Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Fossil Buttercups.

It is remarkable, as Prof. Cockerell points out in NATURE of January 12, p. 42, that until his discovery of a Miocene buttercup no species of the family Ranunculaceæ should have been recorded among the fossil plants of North America. More especially is this the case because the carpels of *Ranunculus* are among the commonest fossils found in deposits of Pleistocene and Pliocene age in Britain and the neighbouring parts of the Continent. Among the many lists of fossils determined by my husband and myself from such deposits, in one only, the Pliocene of Bidart (Basses-Pyrénées), is the genus not represented, and in this deposit very few species of any kind were found.

The oldest carpel I have seen is that of an extinct batrachian *Ranunculus* (*R. gailensis*, E. M. Reid), very thick-walled and globose, from the base of the Pliocene of Pont-de-Gail (Cantal). From the same horizon, but another locality in Cantal, M. Pierre Marty recorded *R. diavorum*, Sap., which he considers nearly related to *R. fluitans*. It is quite probable, though it has not been proved, that carpel and leaf belong to the same species.

In the latest Pliocene of the Cromer Forest-bed, with the exception of two undetermined carpels, all are British species. In the Upper Pliocene of Tegelen (Holland) *R. aquatilis* and *R. repens* are found associated with *R. nodiflorus*, a species of Central Europe and the Orient, and with a single specimen of a peculiar form of *R. sceleratus* found more abundantly at Castle Eden. In the Middle Pliocene of Castle Eden no definite West European species is found, though the form of *R. sceleratus* already mentioned and a peculiar batrachian *Ranunculus*, both probably extinct, occur associated with two Central European species, *R. nodiflorus* and a varietal form (perhaps extinct) of *R. lateriflorus*, also an extinct species of which the affinity has not been discovered. In the Lower Pliocene of the Dutch-Prussian border the only West European species is *R. nemorosus*; it occurs associated with *R. nodiflorus*, *R. lateriflorus*, var., and the South European species *R. brutius*. In the lowest Pliocene of Pont-de-Gail one specifically indeterminate carpel and the batrachian *R. gailensis*, already referred to, were found.

Among the hundreds of Pleistocene and Pliocene specimens examined none has shown indications of two seeds, but I have not been able to carry the record of the genus so far back as Prof. Cockerell.

In the work here referred to the carpels were in every case obtained by "washing" the material and sieving away the matrix. Were this method applied to some of the North American Pleistocene and Tertiary deposits I should anticipate that they might yield, not only abundant carpels of *Ranunculus*, but the fruits and seeds of many other herbaceous plants.

ELEANOR M. REID.

Pinewood, Milford-on-Sea, January 23.

The Accuracy of Tide-predicting Machines.

In the article in NATURE for November 24 last appearing under the title "British Research on Tides" there occurs a statement which may, perhaps, leave an erroneous impression with those not familiar with

tide-predicting machines. The statement in question—"a test of the accuracy of the tide-predicting machines used by the Admiralty and the India Office has indicated some serious errors in their results, and it is concluded that the labour of reading the curves afforded by the machines, with any pretence to accuracy, is comparable with the labour of direct computation, while the value of the results is greater in the latter case"—although made definitely with reference to particular tide-predicting machines, might, nevertheless, leave the impression that tide-predicting machines in general were subject to "serious errors in their results." It therefore appears of value to discuss briefly the subject of the accuracy of tide-predicting machines and to refer to some tests made with a direct-reading type of tide predictor.

Tide-predicting machines, or tide predictors as they are frequently called, make use of the harmonic tidal constants, and are contrived for the purpose of summing a number of terms of the form $A \cos(at + \alpha)$, in which for each harmonic constant A is the amplitude, a the speed per unit time t , and α the initial phase. For any given port, therefore, the height of the tide at any time is the instantaneous sum of the simple constituent tides represented by the harmonic constants. And in the tide predictor this instantaneous summation is effected by means of a flexible chain which passes alternately over and under a series of pulleys the motion of each of which represents the changes in elevation of a particular simple tide.

The accuracy of a tide predictor is therefore to be measured by the accuracy with which it sums the simple constituent tides represented by the harmonic constants. It is necessary to emphasise this, for not infrequently one meets with the assumption that the accuracy of the tidal predictions tests the accuracy of the tide predictor. Tidal predictions are the product of the tide predictor, and for any given port aim to give in advance the times and heights of high and low water. And the test of the accuracy of these tidal predictions is, obviously, the closeness of agreement with the tides as they actually occur.

It is to be noted, however, that the times and heights of the normal or predictable tide are subject to the disturbing effects of variations in wind, atmospheric pressure, rainfall, and seiche. Hence, altogether apart from any imperfections in the tide predictor or in the harmonic analysis which separates out the simple constituent tides, tidal predictions may differ from the observed times and heights of the tide, due to the disturbing effects just mentioned, the times of occurrence of which cannot be foreseen at the time the tidal predictions are made. It is, therefore, obvious that, while in a measure the accuracy of the tidal predictions tests all the processes entering into their making, it does not strictly test the accuracy of the tide predictor.

Tide predictors are of two types, which we may denominate respectively as curve-tracing machines and direct-reading machines. In the former there is traced, to a suitable scale on a sheet of paper, a curve of the predicted tide from which the height of the tide at any given time or the times and heights of high and low water may be scaled. In the direct-reading tide predictor the height of the tide at any time, and also the times and heights of high and low water, are indicated on dials from which they are read off directly.

It is obvious that the prediction of tides can be carried out more rapidly with a direct-reading tide predictor than with the curve-tracing type, for reading figures from two or three dials is less time-consuming than scaling these same values from a curve. But