7:10 on the evening of July 12 and lasted about twenty minutes. As the size of the hailstones was very much larger than is usual in this part of Canada, and as the storm was accompanied by an unusual phenomenon, noted below, it seems worthy of record.

The storm approached us from the southeast, while we were near the divide between streams flowing southwest to the English River and Lake Winnipeg, and those flowing easterly towards the Cat River, a large stream, or rather a chain of lakes tributary to the Albany River. The hailstones varied from about the size of buckshot or small marbles to spheres and other forms over one inch in diameter. One large stone, in shape a compressed ovoid, measured $1.25 \times 1.75 \times 2.25$ inches. Others over 1.50 inches in diameter were plentiful. The smaller hailstones were almost invariably of clear ice with a small white nucleus of snow. The larger ones were usually white with a transparent nucleus. Many of the pellets, both small and large, were almost perfect spheres, but not infrequently the large ones took the form of disks, thin and transparent in the middle, with thicker edges of snow, reminding one of the shape of the red blood corpuscles or the fly-wheel of a sewing machine. One large pellet of this kind measured 1.75 inches in diameter and the circular rim was one inch thick, the middle portion of the disk being transparent. The disks were more often ellipsoidal than circular. The surface was generally warty or mammillated, as if produced by the coalescence of a number of independent hailstones, whereas that of the spheres and ovoids was usually smooth.

The most interesting feature accompanying the storm was the behavior of the moss carpet flooring the spruce forest everywhere. In this portion of the district this surface cover consists almost wholly of a dense mat of the moss *Hypnum triquetrum*, through which are woven a tangled mass of roots, living and dead. The thickness of the cover varies from a few inches to over a foot. During the storm there was no wind noticeable in or near the camp. The moss carpet in front of and underneath our tent was seen and felt to be heaved in waves, the crest lines, just in front of the tent door, sometimes raising the moss as much as a foot above the normal position. These undulations traveled in the same direction as the storm was moving, *i. e.*, towards the northwest. No two crests were seen to be in existence at the same time, but the field of view was limited to an area of about thirty feet across in the direction the waves were moving. The movement began, or at least was first noticed, near the end of the hailstorm, and continued for some time after the rain and hail had ceased to fall, lasting for a period between five and ten minutes. The writer has frequently been in the moss-carpeted spruce forests of central Canada during thunder storms, but has not happened heretofore to have met a similar phenomenon. The cause of the movement seems to lie in the fact that the moss cover retained the water which first fell upon it, soaking it up like a sponge and hence became nearly air-proof. The air underneath, in the interspaces between the boulders and fallen timber upon which the moss lies, would sympathetically respond to slight variations in the barometric pressure and cause the moss to rise and fall as the pressure decreased or increased. Soon after the movement ceased many of the spaces that before contained only air were filled with water, and walking on the moss was not unlike walking on a wet sponge.

Alfred W. G. Wilson.
McGill University, Montreal.

## What is Nature Study?

As was stated in Science for June 20, of this year, there seem to be, among educators, many conflicting definitions in the attempt to answer the above question. Bearing on this subject the following letters have been received from eminent scientific men of this country. They appear in the order in which they were received. W. J. Beal.

Agricultural College, Mich.

The present movement toward developing and spreading an interest in nature studies is one of prime importance. Our American children are, after all the efforts thus far made, woefully lacking in interest in natural

history—far behind German, and even English children, I fancy.

I consider 'nature study' as a study of plant and animal life at first hand, rather than from books; seeing, examining and studying a plant or animal, how it grows; if an animal, how it moves, runs, walks, flies, swims, how it gets its livelihood; and then the child can learn to observe its relation to the life about it and to the world around. Let him observe, for example, ants, the difference between the males, females and workers, how the workers live and care for the colony. He may see a train of ants; let him follow the train off to the nest. Then there are the nests and working habits of wasps and bees.

A student of 'nature study'—a boy or girl—should raise caterpillars to the chrysalis and moth or butterfly state. Collecting, feeding them, watching them through their transformations, is a first class lesson for a child in nature study. So a boy or girl can get a first lesson in physical geography and geology by studying a sand heap or clay bank after a rain—or the work done by a stream or brook.

Nature study is the first step towards natural science, and is all-important in leading one to observe, experiment and reason from the facts he sees. It is of prime importance in teaching a child *what a fact is* in these days of Christian Science and other fads.

