

On the Pre-Glacial Flora of Britain.

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(PLATES 11-15.)

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THE plants living in Britain immediately before the cold of the Glacial Epoch have attracted attention for many years. A certain number of species were collected as far back as 1861 by the Rev. S. W. King. These were determined by Heer, and Lyell published his list, amounting to twelve species*. A few more were added later on; but in 1877, when the Geological Survey commenced the examination of the Norfolk and Suffolk coast, the list was still under twenty species.

In the course of this survey a number of seeds and leaves were collected (by C. R.), and this collection, which was mainly determined by Mr. Caruthers, amounted to nearly thirty species†. It is now in the Museum of Practical Geology, as is the King collection. This small list was of so much interest that after the survey was finished the work was continued during holiday visits. A collection of ripe seeds of British plants (so poorly represented in recent herbaria) was slowly formed, and the fossil flora gradually crept up to fifty-six species in 1890‡, and to seventy-eight in 1899§.

The work of the last few years has led to the discovery of so many additions to this meagre list, that the time has now arrived for a revision of our pre-Glacial flora. This is the more necessary, as on the character of this flora depends the geologist's view of the climatic conditions which then prevailed. We want also to take a census of the plants, in order to understand what amount of change and extermination took place during the forced migrations consequent on the cold period which supervened. And, thirdly, we should like to know what variation the species have undergone during a period of many thousand years.

As regards the certainty of the determinations, it may be as well to say at once that in the case of seeds and fruits—and it is on these that we mainly rely—there is seldom any doubt in either recent or well-preserved fossil specimens. Almost every species that can be distinguished by other characters can be distinguished also by the seed alone; and often the seed or fruit, though apparently undescribed, gives better specific characters than the whole of the rest of the plant. The cases where there is doubt are usually seeds of plants belonging to closely allied species, which give almost as much difficulty when we compare the whole plant. Thus we do not

* 'Antiquity of Man,' 4th ed. 1873, p. 256.

† C. Reid, "Geology of the Country around Cromer," Mem. Geol. Survey, 1882, pp. 62-64.

‡ C. Reid, "Pliocene Deposits of Britain," Mem. Geol. Survey, 1890.

§ C. Reid, 'The Origin of the British Flora,' 8vo, 1899.

pretend to be able to distinguish the different fruticose *Rubi* by their stones, nor can we find satisfactory specific characters in the carpels of *Rosa*, or of the Batrachian *Ranunculi*. The closely allied *Stellaria media*, *S. Boreana*, and *S. neglecta*, however, have seeds noticeably different; *Arum maculatum* and *A. italicum* have seeds remarkably distinct.

Seeds (or the hard parts of fruits) being thus critically distinguishable, it seems advisable to place on record the evidence by which we have been guided in determining the fossil plants. This is the more necessary as many of the seeds are impregnated with pyrites, which tends to decompose and to destroy the specimen. For this reason it is important to preserve exact photographic representations, so that if the fossil itself disappears there may still be a satisfactory record of its discovery*.

Fruits and seeds of our recent plants are seldom figured and described in such a way as to enable the botanist to recognise them specifically, especially if detached from the plant. Seeds are constantly described as smooth or shining, when in reality they have a highly characteristic sculpture, only masked by a coat of varnish. Our fossil fruits and seeds also are preserved in an altered state, the alteration in some cases being so great that their identity with the living plants is not suspected until recent seeds have been reduced by maceration or carbonising to a similar condition. It is not that the fossils are less determinable than the recent, often the intricate patterns on the outside are far clearer. But any botanist finding, for instance, fossil fruits of *Conium* in the state of preservation shown on Pl. 12. fig. 60 would not recognise them, unless he had treated the recent fruits in such a way as to remove their ridges. In this case slow carbonising shows the identity of the recent with the fossil fruit, and this carbonising also causes the recent fruit to shrink till it is as small as the fossil specimens. This difficulty of comparison has given much trouble, and in many cases we have had the fossil for years before we recognised it as being the seed or fruit of a common British plant.

It would need a large number of magnified photographs to illustrate all the details of cell-structure, etc., on which our determinations have been based; but the figures and descriptions now given should be sufficient at any rate to help the botanist, and to prevent the geologist and archæologist from throwing away what looks like most unpromising material for the study of an ancient flora.

The mode of collecting and washing the material need not again be described; but a few words are required as to the best methods of preserving the seeds in such a state as to be fit for study. One remark, however, must be made as to the preliminary work. Fossil seeds if possible should not be allowed to dry, at any rate not after they have been taken out of the

* We have not thought it necessary to reproduce our photographs of the leaves, as the forms and venation of leaves are well known, and the specimens themselves are generally preserved in slabs of ironstone.

clay in which they are found. In drying they shrink, become distorted, or often crack and fall to pieces. It is generally necessary, however, to dry the lumps of clay in which the seeds are contained, or they will not fall to pieces when placed in water; but this drying when tightly packed in a rigid matrix does comparatively little harm. After the clay has fallen to pieces in water the seeds should be collected while still wet and transferred from dish to dish of clean water, till they are in a fit state for the next process.

Pyritised fossils can be preserved fairly well under water; but in this wet state they can neither be studied conveniently nor photographed. If absolute alcohol is used for drying, the seed shrinks and is injured. We wish to preserve them in such a way that they can be safely handled, turned over, compared side by side with recent seeds, and, if necessary, dissected. They must therefore be impregnated with some medium that will protect the pyrite granules from the air, that will prevent the seed from becoming distorted or falling to pieces, and that will leave the surface sculpture intact and in a state fit for photographing. The process must not be too elaborate, as we have to deal with thousands of seeds in a short time.

The method we now employ is as follows:—The specimens are removed a few at a time from the store-bottles in which they have accumulated, and are washed in clean water to remove the weak formalin or salicylic acid used for their temporary preservation. A thin film of wax (we have used “paraffin filtr. 45° Grüber & Co.”) is melted on a glass plate or slide and allowed to harden. The seeds or leaves are removed from the water and are placed, still wet, on the prepared film; the plate is then *immediately* warmed from below to a temperature just sufficient to melt the wax. As the moisture evaporates from the upper surface of the specimen the wax is absorbed from the lower, and in a few minutes, unless the seed is very large, the process is complete, the whole seed is impregnated with wax, and it is rendered so tough that it can easily be handled.

When the seeds have absorbed as much wax as they can, they are transferred to a clean part of the plate and the superfluous wax is removed with warm filter-paper; or they can be allowed to cool thoroughly and then have their surfaces brushed with benzine. If one surface of the seed is better preserved than another, that surface should be placed in contact with the wax, for the lower surface remains uninjured and flat even if the upper surface suffers slightly.

