explained by the consideration, that, when the great ice sheet was most extended, its local depth was great as compared to the height of the mountain ridges, and it traversed them obliquely with little or no deflection; but, as its extent and depth diminished, it yielded more and more to the control of the topography. Prof. E. W. Claypole pointed out, that, granting this explanation, a strong argument was afforded against the theory that ice is a great agent of erosion. If the erosion of the later epoch was too feeble to efface the scratches left by the earlier, we cannot reasonably regard the earlier erosion as great. Mr. William McAdams, who last year exhibited bones from the loess at Alton, Ill., announced further discoveries of the same nature, and described the superficial deposits of the region. The list of species now includes mastodon, ox, deer, megalonyx, beaver of several species, gopher, ground-hog, bear, and an animal allied to the wolf.

A phase of post-glacial geology was treated by Mr. G. K. Gilbert, who has recently traced an old shore-line of Lake Ontario half way about its basin. From Hamilton, Can., to Sodus, N.Y., it runs parallel to the modern shore. It then turns southward, and deviously outlines a great bay, studded with islands, which occupied the basin of the Oswego River and its branches from Lyons to Rome, and sent a narrow arm to Cayuga Lake. East of Lake Ontario it is once more parallel to the modern shore. The outlet was then at Rome, and the discharge flowed down the Mohawk valley. The plane of the old water-surface is no longer horizontal, but inclines southward, with an average slope of about four feet to the mile, and westward more gently. At Adams Centre, in Jefferson county, it is 650′ above tide; on the north shore of Oneida Lake, 480′; along the Erie canal south of the lake, 430′; near Rochester, 423′; at Hamilton, 350′. It passes beneath the water of Cayuga Lake near its north end. Subsequent to the epoch of this shore-line, the water-surface of Lake Ontario was depressed below its present, as is shown by many of its bays, which occupy valleys wrought by post-glacial stream erosion. Mr. Gilbert's working hypothesis is, that the shore-mark associated with the Rome outlet records an epoch in which the retreating ice-sheet still occupied the St. Lawrence valley. The northern side of the basin was then relatively depressed; and when the water finally escaped past the ice at the north-east margin of the basin, its surface rapidly fell to a position below the present shore. The existing system of levels has been effected by subsequent crust movements.

A paper by Prof. Frederick D. Chester, on the gabbros and amphibolites of Delaware, was read by title, and will be published in the proceedings. Prof. A. R. Crandall gave an account of some small volcanic dikes, recently discovered in Elliot county, Kentucky. The surrounding strata lie nearly level, and the locality is about ninety miles north-west of the nearest Appalachian dislocation. The dikes do not impress their form on the topography, but have yielded to decay along with the enclosing carboniferous strata. Prof. L. E. Hicks remarked that he had observed on the White River in Nebraska a dike which resembles these, in that it is associated with no disturbance of the sedimentary rocks.

Mr. George F. Kunz briefly described a new mass of meteoric iron from Carlestown, W.Va., and read a series of notes on minerals from new localities, or otherwise interesting. Among them were native antimony from Prince William, N. B.; tourmaline from Rumford, Me.; a pseudomorph of felspar after leucite (?) from Magnet Cove, Ark.; a curious form of beryl from Auburn, Me.; a capped garnet from Raymond in the same state; and a turquoise from New Mexico, artificially stained to produce a favorite blue shade. He described, also, a collection of rough diamonds, temporarily in the possession of Messrs. Tiffany & Co., bringing out especially the fact, that the convex curves of some rough diamonds are not referable to attrition, since only the diamond can wear the diamond, but are made up of crystalline facets. A paper by Dr. T. Sterry Hunt, on the apatite deposits of the Laurentian rocks, was read by abstract.

EDUCATIONAL MUSEUMS OF VERTEBRATES.[1]

FROM what is known of man's present constitution and environment, and from what is commonly believed respecting his future form, condition, and associates, it seems to follow that all kinds and degrees of zoölogical instruction, whether anatomical, histological, physiological, pathological, psychological, or religious, should be based upon some knowledge of vertebrated animals. As aiding to make this knowledge real and lasting, every educational institution, of whatever grade, should have a vertebrate museum.

From many vertebrate collections the average visitor carries away, besides the sense of fatigue, certain impressions which are inadequate or erroneous, or, if correct, uncomplimentary.

