used for measuring the meteorological elements, and while this is well written, it is a question if the space it occupies could not with advantage be utilized for a somewhat fuller discussion of other topics. The order of development of the subject proceeds from a discussion of temperatures, pressure, evaporation and condensation to a consideration of fogs and clouds. This is followed by a brief and purely descriptive account of mirage, rainbows, halos and coronas, the chapter being labelled Atmospheric Optics. Two chapters are devoted to Atmospheric Circulation followed by what seem to be unduly abbreviated chapters on Forecasting and Climates.

A well-selected list of reference works and the international symbols are given in appendices. M.

A GREEK TRACT ON INDIVISIBLE LINES

THE development in recent years of the subject of transfinite numbers, of point sets, and theories of the continuum is directing the interest of mathematicians to kindred speculations among the Greeks. Recent historians of Greek mathematics have paid due attention to Zeno's arguments on motion as they are presented in Aristotle's "Physics," but thus far they have given no consideration to a kindred tract included among the works of Aristotle, namely, the "Indivisible Lines" or "De lineis insecabilibus." Perhaps the reason for this omission lies in the fact that the text as edited by Bekker was for the most part unintelligible. More recent collations of manuscripts, and the translation into English with careful annotations made by H. H. Joachim, of Oxford, render the tract of undoubted value in the history of mathematics.[1] It reveals the arguments on the existence and non-existence of indivisible lines, and on the possibility of constructing a line out of points, as well as those exhibiting the interaction between physical speculation about atoms and the philosophy of geometry—arguments as they were presumably presented in the most celebrated academy of the most cultured city of antiquity. Who can doubt that the divergence of views then held and the perplexing paradoxes advanced discouraged Greek mathematicians from openly using in geometry the conceptions of the infinitesimal and the infinite? Euclid was about twenty years younger than Aristotle and no doubt was familiar with the trend of philosophic thought of his time. Rigor in geometry demanded the exclusison of paradox and mysticism. Notwithstanding Euclid's total abstinence from controversial conceptions, it is evident that the infinitesimal, the indivisible and the infinite continued to command the attention of some mathematicians, as well as of philosophers, for more than two thousand years. We need only mention the title of Cavalieri's famous work, "Geometria indivisibilibus continuorum nova quadam ratione promota," 1635.

The Aristotelean "De lineis insecabilibus" contains five arguments current among the Greeks in favor of the existence of indivisibles; these are followed by twenty-six arguments supporting the contrary view, and twenty-four arguments intended to establish the impossibility of composing a line out of points. Some of these proofs are rigorous. Thus, it is argued that, if indivisible lines exist, they must be of equal length; an equilateral triangle each side of which is an indivisible line has an altitude less than the indivisible. If a straight line composed of an odd number of indivisibles is bisected, one of the indivisibles will be divided. The Greek failure to build a satisfactory theory of the linear continuum as composed of points is due to their application of metrical ideas; the addition of points could never yield length. Aristotle's failure to construct a satisfactory continuum by starting with a straight line

[1] The Works of Aristotle translated into English under the editorship of J. A. Smith and W. D. Ross. Part 2: "De lineis insecabilibus," by H. H. Joachim, Oxford, 1908. We have not seen this tract used in any history of Greek mathematics, but H. Vogt referred to it in an article on the origin of the irrational, printed in the *Bibliotheca mathematica*, 3s., Vol. 10, 1909–10, pp. 146, 153.

and postulating unlimited divisibility lay primarily in his rejection of actual infinity and acceptance only of potential infinity.

If it is one of the aims of mathematical history to set forth the successes and failures of leaders of mathematical thought, then the Aristotelean tract, "De lineis insecabilibus," is worthy of the attention of mathematicians.

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SPECIAL ARTICLES

JURA-CRETACEOUS STONEWORT AND LIMNEAS, SUPPOSEDLY FROM ARKANSAS

PRESERVED in the paleontological collections at Stanford University is a large block of white chert containing spore-cases of stonewort, a siliceous freshwater algæ and moulds and casts of *Lymnea ativuncula* and *L. consortis* White,[1] two pondsnails originally described from the Jura-Cretaceous red beds, variously called the Morrison formation or *Atlantasaurus* zone, at Garden Park, eight miles north of Cañon City Colorado.

The matrix consists of white siliceous material made up of compacted spicules of stonewort. The surface is rusty and roughened from exposure but shows no sign of stream attrition. The specimen is accompanied by a note by J. F. Newson, mining engineer and former Stanford professor, stating that it was one of two large blocks unlike any rock in place in the vicinity, picked up on the J. L. Van Winkle ranch, east ½ section 6, township 5 north, range 16 west, near the Arkansas river opposite old Lewisburg, Arkansas.

If Dr. Newson is correct in supposing that no beds of similar rock outcrop nearby it is thought that the material was carried there or perhaps lost by one of the early exploring expeditions returning down the Arkansas river from Colorado. I have hoped to obtain information on the subject from the distribution of siliceous rocks derived from stonewort remains in this region but they appear to be of such rare occurrences as to have escaped notice.

With the exception of the nutlets the remains of the Estancia stonewort, *Chara estanciana* Hannibal, are desiccated beyond recognition. These resemble the nutlets of the Bear River stonewort, *Chara stantoni* Knowlton,[2] but are nearly round and marked by six encircling spirals.

There are three groups of limneas found in North America, the Abysmal limneas including *Lymnœa* (*Acella*) *haldemani* Binney, the Moss limneas including *Lymnœa* (*Galba*) *truncatula* Müll., *humilis* Say (+ *cubensis* P fr.), *humilis solida* Lea, *obrussa* Say, and *cooperi* Hannibal and the Marsh limneas including *Lymnœa* (*Lymnœa*) *stagnalis* L., *columella* Say, *auricularia* L., *palustus* Müll. and the European *glaber* Müll. The Garden Park limnea, *Lymnœa ativuncula* White, and Cañon City limnea, *Lymnœa consortis* White, belong to the third group.

These species are the oldest true limneas known from North America. *L. accelerata* White of the Morrison beds is perhaps a *Lioplax* or other operculate while *L. nitidula* Meek of the Bear River Cretaceous is a problematic species that has been confused by White[3] with some other Limnea, possibly the Eocene *L. vetusta* Meek.

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[1] White, C. A., Bull. 29 U. S. Geol. Sur., 1886, p. 20, Pl. IV., Fig. 8–9, *consortis*, 10–11, *ativuncula*.

[2] Knowlton, F. H., *Bot. Mag.*, XVIII., 1893, p. 141, text fig. 1–3; White, C. A., Bull. 128, U. S. Geol. Sur., 1895, pp. 63, 104, Pl. X., Figs. 14–16.

[3] White, C. A., Bull. 128, U. S. Geol. Sur., 1895, Pl. VI., Figs. 1–2 doubtful, Fig. 3 *nitidula*.

SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.
NEW YORK, N. Y.

Entered in the post-office at Lancaster, Pa., as second class matter