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	Page
L. Notulæ Lichenologicae. No. XXXIV. By the Rev. W. A. LERIGHTON, B.A., F.L.S., F.B.S. Ed.—Notes on the Chemical Reaction in the British Species of <i>Pertusaria</i>	473
LI. List of Coleoptera received from Old Calabar, on the West Coast of Africa. By ANDREW MURRAY, F.L.S.	475
 <i>New Books</i> .—1. Preliminary Field-Report of the United-States Geological Survey of Colorado and New Mexico, conducted, under the authority of the Secretary of the Interior, by F. V. Hayden, United-States Geologist. With a Report on the Mines and Minerals of Colorado, by Persifer Frazer, junior; and a Report on the Agriculture of Colorado, by Cyrus Thomas.—2. Geological Report of the Exploration of the Yellowstone and Missouri Rivers, by Dr. F. V. Hayden, under the direction of Captain W. F. Reynolds, Eng. 1859–60. With Report on the Cretaceous and Tertiary Plants, by J. S. Newberry, M.D. With a Geological Map.—3. The Lifted and Subsided Rocks of America, with their Influences on the Oceanic, Atmospheric, and Land Currents, and the Distribution of Races, by George Catlin	
	483
 Land- <i>Planariae</i> , by Walter Elliot, F.L.S.; Notes on the Genus <i>Myoictis</i> , by Dr. J. E. Gray, F.R.S.; On a new Locality for <i>Trocheta subviridis</i> , by Henry Lee, Esq.; On the Motory Phenomena of Animal Cells, by N. Lieberkühn; On the Reptilia of the Triassic Formations of the Atlantic region of the United States, by Prof. Cope	
	495—498
Index	501

PLATES IN VOL. VI.

PLATE I. Batrachiderpeton lineatum.

II. }
III. } Coleoptera from Old Calabar.

IV.—X. New Ostracoda.

XI. }
XII. } New Foraminifera.

XIII. New Species of Subspherous Sponges.

XIV. Development of Rhipiphorus paradoxus.

XV. Rhaphidotheca Marshall-Hallii.—Fieldingia lagettoides.

XVI. Development of Rhipiphorus paradoxus.

XVII. }
XVIII. } Favositipora Deshayesii.

XIX. New Entomostraca.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

“..... per litora spargite museum,
Naiades, et circum vitreos considite fontes:
Pollice virgineo teneros hic carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo.”

N. Parthenii Giannettasii Ecl. 1.

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I.—*The Ostracoda and Foraminifera of Tidal Rivers*. By GEORGE STEWARDSON BRADY, C.M.Z.S., and DAVID ROBERTSON, F.G.S. *With an Analysis and Descriptions of the Foraminifera*, by HENRY B. BRADY, F.L.S.

[Plates IV.—X.]

THAT the stagnant water and mud of salt marshes support a peculiar group of Microzoa has for some time past been well known, though the subject has received the attention of but few naturalists. The number of species inhabiting these localities, however, is probably very small, comprising among Foraminifera, chiefly *Polystomella striatopunctata*, Fichtel & Moll, a *Miliola* hitherto confused with *Quinqueloculina agglutinans*, D'Orbigny, *Trochammina inflata*, Montagu, *Nonionina depressula*, Walker & Jacob;—amongst Copepoda, *Temora velox*, Lilljeborg, *Tachidius brevicornis* (Müller), *Dias longiremis*, Lilljeborg, *Cyclops aequoreus*, Fischer, *C. Lubbockii*, Brady, *Dactylopus tishoides*, Claus, and *Delawalia palustris*, Brady. The Ostracoda are represented almost exclusively by *Cytherca castanea*, G. O. Sars, a smooth form of *Cytheridea torosa* (Jones), *Lorocconcha elliptica*, Brady, and more rarely by *Cypris salina*, Brady, and *Cypridopsis aculeata*, Lilljeborg*.

* See 'Natural History Transactions of Northumberland and Durham,' vol. iii. part 1, "On the Crustacean Fauna of the Salt-Marshes of Northumberland and Durham."