In the determination of the species now to be recorded, we have received invaluable assistance from the British Museum and Kew collections, and from recent seeds supplied to us by Mr. James Groves. Dr. Rendle also has kindly examined our specimens belonging to the genera *Najas* and *Zannichellia*, the discoveries in the former genus being recorded in his monograph*. Our

* Trans. Linn. Soc. ser. 2, Bot. vol. v. (1899) p. 436.

collection of recent seeds is steadily growing, but there are still too many species of which we have been unable to obtain ripe fruits ourselves, or to find perfectly ripe fruits in the herbaria. Until, also, we can obtain a more complete series of Palæarctic plants, it will be impossible to say whether some of the various undetermined seeds belong to living or to extinct species; we have decided therefore not at present to describe any species as new, though in all probability two or three are no longer living.

The plant-remains from the pre-Glacial deposits of the Norfolk and Suffolk coasts belong to the following species:—

RANUNCULACEÆ.

- Thalictrum flavum*, *Linn.*
- Ranunculus aquatilis*, *Linn.*
- R. sceleratus*, *Linn.*
- R. Flammula*, *Linn.*
- R. Lingua*, *Linn.*
- R. repens*, *Linn.*
- R. nemorosus*, *DC.*
- R. sp. 7.*
- R. sp. 8.*
- Caltha palustris*, *Linn.*

NYMPHÆACEÆ.

- Nymphaea lutea*, *Linn.* (*Nuphar luteum*, *Sibth. & Sm.*).
- Castalia alba*, *Woods* (*Nymphaea alba*, *Linn.*).
- Two undetermined species.

PAPAVERACEÆ.

- Hypecoum procumbens*, *Linn.*

VIOLACEÆ.

- Viola palustris*, *Linn.*
- V. cf. hirta*, *Linn.*
- V. cf. Riviniana*, *Reichb.*

CARYOPHYLLACEÆ.

- Stellaria aquatica*, *Moench.*
- S. media*, *Villars.*
- S. Holostea*, *Linn.*
- Arenaria serpyllifolia*, *Linn.*

ELATINEÆ.

- Elatine Hydropiper*, *Linn.*

HYPERICINEÆ.

- Hypericum quadrangulum*, *Linn.*
- H. hirsutum*, *Linn.*

RHAMNÆÆ.

- Rhamnus Frangula*, *Linn.*

SAPINDACEÆ.

- Acer campestre*, *Linn.*

ROSACEÆ.

- Prunus spinosa*, *Linn.*
- Spiræa Ulmaria*, *Linn.*
- Rubus Idæus*, *Linn.*
- R. fruticosus*, *Linn.*
- Potentilla silvestris*, *Neck.*
- Alchemilla arvensis*, *Scop.*
- Pyrus Aria*, *Ehrh.*
- P. Malus*, *Linn.*
- Cratægus Oxyacantha*, *Linn.*
- C. sp. ?*

HALORAGACEÆ.

- Hippuris vulgaris*, *Linn.*
- Myriophyllum spicatum*, *Linn.*

ONAGRARIÆÆ.

- Trapa natans*, *Linn.*
- Circæa lutetiana*, *Linn.*

UMBELLIFERÆ.

- Conium maculatum*, *Linn.*
- Apium* sp.
- Cicuta virosa*, *Linn.*
- Chærophyllum sylvestre*, *Linn.*
- Oenanthe Lachenalii*, *C. C. Gmel.*
- O. Phellandrium*, *Lam.*
- Æthusa Cynapium*, *Linn.*
- Pastinaca sativa*, *Linn.*
- Heracleum Sphondylium*, *Linn.*
- Torilis Anthriscus*, *Bernh.*

CORNACEÆ.

Cornus sanguinea, Linn.

CAPRIFOLIACEÆ.

Viburnum Opulus, Linn.

V. sp. 2.

V. sp. 3?

RUBIACEÆ.

Galium Aparine, Linn.

VALERIANEÆ.

Valeriana sambucifolia, Willd.

Valerianella olitoria, Poll.

COMPOSITEÆ.

Eupatorium sp.?

Bidens tripartita, Linn.

Tussilago Farfara, Linn.

Arctium sp.

Carduus nutans, Linn.

C. cf. nutans.

C. palustris, Linn.

C. heterophyllus, Linn.

Centaurea sp.

Picris hieracioides, Linn.

Crepis succisæfolia, Tausch.

Leontodon autumnalis, Linn.

GENTIANEÆ.

Menyanthes trifoliata, Linn.

SOLANACEÆ.

Solanum Dulcamara, Linn.

SCROPHULARINEÆ.

Verbascum Thapsus, Linn.

Limosella aquatica, Linn.

Veronica Chamædrys, Linn.

LABIATÆ.

Mentha aquatica, Linn.

Lycopus europæus, Linn.

Calamintha arvensis, Lam.

Prunella vulgaris, Linn.

Stachys sylvatica, Linn.

S. arvensis, Linn.

Ballota nigra, Linn.

Ajuga reptans, Linn.

Two undetermined genera.

PLANTAGINEÆ.

Littorella juncea, Berg.

CHENOPODIACEÆ.

Chenopodium album, Linn.

C. rubrum, Linn.

Atriplex hastata, Linn.?

POLYGONACEÆ.

Polygonum Convolvulus, Linn.

P. aviculare, Linn.

P. Persicaria, Linn.

P. amphibium, Linn.

Rumex maritimus, Linn.

R. obtusifolius, Linn.

R. Hydrolapathum, Huds.

R. acutus, Linn.?

R. Acetosella, Linn.

EUPHORBIACEÆ.

Euphorbia amygdaloides, Linn.

URTICACEÆ.

Ulmus montana, Stokes?

Urtica dioica, Linn.

U. urens, Linn.?

CUPULIFEREÆ.

Betula alba, Linn.

Alnus glutinosa, Gaertn.

A. sp.

Carpinus Betulus, Linn.

Corylus Avellana, Linn.

Quercus Robur, Linn.

Fagus sylvatica, Linn.

Salix cinerea, Linn.

S. sp. 2.

S. sp. 3.

CERATOPHYLLEÆ.

Ceratophyllum demersum, Linn.

CONIFEREÆ.

Taxus baccata, Linn.

Pinus sylvestris, Linn.

Picea excelsa, Link.

HYDROCHARIDEÆ.

Stratiotes Aloides, Linn.

TYPHACEÆ.

Sparganium erectum, Linn.?

ALISMACEÆ.

Alisma Plantago, Linn.

Sagittaria sagittifolia, Linn.

NAIADACEÆ.

Potamogeton natans, Linn.

P. heterophyllus, Schreb.

P. prælongus, Wulf.

P. perfoliatus, Linn.

P. crispus, Linn.

P. obtusifolius, Mert. & Koch.

P. pusillus, Linn.

P. trichoides, Cham.

P. pectinatus, Linn.

Zannichellia palustris, Linn.

Z. pedunculata, Reichb.

Najas marina, Linn.

N. minor, Allioni.

CYPERACEÆ.

Eleocharis sp.

Scirpus fluitans, Linn.

S. lacustris, Linn.

S. Tabernæmontani, C. C. Gmel.

Eriophorum vaginatum, Linn.

Carex dioica, Linn.

