as the "Manual of the Common Invertebrate Animals" by the same author (McClurg).

Like this latter book, which leaves out of account the insects, on the ground that they are practically a subdivision in themselves, and have been so often and so repeatedly written up that they may here be well left out of account, so in this new manual of the vertebrates the birds are similarly treated, and for the same reasons. The fishes, too, are limited to those of fresh-waters, that is, ponds, lakes and rivers, leaving out of account the ocean-dwellers. In the same way, no mention is made of the true oceanic mammals, whales and porpoises (Cetacea), although seals and manatees (Pinnipedia and Sirenia) are included, as are, of course, otters and beavers. The polar bear is shut out, on the other hand, not because of his occurrence frequently in salt water, but because of his non-inclusion geographically within the limits of the United States.

Within this territory, and within the limits of the animals treated, the author gives a detailed, and very modern, treatment, including not only the various species into which certain well-established and classical animals have expanded, but also in many cases has found room to enumerate many sub-species or varieties. For example, the fishes commonly called "trout" expand into five species of *Onchorhynchus,* 31 species of *Salmo,* two species of *Cristivomer,* and one species of *Salvilinus,* this last divided into five sub-species. Of course these are not all called "trout," for there are several "salmons" among them, which seem to be nothing but convenient popular distinctions, whose replacement by a more technical classification is much to be desired. The genus *Notropis* (Shiners) contains no less than 64 separate species, for which, although some distinctions may have been observed among careful and enthusiastic fishermen, there are nowhere near enough popular names in use among them. The catfish (Siluridae) are represented by five genera and 23 species, of which the commonest, *Ameiurus nebulosus,* is further divided into five subspecies.

The salamanders, so numerous a group in this country, are well expanded, represented by 21 genera and 63 species, the most plentiful North American family, the *Plethodontidae,* consisting of 14 of these genera and 39 of these species. Certain of the most abundant species, like *Desmogmathus fusca,* and *Eurycea* (*Spelerpes*) *bislineata,* mention seven subspecies, five of the first and two of the second, yet the end is not yet!

Scattered throughout the book there will be noticed certain new and unfamiliar names, such as *Eurycea* for the more familiar *Spelerpes*; *Triturus* for *Diemyctylus,* and the introduction of *Sylvilagus* for a branch of the old genus *Lepus.* These, however, follow closely the most recent revisions of the systematists, and are not only inevitable, but, as the systematists assure us, follow the established law of priority, and will not be changed again. Opinions differ concerning the use of these revised names, especially between the systematists and the anatomists, and differences of opinion are natural among such men, since one of them focuses his attention upon the relations of the mesonephros, and those of the arterial arches, and the other upon the number of costal grooves and whether the fore-legs, when folded, reach the nose or not. Whatever opinion we may have on the matter, it is right and important that in writing a work upon systematic zoology the author adopt the newest uses of the systematists.

It is to be devoutly hoped that, eventually, these two groups will unite and no longer force us to employ a long synonymy for each animal; it is also not beyond the possibility that at least amateur fishermen, men who have a real love for nature and are actually naturalists, although they may be unwilling to acknowledge it, may learn to use the terms of systematic zoologists, and be no longer content with the use of vernacular names, which change locally and confuse well-marked varieties.

To accomplish these greatly desired ends, such works as these two of H. S. Pratt are especially calculated.

H. H. W.

A Manual of Laboratory Astronomy. By HARLAN TRUE STETSON, with the collaboration of JOHN CHARLES DUNCAN. Eastern Science Supply Co., Boston, 1923. 150 pages.

IN the teaching of descriptive astronomy, laboratory work has not, in general, been accorded the same relative amount of attention as it has received in physics and chemistry; and this neglect has in some cases been due not to the disinclination of the instructor to use the laboratory method, but to the want of suitable apparatus for indoor work or to the failure to realize that laboratory work need not be entirely dependent on the weather. This manual is well adapted to obviating such difficulties; for the authors have not only provided sufficient exercises for indoor use during cloudy weather, but have also made arrangements whereby the necessary equipment may be purchased conveniently from a single dealer.