Probably more extended investigation may add to the number of species, but it is evident that the fauna of salt marshes is a very restricted one.

That of river-estuaries, on the contrary, embraces, amongst the Microzoa to which we now refer, a very large number of species, some of which are evidently derived from the fresh-water side, some from the sea, whilst others seem to haunt exclusively water of a more or less brackish character. It is probable, however, that a few examples of purely freshwater or marine type which have occurred sparingly in estuarine situations may have been merely dead shells, washed into the places where they were found either by tides or river-currents. In this class we may reckon, for example, such species as *Cythere abyssicola*, *C. finmarchica*, and probably some of the Cyprides. Out of about ninety species of Ostracoda observed in gatherings taken from river-estuaries, twelve may be looked upon as having marked brackish proclivities; so that, were we to meet with their shells in considerable numbers in any fossiliferous deposit, we should at once infer that the strata must have been produced in water subject more or less to marine influences. Of this group the principal members are *Cythere castanea*, G. O. Sars, *Cytheridea torosa* (Jones) and its varieties, and *Loxococoncha elliptica*, Brady; scarcely less marked in their preference for brackish water are *Cypris salina*, Brady, *Cypridopsis obesa*, B. & R., *C. aculeata* (Lilljeborg), *Potamocypris fulva*, Brady, *Cythere gibbosa*, B. & R., *Cythere porcellanea*, Brady, *Loxococoncha pusilla*, B. & R., *Cythere flavescens*, Brady, *C. Robertsoni*, Brady, *C. cellulosa* (Norman), and *Paradoxostoma Fischeri*, G. O. Sars.

Of species commonly resident in fresh water we notice twelve, the most frequent of which are *Cypris levis*, Müller, *compressa*, Baird, *gibba*, Ramdohr, *Candona candida*, Müller, *lactea*, Baird, and *Limnocythere inopinata* (Baird); while of those usually found in the sea, but not unfrequently spreading plentifully up into estuarine localities, we may name *Cythere pellucida*, Baird, *tenera*, Brady, *albo-maculata*, Baird, *viridis*, Müller, *villosa* (G. O. Sars), *Xestoleberis aurantia* (Baird), *Loxococoncha tamarindus* (Jones), *Cytherura nigrescens* (Baird), *cuneata*, Brady, *striata*, G. O. Sars, *angulata*, Brady, *Cytherideis subulata*, Brady, *Paradoxostoma variabile* (Baird), *abbreviatum*, G. O. Sars, and *ensiforme*, Brady. The total number of Ostracoda known to us as inhabiting tidal rivers and their estuaries, excluding those found in the Norfolk district, of which we shall speak separately, is eighty-six.

From this enumeration and from the accompanying table, it will be seen that the genera *Cytherura* and *Paradoxostoma*

(perhaps also, to a smaller extent, *Loxococoncha*) may be considered especially littoral or estuarine in habitat; the elongated subsigmoid forms of *Cythere* (typified by *C. pellucida*) come also under the same category.

The situations which seem to be most favourable to the growth and multiplication of these animals are quiet sheltered pools which are never left entirely dry by the tide, are unswept by strong currents, and thus able to retain permanently a bed of soft mud. Many species there are, of course, which prefer different conditions; but it is in such localities that we find our gatherings richest, both as to number of individuals and variety of species. A remarkably fine gathering, taken from a place such as we have described is that from the river Blyth (Northumberland), which contained thirty-eight species of Ostracoda and thirty-eight of Foraminifera. Budle Bay, on the same line of coast, with a harder bottom and more subject to the wash of the sea, and also with much less admixture of fresh water, contained, as shown in our gathering, only twenty-six species of Ostracoda and thirty-six of Foraminifera; while the river Coquet and the Warn burn, with much harder beds, stronger currents, and but little admixture of salt water, gave respectively ten and six species of Ostracoda, and no Foraminifera.

