of their ancestors and entered upon a peaceful, quiet life, that called for and gave opportunity for thought and reflection. The settled life gave great stability to such a population, their land and homes were to be defended at all hazards, since they could not be moved. They made use of fortifications into which they could retreat in case of attack and these they defended to the last. A spirit of patriotism, not previously known, was aroused and developed. Certain individuals were especially trained for the common defense. Captives could now be utilized in the fields as never before and the institution of *slavery* was started. From the brutish tree-climber, the savage hunter and the barbarous herder, we have at last reached the humanized and *civil* farmer.

5. MANUFACTURING STAGE. As the farmer and his sons became more and more ambitious in their agriculture there was a demand for improved tools by which the man and his beasts of burden could secure the maximum return for their labor. Those most ingenious devised implements for which there was a demand, and to supply these, certain ones undertook their manufacture. Wood, coal and metal were demanded and other groups of individuals were set to lumbering and mining. The materials so obtained were used in the construction of the manufacturing plants, the homes for the workmen, the articles manufactured, the machinery employed and the fuels required. To shift the raw materials to the place of manufacture, to get the manufactured products to the farmer, as well as his food products back to the workmen, necessitated more and more efficient means of transportation. Other manufacturing were started later to supply the farmers and other laborers with clothing, hats, footwear, household articles and tools required in their various lines of work. In a system becoming more and more complicated it was impracticable to exchange directly a certain amount of grain for a scythe or suit of clothes and some medium of exchange must be devised. Mints and banks, with their cheques, promissory notes and tables of interest, are the result. In order to facilitate business there have sprung up the newspaper, the post, the telegraph and telephone. To settle disputes and see that all get their individual rights we have our lawyers, judges and officers of the law; to look after our physical welfare we have our physicians, surgeons and druggists; to attend to the moral and spiritual welfare of struggling humanity we have our ministers and pastors; and, finally, to adjust the children most wisely and efficiently to this most complicated state of society we have our teachers. No teacher can do this most intelligently and sympathetically who does not know the weary path that has been trodden by the race and who does not understand the natural course of child development.

General Summary of Race Development.

LEADING OCCUPATION.	TYPES OF DWELLINGS.	CHARACTERISTIC MATERIALS.
VI. Manufacturing.	7. Modern houses; frame, brick, stone, cement.	<i>f.</i> Iron.
V. Agricultural.	6. Cabins; sod, adobe, stone, log.	<i>e.</i> Bronze or copper.
IV. Pastoral.	5. Cloth Shelters; tents.	<i>d.</i> Polished stone.
III. Hunting and Fishing.	4. Skin Shelters; wigwams, tepees.	<i>c.</i> Chipped stone.
II. Hunting.	3. Plant Shelters; boughs, leaves, grass, bark.	<i>b.</i> Unshapen stone.
I. Climbing.	2. Caverns and rock shelters.	<i>a.</i> Wood.
	1. Tree homes.	

In the classifications of the various steps in race progress upon the three different bases given above, it is not to be assumed that the stages of one correspond necessarily to those of the others. Neither is it to be supposed that each race of people to-day has traversed the entire series. In New Guinea and along the Amazon and its tributaries there are tribes that still utilize the trees for their homes, but using improved methods of reaching them. When America was discovered the eastern Indian was in the hunting and fishing stage, using skin or plant shelters and only stone and wood for his weapons. In the middle west he had displaced the so-called "mound-builders," a race that appears to have reached the *lower* agricultural stage, having settled homes, extensive fortifications and utilizing copper and silver. The Eskimo in America have reached an *advanced* hunting and fishing stage, while their representatives in Europe and Asia have domesticated the reindeer and advanced into the pastoral. This is as high a stage of culture as their environment will permit. The United States government is at present trying the experiment of introducing the reindeer into Alaska, teaching the natives how to care for it and thus *lifting* them bodily to a higher plane of culture, (National Geographic Magazine, Vol. XIV, p. 127 and Vol. XVII, p. 69). This promises now to be a success and a great boon to the Eskimo. In trying to force the Indian hunter into the *agricultural* stage the American government is not meeting with all the success hoped for and for the reason that the step is too great a one to be made so suddenly. The transition from the hunter to the herder could have been made with relative ease and, in the light of our present knowledge, it should have helped the Indians to have acquired *flocks*, instead of *farms*.

It is well to note that, with the exception of the tree-climbing which has been largely dispensed with, it is still necessary that certain individuals devote themselves to-day to those activities which characterized the stages of the race. The numbers so employed sustain a direct relation to the remoteness of the stage. About one-half our population are engaged directly in agriculture; a considerable, but much smaller percent, devote their lives to the rearing of animals; while still fewer are engaged in fishing and hunting, as a livelihood.

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CHAPTER IV.—THE DEVELOPMENT OF THE INDIVIDUAL.

"Man can only become human through education. He is nothing except what education makes of him."—*Kant*.

"He who considers mankind good does not understand the human race. He is naturally brutal and only education can ennoble him."—*Frederick-the-Great*.

Whatever theories may be held concerning the origin and progress, or origin and degeneration of the human race, there is but one view possible concerning the individual. Beginning with a single cell he progresses through various invertebrate and vertebrate stages that characterize the higher mammals and before birth, appears to have reached what may be regarded as the *human plane*. An attempt to explain the significance of these various stages by the greatest living biologist will be found in Haeckel's "The Last Link." In the interpretation of these *facts* of pre-natal development there must be brought in *theory*, and where there are theories there will be room for diverse opinion. The scientific interpretation is that, owing to the uniformity of Nature, the individual *must* be created in the same general manner that the race itself has been and we have here one of the most convincing, as well as most wonderful, evidences of race development. Upon any theory of direct creation of the race this pre-natal development of the individual is without explanation or meaning.

A. Culture Epoch Theory. The adherents of Ziller's theory of culture epochs maintain that the development of the child does not *cease* with birth, but that, so far as the mind is concerned it has only well *begun*. The "biogenetic law," which necessitates that every individual shall repeat the history of the group to which it belongs, operates upon the child during its embryonic life. We may as easily believe that there are places and times in the universe where the law of gravitation is suspended, as that this great *life law* is operative upon the child up to a certain point and then ceases. Theoretically, the child from birth *must* repeat the history of that portion of the human family to which it belongs.

It might be argued that each race of people has undergone no development, that they stand to-day practically as they were created. If this were true, which all scientific evidence contradicts, then the infant should be, physically, morally and mentally, an *adult, in miniature* and there could be no series of culture epochs. Anatomical and psychological studies of children show conclusively that they differ radically from adults. It might be argued further, admitting the law of development, that race development has been of such a nature that it could leave no recognizable impress upon the child. But it has been shown in the preceding chapter that both the body and mind of primitive man differed essentially from that of our civilized man of to-day and those who are investigating the truth of the culture epoch theory have a right to call for the direct evidence as found in the studies of childhood and early adult life. It is no argument against the theory, in general, to maintain that the series of culture stages given in the preceding chapter may have been passed through in a different order by certain races, or that certain stages were entirely omitted. Still less does it matter if it can be shown that certain groups in one stage reached a higher plane in special directions, than certain other groups in a higher stage of culture. These variations in the rate and order of race development should affect, theoretically, only the descendants of those races having such exceptional development. They will be exempt, in no wise, from the general law of life development, but its effect will differ presumably from that attained in the case of races that have had an essentially different history.

So far as the *truth* of the theory of culture epochs is concerned it matters not what impractical schemes of elementary education have been, or are being founded upon it. It is now desired to bring together in concise form the normal characteristics of the children of our civilized races and to show that, in a general but fundamental manner, they appear to recapit-

CHAPTER IV - THE DEVELOPMENT OF THE INDIVIDUAL

THE INDIVIDUAL IN THE SOCIAL ORDER. The individual is not a mere atom, but a social being. His development is determined by the social conditions in which he lives. The social order is the result of the interaction of many individuals, each of whom is influenced by the actions of others. The individual must learn to live in harmony with the social order, and to contribute to its well-being.

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ulate our race history; physically, intellectually, morally and religiously. If this parallel development of the child and the race is a *fact* and not merely a series of remarkable *coincidences*, then the law of culture epochs is simply a part of the more comprehensive law of organic development from which the child is not and should not be exempt.

B. Infantile Characteristics. The characteristics possessed by every healthy, normal infant, just born into the world, are *hereditary* rather than acquired during his embryonic life. The manner in which he reacts against the hostile environment in which he now finds himself is determined by the sum total of these hereditary traits. The nature of such reaction and the character of the environment will determine what individual characteristics will be acquired. Of the hereditary traits with which the infant is endowed we may recognize two groups; the *mammalian* and the *racial*.

1. MAMMALIAN CHARACTERISTICS. Under this head will be included all those characteristics and structures which the child possesses in common with the higher mammals and which he would have regardless of what had been the history of the race. Here will be included the general anatomical and histological details of his body and the physiology of his various organs. In common with other mammals in their infancy the child is of small size, physically weak, lacking in control and endurance, with poorly developed senses, a cartilaginous skeleton, low specific gravity, and a relatively large head. Without teeth that have cut the gum, he acquires a temporary and later a permanent set. In common with other mammals at this stage his natural food is milk. His respiration and pulse are more rapid than they will be in later life and his bodily temperature is higher. He is active and restless, tires easily, sleeps much and recuperates readily. The securing of exercise for his muscles and the periodic gratification of the hunger appetite chiefly concern the infant during his waking moments.

2. RACIAL CHARACTERISTICS. In conjunction with the above set of purely mammalian characteristics the child possesses still others for which a separate explanation or series of explanations is required. They are characteristics that distinguish him radically from what he will be when an adult and are "greater than the differences between some species of animals." So far as we may judge, most of these characteristics are entirely useless to the infant himself and hence cannot be explained upon the ground of utility. They are to be satisfactorily accounted for only by assuming that the child is repeating physically and mentally that early stage of race history when the trees were the natural dwelling places. It is the conviction of the writer that the stage here indicated in the life of the child is not the *pre-human* brute stage, as generally assumed by authors, but the first stage of *human* culture. The *tout ensemble* of infantile characteristics is *human* rather than *simian*. They are of interest to the primary teacher only in that they reveal the working of the biogenetic law and explain certain traits of character that persist until later life.

Compared with the length of the body the arms of the infant are relatively long and his legs short and bent. Almost from birth he can support his weight by his hands, this power reaching a maximum at about three weeks of age, when infants are able to cling for from two to three minutes. In grasping objects in the hands the thumb is not apposed to the fingers as is done later. The ankles naturally permit the incurving of the soles of the feet, the great toe stands at an angle from the others, all may be separated more or less and curved so as to permit the grasping of small objects. Upon the sole may be distinctly traced the markings which suggest the prehensile character of the foot. When the child is able to support its weight upon its feet, it stands more upon the outer margins of its feet and very readily becomes bow-legged. Its pelvic bones are narrower and longer and the spinal column lacks the double curvature. The forehead is low and retreating, the nose flat, the nostrils capacious and the lower jaw projects forward. The shape of the eye-ball is that of a far-sighted eye and *chlorophyll green* is the most restful and natural color to which the eye can be subjected. Before birth, and generally for a few days afterward, the entire body is covered with a thick growth of hair. The child often displays dislike for and resentment against artificial clothing. His methods of assault and defense are striking, scratching, pulling hair and biting, using first only his natural weapons. When able to move about his method of locomotion is upon "all fours;" not yet having learned to balance himself upon his feet. He shows a fondness for climbing up stairs, loves to be lifted aloft but displays instinctive fear of falling. For the milk there is gradually substituted a vegetable diet, to which meat will later be added.

The child loves noise and rhythm, especially of his own making, and his first musical instruments are a rattle, or something with which to pound. Later come the drum and the horn. His chief interest is in things which move and appear to be alive. He loves to be carried, swayed in the arms and rocked. The cries and gurglings of babyhood are made mainly with the vowels a, u and o, to which are very soon joined the consonants m and p. The first elements of speech are probably of the nature of interjections, followed or accompanied by nouns. His system of naming objects consists in substituting for the object itself his imitation of the sound which it makes. He cares but little for the companionship of children of his own age, until after he is able to walk or run, when the gregarious instinct shows itself. He is selfish, passionate and shows but little regard for the rights of others. In general, infants are afraid of strangers, and those things which suggest the presence of wild animals; such as gruff noises, large eyes, a display of teeth and the feeling of fur. High wind, thunder, darkness and water arouse instinctive fear in the minds of many infants. The child shows especial delight in striking objects with a stick held in the hands. It will prove a good exercise for the student to account for this group of characteristics without making use of the biogenetic law and then to interpret each particular trait in the light of this law.

C. Child of School Age. Judging from the powerful impress left upon the physical structure and organism of the child the arboreal stage of the race was probably of great duration. Without attempting to draw any sharp lines of division it seems that the stage at which the child learns to walk, marks, in a general way, the close of the arboreal stage in his individual development and the beginning of that stage during which the race was able to maintain its foothold upon the surface of the earth. With the assumption of the erect position, changes in the muscles, bones, shape and relative size of the various parts of the body at once begin, which are similar to those which occurred in the case of the race itself. The arms and hands no longer needed for purposes of locomotion are now free for the prehension of every available object. This freedom of the hands and the ability to walk gives the child a wide range of new experiences, leading to a growing fund of new ideas. The desire to express these ideas furnishes the stimulus required for the acquisition of articulate speech. The child now seeks the companionship of other children of his own age and becomes a gregarious and social creature. Co-operation in games makes still further demands upon children's powers of expression and speech is supplemented with pantomime and gesture. If the environment is favorable the muscles and senses, with their corresponding brain centers, are receiving exercise and development. These characteristics are more and more intensified, without marked break, and indicate the hunting and fishing stage of the race. It is this miniature warrior that with more or less reluctance and trepidation knocks at the door of our public school. Teachers, what shall we do with him?

I. PHYSICAL CHARACTERISTICS. All of the infantile physical characteristics enumerated in the preceding section are retained by the child of five to seven years of age, although Nature has begun to eliminate them. His bones are still relatively soft and plastic and easily deformed by improper school desks and unnatural positions. Lacking in control and co-ordination, he executes the more delicate movements only with difficulty. His drawing and whatever writing is demanded of him in these early years should be capable of being done mainly with arm movements. The child is very active and restless, demands frequent change of position and occupation, breathes rapidly, has a rapid pulse and for his complete development requires the maximum amount of out-door life, pure air and sunshine. To shut him up in the *typical* modern school-room, with its poor seats, bad lighting, unevenly distributed heat, foul air and unnatural restraint is doing violence to his physical nature from which he can never fully recover. With his sense and motor centers developing and demanding exercise he *yearns* for the fields and forests, how strongly only those can understand whose memories carry them back to childhood. And here, let no one imagine that Nature has made a mistake in thus implanting this inordinate desire in the breasts of children; she is endeavoring to save those that are worthy. The ideal school-room is that which lies *outside* of the brick walls and the portion inside should be used largely as a retreat and shelter. For the younger children of school age, say from six to nine, the teacher should be field-assistant, guide and chaperon. She should perfectly understand and sympathize with children, should equally well understand the hunting and fishing people the world over, should have a full and intimate knowledge of her immediate environment. To attend such a school children would *run away from home* instead of *away from school*.

Nowhere else is the law of child development shown more strikingly than in the play of children. To the adult this impulse to play seems almost *insane* in the hold that it has upon the child; but here again Nature is not in error. We wonder at the persistence with which children play and we may well consider their types of activity. As has been well said, all good play has in it the elements of work and all good work should have in it the elements of play. Is it then possible to distinguish between work and play? By some play is regarded as simply *pleasurable* activity. But fortunately for most of us genuine work is often pleasurable and it occasionally happens that genuine play becomes far from pleasant. By others play is defined as a pleasurable, *purposeless* form of activity, and this applies to most play. In certain cases, however, children indulge in forms of play for the express purpose of acquiring skill, as in jumping, running, throwing, etc. It does not meet this objection to say that the purpose must be a *useless* one, since this form of skill acquired may even be the means of saving the individual's life. Play may be defined as the purely voluntary expenditure of energy. There is no impelling force, other than what may be called the "play impulse" itself. The distinction between play and work rests upon the mental attitude of the child towards the activity, one may change to the other instantly and in the same game one child may be playing while another is working. The impelling force that changes the activity to the form of work may come from without, or may arise from within the mind of the child as a sense of duty, pride, loyalty, ambition, etc. When a hungry child is eating his dinner he is not playing, however pleasurable may be the exercise. When, as his young sister's guest of honor, in one corner of the sand-pile or in the shade of the old apple tree, he obligingly nibbles a cookie or sips imaginary tea, he is playing. Psychologically there is no distinction to be made between play and the recreation of the adult.

It remains to consider why children the world over possess this intense play impulse and why they play as they do. The theory suggested by Schiller and later elaborated by Spencer is that they are working off, by this means, their superfluous energy. That this theory can not completely explain the play of children is at once shown by the fact that they often continue to play long after the *superfluous* energy is exhausted. Furthermore, many forms of work would be equally serviceable in enabling them to dissipate energy. A second theory advocated by Lazarus and Gutschmuths is that children play for purposes of relaxation and recreation. There is no question but that when children are kept quiet for an hour or more in the school-room the desire to play is intensified, but that the theory can not completely explain the play of children is at once shown by the fact that children are ready to play from the time that they open their eyes in the morning until forced to close them again at night. Furthermore, it is known that a change of work can furnish relaxation. These two attempts to explain physiologically the phenomena of play are plainly incomplete in what they attempt to explain and do not account at all for the forms of activity seen in natural play.

A theory which not only explains fully and completely the play of children, but that of young animals as well, is found in Groos' biological theory, based upon the theory of culture epochs. The child is in that stage of development which represents the hunting stage of the race, when the most varied activity of muscles and senses was demanded. The motor and sense centers in the child's brain are now ready to be developed and are demanding exercise. The forms of activity required, in order that the individual brain may be developed as was the race brain, must correspond with the primitive activities. In operating upon the child the biogenetic law implants in him an instinctive impulse to use his muscles and senses and to use them in a certain way. The resulting activity we call *play*. This impulse is as powerful as it is because of its great importance to the child and a generous proportion of his life is set apart by Nature for its operation. If we watch a group of boys engaged in plays of their own devising we will at once discover what the primitive activities really were;—running, jumping, dodging, whirling, striking, kicking, wrestling, boxing, hiding, climbing, digging, swimming, throwing, yelling, etc. The average boy can think of no higher paradise than a complete camp, located alongside a beautiful sheet of water, with a full equipment for hunting, fishing and boating. In the case of the girls at play some of the rougher elements are eliminated and for these are substituted certain phases of the domestic arts, including the care of dolls. In their romping games the girls just as they are caught instinctively *scream*, in striking contrast with boys, which may be explained by assuming that in primitive times the women habitually called for help in times of danger, while the men reserved their strength for the encounter. If we could get a *composite scream* from the girls of all nations of the earth it would probably very closely represent the original female cry for help.

With imitation and imagination strongly developed in the child placed in a civilized environment the play impulse will be directed into new channels and instead of prancing down the road as a wild horse, or clawing the air like a bear, you may see him puffing like an auto or locomotive. Those artificial games that are devised by adults, and taught children must have in prominent sight the above natural elements of play in order to ever become popular with children. Analyze the games of base-ball and foot-ball in order to discover the various types of activity represented. In primitive society the children played essentially as they do to-day and acquired skill in doing those things which enabled them to survive as adults. We have out-grown, in large part, the necessity for these special activities in later life and still the ability to run, jump or swim not infrequently enables the individual to save his life. Aside from the practical value of the skill acquired in play, the activities demanded by Nature develop muscles and senses and the corresponding brain centers and mental powers. This is why "all work and no play makes Jack a dull boy." Furthermore, if the play impulse is fully satisfied there is much less likelihood of fighting amongst the boys. The wise teacher will do all she can to encourage and supervise the play of children entrusted to her care.