The book in its present form contains 33 exercises designed to cover the material usually presented in an elementary course in descriptive astronomy, with references to Moulton's "Introduction to Astronomy," to Young's "Manual of Astronomy," and occasionally to Willson's "Laboratory Astronomy." The exercises are contained, however, in a demountable binding, which, for all practical purposes, holds the leaves as firmly as would a permanent binding, but which permits the addition of new material or the rearrangement of the exercises to conform to any desired order of presentation.

Although trigonometry is not used, which may be regretted by some teachers, the exercises are not too elementary. The questions which accompany each exercise are especially well chosen and demand considerable thought on the part of the student. The explanations and instructions to students are admirable for their clearness and completeness, and should reduce personal supervision to a minimum.

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SPECIAL ARTICLES

ON THE DIFFICULTIES ENCOUNTERED IN THE EVOLUTION OF AIR-BREATHING VERTEBRATES

GEOLOGISTS and paleontologists have noticed and commented upon the relatively late origin of the air-breathing forms of animals, meaning thereby, as I understand the situation, the animals which can range freely at a considerable distance from the water. Some have attributed this late origin to the presence of high concentrations of carbon dioxide in the early atmosphere, so high, in hypothesis, as to preclude respiration in the atmosphere. When one compares the relative solubilities of carbon dioxide and oxygen in water at ordinary temperatures, it is a bit difficult to see how aquatic or marine forms would be very much better off as regards the presence of oxygen or the absence of carbon dioxide than the terrestrial forms. Chamberlin,[1] dissents from the view that high concentrations of carbon dioxide in the atmosphere prevented or delayed the appearance of land forms, and regards their late origin as due to the difficulties encountered in their evolution. I am inclined to agree with Chamberlin, as the difficulties to be overcome by these forms seem considerably greater than has been realized by either comparative anatomists or paleontologists. Some months ago, I[2] presented a short summary of my views on the organization of the nervous mechanism for the control of respiratory movements. The full data on which these conclusions were based have not yet been published, and the survey of the phylogenetic development of the respiratory mechanism is not yet finished, but some further conclusions bearing on the origin of the air-breathing vertebrates seem fairly clear. In view of their paleontological as well as physiological interest, I wish to make a further brief statement at this time.

[1] Chamberlin, T. C., *Journal of Geology*, 1897, V, 653.

[2] Pike, F. H., and Coombs, Helen C., SCIENCE, 1922, LVI, 691–693.

It is apparent that the respiratory mechanism of vertebrates has undergone more profound and far-reaching changes in the transition from aquatic to air-breathing forms than any other functional mechanism of the organism unless we except the central nervous system itself. The development of lungs has received much attention from comparative anatomists and paleontologists, but the development of lungs has supplied only a part of the new mechanism which was necessary. The respiratory muscles of fish are mainly those of the mouth or the special branchial muscles of the neck. So far as inspiration goes, these same muscles, or their lineal descendants, in the mouth are still functional in the amphibia which possess lungs. No conflict between food swallowed and respiratory medium taken into the mouth —water containing air in solution—occurs in fishes. With the development of an offshoot of the esophagus as an air passage in the frog, a coordination of the swallowing and the respiratory movements becomes necessary to prevent the entrance of food into the trachea and the air passages generally. This need becomes greater rather than less in successively higher types of vertebrates. The coordination of these two acts (swallowing and respiratory movements) requires the development of a special nervous mechanism which, so far as I am aware, does not exist in fish. The muscles of the flank and abdomen of the frog have some expulsive or expiratory action, but no true inspiratory action. It is only when the reptiles are reached that we find the muscles of the body wall acquiring a true inspiratory function. The frog, depending upon the muscles of the floor of the mouth for forcing the air into the lungs, can not take air into the lungs while holding the mouth open. Its food is limited to such things as it can swallow without holding the mouth open too long. The serpents, because of their ability to draw air into the lungs through the action of the muscles of the body wall, may swallow animals of considerable size, taking their leisure for the process and pausing to breathe when necessary. Though many of the reptiles still remain near the water, or even live in it most of the time, it is among these forms that we find the first animals which can live far from the water for relatively long periods. Lastly, we find in the mammals the final stages of the development of the new mechanism for maintaining a biologically adequate relation of the animal to the atmosphere. The diaphragm makes its appearance here, and I am one of those who dissent from the view that the diaphragm is of relatively little importance in respiration. All mammals may continue to take food or hold prey with the teeth without being compelled to stop occasionally to swallow air.

The change from the respiratory mechanism of