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COURSE

IN

NATURE STUDY,

FOR

DETROIT SCHOOLS,

BY

Supervisor LOUISE MILLER.

1896.
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DETROIT.

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TO TEACHERS.

It is neither expected nor desired that all the work herein outlined shall be accomplished, but that it shall prove largely suggestive.

It is hoped all will grasp fundamental principles and teach only that which is vital. Too much time is spent upon non-essentials, and the great unity in nature overlooked.

Nothing should be taught in isolation, but the close relation between organic and inorganic should be emphasized. Plants should be studied as the great animating principle, forming a connecting link between dead mineral matter and the highly organized animal life.

Constantly encourage pupils to collect material, to construct apparatus, to observe all natural phenomena, and then gradually lead them to discover relations. All knowledge is largely a matter of relations.

After development of clear concepts through inductive study of the thing, appropriate literature may be given as an aid to language.

Each lesson should be made a basis for language, and related to number, reading, and all forms of expression.

Much attention should be given to sense-training; color, form, texture, perfume, taste carefully noted.

The ethical value should always be prominently brought out.

The pupils should be led to realize their place in nature and to feel that they are but higher expressions of the same energy which produced a drop of dew or a world.

LOUISE MILLER,

Supervisor of Nature Study.

DETROIT, Sept., 1896.

FIRST GRADE.

SEPTEMBER.

PLANTS.

Compare growth of twigs on different trees—maple, horse chestnut, poplar, spruce.

Relation of insects to leaves—used as nests, for food, for depositories for eggs, not disturbed.

Fruits.—Classification as to color and taste; reason for color and taste.

ANIMALS.

Migration of birds. Study cat and dog. Compare coats as to texture, color, distribution, warmth and protection.

ELEMENTARY GEOGRAPHY.

Construct a magnetic needle to determine directions.

Daily record of day, date, frost or dew, direction of wind, clouds or fogs, rain, temperature.

Locate places in the horizon where the sun rises and sets. Position of sun at noon; morning and evening star.

MINERALS.

Make collections of pebbles. Classify as to color, form, smoothness, weight, etc. Examine coarse and fine sand. Relate to smoothness of pebbles, and effects of water.

NOTE.—In the study of trees, observations should be confined to a few throughout the year. The shape, bark, wood, leaves, blossoms, and fruit should be studied and comparisons made. The life infesting the tree should be noted and, if possible, reasons assigned.

Place list of different kinds of birds observed by pupils during summer in a conspicuous place on the board, also list of those observed during first weeks of school. Relate migration of birds to Weather Record, noting effect of temperature upon insect life.

Construct magnetic needle by magnetizing end of a needle with opposite poles of a magnet, inserting through center of small cork, and suspending by silk thread.

Suspend a prism in a window where the sun may strike it, forming a spectrum.

Compare color of flowers, leaves, fruits, pebbles with spectrum, noting prevailing color.

Much attention should be given to sense-training. Children should be led to detect form and texture by touch alone, perfume by smell, sound by hearing, flavors by tasting, weight by the muscular sense.

OCTOBER.

PLANTS.

Buds for next year's growth; color of bark, growth of wood; hardness of bark and wood.

Leaves.—Effect of frost, color of falling leaves, leaf-scars. Seeds.—Distribution by wind, bursting pods. Protective coloration of seeds.

ANIMALS.

Disappearance of birds, insects and animals. Relate covering to disappearance. Compare movements of cat and dog with birds, insects and other animals.

ELEMENTARY GEOGRAPHY.

Compare frost, dew, winds, clouds, fogs, rain and temperature with September.

Change in rising and setting sun; position of sun at noon. Change of length of day and night.

MINERALS.

Classify as to physical properties sandstone and limestone. Compare sand and clay. Relate to disappearance of frogs, turtles, snakes, etc.

NOTE.—Children should be led to see that destiny of tree does not depend alone upon the production of its seeds, but that much of its energy is devoted to growth. Compare number of buds formed by different trees and relate to its development. Relate falling leaves to disappearance of sap into roots, structure of leaves to distribution, etc.

Fruits whose germs are destroyed when eaten, are usually of a dull color when ready for distribution—nuts; those whose germs are not so destroyed, assume a brilliant color, luscious taste and fragrant odor—cherries, peaches, grapes.

Relate frost to disappearance of birds and insects, winds to distribution of seeds, change of position of sun to change in temperature and its effects upon life. In primary grades pupils should be forming geographical concepts and they can do so most effectually by coming in contact with things.

NOVEMBER.

PLANTS.

Preparation of twigs for winter—thickened bark, scales on buds, etc.

ANIMALS.

Preparation of animal life for winter. Compare covering of cat, dog and sheep in their preparation for winter. Use of wool for clothing.

ELEMENTARY GEOGRAPHY.

Prevailing winds cold or warm, wet or dry. Clouds higher or lower than in September and October. Examine frost crystals.

Compare rising, setting and position of sun at noon with September. Rising of new, full and waning moon.

MINERALS.

Examine granite and marble. Compare size of crystals. When are snow crystals large?

NOTE.—Compare preparation of twigs, thickening of bark, number and character of scales on bud, varnish and protection of leaves inside of bud. Relate change in temperature to preparation of animals for winter. Relate change of position of sun to change of temperature.

DECEMBER.

PLANTS.

Effect of frost upon plant life; protection and use. Any germination.

ANIMALS.

Compare dog, cat, sheep, horse and cow as to movements, means of getting food, means of protection, use to man.

ELEMENTARY GEOGRAPHY.

Examine snow-flakes. Frost and snow protection to life.

Compare rising, setting and position of sun at noon with September.

MINERALS.

Compare structure of granite, marble, limestone, and sandstone.

NOTE.—Relate length of day to frost and its effects. Spruce trees should be studied in relation to Christmas. Difference between evergreen and deciduous trees, leaves and needles, fruit and cones, bark, wood, etc. Relate structure of animals to environment. Compare manner of putting down the feet, length and structure of limbs, cushions, claws, hoofs, etc. Relate to manner of getting food. Relate snow flakes and frost, dew and rain, to change in temperature. Note effect of frost upon soils. Relate to plants and seeds and hibernating animals.

JANUARY.

PLANTS.

Effect of warm days upon plants. Enemies of buds—birds and frost; protection of buds. Sap in trees.

ANIMALS.

Compare food of January and June. Compare teeth of dog and cat, sheep, cow and horse with human teeth and relate to kinds of food.

ELEMENTARY GEOGRAPHY.

Compare number of rainy or snowy days with December. Increase of day; rising and setting sun. Compare with November.

MINERALS.

Compare physical characteristics of granite, marble, sandstone, limestone and slate.

NOTE.—Of what advantage or disadvantage, are warm days in January to plants? When and why are buds used by birds as food? Examine twigs of maple, horse-chestnut, and spruce. Note buds destroyed by birds, wind, or killed by frost. Compare hibernating and non-hibernating animals as to covering, structure, manner of getting food, etc.—turtle, cat, dog or bird. Place hibernating animals in a box of moist earth and permit pupils to observe them disappear.

FEBRUARY.

PLANTS.

Determine location of frozen buds on twigs; number found, kind, number killed and number alive.

ANIMALS.

Manner in which dog, cat, sheep, horse and cow take their food. Compare prehensile organs with man's.