The Entomostraca of the tidal waters of Norfolk, Suffolk, and the Cambridge fen-district constitute so remarkable a group that it seems best to speak of them separately; and in so doing we shall call the area to which we refer the *East-Anglian district*, understanding by that term the whole tract drained by the rivers Nene, Cam, Bure, Yare, and Waveney. The drainage-tract of the adjoining rivers on the south, Ald, Deben, Stour, &c., is separated by rising ground, and appears to be zoologically distinct; but whether the more northern fen-district of Lincolnshire be likewise distinct, we have not yet had the opportunity of examining. If, as is probable, the two tracts were in former times one continuous fen, we shall doubtless find an indication of it in the similarity of their microscopic faunas.

It is well known that the present physical condition of East Norfolk is of very recent origin. Only a few centuries back, the ground on which Great Yarmouth now stands was a sand-bank covered by the sea; and the extensive tract between Yarmouth and Norwich was a shallow estuary, the gradual silting-up of which has produced the present physical conformation of the district. Through this extensive flat, which lies below the level of the sea, now flow in tortuous channels the rivers Bure, Yare, and Waveney; and connected with

these rivers are numerous freshwater lakes or meres, locally called "broads," occupying, doubtless, areas which were formerly depressions of the sea-bed. These have at the present day all the external characteristics of freshwater lakes; they are mostly surrounded by wood, their edges fringed with wide and dense growths of sedge and rushes, and their shallow waters supporting luxuriant forests of aquatic weeds, *Potamogeton*, *Myriophyllum*, *Chara*, water-lilies, and the like. Yet they are to a greater or less degree subject to the influence of the tides, rising and falling to some inconsiderable extent; and though the water which thus ebbs and flows must usually be fresh, we are informed that in some broads sea-water has been known to penetrate in sufficient quantity to kill the fish. There can be no doubt that the changes which produced the present aspect of the district are still in progress, that the broads are yearly becoming shallower, and that, owing partly to the débris brought down by the rivers, partly to the choking arising from constantly decaying vegetation, they will at no distant date cease to exist. In 1827, Mr. Taylor stated their depth to range from 15 to 30 feet; at the present time, 3 to 15 feet would be a tolerably correct estimate. Mr. Stevenson tells us that "Mr. Gunn estimates the growing-up process, from subsidence of vegetable matter, aided by drainage, at a foot in twenty years, but in places this estimate must be exceeded considerably;" and he adds, "to my knowledge, where, some fifteen years back, I could pull a boat through, is now a pathway almost firm enough for a marsh-man in boots." The rise and fall of the tides along the Norfolk coast is extremely small, averaging at Yarmouth only three or four feet; yet, owing to the low level of the district, they affect the rivers for a very great distance inland. The Rev. Canon Kingsley, in an interesting paper on "the Fens," in 'Good Words' for 1867, states that, were it not for the great sea-sluice of Denver, on the Ouse, the tides would be felt to within ten miles of Cambridge. There can be no difficulty, then, in understanding how a fauna introduced when the whole East-Anglian district was overspread by the sea, should hold its ground for a lengthened period, while its habitat was year by year becoming less subject to marine influences, and that the more hardy or more plastic species should remain even after fresh water entirely usurped the place of salt, while at the same time a new fauna derived from the landward side was also gradually establishing itself, as the conditions of existence became more favourable. It is, indeed, impossible to account in any other way for the existence in the more remote broads of Norfolk, in the river Cam at Ely, and in the dykes about Whittlesea, of species purely marine (or, at least, decidedly estuarine) in

character. Their introduction along the river-channels at the present time can scarcely be thought possible; moreover there are two facts which strongly oppose such an idea. In the first place, we find in the dykes about Whittlesea several Foraminifera and Ostracoda, of marine character, which do not occur in our gatherings from the closely adjacent river Nene*, and which would therefore appear to be the relics of a previous fauna; secondly, some of the species found commonly in the most inland waters of the East-Anglian district are unknown anywhere else, and certainly cannot have been introduced from the sea. Judging from analogy, we may, indeed, say with tolerable certainty that some of them are unfitted for a marine habitat, and, at any rate, are not now to be found there.