C. muricata, Linn.

C. cf. helodes, Link.

C. hirta, Linn.

C. acutiformis, Ehrh.

C. riparia, Curtis.

C. rostrata, Stokes.

C. sp. 9.

C. sp. 10.

C. vesicaria, Linn.

GRAMINEÆ.

Phragmites communis, Trin.

FILICES.

Osmunda regalis, Linn.

NOTES ON THE PLANTS.

THALICTRUM FLAVUM, Linn. (Plate 11. fig. 1.)

Achenes are not uncommon at several localities. They agree exactly with recent specimens.

RANUNCULUS AQUATILIS, Linn. (Pl. 11. figs. 2, 3.)

Achenes are abundant and variable; but we are unable to separate the different species of Batrachian *Ranunculi* from fruits alone. We must therefore leave them under the Linnean aggregate *Ranunculus aquatilis*.

RANUNCULUS SCELERATUS, Linn. (Pl. 11. fig. 4.)

Indistinguishable from recent achenes. Found rarely at Beeston, Cromer, and Pakefield.

RANUNCULUS FLAMMULA, Linn. (Pl. 11. fig. 5.)

As yet only found at Pakefield.

RANUNCULUS LINGUA, Linn. (Pl. 11. fig. 6.)

Calls for no remark. Achenes have been found at Beeston and Pakefield.

RANUNCULUS REPENS, *Linn.* (Pl. 11. fig. 7.)

Achenes are common at several localities and are usually well-preserved. They are clearly distinguishable both by their shape and the character of their punctation from *R. acris* and *R. bulbosus*, neither of which has yet been discovered.

RANUNCULUS NEMOROSUS, *DC.* (Pl. 11. fig. 8.)

An achene resembling *R. repens*, but larger, with wider, more bevelled margin, sides more coarsely pitted, and ridges between the pits rounded instead of sharp. This agrees with *R. nemorosus* and does not correspond with any other European form. The species belongs to woods and shady places in Central and Southern Europe. The fossil was found at Pakefield.

RANUNCULUS sp. 7. (Pl. 11. fig. 9.)

A single achene of *Ranunculus* found at Beeston is very large, elongate oval, with terminal style, and no margin, the sides are rounded but pinched in. We can find no *Ranunculus* with achenes resembling this; it must wait for more specimens.

RANUNCULUS sp. 8. (Pl. 11. fig. 10.)

An achene from Pakefield, in shape much like *R. Lingua*, but the surface-pits are not elongated. We cannot match this; but require more specimens for thorough examination.

CALTHA PALUSTRIS, *Linn.* (Pl. 11. figs. 11, 12.)

Several seeds have been found at Mundesley and Pakefield; but the testa is so fragile that they are difficult to preserve.

NYMPHÆA LUTEA, *Linn.* (NUPHAR LUTEUM, *Sibth. & Sm.*). (Pl. 11. fig. 13.)

Abundant at various localities.

CASTALIA ALBA, *Woods* (NYMPHÆA ALBA, *Linn.*). (Pl. 11. fig. 14.)

This species was recorded in 1861 by the Rev. S. W. King, but till lately we could obtain no corroborative evidence, and some of Mr. King's specimens were certainly derived from a more modern deposit than the Cromer Forest-bed. We have now found two seeds at Pakefield. They are much crushed and damaged; but still show the very characteristic surface-sculpture, of which, however, we have not obtained a satisfactory photograph.

NYMPHÆACEÆ sp. 3. (Pl. 11. fig. 15.)

Seed smaller than *N. lutea* and differing in shape and surface-pittings. It shows the characteristic funnel-shaped infolding of the testa, into which the embryo fits, and the surface-sculpture also suggests Nymphæaceæ.

We require more material for the determination of this interesting seed, which belongs to no living water-lily of which we have yet been able to examine seeds.

NYMPHÆACEÆ sp. 4. (Pl. 11. fig. 16.)

Two or three much damaged seeds that appear to belong to a fourth species of water-lily have been found at Pakefield. Length 4·3 mm.; testa with conspicuous rectangular pits arranged in lines. These also must wait for further material.

HYPECOUM PROCUMBENS, *Linn.* (Pl. 11. fig. 17.)

Seeds of this plant are common at Corton and correspond exactly with those of the recent plant, which belongs to the Mediterranean region and Southern France.

All the species of this genus have the seed protected by a close mosaic of cubic crystals of oxalate of lime. These impress the testa with quadrangular pits; and traces of these thin-walled quadrangular pits are to be found on several of our specimens.

VIOLA PALUSTRIS, *Linn.* (Pl. 11. fig. 18.)

Damaged seeds of *Viola* are common at various localities, but are seldom sufficiently well preserved for determination. Fig. 18 corresponds with *Viola palustris*.

VIOLA, cf. *HIRTA*, *Linn.* (Pl. 11. figs. 19, 20.)

Many of the seeds of *Viola* belong to a larger form, closely resembling *V. hirta*, but slightly more slender than our recent seeds of that species.

VIOLA, cf. *RIVINIANA*, *Reichb.* (Pl. 11. fig. 21.)

The majority of the seeds of *Viola* belong to a third species. They closely resemble *V. Riviniana*, but are larger than our recent seeds.

STELLARIA AQUATICA, *Moench.* (Pl. 11. fig. 22.)

S. MEDIA, *Villars.* (Pl. 11. fig. 23.)

S. HOLOSTEA, *Linn.* (Pl. 11. fig. 24.)

These correspond so exactly with the recent seeds that no remark is needed. They were all found at Pakefield.

ARENARIA SERPYLLIFOLIA, *Linn.* (Pl. 11. fig. 25.)

One perfect seed and one fragment are all that we have found of this species.

ELATINE HYDROPIPER, *Linn.* (Pl. 11. fig. 26.)

Several seeds have been found at Pakefield.

HYPERICUM QUADRANGULUM, *Linn.* (Pl. 11. fig. 27.)

H. HIRSUTUM, *Linn.* (Pl. 11. fig. 28.)

The shape and sculpture of the testa in the different species of *Hypericum* are very characteristic, and the fossil seeds are well preserved. We have only as yet found these two species.

RHAMNUS FRANGULA, *Linn.* (Pl. 11. fig. 29.)

Seeds are very scarce, and have only been found at Pakefield.

ACER CAMPESTRE, *Linn.* (Pl. 11. figs. 30, 31.)

Trees of this maple must have overhung the small channel at Pakefield, for seeds, fragments of wings, and broken leaves are very plentiful.

RUBUS IDÆUS, *Linn.* (Pl. 12. fig. 34.)

Two or three characteristic stones have now been found ; it is much more scarce than *R. fruticosus*.

POTENTILLA SILVESTRIS, *Neck.* (Pl. 12. figs. 36, 37.)

The carpels are very variable, but all seem referable to this species.

ALCHEMILLA ARVENSIS, *Scop.* (Pl. 12. fig. 38.)

A few nuts of this plant have been found at Pakefield.

PYRUS ARIA, *Ehrh.*

We have only seen one damaged leaf of this tree. It is too black to photograph.