ELEMENTARY GEOGRAPHY.

Increased or decreased temperature since December. Compare January and February. Prevailing wind—cold or warm.

Compare length of day and night with previous months. Note sunrise and sunset.

MINERALS.

Compare different kinds of coal in color, weight, softness, hardness, etc.

NOTE.—Observe amount of work done by different trees in preparation for winter. Relate to effectiveness. The horse-chestnut has a few well protected buds prepared; others many, but not so well protected. Moral lesson.

Function of leaves, assimilation of food.

Compare this year's growth of horse-chestnut, maple, and spruce as to number, size, shape, texture, etc. Reason.

Compare perfection of jaws of animals with length of jaw.

MARCH.

PLANTS.

Study tree—environment, beauty, form, leaves, blossoms, etc.

ANIMALS.

Begin Natural History Calendar—observation, day, date, by whom, remarks. Watch for first appearance of birds.

ELEMENTARY GEOGRAPHY.

Change in cloudiness, rainfall. Compare with September and December.

Compare length of day and night.

MINERALS.

Compare granite, limestone, marble, sandstone and coal, as to color, texture, weight, tenacity.

NOTE.—Effect of location of a tree near house, other trees, in open space. Observe trunk and branching of maple, horse-chestnut and spruce. Note beauty, grace, symmetry, form. Press specimens of leaves from different kinds of maple trees, also preserve fruit of trees.

APRIL.

PLANTS.

Germination of seeds—bean, pea, corn, wheat.

ANIMALS.

Appearance of moths and butterflies. Change in covering of cat, dog, sheep. Compare eyes. Imitate sounds made by cat, dog and sheep.

ELEMENTARY GEOGRAPHY.

Observation of temperature, direction of wind, number of foggy and clear days. Compare with other months.

Relate lengthening day to change in movement of sun; to shadow at noon. Compare with previous months.

MINERALS.

Examine sand, gravel, loam and clay. Value of earth in relation to plant life.

NOTE.—Examine dry and soaked peas, beans, corn, and wheat. Note coats, scars and opening near the scar.

In all work in plant life, as in every other study, thought should first be acquired, and then expression.

Collect larvae during the fall, permit pupils to see and note date of spinning cocoons, and appearance of insects.

Animals and plants should be studied in life cycles.

Relate movement of sun to temperature and its effect upon life.

Encourage pupils to plant seeds at home and care for the plants.

MAY.

PLANTS.

Flowers; buds, color, perfume, honey; pollen distributed by insects, wind; leaves—blade, parallel and netted veined.

ANIMALS.

Observe habits of common birds, location and kinds of nests, protective coloration of feathers.

ELEMENTARY GEOGRAPHY.

Compare clear, cloudy and rainy days with April.

Continued observation of sun and shadow; relate to temperature and life.

MINERALS.

Study of soils.

NOTE.—In teaching flowers, technicalities should be avoided. Emphasize color, form, marking, perfume, honey. Influences which produced the flower—earth, air, rain, sun, insects, birds.

Relate soils to food for plants.

JUNE.

PLANTS.

Continued study of flowers and leaves. Parts of flowers—calyx, sepals, corolla, petals, stamens, carpel. Plants as wholes.

ANIMALS.

Birds—hatching of young, care of young, food. Compare young of cats, dogs, birds, butterflies, in covering, ability to help themselves, food, movements, etc.

ELEMENTARY GEOGRAPHY.

Thunderstorms, hailstones. Destructive effects of each. Compare length of day and night.

NOTE.—Children can readily distinguish parts of fruit blossoms. The dandelion should be studied as a whole.

The sparrow, robin, woodpecker and oriole are best adapted to this grade.

SECOND GRADE.

SEPTEMBER.

PLANTS.

Compare growth of twigs of different trees, of different years. Oak, elm, pine.

Relation of insects to leaves as food, as nests, as depositories for eggs. Prevailing color in same leaves. Plants storing food.

ANIMALS.

Migration of birds. Compare coats of squirrel and rabbit as to texture, color, distribution, warmth, protection. Habits of grasshoppers. Observe caterpillars spin cocoons. Prepare an ants' nest.

MINERALS.

Visit a stream; forces acting upon pebbles; formation of marbles.

ELEMENTARY GEOGRAPHY.

Daily record of day, date, frost or dew, direction of wind, clouds or fogs, rainfall, temperature. Moon's phases, rising and setting sun.

Locate places in the horizon where the sun rises and sets.

NOTE.—Weather Record should be kept from year to year and differences in growth of different years should be referred to variations in atmospheric conditions.

Observations of life infesting trees continued.

Record of migration of birds same as Grade I.

Study squirrel and rabbit as to shape of body, head, ears, mouth, legs and paws.

Oak, pine, turnips, parsnips store food for animals.

Remove an ant hill to a glass fruit jar and cover with brown paper. Food—sugar. By removing the paper, habits, galleries, and habits may be observed.

Place larvae of insects in an empty chalk-box containing leaves on which they feed. Slide piece of glass in the top that the feeding and spinning cocoons may be observed. Record dates.

OCTOBER.

PLANTS.

Preparation of twigs for winter; disappearance of sap, drying leaves; falling leaves, scars; location and arrangements of buds; structure of seed for distribution—wings, pappus, hooks. Color of seeds.

ANIMALS.

Habits of squirrel, of rabbit, as to storing food—how, where, kind and quantity.

MINERALS.

Formation of pebbles. Compare as to transparent, translucent and opaque.

ELEMENTARY GEOGRAPHY.

Effect of prevailing wind upon clear, cloudy, wet and dry weather. Direction of heaviest rains. Compare with September.

Compare October and September as to rising and setting sun, length of day and night.

Constant position of North Star, revolution of Great Bear around it; pointers in Great Bear.

NOTE.—The wind distributed seeds are supplied with wings and pappus, usually found on tall trees accessible to wind. Seeds supplied with hooks grow on low bushes so they can attach them-

selves to passing animals. Before seeds are ripe they are enclosed in green pods or shucks, color of leaves of plants. When ripe, they are brown like earth upon which they fall.

In studying squirrel and rabbit, secure a live specimen if possible. Pupils enjoy the action, and the results are more effective. Nothing engenders a love for animals as care of them.

Place fragments of rock in bottle of water and shake frequently. Place pebbles of different sizes in bottle and shake frequently. Which wears away more quickly?

NOVEMBER.

PLANTS.

Dormant condition of plant life: annuals—those producing many seeds; biennials—those storing nourishment; perennials—those producing buds and seeds.

ANIMALS.

Squirrel and rabbit—manner of eating. Food of squirrel stored by itself; food of rabbit stored by plants.

MINERALS.

Collect and classify metals and minerals—very soft, soft, hard and very hard.

ELEMENTARY GEOGRAPHY.

Frost or dew more common? Effect of wind, and clear or cloudy night upon formation of frost or dew.

Compare course of sun with September and October. Effect upon length of day and night; temperature.

NOTE.—Relate effect of shortening of days upon temperature and plant life.

Compare milkweed, turnip and tree. Destiny of annuals depends entirely upon production of seed. Count seeds in pods of one milkweed plant. Trace life history of biennial—appearance of root and stem of first year; root, stem, leaves, flowers, fruit of second year. Count seeds. Show relation between number of seeds prepared and number of buds formed by perennials.