The Ostracoda specially characteristic of the East-Anglian district, and here (except *Cythere fuscata*) first described, are

<i>GonioCypris mitra</i> , nov. gen. & sp.		<i>Polycheles Stevensoni</i> , nov. gen. & sp.
<i>Metacypris cordata</i> , nov. gen. & sp.		<i>Cythere fuscata</i> , Brady.

More or less frequent also throughout the district, but of doubtful significance, because probably spreading beyond its limits, and being also less pronounced in external character, are

<i>Cypris fretensis</i> , nov. sp.		<i>Limnocythere Sancti-Patricii</i> ,
<i>Cypridopsis Newtoni</i> , nov. sp.		<i>B. & R.</i>
<i>Candona Kingsleyi</i> , nov. sp.		<i>Cytheridea torosa</i> (<i>Jones</i>) (<i>torose</i>
<i>Candona hyalina</i> , nov. sp.		<i>form</i>).

A highly interesting circumstance connected with some of the most remarkable of the new East-Anglian species, is their occurrence likewise in dredgings (for which we are indebted to Mr. E. C. Davison) taken in the Dutch rivers Meuse and Scheldt. These species are *Metacypris cordata*, *Cypris fretensis*, *Cythere fuscata*, and *Polycheles Stevensoni*. It is not likely that they lived, except perhaps *Cythere fuscata*, in the places where they were taken, near the mouths of the two rivers: we must therefore suppose that they have been washed down from inland localities, probably dykes or canals, where they may probably be as abundant as in similar situations in our Fen-district. Empty shells of the same species occur also in the same way at the mouths of the East-Anglian rivers. Other points of resemblance between the faunas of Northern Europe and Eastern England are well known, and have been noticed by the Rev. C. Kingsley, in the paper already referred to; and it is interesting and important to find a further confirmation of this relationship in the microscopic inhabitants of

* Our dredgings in the river Nene were made at several points over a course of about six miles between Peterborough and Whittlesea, and must have included every thing most characteristic of the place. It is remarkable that, though Foraminifera are very abundant in the Whittlesea dykes, scarcely any occurred in the river Nene.

the two districts. But the theory of the efflux in bygone times of many of the rivers of northern Europe, including East Anglia, into one common estuary, though, no doubt, correct, is scarcely sufficient to explain the identity of the two microscopic faunas to which we now invite attention; for most of these peculiar species appear not to inhabit estuaries or even brackish water, but solely fresh water, which in many cases may be affected by the tides, but not sufficiently so to render it to any perceptible extent brackish. It is not likely, therefore, that these species had their origin in any estuarine locality, though doubtless such a means of communication may easily have helped to spread them from one district to another. Still it seems to us most probable that the real habitat of these species was at that early time, as it is now, almost entirely beyond the reach of marine influences, consisting perhaps of an extensive series of lagoons or low-lying fens surrounding the margins of the estuary, of which the present fen-districts of England and Holland are but the remnants.

M. Félix Plateau has recently published a memoir on the freshwater Crustacea of Belgium, but does not mention any species identical with those new ones noticed by us in the East-Anglian district. It is probable, however, that his gatherings have been made entirely by the ordinary hand-net, in which case it is scarcely likely that any of our characteristic species would be obtained. In our own fen-gatherings, the *dredged material only* yielded the species to which we refer; though surface-gatherings were diligently made in most places visited by us, they yielded little or nothing of special interest. The swimming Entomostraca taken in this way were all of purely freshwater character, and such as might have been found in any British waters of like extent. Our memoranda of these captures include the following species:—

Daphnia pulex (Linn.).
 — *vetula* (Müller).
 — *mucronata* (Müller).
 — *rotundata* (Strauss).
Sida crystallina (Müller).
Polyphemus pediculus (Linn.).
Bosmina longirostris (Müller).
Lynceus sphaericus, Müller.
 — *trigonellus*, Müller.
 — *quadrangularis*, Müller.
 — *harpæ* (Baird).
 — *costatus* (G. O. Sars).
 — *nanus* (Baird).
 — *testudinarius*, Fischer.
 — *truncatus* (Müller).
 — *globosus* (Baird).
Eurycerus lamellatus (Müller).