The following plans and methods are followed in a preliminary re-arrangement of the vertebrate collections at Cornell university: The exhibition-cases should contain only specimens which can instruct or interest the visitor. Not only should facts be displayed, but fundamental principles should be illustrated. There should not only be special series of embryos, brains, hearts, etc., but such preparations should be associated, to a certain extent, with the animals to which they belong. Preparations illustrating important facts should retain so much of the entire animal as may facilitate recognition and association; when this is inconvenient, the preparation may be accompanied by a figure of the animal. When the relative rank of several forms is well determined, the lower or more generalized should be placed below or at the left, and the higher or more specialized

[1] Abstract of an address delivered before the section of biology of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Dr. BURT G. WILDER of Cornell university, vice-president of the section.

above or at the right. As a rule, each specimen should teach but one thing, and that thoroughly. The same form may, therefore, properly recur in several parts of the museum, to illustrate different parts or ideas. Quality is more important than quantity, and arrangement is usually more needed than acquisition. True economy consists in paying liberally for what is wanted, rather than in taking what is not wanted as a gift. The usefulness of a specimen, and thus its real value, is to be measured, not by its rarity or cost, but by the degree in which it exemplifies important facts or ideas. Many specimens should not only be labelled, but also accompanied by figures and explanations.

In addition to, or more often in place of, the three great series — physiological, taxonomic, and geographical — which are commonly attempted in museums, but which it is rarely possible to complete, specimens representing an equal amount of time or money would have a higher educational value if divided among a considerable number of special series, each illustrating some morphological or teleological principle.

Some of these series are strictly artificial, yet useful; as, e.g., animals exterminated by man; those which supply us with food, medicine, weapons, clothing, or materials for habitation; fabulous, mythical, and sacred animals; and those which are mentioned by Shakespeare, and in the Scriptures.

Of natural series, the most conspicuous and complete should be the *vertebrate branch synopsis:* this should embrace, within a space easily covered by the eye, one stuffed example or model of a species representing each vertebrate class, together with four preparations exhibiting the vertebrate type of structure; viz., a transection of the whole body; a hemisection of the whole body; a complete vertebral segment; a hemisected skeleton showing the variation in size of the neural and haemal cavities. So far as possible, these preparations should be made from members of different orders of the class, and be accompanied by outline diagrams and explanations.

Each class, but first and especially the mammalian, should have its own special synoptic series, embracing one or more entire examples of each order, and preparations illustrating the characters of the class. The choice and arrangement of these preparations are complicated by the desirability of indicating that what are commonly enumerated as class characters are of unequal degree: some are constant and peculiar; some constant, but not peculiar; others peculiar, but not constant; and others, again, though usual, are neither peculiar nor constant. The neglect to indicate these differences in lectures, text-books, and museums gives rise to inaccuracy or uncertainty in the minds of students.

Instead of vainly attempting to obtain and exhibit all the species of all the groups, most educational museums would attain more satisfactory results by selecting the more interesting or instructive forms from all classes, and limiting their efforts to complete groups for a few, upon which, as well as upon a larger number, may be illustrated the principles of classification, and of individual and geographical variation.

Among special series other than systematic, are *analogous forms and structures* which are sometimes mistaken for one another, but more readily discriminated when brought together. Such series are the rostrated animals, spinous forms, and those which have parachutes. *Physiological series* would contain the hibernating animals, those which are blind or nearly so, and such as are provided with scent-glands, tusks, and all poisonous vertebrates.

A *local collection* should embrace all the animals of the vicinity, and will benefit the student, both as an example for him to follow or improve upon, and as exemplifying the laws of geographical distribution and the influence of environment. The local collection need not contain anatomical preparations, but should exhibit both sexes, and all stages of growth of each species, — its mode of life, friends and foes, — so as to interest also the children, farmers, fishermen, hunters, and other residents of the neighborhood.

Special attention should be called to existing deficiencies, not only in the local collection but in all parts of the museum; and graduates or other friends of the institution should be reminded of the opportunities, often peculiar, which they may have of supplying desiderata.

Although more than a quarter of a century has passed since the modern scientific doctrines respecting the methods of creation began to be accepted; although opposition to the general idea of organic evolution is now nearly confined to the stubborn and ill-informed; and although its substantial truth is tacitly admitted, or openly claimed, in nine out of ten higher educational institutions in this country, — I have yet to learn that any considerable part of a college museum has been specifically devoted to the exhibition of the facts which are described or figured in most zoölogical manuals, and in many works upon popular science.

Such a collection should embrace much more than a few ape-skeletons hung beside that of man. To avoid the appearance of dogmatism, let me briefly mention the various series relating to evolution which have been begun at Cornell university: Simple ontogenetic series, exemplifying the extent and rapidity of individual transformation; comparative ontogenetic series, illustrating the resemblance between successive stages of one form and the adult conditions of others; generalized, synthetic, or intermediate forms, or 'connecting links;' forms supposed to have degenerated; apparently useless or even hurtful organs or conditions; apparently needless rules, with equally unaccountable exceptions thereto; human peculiarities, not only as to the skeleton, but as to the brain, heart and other organs; human resemblances to mammals in general; features which unite man with the tailless apes, and separate them all from the other mammals; transitory human organs and conditions which resemble the permanent organs and conditions of other mammals, especially apes; human anomalies resembling the normal structures of apes; anomalies and malformations affecting

man and other vertebrates in a similar manner; evidences of accident and disease among wild animals.