Relate minerals and metals to material stored away in the ground for man's use.

DECEMBER.

PLANTS.

Effect of frost upon twigs, buds, and seeds.

ANIMALS.

Compare development of limbs in quadrupeds and bipeds; position of body in each; use of upper limbs. Compare squirrel and rabbit with cat and dog.

MINERALS.

Effect of thawing and freezing upon roots of plants. Power of granite, limestone, sandstone, coal, sand, clay, iron ore, copper ore to absorb and retain moisture.

ELEMENTARY GEOGRAPHY.

Increased or decreased cloudiness, rainfall; wind more or less variable; wind preceding rain or accompanying clearing weather.

Relation of line showing apparent paths of sun since September. Winter solstice.

NOTE.—Pupils should have definite idea as to rising and setting of sun, its position at noon in December. From personal observation difference between animal and plant life of June and December carefully noted.

Development of most parts of animal organism is for the purpose of securing food. Erect position of body is proportioned to development of fore-legs as prehensile organs.

The work on minerals is for the purpose of showing the value of each for building purposes. Weigh in air, immerse in water and weigh again while wet. Difference in weight shows absorptive power. Effect of frost—cracking rock.

JANUARY.

PLANTS.

Dormant condition of plants.

ANIMALS.

Winter condition of animal life. Compare teeth of rabbit and squirrel with dog and cat. Compare teeth and food of each with man.

MINERALS.

Recognize different kinds of iron ore by color, hardness, crystals, weight. Relate to steel and sharp cutting instruments and tools.

ELEMENTARY GEOGRAPHY.

Month of greatest change in temperature. Compare prevailing winds with previous months. Effect of temperature upon rainfall.

Note sun at noon; apparent movement, effect upon day and night.

NOTE.—Effect of frost upon germination. Snow a warm covering. A poor conductor of heat, excludes cold and prevents radiation of heat. Relate prevailing winds to frost and snow.

Pupils should be led to see that animals use their claws for digging, and their teeth for cutting and tearing their food, but man has too many demands for his physical organism and is forced to construct tools for his use.

FEBRUARY.

PLANTS.

Winter condition of trees.

ANIMALS.

Compare structure of head, hand and teeth of different animals; effect of development of one upon the other. Compare jaw, teeth and hand of squirrel, rabbit and man.

MINERALS.

Recognize different kinds of copper ore by color, hardness, crystals and weight. Uses.

ELEMENTARY GEOGRAPHY.

Compare snowfall, rainfall and fogs with previous months.

Note lengthening day; morning or evening longer. Movement of sun on horizon.

NOTE.—Shape of tree, angle of branching, development of tree.

Compare head of cat or dog, sheep or cow, rabbit or squirrel, and human teeth.

Relation of lengthening of day to enlivening of bark and swelling of buds.

Use of copper for wires; value to man. Man's superiority over other animals in his use of tools.

MARCH.

PLANTS.

First awakening of plant life; select a tree for accurate and systematic study; difference between a tree and shrub.

ANIMALS.

Return of birds, appearance of insects. Natural History Calendar. Protective coloration of squirrel and rabbit.

MINERALS.

Study soils in relation to plant life; power of different kinds of soil to absorb and retain moisture.

ELEMENTARY GEOGRAPHY.

Highest and lowest temperature during the month; character and amount of cloudiness in March, December and September.

Compare number of rainy days, in autumn, winter and spring.

Vernal equinox; seasons of year since autumnal equinox; rising and setting sun; length of shadow at noon.

NOTE.—Observations should be recorded on Natural History Calendar. Foster an interest in Nature, and gradual unfolding of life.

Select a tree convenient for constant observation. Measure diameter, height of branching, etc. Secure transverse and longitudinal sections of wood of the same kind of tree. Note carefully color, hardness, softness, toughness of bark of different years' growth. Location and arrangement of buds. Study color, size, covering, protection, etc. Record first appearance of leaves, flowers, and fruit. Study continued to end of year.

Nesting habits of birds; location of nests, material used. Birds of dull color have open nests,—brilliant colors concealed nests.

Relate color of squirrel to bark of tree, color of rabbit to ground and weeds. Why are black squirrels disappearing in Michigan?

Study meadow-lark, owl, duck, snipe, tanager, duck; relation of color, structure to environment and manner of getting food.

APRIL.

PLANTS.

Observe germination of seeds, different parts of seed; ratio of leaf buds and flower buds.

ANIMALS.

Earthworm—food, manner of moving, value to mankind. Relate earthworm to preparation of soil for plants. Compare earthworm and squirrel and rabbit, as to appearance, senses, movements, manner of getting food.

MINERALS.

Power of different soils to absorb and retain heat. Relate to plant life.

ELEMENTARY GEOGRAPHY.

Wind that accompanies wet, dry, clear, cloudy or foggy weather. Difference between April and winter rains.

Compare course of sun with December, reason for shortening of shadow; relation of length of shadow to temperature.

NOTE.—Measure a gill of corn, wheat, beans and peas; soak twenty-four hours. Measure. Which absorbs most water? Let each pupil examine a dry and soaked seed. Plant seed in different kinds of soil—clay, sand and loam. Place in light, shade, and dark to detect influence of light upon plant. Record time of planting, first appearance above ground, dropping of exhausted cotyledons.

Seed.	Bean.	Pea.	Corn.	Wheat.
Planted.	April.			
Depth.	1 inch.			
Above ground.	April.			
Cotyledons.	Above.	Below.	Below.	Below.
Leaves.	Netted.	Netted.	Parallel.	Parallel.
Leaves.	Compound.	Compound.	Simple.	Simple.
Position.	Alternate.	Alternate.	Alternate.	Alternate.
Margins.	Entire.	Entire.	Entire.	Entire.
Shapes.				

To compare gradual development of plant, pull up, press, and mount specimens on alternate days, showing development of different parts from seed to seed. Development may also be observed by being placed in bottles of alcohol. Carefully date each specimen. Plant acorns in yard.

Fill a large sponge with flaxseed and place in a shallow dish filled with water. Keep moist.

Mark off a yard square and observe the work of earthworms. Each morning, carefully collect castings and measure. Some idea of amount of work being done in renewing and fertilizing soil. Study structure, food, habits, senses; adaptation of structure to environment. Pupils should be led to see that each plant and animal is adapted to perform its function in the economy of nature.

Relate April showers to increasing temperature—greater heat, greater evaporation, consequently greater condensation.

MAY.

PLANTS.

Reason for early appearance of wild flowers; food; protection and color of spring flowers; advantage of color; unfolding of buds. Venation.

ANIMALS.

Study snails—land and water snails; difference in structure, shells, food, etc. Compare with earthworm, as to senses, manner of moving, muscular action, food protections. Compare snail shells with other shells.

MINERALS.

Examine soils carefully. Origin of soil—decayed vegetation and disintegration of rock. Relate qualities of soil to vegetation.

ELEMENTARY GEOGRAPHY.

Number of frosts or dews; compare with November; temperature of nights; direction of prevailing wind. Relation of wind to rainfall.

Lengthening of days; changing course of sun and effects upon all life.