Cypris reptans (Baird).
 — *ovum* (Jurine).
 — *lævis* (Müller).
 — *striolata*, Brady.
 — *fusca*, Baird.
Cypridopsis vidua (Müller).
 — *aculeata* (Lilljeborg).
Candona lactea, Baird.
 — *albicans*, Brady.
Limnocythere inopinata (Baird).
 — *monstrifica* (Norman).
Cyclops (*species varia*).
Canthocamptus staphylinus (Jurine).
Diaptomus Castor (Jurine).
 — *Westwoodii*, Lubbock.
Argulus foliaceus (Linn.).

Amongst our dredged material from the Norfolk Broads occurred a few fragments of Amphipodous Crustacea to which we cannot with any certainty attach names, and a few entire specimens of *Gammarus pulex*: a few fragments of *Echinus*-spines were also noticed, the origin of which it is difficult to decide. It seems unlikely that fragments of such considerable size and weight could be brought up from the sea by tides for a distance of many miles; and, on the other hand, with the beds of the broads constantly accumulating layer by layer of new material, it is impossible to suppose that a light hand-dredge, such as that used by us, can have penetrated to any fossiliferous strata. Perhaps a more likely supposition is that the objects in question may have been washed *downwards* out of some exposed posttertiary deposits. Fragments of a similar character occurred also in the river Nene, near Peterborough, and possibly may there have been derived from similar sources or from the Gault. In dredgings from the river Cam, at Ely, occurred a large number of valves of Ostracoda totally different from any thing known to us amongst recent species, and, from their appearance, probably fossil. At the same time, one or two of the most remarkable of these had such a wonderfully recent and unfossilized appearance, and were in such perfect condition, as to throw a shade of doubt over the whole, especially when with them were found some really marine species, about whose recent character there can be no doubt. Further remarks respecting these will be found under our description of *Cytheridea inaequalis*.

We must here express our hearty thanks for the valuable assistance which we have received, in prosecuting our researches in the East-Anglian district, from the Rev. John Gunn, Mr. H. Stevenson of Norwich, the Rev. Canon Kingsley, and Professor Alfred Newton of Cambridge; also for information kindly given us respecting the physical peculiarities of the district by Mr. Spencer Smyth of Gorleston and Mr. Arthur Saunders of King's Lynn. To Mr. E. C. Davison of Sunderland our thanks are also especially due for help afforded in many ways, as well as for several interesting gatherings of Ostracoda, which led to the researches noted in the present paper.

The following tables show the distribution and comparative frequency of the various Ostracoda in each locality, their relative abundance being indicated by the number of asterisks affixed. We prefix a catalogue of the various localities, describing briefly their physical characteristics, and noticing such other circumstances as seemed to be of interest in connexion with the fauna.

GROUP I.

A. *Clyde Estuary*.—At Langbank the tide leaves bare a long

muddy flat along the river, nearly a quarter of a mile broad, and when the tide is out and the river swollen to any extent, this is covered entirely with fresh water. Our gatherings at this place were taken from low-water to near high-water mark. Other gatherings were taken from Port Glasgow up along the river for fully a mile, in four to eight feet water beyond low tide. In some places the bottom is soft black mud, in others muddy gravelly sand, much covered by mussels (*Mytilus edulis*). The estuary here is a few miles broad, and the tide rises from eight to ten feet, the fresh water being much less felt than at Langbank, which is about four miles further up, where the water narrows greatly as it reaches Dumbarton Castle. It is somewhat remarkable, considering the extent of the gatherings, the diversity of bottom, and very promising appearance in every way of the locality, together with the profusion of *Corophium*, Isopoda, and other forms of animal life, that the Ostracoda and Foraminifera met with were exceptionally few, both in number of species and individuals, and these mostly of brackish or freshwater type. We are inclined to suppose that the great amount of chemical refuse poured into the river Clyde from around Glasgow and Paisley may account for the scarcity of these animals. In the river Wear, where somewhat similar conditions exist, we have found the fauna affected in exactly the same manner. That some artificial cause is at work seems almost certain, as we have not found so poor a microscopic fauna in any river unconnected with manufacturing operations.