CRATÆGUS OXYACANTHA, *Linn.* (Pl. 12. figs. 40–44.)

This species has only been found at Overstrand, where the fruits are very variable. Five have been figured, to show the range of variation.

CRATÆGUS sp. ? (Pl. 12. fig. 45.)

The fruit figured seems to belong to a second species of *Cratægus*. We have only one specimen, which was found at Pakefield.

TRAPA NATANS, *Linn.* (Pl. 12. figs. 49–56.)

Several specimens are figured, to show the variability of these fruits.

CIRCÆA LUTETIANA, *Linn.* (Pl. 12. fig. 59.)

Two fruits of this plant have been found at Pakefield. They are in a peculiar state of preservation, having lost their hooked hairs.

CONIUM MACULATUM, *Linn.* (Pl. 12. fig. 60.)

These are well preserved, though the ridges have been lost. Even in Roman deposits, in which the fruits are very abundant, the ridges have disappeared.

APIUM sp. (Pl. 12. fig. 61.)

Fruits of *Apium* occur, but are never well preserved. As a rule the state of preservation of the Umbelliferae is not satisfactory.

CHÆROPHYLLUM SYLVESTRE, *Linn.* (Pl. 12. fig. 64.)

Two or three fruits of this plant have been found at Pakefield.

CENANTHE LACHENALII, *C. C. Gmel.* (Pl. 13. fig. 65.)

A few damaged fruits have been found at Pakefield. The skeleton photographed is one of the best.

CENANTHE PHELLANDRIUM, *Lam.* (Pl. 13. figs. 66, 67.)

Fruits of this plant are abundant everywhere; but are usually much smaller than recent specimens.

ÆTHUSA CYNAPIUM, *Linn.* (Pl. 13. figs. 68, 69.)

A few fruits occur at Pakefield.

PASTINACA SATIVA, *Linn.* (Pl. 13. fig. 70.)

Occurs at Pakefield and Trimingham.

HERACLEUM SPHONDYLIIUM, *Linn.* (Pl. 13. fig. 71.)

Three specimens seen; all have the obcordate fruit here figured.

TORILIS ANTHRISCUS, *Bernh.* (Pl. 13. fig. 72.)

Two characteristic fruits have been found at Pakefield.

VIBURNUM OPULUS, *Linn.* (Pl. 13. fig. 74.)

Only two seeds have been found.

VIBURNUM sp. 2. (Pl. 13. figs. 75-77.)

At Pakefield about 30 or 40 flat or plano-convex seeds belonging apparently to a second species of *Viburnum* have been found. They are about the size of *V. Tinus*, but in other respects do not agree with that species. The fossil seeds are oval, the ventral face is flat or slightly rounded and channelled, the dorsal face has two ridges which are not quite symmetrical, the testa is very thick. Length 3 mm., breadth 2 mm.

At first, from their general appearance and their slight want of symmetry, these seeds were thought to belong to *Lonicera*; but in that genus the testa

is thin, not exceptionally thick as in our fossil. They appear to belong to Caprifoliaceæ, but we can find no European plant to which they can be referred. Only three species of *Viburnum* now inhabit Europe.

VIBURNUM sp. 3. (Pl. 13. figs. 78, 79.)

About a dozen large woody seeds found at Pakefield seem to belong to a third species of *Viburnum*. Seed oval, flattened; ventral face slightly rounded and channelled, dorsal face rounded and obscurely, irregularly ridged longitudinally. Length 7 mm., breadth 5 mm. These seeds obviously belong to the same genus as the last, but are more than double the length. We can find nothing to correspond with them.

Many fossil species of *Viburnum* have been described, but always from leaves. Until we have further material, both recent and fossil, we cannot give a name to the Pakefield specimens.

GALIUM APARINE, Linn. (Pl. 13. fig. 80.)

This plant occurs at Pakefield, but the fruits have entirely lost their outer coat and hooked bristles.

VALERIANA SAMBUCIFOLIA, Willd. (Pl. 13. fig. 81.)

The only fruit of *Valeriana* is so crumpled that it cannot be photographed satisfactorily; it certainly belongs to this species.

VALERIANELLA OLITORIA, Poll. (Pl. 13. fig. 82.)

One fruit, crushed so as to expose the seed, and a few detached seeds are all that we have seen. The coarse punctation of the seed is very marked, and characteristic of this species.

EUPATORIUM sp.? (Pl. 13. fig. 83.)

A minute composite fruit with linear shape and five sharp ridges would appear to belong to this genus, but we have not been able to identify it. *Eupatorium cannabinum* has not yet been found in pre-Glacial deposits, though its fruits are not uncommon in newer strata.

TUSSILAGO FARFARA, Linn. (Pl. 13. fig. 85.)

Two or three characteristic fruits have been found at Pakefield.

ARCTIUM sp. (Pl. 13. figs. 86, 87.)

Two different forms of fruit of *Arctium* have been found; but we cannot satisfactorily determine them without more recent material.

CARDUUS NUTANS, Linn. (Pl. 13. figs. 88, 89.)

Not uncommon in the Cromer Forest-bed.

CARDUUS, cf. *NUTANS*, *Linn.* (Pl. 13. fig. 90.)

Fruits like *C. nutans*, but with finer sculpture and without longitudinal ribs. We find this species occurring also in a deposit of slightly older date at Tegelen in the Netherlands. The Pakefield seeds vary considerably in size, the one figured is large.

Our series of recent fruits of *Carduus* is still very imperfect, and in herbarium specimens the fruits are seldom ripe. The fossil may belong to some well-known continental plant.

CARDUUS PALUSTRIS, *Linn.* (Pl. 13. fig. 91.)

A few fruits have been found at Pakefield.

CARDUUS LANCEOLATUS, *Willd.* ?

This species has been recorded with doubt ('Origin of the British Flora') but the specimen was badly preserved and we can find no others.

CARDUUS HETEROPHYLLUS, *Linn.* ? (Pl. 13. fig. 92.)

The coarse rugose sculpture of the fruit figured corresponds so closely with that of *C. heterophyllus*, that we must refer our fossil to that species. We have only one specimen, and this is the only plant at Pakefield that suggests northern rather than southern latitudes.

CENTAUREA sp. (Pl. 13. figs. 93, 94.)

Two fruits of *Centaurea* have been found at Pakefield, probably representing two species. The fruit shown in fig. 94 corresponds with *C. Calcitrapa*, and with no other British form. But there are so many European species of this genus the fruits of which we have yet been unable to examine, that we hesitate to refer our fossil to a species belonging so markedly to dry soils.

CREPIS SUCCISÆFOLIA, *Tausch.* (Pl. 13. fig. 96.)

Not uncommon at Pakefield.

LEONTODON AUTUMNALIS, *Linn.* (Pl. 13. fig. 97.)

Occurs rarely at Pakefield.

VERBASCUM THAPSUS, *Linn.* (Pl. 14. fig. 102.)

A single seed has been found at Pakefield. The species in this genus are readily distinguished by their seeds.