NOTE.—Compare roots of spring beauty, crow-foot, watercress, Indian-turnip, tulip, crocus. Relate food stored by plants in roots to nourishment provided by cotyledons. Rapid growth due to food already assimilated. Color to attract insects and effect fertilization of flower. Relate lengthening days and increasing temperature to appearance of wild flowers and abundance of pond life. Relate falling leaves to formation of vegetable mould. Effect of rain upon surface of ground to disintegration of rocks.

Note difference in growth of plants grown in sand and loam. Reason.

Make a collection of spring flowers.

JUNE.

PLANTS.

Continue study of flowers. Arrangement of leaves on twigs; simple and compound, netted and parallel veined.

ANIMALS.

Insects; compare ants, spiders, flies and beetles; likenesses and differences in habits. Usefulness.

MINERALS.

Compare soil used as homes by ants, and earthworms. Effect of each upon soil.

Elementary geography.

NOTE.—Parts of leaves—petiole, blade, midrib, veins, veinlets, base, apex, margin. Distinguish between simple, palmately and pinnately compound. Press and mount specimens of all species of oak leaves. One boy found eleven species on Belle Isle. Make a collection of acorns.

Recognize linear, lanceolate, oblong, elliptical, and oval forms. Bases—heart-shaped and shield-shaped. Apex—acute and obtuse. Margins—entire, toothed, notched.

Function of veins—to carry sap; blade—to absorb moisture and carbon dioxide.

Flower: calyx—sepals, corolla—petals, stamens—filament, anther and pollen; carpel—ovary, ovules, style, stigma.

Study syringa and pansy.

Parts of insects: head—eyes, antennae, mouth-parts. Compare life history of each—egg, larva, pupa, imago; community life of ants. Habits of spiders and beetles. Encourage habit of personal observation on part of pupils.

The study of the ant is suggested for this grade, being accessible and harmless. The habits, home making and community life can better be observed in a jar than in the ground; food getting and storing by watching them in the grass and on sidewalks. Study members of the household:—queen, workers, warriors, etc. Note care of young, intelligence, communication; battles, excursions for food, etc.

THIRD GRADE.

SEPTEMBER.

PLANTS.

Relate growth of twigs on north, south, east and west side of trees to symmetrical development of tree. Study pine—type of excurrent tree, fruit tree—type of deliquescent tree. Note color of leaves on different parts of tree. Relate coloration of seed to distribution by animals as food, by animals in covering, by wind.

ANIMALS.

Distinguish between vertebrated, mollusious, articulated and radiated animals. Food, homes, and means of protection. Use familiar examples of each—bird or fish, oyster or clam, insects, starfish, etc. Review and classify animals previously studied.

MINERALS.

Compare sandstone and limestone. Sedimentary rock. Bed rock in parts of Michigan.

ELEMENTARY GEOGRAPHY.

Evaporation; dew, frost, rain.

Daily record of day, date, direction of wind, clouds or fogs, rainfall, temperature, barometer, moon's phases, morning and evening stars.

Rotation and revolution of the earth; inclination of axis; day and night; change of seasons; Autumnal Equinox; Little Bear, Jupiter, and Venus.

NOTE.—Emphasize geology in this grade, and do as much field work as possible. Take advantage of any natural features in the vicinity of the school house.

Forces at work: air, water, wind, frost; building coasts; crumbling cliff; deepening gulch; filling marsh.

Note erosion and sedimentation in school yard and street. Always relate physical characteristics of minerals and soils to erosion and change in earth surface.

Relate lime in solution in water to life in water, and beds of limestone.

OCTOBER.

PLANTS.

Compare new and old growth of twigs as to color, hardness, softness, texture; seeds growing on twigs—wings, hard, round, shell; near ground—pappus, hooks and prickles.

ANIMALS.

Relate color of animals to their environment. Protection and attractive coloration. Frogs, toads, grasshoppers, quail, wild cat, polar bear, leopard, tiger, etc. Relate to food-getting.

MINERALS.

Stratified and unstratified rock; limestone, sandstone, slate, granite and marble.

ELEMENTARY GEOGRAPHY.

Condensation—formation of rain, snow, hail, frost, dew, clouds. History of a raindrop.

Different forms of clouds: Cirrus, Cumulus, Stratus, Nimbus. Elevation of each.

Time and place of rising of new, full and waning moon. Effect of day and night upon life.

Movements of Jupiter and Venus.

NOTE.—Powder gray sandstone, put into a jar of water, shake contents and allow to settle. Next day drop powdered red-sandstone and continue for several days. Result—stratified material. Drop sand, gravel, loam, clay into a jar of water. Shake and allow to settle. Result—Stratified, assorted material. Dissolve lime in water and allow to settle.

NOVEMBER.

PLANTS.

Mode of distribution of seeds of annuals, biennials, and perennials. Effect of frost upon twigs, scaly and naked buds.

Preparation of plants for winter.

ANIMALS.

Preparation of animals for winter—thickening of coat, preparation of homes and storing food. Relation of structure of animals to manner of getting food; land and water animals.

MINERALS.

Life history of a pebble—part of cliff or rock; acted upon by air, water and frost. Compare sandstone, granite and limestone pebbles—as to color, form, smoothness, hardness, etc.

ELEMENTARY GEOGRAPHY.

Compare rainfall with October and September. Forms of clouds most common—high or low. Relation of temperature to cloudiness and rain; relation of cloudiness to rainfall.

Compare variation of shadow of October, September, and November. When greatest? When least?

NOTE.—No work can be more conducive to the cultivation of the imagination than to trace the history of a pebble. Moral lesson: contact with different conditions in wearing off the rough edges. Difference in color and texture show different origin; bands and faults show varied experience in life history. Physical forces acting.

DECEMBER.

PLANTS.

Examination of horse-chestnut, maple and fruit trees. Compare growth, bark, scars, number, arrangement and covering of buds formed. Probable fate of buds.

ANIMALS.

Distinguish between vertebrated animals; mammals, birds, fishes, reptiles, amphibians.

MINERALS.

Action of acids upon sandstone, limestone, marble, granite, mica, quartz, coral, shell. Relate to formation of caves—chemical forces acting.

ELEMENTARY GEOGRAPHY.

Influence of storm upon barometer. Effect upon temperature.

Winter Solstice. Compare shadow of September twenty-first and December twenty-first.

NOTE.—Place small piece of rock in test-tube and note effect of dilute sulphuric or hydrochloric acid upon it. Result. Note which one dissolves most readily. Beds of rock best adapted to formation of acids. Effect of water, holding acid in solution, upon lime rock. Why was it possible for mammoth cave to have been formed where it is? Why is the Blue Grass region so fertile?

Compare physical and chemical forces acting.

JANUARY.

PLANTS.

Dormant condition of plant life; death of all annuals; roots of biennials; stems of perennials.

ANIMALS.

Compare teeth, hoofs, and claws of rodents, carnivorous, herbivorous, and omnivorous animals; teeth—crown, fangs, enamel, incisors, canine, bicuspid, molars.

MINERALS.

Fossil animals, teeth, shells, plants, leaves, etc. Identify fossil animals and plants with living things. Conditions of fossilization. Change in earth conditions. Account for fossil coral in Michigan.

ELEMENTARY GEOGRAPHY.

Variation of temperature before, during and after a storm; variation of barometer and thermometer.

Effect of sun's position on temperature. When do shadows correspond and differ most?

NOTE.—Relate fossil animals and plants to kind and quantity of life extant in remote ages. Compare similar life of the present day.