B. *Montrose Basin, Forfarshire*, is an area of considerable extent, communicating with the sea by a narrow channel. The whole area, with the exception of the tortuous channels of the river South Esk, is left dry at low water, exposing a muddy flat; at high water it is covered to a depth of six feet by the sea.

C. *Budle Bay, Northumberland*.—The description of Montrose Basin applies also pretty accurately to this locality, except that Budle Bay is exposed across the whole of its wide mouth to the action of the sea. It is thus, owing to want of shelter, a less favourable place for the habitation of organisms requiring an undisturbed muddy bottom and quiet water. Our gathering was taken from almost the only sheltered spot in the bay, on a bottom of hard muddy sand just beyond low-water mark, and behind a small quay or breakwater belonging to the coast-guard service. Samples of sand collected in other more exposed spots showed no trace of animal life. Two small streams, the Warn burn and the Buckton burn, empty themselves into the bay; but their channels on the tidal flat were not examined, owing to difficulty of access.

D. *Warn Burn*.—This gathering was from a sheltered pool in the bed of the burn, not more than about a hundred yards above its outlet into Budle Bay. The bottom consisted of rather coarse sand and stones. The stream, coming down through a somewhat hilly country, and subject, no doubt, to strong currents and violent floods, exhibits a very scanty fauna when compared with others in the same district, but of a more sluggish character, especially the river Blyth, about thirty miles further south.

E. *River Aln above Alnmouth*.—The bed of the river above the mouth is everywhere muddy, more or less hard according to exposure and rapidity of current. Our examples were taken from beyond low-water mark, just below the "Duchess's Bridge;" the bottom a rather tenacious mud.

F. *River Coquet at Warkworth Hermitage*.—At this spot the river, though subject to a rise and fall of many feet, has, owing to its precipitous banks, always a considerable depth of water at low tides. The bottom consists of a hard muddy or loamy sand, and must often be much scoured by the floods to which the river is subject.

G. *River Wansbeck*.—Gathering taken from near low-water mark, in a somewhat strong current, about half a mile from the mouth of the river; bottom of fucus-covered stones. Probably a more sheltered and muddier spot, which might have been found higher up the river, would have yielded a larger variety of species.

H. *River Blyth*, at the junction of the Sleek burn, about two miles from the sea.—Gatherings taken from below low-water mark, partly from the bed of the Blyth, but chiefly from a small pool above some stepping-stones on the Sleek burn; bottom of soft black mud. This river, draining a low country, is slow and deep throughout the greater part of its course, and for a distance of several miles from its mouth exposes at low water a large surface of muddy banks to the air.

I. *River Ouse, Yorkshire*.—From muddy sand at low-water margin of river, a short distance above Goole, forty-five miles from the sea. Though the average rise of the tide at high water is twelve feet, the water at low tide is fresh.

J. *River Humber*.—A dredging on the Ferry Sand, three miles above Hull (and twenty-three miles from the sea), where the river is about two miles and a half wide, and the depth at low water is six feet, and at high water twenty-four feet. The Humber, receiving the drainage of a larger extent of country than any other river of England, the amount of fresh water carried by it to the German Ocean is considerable. The material dredged was a fine reddish sand mixed with vegetable remains.