LIMOSELLA AQUATICA, *Linn.* (Pl. 14. fig. 103.)

Only one specimen has been found ; but the seed is so small that it may easily be overlooked, or lost in washing the clay.

VERONICA CHAMÆDRYS, *Linn.* (Pl. 14. fig. 104.)

Seeds of *Veronica* are not uncommon ; but are usually decayed in such a curious way that they are not easily recognised. The determinable specimens belong to *V. Chamædrys*, and as yet we can find no trace of our three aquatic species.

CALAMINTHA ARVENSIS, *Lam.* (Pl. 14. fig. 109.)

PRUNELLA VULGARIS, *Linn.* (Pl. 14. fig. 110.)

A few nutlets of each of these have been found at Pakefield.

STACHYS SYLVATICA, *Linn.* (Pl. 14. fig. 111.)

Not uncommon. The nutlets previously referred to *S. palustris* belong to this species. We cannot yet find *S. palustris*.

STACHYS ARVENSIS, *Linn.* (Pl. 14. fig. 112.)

Two nutlets from Pakefield show the characteristic rugosity and punctation of this species.

BALLOTA NIGRA, *Linn.* (Pl. 14. fig. 113.)

Rare at Pakefield.

AJUGA REPTANS, *Linn.* (Pl. 14. fig. 114.)

The illustration represents the only specimen yet found. It is unfortunately so crushed that it is difficult to show the characters in a photograph. The nutlet shows, however, the enormous aperture and reticulated back characteristic of this species.

LABIATE, genus undetermined. (Pl. 14. fig. 115.)

Nutlets ovate, rounded above, sharp below, with a very sharp prominent ventral ridge ; sculpture of fine, very regular punctation (thimble-pitting), without rugosity or tubercles. Length 1·6 mm., breadth 1·0 mm.

This belongs to no British plant. We have few fruits of foreign labiates to compare with it, and only unripe nutlets are usually to be found in herbaria.

LABIATE, genus undetermined. (Pl. 14. fig. 116.)

Nutlet broad, very tumid and rugose, with sharp ventral ridge. Length 1·8 mm., breadth 1·25 mm.

This also belongs to no living British plant ; but we have found a similar nutlet in a somewhat older deposit at Tegelen in the Netherlands.

LITTORELLA JUNCEA, *Berg.* (Pl. 14. fig. 117.)

Two fruits only have been found, but they correspond exactly with those of the recent plant.

CHENOPodium ALBUM, *Linn.* (Pl. 14. fig. 118.)

C. RUBRUM, *Linn.* (Pl. 14. fig. 119.)

Call for no remark ; they correspond with recent seeds.

ATRIPLEX HASTATA, *Linn.* (Pl. 14. fig. 120.)

After examining a number of specimens we have come to the conclusion that the seeds previously referred to *A. patula* must all be referred to this species ; but we can only find seeds of one size.

POLYGONUM CONVULVULUS, *Linn.* (Pl. 14. fig. 121.)

A single nut with part of the perianth has been found at Pakefield.

POLYGONUM AVICULARE, *Linn.* (Pl. 14. fig. 122.)

A few nuts have been found ; the one figured has part of the perianth attached.

POLYGONUM PERSICARIA, *Linn.* (Pl. 14. fig. 123.)

Nuts somewhat smaller than our recent specimens, but otherwise correspond.

POLYGONUM AMPHIBIUM, *Linn.* (Pl. 14. fig. 124.)

Agrees exactly.

RUMEX MARITIMUS, *Linn.* (Pl. 14. figs. 125, 126.)

Abundant and somewhat variable. Two forms are figured.

RUMEX OBTUSIFOLIUS, *Linn.* (Pl. 14. fig. 127.)

Shows the characteristic venation of the fruiting sepals.

RUMEX HYDROLAPATHUM, *Huds.* (Pl. 14. fig. 128.)

A very large nut with remains of the fruiting sepals can only be referred to this species.

RUMEX ACUTUS, *Linn.*? (Pl. 14. fig. 129.)

A specimen showing fruiting-perianth with no tubercle, without nut, seems very close to *Rumex acutus*. The venation does not correspond with either *R. crispus* or *R. obtusifolius*.

RUMEX ACETOSELLA, *Linn.* (Pl. 14. fig. 130.)

A nut in skeleton fruiting-perianth, showing the characteristic venation.

ULMUS MONTANA, *Stokes*?

Leaves have been found in the ironstone of Happisburgh ; but we cannot get a satisfactory photograph.

URTICA DIOICA, *Linn.* (Pl. 14. fig. 132.)

U. URENS, *Linn.*? (Pl. 14. fig. 133.)

These two species are not uncommon; but the sculpture of the nut referred to *U. urens* differs slightly from our recent specimens.

ALNUS GLUTINOSA, *Gaertn.* (Pl. 14. figs. 135, 136.)

A. sp. (Pl. 14. figs. 137, 138.)

Cones and seeds of alder are very abundant and generally belong to *A. glutinosa*. At Pakefield there appears to be a second species, the seeds of which have a narrow somewhat stipitate base, and always differ somewhat in colour from the seeds of *Alnus glutinosa* with which they are mixed. We can find no recent alder to correspond with this. The cones are not sufficiently well preserved for us to distinguish them.

SAGITTARIA SAGITTIFOLIA, *Linn.* (Pl. 15. fig. 152.)

A few carpels have been found, but none are well preserved.

POTAMOGETON NATANS, *Linn.* (Pl. 15. fig. 153.)

P. PERFOLIATUS, *Linn.* (Pl. 15. fig. 156.)

P. OBTUSIFOLIUS, *Mert. & Koch.* (Pl. 15. fig. 159.)

P. PUSILLUS, *Linn.* (Pl. 15. fig. 160.)

Fruits of *Potamogeton* are extremely abundant at nearly all localities; but the species vary from place to place. Thanks to Mr. James Groves we have been able to compare our fossils with a good series of recent fruits, and now make four additions to the list. One species previously recorded (*P. lucens*) must, however, be deleted as a wrong determination.

CYPERACEÆ.

Many species of Cyperaceæ are found, but most of them are only represented by detached nuts without setæ or utricles. We have only ventured to determine a few of the best preserved and most characteristic forms.

A few plants previously recorded are not included in the above list and notes, and have been omitted till they can be verified. The determinations may have been right; but in some cases the seeds have suffered so much, from gradual decay of the pyrites, that we cannot now say whether they were right or wrong. In other cases we await more material before authenticating the determination. *Pinus montana*, for instance, has been recorded by Heer and Saporta; but we can find no cones belonging to this pine, though we have examined a large amount of material. Possibly the cones came from a later deposit, with Arctic plants, which overlies the Cromer Forest-bed, and is not included within the scope of this paper.

General Conclusions.

