carapace or any part of it "fascia bones"; they must certainly have arisen as purely dermal, membrane bones, and must have preceded the development of an outer layer. And one can not understand why such ossicles might not have developed, under the stress of peculiar environmental conditions, in the aquatic turtles after the loss of the true dermal carapace. Furthermore, this phylogeny seems yet to be based almost wholly on hypothesis, for we have little evidence of such a primitive condition, save that possibly afforded by the neural ossicles of *Toxochelys*. Here, too, it seems to the writer the argument is against the hypothesis, since the more specialized aquatic *Toxochelys* has the neural ossicles, while the nearly related, and less aquatic *Porthochelys* is without them.

The usual suborders, Cryptodira, Amphichelydia, Pleurodira and Trionychoidea are made superfamilies by the author, and, so far as the Trionychoidea are concerned at least, the writer agrees with him under any classification.

Dr. Hay recognizes the difficulty in deriving the turtles from any except the most primitive of reptiles; in other words, the order represents a phylum all its own in the evolution of the reptiles, a view first offered by Cope, with which the present writer is wholly in accord.

From his wide and accurate acquaintance with the literature of American fossil vertebrates it would be expected that little has escaped the author's attention; but he is not infallible. He expressly states that no fossil turtles are known from the Dakota Cretaceous, overlooking the fact that only a few years ago (1899) a very interesting specimen from that formation was described and figured by Parmenter in the *Transactions of the Kansas Academy of Science;* and it is to be regretted that he did not examine and describe the remains of a large marine turtle from the Benton of Kansas now in the University of Kansas Museum, to which attention was called six years ago by the present writer in the *Kansas University Quarterly*. However, such omissions will be found to be very rare in the work, and are not disquieting.

The illustrations are for the most part good, especially the text figures, of which there are over seven hundred. The Carnegie Institution is to be congratulated on the publication of this valuable and useful work.

S. W. Williston

The Study of Stellar Evolution. By Geo. E. Hale. Pp. xi + 252; 104 plates; 7 text-figures. University of Chicago Press. 1908. Price, postpaid, $4.27.

The past quarter of a century has witnessed a complete revolution in the conception of astronomy and of an astronomical observatory. The astronomy of twenty-five years ago was the science of position and of motion. The problems which then confronted the investigator were those concerning the size and shape of the planets, their distances from the sun, the periods of time in which they complete their orbits, and the discovery and explanation of the laws which govern their motions. The solution of these problems requires the precise measurement of the positions of the various bodies in the heavens at frequent intervals covering long periods of years. The old observatories were built and equipped with this end in view; the fundamental instruments were the meridian circle and the clock. The chief use of the equatorial was to measure the position of objects too faint to be seen with the meridian circle. Photography and spectrum analysis, as applied to astronomy, were beginning to obtain recognition, but were hardly regarded as the work of a "simon-pure" astronomer.

To-day this is changed; the astronomer is concerned not so much with the position and motions of the bodies, as with their physical characteristics; he wishes to know what they are, not where they are; from what they developed and what their future life history will be, rather than the exact path through space which they have traveled and are traveling. To solve these problems an astronomer to-day must be a physicist and a chemist, as well as a mathematician. The simple observatory of the past has become a great complex laboratory, in which the spectroscope of the phys-

icist, and the electric furnace of the chemist are of almost equal importance with the telescope.

Professor Hale, in this most interesting volume, describes the new type of observatory and explains the work of a modern astronomer and the problems which confront him. From his great experience in designing and equipping two great modern institutions of astronomical research—the Yerkes and the Mount Wilson observatories—Professor Hale has drawn freely for concrete illustrations of the difficulties which confront the student of stellar evolution. He shows how the feeble rays of light from a scarcely visible star are gathered together by the giant lens or mirror of the telescope and brought into a physical laboratory, where they are analyzed by the spectroscope, and forced to reveal the secret of the star's evolution.

The book is essentially a popular treatise; it was planned as a handbook to the Yerkes Observatory. It is non-technical, readable and gives a clear explanation of the purposes and observational methods employed by the author in his notable researches upon the sun and the chemistry of the stars. The book is discursive, however: the problems are treated individually, without showing clearly their interrelation and their bearing upon the general problem of stellar evolution. But the work was not intended as a scientific presentation of the subject; it was planned for the general reader, not for the investigator. The illustrations, from photographs taken principally at the Yerkes and Mt. Wilson observatories, are very beautiful, but are, if anything, rather too numerous.

CHARLES LANE POOR

ACTION OF THE RADIUM EMANATION ON SOLUTIONS OF COPPER SALTS[1]

A year ago Messrs. Ramsay and Cameron announced in several journals that they had observed the formation of the alkali metals and of lithium in solutions of copper salts which had been subjected to the action of the radium emanation. They concluded that the metal copper was *degraded,* in the presence of the emanation, into elements of the same series having lower atomic weights: potassium, sodium, lithium.[1]

These important results attracted a great deal of attention and it seemed desirable to repeat the experiment in laboratories possessing a sufficient quantity of radium. The experiment to be repeated was as follows. A solution of a copper salt (sulphate or nitrate) was placed in a small glass flask into which was introduced a large amount of the emanation and this was allowed to decay spontaneously. The copper was then removed, the resulting solution was evaporated to dryness, and the residue examined. The same processes were performed with a solution of the same copper salt which had not been subjected to the action of the emanation. The experiments were repeated several times. The residue consisted chiefly of sodium salt (with a small amount of potassium and calcium). In the four experiments described, in which the emanation acted, lithium was detected by means of the spectroscope. In the blank experiments there was much less residue and the presence of lithium could not be detected. Messrs. Ramsay and Cameron made one experiment to determine the quantity of lithium observed and they estimate the presence of about 0.00017 milligram in the residue which weighed 1.67 milligrams, the amount of copper taken being 0.27 g. (0.815 g. copper nitrate). In the corresponding blank experiment the residue was only 0.79 milligrams.[2]

We have tried to reproduce the results under conditions as free from error as possible. The experiment is a delicate one and there are several sources of error, chief among them being the use of a glass vessel as Mr. Ramsay himself remarks.

[1] Translated from the paper by Mme. Curie and Mlle. Gleditsch, *Comptes rendus,* **147**, 345 (1908).

[1] *Nature,* July, 1907; *Jour. Chem. Soc.,* September, 1907; *Comptes rendus,* 1908; *Archives de Genève,* April, 1908; etc.

[2] This quantity of metallic lithium does not check with the value indicated by the mixture of sodium and lithium salts which was taken as a comparison. There must be some error of calculation which we have not been able to locate.