Pupils should be encouraged to make collections of fossil plants and animals and to look for them in limestone used for building purposes. At first it is sufficient to be able to distinguish them by sight.

FEBRUARY.

PLANTS.

Examine trees for frozen buds and twigs; roots and blades of grasses; trunks of trees for mosses.

ANIMALS.

Begin study of birds; environment—earth, air, water. Relate structure to environment. Aerial birds—long, slender bodies, powerful wings; terrestrial birds—large bodies, strong feet, small wings; aquatic birds—boat-shaped bodies, short legs, webbed feet, or long legs, long neck, long bill; eagle, chicken, duck or crane.

MINERALS.

Continue study of fossil animals. Change of structure in earth's crust; erosion, sedimentation, upheaval, denudation. Relate coral and limestone to rock in Michigan.

ELEMENTARY GEOGRAPHY.

Compare temperature, barometer, rainfall, fogs, clouds, wind with previous months; with months whose days are about the same length.

When do shadows correspond and differ most.

NOTE.—Compare fossil coral with coral that is being made at the present time. Work done by coral animals. Casts and imprints of shells and leaves. Petrified wood.

MARCH.

PLANTS.

Begin close and comparative study of horse-chestnut, maple and fruit trees. Environment, shape, symmetry.

ANIMALS.

Continue study of birds. Manner of getting food, etc. Birds of prey, climbers, perchers, scratchers, waders, swimmers and divers.

MINERALS.

Recognize different kinds of iron ore, by color, weight, crystals and external appearance.

ELEMENTARY GEOGRAPHY.

Compare March with September. Note frost, or dew, wind, clouds, fogs, rainfall, temperature, barometer, sunrise and sunset.

Relative position of earth on September twenty-first and March twenty-first.

NOTE.—Distribution and abundance of fruit trees and iron should be taken up as some of the resources of the State of Michigan. Relate location of fruit farms to influences of lake, direction of wind, etc., upon climate. Relate iron mines to lake commerce.

APRIL.

PLANTS.

Germination of seeds; continue tree study.

ANIMALS.

Continue study of birds; parts of bird—head, body, wings and legs. Nesting habits of birds. Relate color to nesting habits.

MINERALS.

Reduction of iron. Compare pig iron, cast iron, wrought iron and steel. Uses of iron. Iron as a factor in civilization.

ELEMENTARY GEOGRAPHY.

Compare April showers with winter rains; temperature of nights and days. Explain differences of character and position of clouds in winter and spring.

Compare variation of shadow with November.

NOTE.—Germinate peach, apple, horse-chestnut, maple and pine seeds. Relate protection of the embryo to use of fruits for food.

Compare structure of birds' nests with the homes of other animals, and man.

Visit a rolling mill if possible and learn the reduction of iron from observation.

MAY.

PLANTS.

Parts of flower—floral envelope and essential organs. Compare fruit blossoms, maple and horse-chestnut.

ANIMALS.

Continue study of birds; hatching of young; care of young; manner of walking, of movement, of flight. Relate nesting habits, and food of birds to trees.

MINERALS.

Recognize different kinds of copper ore. Mining interests of Michigan.

ELEMENTARY GEOGRAPHY.

Influence of April showers upon May flowers. Wind that accompanies highest and lowest temperatures.

Compare long twilights of summer with short twilights of winter.

NOTE.—Pupils should be led to see that the energy of the plant is directed toward maturing seeds; that each part of the plant has its own work to do; that color, form, texture, perfume, are modifications to effect cross-fertilization of the flowers.

JUNE.

PLANTS.

Continue study of flowers; plan of flowers. Distinguish between imperfect and incomplete flowers. Continue tree study. Leaves: simple and compound, parallel and netted veined.

ANIMALS.

Study bees in relation to fertilization of flowers. Continue study of birds. Feathers: shaft, vane, quill, barbs, barbules. Compare feathers on different parts of body. Relate to food getting. Eagle's wing, feathers of an owl, tail of a woodpecker, body of a duck, wings of an ostrich.

MINERALS.

Reduction of copper ore. Uses: telephone and telegraph wires.

ELEMENTARY GEOGRAPHY.

Which month had largest number of clear days, rainy days; which coldest month; which warmest. Extremes of temperature.

Summer Solstice. Relative position of earth and sun June twenty-first. Compare sunrise, sunset and sun at noon with September, December and March.

NOTE.—The study of bees is a very interesting subject. Their community life, habits, food, keen sense perception furnish a fine opportunity for investigation.

Pupils should be encouraged to imitate the calls of the birds, and note manner of communication.

Copper should be considered as a means of communication between man and man.

FOURTH GRADE.

SEPTEMBER.

PLANTS.

Each pupil select tree for systematic study throughout the year. Protective coloration of leaves and fruit; development of flowers into fruit; form of fruit—fleshy, stone, dry.

Lower forms of plant life—algae, fungi, and lichens.

ANIMALS.

Swamp life. Observe larval stage of insects. Compare clam and oyster, as to food, habits, structure, movements, protection, nature of shell.

MINERALS.

Character of soil formed in swamps and marshes. Relate to peat bogs.

ELEMENTARY GEOGRAPHY.

Magnetic needle; compass; construction and use. Relate to iron and steel.

Dissolve salt, alum, lime in water. Relate solution to erosion of rock, and lime in solution to shells and bones of animals.

Daily record of day, date, frost or dew, clouds or fogs, rainfall, temperature, barometer, sunrise, sunset, morning star, evening star, moon's phases, moonrise, moonset.

Measure slant of sun's rays on shadow stick. Autumnal Equinox, September twenty-first; path of sun, Mars, Mercury.

NOTE.—Systematic study for trees following outline for tree study. Environment, shape, parts.

Observe fallen leaves exposed to the air, and those in streams or ponds.

Prepare a self-sustaining aquarium, showing the co-operation of animal and plant life.

In this grade pupils should get a glimpse of the evolution of plants and animals and their interdependence.

OCTOBER.

PLANTS.

Protection of unripe nuts; distribution of nuts and seeds; different appliances for distribution. Make collections of seeds in their pods. Storing of seeds by insects and animals.

ANIMALS.

Careful and systematic study of insects hibernating and non-hibernating. Habits of turtle and crayfish. Animals that store food and those that do not.

MINERALS.

Study coal. Collect carbon from burning candle, sugar, paper, wood, meat, wool and coal. Relate carbon to plants and animals.

ELEMENTARY GEOGRAPHY.

Influence of mountain ranges and large bodies of water upon rainfall and temperature.

Compare variation of shadow with September. Compare shortening of days in morning and evening. Change in position of constellations and stars.

NOTE.—Pupils should be led to regard the sun as a great benefactor—a great store-house of energy, supplying all our needs, clothing the world with beauty and majesty, and giving us power to respond to the influences of creation.

Coal should be regarded as energy stored up by the ages. Distinguish between anthracite and bituminous coal, cannel, coke and charcoal. Formation of coal (Shaler's First Book in Geology). Relate to plants. Account for presence of carbon in sugar, paper, wool, meat, etc. Forces which produce different varieties of coal.

NOVEMBER.

PLANTS.

Select annual and biennial plants and trace life history; as—pea or morning-glory, turnip or carrot. Compare root, stem and leaves with aquatic plants. Storing of nourishment; preparation for winter.