This revision nearly doubles the number of plants recorded from British pre-Glacial deposits, for it includes 147 species. We have also various seeds and fruits in a perfectly determinable state, but belonging either to extinct forms, or more probably in the main to British or exotic species not represented in our recent collection. The determination of these is a very slow process; for a seed so peculiarly sculptured as to be readily determinable, if we happen to know the recent form, may be so wanting in generic or broader characters as to give no clue to guide us in our search. We have not thought it advisable to figure these *incertæ sedis*, unless we could make a definite suggestion as to the families or genera to which they belong, or could draw up a clear botanical description. This is often impossible without destroying a unique specimen in order to examine its internal characters.

The mention of internal characters as applied to specimens of which nothing now remains but the testa or endocarp may seem absurd. It must not be forgotten, however, that in botany, as in zoology, soft parts impress their forms on indestructible hard parts, and convolutions of the embryo or vascular markings may be as well studied from the inside of the testa as in the interior of the skull of some extinct race of man. The illustration of the interior of the fruit of *Ceratophyllum demersum* (Pl. 14. fig. 143) will indicate how perfect may be this preservation.

Our pre-Glacial flora is found in a series of alluvial and estuarine deposits, which underlie the boulder-clay and stretch for nearly fifty miles along the Norfolk and Suffolk coasts, from Sherringham to Pakefield. The deposits consist of estuarine muds and gravels, apparently brought down by the Rhine, which at that period, after receiving numerous large tributaries—now separate rivers—seems to have flowed across the present bed of the North Sea. It probably entered the sea somewhere near Cromer. Unfortunately the estuarine deposits are very stony, contain ferruginous concretions, and show few drift fruits; they have therefore not yet been properly examined for plants. It is in these, if anywhere, that we should expect to discover the dry-soil exotic forms lately found higher up the Rhine, at Tegelen, in Limburg. At that place an ancient Rhine alluvium, somewhat older than the Cromer Forest-bed, contains a large flora, the plants showing drier conditions and slightly more southern affinities. The Tegelen list includes *Magnolia Kobus*, *Juglans*, *Pterocarya caucasica*, *Vitis vinifera*, several South European plants, and new species of *Euryale* and *Stratiotes*. It also contains a number of dry-soil North European plants, which help to complete the imperfect picture of the pre-Glacial flora left by our British fossils*.

The plants of our British pre-Glacial deposits, unfortunately, have been collected almost exclusively from the alluvium of small tributary channels,

* The Tegelen flora has been described by us in a communication sent to the Academy of Sciences at Amsterdam: Versl. K. Akad. Wetens. 2e Sect. xiii. n. 6 (1907).

not from the alluvium of the main river. These small stream-channels necessarily yield in the main the plants that lived in them, or grew on the adjoining wet meadows, or in moist woods not far away. A few winged seeds dropped in and others were brought by birds; but though the dry-soil element is gradually being discovered, it is only represented by perhaps one seed out of a hundred, the bulk of the specimens belonging to a few aquatic genera. This scarcity of dry-soil plants makes our pre-Glacial list at present a poor representation of the ancient British flora. We can only compare it with the plants now living in or around a Norfolk Broad and those that accidentally drift in.

Perhaps the first thing to strike a botanist on examining our list will be, how little the flora has altered in the many thousand years that have elapsed and during the various climatic changes that have intervened. It was driven out by the cold of the Glacial Epoch and came back little altered.

But closer study somewhat modifies these conclusions, for a good many exotic species occur, and it must be remembered that several if not most of the *incertæ sedis* will almost certainly be exotic also. The non-British forms now recorded are *Ranunculus nemorosus*, two other species of *Ranunculus*, one or perhaps two water-lilies, *Hypecoum procumbens*, *Trapa natans*, two species of *Viburnum*?, two labiates, a second species of alder, *Picea excelsa*, and *Najas minor*. These give a decidedly peculiar appearance to the flora.

It is not very safe to deal with negative evidence, but there is another peculiarity in this fossil flora that only those who have handled a large amount of material will notice. A number of our plants have seeds and fruits so soft or decaying so readily that they seem never to be preserved in the fossil state. Such are *Ranunculus Ficaria*, most of the crucifers, leguminosæ, and many umbellifers and grasses; these we cannot expect to find save under very exceptional conditions. Certain of our common meadow and woodland plants, which we know, from the examination of more modern deposits, have seeds which preserve perfectly and abundantly, are, on the other hand, still missing in our pre-Glacial list. Disregarding plants which we find in deposits of Roman date, but no earlier, for these may be weeds of cultivation, we notice the absence of *Ranunculus acris*, *R. bulbosus*, *Lychnis Flos-cuculi*, *Potentilla palustris*, *Sambucus nigra*, *Taraxacum*, *Sonchus*, *Lamium*. The hazel, so abundant in our Neolithic submerged forests, is only represented in the Cromer Forest-bed by a few nuts, usually stunted and distorted in growth.

The pre-Glacial plants suggest climatic conditions almost identical with those now existing, though slightly warmer. This difference, however, may be largely due to the connection of Britain with the Continent while the plant-bed was forming. The influence of altered geographical conditions on our living fauna and flora has already been discussed (*op. cit.*) and need not be further commented on. Nothing in the present revision has tended to modify the conclusions already arrived at, except that the southern element

in the flora is becoming more marked. Also, it now appears that it includes in all probability several extinct species. This brings it more into line with the pre-Glacial mammals and mollusca, both of which groups contain various extinct forms.

EXPLANATION OF THE PLATES.

PLATE 11.

- Fig. 1. *Thalictrum flavum*, Linn., carpel, $\frac{12}{1}$. Pakefield.
- 2, 3. *Ranunculus aquatilis*, Linn., carpels, $\frac{12}{1}$. Pakefield.
4. *R. sceleratus*, Linn., carpel, $\frac{12}{1}$. Pakefield.
5. *R. Flammula*, Linn., carpel, $\frac{12}{1}$. Pakefield.
6. *R. Lingua*, Linn., carpel, $\frac{12}{1}$. Beeston.
7. *R. repens*, Linn., carpel, $\frac{12}{1}$. Pakefield.
8. *R. nemorosus*, DC., carpel, $\frac{12}{1}$. Pakefield.
9. *R. sp. 7*, carpel, $\frac{12}{1}$. Beeston.
10. *R. sp. 8*, carpel, $\frac{12}{1}$. Pakefield.
11. *Caltha palustris*, Linn., short seeds, $\frac{12}{1}$. Pakefield.
12. — long seed, $\frac{12}{1}$. Mundesley.
13. *Nymphæa lutea*, Linn., seed, $\frac{6}{1}$. Pakefield.
14. *Castalia alba*, Woods, seed, $\frac{6}{1}$. Pakefield.
15. Undetermined species belonging to Nymphæaceæ, seed, $\frac{6}{1}$. Pakefield.
16. Another undetermined species belonging to Nymphæaceæ, seed, $\frac{12}{1}$. Pakefield.
17. *Hypocoum procumbens*, Linn., seed, $\frac{12}{1}$. Corton.
18. *Viola palustris*, Linn., seed, $\frac{12}{1}$. Pakefield.
- 19, 20. *V. cf. hirta*, Linn., seed, $\frac{12}{1}$. Pakefield.
21. *V. cf. Riviniana*, Reichb., seed, $\frac{12}{1}$. Pakefield.
22. *Stellaria aquatica*, Moench, seed, $\frac{12}{1}$. Pakefield.
23. *S. media*, Villars, seed, $\frac{12}{1}$. Pakefield.
24. *S. Holostea*, Linn., seed, $\frac{12}{1}$. Pakefield.
25. *Arenaria serpyllifolia*, Linn., seed, $\frac{12}{1}$. Pakefield.
26. *Elatine Hydropiper*, Linn., seed, $\frac{24}{1}$. Pakefield.
27. *Hypericum quadrangulum*, Linn., seed, $\frac{24}{1}$. Pakefield.
28. *H. hirsutum*, Linn., seed, $\frac{24}{1}$. Pakefield.
29. *Rhamnus Frangula*, Linn., seed, $\frac{6}{1}$. Pakefield.
30. *Acer campestre*, Linn., fruit wanting wing, $\frac{3}{1}$. Pakefield.
31. — part of wing, $\frac{3}{1}$. Pakefield.

