difficult problems. On page 63 we are invited to think of a moving point as going from one position to the "next." Two points thus next to each other *form* an infinitely small straight line. The two points are consecutive, without distance between them, and "may practically be considered as one point." No talk about limit: a curve is, for thought, composed of infinitely short straight lines. The term locus does not appear except incidentally as on page 84. But "if a point moves so as continually [not continuously] to change its direction from point to point, the line generated is a curved line, or curve." According to the highest mathematical standards, descriptive geometry has not attained, in America, to the rank of a science. It is a tool. Judged as a work designed to teach the use of an important tool, Professor Bartlett's book will render good service. But such books ought to get up-to-date in respect to logic, geometric spirit, conception and nomenclature.

Columbia University C. J. Keyser

Les Poissons Wealdiens de Bernissart. By Ramsey H. Traquair, M.D., LL.D., F.R.S. Extrait des Mémoires du Musée Royal d'Histoire Naturelle de Belgique, T. VI. Bruxelles. 1911. 4to. Pp. iv + 65; 12 pls. and 21 text figures.

In this memoir Dr. Traquair—the dean of paleichthyologists—discusses the fishes of the Wealden, or basal Cretaceous, of Belgium. This formation, though known chiefly for fine skeletons of the dinosaur *Iguanodon,* contains also a highly interesting fish-fauna. This is remarkable for the fact that its species, though relatively few (sixteen), represent both the more archaic members of the group of ganoids as well as the quite modern teleosts. In discussing this fauna, therefore, Dr. Traquair has opportunity of reviewing at once such forms as *Coccolepis,* the last survivor of the Palæoniscidæ, as well as *Leptolepis,* the earliest of the clupeoids.

The memoir is of necessity devoted mainly to systematic details; none the less broader questions, such as those of morphology, relationship and geological distribution, are not overlooked. And all these themes are treated with the author's characteristic painstaking regard to fact. In short, the memoir is an example of what a systematic review of a fossil fauna should be.

An interesting and very useful feature is the carefully drawn restorations, of which there are thirteen. Especially noteworthy are those of *Coccolepis, Callopterus, Amiopsis, Mesodon* (with new interpretations of the cranial elements) and *Aethalion.* These figures are sure to follow the many others from the same hand, and become part of the stock in trade of all writers on ichthyology.

The fauna of Bernissart, as a whole, is regarded as fresh water. The chief evidence for this view is the entire absence of sharks from this formation, although the group is abundantly represented in other European rocks of equivalent age.

To the friends of Dr. Traquair—and they are many, both in Europe and America—the publication of this memoir has an especial interest. For it shows the doctor, who is past his seventieth anniversary, still working away, with his old-time vigor and enthusiasm, in the field which he has done so much to advance.

Ave Magister! Many be the years
That lie before thee, thronged with busy hours![1]

L. Hussakof
American Museum of Natural History

THE HARRIS TIDAL MACHINE

The Coast and Geodetic Survey has recently put in operation, after a thorough test, a new tide-predicting machine, which performs simultaneously all the operations of the British or Thomson machine and of the first American machine invented by Professor Ferrel. As in the Thomson machine, the tidal curve is drawn from which the height of the tide at any time may be scaled off, but, in addition to this, the times of high and low water are marked upon its axis, and both the time and height of the tide, as well as the height of the water's surface at any given

[1] Dr. S. Weir Mitchell, "The Comfort of the Hills and Other Poems," p. 95. New York, 1910.

time, are shown upon graduated circular dials on the face of the machine. The machine was invented by Dr. R. A. Harris, who seventeen years ago published a brief but comprehensive description and submitted a general plan to the Coast Survey Office. (See report of superintendent for 1894.) The details of the machine-design were worked out by Mr. E. G. Fischer, under whose direction the machine was set up in the instrument division of the survey.

Mechanical aids of this kind are used in connection with the tides, because good predictions require the combination of a considerable number of sine or cosine terms whose arguments vary uniformly with the time. The new machine contains 32 short-period components (*i. e.,* daily, semi-daily, quarter-daily, etc.) and 7 having long periods (*i. e.,* fortnightly, monthly, semi-annual and annual.

In combining these numerous terms two summations are carried on continuously by means of two chains each fixed at one end and free to move at the other. Each chain is laid alternately over and under a series of pulleys whose upward and downward movements cause the free end of the chain to travel back and forth across a fixed initial point. The motion of the free end of one of the chains is proportional to the rise and fall of the tide to be represented or predicted; that of the free end of the other chain (or rather of a marked link a certain distance from this end) is such that when this link passes across a fixed point the height represented by the first chain is at its maximum or minimum value. These statements describe very briefly the general plan upon which the times and heights of the tides are mechanically determined. As already stated the times and heights are shown upon the face of the machine while a curve is drawn which makes a permanent record of all stages of the tide.

The machine is driven by hand and the gears are such that the periods of motions which depend upon them shall represent the known periods of the various sine and cosine terms into which tidal records or observations can be resolved.

In the new machine the error resulting from the representation of the incommensurable astronomical ratios by the gears amounts to less than one degree for a period representing a year in prediction. For the larger terms the error is much less, so that after predicting a year's tides and reading hourly heights for December 30 and 31, the predicted values agreed so well with the values computed directly from astronomical data, as to make the errors negligible.

It may be stated that, although tide-predicting is the most useful purpose to which the machine is put, its broadest application is in the solution of equations of the form $y = H_0 + A \cos(at + \alpha) + B \cos(bt + \beta) + \cdots$, where $A, B, C, \ldots$ denote the amplitudes and $a, b, c, \ldots$ their speeds per unit of time t, of which it draws the graph and indicates the positions and magnitudes of the roots.

SAMUEL TIERNEY, JR.

SPECIAL ARTICLES

XERALEXIS

WHOEVER brings forward a new word must show what the students in journalism would call a "crying need" for it, or take the consequences. The undersigned is not altogether certain as to how crying the need may appear to others, but it seems to him that a single euphonious, appropriate word should be sought to replace the clumsy and rather ill-sounding compound, "drought-resistance." The writer proposes the coining of the word *xeraléxis,* from the Greek ξηρότης, drouth, and ἀλέξησις, a keeping off or resistance.

We have, of course, the words, "xerophytic" and "xerophytism," which do not, however, involve the idea of resistance to drouth in their composition, and do not convey that meaning in usage, although it stands to reason that a "drouth-resistant" plant will have "xerophytic" characteristics of some kind.

There is ample justification for the new word on etymological grounds. The Greeks had many compounds in which the above roots were employed. The root of the adjective *xēros,* "dry" and *xērótēs,* "drouth," is found