ANIMALS.

Coverings of animals; change in coverings for different seasons. Value of skins, hair, wool, shell in commercial world.

MINERALS.

Continued study of coal. Formation of coke and charcoal; illuminating gas; other products. Relate to comfort and protection of man.

ELEMENTARY GEOGRAPHY.

Relation of barometer to change of weather. Compare fluctuations of barometer with September and October.

Relate change in animals and plants to position of sun.

NOTE.—The structure and covering of animals should be closely related to their environment and change of seasons. The economic relations of animal life should be emphasized. Call attention to man's dependence upon Nature for his necessities, comforts and luxuries.

DECEMBER.

PLANTS.

Dormant condition of plant life.

ANIMALS.

Animal movements. Compare horse, cow, dog, cat, sheep, squirrel, and man as to manner of walking. Compare hoofs, claws, paws, hands. Relate to homes, manner of getting food, intelligence.

MINERALS.

Distribution of carbon; compounds in all mineral, vegetable, and animal matter; obtained by chemical change. Relate carbon to plant life—food of animals; interchange of carbon between plants and animals.

ELEMENTARY GEOGRAPHY.

Compare variation of temperature before, during and after storm. Compare temperature, barometer, rainfall, fogs, clouds, wind with previous months. Trace snow line on signal service map.

Compare area covered by beam of light in September and December. Relate heat received in different latitudes to life.

NOTE.—Lead pupils to see stores of wealth deposited for man's convenience, comfort and progress. Civilization is man's power to overcome his environment.

JANUARY.

PLANTS.

Effect of frost upon plant life.

ANIMALS.

Food of animals that do not migrate or hibernate.

MINERALS.

Study quartz crystals; form, size, color, hardness, texture, varieties.

ELEMENTARY GEOGRAPHY.

Compare snow line with December; when farthest north; farthest south; range of latitude covered; influence of Great Lakes.

Compare marks on shadow stick with previous months; effect upon temperature.

NOTE.—Relate effect of frost upon plants, scarcity of food of animals, the southern limit of snow line, the length of shadow to movement of sun.

Examine snow crystals. Note form, size, and law of crystallization.

Saturate solution of salt, alum, chalk, soda, blue vitriol, copperas, bichromate of potash. Note temperature of water in solution. Place solution in shallow dish or bottle with a string suspended in it. Evaporate rapidly; slowly. Relate solution to erosion of rocks; crystallization to crystalline rock, quartz—crystals, geodes, etc.

FEBRUARY.

PLANTS.

. Any awakening in plant life. Observe trees for mosses.

ANIMALS.

Any appearance of animal life.

MINERALS.

Distinguish different species of quartz. Relate hardness of granite to quartz. Association of quartz with other minerals.

ELEMENTARY GEOGRAPHY.

Compare snow line and zero isotherm with January. Influence of wind upon course of storm.

Compare angle of sun's rays at New Orleans and Detroit. Compare relative amount of heat and light; effect upon life.

NOTE.—Relate effect of frost upon rocks to rapid disintegration. Effect of chemical and physical forces upon calcareous and silicious rock.

Read Ruskin's "Ethics of the Dust" in connection with the study of crystals.

MARCH.

PLANTS.

Watch first awakening of the tree following outline for "Tree Study."

ANIMALS.

Note first appearance of insects. Note beauty of color, delicacy of marking. Compare fully developed insect with larva; what likenesses and differences—food, manner of feeding, locomotion.

Pond life—spawn of frogs and toads; development of tadpoles into frogs. Crayfish; turtles; snails.

MINERALS.

Water. Place a drop of salt, hydrant, lime, rain, filtered or distilled water on a clean piece of glass, and evaporate. Explain result. Relate to animal life in water, and beds of lime-stone.

ELEMENTARY GEOGRAPHY.

Compare lowest and highest temperature of March with September and December. Compare most northern and southern isotherm of September and March.

Vernal Equinox. Angle of sun's rays with horizon; relate to latitude. Relation of latitude to climate.

NOTE.—Relate lime, shell life and coral in ocean to beds of limestone. Encourage pupils to make collections of land and sea shells; note beauty of texture, color, form, markings, spines, etc.

APRIL.

PLANTS.

Continue tree study. Examine lichens, fungi, for spores. Note color, texture, form, growth of lower forms of plants.

ANIMALS.

Study dragon fly. Compare life history with that of a moth.

MINERALS.

Effect of rain upon soil. Transporting power of a stream of rapid and slow velocity. Effect of stream carrying sediment and one which does not. Relation of hardness of minerals to erosion.

ELEMENTARY GEOGRAPHY.

What isotherm passes through Detroit. Compare this with October. Compare temperature and rainfall with October.

Compare force of sunbeam in Detroit with December.

NOTE.—Pupils should observe forces acting about them, and should be led to see the great sculpturing of the face of Nature is produced by same forces acting on a greater scale. Relate hardness of rock to resistance to erosion.

MAY.

PLANTS.

Compare flowering and flowerless plants; flowers and spore cases.

ANIMALS.

Study May fly—egg deposited in water, long larval period, pupa, imago. Compare parts with other insects.

MINERALS.

Pupils should be encouraged to make field excursions, to collect and classify minerals studied during the year; to verify by observation facts learned about erosion and sedimentation.

ELEMENTARY GEOGRAPHY.

Trace isotherm of Detroit; compare same with November and December; effect of coast line upon east and west end.

Variation of sun's rays indicated by shadow stick: changing angle of sun's rays (indicated by shadow on stick changing) to horizon; effect upon temperature and life.

NOTE.—In early spring pupils should be encouraged to go to the woods and fields and enjoy the beauty of Nature in its entirety. Discourage any careless plucking and destroying of flowers, birds, insects, or life of any kind.

JUNE.

PLANTS.

Continue study of flowers and plants. Follow outline.

ANIMALS.

Reptiles: Compare snakes and turtles—scales, shells, manner of locomotion, kinds of food, manner of taking food, manner of laying and hatching eggs.

MINERALS.

Co-operation of mineral, plant and animal world.

ELEMENTARY GEOGRAPHY.

Compare isotherm of this month with last. The same isotherm in plains, mountains near coast lines; compare variations of isotherms in north and south. Reasons. Regions of lowest and highest temperature.

NOTE.—If the work is carefully presented in the first three grades, by the end of the fourth grade pupils should have a good, general idea of the mineral, plant and animal worlds. No attempt should be made at any scientific classifications, except that which comes from the personal experience of the pupils. Lead the pupils to see, enjoy, love and reflect upon the beauties and wonders of creation.

OUTLINE FOR TREE STUDY.

ALL GRADES.

Cause each pupil or class to select an individual tree for systematic and consecutive study throughout the year. If a maple is chosen, careful observations should be made and recorded in writing, painting, and drawing; different species as to shape, symmetrical development, bark, wood, leaves, flowers, fruit, etc. Skillful effort on part of teacher may foster love for trees that shall be life-long.

I. Environment.

- (a) Open fields—symmetrical development.
- (b) In a forest—tall, slender, etc.
- (c) Near another tree or house—development irregular.

II. Shape.

- (a) Excurrent—development of terminal buds.
- (b) Deliquescent—development of lateral buds.

III. Symmetry.

IV. Parts of Tree.

(a) Roots.