K. *River Deben at Woodbridge*; L. *River Stour at Manningtree*.—These rivers are of a character very similar to the river Blyth (H), though of larger dimensions, and, owing to their course through an exceedingly flat country, affected by the tide to a much greater distance from the sea. Our gatherings were got chiefly from beyond low-water mark; those from the Deben at about eight miles from the mouth of the river, the average rise of the tide being eight feet; those from the Stour at about twelve miles from its mouth, the rise of tide ten feet.

M. *Estuary of the Thames*.—The collections from the Thames estuary, with the exception of one from the "Girdler Sand," which was procured from a portion of the bank uncovered at low water, were obtained by dredging in various parts of the estuary between a line joining Margate and the Maplin lighthouse to the eastward, and the Nore to the westward; the depths were from two to twelve fathoms; the average rise of tide at high water over this district is fourteen feet.

N. *Fowey Harbour*.—Dredged in from three to five fathoms, in the harbour, which is the outlet of the river Fowey or Lostwithiel, Cornwall. Average rise of tide at high water thirteen feet.

GROUP II.

O. *Dykes on the site of Whittlesea Mere*; P. "*Whittlesea Dyke*," south of *Whittlesea*.—These are artificial drainage-channels, containing in all weathers a few feet of water, and in winter, on the site of the old Whittlesea Mere, often overflowing their banks to a considerable extent; they contain abundant aquatic vegetation.

Q. *River Nene, between Peterborough and Whittlesea*; R. *River Cam at Ely*.—These rivers have a very sluggish current, and in appearance are more like canals than rivers, the present course of the Nene being, indeed, in great part an artificial one. In both cases our gatherings were taken from the bed of the river, in the Nene at several points over a course of about six miles, in the Cam over a very small area near the bridge; the distance from the sea is in both cases about thirty miles. Notwithstanding the apparently marine character of some of the species found in both rivers, it must be remembered that sea-water finds no access whatever to these localities, being entirely shut out by the Denver sluice. And even long before the construction of this sluice, it is probable that any tidal influence felt at these remote points would be confined to the driving back of the fresh, rather than the influx of salt water.

S-Y. *The Broads of Norfolk and Suffolk* may be considered as expansions of the various tidal rivers, though situated at

such distances from the sea as to be but slightly influenced by tidal ebb and flow. Wroxham and Barton Broads, the most distant of the group, are, in a direct line, sixteen miles from their sea-outlet; but, the river-channel being exceedingly tortuous, their real distance is very much greater. They support mostly a rank vegetation of freshwater character, being fringed with dense masses of sedge and rushes, under the shelter of which, and often far out into the lake, grow patches of water-lily, water-milfoil, and other aquatic weeds. Hickling Broad constitutes, however, an exception to this rule, its vegetation consisting to a large extent of a *Chara*, which is so abundant as to afford occupation to some of the neighbouring population in fishing it up and selling it at the rate of nine-pence a ton. The broads are uniformly shallow, varying from three to fifteen feet in the channels, and (except Hickling, which is gravelly) have a bottom of peaty or decaying vegetable matter; they are probably in all cases fast filling up. Sea-water appears to find access to some of them to a small extent at very high tides, about once in six or seven years.

From particulars obligingly furnished by Mr. Spencer Smyth, we here extract the following:—"The level of the broads Higham and Hickling seldom varies three inches; and they are not affected by saline particles injurious to fish, except after extreme high tides at Yarmouth—say, eleven feet, or two following tides of nearly that height, occurring perhaps once in six or seven years: at such times some pike and bream are killed in Hickling, but, I believe, not in Horsey or Martham Broads, the former only reached by a long, tortuous, and narrow dyke from the upper part of Whittlesea, and Martham by an equally difficult although shorter channel from the river Thune. Martham Broad is fast filling up, choked by reeds, with only a sailing channel four feet in depth for small wherries to Somerton and Martham. Higham and Hickling are also growing up; but the channel has four feet and a half till near Hickling, where it falls off to three and a half." This extract, though not referring entirely to broads visited by us, applies pretty accurately to all, the more remote ones (*e.g.* Wroxham and Barton), however, being even less affected by tides. The information is especially valuable as coming from one whose official duties are connected with the survey of the navigable river-channels of the district.