Presumed lines of human descent may be indicated better than by diagrams upon a plane surface, by placing actual representatives of the various groups, not upon fixed shelves, but upon brackets capable of adjustment.

The candid teacher or curator will endeavor to show not only the facts which seem to support evolution, but also those which constitute its difficulties.

A statue of Darwin has recently been unveiled in London with honorable ceremonies. What monument to his memory could be more appropriate or lasting than the formation, in all educational institutions, of collections especially designed to exhibit the facts which he made significant, and the ideas which his knowledge, his industry, and his honesty have caused to underlie the intelligent study of nature throughout the world?

PROCEEDINGS OF THE SECTION OF BIOLOGY.

THE biological section opened with two papers by Prof. E. L. Sturtevant as the result of observations and experiments at the New-York agricultural experiment station. The first, on the hybridization and cross-fertilization of plants, showed in a conclusive manner that in our common vegetables (peas, corn, beans, barley, lettuce, are some of the forms experimented with), cross-fertilization tends toward atavism rather than to a blending of individual properties of the parent plants. As a rule, all the crosses tended to revert to an ancestral form, regaining in many cases characters which the immediate parent had lost. The paper forms a valuable contribution to the subject of the origin of species, on account of the carefulness of experiment and accuracy of observation apparent in the work. In the second, 'Germination studies,' the author states, as a result of many trials with commercial seeds of our common plants, that very extended series of trials must be made with each species in order to obtain the desired accuracy in results; since in a short series of trials many errors will probably occur which would be eliminated from the final result by the use of a larger series. Prof. W. J. Beal of the Michigan agricultural college described an experiment on the longevity and endurance of seeds — in which ripe seeds were buried in sand below frost for five years, at the end of which time they were exposed to frost for a period of two years and a half more.

An interesting paper on the biological deductions to be drawn from a comparative study of the influence of cocaine and atropine on the organs of circulation, was given by Dr. H. G. Berger, U.S.N. The generally accepted opinions regarding the use of atropine, muscarine and cocaine, on the organs of circulation, are, that atropine induces an augmentation and acceleration of the circulation by paralyzing the vagus nerve-endings in the substance of the heart; and that muscarine, by acting as a stimulus to the same nerve-endings, produces diastolic arrest. The later view of Glouse, however, is, that the arrest is due to its paralyzing influence on the muscles of the heart. The main points in these two views are, 1°, that the action is purely a nervous phenomenon; 2°, that it is purely muscular. When atropized blood is put into a frog's heart, the organ is first highly stimulated, but shows evidence of exhaustion by over-stimulation; this is associated with a break in the rhythm of the beats, the auricles contracting two to three times oftener per minute than the ventricles: the dose of atropine can be so regulated that this unrhythmical action may be kept up indefinitely, and even be reproduced in a heart which has recovered from atropization in normal blood. The most rational explanation of this phenomenon is found in the facts, that, while muscarine paralyzes, atropine stimulates, the cardiac muscles as well as the cardiac nerve-endings; though in case of the latter only in a slight degree. Cocaine affects the nerve-endings within the heart much the same as atropine, but is not a muscular stimulant. From his researches, Dr. Berger reached the conclusion that the drugs used acted directly on the muscle-tissue, producing paralysis, and not indirectly through the nerve-endings, — a view which was combated by Profs. Charles A. Sewall and H. N. Martin in the discussion which followed the reading of the paper.

'On the brain and auditory organs of a Permian theromorph saurian' was the title of an interesting paper by Prof. E. D. Cope. The author called special attention to the morphology of the brain, the character of the cranial walls and the auditory apparatus. The characters of the brain were considered to show affinities to the reptilian and the simpler mammalian types. The corpora quadrigemini are small, and the cerebral hemispheres exceedingly small — relatively inferior in bulk to those of any other known animal. The epiphysis is larger than is usual for reptiles. The absence of an optic foramen is a very striking character. This form is peculiarly characterized by the presence of a large oval foramen in the frontal region, the exact nature of which has not been determined. The vestibule and its walls were thoroughly described, and the relations of the well-formed semicircular canals explained. The stapedial bone connects with the fenestra ovalis external to the brain case, and at a great distance from the cochlea — the cavity of which is a mere extension of the fenestra ovalis to the vestibule. The semicircular canals resemble those of modern reptiles.

Mr. A. W. Butler presented many interesting facts concerning the habits of the musk-rat. The author mentioned well-authenticated cases of the change of habits as a means of adapting itself to the changed conditions of life, — conditions brought about by the presence of civilized man.

The disputed question of the bisexuality of the pond-scums (Zygnemaceae) was discussed by Prof. C. E. Bessey of the University of Nebraska, who concluded that these organisms do not possess true bisexuality such as Bennett of England claims for