2. INTELLECTUAL AND ETHICAL CHARACTERISTICS. Under this head we may group a series of characteristics which relate the child to primitive man and distinguish him from our ideal civilized adult. The *average* child is jealous, selfish and inconsiderate of the feelings of others. He is heartless and often cruel, delighting in stories of adventure, fighting and bloodshed. He loves to tease and annoy helpless animals and his weaker fellows, which is simply a mild form of torture. He has a feeling of hostility toward all strange boys, is clannish and quarrelsome. Because of his vivid imagination, his unreliable senses, or his willingness to deceive, the statements of children are often untrue. Judged from adult, civilized standards, his ideas of right and wrong are very vague, as is also his sense of modesty. Property rights are not fully understood or respected, *might* often making *right*. Many teachers and parents believe that these low traits, which they cannot help but recognize in their children, have been *caught* from other children, just as they might catch the measles. The purpose of this discussion is to show that they are perfectly natural and to be expected in every healthy boy, less pronounced in the case of the girls, and not due to acquired viciousness. Sympathy! sympathy! is what the dear little rascals need. To know how to handle them most wisely requires divine help.

Because of the developing sense centers in the brain the senses are particularly active and the child desires to see, feel, taste, smell and hear. He lives largely in the present, is naturally improvident and lacking in thrift. Not having yet become strongly attached to any single locality he is nomadic and, if he could carry with him his parents, friends and pets, he would like to be almost continually upon the move. A house upon wheels, or a private car or yacht would be ideal. He is lacking in power of mental concentration, is not methodical, reasons superficially, is easily deceived, and has but a weak grasp of numbers. He is by nature untidy and lacks in fastidiousness, is not seriously distressed by the usual condition of his hands, face, hair and clothes. He is not overly choicive in regard to the things with which he periodically fills his stomach. He makes much use of gesture and loves pantomime as a form of expression; delights in wild, weird calls and cries. Imagination and associative memory are strongly developed in children and they have a passion for imitating the activities of animals and grown-ups. Children are surprisingly confident of their powers and are often boastful. When a little older they develop, especially the boys, a type of stoicism, which enables them to take a thrashing without any show of pain. Owing partly to their innate curiosity and partly to their instinct to kill, children are naturally destructive of plants, animals, toys and property. Stories of the fiercer animal life, of war and the chase, of primitive adventure, appeal most strongly to them. The child is passionately fond of play; i. e.—the voluntary expenditure of energy,—but just as thoroughly detests work. He loves Nature rather than art, the *real thing* rather than any representation of the thing. He loves strong perfumes and brilliant colors, having no appreciation of the harmony of shades of color. Most children prefer red and have a positive distaste for black. Their fondness for color may be transferred to the object possessing it. A teacher informed the writer that the children are much more tractable when she wears a dress that they like. Musically the child has not advanced much from infancy, still loving *rhythm*, rather than melody, or harmony. However, it now requires more noise and rhythm to satisfy him. The music that takes the firmest hold upon the child is of the *minor* character.

In his drawings the child also comes close to primitive man and the modern savage. Because of equal powers of representation and interpretation the drawings of the two are very similar, appearing as grotesque caricatures. This arises from the fact that with each drawing is not *art* but a *form of expression*, the simplest and most natural form of written language. The child draws what is in his mind, rather than what he sees before him, and he introduces into his drawings only that which he, at the moment, regards as most essential. He shows a preference for animals and the human subject, in action, giving a *side* view of the animal and a *front* view of man. In drawing an animal the child begins with the head, adds the body and then the legs to support both, this appearing to him the order of their importance. In drawing a man the head is generally drawn first, as the most important part of his anatomy, the eyes and mouth usually inserted next, and a pair of stiff legs to support the head. If arms are added they at first branch from the head, the body not being recognized in man as of any importance. The relative size of the various parts, or of neighboring objects, gives a clue as to their importance in the mind of the child. In these drawings there is thus mirrored, for the moment, the contents of the child's mind and this form of expression becomes for the teacher a most valuable auxiliary, in case she is wise enough to utilize it. A very complete series of children's drawings was made the subject of study by Earl Barnes some years ago. The children of various grades were given paper and pencil and then were read the story of "Johnny Look-in-the-Air." They were then asked to illustrate one or more episodes of the story and the poem was read to them a second time. Papers were received from 6393 children, mostly in California, from which some interesting generalizations were made (see *The Pedagogical Seminary*, Vol. 2, p. 455). In order that teachers may secure similar data for comparison the poem is here reproduced, as translated from the German.

STORY OF JOHNNY LOOK-IN-THE-AIR.

As he trudged along to school,
It was always Johnny's rule
To be looking at the sky
And the clouds that floated by;
But what just before him lay,
In his way,
Johnny never thought about;
So that everyone cried out—
"Look at little Johnny there,
Little Johnny Look-in-the-Air."
Running just in Johnny's way,
Came a little dog one day;
Johnny's eyes were still astray
Up on high in the sky;
And he never heard them cry—
"Johnny, mind, the dog is nigh!"
What happens now?
Bump! Dump!
Down they fell with such a thump,
Dog and Johnny in a lump!
They almost broke their bones
So hard they tumbled on the stones.
Once with head as high as ever,
Johnny walked beside a river.
Johnny watched the swallows trying
Which was cleverest at flying.
Oh! What fun!
Johnny watched the bright, round sun
Going in and coming out;
This was all he thought about.
So he strode on, only think!
To the river's very brink.

Where the bank was high and steep,
And the water very deep;
And the fishes in a row,
Stared to see him coming so.
One step more! Oh! sad to tell!
Headlong in poor Johnny fell.
The three little fishes in dismay,
Wagg'd their heads and swam away.
There lay Johnny on his face,
With his nice red writing-case;
But, as they were passing by,
Two strong men had heard him cry;
And with sticks these two strong men
Hook'd poor Johnny out again.
Oh! you should have seen him shiver
When they pulled him from the river.
He was in a sorry plight,
Dripping wet and such a fright!
Wet all over, everywhere,
Clothes and arms and face and hair;
Johnny never will forget
What it is to be so wet.
And the fishes, one, two, three,
Are coming back again you see;
Up they came the moment after,
To enjoy the fun and laughter.
Each popped out his little head,
And to tease poor Johnny, said,
"Silly little Johnny, look,
You have lost your writing-book!"
Look at them laughing, and do you see
His writing-book drifting far to sea."

In using the above with a single child, or a grade of children, record the name, date, residence and age and have the story retold by picture method in order to get an idea of primitive expression. Doubtful portions should be explained while the matter is fresh in the mind of the child.

3. EMOTIONAL AND SUB-RELIGIOUS CHARACTERISTICS. The child is dominated very largely by his feelings and is naturally impulsive and passionate. His moods are rapidly

changed and he is easily diverted, from one extreme to another. With him the 'fount of joy lies very near the lake of tears.' As has been pointed out the child is hopeful and confident, but still subject to vague and unreasonable fears. He has a great admiration for *physical* skill or power and but little appreciation of intellectual strength. His classic heroes are David, Ulysses, Siegfried and Arthur, rather than Socrates, Plato or Aristotle. The Diety he pictures as a giant. He assigns a personality to inanimate things. Objects that bring to him pain must be scolded or punished, as a stone over which he falls. The doll is often alive to the imagination of the little girl, and never in after life will sorrow be any more real than when her savage brother crushes its head. The child readily and gladly believes in the supernatural, is superstitious and a fetish-worshiper. His world is peopled with brownies, fairies and goblins. He believes in luck and chance. All those who have lived for any length of time with savage peoples have been impressed with the similarity between them and children.

D. Persistent Savage Traits. From this low stage of culture, as a result of heredity and through the operation of the home, school, church, state and society, the individual passes to a higher plane of culture and gradually attains those physical, emotional, intellectual, ethical and religious traits that characterize the civilized adult. Eliminate the influence of the above social institutions and the individual makes but little progress. In spite of their influence every person retains many reminiscences of the primitive life of tree-climbing and hunting man, suggesting that only a relatively short time has elapsed since civilized man attained the higher plane of culture and explaining why some individuals have succeeded in acquiring only such a very thin *veneering*.

1. TREE-CLIMBING ATAVISMS. Amongst civilized adults are still found, more or less frequently, peculiarities of the skeleton which were characteristic of climbing man. The standing position, as Drummond points out, is difficult for man to retain for any considerable length of time. The sneer seems to be what remains of early man's display of his formidable canine teeth. When our eyes become weakened, or diseased, *green* bandages, eye shades and lamp shades are prescribed. Many adults show a fondness for swings, hammocks, and rocking-chairs. Two of the most deep-seated fears with civilized man are the fear of falling from a height and the fear of snakes. Many people are instinctively and unreasonably afraid of the dark, thunder and lightning and high wind.

2. HUNTING AND FISHING ATAVISMS. The love for hunting and fishing has still a deep hold upon many, in which the instinct to kill has not been replaced with a love and sympathy for animal life. This instinct is partially satisfied by shooting at a target or "clay pigeons." The gathering of nuts and wild berries from the fields and forests furnishes a tamer and milder pleasure than one does not get when ordered from the grocer. Fortunately but few have lost the charm of the woods, fields, streams, lakes and mountains. The nomadic instinct is still strong in many and they constitute our "globe-trotters." Very few people there are who are not affected more or less by absurd superstitions. The readiness with which a mob will drop back into savagery and indulge in the most revolting cruelty to their fellow-man furnishes evidence of the thinness of the veneering that we call civilization. There is no crime that man or woman commits against society that may not be looked upon as a form of savage atavism. The most satisfactory theory of the criminal is that he is an individual who insists upon practicing to-day the code of ethics that was developed and recognized when the race was in its youth.

The instinctive clenching of the fist in anger, the setting of the jaws, the stamping of the foot and the rapid heart beat, even when the cause of anger is not present, are readily understood. The interest which so many of the lower and middle classes manifest in personal encounters, prize-fights, wrestling-matches, and the corresponding contests of animals, are simply so much savage atavism left in their natures. The throwing of a hammer to the ground, with which one has struck his finger, is an ineffectual attempt to punish an inanimate object. The kicking of loose objects upon the walk, the carrying of a cane, various sleeping postures, the fondness for rhythm in music and poetry, the use of gesture, the taste for gaudy color and powerful perfumes, are all explainable upon the theory that every individual must recapitulate the race history. For the great majority of people a camp-fire at night has a strange, undefinable attraction, which is less in the case of the old fire-place and grate, but still recognizable. As you watch the weird tongues of flame licking the embers, if you shut out all other sounds and listen intently you may hear reverberating through the misty corridors of memory the "Call of the wild."

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CHAPTER V.—THE PEDAGOGY OF NATURE STUDY.

"The education of the child must accord both in mode and arrangement with the education of mankind as considered historically; or, in other words, the genesis of knowledge in the individual must follow the same course as the genesis of knowledge in the race."—*Spencer*.

As a result of the studies thus far pursued it is expected that the teacher will take a keener interest in the observation and study of children. This will lead to a better understanding of the individual child and the establishment of more sympathetic relations between him and the teacher. The most favorable conditions for his development will be at once apparent and teachers, as a body and as individuals, can do much in the way of improving the conditions under which young children struggle. With a clear understanding of the biogenetic law the teacher is no longer an automaton, but capable of independent thought and judgment concerning the materials of the course of study and methods of presentation. She should be able to diagnose defects and prescribe remedies.

A. Purposes of Nature Study. One of the most sweeping and most satisfactory utterances concerning the purpose of education in general, is that it is a process by which the individual is *adjusted to his environment*. This applies to all times, to all climes and to animals as well as man. In the adjustment of the race to its present civilized environment Nature knowledge has had a most important share, as has been outlined in chapter III. Considered in its broadest sense it has had most to do with the development of the race brain and from it as a center there was developed those subjects of the elementary school which are of richest content (geography, science, literature and history)—the *thought* subjects. From the Nature studies in very large part, and from the above thought subjects as well, there was gradually developed and perfected the *expression* subjects—pantomime, oral expression, composition, spelling, penmanship, reading, numbers, music, drawing, painting, modelling and making. These forms of expression were not acquired independently of one another nor of the thought subjects themselves. The idea came first, the desire to express it next and the form of expression resulted. Primitive man did not learn to count until he had something that he wanted very much to count, nor to draw until he had something in his mind that he much desired to express in this way. All of the industries and occupations connected with the home and the obtaining of food and clothing were developed gradually by the race in its efforts to utilize Nature's materials and to secure better adjustment to the changing environment. So far as the historical development of all the subjects of our elementary schools is concerned—thought subjects, expression work, manual training and domestic art—they have all had a Nature basis. It is desired to enumerate what the writer conceives to be the claims of Nature study to a prominent position in the elementary schools of today.

I. SENSE TRAINING. More strongly than is generally recognized today by those who discuss the subject the writer believes in the disciplinary value of Nature Study. This he believes to be of primary and fundamental importance. In a favorable environment the play impulse will take care of the muscular development and the building up of the motor centers of the brain, at the right time and in the right way. If left to himself, also in a favorable environment, the natural impulse to use his senses will furnish the training necessary for the development of his sense organs and the corresponding sense centers in the brain. When, however, the child is imprisoned in the school-room for the choicest hours of the day and his energies expended in activities entirely foreign to his nature, neither motor centers nor sense centers can develop in harmony with the law of brain development. This might not be so serious if it did not happen that upon these centers as a foundation are to be built up the higher centers of the brain and its entire effectiveness as a tool of the mind seriously impaired. The greatest possible amount of sense training should be secured in connection with the Nature work, every special sense being called into requisition and, in addition, the muscular sense, the temperature sense and the sense of direction. For each exercise in

school the children will set for themselves hundreds of related exercises out of school. The result of this work is that the sense organs are trained, the fundamental brain centers are developed and the mind is stored with a fund of elementary concepts, of the greatest value in the later apperceptive work of the school.

As indicative of the value of this training to the individual the fact may be cited that whenever one person stands out prominently above his fellows, in any avenue of life in which there is severe competition, it will be found that this individual has had the benefit of a rural environment during the critical period of his development. Almost without exception it will be found that he was reared in the country, or in a village with its rural advantages, or that prolonged visits to the country were made during his childhood. If one will write down the great names of any branch of knowledge or human activity, from the earliest times to the present day, and then will take the trouble to look up their early biography he will be impressed with the importance of the rural over the urban environment. This is all the more remarkable when we consider that about one-half the people live in the cities and that here are to be found the best schools and other institutions calculated to promote individual culture and power. It is remarked by business men that the boys from the country come to the city and in time work into the best places. The subject is a most important one and worthy of the fullest investigation, because of its bearing upon the education of city children. In searching for an explanation a considerable variety of views will be developed. Is it that the average country boy is better fed, better clothed, has better air, is more active or has more responsibility thrust upon his shoulders? There are many city boys over whom the country boy has no such advantage. Some see the explanation in the opportunity for manual training afforded by the farm but this could scarcely account for those forms of genius possessed by the poet, orator, statesman or financier. The most probable explanation is that the environment found in the country and village is favorable for that direct contact with Nature in this critical, formative period of the child's development. His motor and sense centers are developed symmetrically and *naturally* and a stable foundation laid for those centers controlling the higher mental powers. In the case of the city child no such foundation is laid, and in the highly artificial environment of this industrious and commercial age he is prematurely developed. Of the wealthier classes many have their country homes, but for the middle and lower classes the only practicable remedy is to send the children to the country for the summer and to bring as much as possible of the country into the schools during the year.

2. METHODS OF STUDY. Beginning with the very simple, superficial observations of the younger children the result of the Nature work of the elementary grades should be to develop correct methods of scientific study. The results secured will form a splendid foundation for the work of the high school, in the case of the limited number who continue their studies, and will render life-long service to those who are compelled to drop out at the close of the eighth grade. Following the lead of primitive man the child observes more or less superficially, illogically and incompletely. By skillful guidance the Nature work may be made to yield a rich harvest of results. The *habit* of observing closely, accurately and completely and according to some systematic order, may be acquired by school children. The ability to discover differences and resemblances, to arrive at correct judgments and to reason inductively will result from Nature work that is properly presented. Every child should be made to understand the danger of error arising from hasty judgments based upon a single, or limited number of observations. (See President Eliot's paper "Wherein Popular Education has Failed;" Forum, Volume XIV, page 411.) The child should be gradually freed from the bondage and tyranny of superstition. Just here the teacher should be warned that these results are to be secured as the result of the Nature study and elementary science of the entire eight grades and that only a *beginning* is desirable for the primary grades. In these lower grades the constantly recurring question should be *what*; in the intermediate grades *what* and *how* and in the grammar grades *what*, *how* and *why*.

3. ACQUISITION OF KNOWLEDGE. In placing this as one of the important purposes of Nature work in the schools there is danger of the teacher inferring that it is the sole, or most important purpose. This attitude of the teacher is rendered easier because of the over-emphasis placed upon mere information in the other subjects of the school course and results in the teacher merely lecturing *about* the Nature topics. As a matter of fact the securing of information, adapted to the age of the pupil, is of importance, since none of the higher results

enumerated below can be secured without it. The acquisition of this knowledge has educational value, in proportion to the method employed and the knowledge itself helps to give the child a command over his environment that animals, savages and the uneducated do not possess. Knowledge may be considered worth while that enables the individual to cause two grains to grow where there would be but one, to predict the approach of important weather changes or to ward off an attack of typhoid or blood poisoning. The rich fund of ideas acquired in the Nature work will serve as a basis for the apperception of the thought subjects of the elementary school;—science, geography, literature and history. If one attempts to develop either of these subjects in the primary grades the necessity is at once felt for the Nature basis and the *historical* order of the development of these subjects becomes the *pedagogical* order.

4. BASIS FOR EXPRESSION WORK. The greatest distaste which the child has for the school, aside from the restraint imposed, centers about the expression work. An interesting and profitable exercise for any grade teacher would be to have her pupils indicate upon unsigned slips of paper the subject, or subjects, that they are least in love with. Under usual conditions the subjects mentioned most frequently will be expression subjects and the reason for the disfavor will not be difficult to locate. Children are called upon to express themselves in various ways when they have nothing to express and, as Dewey has said, "there is all the difference in the world between having something to say and having to say something." They must commit so many pages of strange words, fill so many pages of a writing tablet, or drawing book and periodically prepare a "composition" upon some subject about which they care little and know less. This will be in large part remedied if the *impression* is allowed to precede the *expression*. There must be a certain amount of substantial *work* done along this line, which the average child will scarcely view with entire favor, but it is wise to secure in its doing the greatest possible interest. These expression subjects are of such a nature that they can be developed most naturally, and hence most easily, by following again the historic order and basing them upon the Nature work and the above enumerated thought subjects. Any attempt to develop expression work entirely independently of these subjects, and it may and is being done, will meet with the disfavor of the pupil and the amount accomplished can not be as great as when pupil and teacher are working unitedly and happily towards a common end. Superintendents and school officers should simply hold the teacher responsible for *results* and this will probably be done when the teachers have demonstrated that they are experts in their line. This does not mean that any less time will be devoted to the expression work of the school, but simply that its various phases will be developed as the desire arises for the expression of ideas acquired in the Nature Study and thought work of the school.