PLATE 12.

- Fig. 32. *Prunus spinosa*, Linn., nut, $\frac{3}{1}$. West Runton.
 33. *Spiraea Ulmaria*, Linn., seed, $\frac{6}{1}$. Pakefield.
 34. *Rubus Idæus*, Linn., seed, $\frac{6}{1}$. Pakefield.
 35. *R. fruticosus*, Linn., seed, $\frac{6}{1}$. Pakefield.
 36, 37. *Potentilla silvestris*, Neck., nuts, $\frac{12}{1}$. Mundesley and Pakefield.
 38. *Alchemilla arvensis*, Scop., nut, $\frac{12}{1}$. Pakefield.
 39. *Pyrus Malus*, Linn., seed, $\frac{6}{1}$. Pakefield.
 40-44. *Cratægus Oxyacantha*, Linn., series showing variation in form at one locality, nuts, $\frac{6}{1}$. Overstrand.
 45. *Cratægus* sp. ? , nut, $\frac{6}{1}$. Pakefield.
 46. *Hippurus vulgaris*, Linn., fruit, $\frac{12}{1}$. Pakefield.
 47, 48. *Myriophyllum spicatum*, Linn., nuts, $\frac{12}{1}$. Pakefield.
 49-56. *Trapa natans*, Linn., nuts, $\frac{1}{1}$. Mundesley.
 57, 58. — spine and abnormal spine, $\frac{6}{1}$. Pakefield.
 59. *Circeæ lutetiana*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 60. *Conium maculatum*, Linn., carpel, $\frac{12}{1}$. Pakefield.
 61. *Apium* sp., carpel, $\frac{12}{1}$. Pakefield.
 62, 63. *Cicuta virosa*, Linn., carpels, $\frac{12}{1}$. Pakefield and Beeston.
 64. *Chærophyllum sylvestre*, Linn., carpel, $\frac{6}{1}$. Pakefield.

PLATE 13.

- Fig. 65. *Enanthe Lachenulii*, C. C. Gmel., skeleton carpel, $\frac{12}{1}$. Pakefield.
 66. *Æ. Phellandrium*, Lam., carpel, ventral face, $\frac{12}{1}$. Pakefield.
 67. — carpel, dorsal face, $\frac{12}{1}$. Pakefield.
 68. *Æthusa Cynapium*, Linn., carpel, dorsal face, $\frac{12}{1}$. Pakefield.
 69. — carpel, ventral face, $\frac{12}{1}$. Pakefield.
 70. *Pastinaca sativa*, Linn., carpel, $\frac{6}{1}$. Pakefield.
 71. *Heracleum Sphondylium*, Linn., carpel, $\frac{6}{1}$. Pakefield.
 72. *Torilis Anthriscus*, Bernh., carpel, $\frac{12}{1}$. Pakefield.
 73. *Cornus sanguinea*, Linn., nut, $\frac{6}{1}$. Pakefield.
 74. *Viburnum Opulus*, Linn., seed, $\frac{6}{1}$. Pakefield.
 75. *V.* ? sp. 2, seed, ventral surface, $\frac{6}{1}$. Pakefield.
 76. *V.* ? sp. 2, seed, dorsal surface, $\frac{6}{1}$. Pakefield.

- Fig. 77. *Viburnum* ? sp. 2, seed, inside, $\frac{6}{1}$. Pakefield.
 78. *V.* ? sp. 3, seed, ventral surface, $\frac{6}{1}$. Pakefield.
 79. *V.* ? sp. 3, seed, dorsal surface, $\frac{6}{1}$. Pakefield.
 80. *Galium Aparine*, Linn., fruit, wanting bristles, $\frac{6}{1}$. Pakefield.
 81. *Valeriana sambucifolia*, Willd., fruit, $\frac{6}{1}$. Pakefield.
 82. *Valerianella olitoria*, Poll., fruit, burst so as to show seed, $\frac{6}{1}$. Pakefield.
 83. *Eupatorium* sp. ?, fruit, $\frac{12}{1}$. Pakefield.
 84. *Bidens tripartita*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 85. *Tussilago Farfara*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 86, 87. *Arctium* sp., fruits, $\frac{6}{1}$. Pakefield.
 88, 89. *Carduus nutans*, Linn., fruits, $\frac{6}{1}$. Pakefield.
 90. *C. cf. nutans*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 91. *C. palustris*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 92. *C. heterophyllus*, Linn. ?, fruit, $\frac{6}{1}$. Pakefield.
 93. *Centaurea* sp., fruit, $\frac{6}{1}$. Pakefield.
 94. *C. Calcitrapa*, Linn. ?, fruit, $\frac{6}{1}$. Pakefield.
 95. *Picris hieracioides*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 96. *Crepis succiseifolia*, Tausch, fruit, $\frac{6}{1}$. Pakefield.
 97. *Leontodon autumnalis*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 98. Undetermined Composite ?, $\frac{24}{1}$. Pakefield.

PLATE 14.

- Fig. 99. *Menyanthes trifoliata*, Linn., seed, $\frac{12}{1}$. Pakefield.
 100, 101. *Solanum Dulcamara*, Linn., seeds, $\frac{12}{1}$. Pakefield. (Fig. 101 is mounted in glycerine jelly, to bring out cell-structure.)
 102. *Verbascum Thapsus*, Linn., seed, $\frac{12}{1}$. Pakefield.
 103. *Limosella aquatica*, Linn., seed, $\frac{24}{1}$. Pakefield.
 104. *Veronica Chamædrys*, Linn., seed, $\frac{12}{1}$. Pakefield.
 105, 106. *Mentha aquatica*, Linn., nutlets (dorsal and ventral faces), $\frac{12}{1}$. Pakefield.
 107, 108. *Lycopus europæus*, Linn., nutlets (dorsal and ventral faces), $\frac{12}{1}$. Pakefield.
 109. *Calamintha arvensis*, Lam., nutlet (ventral face), $\frac{12}{1}$. Pakefield.
 110. *Prunella vulgaris*, Linn., nutlet (ventral face), $\frac{12}{1}$. Pakefield.
 111. *Stachys sylvatica*, Linn., nutlet (ventral face), $\frac{12}{1}$. Pakefield.

