large and spiny shells. The original type of snails followed the "young" part of the stream backward and thus there tends to be a continuous series of forms as one follows the stream. One has but to start at the headwaters and go down stream in order to see unfolded the history of both stream and shell. By the time Chattanooga is reached the stream has gotten too old, physiographically, for the snails, too deep and possibly too contaminated.

The finding of smooth shells near Rogersville in the Holston River and of spiny shells above them really fits in with this idea if we look more closely into the history of this part of the river system, for here there has been stream piracy. A young stream containing smooth shells has probably worked over into the valley of an old stream, containing spiny shells above the point of intersection, and the result is the Holston River as we now know it.

To be sure, we should like to have an explanation of the causes underlying the law of ornamentation, and also of the reason why the successively spinier snails seem to have forced their smoother relatives to migrate with the growth of the stream or to have been prevented from working up to the headwaters themselves, but we can not expect an explanation of the ultimate and Dr. Adams is to be congratulated on the progress which this paper makes in the, as yet, largely unexplored field of animal ecology. FRANK E. LUTZ

THE PLIOCENE FLORAS OF HOLLAND

THE study of the more immediate progenitors of the existing flora, the vast changes in distribution, and the extensive extinctions and migrations that resulted from the glaciation of the Pleistocene, as well as the evolution of recent herbaceous forms that followed in its wake, constitutes a field of endeavor that not only appeals to the imagination, but one that offers much to botany and much that is useful in reconstructing the geography, climate and history of the late Tertiary and the Quaternary. For thirty-odd years Clement Reid has been engaged in the study of the Pliocene and Pleistocene deposits of Britain and their contained floras. Some years ago with the assistance of Eleanor M. Reid he described the upper Pliocene flora of Tegelen in Holland,[1] and recently these authors have published the results of an elaborate study of similar remains from a slightly older horizon collected from the brick-clays of Reuver, Swalmen and Brunssum along the Dutch-Prussian border.[2]

This study is not only a significant contribution to the botany of the Pliocene, but it furnishes data of great importance to historical geology. With the shallowing of the Diestian or perhaps the Scaldisian sea, the delta of the combined Rhine and Meuse extended a long distance to the northwest as it did at several subsequent times during its history, as is proven by the Rhine gravels in the Cromer beds of Norfolk, and by the mammalian fauna and peat of the Dogger Bank. Remains of the middle Pliocene high-level terraces, much faulted, occur to the south and east of the Limburg plain, where the brick clays are exposed in the scarp facing that plain. The materials were collected by W. Jongmans of Leiden and P. Tesch of the Geological Institute for the exploration of the Netherlands. The Reids expended all of their efforts on the remains of fruits and seeds which they laboriously picked out of the washings of an enormous amount of material.

In the less lignitic loams lying immediately below the horizon reported upon, impressions of leaves occur and these were studied some

1 Reid, C., and E. M., "The Fossil Flora of Tegelen-sur-Meuse, near Venloo, in the Province of Limburg," *Verhandl. Kon. Akad. Wetensch.* (Tweede Sectie), Deel XIII., No. 6, 1907; "On *Dulichium vespiforme* sp. nov. from the Brickearth of Tegelen," *Verslag. Kon. Akad. Wetensch. Amsterdam,* 1908, p. 898; "A Further Investigation of the Pliocene Flora of Tegelen," *Ibidem,* 1910, pp. 192–199.

2 Reid, C., and E. M., "Preliminary Note on the Fossil Plants from Reuver, Brunssum and Swalmen," *Tijdsch. Kon. Ned. Aardrijks. Genootschap,* 2e ser., Deel XXVIII., afl. 4, 1911, pp. 645–647; "The Pliocene Floras of the Dutch-Prussian Border," *Mededeelingen Rijksopsporing van Delfstoffen,* No. 6, The Hague, 1915, 178 pp., 4 tf., 20 pls.

years ago by L. Laurent of Marseilles.[3] His determination included ten dicotyledons and one conifer and indicated a similar age to that indicated by the overlying seed and fruit flora. The latter is remarkable in including nearly three hundred species, of which the botanical position of about 77 per cent. is determined with considerable certainty. This flora is shown to present a striking similarity to the living flora of the uplands of western China and to its more or less allied geographical provinces, *i. e.,* Japan, the Himalayas, eastern Tibet and the Malay Peninsula. A more remote relationship is shown with the existing flora of Europe or the Caucasus, and a still more remote relationship with the existing flora of North America.

This oriental character is shown by the presence in Limburg of forms like *Gnetum scandens, Zelkowa keaki, Pyrularia edulis, Magnolia kobus, Prunus maximoviczii, Stewartia pseudo-camellia,* etc., no longer natives of Europe, as well as by representatives of genera such as *Meliosma, Actinidia, Corylopsis, Camptotheca,* etc., not found in the existing European flora, but represented by closely allied species in China. Even when the genus is still a member of the European flora, the fossil species appears to be closer to the existing Asiatic rather than the existing European representative, as, for example, in the genera *Pterocarya, Styrax, Betula, Cornus, Clematis, Eupatorium,* etc. There are, however, among the fossils a number of large-seeded forms that are still represented in the flora of Europe, among which may be mentioned *Picea excelsa, Quercus robur, Carpinus betulus, Corylus avellana, Prunus speciosa, Ilex aquifolium, Vitis vinifera* and *Fagus* cf. *silvatica.*

The Reuverian flora, as it has been called, appears to indicate a climate about like that of southern France of the present time, but with a more abundant rainfall. It was richer in species than the present flora of Central Europe and the number of arborescent forms was greater, both relatively and absolutely, comprising fifty per cent. of the determined forms. This and other conclusions which are deduced from the present study are well known to paleobotanists, but seem to require constant reiteration to get a hearing with botanists or geologists.