5. ETHICAL TRAINING. The disciples of the illustrious Herbart grant to the Nature studies high value in the training of character but claim that they have no ethical content in themselves. They are to be thought of as ethical *instruments* to the extent that they make the individual careful, industrious, thoughtful and regardful of the truth (See De Garimo's "Herbart and the Herbartians," pages 121 and 247.) They concern themselves with *facts* and their explanation, rather than good and bad deeds of men, as narrated in literature and history. This must be admitted to be true for genuine science and geography, which will be developed from the Nature studies, but is not necessarily true for the Nature work that should find its way into the elementary schools. This work is not to cease with the simple observations upon the material but reaches out and establishes vital relations with the child himself. Herein lies the real moral content. Starting with the formidable list of undesirable ethical traits, supposedly inherited from hunting and fishing man, the first higher trait of character to be developed is *sympathy*. But sympathy for what? Preferably for other human beings first and then later for animals and plants. If we are correct in assuming that sympathy for animal life was developed first during the pastoral life and then transferred to mankind, then the historical order becomes again the pedagogical order. In the home every child should have one or more pets, not only to play with but to *care for*. At school there should be moths, butterflies, grasshoppers, ants and bees, frogs and toads, rabbits, birds, plants and trees in the care of which he has his full share. The savage impulse to *kill* can be fully eliminated only by displacing it with the impulse to *preserve* and when the process is complete, hunting and fishing can no longer be indulged in as *sport*. Such a boy will no longer deliberately and gleefully pull the wings from a fly, crush the life out of a toad, wring

the necks of young birds, or bark a young tree. With his sympathies thus fully aroused towards animals and plants they will not long be withheld from his companions and the foundation is well laid for the development of all the ethical traits. Without this basis the moral structure that the teacher attempts to erect is unstable and liable to go to pieces just when it is most needed.

6. **ÆSTHETIC TRAINING.** As the result of the Nature work of the elementary school the child is led gradually to appreciate the unity and harmony that everywhere characterizes Nature and her laws; the common source of energy, the unity in structures, harmonious and uniform laws of development, and the striking similarities found in the physiological processes of plants and animals. As he gains a deeper insight into Nature's laws and processes he appreciates more and more the principles of adaptation and the dependence and interdependence of the three kingdoms of Nature. There is no longer presented to him "the appearance of an inextricable chaos but that of a well-ordered mechanism, its parts fitting exactly to one another, ruled by unchangeable laws and engaged in perpetual labor and production." All the *beauty* that we recognize in Nature results from this unity, order and perfect adaptation of organism to environment and organ to function. Insight into Nature is required in order to fully appreciate this beauty, whether of the snowflake, the leaf, flower or ocean shell. In the inorganic world all that pleases and fascinates the eye is the result of unity, order and harmony. In the organic world that only is beautiful which is useful and an understanding of the utility secures a deeper appreciation of the beauty. So far as art is the representation of Nature it can be interpreted and fully enjoyed only through the fund of concepts obtained by direct contact with natural objects and natural phenomena. So long as our choicest literature is inspired by, and filled with illustrations drawn from Nature, so long will it be necessary for the individual to go to this fountain-head for the store of apperceptive knowledge.

7. **FOUNDATION FOR RELIGIOUS BELIEF.** In contrast with the English and German schools the teaching of religion in American public schools is, rightly or wrongly, forbidden. It becomes the duty and privilege of the Nature Study to lay a foundation for the religious belief that is based upon no particular creed or word of authority;—a foundation that is built up as the result of the child's own cogitation and to which no sane churchman or layman will interpose objection. The laws of development, to which we give the name evolution, account for the *modification* of life but not its *origin*. The teaching of science to-day is that life does not originate of its own accord—spontaneously—but that it is always derived from some pre-existent form of life. The inference is justified that the original life must have been *created* and hence that there is a CREATOR. The unity, order and harmony everywhere found in the universe points to the *singleness* of this Creator. The tremendous energies that we have been able to trace to the sun point to that body as endowed with energy beyond the comprehension of the human mind. Knowing that this luminary can not *originate* energy and that it is but one of millions of similar bodies, we are driven to the conclusion that there must exist an Agency that is *all-powerful*. Everywhere in Nature we find evidence of *wisdom* far beyond the comprehension of man. The principles of Natural Selection explain many beautiful adaptations but we must never forget that these principles themselves must be explained and accounted for. The supplying of our needs in proportion to our wants testifies to the supreme *goodness* of this all-wise and all powerful Creator. Still further attributes to be clearly discerned from a study of Nature are economy, foresight and patience. But granting and accepting all this does not necessarily make the individual *religious*. There must first be developed a feeling of helplessness and *dependence*. Nature work need be carried through only a few seasons before the individual is firmly convinced that he is absolutely dependent upon other persons, animals, plants and inorganic matter and that these all derive their ability to help him from the *sun*. Here is where the sun-worshiper stopped, but all that he needed to make him truly devout was to have some one point out Him who made the sun.

B. Principles of Method. A charge that is often made against special schools for the training of teachers is, they over emphasize methods and devices and tend to make machines of their pupils. In too many cases in the past this accusation has been justified by the practices of such schools. Upon the other hand some of our universities and colleges have completely ignored the subject of method, claiming that if the prospective teacher has thoroughly mastered her subject, she will find a way to teach it and this she will do, in the great majority of cases, providing she has a body of children and sufficient time given her to *experiment* upon them. As is usual the "happy mean" lies between these two extremes, it being possible to impart to

a prospective teacher certain principles of method, which if applied will contribute much to her immediate success in the school-room. The writer has seen the value of method strikingly shown by a most enthusiastic women teacher of *swimming*, an art in which theory is supposed to count for but little. This woman teaches people in from one to two hours to swim and *withoutgoing near the water*. In presenting the following body of principles an effort is made to have the reader understand the reason for each, so that none of them is to be blindly followed.

1. The Nature topics should connect themselves more or less closely with the *season*, in order that the material may be available and to insure the greater interest of the child. A few topics that are equally seasonable at all times may well be reserved for winter work, when seasonable Nature topics are less plentiful than in the spring and fall.

2. The work should be largely upon well selected *types*, which should be familiar and should come from the immediate environment of the school. The advantage of this method of study is that when this type is understood, there is also understood in a general way, all the other forms for which this type stands. Comparison of other forms should be made with the type, making abundant use of pictures, and the foreign forms thus understood through the home representatives.

3. As far as is practicable begin with the *living forms*, in their natural environment. This will ensure that the *whole* is first presented to the child, instead of some part, and that its relation to its environment has been observed. In many cases the forms may be transferred to the school-room for more complete observation, study and *care*.

4. Ideally the material studied by each pupil should have been *collected* by himself, since this intensifies the interest and takes the child into its natural environment. In the case of certain types of plants they should have been *grown* by the child, either at school or at home, because this adds to the interest, knowledge and sympathy of the child for the plant. In the case of the city schools this principle will need to be violated often, but the teacher should understand that much is thereby sacrificed.

5. Just as far as is practicable every child should have one or more specimens for *individual study*, or should perform the experiment. The observations are to be directed by questions definitely in the mind of the teacher, leading the children to observe the most obvious and general characteristics first and then gradually passing to those most likely to be overlooked. The ability to observe accurately, completely and according to the natural order is to be slowly and gradually acquired, along with power of continued attention. Freedom should be permitted but much digression avoided. In the lower grades the replies will necessarily be oval, but when the children are old enough to write more originality will be secured if the replies are written.

6. The work should be of an *intensive*, rather than an extensive nature, when the stage of advancement of the pupils is fully considered. In studying one form well, rather than many superficially, the child acquires the scientific habit which is of high value. It must be remembered, however, by the teacher that the child demands *variety*, in order to sustain his interest, and the topic under study must present many different view-points. When the interest of the class begins to flag something is wrong, either with the topic or the teacher, and if the fault can not be located and remedied a new topic should be found without delay.

7. In order to secure the desired results the child must be allowed to discover certain things for himself and the teacher should use the necessary self-restraint to avoid *telling*. Telling the wrong thing and at the wrong time, deadens interest and cheats the child out of his due. I rarely see a Nature lesson given that I do not long for an electric *muzzle* attached to the teacher's jaw and operated by a push-button. The time does come for telling, however, when for lack of time to be devoted to the subject, or from the nature of the question, the children have done all that can be expected of them. Here is the legitimate place for pictures, stories, anecdotes, nature-readers and the small amount of lecturing that is permissible.

8. Do not make the mistake of teaching what the children *already know*, but begin where the average knowledge of the class ceases. Proceed slowly and step by step. Avoid too technical terms and teach names only as they are needed. Reasons and explanations should be sparingly demanded of the younger children. Avoid too much or too early generalization. Do not ask questions that children can not possibly be expected to answer.

the teacher's hands. It is not the teacher's hands which are the source of the child's knowledge, but the child's own mind which is the source of his knowledge. The teacher's hands are only the means by which the child's mind is directed towards the truth. The teacher's hands are only the means by which the child's mind is directed towards the truth. The teacher's hands are only the means by which the child's mind is directed towards the truth.

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9. In connection with the work of each season, of each topic and of each lesson, have a *definite, attainable aim*. This aim should appeal to the child in order to arouse his full interest and serve as an incentive to his best efforts. Emphasize the *human element* as much as possible and make frequent application of principles deduced.

10. The *economic* phases of the various topics should be developed, these being of greatest interest and value to the child. Topics should be selected very largely because of their economic importance.

11. The observational study of *animals* and *plants* should be given first place these having been of fundamental importance to the race. Following this should come the study of the weather, the home geography and the minerals and rocks. Still later the simple principles of physics, chemistry and physiology, with suitable experimentation.

12. All the Nature topics should be as thoroughly *knit together* as possible ("unified," "integrated," "correlated,") the strictly *logical* order being sacrificed for the *pedagogical* order. In this way one topic will supplement and strengthen the others. It may not be feasible to take up the related topics simultaneously but they may be taught in proper sequence and by means of drill and reviews the earlier acquired knowledge may be fully utilized in apperceiving the new.

13. As soon as the children have made the necessary progress simple *note-books* should be kept and the Nature work correlated with the expression work of the school. The time devoted to the Nature lessons should be employed as fully as possible in first hand observations with the children face-to-face with the material. The formal accounts of the work should be made an exercise in oral or written language and should be given the time set apart for this expression subject. The mastery of the spelling of the needed terms, along with those required in the other thought subjects, should be secured during the time devoted to spelling. The formal copying of the corrected notes should constitute an exercise in penmanship. When drawings are required they should be made during the drawing period and the teacher should be on hand to teach the necessary principles. In this way there may be secured a very creditable note-book, and at the same time valuable drill in expression without taking any extra time of pupil or teacher. The following advantages of keeping such a note-book will occur at once to the thoughtful teacher.

- a. There is thus secured a permanent record for reference.
- b. Leads to more accurate and complete observations.
- c. Results of work are more firmly held in the memory.
- d. Gives opportunity for the ideal development of the expression work.
- e. Enables the teacher to judge of the quality and quantity of each pupil's work.
- f. Secures an orderly arrangement of the divisions of each topic.

14. The following general plan for the study of a living type may be found to be suggestive. a. Preparation; in which is ascertained the state of the pupil's knowledge, the recalling of former concepts now needed, statement of aims and arousing of interest. b. Simple environment. c. General parts and their characteristics. d. Points of adaptation. e. Habits, in case of animals. f. Life history, or seasonal history. g. Simple classification. h. Relation to man. i. Related forms. The mere anatomy of animals and plants should be introduced only that the habits and points of adaptation to the environment may be appreciated. The most interesting and valuable work centers about what the organism does to maintain itself and how it came to be what it is.

C. Course of Study. Two enthusiastic workers and writers along the line of Nature Study—Prof. Bailey and Dr. E. F. Bigelow—have recently opposed the idea of having any schedule whatever, simply depending upon what the children can be encouraged to bring in for the day. They limit the results to be secured mainly to the development of a close bond of sympathy and love for Nature and fear that this can not be secured if a definite outline is formulated. In blindly following a rigid schedule there is danger of losing this higher aim and more especially if the child is given in advance a syllabus of the ground to be covered in the year, or through the eight grades. Either Prof. Bailey or Dr. Bigelow could take the twig, shell, pebble or insect from the tiny fingers and have the children so enthusiastic that they could not be kept in their seats, but with the majority of teachers the lesson would develop into an impromptu *lecture*, and a very poor one, from a single specimen. The same

amount of time and energy may be made to yield much more definite results and, at the same time, greatly strengthen the child's love and sympathy for Nature.

The advantages of having a course of study based upon the interests and needs of the child, elastic enough to permit adjustment to various localities and variable grades of pupils, will be apparent to the practical teacher. There is thus permitted an orderly development of the various topics along pedagogical lines, the teacher has an opportunity to make all needed preparation, each teacher may know what has been done in the preceding grades and what is intended for the grades following her own. Too much repetition is thus avoided, which would prove fatal to interest, and the keen edge is not taken off of topics to be treated later. The teacher may make use of expert knowledge in the difficult task of planning her schedule of work and may soon be master of the topics selected. The course of study is to be in the mind, or in the *desk* of the teacher and not presented to the pupils. If the topics are of fundamental interest to the children and closely related to the season, the out-door observations and collecting will be just as spontaneous and as enthusiastically done as though no schedule had been attempted. The small amount of system introduced into the work will intensify the interest and lead to more thorough exploitation of the region.

The almost overwhelming task of framing a course of study for the elementary grades is greatly lightened by the application of the principles of the Culture Epochs. This doctrine explains the nature of the child, the topics necessary for his development, the ideal results to be secured, and the proper method of presentation and the interrelation of subjects. Could anything be more beautiful? From the world's greatest educators cull out those principles and practices that modern pedagogy accepts as sound to-day and they will be found in entire harmony with this doctrine. Upon the other hand pick out those "fads" that have flashed into prominence and have been discarded, such as the Grube method, Speer method, spiral method, first grade Shakespeare, etc., and note how forcibly they violate the fundamental principles of the recapitulation doctrine. Any method that does this should be viewed with the greatest distrust. Although accepting more or less fully the value of the principles involved the modern Herbartians, following the lead of Ziller, endeavor to develop the thought and expression work from history and literature. This is not the *historical* order, is consequently unnatural and the result can never be fully satisfactory. In the course of study submitted in the following chapter an attempt has been made to plan a course of Nature work, so-called, from which it is possible to develop the science, geography, literature and history of the primary school and upon which *may* be based the various forms of expression.

In order that the course may be as flexible as possible, so that it may be readily adapted to different localities and the variable capacities of pupils, there has been selected a *central thought* for each season, which serves as a correlating thread for binding together the various topics. In case the material mentioned is not available in the locality, a substitute equally good, possibly better, may readily be found for developing this thought. The teacher knows what to look for. These central thoughts have been derived from those problems that were uppermost in the minds of primitive man and hence must appeal strongly and naturally to children in the corresponding stage of development. These vital problems were the securing of shelter and protection by means of the *home*, the making of *clothing*, the obtaining of *food*, the production and use of *fire* and means of *transportation*. To the Herbartian these central thoughts will not be acceptable because the ethical element is apparently lacking. This apparent lack is necessitated by the historical order of development of the ethical traits themselves. We secure the result that all good teachers desire above everything else by indirect means. The lower nature of the child, inherited from the race, can not be plucked out by the roots and discarded, but upon it there may be "grafted" or "budded" thrifty scions that will bear better and more abundant fruit because the stem and roots are naturally grounded. When in her enthusiasm for universal peace Mrs. Mead pleads with the mothers to keep from their children the toy cannon and the tin soldier, she makes the same mistake that the music and art teacher would if they sought to eliminate rhythm and gaudy color from the life of the child. The ideal *preparation* for to-morrow's living is ideal *living* to-day.

The child can be most simply and completely adjusted to this highly complex environment by briefly retracing the path that was trodden by the race. We plead for the "obsolete process" because of its simplicity, its interest to the child and the insight into human progress that it affords. A person set down upon a strange road with no idea of where it comes from,

nor where it leads to, may somewhat appreciate the feelings of a child who gets his first knowledge of milling by being taken to the latest improved, roller-process establishment. In retracing the path that was trodden by the race the child need not be led into the quagmires of error and superstition, with which this path was often lined. Prof. De Garmo asks shall we begin astronomy with astrology, or chemistry with alchemy? Had the astrologers and alchemists really been successful in predicting future events by means of the stars and planets, or in converting the baser metals into gold, we should have an ideal starting point for astronomy and chemistry. Geometry was developed from the necessity for earth measurements along the Nile, we are told, and there is no better method of beginning the subject with immature minds. Had it been developed in unsuccessful attempts to signal to the inhabitants of Mars, no sensible teacher would feel called upon to start the subject until where it had reached the solid road of progress towards the Truth.

Since the work of each year presupposes that the work of the previous year has been done, in starting the course it will be found desirable to start the first year's work in each of the three primary grades, doing a little more and a little better work with the older children. In the fourth, fifth and sixth grades the work of the first two years could easily be done in starting. Where two grades are combined it will not be found feasible to carry more than one line of work at the same time. In the case of rural schools a series of topics may be selected and studied by the school as a whole, adjusting the work as far as possible to the individual capacities of the pupils. Here should be especially emphasized the economic phases of plants, animals, soil and weather. If the school board will not provide the small amount of apparatus, reagents and materials required have a lecture given, or get up an entertainment. No more time is required for the Nature work than for any of the regular subjects of the elementary school, but it should have as much. A good deal, however, can be accomplished with three periods a week if they are devoted strictly to the Nature work and the necessary expression work done during the appropriate periods. The weather study may very satisfactorily be made a part of the daily opening exercises, the necessary observations having been made before school. The following list of books should be accessible to the teacher.

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4. THE NATURE STUDY IDEA—Bailey. Doubleday, Page & Co., 1903.
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6. COURSE OF STUDY IN THE EIGHT GRADES—McMurry, 2 volumes. The Macmillan Co., 1906.
7. HANDBOOK OF NATURE STUDY—Lange. The Macmillan Co., 1898.
8. SYSTEMATIC SCIENCE TEACHING—Howe. Appleton & Co., 1894.
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14. NATURE STUDY FOR GRAMMAR GRADES—Jackman. The Macmillan Co., 1899.
15. THE SCHOOL AND SOCIETY—Dewey. University of Chicago Press, 1899.
16. THE SEVEN LITTLE SISTERS—Andrews. Lee & Shepard, 1888.

CHAPTER VI.—PRIMARY COURSE OF STUDY.

"I should not try directly to teach young people to love Nature so much as I should aim to bring Nature and them together, and let an understanding and intimacy spring up between them."—*Burroughs*.

First Grade. Hunting Phase. Age of Combat.

CENTRAL FALL THOUGHT:—Shelter and Protection Afforded by Homes of Animals, Plants and Man.

Study of live kitten in school-room as to structure, habits and adaptation.

Varieties of cats by specimens or pictures. Pussy's cousins by pictures and stories; wildcat, lynx, puma, leopard, tiger and lion.

Domestication of cat, use in home and danger to birds.

Bring out strongly the cleanliness, love for home, friendliness, courage and affection for young.

Story of old "sabre-tooth" and primitive man.

Begin written language with picture-writing.

Have frequent field lessons in search of animal and plant homes.

Pods as seed homes; peas, beans, milkweed, catalpa, wild-cucumber, etc.

Caterpillars of all kinds; chrysalis and cocoon formation.

Gall homes upon oaks, willows, cottonwood, rose bushes, goldenrod, blackberry, etc.

Homes of mud and paper wasps.

Land snails, water snails, mussels and caddis-fly portable homes.