- Fig. 112. *Stachys arvensis*, Linn., nutlet (ventral face), $\frac{12}{1}$. Pakefield.
 113. *Ballota nigra*, Linn., nutlet (dorsal face), $\frac{12}{1}$. Pakefield.
 114. *Ajuga reptans*, Linn., nutlet (ventral face), $\frac{12}{1}$. Pakefield.
 115. Undetermined labiate, nutlet (ventral face), $\frac{12}{1}$. Pakefield.
 116. Another undetermined labiate, nutlet (dorsal face), $\frac{12}{1}$. Pakefield.
 117. *Littorella juncea*, Berg., fruit, $\frac{12}{1}$. Pakefield.
 118. *Chenopodium album*, Linn., seed, $\frac{12}{1}$. Beeston.
 119. *C. rubrum*, Linn., seed, $\frac{12}{1}$. Pakefield.
 120. *Atriplex hastata*, Linn.?, seed, $\frac{12}{1}$. Pakefield.
 121. *Polygonum Convolvulus*, Linn., nut with part of perianth, $\frac{6}{1}$. Pakefield.
 122. *Polygonum aviculare*, Linn., nut with trace of perianth, $\frac{6}{1}$. Pakefield.
 123. *P. Persicaria*, Linn., nut, $\frac{6}{1}$. Pakefield.
 124. *P. amphibium*, Linn., nut, $\frac{12}{1}$. Mundesley.
 125, 126. *Rumex maritimus*, Linn., fruits, $\frac{6}{1}$. Pakefield.
 127. *R. obtusifolius*, Linn., fruit, $\frac{6}{1}$. Pakefield.
 128. *R. Hydrolapathum*, Huds., fruit, $\frac{6}{1}$. Pakefield.
 129. *R. acutus*, Linn.?, fruit, $\frac{6}{1}$. Pakefield.
 130. *R. Acetosella*, Linn., fruit, $\frac{6}{1}$. Beeston.
 131. *Euphorbia amygdaloides*, Linn., seed, $\frac{12}{1}$. Pakefield.
 132. *Urtica dioica*, Linn., nut, $\frac{12}{1}$. Pakefield.
 133. *U. urens*, Linn.?, nut, $\frac{12}{1}$. Pakefield.
 134. *Betula alba*, Linn., fruit showing part of wing, $\frac{12}{1}$. Pakefield.
 135. *Alnus glutinosa*, Gaertn., seed, $\frac{6}{1}$. Pakefield.
 136. — cone, $\frac{2}{1}$. Pakefield.
 137, 138. *Alnus* sp., seeds, $\frac{6}{1}$. Pakefield.
 139, 140. *Carpinus Betulus*, Linn., nuts (ventral and dorsal faces), $\frac{3}{1}$. Pakefield.
 141. *Corylus Avellana*, Linn., nut, $\frac{1}{1}$. Pakefield.
 142. *Quercus Robur*, Linn., acorn-cup, $\frac{1}{1}$. Happisburgh.
 143. *Ceratophyllum demersum*, Linn., fruit, inside, $\frac{3}{1}$. Pakefield.
 144. — fruit, outside, $\frac{3}{1}$. Pakefield.

PLATE 15.

- Fig. 145. *Taraxacum baccata*, Linn., seed, $\frac{3}{1}$. Happisburgh.
 146. *Pinus sylvestris*, Linn., cone, $\frac{1}{1}$. Cromer.

- Fig. 147. *Picea excelsa*, Link, cone, $\frac{1}{1}$. Mundesley.
148. *Stratiotes Aloides*, Linn., seed, inside, $\frac{3}{1}$. Beeston.
149. — seed, outside, $\frac{3}{1}$. Pakefield.
150. *Sparganium erectum*, Linn.?, nut, $\frac{6}{1}$. Pakefield.
151. *Alisma Plantago*, Linn., carpel, $\frac{12}{1}$. Mundesley.
152. *Sagittaria sagittifolia*, Linn., carpel, $\frac{12}{1}$. Pakefield.
153. *Potamogeton natans*, Linn., nut, $\frac{6}{1}$. Overstrand.
154. *P. heterophyllus*, Schreb., nut, $\frac{6}{1}$. Cromer.
155. *P. prælongus*, Wulf., nut, $\frac{6}{1}$. Cromer.
156. *P. perfoliatus*, Linn., carpel, $\frac{6}{1}$. Mundesley.
157. *P. crispus*, Linn., carpel, $\frac{6}{1}$. Pakefield.
158. — nut, $\frac{6}{1}$. Beeston.
159. *P. obtusifolius*, Mert. & Koch, nut, $\frac{6}{1}$. Mundesley.
160. *P. pusillus*, Linn., nut, $\frac{6}{1}$. Pakefield.
161. *P. trichoides*, Cham., nut, $\frac{6}{1}$. Sidestrand.
162. *P. pectinatus*, Linn., carpel, $\frac{6}{1}$. Pakefield.
163. *Zannichellia palustris*, Linn., carpel, $\frac{12}{1}$. Pakefield.
164. *Z. pedunculata*, Reichb., carpel, $\frac{12}{1}$. Pakefield.
165. *Najas marina*, Linn., fruit, outside, $\frac{6}{1}$. Pakefield.
166. — fruit, inside, $\frac{6}{1}$. Pakefield.
167. *N. minor*, Allioni, fruit, $\frac{12}{1}$. Pakefield.
168. *Eleocharis* sp., nut, $\frac{12}{1}$. Beeston.
169. *Scirpus fluitans*, Linn., nut, $\frac{12}{1}$. Beeston.
170. *S. lacustris*, Linn., nut, $\frac{12}{1}$. Pakefield.
171. *S. Tabernæmontani*, C. C. Gmel., nut, $\frac{12}{1}$. Mundesley.
172. *Carex dioica*, Linn., fruit, $\frac{6}{1}$. Corton.
173. *C. muricata*, Linn., nut, $\frac{12}{1}$. Pakefield.
174. *C. cf. helodes*, Link, fruit, $\frac{6}{1}$. Pakefield.
175. *C. hirta*, Linn., fruit, $\frac{6}{1}$. Pakefield.
176. *C. acutiformis*, Ehrh., fruit, $\frac{6}{1}$. Pakefield.
177. *C. riparia*, Curtis, fruit, $\frac{6}{1}$. Pakefield.
178. *C. rostrata*, Stokes, nut, $\frac{12}{1}$. Pakefield.
179. *C. vesicaria*, Linn., fruit, $\frac{6}{1}$. Corton.
180. *C. sp. ?*, nut, $\frac{12}{1}$. Pakefield.
181. *C. sp. ?*, fruit, $\frac{12}{1}$. Corton.