1. Tap-root—long root deep in ground, as nut trees, hickories.
2. Multiple roots—many large roots extending outward from trunk, as in maple, elm, horse-chestnut, poplar.
3. Primary roots—growing from root-end of embryo, as in apple, peach, cherry.

4. Secondary roots—growing from slips or stems, as in willow.

(b) Stems and Branches.

2. Tree—plant of woody structure branching some distance above ground.
2. Shrub—plant of woody structure branching directly above ground.
3. Exogenous stems—separable bark, wood in annual layers, as maple, oak, etc.
4. Endogenous stems—no separable bark. Woody substance in threads within pithy material; as palmetto, cornstalk, etc.

(c) Bark.

1. Birch—bark peels in thin horizontal layers.
2. Ash—bark opens in many irregular netted cracks near each other.
3. Chestnut—bark opens in longitudinal cracks quite distant from each other.

(d) Wood.

1. Heart-wood—dead, dark, central wood.
2. Sap-wood—carries sap in growing season.
3. Medullary rays—silver grain.
4. Annual layers—minute tubes or cells. Large in early growing season; small in late growing season.
5. Age of tree generally told by annual layers.

(e) Branches.

1. Opposite leaves, generally opposite branches.
2. Alternate leaves, always alternate branches.
3. Erect, horizontal and drooping Lombardy poplar, pine and weeping willow.

(f) Buds.

I. As to Position.

1. Terminal: at end of twig.
2. Lateral: along sides of twig.
 - (a) Axillary, in the leaf axil.
 - (b) Accessory, buds clustered around axillary buds.
 - (c) Adventitious, buds produced irregularly.

Nodes: points on stem at which buds are produced.

Internodes: spaces between nodes.

II. As to Activity.

1. Active: those that develop.
2. Dormant: those that form but do not develop.

III. As to Covering.

1. Scaly: covered with dry, tough, bark-like layers.
2. Naked: without scaly covering.
3. Hidden: those buried under or in bark.

IV. As to Arrangement.

1. Opposite: two at same node and opposite.
2. Whorled: three or more arranged around the same node.
3. Alternate: in ranks around stem not being opposite or whorled.

(g) Leaves: lungs of plants.

1. Arrangement: alternate—poplar; opposite—maple; clustered—pines; scattered—spruce.
2. Parts: blade—thin expanded portion; petiole—leaf stalk; stipules—pair of small blades at base of petiole.

3. Veining: parallel, netted; midrib—central line; ribs—second in size; veins—third in size; veinlets—minute lines.
 4. Kinds of leaves: simple—one blade, compound—more than one blade, palmately compound—blades from one point, pinnately compound—blades arranged along-side.
- V. Forms of leaves: broadest in the middle—orbicular, oval, elliptical, oblong, linear, needle-shaped; broadest near base—deltoid, ovate, cordate or heart-shaped, lanceolate, awl-shaped, scale-shaped; broadest near apex—obovate, obcordate, oblanceolate, cuneate or wedge-shaped.
1. Bases of leaves: cordate or heart-shaped, auriculate. Abrupt, tapering, peltate or shield-shaped, reniform or kidney-shaped, halberd-shaped, oblique.
 2. Apexes of leaves: truncate, retuse, emarginate, obcordate, obtuse, acute, acuminate, bristle-pointed, spiny-pointed, mucronate.
 3. Margins: entire, repand, sinuate, dentate, serrate, crenate, lobed, notched, cleft, parted, divided, pinnatifid.
- VI. Nature of Leaves.
1. Surface—pubescent, glabrous, canescent, scabrous.
 2. Texture—succulent, punctate, membranous, thick, thin.

OUTLINE FOR TREE DESCRIPTION.

Tree as a whole: size, general form, trunk, branching, twigs, character of bark, color of bark on trunk, branches, and fine spray.

Leaves: parts, arrangement, kinds, size, thickness, form, edges, veining, color, surface, duration.

Buds: position, size, form, covering, number, color.

Sap and juice.

Flowers: size, shape, color, parts, odor, position, time of blooming, duration.

Fruit: size, kind, form, color when young and when ripe, time of ripening, substance, seeds, duration, usefulness.

Wood (often necessarily omitted): hardness, weight, color, grain, markings, durability.

Remarks: the peculiarities not brought out by the above outline.

FOUR FORMS OF TREE DESCRIPTION.

- I. A bare skeleton description written by aid of topical outline from observation of single tree and its parts.
- II. A connected description conveying as many facts given in outline as can well be brought into good English sentences. This a description of a single tree.
- III. A connected readable description of a certain kind of tree, made up from observation of many trees of same species to be found in neighborhood.
- IV. Third description, including information to be obtained from outside sources in regard to origin, geographical distribution, hardness, character of wood, habits, durability, etc.

NOTE.—The outline for study of a tree is for entire year. Tree should be selected at opening of school year. Monthly drawings and written descriptions by each child regarding its condition at that time. Papers should be of uniform size, properly dated, so that by June the record for a year will be complete. Specimens of autumn leaves, showing depredations of insects, pressed and mounted. Collection of seed made. Specimens of twigs from north, east, south and west sides mounted and compared. Carefully prepared transverse and longitudinal sections of wood. Specimen of newly developed leaves pressed and mounted, showing exposition of leaf area to sun. Specimens of flowers mounted and preserved. Written description should relate growth of tree to atmospheric conditions, soil, etc., and should contain everything that influences its growth.

DRAWINGS.

September—Leaves showing depredation of insects, insects' nests, cocoons, birds' nests and birds found in tree.

October—Groups of fruit—transverse and longitudinal sections, seed.

November—Twig showing buds and scars.

December—Tree as a whole showing shape of top, cone, sphere, hemisphere, oval, ellipse.

January—Transverse section of wood.

February—Longitudinal section of wood.

March—Drawing of twig.

April—Transverse and longitudinal section of bud.

May and June—Weekly drawings showing development, enlarged bud, arrangement of scales, opening buds, flower and parts of flower.

TREES FOR DIFFERENT GRADES.

First. Horse chestnut, maple and spruce.

Second. Oak, hickory and pine.

Third. Fruit trees—apple, cherry, plum; fir.

Fourth. Willow, sycamore, poplar, hemlock.

Fifth. Comparison of trees commercially: as to food, building material, fuel, machinery, railroads, ships, telegraph and telephone poles, arts and sciences.

Sixth. Distribution of trees as to latitude and altitude. Comparison of foreign and domestic woods.

Seventh. Effect of ruthless destruction of trees. Famous trees in history.

Eighth. Literature of trees.

The horse chestnut is chosen for the First grade because the parts are large and conspicuous, and can be easily discovered by the unskilled hand and untrained eyes of little children; the maple for its beauty, abundance, graceful form of fruit, and brilliant coloring of its leaves in the fall; the spruce, that comparisons may be made between evergreen and deciduous trees, and because of its relation to Christmas.

The oak, hickory and pine may be studied as supplying food for the squirrel. The leaves and acorns of as many different oaks, as possible, should be collected and form, size, color, texture of leaves, cups and acorns compared. One class found thirteen varieties in one locality.

Make a collection of pine cones and twigs and distinguish between white, yellow, red, Scotch, and pitch pine, by length, form, arrangement of needles and nature of cones. Make collections of nuts that have been used as food and notice where they have been opened, and compare hardness of shells.