The authors' explanation of events is in brief an immigration of this rich and varied warm temperate flora into the Dutch region [a survival in this region as a part of the rich and more or less cosmopolitan flora of the earlier Tertiary is probably a better way of stating the case], where with the progressive lowering of temperatures in the late Pliocene as is indicated by the floras of Tegelen near Venloo, Wylerberg near Nijmwegen and the Cromer Forest bed, it found its retreat to the southward cut off by mountains, seas or deserts, from the Pyrenees on the west eastward all of the way to Tibet, so that all but a few forms like *Quercus robur, Corylus avellana* and *Picea excelsa* were subsequently exterminated. Even those forms that succeeded in reaching the shores of the Mediterranean seem to have found themselves in a climate that was too dry.

Compared with Europe both North America and eastern Asia afforded better facilities for a continuous movement of plants to the southward and back—North America with its mountains trending north and south, with the broad valley of the Mississippi and the well-watered Atlantic coastal plain—eastern Asia with the coastal plain of China and the great river-valley systems of that country. Recolonization from the southward in post-glacial Europe was a slow process and these are two of the reasons why the existing Asiatic flora or that of eastern North America is so much richer than that of Europe.

Among botanical items that I have not yet mentioned are species of *Ardisia, Mæsa, Liriodendron, Cinnamomum, Hakea, Mimusops, Diospyros,* stones of a *Nyssa* indistinguishable from our American *sylvatica,* as well as many others that might be enumerated. It must make the shade of Bentham turn over to have an Englishman identify the fruits of Proteaceæ in Europe.

All of the material is carpological, *i. e.,* the

[3] In Jongmans, W., "Rapport over zijne paleobot," *Rijksopsporing van Defstoffen,* Jahren, 1908–11, pp. 23–25.

remains of fruits and seeds, which is supposed to be more certainly determinable than leaf impressions. It has been laboriously compared with recent material in the Kew herbarium and from other sources and is illustrated by enlarged photographs often showing the recent seed by the side of the fossil. One is impressed with the care with which the work has been done and the authors certainly merit the gratitude of their confrères. I venture to hope that they will feel called upon to give us the benefit of their experience in instituting a comparison, confessedly difficult, between their Pliocene fruit and seed floras of Reuver, Tegelen, Cromer, etc., and the abundant Pliocene floras represented by leaves in France, Italy and throughout southeastern Europe.

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SPECIAL ARTICLES

THE MEASUREMENT OF OXIDATION IN THE SEA-URCHIN EGG

BECAUSE of its accuracy and convenience, Winkler's method of determining the amount of oxygen in solution has been almost exclusively used in the various studies of oxygen consumption of sea-urchin eggs. This method, as described in various texts of quantitative analysis, depends upon a chain of reactions, which result finally in the liberation of two atoms of iodine for each atom of oxygen originally present in solution. The investigator of egg oxidations measures the oxygen content of some sea-water before and after eggs have been contained in it. The usual procedure appears to be about as follows: The eggs are enclosed in a 300 c.c. bottle filled with sea-water and tightly sealed. At the conclusion of a certain time interval (usually an hour), the supernatant sea-water is siphoned off into a 250 c.c. bottle and tested for oxygen. From the value thus obtained, the oxygen concentration in the 300 c.c. bottle at the conclusion of the experiment can be computed, and thus if the original oxygen content of the sea-water is known, the amount of oxygen consumption is readily obtained by subtraction.

It is obvious that the ordinary Winkler method of determining oxygen loses its efficiency in the presence of any substance which takes up iodine. Now it is a fact that iodine absorbing substances are actually present in sea-water which has stood over sea-urchin eggs. This can best be shown by actual measurement of the iodine absorption of such "egg sea-water."[1] These measurements have been made a number of times. They show a small but quite constant value.

Of course after the eggs have been treated with any cytolytic agent, they give off to the sea-water very much larger quantities of iodine-absorbing substances.

Analytical chemists have suggested at least two methods of making Winkler determinations in the presence of organic substances. Perhaps the Rideal and Stewart method is the one most often used.[2] In this method the organic substances are oxidized by potassium permanganate in the presence of sulphuric acid. This method may do very well for most organic substances, but in order to oxidize proteins completely, hot concentrated permanganate solutions are necessary, and the dilute solutions recommended by Rideal and Stewart can accomplish but very little in the way of oxidations. The extensive literature on the oxidation of proteins by permanganate solutions can not be referred to here; the reader will find many references in Oppenheimer's "Handbuch der Biochemie."[3] In actual practise the Rideal and Stewart method has not proved satisfactory.

Another method is to determine the iodine-absorbing powers of the water which contains organic matter.[4] In this way a correction is obtained which is added to the value determined by the ordinary Winkler method. In measuring egg oxidations, this method is open to the objection that the sample chosen for the correction may not be truly representative of

[1] *I. e.*, sea-water which has stood over eggs.

[2] Rideal and Stewart, *Analyst*, XXVI., 141, 1901.

[3] Vol. 1, pp. 489–495.

[4] *Cf.* Lunge, "Technical Methods of Chemical Analysis," New York, 1908, Vol. 1, Part II., p. 783.