Squash, pumpkin and gourd seed houses.

Deserted bird homes and bird departure.

Properties of bark and uses to trees of region.

Procure a good roll of birch-bark by sending away, if necessary.

What trees first shed their leaves and which hold longest to them?

Autumn leaves; press and mount.

Special Thanksgiving theme; gratitude for shelter and protection of home.

Simple studies on evergreens available as to cones, bark, resins and leaves, carried through December and leading up to the Christmas Tree.

CENTRAL WINTER THOUGHT:—Simple Homes of Early Hunting Man.

Without waiting for the completion of the fall work begin the consideration of human homes from vegetable materials.

Have children collect the needed materials and construct grass, leaf and bark houses of their own designing.

Look sharply for points of excellence in the stability, ease of construction, shedding of rain and snow, resistance to wind and protection against animals.

Discuss best types originated.

Using twigs stuck in a box of earth show children how houses may be made by weaving grass, leaves or flexible bark.

Have children design a tiny house from a single piece of birch bark.

Use resin from trees as cement and for mending cracks and holes.

What winter birds are to be found and how do they live?

Using an old dish-pan lined with clay, mould a rough basin-like affair of portland cement to represent a cave-home, and break out one side for an entrance.

Life and house-keeping in these primitive homes; sleeping, eating, sitting, washing, cooking, heating, lighting, protection against animals.

Fit up the cave for occupancy by weaving mats of straw or fiber, crude birch baskets, making tubs or pails of small gourds, miniature logs, and selecting stones for various uses.

Appropriate stories, folk lore, fables and myths.

Sports and games of primitive children.

Simple lessons in hygiene upon care of skin, nails, hair and teeth.

Necessity of keeping body and feet dry and warm.

Cause, danger and treatment of colds. Treatment of burns.

CENTRAL SPRING THOUGHT:—Nature's Awakening.

In-door germination of coarse seeds in window or desk gardens; beans, sweet peas, corn, sun-flower, morning-glory, wild-cucumber, squash, pumpkins, gourds and melons.

How the young plant gets out of the seed-coats, through the ground, and what it does afterward.

Opening of leaf and flower-buds on twigs kept in water.

Out-of-door observations as the season advances.

Follow through the buds upon a single bush, such as a lilac.

Development of frogs and toads from eggs.

Return of birds from South. Bird calendar.

Simple bird homes made from boxes and erected about grounds.

Feed birds suet, nuts, grain and bread and observe.

Observations upon, foods and habits of birds. Location of nests.

Select the robin for special study.

Rearing of silk worms in school-room.

Which trees are first in leaf and which come out last?

Butterflies and moths emerging from winter homes.

If feasible have brood of chickens raised with incubator or hen.

Celebrate Bird-day and Arbor-day, planting white mulberry, osage orange, birch and pine.

Rear a colony of tent caterpillars in wire gauze cage.

Transfer plants started in-doors to suitable beds upon the school-grounds and have children care for same.

With a pole, wires and vines shape a tepee of full size.

SUGGESTIONS TO FIRST GRADE TEACHER.

In presenting the above course of work no preliminary knowledge is assumed, or required, the teacher being expected to place herself upon the same plane as the pupils, learning with them and from them. She should understand the importance of the work, the methods to be followed and what it is to do for the child. The kitten is first introduced to bridge over the chasm between home and school, to "break the ice" for the children and furnish a basis for oral expression. It might well be made the very *first* exercise upon the opening of school. Talking about it and their pets at home will lead them to forget the strangeness of their surroundings. From the real object pass to the picture and finally to the written word. Experiment with the picture method of expression as an introduction to our highly artificial method. The cat is to serve as a type of the group of animals that was the most serious menace to the home circle. Use colored chalk and crayon and coarse sheets of paper for the drawings.

The topics need not be taken up in any particular order, except as made necessary by the season, and animal and plant work may be carried along simultaneously. The central thought is the correlating thread and will suggest to the teacher numerous other topics. Get together an extensive collection of stories, anecdotes, poems, fables, myths and pictures and classify in envelopes. Cheap pictures may be secured from the Perry Picture Co., Malden, Mass. and

The first part of the book is a general introduction to the subject of the book, which is the study of the human mind. It discusses the various schools of thought in psychology, from the behaviorists to the humanists, and the various methods used to study the mind. It also discusses the importance of the study of the mind in understanding human behavior and the role of psychology in society.

CENTRAL PART: THE HUMAN MIND

The second part of the book is a detailed study of the human mind. It begins with a chapter on the development of the mind, from the prenatal period to the adult period. It then discusses the various functions of the mind, such as perception, learning, memory, and problem-solving. It also discusses the various theories of the mind, such as the behaviorist theory, the cognitive theory, and the humanistic theory. The chapter on the development of the mind is particularly interesting, as it discusses the various factors that influence the development of the mind, such as genetics, environment, and experience.

CONCLUSION: THE FUTURE OF PSYCHOLOGY

The third part of the book is a conclusion to the study of the human mind. It discusses the various challenges that face the study of the mind, such as the difficulty of studying the mind, the need for more research, and the importance of the study of the mind in understanding human behavior. It also discusses the future of psychology, and the role of psychology in society. The conclusion is particularly interesting, as it discusses the various ways in which psychology can be used to improve human life, such as in the treatment of mental illness, in the development of educational programs, and in the development of social policies.

The book is a very good introduction to the study of the human mind. It is written in a clear and concise style, and it covers a wide range of topics. It is a must-read for anyone who is interested in the study of the human mind.

from A. W. Mumford, Chicago, Ill., 378 Wabash Ave. Write for catalogue and samples. A series of Nature Study charts is sold by John C. Mountjoy, Chicago, Ill., 378 Wabash Ave. The work of the three seasons may be allowed to overlap, especially that of fall and winter. Caterpillars and other insects may be kept in chalk boxes, having a small pane of glass substituted for the cover, or in cages made of wire gauze set down over boxes of moist earth. Have the best aquarium that you can afford, fitted up with water plants and animals, so that the water need not be changed. Fruit jars, battery jars, and candy jars will answer, but better ones can be made at the tinsmiths. Directions for making aquaria are given in Hodge's Nature Study, page 393. They may be purchased from the Bausch and Lomb Optical Co., Rochester, N. Y. Birch bark is so interesting to children and can be utilized in such a variety of ways that a good supply should certainly be secured.

If approved by your authorities, place the Nature work the last exercise in the afternoon, so that frequent field lessons may be given and the trip extended into the play hours. The fields, woods, streams and ponds will be full of interest for teacher and pupil; especially in the fall and spring. Lay in a supply of good rich loam for germination work of the early spring. Keep the cocoons cool during the winter and spring, where the mice and rats can not injure them and do not bring them into the school-room to remain until the weather is warm enough outside for the moths or butterflies. If you have the white mulberry, or osage orange at hand, you may easily rear a brood of silk worms in the school-room. Eggs may be procured from the Nonotuck Silk Co., Florence, Mass. The least they will sell is 25 cents worth, but this will supply a number of schools. Drop them a postal about April 1st telling them to save you a supply and then write for them, enclosing money, just as the very tiny leaves are coming out. The young may be kept alive for a few days upon lettuce, cut into very fine shreds with scissors. Have children feed with leaves, free from moisture, twice a day and transfer daily to clean paper and fresh leaves, being careful to not overlook any of the worms upon the dried leaves. They do not need to be confined in a cage as do our wild caterpillars. From the same company get their booklet on Silk, price 10 cents. At all times *teach* and *practice* the utmost tenderness towards animal and plant life. Release the moths and butterflies that come out of their cocoons in the school-room, when observations are completed. Carry the young toads and frogs to favorable places for them, along with the other aquarium material at the close of the school year. A small collection of *deserted* birds' nests may be made in the fall. Do not endeavor to arouse interest in birds' eggs. The dry portland cement may be easily procured from certain dealers. Add about twice as much sand, or fine gravel, as cement and stir up with water into a thick slush. Some little time after the frogs and toads are heard "singing" in the early spring their eggs may be found in abundance along the margins of streams and pools. The frogs' eggs are laid in gelatinous masses the size of ones fist, attached to weeds or twigs, while the toads' eggs are drawn out into long strands. They will readily hatch in the school-room if kept in fresh water, and the tadpoles may be fed upon decayed leaves or, better still, green algae from the brook. Tadpoles of the frog, one year old, may be found in the ponds and will show their later transformations. Give the toad tadpoles a bank of sand after they have passed into the salamander stage and after they have left the water transfer to a covered dish containing moss and moist sand in which they may be fed upon small insects caught by sweeping the grass with an insect-net. Of the numerous butterflies available the milkweed butterfly should not be overlooked. Look for larvae upon the milkweeds, transfer to the school-room, feed for a few days upon fresh leaves and keep your eyes open.

Children of this grade will enjoy a little simple gardening such as indicated upon the outline. Have the children at first get along with digging-sticks, shells and suitable stones of their own selection. If these prove sufficient there will be no need of introducing modern tools, after the first spading has been done. These children are not ready for more elaborate gardening, which would better be withheld until a little later. Simple meteorological work may be continued throughout the year, either as a part of the Nature work, or for opening exercises. Four points of the compass, taught out-doors, daily movement of the sun, movements and phases of the moon; clouds, halos, rain, snow, dew, frost, fog, etc., observed but without attempt at explanation. Use as many myths as are suitable. Upon a large calendar paste colored circles to represent sunshine, clouds, rain and snow. Make summaries at the close of each month of the various types of days and compare the various months. The colored

circles may be procured from dealers in kindergarten supplies. Those of any size and color, with mucilage upon the back, may be obtained from the Scharf Tag, Label & Box Co., Ypsilanti, Mich. Upon another calendar show the phases of the moon by pasting on well made cuttings of paper, allowing the children to *discover* that they recur at regular intervals. Consider the possibility of using the moon for measuring time. (The school year might be kept track of in "moons.") Make toy weather-vanes of paste-board and discover their principle by blowing upon them. Have a suitable vane upon or near the school building and note the directions of the wind. Without the use of the thermometer have children state their impressions of temperature changes and connect with the directions of the wind. Let them *discover* that the north wind is cooler and the south wind warmer, inferring the climate in these two directions, and finding out which way the birds would better move when they are ready to migrate. Myths of the various winds. Connect with the increasing cold in the fall the necessity for plant, animal and human protection. In the field trips train the sense of direction by keeping track of the cardinal points. After these have been mastered the four intermediate points may be taught. Miss Katharine Dopp's "The Tree Dwellers" (Rand, McNally & Co., Chicago) will make most interesting and valuable reading and is full of helpful suggestions. These children will enjoy having read to them, after the winter work is well advanced, "The Story of Ab," by Waterloo (Doubleday, Page & Co., Chicago). The following books and special articles will assist the teacher in planning and presenting the work of the grade. The most serious problem is that of adapting the topics to the locality and the particular body of children.

HELPFUL LITERATURE.

1. Lange's Handbook of Nature Study—Outline on cat, page 97.
2. Longman's Object Lessons—Outline on cats, pages 54 and 94.
3. The Cat—Huidekoper. Appleton & Co., 1895.
4. Book of Cats and Dogs—Johonnot. Amer. Book Co., 1884.
5. Neighbors with Claws and Hoofs—Johonnot. Amer. Book Co., 1885.
6. Stories retold from the St. Nicholas Magazine—Carter. Century Co., 1904. (The Cat Stories, Panther Stories, Lion and Tiger Stories).
7. Insect Life—Comstock. Appleton & Co., 1897.
8. Ways of the Six-footed—Comstock. Ginn & Co., 1903.
9. Among the Moths and Butterflies—Ballard. Putnam's Sons, 1897.
10. Moths and Butterflies—Dickerson. Ginn & Co., 1901.
11. Nature Biographies—Weed. Doubleday, Page & Co., 1903.
12. Outdoor Studies—Needham. Amer. Book Co., 1898.
13. Elementary Lessons in Zoology—Needham. Amer. Book Co., 1895.
14. The House I Live In—Brown. Amer. Book Co., 1887.
15. Bird Life—Chapman. Appleton & Co., 1903.
16. The Birds about Us—Abbott. Lippincott, 1895.
17. Birds of Village and Field—Merriman. Houghton, Mifflin & Co., 1898.
18. Bird Ways—Miller. Houghton, Mifflin & Co., 1885.
19. Little Brothers of the Air—Miller. Houghton, Mifflin & Co., 1894.
20. Citizen Bird—Wright. The Macmillan Co., 1898.
21. How to Attract the Birds—Blanchan. Doubleday, Page & Co., 1902.
22. Our Birds and their Nestlings—Walker. Amer. Book Co., 1904.
23. Nature Myths—Cooke. A. Flanagan, 1895.
24. Seed-Babies—Morley. Ginn & Co., 1901.
25. Flowers and their Friends—Morley. Ginn & Co., 1901.
26. From Seed to Leaf—Newell. Ginn & Co., 1894.
27. The Frog Book—Dickerson. Doubleday, Page & Co., 1906.
28. The Common Toad—Hodge. Nature Study Leaflet No. 1, Clark Univ.
29. The Life History of the Toad—Gage. Cornell Teacher's Leaflet, No. 9.
30. Life in an Aquarium—Rogers. Cornell Teacher's Leaflet, No. 11.
31. Evergreens, and How they Shed their Leaves—Gould. Cornell Leaflet, No. 13.
32. Some Tent-Makers—Comstock. Cornell Leaflet, No. 5.
33. How a Squash Plant gets out of the Seed—Bailey. Cornell Leaflet, No. 1.
34. Beans and Peas before and after Sprouting—Beal. Michigan Agricultural College.

Second Grade. Hunting and Fishing Stage. Age of the Chase.

CENTRAL FALL THOUGHT;—Maintenance of Life in Field and Forest.

- A live pet dog as to simple structure, habits and adaptation.
- Differences between dog and cat as to structure, habits and disposition.
- Varieties of dogs by pictures; differences and uses of each.
- The dog's wild cousins by pictures and stories; wolf, jackal, hyena and fox.
- Domestication of dog, use in hunting and guarding home.
- Weapons of primitive man; axes, spears, darts, bow, arrows and quivers.
- Selection and use of suitable materials.
- Collection and studies of different varieties of quartz.
- Primitive methods of boring and drilling holes.
- Study of edible and poisonous wild foods of neighborhood.
- Basket weaving for holding edible foods. Vegetable dyes and stains.
- Designing of traps for game and fish
- Study of live fish in aquarium; parts, covering, form, habits, locomotion, feeding and breathing. Goldfish, sunfish, etc.
- Have children design various types of fishing nets.
- If a large but shallow galvanized tank can be provided, have children experiment with miniature logs for boats and rafts.
- Make a "dug-out" by burning, birch bark canoes and paddles.
- Illustrate the action of the rudder upon small boats.
- Have children act out hunting scenes in pantomime, singly and in groups.
- Search fields and gravel pits for yellow and red ochre for paint.
- Help children originate a secret, gesture language.
- Primitive methods of fire making illustrated.
- Primitive cooking; roasting, broiling, boiling with hot stones and baking.
- Drawing and clay modelling of men, animals, fish and boats.

CENTRAL WINTER THOUGHT;—Winter Homes of Later Hunting Men.

- Tan a little raw sheep-skin by thorough pounding and drying.
- From scraps of thin sheep leather have children construct tepees, sewing with awl (bone, stone or thorn) and thong.
- Necessity of nomadic life and possible methods of transportation.
- From scraps of chamois-skin make articles of clothing, of children's own designing, using delicate awl and sinew for thread.
- Similarly let each design and make a pair of moccasins.
- Study of snow and snowflakes.
- Children of the snow—the Eskimo—their homes and home life.
- Mould bricks of snow and construct on the school grounds an Eskimo house.
- Eskimo hunting, boating, cooking, clothing, weapons and use of dogs.
- Let children make, draw and model as many articles as possible.
- Consider games and sports of Eskimo children.
- Their long summer day and winter night.
- Lessons in hygiene an extension of that outlined for first grade.
- Treatment of wounds to prevent lockjaw, blood poisoning and hydrophobia
- Harm resulting from eating uncooked and unripe foods.
- Benefits of perfect ventilation.

CENTRAL SPRING THOUGHT;—Importance of the Sun in Nature.

- In early spring set up and observe a "shadow-stick," from which discover that the sun is rising higher each day in the heavens.
- Upon base of shadow-stick mark off a simple sun-dial.

CENTRAL FALL THOUGHT:—Maintenance of life in Fall and Fall

A first step is to supply to the child, before and after, the
differentiation between the fall and the winter, before and after
the fall of the leaves, before and after the fall of the leaves.

The first with the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Secondly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Thirdly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Fourthly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Fifthly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

CENTRAL WINTER THOUGHT:—What is the Winter?

First, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Secondly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Thirdly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Fourthly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Fifthly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Sixthly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Seventhly, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

CENTRAL SPRING THOUGHT:—Importance of the Sun in Spring

First, the child is to supply to the child, before and after,
the fall of the leaves, before and after the fall of the leaves.

Illustrate method of keeping time by burning candles and by hour-glass.
 Discover that a pendulum beats time and suggest its use in regulation of clock machinery.
 Teach children to tell time by means of clock.
 Get as many children's records of the time of rising and setting of sun necessary to discover that the day is growing longer.
 Soak a variety of seeds and place in moist saw-dust, keeping one batch cold, the other warm.
 Conclusions?
 Discover effects of increasing warmth upon vegetation; the swelling of buds, the starting of grass and early weeds.
 Teach children how to read a thermometer.
 Locate young dandelions in some loose soil, carefully remove, wash roots and place in suitable bottles of water for study and drawing.
 Compare the growth of these with those outside the school-room.
 Prepare series of colored drawings to show the gradual development of dandelions growing under natural conditions.
 Follow through the changes to be seen in single blossoms.
 Have pupils bring in the earliest wild flower (not the plant) that they discover, keep a record by painting the flower on a large calendar.
 Continue similarly the bird calendar of the first grade.
 Have a bird-day celebration.
 Place growing plants near window, some farther back and some in a dark box with single opening to show search for light by leaves.
 Consider the reason for the arrangement of dandelion leaves, and then of plants in general.
 Show how men's and children's activities are affected by the changing season.
 Give the children a second chance to rear a brood of silk-worms.
 Follow through the development of the "wrigglers" into mosquitoes in a covered glass dish.
 Harm done to man by mosquito and prevention.
 Make "blue prints" of leaves, grasses and flowers.
 Stories of the "sun worshippers."

SUGGESTIONS TO SECOND GRADE TEACHER.

No formal gardening is recommended for this grade since the children are not yet able to take full charge of the work and interest in plants is a matter of rather slow growth. The same kind of work recommended for the first grade may still be done, the children caring for beds artistically located about the grounds. The spring work of the first two grades is calculated to awaken a general interest in the plants of the neighborhood that are growing without cultivation, this agreeing with the *historical* order. The child is to be led to appreciate the importance to the plant of the heat and light of the sun, and a considerable variety of plants may be used for the purpose.