The fruit trees are studied in the third grade in connection with birds and insects and birds showing interdependence of animal and plant life, in the distribution of pollen and seeds in return for honey and fruit. Also in connection with the study of amber and gums in which in-

sects have been imprisoned showing difference between extinct and extant species.

The willow and sycamore are trees which grow best near streams, and should be taken in connection with swamp vegetation. The poplar and willow show marked difference between drooping and erect branching. Compare protection of buds and development of catkins.

In the early years of a child's school life most of the work should be devoted to instilling into his soul an interest and love for trees, but when he reaches the fifth grade he should begin to appreciate their utility; the factor they have been in civilization. Compare the characteristics of different woods and their value for certain purposes. Why should the wood of one tree be used for the mast and another for the keel of a vessel that will weather the fiercest gale, and of another the body of a violin whose vibrations shall thrill the hearts of men.

Relate great forest belts to regions of constant rainfall. Compare growth of same trees under different conditions of climate.

Specimens of ebony, mahogany, bamboo, etc., should be compared with pine, oak, etc. Relate to house furnishing and furniture.

A love for trees should be engendered and a sentiment against the great destruction of forests aroused. When possible have trees planted, and others cared for by destroying harmful insect life infesting trees.

Some experiments can be made showing something of the physiology of plants. Some very valuable suggestions may be found in "Botany" for June, in "Nature Study," by W. S. Jackman.

Outline from "Trees of North America," by Apgar. Read "Under the Trees," by Hamilton R. Mabie.

STUDY OF BIRDS.

- I. Parts of Body.
 1. Head: bill—upper mandible and lower mandible, forehead, crown, hind head, nape, throat, ears, chin, eyes, nostrils.
 2. Body: back, rump, upper tail coverts, tail, under tail coverts, abdomen, breast.
 3. Wings: primaries or hand, secondaries or forearm, tertiaries or arm, false wing or thumb, greater middle and small wing coverts.
 4. Legs: femur, tarsus, metatarsus, hind toe, inner or second toe, outer or front toe, middle or third toe.
- II. Environment: air—aerial; earth—terrestrial; water—aquatic.
- III. Adaptation of structure to food getting. Birds of prey, climbers, flyers, scratchers, swimmers, waders, divers.
- IV. Relation of color to nesting habits. Dull color and open nests; brilliant color and concealed nests.
- V. Compare nests: location, material, size, structure.
- VI. Compare food: manner of securing—characteristics.
- VII. Care and rearing of young.
- VIII. Emphasize beauty, song, use. Kindness to birds.
- IX. Compare likenesses and differences in structure, habits, and usefulness.

STUDY OF INSECTS.

- I. Head: eyes—simple, compound; antennae, mouth parts.
- II. Thorax: legs, wings.
- III. Abdomen.
- IV. Life cycle: egg, larva, pupa, imago.

NOTE.—Place of deposition of eggs. Environment, food, and habits of larval period. Cocoons and different forms of pupa cases; environment, food and habits of imago. Compare imago with larva. Compare homes, habits, food, members of household, community, life, care of young, thrift, frugality, intelligence, communication, manner of locomotion—walking, crawling, flying, beauty of form, color, adaptation of structure to function, economic relation of insects—for honey, scavengers, etc.

Some orders of insects for study—Dragon fly, crickets, potato bugs, butterflies and moths, bees and ants, flies and mosquitoes.

“Insecta,” D. C. Heath & Co.

Outline for Determination of Minerals.

I. Scale of Hardness.

1. Talc and Gypsum. Very soft. Can be scratched with finger nail, or very easily with a knife.

2. Calcite and Fluorite. Soft. Cannot be scratched with finger nail, but easily scratched with knife.

3. Apatite and Orthoclase. Hard. Not easily scratched with knife; scratches glass.

4. Quartz and Topaz. Very hard. Cannot be scratched with knife; scratches glass. Topaz scratches quartz.

5. Corundum and Diamond. Corundum scratched by diamond and itself; diamond not scratched by any other mineral.

II. Specific Gravity.

1. Weight in air.

2. Weight in water.

3. Specific Gravity—weight in air; loss of weight in water.

III. Form.

1. External. Surface—grape like. Porous—mineral incrustations formed from solutions. Stalactitic—hanging from under surface of rock, cone-shaped. Stalagmitic—formed on floors of caverns from dripping water. Stratified—deposited in layers.

2. Internal. Granular, coarse or fine—small crystals. Compact—crystals invisible to unaided eye.

IV. Tenacity.

1. Brittle—breaks easily.

2. Malleable—flattens into thin sheets under hammer.

3. Sectile—may be cut into thin slices.
4. Flexible—retains its form when bent.
5. Elastic—comes back in its original form when bent.

V. Lustre.

1. Metallic, as in metals.
2. Non-metallic—vitreous, as in glass. Pearly, as in pearl. Resinous, as in sulphur, sphalerite, resins. Pitchy, as in cannel coal. Silky or satiny, as in satin spar. Greasy, or waxy, as in serpentine. Dull, as in chalk.

VI. Streak.—Color obtained by rubbing mineral over surface of a piece of ground glass or file.

VII. Diaphaneity.

1. Transparent, semi-transparent.
2. Translucent, sub-translucent.
3. Opaque.

VIII. Acid tests. Use H. Cl. (hydrochloric acid) or dilute H_2SO_4 (sulphuric acid), or both. Use a little of the mineral in a test tube.

1. Insoluble.
2. Soluble. With effervescence, with or without heat. Without effervescence, with or without heat.

IX. Flame Tests. Use a fine splinter of the mineral, or thin edge in the flame of an alcohol lamp or bunsen burner. Note color imparted to flame.

1. Fusible—melts.
2. Infusible—does not melt.
3. Decrepitates. Breaks into small pieces with crackling sound.

4. Intumescs. Swells up without fusion.

Taken from "Nature Study," by W. S. Jackman.

GERMINATION OF SEEDS.

- I. Function of life to reproduce itself.
- II. Environment and activity of a plant directed toward producing seed.

A SEED.

- I. Outer parts: hilum or scar-point of attachment; micropyle—opening near hilum. Seed-coats; outer—testa; inner—tegmen.
- II. Inner parts: cotyledons—thickened leaves in which nourishment is stored. (a) Dicotyledons—two. (b) Monocotyledons—one.

Plumule—small terminal bud; caulicle or radicle—small stem within seed-coats.

Embryo: plantlet.

Seed,	I. Dicotyledon.	II. Monocotyledon.
Venation,	Netted.	Parallel.
Wood,	Ringed.	Fibrous.
Flower,	Fives.	Threes.

I.	II.
/ Bean.	Corn.
Pea.	Wheat.

- III. Plant seeds under different conditions.

- 1. Light, shade, dark.
- 2. Sand, clay, gravel, loam.
- 3. Dry, moist, damp.
- 4. Hot, warm, cold.

IV. Development of plantlet.

1. Bursting of seed-coats.
2. Plumule into stem.
3. Radicle into root.
4. Cotyledons that are leaf-like.
5. Cotyledons not leaf-like.
6. Those that grow above ground.
7. Those that do not grow above ground.

NOTE.—Record accurately the date of planting, first appearance of plant, first leaves, second leaves, etc. Press and mount plants showing development during two or three days.

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