A. S. PACKARD.

BROWN UNIVERSITY.

I do not believe I can give in a few sentences my views as to what constitutes nature study. I think the thing is in a chaotic state at present, and I do not feel competent to define it. I have fairly definite ideas as to what material in botany should be included, but botany is only one of the phases of the subject as handled. I think the name nature study is too indefinite to be retained.

JOHN M. COULTER.

UNIVERSITY OF CHICAGO.

I have your letter asking for my definition of 'nature study.' I hope you will succeed in getting this much-abused term properly defined.

I would have nature study mean the study of living things to determine their habits, instincts, adaptations and relations to environments. To be nature study in the highest sense of the term, the work must be carried on under natural, as opposed to artificial, conditions.

If a broader interpretation were given, where can we stop short of geology, mineralogy, chemistry, physics, and in fact nearly everything else outside of mathematics.

C. P. GILLETTE.

FORT COLLINS, COLO.

Much that has been taught under the name of nature study is not properly a study of nature, but a *memoriter* drill or an empirical abstract of what some one else has learned by a study of nature. The subject has too often been presented under the guidance of teachers who themselves have made no real study of nature—who have no clear understanding of the scientific method of study by which alone matters of natural fact can be approached, and who have not sufficient competence to carry on the study of nature by themselves. But nature study is sometimes what it ought to be: a truly scientific and well-conducted study of nature, of a grade, whether elementary or advanced, appropriate to the age of the pupils; as logical as geometry and as disciplinary as Latin, but entirely unlike either one of these standard subjects.

Direct observational appeal to natural phenomena should always be the essential foundation of a real knowledge of nature, and much skill should be exercised by the teacher in selecting from nature's inexhaustible store such phenomena for study as shall really be within reach of the pupils' own observation and understanding. The text-books should serve chiefly to broaden the knowledge gained through observation by presenting additional examples of similar phenomena from various parts of the world. At the same time, and always in a measure appropriate to the grade of the class, the various other processes of scientific method should be brought into play: generalization, invention of explanations, test of explanations by deduction, appeal to experi-

ment, the need of a critical and unprejudiced judgment in reaching conclusions, revision of work and suspension of judgment in doubtful cases. Elementary examples of all these processes may be presented, though those just named are more appropriate than the others for young classes.

In the illustration of nature study with excerpts from poems, I have comparatively little interest, especially when, as is so often the case, the excerpts are not chosen by the teacher, and still less when the teacher's temperament is not poetic. Spontaneous quotations from any field of really good literature in prose or poetry, brought in because of real literary feeling on the teacher's part, are in just measure admirable aids to study of all kinds; but if poems on nature be made an essential part of nature study, it is likely to become emotional rather than scientific and disciplinary.

Desire and capacity to carry the study of nature further should be the chief end of nature study, and it is for this reason that I would emphasize in all grades the disciplinary rather than the sentimental view of the subject. The scientific method should be constantly inculcated, but more by example than by precept.

This should lead to a clear understanding of the order of nature, based not on authority but on the cultivation and use of a keen, unprejudiced, sympathetic reason: emotional sentiment, a subject responsive in so far as it is excited by natural phenomena, is better cultivated in the appreciative study of art and literature than in nature study.

W. M. Davis.

Cambridge, Mass.

Properly it is simply synonymous with the good old term 'natural history.'

As I take it, all zoologists, botanists, biologists, etc., are pursuing 'nature study,' each in his own way. I have no sympathy with the desire of some superficial persons to limit such a term to kindergarten work in zoology and botany, which is about the idea held in some schools.

That kind of work is right and proper and useful in its place, but why it should monopolize the term 'nature study' is known only to the minds of those who can go no farther than the a b c of science.

E. A. Verrill.

New Haven, Conn.

I should say that, on the positive side, any direct contact with natural objects, continued by critical or comparative studies, either elementary or advanced, should come under the head of nature study. Negatively, I should exclude all fairy stories about animals and plants, all fantastic stories of creatures more or less imaginary, and should restrict the term so as to include only such work as would bring the student face to face with realities. The essential virtue of nature study lies in its reality, as distinguished from the conventional, artificial or second-hand kinds of learning.

David Starr Jordan.

Stanford University, Calif.