The weather studies of the first grade may be extended throughout the second grade. In addition to the weather calendar with colored circles, the direction of the wind may be stamped across the circle with an arrow made on a rubber stamp. Send a design of the arrow wanted to the Detroit Rubber Stamp Co., for estimate of cost. A common "printing-pad" will also be needed to supply the ink. Note not only the changes in temperature, but also the *kinds of weather* that accompany changes in the direction of the wind; the east and west winds, as well as the north and south. Upon some unused portion of blackboard draw a couple of concentric circumferences with colored crayon and attach a large arrow cut from strong pasteboard, with which to indicate the direction of the wind. Indicate the points of the compass, placing north at the top, and have the arrow point to the direction from which the wind comes, as in the case of the weather-vane. In stamping the arrows upon the weather calendar have them fly with the wind, so as to get ready for the reading of a government weather map later. In the spring a graphic design for showing the changes in the length of day and night and the increasing temperature will be found of educational value. The length of day and night may be obtained from an almanac and a series of parallel columns colored to show the relative lengths graphically. At the side of this chart may be figured the scale of a thermometer and upon each column, representing each day of the month, can be placed a dot to indicate the reading of the thermometer taken at the same hour each day. These dots will be connected with a line to show the temperature

"curve" for the month. Such a chart will show strikingly the gradual increase in temperature, as the days increase in length and the sun has more chance to act. With this increase in sun's action should be closely connected the changes in vegetation and animal life, including man himself.

Here as in the first grade there is much suggested for the child to do and the teacher need not have mastered the topics in advance. Several topics may be carried along simultaneously when the material is available and in danger of disappearing. No sharp line need be drawn between the work of the seasons. Some of the older boys will gladly procure from the fields the cleaned skull of a dog and cat for comparison. Lay in a good supply of dog stories, anecdotes and pictures and use at the proper time. By inquiries ascertain how many and what breeds of dogs are represented in your community. Arouse the human interest by reading such stories as "Beautiful Joe." In most localities chert and quartzite may be abundantly collected from the fields. Flint and other varieties of minerals may be purchased by the pound from the Foote Mineral Co., Philadelphia, and from Ward's Natural Science Establishment, Rochester, N. Y. In the case of the manual training and domestic science work the attention of the teacher is strongly called to the fact that this work is demanded by the Nature work, grows directly from it and that the desire and motive to do the work precedes its assignment. The results are not so important as the *doing* and every child can do as well as primitive man did in his first attempts. With a little practice and reading the teacher can do still better. In the pantomime work the children will need very few suggestions as they take to this naturally and confidently. Some teachers may balk at the question of encouraging the gesture language for the grade. In favor of this it may be said that children love this expression, that its practice will develop ease and grace in bodily movements. If the gesture language is *natural* it can be made to re-enforce oral expression and the general awkwardness of the typical pupil in part overcome. Keeping the language a *secret* from the other grades will greatly enhance its value in the eyes of the children.

If the drilling work is attempted it would be well to begin with shell, slate, or other soft material. In the work with wild edible and poisonous plants the purpose is to distinguish certainly between them and to have the children understand the danger of touching or eating certain ones to be found in every locality. If the teacher is not a botanist she should make the acquaintance of some one who is and have pointed out to her the poisonous forms of the locality, in order that she may safely instruct her pupils. Read Hodge's Nature Study, page 106 to 119, and write to the U. S. Department of Agriculture, Washington, D. C., for free copy of Chestnut's "Thirty Poisonous Plants of the U. S.," Farmer's Bulletin, No. 86. The tank referred to for work with the boats and rafts can be passed from grade to grade and used in a great variety of ways. The method of burning out "dug outs" may be illustrated by using a hot wire and suggesting how hot stones might be used. For the birch bark canoe, have the children first make their pattern of paper before attempting to cut the bark. Use some natural gum for cementing the ends together and repairing breaks. Sparks may easily be procured by striking two pieces of chert or flint together, but it is not easy to get a fire from them. A piece of dry pine rubbed vigorously in a groove in dry wood may be made to char. Children *may* produce fire by means of a fire-drill. The teacher may study the following papers for suggestions.

Fire Making Apparatus in the U. S. Nat. Museum—Hough.

Smithsonian Rep. for 1888, pages 531 to 587.

Methods of Fire Making—Hough.

Smithsonian Rep. U. S. Nat. Museum for 1890, pages 395 to 409.

Origins of Inventions—Mason, pages 84 to 120.

From the last of these many other helpful suggestions may be obtained, as well as from Miss Dopp's "Early Cave Men," Rand, McNally and Co., Chicago. The moulds for making the snow bricks consist of simple frames of suitable size (say 18 x 12 x 8 inches,) with a hinge at one corner and a hook at the opposite one, so that the frame may be readily opened for removing the brick of snow. This work is to be done outside of school hours when the snow is in good condition. Let the house be large enough for a child to crawl into.

The shadow-stick is simply a pointed, wooden peg, 8 to 10 inches high, set perpendicularly upon a smooth wooden base. It is to be placed where the sun can reach it during school hours and may carry a string and be used as a sun-dial, by marking the shadow at the

even and half hours. The base should be level and from the peg should be drawn the north-south line. To get the position of the sun in the heavens the length of the shadow of the peg is to be noted at *noon*, as it falls upon this line. It is not desirable to take up with children of this age the question of mean solar time, or of standard time. The principle of the pendulum may be discovered by having the children count the number of oscillations in a minute. Repeat a number of times upon different days. If children can be shown now that one beat allows a wheel to turn one notch they have all that they need for comprehending modern methods of time keeping. This work is not called for in this stage of culture, but is rendered desirable because of the environment in which the child is placed. The same is true of the thermometer. For the work upon the dandelion see Scott's Nature Study, page 15 to 37. The blue prints are simple, cheap and furnish fascinating work for children. The blue print paper may be secured from book dealers ordinarily, or dealers in photographic supplies. The objects to be printed are pressed to render them flat, laid upon the special paper with a piece of common glass over them and placed in the sun for a few minutes. A piece of firm card board for the back is desirable and the glass and cardboard may be held firmly together with spring clothes-pins. After exposure to the sun the prints are simply washed in water and dried. Some experimenting will be necessary in order to find how much exposure is required. (See Howe's Systematic Science Teaching, page 122). The following books and special articles will contain much of value for the second grade teacher who desires to carry out the above line of work. For work upon birds and silkworms consult the first grade list. For references upon primitive life see list upon page 23.

HELPFUL LITERATURE.

1. Lange's Handbook of Nature Study—Outline on Dog, page 94.
2. Longman's Object Lessons—Outline on Dog, page 56.
3. Book of Cats and Dogs—Johonnot. American Book Co., 1884.
4. Neighbors with Claws and Hoofs—Johonnot. American Book Co., 1885.
5. Stories of Brave Dogs—Carter. The Century Co., 1904.
6. Some Useful Animals—Monteith. American Book Co., 1903.
7. Habits of Animals—Ingersoll. Interstate Pub. Co., 1882.
8. Call of the Wild—London. Grosset & Dunlap, 1903.
9. Stories from Animal Land—Chase. Educational Pub. Co., 1891.
10. Four-Footed Americans—Wright. The Macmillan Co., 1898.
11. Wild Animals I have Known—Thompson. Scribner's Sons, 1898.
12. Elementary Lessons in Zoology—Needham. American Book Co., 1895.
13. Lange's Handbook of Nature Study—Outline on Fish, page 295.
14. Indian Boyhood—Eastman. McClure, Phillips & Co., 1902.
15. Gesture Language—Mallery. 1st. Rep. Bureau of Ethnology, 1879-80, page 281.
16. Stories of Rocks and Minerals—Fairbanks. Educational Pub. Co., 1903.
17. Studies Among the Snow Crystals—Bentley. U. S. Weather Bureau, 1902.
18. The Children of the Cold—Schwatka. Educational Pub. Co., 1899.
19. The Snow Baby—Peary. F. A. Stokes Co., 1901.
20. Each and All—Andrews. Story of Agoonack. Ginn & Co., 1894.
21. The Book of Nature Myths—Holbrook. Houghton, Mifflin & Co., 1902.
22. How to Make Baskets—White. Doubleday, Page & Co., 1903.
23. Practical and Artistic Basketry—Tinsley. Kellogg & Co., 1904.
24. Graded Lessons in Hygiene—Krohn. Appleton & Co., 1903.
25. First Studies in Plant Life—Atkinson. Ginn & Co., 1902.
26. Bird Day and How to Prepare for it—Babcock. Silver, Burdett & Co., 1901.
27. The Mosquito—Howard. See also Hodge's Nature Study, page 64. Nature Study Review, Feb. 1907.
28. Language through Nature, Literature and Art—Perdue and Griswold. Rand, McNally & Co., 1902.
29. All the Year Round—Strong. Ginn & Co., 1898 to 1905. Spring, Summer, Autumn and Winter.
30. The Hiawatha Primer—Holbrook. Houghton, Mifflin & Co., 1898.
31. Robinson Crusoe or Swiss Family Robinson.

Third Grade. Pastoral Phase. Age of Flocks and Herds.

CENTRAL FALL THOUGHT;—Protective Covering of Plants and Animals.

Horse chestnut or buckeye tree; form, size, parts, branching,
bark, twigs, leaves, fruit and buds.

Show children how to read the story of a twig by means
of leaf, flower and bud scars.

Practice with twigs from other trees.

Make a special study of the protective devices of the nut,
the baby tree inside the nut and the embryonic flowers and leaves in the buds.

Comparison of horse chestnut and pine to discover differences.
 Live sheep if a flock can be visited; otherwise a cleaned skull,
 feet from butchers, tanned skin with wool, raw wool, carded wool
 and good pictures.
 Mountain home of wild sheep and protection against rain, snow and cold.
 Food, teeth, legs, feet, means of defense and escape.
 Domestication of sheep and use to man in providing
 wool, leather, meat and tallow.
 Traits of shepherd dog and his assistance in caring for flocks.
 The goat and the chamois by means of pictures.
 The cow as to simple structure, food and habits and comparison with sheep.
 Uses of cow to man; leather, meat, tallow, milk, butter,
 cheese, hair, horns, hoofs.
 Comparison of cow and horse and its use in caring for cattle.
 Life on the great sheep and cattle ranches of the west.
 Nomadic life required.
 Why man changed from a hunter to a shepherd and cow boy.
 By means of pictures and stories the deer, antelope, bison, camel, giraffe and reindeer.
 Reeling of silk from cocoons of silk moth.
 Study of raw cotton bolls and relation of fibers to seeds.
 Flax and its fiber.
 Compare fibers of wool, silk, cotton and flax.
 Feathers and their value as a protective covering.

CENTRAL WINTER THOUGHT;—Man's Preparation for Winter by Clothing and Footwear.

Simple experiments to show that heat and cold are not felt through
 pads of wool, silk, cotton and linen. Same for leather.
 Suitability for clothing and advantages over skins and furs.
 Cleaning and carding of wool. Hand spinning to illustrate process.
 The use of the distaff and spindle in spinning.
 If possible show a spinning-wheel in operation.
 Illustrate the spinning of cotton and flax fiber.
 Upon simple hand looms have children weave yarn, silk, cotton or linen thread.
 Have children take to pieces various types of thread and cloth.
 Simple accounts of their manufacture.
 The dyeing of fabrics by horse-chestnut bark and "Diamond dyes."
 If it is desired to teach sewing, simple articles of clothing may be made.
 The use of shoe and boot compared with the moccasin.
 If feasible visit the shoemaker. His materials and tools.
 Exhibit a pair of wooden shoes and consider advantages and disadvantages.
 Have a miniature pair carved from horse chestnut wood.
 Further study of the skin as Nature's protective covering.
 Danger from wet clothing and wet feet.
 The skin as a respiratory and excretory organ.
 Necessity for keeping pores open.
 Necessity for and proper times for bathing.
 Danger of bathing when body is too warm. "Cramps."
 Test various fabrics as to their ability to absorb moisture.
 Test inflammability of wool, silk, cotton and linen. Give needed warning.
 Primitive and modern umbrellas.
 Source and properties of India rubber and its use to protect body and feet.
 Let children design a tent in paper and then make from muslin, linen or silk.
 The advantages and disadvantages of the tent when compared with tepee.
 Occasional winter observations upon horse chestnut tree.
 Work of frost upon bottles of water, pipes, rocks and lumps of soil.

CENTRAL WINTER THOUGHT—MAY'S Preparation for Winter by Clifford and

[illegible]

CENTRAL SPRING THOUGHT;—Nature the Source of all Supply.

Call attention to the fact that all the animals studied in the fall derive their sustenance from vegetation.

Man's dependance upon the soil for all materials supplied by animals.

What plant products so far studied have come directly from the soil?

Work out experimentally that moisture, warmth and air are necessary for germination.

Find also whether the dark and soil are also necessary.

Count the number of seeds in a small cup or can before and after soaking.

Simple studies upon the origin of soils from rock fragments.

Collect and study the four important types; sand, clay, loam and muck.

Absorption and retention of moisture by these varieties of soil.

Have a simple rain-gauge made and measure rainfall.

Make a small "hot bed," compare temperatures inside and outside, explain principle and start seeds for garden.

Importance of rain, sun and soil in growth of plants.

Compare our own with desert regions.

Indoor germination of seeds for garden with more or less detailed study.

Seed testing experiments between moist blotting-paper.

Collect horse-chestnuts that have wintered out-doors and are bursting open, plant in rich soil and care for until Arbor-day.

Have children select various nuts and fruit seeds for germination.

Gardening with each an individual bed and some few in common.

Importance of cultivation and keeping down of weeds.

Simple study of the earthworm as a friend of the gardener.

Animal enemies in the garden, transferred to the school-room, fed, and development carefully observed.

The habits and damage to furs and woollens by the clothes moth.

Importance to the farmer, gardener and fruit grower of birds and bats.

Establish a bird hospital for birds too early out of the nest.

Make each child feel responsible for the protection of helpless birds against cats and boys.

Collect toads for the garden and emphasize their importance.

Flowers of horse chestnut and pine compared.

Arrange to have garden cared for during summer vacation.

SUGGESTIONS TO THIRD GRADE TEACHER.

The chief purpose of the Nature work of this grade is to get the child sympathetically interested in animals and plants, to show him their need for protective coverings against the winter's cold and to acquaint him with the raw materials from which he may select those required for his own protection. During the first two years the child's interest has centered about the primitive type of home and the simple maintenance of life in field and forest. Animals have been viewed only as enemies to be disposed of, or as the source of those materials required for his immediate existence. If this life has been lived to the full the interest of the child may now be diverted towards domesticated animals and they become the object of his solicitude and care. If this phase of the Nature work is omitted, and a substitute not provided in the home, the savage nature is longer retained and loses but little in its intensity. If the work is successfully presented the child loses his pleasure in the wanton taking of life and more humane feelings towards animals and mankind are started. We need not be surprised if these seeds are slow in developing and the fruit long delayed. The making over of an individual is no simple task.

The horse chestnut is selected as a type because of its availability throughout the northern states, because of its beauty and the interest which attaches to all its parts. Some other tree may be substituted until a small group of these can be started about the school grounds, either from the nuts or by transplanting. A cleaned sheep skull and fragments of jaws of a cow and horse may usually be obtained from the fields. The teacher should acquaint herself with the habits of domesticated sheep and the play of the lambs and interpret in the light of their wild ancestry. Have children fully appreciate the special characteristics of the shepherd dog and

his wonderful intelligence. If there is a pet goat in the neighborhood try to have him visit the grade. Bring out strongly the great importance of the cow to man and the use of the horse in caring for them upon the great plains of the west. The importance of the reindeer to the people of northern Europe and Asia and of the camel to the "children of the desert." Cocoons for the reeling of silk may be purchased from the Nonotuck Silk Co., Florence, Mass. Small hand reels are easily made from wooden circles, connected with stiff wires and having an axis on some suitable support. Instead of a crank twirl the axis in the fingers. They may be made at the tinsmith's at small expense. Remove the floss from the dry cocoons, soak for two or three minutes in boiling water to soften the cement and begin pulling off the silk until you come to a single thread which is then looped over the reel. If the cocoons are not soaked long enough the thread will break; if too long the cocoons become flabby and the silk comes off in layers. Very attractive exhibits of *spun* silk may be obtained gratuitously from Cheney Brothers, South Manchester, Mass. Cotton seeds and bolls may be obtained from Mrs. A. G. Helmer, of Helmer, Georgia. If flax is not grown in the neighborhood a small bed of it may be raised in the school garden, along with the cotton. The main purpose of introducing the various processes connected with the manufacture of clothing is for illustration, rather than the acquiring of skill in the doing. Have the children do their best, however, and get creditable results as far as possible.

The methods of twisting fibrous materials into thread by means of the fingers can be very simply shown and the advantages and simple methods of carding be understood. The Elementary School Record (University of Chicago Press) No. 3, on Textiles, gives a simple and helpful discussion of the spinning by means of the distaff and spindle of the children's own manufacture. The school should possess an old spinning-wheel and some individual may still be found in most communities who knows how to run it. Small hand looms may be made from old slate frames, by driving a row of small nails across either end to hold the warp. Let children make a simple design for a doll's blanket, mat or shawl and then execute it in yarn. A more elaborate type of loom, of which it would be well to have a working model in the school-room, is figured and described in Black and Carter's Natural History Lessons. This will prepare the way for an understanding of how the weaving is extensively carried on to-day by means of complicated machinery. In connection with the idea of clothing the child is led to see that it is in itself not *warming*, but simply prevents the heat of the body from escaping. The idea if not the name "poor conductor" is to be learned. A block of ice is wrapped up in a blanket in the summer time to preserve it. Crude india rubber may be obtained from the larger manufacturers of rubber goods. In the early fall the behavior of a drop of milk from the milkweed stem, when placed between the thumb and finger may be observed. As it dries it assumes much the appearance of genuine rubber. Experiment with a larger quantity.

A little previous knowledge of the properties, history and location in the neighborhood of the typical soils will be found necessary for the successful presentation of the early spring work. Consult some of the references given below. This work must be decidedly practical in order to hold the interest of the children. A funnel and a bottle will serve as a rain-gauge, the water for measurement being poured into a cylindrical vessel the area of whose cross-section is equal to a certain simple part of the area of the larger opening of the funnel, say one-tenth. A crude but satisfactory gauge may be made at the tinners. It should be exposed so as not to be sheltered by trees or buildings and should at the same time be quite accessible to the children. In the seed testing a certain number of seeds, from one to one hundred, may be counted out for the children, depending upon their size and the quantity on hand. The seeds are given favorable conditions for germination and the results carefully noted and tabulated. In the late spring the larvae of the clothes moth may be collected in the homes, brought to school in bottles and fed upon small bits of woolen goods. A knowledge of their destructiveness to clothing and sly habits should be taught and methods of preventing their development in the home understood. (See Hodge's Nature Study, page 71). If the teacher desires some interesting observations may be made upon the spider as a type of *spinning* insect. Their work may be observed both out doors and in the school-room in cages or jars. Try the experiment described upon page 420 of Hodge's book to show the intelligence of the spider. Series of pictures should be secured from various sources to illustrate the principal topics. The stereoscope may be used to very excellent advantage if sets of views can be procured, such as those illustrating cattle and sheep raising, the rearing of silkworms, the growth of

cotton, the production of cloth, etc. Write to the Keystone View Co., Meadville, Penn., for catalogue and prices. Sets of views may be gradually gotten together illustrating the work of each grade and the instruments passed from grade to grade as they are needed. Upon pieces of heavy cardboard arrange collections to show in various stages of manufacture wool, silk, cotton and linen, obtaining the materials from the various manufacturers. Wool and woolen cloth in various stages of manufacture may be secured from the Clinton Woolen Mills, Clinton, Mich. Similar collections to show the stages in the manufacture of thread and needles will prove of value and interest. These may be obtained from J. and P. Coats, the Spool Cotton Co., N. Y. City.

The spring work is calculated to get the child interested in the agricultural work strongly recommended for the fourth grade and is preparatory to this. Small beds that are worked in common should be laid out in the school garden and planted with corn, wheat, oats, rye, barley, buckwheat, potatoes, flax and cotton. Individual beds may also be assigned to each pupil, providing there is sufficient ground available and the following plants grown from the seed for the use of the same pupils in the fall work of the fourth grade:—turnips, kohlrabi, cabbage, brussels' sprouts, kale, cauliflower, beets, onions, radishes, parsnips and carrots. If the individual beds must be small these vegetables may be distributed. A bed of peanuts will prove of interest and one of sweet potatoes may well be added. One corner of the garden or of the school grounds might be set apart as a nursery for fruit and nut trees, including the horse-chestnut. The young trees should be labeled, carefully cared for and eventually set out about the school grounds and homes of the children. Children can not be depended upon to properly care for the garden during the summer vacation although they should be encouraged to give it some attention. The school board should be importuned to make this a part of the regular duty of the janitor of the building, even if he is employed only during the school months of the year.

If the children do not appear to have grown tired of the daily weather observations of the first two grades they may be continued and extended. The use of the colored circles has probably served its purpose and may be dropped unless demanded by the interest of the pupils. The curve to show graphically the rise and fall of the temperature, begun in the spring of the preceding grade, may be continued to advantage throughout the third grade. These charts may be made upon heavy manilla paper, with narrow vertical columns for the days of the month and a simple design of the thermometer scale at the left hand margin. The rainfall and snowfall may be measured and placed upon the chart according to some simple scale, ten inches of snow being regarded as equal to one inch of rain. The charts should be dated and preserved and as they accumulate those for the corresponding months of previous years displayed for purposes of comparison. Note the connection between changes in temperature and precipitation. Since pastoral man in caring for his flocks at night had unusual opportunity for studying the stars, a few simple constellations may be taught the children at this stage.

HELPFUL LITERATURE.

1. **Nature Study and Life**—Hodge. Outlines and many helpful suggestions.
2. **Longman's Object Lessons**—Salmon and Woodhull. Outlines.
3. **Handbook of Nature Study**—Lange. Outlines.
4. **Nature Study**—Jackman. Skin, p. 102; earthworm, p. 303; soils, pp. 390 and 436; meteorological and astronomical suggestions throughout.
5. **Domesticated Animals**—Shaler. Scribner's Sons, 1895.
6. **The Horse—Flower**. Appleton & Co., 1901.
7. **Black Beauty**—Sewell. Various publishers.
8. **Four-Footed Americans**—Wright. Macmillan & Co.
9. **Wild Animals I have Known**—Seton-Thompson. Scribner's Sons, 1900.
10. **Lives of the Hunted**—Seton-Thompson. Scribner's Sons, 1901. Krag, the Kootenay Ram.
11. **The Play of Animals**—Groos-Baldwin. Appleton & Co., 1898.
12. **Stories of Silk and Wool**—Brown & Mayne. World's Events Pub. Co., 1905-6.
13. **Silk, its Origin, Culture and Manufacture**. Nonotuck Silk Co., 1902.
14. **Short Description of Silk and Silk Manufacture**—Cheney Bros.
15. **Silkworm Culture**—Kelly. Farmers' Bulletin No. 165.
16. **Hand-Loom Weaving**—Todd. Rand, McNally & Co., 1902.
17. **Natural History Lessons**—Black & Carter. Holt & Co., 1892.
18. **The Cotton Plant**—True. U. S. Department of Agriculture, 1896.
19. **Yearbook of the U. S. Department of Agriculture**, for 1903. Cotton, Silk, Corn.

20. The Story of the Cotton Plant—Wilkinson. Appleton & Co., 1901.
21. The Story of Cotton—Brown. Owen Publishing Co., 1905.
22. Manual of Hygiene—Bissell. Baker & Taylor Co., 1904.
23. Notes on the Frost—Farmer's Bulletin No. 104.
24. The Soil—King. Macmillan & Co., 1895.
25. Town Geology—Kingsley. Appleton & Co., 1890.
26. Stories of Starland—Proctor. Potter & Putnam, 1898.
27. The Stars in Song and Legend—Porter. Ginn & Co., 1901.
28. First Studies in Plant Life—Atkinson. Ginn & Co., 1902.
29. Seed Babies—Morley. Ginn & Co., 1901.
30. Agriculture for Beginners—Burkett, Stevens & Hill. Ginn & Co., 1903.
31. Practical Agriculture—James. Appleton & Co., 1900.
32. First Principles of Agriculture—Goff & Mayne. American Book Co., 1904.
33. Principles of Agriculture—Bailey. Macmillan & Co., 1902.
34. Children's Gardens—Miller. Appleton & Co., 1904.
35. School Gardens and Elementary Agriculture—Superintendent Public Instruction, Lansing, Mich., 1904.
36. How to Make School Gardens—Hemenway. Doubleday, Page & Co., 1903.
37. The Vegetable Garden—Greathouse. Farmer's Bulletin No. 94.
38. A Reader in Botany—Newell. Pt. I., Ginn & Co., 1895.
39. From Seed to Leaf—Newell. Ginn & Co., 1892.
40. Vegetable Mould and Earthworms—Darwin. Appleton & Co., 1882.
41. The Insect World—Weed. Appleton & Co., 1899.
42. Injurious Insects of the Farm and Garden—Treat. Orange, Judd Co., 1882.
43. Insects Injurious to Vegetation—Harris. Orange, Judd Co., 1890.
44. Insects of the Garden—Pettit. Michigan Agricultural College, 1905.
45. Tenants of an Old Farm—McCook. Jacobs.
46. Spiders, their Structure and Habits—Emerton. Cassino & Co., 1883.

CHAPTER VII.—INTERMEDIATE COURSE OF STUDY.

"Spacious and fair is the world; yet oh ! how I thank a kind heaven,
That I a garden possess, small though it be, yet mine own.
One which enticeth me homewards; why should a gardener wander?
Honor and pleasure he finds, when to his garden he looks."—*Goethe*.

Fourth Grade. Agricultural Phase. Age of Cultivated Plants.

CENTRAL FALL THOUGHT;—Storage of Food by Animals, Plants and Man.

Live rabbits in school-room, or on grounds; structure, habits, food, enemies, adaptation.

Failure to store food and consequent disadvantages.

Beets, carrots, turnips, kohlrabi, cabbage, parsnips from children's garden.

Plant storage in root, leaf and stem.

Utilization of this food by rabbit, other animals and man.

Methods and reasons for cooking vegetables.

Pet squirrel in school-room, or on grounds, if procurable.

Comparison with the rabbit as to structure, habits, food, enemies.

Find reasons for differences between rabbit and squirrel.

Homes of squirrels, storage of food and advantages.

Study of oak, hickory and walnut.

Storage of food in nuts and utilization by squirrel and man.

Varieties of squirrels and rabbits by pictures and stories.

Other gnawers as; beavers, ground-hogs, muskrats, prairie-dogs, mice, rats, etc.

Comparison of teeth of cat, dog, sheep, gnawers and man.

Corn, wheat, oats, rye, barley and buckwheat from children's gardens.

Gathering and threshing of grains illustrated by the hands.

Use of knife, sickle, scythe, reaper and binder by pictures.

Storage of the white powder (starch) in grains.

Physical properties of starch and test with dilute iodine solution.

Manufacture starch from potatoes.

Thanksgiving Theme:—Food. Have children collect and distribute to needy.

Before weather is too cold arrange some beds of bulbous plants for spring;

tulips, daffodils, hyacinths, snowdrops, crocus, June lilies, etc.

CENTRAL WINTER THOUGHT;—Use of Stored Vegetable Food in the Home.

Why the growing of vegetables and grains required a settled life.

Opportunities afforded for a better and larger home.

Have the children unite in the construction of a log cabin.

Mould from clay small bricks and allow to dry.

From these bricks construct an adobe house.

Stand some of these dry bricks in water and observe effect.

Thoroughly dry some bricks and heat intensely in a furnace or anthracite stove.

Stand these "burned brick" in water and observe.

The making, drying and burning of household pottery.

In small vials, one for each child, dissolve in water some sugar or salt. Taste.

Using a glass funnel and filter-paper filter a solution of the same and taste.

Evaporate water, condense some of the vapor for tasting and recover substance dissolved.

Try to dissolve starch in cold water, filter and test with iodine.

Boil a little starch in water, filter and test for starch. Conclusions?

CHAPTER VII. INTERMEDIATE COURSE OF STUDY.

"...and this is the way, for the first time, that I have seen a kind of...
That I have seen, and I have seen it in the same way...
one who is not a wanderer, but a wanderer...
Home and I have been in the same way."—(C. G. L.)

Fourth Grade. Agricultural Phase. Age of Cultivated Plants.

CENTRAL FALL THOUGHT: Storage of Food by Animals, Plants and Man.

Live rabbit in school room, or on ground, to show its habits, food, enemies, adaptation
Plants to store food and consequent disadvantages.
Beets, carrots, turnips, radishes, potatoes from children's garden.
Plant storage in root, leaf and stem.
Utilization of the food of rabbit, other animals and man.
Methods and reasons for storing vegetables.
Plants in school room, or on ground, if possible.
Comparison with the rabbit as to structure, habits, food, enemies.
Find reasons for differences between rabbit and human.
Human storage of food and advantages.
Study of oak, hickory and walnut.
Storage of food in nuts and utilization by animal and man.
Varieties in storage and habits by pictures and stories.
Other growers as; beets, ground nuts, mushrooms, turnips, etc.
Comparison of food in rat, dog, sheep, cow and man.
Corn, wheat, oats, barley and buckwheat from children's garden.
Comparing and classifying of stores illustrated by the hands.
Use of knife, table, scales, ruler and ruler by picture.
Storage of the white powder (starch) in grains.
Physical properties of starch and test with dilute iodine solution.
Manufacture starch from potato.
Thinking Time.—Food. Have children collect and distribute to study.
Notice whether is too cold storage some parts of bulbous plants for spring.
Lilies, dahlias, cyclamen, snowdrops, crocuses, June lilies, etc.

CENTRAL WINTER THOUGHT:—Use of Stored Vegetable Food in the Home.

Why the growing of vegetables and grains required a settled life.
Opportunities afforded for a better and larger home.
Have the children write in the construction of a log cabin.
Should this have small windows and allow to dry.
From these bricks construct an adobe house.
Stand some of these dry bricks in water and observe them.
Thoroughly dry some bricks and heat them in a furnace or on a hot plate.
Stand these "burned bricks" in water and observe.
The making, drying and burning of hot-baked pottery.
In small vials, one for each child, illustrate in words some paper or wall. Taste.
Taste a glass of cold and hot water after a solution of the same and taste.
Evaporate water, compare some of the vapor for taste, and recover the same dissolved.
Tie a little starch in cold water, filter and test with iodine.
Boil a little starch in water after and test the starch. Conclusions.

Test a large variety of food substances for starch and prepare lists.

Bring out necessity of cooking starchy foods.

Primitive boiling and baking illustrated with hot stones.

Mirror the life of pioneer days and of frontier life to-day.

Boil for a few minutes in similar vessels and the same amount of water 100 sound kernels of corn and 100 cracked kernels. Filter the water from each and test for starch.

Necessity for cracking, or grinding, starchy grains.

Selection of suitable stones by children for this purpose.

Let each child design and mould in clay a hand mill.

The evolution of milling by pictures and stories.

Visit to the flouring mill.

Bread making in school, at home and at the bakery.

The teeth as a mill; variety of shapes, uses and care.

Hygiene of eating.

The harm of stimulants and narcotics.

Typhoid, consumption and diphtheria in water, milk or other food.

Condemn and abolish in the school-room the common drinking cup, pencils in common and the slate and sponge.

Bring out clearly the especial need of sanitary precautions about a fixed home as compared with a temporary one.

Sanitation of vegetable cellars.

CENTRAL SPRING THOUGHT;—Use of their Stored Food by Plants.

Germination of corn, wheat, barley, buckwheat, etc., in late February, in moist sawdust or upon clean blotting paper.

Have children discover the loss of starch in the seed.

Pinch off the kernel of corn and chew the stem. Conclusion ?

This sweet substance (sugar) could have come only from the starch.

Elicit the reason for this change, recalling previous experiments.

When the season is sufficiently advanced tap some hard maple trees, collect sap and boil down to syrup and sugar.

Split some maple twigs and test with iodine.

Elicit probable source of the sugar, the reason for the change and what the tree intends to do with sugar.

From pictures and stories describe a "sugar bush." Visit one if practicable.

Soak a supply of barley and when starting to grow kill with a dry heat which is not sufficient to burn. This is malt.

Have children chew a few grains before and after germination.

Get a supply of ground malt, soak in warm water, filter and evaporate.

This is malt sugar, or "maltose."

Fill fruit jars even full of "culture fluid," cover with mosquito netting, on which place germinating corn or peas.

Prepare others similarly but use rain water. Account for results and develop uses of root to feed plant and hold it in position.

Study flowers of soft maple and later of the hard maple.

Development of flowers into seeds.

Love of bees for the soft maple, gathering and distribution of pollen.

Place in suitable vessels of water specimens of carrot, turnip, parsnip, beet and kohlrabi, preferably those raised by the children.

Their use of stored food leading to growth, flower and seed.

The purpose of the first year's growth and storage is now apparent.

Carefully take up early weeds as dandelion, mullein, thistle and burdock, note food in root and consider advantages.

Sprouting of Irish potatoes which do not need to be placed in water.

Place sweet potatoes (not killed by heat) in bottles and secure a vine.

Collect acorns, walnuts and hickory nuts that have wintered out doors and continue their germination in moist sawdust.

Their use of stored food.
 Place in window boxes, watch growth and later give a place in the garden.
 For arbor day set out maples and nut trees.
 In the garden set out turnips, kohlrabi, parsnips, carrots and beets in order to
 get the flowers and seeds.
 Bulbous plants to illustrate use of stored food, planted in the fall.
 Lessons in transplanting, cultivating and fertilizing soil.
 Individual flower-beds giving freedom of choice.
 Competitive flower rearing with dwarf nasturtium.
 Experiments and observations of same plant growing in various soils.
 Compare ripe and unripe fruits with reference to presence of starch and sugar.
 Danger from unripe fruits.
 Action of saliva on starch and necessity for thorough mastication.
 Suspend a large moist sponge and sprinkle over it a liberal supply of flax seed.

SUGGESTIONS TO FOURTH GRADE TEACHER.

Domesticated hares and rabbits are now so common that no special difficulty will be encountered in having a live specimen at school. A pet squirrel will be more difficult to find, and if it can not be secured a good mounted specimen, (Ward's Natural Science Establishment, Rochester, N. Y.) should be provided. These two related forms are taken for the purpose of showing the advantage that comes to the individual from the storage of food. The most interesting work for the child will center around the differences of habits, size, structure and enemies, arising from the fact that one digs its coarse, unnutritious food from the ground and the other gets its rich, oily food from the trees. A collection of pictures will be needed in order to present the varieties of rabbits and squirrels and other gnawing animals. As many skulls to show the teeth should be provided as is feasible. These may be prepared by removing the skin and flesh and placing the skull in an ant-hill for cleaning. Get a collection of nuts of various kinds that have been opened by red squirrels. From the wood yard specimens of squirrels' homes may often be procured.

In taking up the grains in the fall the entire plants should first be studied. If permitted, the children will discover the essential physical properties of starch stored away in the grains. The iodine solution for the recognition of starch is very easily prepared by dropping into water a few scales of the solid iodine obtained from the drug-store. It should be strong enough to give the rich blue or purple color and not so deep as to appear black. Several small bottles of the solution, with medicine droppers, should be provided. To separate starch from the potato, cut into fine bits, shake in water and while the water is milky pour off and allow to settle. Pour off the excess of water without disturbing the starch and repeat as often as desired. Finally allow the last of the water to evaporate so as to get the dry starch. The winter experiments are for the purpose of showing that starch will not dissolve in cold water, but will do so in hot water. The filter paper may be procured from the chemical laboratory or the drug-store and is used to separate the undissolved granules before testing. An opportunity is afforded for developing simple phases of domestic science work from the Nature work, or where this is not desired, of illustrating these processes in the school-room.

Suitable twigs for the log-cabin and a supply of clay for the adobe house should be laid in during the fall. A mould for the bricks should first be made, holding, say a half dozen, moistened and sprinkled with sand each time to keep the bricks from sticking. A thatched roof of grasses may be provided for the adobe house and one of bark or split twigs for the log house. The children will be able to design and make pieces of pottery without any instruction quite as good as primitive man was first able to make. If the teacher is at all enterprising she can readily learn and teach the simple methods used by the lower races today. If thoroughly dried the smaller pieces may be burned in furnaces and anthracite stoves, while the larger pieces may have fires built in and around them upon the school grounds. Save the best pieces for the school collection and try to secure specimens of Indian pottery for comparison. In modelling the hand mills from clay care should be taken that the children do not see the actual utensils used by primitive man until their own work has been done, when the real stone implements may be exhibited and studied.

The purpose of the spring work is to lead the child to see that the material stored by the plant during the first season's growth, which was appropriated by animals and man, was either for the plant's own use during the second season or for the next generation. Starch being insoluble in cold water it is very generally converted into sugar, so very soluble, in order that it may be transported through the various tissues to the place where it is needed for plant growth. After a moderate amount of maple sap has been collected have the children close the holes perfectly with corks, or wooden plugs, in order that the tree may not "bleed". Ground malt may be procured from a malt house, or brewery, sending away for it if necessary. One supply will last for several years. The malt sugar does not readily grain but the wax-like form may be readily secured by the method indicated in the outline. A small supply of maltose may be purchased from Eberbach & Son, Druggists, Ann Arbor, Mich. Educational exhibits of flour and other food products made from wheat may be secured without cost from the Pillsbury Milling Co., Minneapolis, Minn. Tablets for making the "culture fluid" may be purchased from Dr. E. W. Bigelow, Stamford, Mass., for ten cents per box. The purpose of these experiments is to show that plants require no food until that in the seed is exhausted, after which they will die if food is not supplied to the roots. The maples will be found to possess two types of flowers, the staminate and pistillate, each borne upon separate trees. The flower-dust (pollen) is being carried from one to the other by the bees. By collecting flowers a few days apart the children may *discover* that one of these types of flowers gives rise to the pairs of winged seeds, and the *purpose* of the flower becomes understood.

The spring gardening is for the purpose of getting the final stages in the life of the biennial vegetables that were started in the spring of the third grade, the rearing of nut trees for the school grounds and home, to teach some of the elementary principles of agriculture and to get the children interested in the rearing of flowers. Children should be encouraged to start small gardens at home which should be visited by the teacher. Competitive flower rearing, as described in Hodge's Nature Study, pages 94 to 100, will add zest to the work. Distribute an equal number of seeds to those willing to participate and have the plants grown in pots so that the best may be brought to school for the final exhibit. Have the plants numbered instead of named, appoint judges and award some simple prizes. If the nuts do not sprout promptly enough a search beneath the parent trees will usually reveal some that are sprouting and these may be used. To the list given in the outline there may be added other nuts, as the butternut, sweet chestnut, hazel, etc. A good sized bed of nasturtiums is desired for the work of the fall. To furnish practice in transplanting beds of wild flowers which grow from bulbs may be made a part of the garden; adder tongue, spring beauty, Jack-in-the-pulpit, trillium, leek, etc. In studying the question of adaptation of plants to certain soils similar plants may be grown in different soils, starting with the seeds and otherwise treated just alike. Differences should be carefully looked for and, as far as possible, explained.