I should say that by nature study a good teacher means such study of the natural world as leads to sympathy with it. The keynote, in my opinion, for all nature study is sympathy. Such study in the schools is not botany; it is not zoology; although, of course, not contravening either. But by nature study we mean such a presentation, to young people, of the outside world that our children learn to love all nature's forms and cease to abuse them. The study of natural science leads, to be sure, to these results, but its methods are long and have a different primary object.

Thomas H. Macbride.

University of Iowa.

Besides the letters above, a brief quotation is here given from an excellent book recently published by Clifton F. Hodge, Ph.D., of Clark University:

Nature study is learning those things in nature that are best worth knowing, to the end of doing those things that make life most worth the living.

My point is that nature study, or elementary science, for the public school ought to be all for *sure human good.*

Here is a paragraph from a recent letter

from Mrs. J. M. Arms, who is in charge of nature study in the schools of Boston, Mass.:

Nature study is simply the study of nature, not the study of books. It is a course of nature lessons especially adapted for elementary schools. Minerals, rocks, plants and animals are the necessary materials for such lessons. The method of study may be expressed in three words, observation, comparison, inference. The child must be made to see the object he looks at, and to this end he tries to draw it and to describe it in writing. Comparative work is mental training, which, combined with the observational training already spoken of, gives a certain degree of mental power. This power gained in the early years increases with continued effort. Fortunately, this work is recognized as one of the potent agencies in producing efficient men and women equipped for a life work that shall make for the betterment and enlightenment of humanity.

## *SHORTER ARTICLES.*

### DISCOVERY OF TEETH IN BAPTANODON, AN ICHTHYOSAURIAN FROM THE JURASSIC OF WYOMING.

AMONG the vertebrate fossils collected by Mr. O. A. Peterson during the season of 1900 on Sheep Creek, Albany County, Wyo., there was obtained from the lower beds of the Jurassic a very complete skull of an Ichthyosaurian reptile (*Baptanodon discus?*) together with a few vertebræ and ribs.

Through the courtesy of Mr. J. B. Hatcher, curator of the Department of Vertebrate Paleontology of the Carnegie Museum, this material has been placed at the disposal of the writer for study and description.

Heretofore the American Jurassic Ichthyosaurians were supposed to be edentulous, but while preparing this specimen (No. 603) for study the remarkable discovery was made that the jaws bore teeth, two of which were found between the jaws near the end of the snout. One tooth was apparently in position in the upper jaw, while the other lay imbedded in the matrix between the jaws and entirely detached from them. The teeth are small, conical, and covered with longitudinal striæ. In general form and surface markings they resemble very closely the teeth of the Liassic Ichthyosaurs of England and Europe. The teeth were undoubtedly loosely fixed in the jaws and have been lost in all previously discovered specimens. In the present skull a few of them have fortunately been retained, and we have here the first evidence of their presence in *Baptanodon,* which may be regarded as the American representative of the Ichthyosaurian reptiles.

When the skull is entirely freed from the matrix and the jaws separated from one another, more teeth will doubtless be exposed.

From the above evidence it would appear that the generic terms *Baptanodon* (*Saurano-don*) of Marsh* are misnomers.

The reduction in size and number of the teeth in the Jurassic Ichthyosaurians is paralleled in some of the recent Cetacea. Most if not all of the early (Eocene and Miocene) cetaceans were well provided with functional teeth, while in many modern forms these either have been entirely lost or have become rudimentary, in some instances appearing only in the embryonic or young stage of the individual. Just so the early Ichthyosaurs were provided with an abundance of teeth, but in later forms the number and size of the teeth were reduced, until in *Baptanodon* a form was developed which, while still possessing teeth, was practically edentulous.

*Ichthyosaurus longirostris* as described by Owen,† was in this respect intermediate between *Ichthyosaurus longifrons* from the Lias of England and Europe, and *Baptanodon discus* of the American Jurassic.

The presence of teeth, though undoubtedly reduced in number and in size in American Ichthyosaurians, may perhaps be considered as invalidating the genus *Baptanodon,* for on that character alone Marsh distinguished that genus from the European genus *Ichthyosaurus.* It would seem better, however, to retain the generic name *Baptanodon* until

* 'A New Order of Extinct Reptiles, Sauranodonta,' *Amer. Journ. of Science and Arts,* Vol. XVI., January, 1879, p. 85.

† 'Fossil Reptilia of the Liassic Formation,' part third, p. 124.