In the meteorological work recommended for the three preceding grades no individual records have been kept. It is now recommended that each pupil keep a record in a suitable note-book of the temperature taken just at the beginning of the afternoon session, of the direction of the wind at this time and the amount of rain or snow for the previous twenty-four hours. These observations may be made by special committees of the pupils and as far as feasible verified by the others. For certain months the construction of temperature curves upon "cross-ruled" paper will be found valuable, similar to the charts described for the third grade. From the children's records determine the prevailing wind for each month and for the seasons and school year. Observe the shifting of the winds as the storms pass over the region and see whether any general conclusions can be reached. Omit any attempt at explanation. Collect all the weather proverbs, signs and sayings current in the community and test each one as often as possible. Classify them into sets which seem to be reliable, doubtful and unreliable.

HELPFUL LITERATURE.

1. Handbook of Nature Study—Lange. Outlines on squirrel and rabbit.
2. Object Lessons in Elementary Science—Murche, Vol. I., Macmillan & Co., 1902.
3. Science Readers—Murche, No. II. Outline on rabbit. Macmillan & Co., 1896.
4. Squirrels and Other Fur Bearers—Burroughs. Houghton, Mifflin & Co., 1901.
5. Ways of Wood Folk—Long. Ginn & Co., 1902. Rabbit and beaver.

[illegible]

6. Wild Neighbors—Ingersoll. Macmillan & Co., 1897.
 7. Country Cousins—Ingersoll. Harper Bros.
 8. Four Footed Americans—Wright. Macmillan & Co.
 9. Wild Animals I Have Known—Seton-Thompson. Scribner's Sons, 1900. Raggylug and Molly.
 10. Popular Natural History—Wood. Porter & Coates.
 11. Friends Worth Knowing—Ingersoll. Harper Bros., 1880. Wild mice.
 12. Familiar Trees and their Leaves—Mathews. Appleton & Co., 1897.
 13. Stories of the Trees—Dyson. Nelson & Sons, 1890.
 14. Trees in Prose and Poetry—Stone and Fickett. Ginn & Co., 1902.
 15. The Oak—Ward. Appleton & Co., 1900.
 16. Leaves and Acorns of our Common Oaks. Wyman. Cornell Leaflet No. 8.
 17. First Book of Forestry—Roth. Ginn & Co., 1902.
 18. Domestic Science in Grammar Grades—Wilson. Macmillan & Co., 1900.
 19. Woman's Share in Primitive Culture—Mason. Appleton & Co., 1894.
 20. Story of Wheat—Halifax. World's Events Publishing Co., 1906.
 21. Elements of the Theory and Practice of Cookery—Williams & Fisher. Macmillan & Co., 1901.
 22. Bread and Bread Making. Farmer's Bulletin No. 112.
 23. School Sanitation and Decoration—Burrage & Bailey. Heath & Co., 1900.
 24. Graded Lessons in Physiology and Hygiene—Krohn. Appleton & Co., 1906.
 25. School Hygiene—Shaw. Macmillan & Co., 1901.
 26. Story of Germ Life—Conn. Appleton & Co., 1897.
 27. Our Bodies and How We Live—Blaisdell. Ginn & Co.
 28. How to Make Pottery—White. Doubleday, Page & Co., 1904.
 29. Real Things in Nature—Holden. Macmillan & Co., 1903.
 30. Nature Study with Common Things—Carter. American Book Co., 1904.
 31. Natural History Lessons—Black & Carter. Holt & Co., 1892.
 32. The Maple Sugar Industry—Fox & Hubbard. United States Department of Agriculture, 1905.
 33. Great American Industries—Rocheleau, Volumes II and III. Flanagan, 1901.
 34. Life on the Farm—Sheperd. Flanagan, 1901.
 35. The Great World's Farm—Gaye. Macmillan & Co., 1894.
 36. Lessons with Plants—Bailey. Macmillan & Co., 1902.
 37. The Soil—King. Macmillan & Co., 1895.
 38. How Crops Feed—Johnson. Orange Judd Co., 1883.
 39. Lessons in Botany—Flower and Fruit. Newell. Ginn & Co., 1893.
 40. First Studies in Plant Life—Atkinson. Ginn & Co., 1902.
 41. Nature Study—Hodge. Flower rearing and forestry.
 42. Tree Planting on Rural School Grounds—Farmer's Bulletin No. 134.
 43. About the Weather—Harrington. Appleton & Co., 1899.
- See also Third Grade list upon Agriculture.

Fifth Grade. Communal Phase. Age of Co-operation and Mutual Helpfulness.

CENTRAL FALL THOUGHT;—Community Living and Thrift.

Grasshopper studied afield and indoors, as to structure, habits, adaptation, food, and enemies.
 Shiftlessness of insect, failure to provide a home, to co-operate with fellows, to store food and resulting consequences.

Varieties of grasshoppers, crickets, katy-dids, etc.

The hive bee studied afield and in glass observation hive as to structure, habits, adaptation, food and enemies.

Industry, co-operation, patience, thrift, loyalty, a home and abundant food supply.
 Contrast with condition of grasshopper.

A study of bees-wax; color, odor, taste, feel, plasticity, lightness and melting temperature.
 How produced and use in making comb.

Study of some old comb, shape, size, arrangement and use of cells.
 Physical properties and source of honey.

Propolis upon old frames; its nature, source and use by bees.

Along with the above work take up the nasturtium in the school gardens. Study entire plants and end with flowers; color, odor, shape, position, parts, markings, fringes, nectar in spur.

Observe how many different kinds of insects visit the flower.

Starting with young flowers in water, have each child *discover* how the stamens behave and finally the pistil.

Meaning of this behavior and explanation of the flower characteristics.

Idea of cross *pollination* but not fertilization.

Follow individual flowers through to the seeds.

Follow individual flowers through to the seeds.

Meaning of this behavior and explanation of the flower characteristics.

Startling with young flowers in water, have each child observe how the stamens

behave and finally the pistil.

Observe how many different kinds of insects visit the flower.

Stingers, nectar in spur.

plants and end with flowers; color, odor, shape, position, parts, markings.

Along with the above work take up the nasturtium in the school gardens. Study entire

propolis upon old frames; its nature, source and use by bees.

Physical properties and source of honey.

Study of some old comb, shape, size, arrangement and use of cells.

How produced and use in making comb.

A study of bees-wax, color, odor, taste, feel, plasticity, lightness and melting temperature.

Contrast with condition of grasshopper.

Industry, co-operation, patience, thrift, loyalty, a home and abundant food supply.

The hive bee studied afield and in glass observation hive as to structure,

habits, adaptation, food and enemies.

Various of grasshoppers, crickets, katy-bids, etc.

food and resulting consequences.

Shiftlessness of insect, failure to provide a home, to co-operate with fellows, to store

Grasshopper studied afield and indoors, as to structure, habits, adaptation, food, and enemies.

CENTRAL FALL THOUGHT;—Community Living and Thrift.

Fifth Grade. Communal Phase. Age of Co-operation and Mutual Helpfulness.

43. About the Westcott—Harrington. Appleton & Co., 1899.
42. Tree Planting on Rural School Grounds—Farmer's Bulletin No. 124.
41. Nature Study—Ildredge. Flower raising and forestry.
40. First Studies in Plant Life—Alderson. Ginn & Co., 1902.
39. Lessons in Botany—Howar and Fenn. Newell. Ginn & Co., 1897.
38. How Crops Grow—Johnson (Orange Ind. Co., 1883).
37. The Soil—King. Macmillan & Co., 1895.
36. Lessons with Plants—Bailey. Macmillan & Co., 1902.
35. The Great World's Farm—Gayer. Macmillan & Co., 1904.
34. Life on the Farm—Sheddy. Hargreaves, 1901.
33. Great American Industries. Rochester Columns II and III. Hargreaves, 1901.
32. The Maple Sugar Industry—Fox & Hubbard. United States Department of Agriculture, 1902.
31. Natural History Lessons—Black & Carter. Holt & Co., 1902.
30. Nature Study with Common Things—Carter. American Book Co., 1904.
29. Real Things in Nature—Holden. Macmillan & Co., 1903.
28. How to Make Pottery—White. Doubleday, Page & Co., 1904.
27. Our Bodies and How We Live—Halsdell. Ginn & Co.
26. Story of Germ Life—Conn. Appleton & Co., 1897.
25. School Hygiene—Shaw. Macmillan & Co., 1901.
24. Graded Lessons in Physiology and Hygiene—Krohn. Appleton & Co., 1900.
23. School Sanitation and Decoration—Buttrage & Bailey. Heath & Co., 1900.
22. Bread and Bread Making. Farmer's Bulletin No. 112.
21. Elements of the Theory and Practice of Cookery—Williams & Fisher. Macmillan & Co., 1901.
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19. Woman's Share in Primitive Culture—Mason. Appleton & Co., 1894.
18. Domestic Science in Grammar Grades—Wilson. Macmillan & Co., 1900.
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16. Leaves and Acorns of our Common Oaks. Wyman. Cornell Leaflet No. 8.
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14. Trees in Prose and Poetry—Stone and Fickell. Ginn & Co., 1902.
13. Stories of the Trees—Dyson. Nelson & Sons, 1890.
12. Familiar Trees and their Leaves—Mathews. Appleton & Co., 1897.
11. Friends Worth Knowing—Ingersoll. Harper Bros., 1890. Wild mice.
10. Popular Nature History—Wood. Porter & Coates.
9. Wild Animals I Have Known—Seton-Thompson. Scribner's Sons, 1900. Kissing and Molly.
8. Four Footed Americans—Wright. Macmillan & Co.
7. Country Con in—Ingersoll. Harper Bros.
6. Wild Neighbors—Ingersoll. Macmillan & Co., 1897.

Find other fall flowers upon which the bees are working and study their structure.
Contrast the bee and grasshopper as to their importance to the plant world and to man.
Study those devices for securing seed distribution in which the agency of animals and man is employed.

Height of such plants, position of seeds, ease of detachment, ability to cling; how the seed reaches the ground; type of animal needed.

Search for *trees* with any such devices.

School savings bank to encourage thrift.

CENTRAL WINTER THOUGHT;—Man's Protection Against Cold by Fire.

Develop physical properties of carbon from charcoal.

Make charcoal from pine splinters by heating in a test-tube.

Describe manufacture upon a commercial scale.

Discuss various uses of charcoal.

From washed specimens study hard and soft coal.

In soft coal find traces of plant structure and explain origin.

Coal deposits in the United States, its mining and transportation.

Importance of coal in the home, school and factory.

Our dependence upon the miner and his arduous and dangerous life.

Illustrate method of making coal gas with clay pipe.

Visit gas works, if practicable, and get samples of coal, coke, tar, etc.

Origin of natural gas and petroleum.

Combustion a union of carbon and oxygen with evolution of heat; wood, charcoal, coal, coke, candles, kerosene lamps and gas.

Properties of carbon-dioxide gas and danger to life. Lime water test.

The smothering of incipient fires; home and clothing.

Investigate methods of heating school and home; stoves, furnaces, steam, hot water.

Fire getting by means of matches. Gunpowder and explosives.

Effect of heat upon liquids; expansion and evaporation. Condensation.

Application to clouds, fogs, rain, dew and frost. Saturation and dew point.

Principle of thermometer explained.

Effect of heat upon solids; expansion and melting. Application.

Effect of heat upon air; expansion and production of vertical currents.

Hot air balloons and hot air wheels.

Application of principles in the ventilation of rooms.

Introduce a very simple barometer and explain its use.

By charring small bits discover that carbon is a common ingredient of practically all our foods; starch, sugar, meat, fruits, etc.

Present respiration as a process of combustion by which the body is warmed. Animals and man.

Test breath with lime water, and a jar of it with a lighted candle.

Organs of respiration; the lungs and skin.

Waste matters exhaled and necessity for pure air.

Regulation of the temperature of the body by evaporation.

Colds, influenza, pneumonia and consumption.

The respiratory process in germinating seeds, the giving off of heat and production of carbon-dioxide.

CENTRAL SPRING THOUGHT;—Animal and Plant Co-operation.

The study of the bee continued with the observation hive.

The rearing of young and the life history directly observed.

The queen the mother of the colony and the devotion of her children.

The gathering of bee bread and the work of the nurse bees.

The gentlemen bees of the colony.

Making comb, gathering nectar, cleaning, guarding and, in the late spring, ventilating and swarming. Fate of the drones.

Study these devices for a purpose, and distribution in which the action of animals will be
 Consider the law and principles as to their importance to the plant world and to man
 Which other fall flowers upon which the bees are working and only their structure
 is explained.
 Height of each plant, position of seeds, mode of detachment, ability to cling, how
 the seed reaches the ground, typical animal needed.
 Search for facts with each device.
 School savings bank to encourage them.

CENTRAL WINTER THOUGHT:—Man's Protection Against Cold by Fire.

Develop physical properties of carbon from charcoal.
 Make charcoal from pine splinters by heating in a test-tube.
 Describe manufacture upon a commercial scale.
 Discuss various uses of charcoal.
 From washed specimens study hard and soft coal.
 In soft coal find traces of plant structure and explain origin.
 Coal deposits in the United States, its mining and transportation.
 Importance of coal in the home, school and factory.
 Our dependence upon the mine and the mine and dangerous life.
 Illustrate method of making coal gas with clay pipe.
 Visit the works, if practicable, and get samples of coal, coke, tar, etc.
 Origin of natural gas and petroleum.
 Combustion a union of carbon and oxygen with evolution of heat, wood, charcoal, coal, coke,
 candles, kerosene lamps and gas.
 Properties of carbonaceous gas and danger to life. Mine water test.
 The manufacture of kerosene, gas, home and clothing.
 Investigate method of heating school and house, stove, furnace, steam, hot water.
 Fire getting by means of matches. Combustion and explosion.
 Effect of heat upon liquids; expansion and evaporation. Combustion.
 Application to clouds, fog, rain, snow, frost. Saturation and dew point.
 I think of thermometer explained.
 Effect of heat upon solids; expansion and melting. Application.
 Effect of heat upon air; expansion and production of various currents.
 Hot air balloons, and hot air wheels.
 Application of principles in the ventilation of rooms.
 Introduce a very simple barometer and explain its use.
 By starting small but discover that carbon is a common ingredient of practically all our
 food; starch, sugar, meat, milk, etc.
 Present respiration as a process of combustion by which the body is warmed. Animals and
 man.
 Test breath with lime water, and a jar of it with a lit match.
 Quant of respiration; the lungs and skin.
 Warmth factors external and necessary for pure air.
 Regulation of the temperature of the body by respiration.
 Control internal, pneumonia and consumption.
 The respiratory process in germinating seeds, the giving off of heat and production
 of carbon-dioxide.

CENTRAL SPRING THOUGHT:—Animal and Plant Co-operation.

The study of life bee continued with the observation hive.
 The reason of many and the life history closely observed.
 The queen the mother of the colony and the division of her children.
 The gathering of the bees and the work of the nurse bee.
 The respiration of the colony.
 Making combs, gathering nectar, cleaning, warming and in the spring, swelling and
 warming. Late of the brood.

- Study ants afield and in school nest.
- Members of the ant community and their duties.
- Stories of slave making and agricultural ants.
- Search upon shrubbery and grape vines for ants' *cows* (aphids).
- Why ants are not welcome in flowers and devices in nasturtium to exclude them.
- Watch ants trying to enter these and other flowers.
- Industry, perseverance, courage, self-sacrifice, loyalty and willingness to co-operate as shown by ants.
- Have children deduce those human qualities necessary for an ideal community. Professional tramps and thieves as notably lacking these qualities.
- Develop the impractical nature of modern socialism.
- Butterflies and moths and humming birds as flower guests; mutual adaptations and mutual advantages.
- Comparison of bumble bee with hive bee. Importance to man.
- Find as many flowers as possible, wild or cultivated, which are dependent upon animals for pollination.
- Study carefully color, shape and mechanisms.
- Study similarly the tree flowers; horse chestnut, basswood, catalpa, locust, etc.
- The child is to be led to appreciate the purpose of the flower and the importance of insects in making good seed.
- Compare such flowers as pine, corn and grasses with those studied, note and understand differences.
- Competitive flower rearing with "Emperor William."
- Budding and grafting of fruit trees.

SUGGESTIONS TO FIFTH GRADE TEACHER.

The work of this grade approaches more nearly the nature of elementary science, into which Nature Study passes by imperceptible gradations and from which is to be evolved the science work of the grammar grades and high school. Grasshoppers and other large insects may be conveniently kept in cylinders made of wire-gauze, closed at the top and set down in a box of moist loam. The food plants may be kept fresh by placing them in wide mouthed bottles, or fruit jars, sunk in the earth and kept filled with water. The grasshoppers are partial to young shoots of corn. For the bee study of the fall the materials needed may be obtained from the nearest bee keeper. Arrangements should be made for setting up a glass observation hive in the spring. These may be purchased from certain dealers but are very simply and satisfactorily made. If manual training has been introduced into the school the children themselves should be permitted to make their own hive. If not yet introduced here is an opportunity to bring in some work that will appeal to the child more strongly than the making of pen-trays and picture frames. After the observation hive has once been used in the school-room the teacher will not willingly dispense with it. Suggestions will be found in Hodge's Nature Study, chapter XIV. A firm base, with four strong corner posts carrying grooves for the insertion of heavy window glass and a movable cover, fitting snugly over the top, comprise the main features of the hive. Shutters should be provided to exclude the light when the bees are not being observed. It will be convenient to have the glass in the sides and at the back set in frames which are hinged to the corner posts, in order that the interior of the hive may be easily reached. The movable frames with which the hive is to be furnished hang from thin strips of metal across the ends of the hive and the dimensions of the hive will be determined by the length, height and number of these frames, which are to be obtained from the nearest bee keeper. Six or seven of these frames will give a very satisfactory hive. The hive is to be screwed very firmly to a strong shelf on a level with the inside window-sill. A narrow strip of wood is placed beneath the window-sash, having an opening opposite that provided for the hive. Flush with this opening, upon the outside, is a small shelf to be used by the bees for alighting, guarding and ventilating purposes. The window is to be fastened with a hook so that it can be raised only as desired. The hive is started in May by being taken to the bee keeper who will insert a frame of brood and one of honey with queen and all the bees that will remain. Empty frames with "foundation comb" are added. In a few days it may be brought to the school-room and placed permanently in position. It

will require no attention during the summer except to be screened from the hot sun by placing cloth or cardboard between the hive and window. If possible the hive should not be placed directly over a radiator or steam pipes as it will become too warm in the winter. A box carrying empty sections should be placed above the hive, between it and the cover, which will give the bees a chance to store honey during the season. Advise with the bee keeper in regard to this and also the handling of bees. Read the references given below. Unless a second colony is desired let the bees swarm at will.

The temperature at which wax melts may be obtained by floating small bits upon water and heating slowly. Wax is beautifully adapted to its use except for this low melting temperature. Everything pertaining to the comb is well worthy of study; shape of cells, termination at the bottom, horizontal position, relation to one another, arrangement in double tiers, ability to hold liquids (try with water). Have children cut from cardboard regular figures of 3, 4, 5, 6, 7, 8, 9 and 10 sides. Upon the blackboard outline these figures with chalk and endeavor to cover a portion of the board so as to have no spaces between. This can be done with only the triangle, square and hexagon. Which did the bee select and why?

The work with the ant in the spring is quite as interesting as with the bee, when the young are being cared for. A simple school nest is described in Lubbock's *Ants, Wasps and Bees*. This consists of a heavy base-board in which is cut a *moat* around the outer margin, supplied with water to keep the ants from escaping. A firm post supports an upper platform, considerably smaller than the base, which holds the nest proper. This consists of two panes of glass separated by thin strips of cork or wood and held together with thick white lead, a small space being left for an entrance. Between the glass fine dirt is sifted and moistened and a cardboard cover is provided to exclude the light. The nest is started by digging into a hill of large ants and transferring to a pail as many ants and as little dirt as possible and dumping this upon the base board of the school nest. Larvae and cocoons should be procured and, if possible, one of the large sized queen ants. At first the ants will rush into the water in which they are helpless and from which they must be rescued. As the dirt dries up the ants will discover the moist dirt in the nest and will take possession. When the dirt below is deserted the entrance may be temporarily closed with paper or cotton, the nest lifted off and the base thoroughly cleaned. Keep the moat supplied with water, restore the nest and all is ready for study. The ants will need to be fed upon syrup, dead insects, moist bread, etc., and may be kept indefinitely. As the dirt dries up a little water should be added as the ants prefer moist ground. At the close of the school year the ants may be allowed to leave and a new nest started again in the fall.

The work upon the nasturtium should be taken up early in the fall and carried along with the bee work. The temptation here will be strong to *tell*, but use all possible restraint. To illustrate the method of gas manufacture fill the bowl of a clay pipe with powdered cannel coal, seal with plaster paris and strongly heat. If a rubber tube is attached to the stem and a glass tube, drawn to a point, is inserted, the gas may be burned and passed through water and washed. A tinsmith can make a miniature gas tank to illustrate those used by the gas companies, or one may be improvised from baking-powder cans. Lime water for testing carbon-dioxide gas is prepared by placing a little lime in water and pouring off the clear solution. The gas itself is obtained by putting hydrochloric acid, obtainable at the drug-store, upon marble dust or fragments. By means of a cork and tube it may be conducted to other jars. The effect of heat upon water may be simply shown by taking a flask or bottle, corking it tightly with a cork through which has been passed a glass tube, say a foot in length. Fill the flask with water until it rises into the tube a short distance; mark the height and warm the water, observing the effect. Allow to cool and note the effect. When empty the same apparatus may be used to show the expansion of air as it is warmed. Place the end of the tube in water, warm first with the hands and then with burner or lamp and note the escape of the air. As it cools note the ascent of water in the tube, representing the amount of air driven out by expansion. The expansion of solids is strikingly shown by the ring and ball experiment of the physical laboratory. Simple apparatus may be made by which a strip of metal presses against the short arm of a lever. It has its application in the breaking of glass by sudden cooling or heating, removal of stoppers, tops of fruit cans, laying of car rails, etc. The barometer used should be of the simplest possible type and the children should understand that it registers the varying pressure of the air.

The gardening in the spring may be limited to the making of attractive beds of flowers especially modified for insect visitation; nasturtiums, hollyhocks, snap dragons, butter-and-eggs, salvia, fox glove, sweet peas, iris, cobaea, datura, orchids, clovers, buckwheat, etc. The meteorological work of the fourth grade may be continued and after the winter work is completed the study of clouds as to their formation, types, and importance. Daily reading of the barometer and the construction of pressure curves upon the same sheet as the temperature curves in order to discover the relation of air pressure, temperature and precipitation. Notice the winds which precede and follow the passage of the areas of low and high pressure. Train the children so that they can begin to anticipate the arrival of storms by means of the weather-vane, thermometer and barometer. For instance they will discover that a south wind, high thermometer and descending barometer generally mean a storm is approaching; while a north wind, dropping thermometer and rising barometer mean bright skies and fair weather. Keep a record of predictions and result.

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3. Elementary Lessons in Zoology—Needham. American Book Co., 1895.
4. The Honey Bee—Langstroth. Dadant & Son, 1896.
5. The Life of the Bee—Maeteclinck and Sutro. Dodd, Mead & Co., 1901.
6. The Bee People—Morley. McClurg & Co.
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MAPIE. DIFFERENCES

THEME FOR THE YEAR:—Utilization of Nature's Inorganic Materials and Energies.

- Fresh water mussels in a large, shallow tank in school-room.
- Valves, foot, locomotion, siphons, currents, mantle, gills, palpi, muscles.
- Structure of valves; epidermis, prismatic and pearly layers.
- Action of dilute acid upon each. Lime carbonate.
- Structure and formation of pearls.
- A collection of oyster shells for comparison with mussel.
- Test with acid snail shells and coral fragments.
- Limestone the product of shell and coral accumulation.
- Properties of limestone, varieties, uses, distribution over state.
- Formation of marble, varieties, uses.
- Calcite; color, luster, weight, cleavage, hardness, streak, action of acid.
- Study the incrustation from tea kettle and then calcareous tufa, hot springs formation, stalactites and stalagmites.
- Precipitated chalk from lime water and carbon dioxide. Use in tooth powder.
- Erosion by running water, wave action and ice-sheets.
- Sorting power of water and accumulation of sand and clay deposits.
- Sandstone; formation, varieties, properties, uses and distribution over state
- Clay, shale and slate; properties and uses.
- The formation and properties of chalk and marl.
- Cement manufacture from clay or shale and limestone or marl.
- Uses of cement; sidewalks, curbing, bridges, houses, etc.
- Galenite studied as was calcite; reduction to lead on charcoal.
- Properties and uses of lead. Comparison with ore.
- General properties of limonite, hematite and magnetite, including effect with magnet.
- The alteration in limonite and hematite by heating upon charcoal.
- The reduction of iron ores to iron, its properties and uses.
- The manufacture and uses of steel.
- Loadstone, magnetism and the compass.
- Pyrite and chalcopyrite, properties and reduction.
- Native copper, its properties and uses. Color imparted to flame both with and without hydrochloric acid. Test the chalcopyrite in this way.
- Properties, formation, occurrence and uses of rock salt.
- Baking soda and soda ash from limestone and salt.
- Uses of soda in baking and glass manufacture.
- Principles of simple lever; fulcrum, power, weight, arms, law and various applications in quarries and mines.
- Pulleys and wheel and axle as types of continuous levers.
- The derrick and its uses.
- The principle of the inclined plane, wedge, and the screw.
- Supposed method of building the pyramids.
- Modern fire-proof buildings of steel, stone, brick, cement, glass and slate.
- Properties of a piece of dry, cleaned bone; color, lustre, weight, hardness, manner of breaking, strength, etc.
- Presence of carbon, shown by incomplete burning and production of bone black.
- Complete burning in a stove or furnace, and only mineral matter left. Comparison of burned and unburned bone, to discover what properties are due to the burnable (organic) ingredients.
- Test burned bone with dilute acid to show presence of carbonate.
- Other mineral matter present, which will dissolve, but which is not a carbonate, (lime phosphate).

Other mineral waters present, which will dissolve, but which is not a carbonate (this phosphate).

Test burned bone with dilute acid to show presence of carbonate.

burnt (or are) (phosphate).

burned and unburned bone, to discover what properties are due to the

Complete burning in a stove or furnace and only mineral matter left. Comparison of

Presence of carbon, shown by blowpipe burning and production of blue flame.

fracture, strength, etc.

Properties of a piece of dry, steamed bone: color, taste, weight, hardness, manner of

Modern fire-proof buildings of steel, stone, brick, cement, glass and other.

supported method of building the pyramids.

The principle of the inclined plane, wedge and the screw.

The lever and its uses.

Pulleys and wheel and axis as types of continuous levers.

in pulleys and others.

Principles of simple levers: fulcrum, power, weight, arms, law and various applications.

- Uses of soda in baking and glass manufacture.

Baking soda and soda ash from limestone and salt.

Properties, formation, occurrence and uses of rock salt.

hydrochloric acid. Test the chlorophyll in this way.

Native copper, its properties and uses. - Copper imported to China both with and without

lignite and chalcopite, properties and reduction.

Limestone, magnesia and the compounds.

The manufacture and uses of steel.

The reduction of iron ores to iron, its properties and uses.

The relation of iron ores to iron, its properties and uses.

General properties of iron, its properties and uses.

Properties and uses of lead. - Comparison with zinc.

Oxide studied as was called, reduction to lead on charcoal.

General manufacture from clay or shale and limestone or marl.

Uses of cement, plaster, roofing, building, painting, etc.

The formation and properties of chalk and marl.

Clay, shale and slate, properties and uses.

Sand, marl, formation, properties, uses and distribution of water.

Sorting power of water and sedimentation of sand and clay deposits.

Formation by running water, wave action and ice sheets.

Prepared chalk from lime water and carbon dioxide. Use in tooth powder.

calcium and strontium.

Study the incrustation from sea shells and their calcareous tube, and various formations.

Change color, under weight, hardness, strength, shape of body.

Formation of marble, variety, uses.

Properties of limestone, variety, uses, distribution over the world.

Limestone the product of shell and coral accumulation.

Test with acid shells and coral fragments.

A collection of water shells for comparison with fossils.

Structure and formation of quartz.

Action of silica with iron oxide. Limestone.

Structure of calcareous, especially for marble and travertine.

Values for limestone, especially for marble, with fossils.

From water minerals in a lake. - Yellow lake in Canada.

THEME FOR THE YEAR - Discussion of Nature's Geological Features and Processes

Individual estimates of amount of carbonate and phosphate present.
If feasible, weigh a dry bone before and after burning, to get amount of organic and mineral matter.

Soak a sheep's rib in dilute acid to dissolve the mineral matter and discover the properties imparted to the bone by the organic matter alone.

Examine the bones of some very young animals, as those of a rabbit. Conclusions as to composition.

Bones in the body for protection, shape, and use as levers.

Hygiene of and repair of bones.

Shapes, structure and names of a few important bones of the body.

The nature and use of muscles and tendons.

The effect and necessity of exercise, hygiene of muscles and principles of training.

Nourishment of muscles and bones by blood. Circulation.

The effects of alcohol and tobacco upon muscles.

Location, action and names of a few of the important muscles.

The windmill, a type of wheel and axle for utilizing the energy of air in motion.

The water-wheel in the same way for utilizing the energy of running water.

Practical study of magnetism and frictional electricity. Lightning and the protection of buildings by rods.

The simple action of electric bells, telegraph instruments, dynamos and electric motors. Application.

Visit to the power plant or electric light works.

Simple action of a toy steam engine and application to stationary engines, locomotives and boats.

The necessity for transportation of raw materials and manufactured products.

The great railroad lines and steamboat routes of the world.

How goods are shipped and how people travel.

Stories of great inventors.

SUGGESTIONS TO THE SIXTH GRADE TEACHER.

The purpose of the work above alluded to is to introduce the child to the present highly complex environment in which he is living, and of which he is to become a part. His interest in the lower stages of culture having been, in part, gratified, he will take kindly to this work if it is made practical and brought within his comprehension. The mussels for the early fall work may be procured from the ponds and lakes of the neighborhood. Although present in most of the streams, they are not so easily found. They may be shipped some distance in a canvas bag and are very easily kept. Those that die in the tank should be removed in order to avoid polluting the water for the others. When the studies are completed the live ones should be returned to some favorable place. Irregular pearls are not uncommon, either attached to the inside of the valves, or embedded in the body just beneath the beaks. Oyster shells may be procured from the dealers. The weak acid referred to in the outlines is prepared by taking one part of commercial hydrochloric acid and adding four parts of water. Although not strongly corrosive when thus diluted, it should not be gotten upon the clothes or fingers. It is promptly neutralized with ammonia. Limestone charged with shells and corals may usually be found in the fields and gravel banks. The various rocks and minerals called for in the outlines may be purchased from Ward's Natural Science Establishment, Rochester, N. Y. They are not expensive, and may be used over and over and passed from one grade to another. The state geological reports may be consulted for the distribution of economic rocks and minerals. The Mineral Resources of the United States, obtained gratuitously from the U. S. Geological Survey, Washington, D. C., gives much information concerning the distribution and output of this class of materials.

The manufacture of glass may be very simply illustrated in the school-room by fastening (by melting) a short piece of fine wire in a small glass tube. Turn the end of the wire into a loop, heat in an alcohol lamp or bunsen burner, and dip into dry soda. Melt that which adheres into a small clear bead, and while hot touch it to a quartz sand grain. Reheat and

EFFECT OF DIETARY INTAKE OF EXOTIC FRUITS

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observe the agitation and final melting of the quartz in the soda forming *glass*. The coloring of glass may be illustrated best by making beads of borax upon the wire and adding a very little of some substance containing cobalt (blue), manganese (purple), chromium (green). For this work each child should have his own wire, and have access to the lamp or burner, under the eye of the teacher. For illustrating the use of Portland cement, a supply of the dry materials may be secured from the dealers and mixed by the children with water and sand into a slush, and allowed to harden. They may find out experimentally the best proportions of cement and sand by observing which gives the hardest product. If desired, a mould could be made and some building blocks manufactured. To get the lead from its ore, pulverize the galenite, mix with an equal volume of soda and heat on a piece of charcoal, using a regular blow-pipe, or one made from a glass tube. The lead readily separates into small globules. Fragments of iron ores are to be similarly heated on charcoal without any soda, when it will be found that the limonite and hematite will become magnetic. The carbon of the flame and charcoal withdraw oxygen from the ore, thus *reducing* a portion of it. This illustrates the process that takes place in the blast furnace. The common toy magnet should be provided for each child. Charcoal, after use, should be dipped in water to keep from taking fire. Simple compasses may be made by rubbing a needle over lodestone, from end to end, running through a fragment of cork to float it, and placing in a dish of water. Levers, pulleys, wheels, inclined planes, etc., may be borrowed from a physical laboratory, or purchased from dealers in physical apparatus. A derrick could be easily manufactured by the children as part of their manual training work. Similarly windmills and water-wheels.

The purpose of the work upon bone is to show the child how to discover its most important properties, and to lead him to appreciate how well it is adapted to the purpose that it is to serve. The bones of some young animal that has died a natural death may be secured and preserved in alcohol or brine, and used year after year. The preparation of the sheep's rib should be made each year by the children. The important modern inventions for utilizing energy can be simply presented by means of toys, and will strongly appeal to children of this age. No gardening work is called for by the theme for the year, that of the previous grades serving as a foundation for this work. If the work in agriculture has been successfully presented, many of the children will wish to conduct gardens at home for the supply of the family, or for sale at the market. This they should be encouraged to do. Many vacant lots could thus be utilized in the cities and villages, which now yield only an unsightly crop of weeds, bones, and tin cans. The civic improvement spirit should be strongly fostered in the intermediate and grammar grades.

For the work in meteorology it is recommended that work be begun upon the U. S. weather map, and that the work and importance of the weather bureau be understood by the child. The daily map for the use of schools may be obtained gratuitously, and a case for its display. Write to the observer at your nearest station for information. These maps should be displayed where the children can conveniently study them, and the progress of the "lows" and "highs" across the country followed from day to day. Isobars and isotherms are to be understood by the children. The arrival of these areas may be watched for, and signs of their approach noted. The work will be made more real if dispatches in the daily press are read, giving accounts of specially noteworthy climatic conditions in certain sections. The general eastwardly movement of the low and high areas across our country will be discovered, their places of entrance and departure noted, and the general direction of the movement of the winds about these areas understood. The methods of weather prediction as practiced by the general government, should be explained, and the importance of these predictions to the community at large fully understood.

HELPFUL LITERATURE.

1. Elementary Lessons in Zoology—Needham. American Book Co., 1895.
2. Animal Forms—Jordan & Heath. Appleton & Co., 1902.
3. First Book in Geology—Shaler. Heath & Co., 1890.
4. The Earth and Its Story—Heilprin. Silver, Burdett & Co., 1896.
5. Geological Excursions—Winchell. Grigg & Co., 1884.

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For the work in meteorology it is recommended that work be begun upon the U. S. weather map, and that the work and importance of the weather bureau be understood by the pupils. The daily map for the use of schools may be obtained gratuitously, and a card for its delivery. While in the weather map station for information. These maps should be displayed where the children can conveniently study them, and the progress of the "low" and "high" across the country followed from day to day. Lessons and recitations are to be conducted by the children. The arrival of these areas may be watched, and again the approach noted. The work will be made more real if children in the daily papers are given accounts of specially noteworthy climatic conditions in certain sections. The general movement of the low and high areas across our country will be discovered, that places of entrance and departure noted, and the seasonal duration of the movement in the winter about these areas understood. The methods of weather prediction as noted in the general government should be explained, and the importance of these predictions to the community at large fully understood.

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1. *Exhaustive* - Exhaustive is a term used to describe a list or collection that includes every possible item or element. For example, a list of all the countries in the world is exhaustive.
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5. *Exhaustive* - Exhaustive is a term used to describe a list or collection that includes every possible item or element. For example, a list of all the countries in the world is exhaustive.

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10. Longman's Object Lessons—Salmon and Woodhull. Longmans, Green & Co., 1894.
11. First Lessons in Minerals—Richards. Heath & Co.
12. Common Minerals—Crosby. Heath & Co.
13. Thirty-Six Observation Lessons in Minerals—Clapp. Heath & Co.
14. Up and Down the Brooks—Bamford. Houghton, Mifflin & Co.
15. Mineral Resources of the U. S. U. S. Geological Survey.
16. Economic Geology of the U. S.—Ries. Macmillan & Co., 1905.
17. Story of Glass—Hanson. World's Events Pub. Co., 1906.
18. Drama of Glass—Field. Libbey Glass Co., Toledo, O.
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21. The Portland-Cement Industry in Michigan—Russell. U. S. Geol. Survey, 22nd Rep., pt. 3, p. 629, 1902.
22. Elementary Meteorology—Waldo. Amer. Book Co., 1896.
23. About the Weather—Harrington. Appleton & Co., 1899.
24. The Human Body—Martin. Holt & Co., 1895.
25. How to Keep Well—Blaisdell. Ginn & Co.
26. Graded Lessons in Physiology and Hygiene—Krohn. Appleton & Co., 1906.
27. How to Get Strong—Blaikie. Harper & Bros., 1879.
28. Physical Training for Children—Hancock. Putnam's Sons, 1904.
29. Nature Study—Jackman. Holt & Co., 1894.
30. First Lessons in Physical Science—Avery and Sinnott. Butler, Shelden & Co.
31. Physical Science at Home—Trowbridge. Appleton & Co., 1898.
32. The Transportation and Lifting of Heavy Bodies by the Ancients—Watkins. Smithsonian Rep. for 1898, p. 615.
33. Boy's Book of Inventions—Baker. McClure, Phillips & Co.
34. Stories of Invention—Hale. Roberts Bros., 1895.
35. A Study of Elementary Magnetism and Electricity by Experiment—St. John. T. M. St. John, 1900.
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37. The How and Why of Electricity—Child. Electrical Review, 1905.
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1. NATURE STUDY REVIEW. 30 Linden st., Geneva, N. Y. \$1.00 per annum.
2. BIRD LORE. Harrisburg, Pa. \$1.00 per annum.
3. CHILD-STUDY MONTHLY. A. W. Mumford, 203 Michigan ave., Chicago. \$1.00 per annum.
4. AMERICAN JOURNAL OF PSYCHOLOGY. Clark University, Worcester, N. Y., \$1.00 per annum.
5. NATURE STUDY LEAFLETS. Cornell University, Ithaca, N. Y.
6. NATURE STUDY LEAFLETS. Clark University, Worcester, Mass.
7. ELEMENTARY SCIENCE LEAFLETS. Agricultural College, Michigan.
8. LEAFLETS ON NATURE STUDY. Purdue University, Lafayette, Ind.
9. FARMERS' BULLETINS. U. S. Dept. of Agriculture, Washington, D. C.
10. PUBLIC HEALTH. State Dept. of Health, Lansing, Mich.

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