Z. *Lake Lothing* is a tidal expanse separated from Oulton Broad, at its western extremity, by an embankment, through which canal-boats pass by means of a lock. In this way some slight communication exists between the waters of the two basins; but the true outlet of Oulton Broad is by the river Waveney, which from this point takes a circuitous course of

about fifteen miles to Breydon Water. The western end of Lake Lothing has quite a marine appearance, its stones being coated with the usual Algæ of the upper littoral zone. Our gatherings are from the soft black mud of the channel beyond low-water mark. The sea was once known, on the occasion of an unusually high tide, to break over the top of the lock into Oulton Broad.

A a. *River Bure near Yarmouth*.—These gatherings were from the bed of the river, below low-water mark, the bottom consisting of stones and mud.

B b. *Breydon Water*, a large tidal basin which receives the waters of the rivers Bure, Yare, and Waveney, is situated to the west of Great Yarmouth. It is about four miles long by a mile broad, and a large proportion of its surface is left dry at low water. Our gatherings extended from Yarmouth to the confluence of the rivers Yare and Waveney, and were taken both in mid-stream and more or less over the sides. The bottom at some places was coarse sand, at other parts black or brownish coloured mud.

C c. *River Ouse (Norfolk) at Lynn*.—Muddy sand, from low-water margin of the river. Rise at spring-tides eighteen feet.

D d. *River Scheldt, Antwerp*.—"Material a light-coloured sand mixed with vegetable remains. It was obtained from a sandbank near the town, where the river is a quarter of a mile wide. The rise of tide at springs is fifteen feet. Distance from the sea about sixty miles."—*E. C. Davison*.

E e. *River Maas or Meuse, near Schiedam*.—"Material somewhat similar to the last mentioned. A good many years have elapsed since I obtained them, and my information is but scanty respecting the localities."—*E. C. Davison*.

Genus CYPRIS, Müller.

Cypris ventricosa, nov. sp. (Pl. IV. figs. 1-3.)

Carapace (of the female?), as seen from the side, subelliptical, highest in the middle; greatest height equal to nearly two-thirds of the length; anterior extremity somewhat obtusely, posterior boldly rounded: superior margin boldly arched, highest in the middle, where it is somewhat gibbous; inferior almost straight, slightly sinuated, however, in the middle, in front of which is a slight convex protuberance. Seen from above, ovate, widest in the middle, thence tapering gradually towards the anterior extremity, which is sharply acuminate; posterior extremity well rounded, greatest width equal to half the length: end view broadly oval, nearly circular. Surface of the shell smooth, sparingly

beset with minute rounded papillæ. Colour (of dried specimens) very slight, whitish. Lucid spots narrow, crescentic. Length $\frac{1}{2}$ inch. Animal unknown.

Hab. Site of Whittlesea Mere. Only one or two perfect specimens obtained.

Cypris tumefacta, nov. sp. (Pl. IV. figs. 4-6.)

Carapace (of the female?) very tumid, seen from the side, subreniform, highest in the middle; greatest height equaling rather more than half the length; extremities rounded, sloping steeply above the middle: superior margin very boldly arched, rising almost to a point in the middle, inferior gently sinuated in the middle. Seen from above, broadly ovate, suddenly and acutely mucronate in front, well rounded behind; sides subparallel, greatest width situated in the middle, and somewhat greater than the height: end view subrhomboidal, pointed above, broadly rounded below, sides excessively convex. Shell perfectly smooth, opaque white. Length $\frac{1}{5}$ inch. Animal unknown.

Hab. Warn burn and river Coquet, Northumberland.

If viewed only from the side, this species might not unreasonably be suspected to belong to *C. virens* or perhaps *C. incongruens*; but when seen in any other direction, this similarity entirely disappears: no species possesses a more characteristic or well-marked contour when looked upon from above. In the Warn burn about half a dozen specimens were found, in the river Coquet only one.

Cypris fretensis, nov. sp. (Pl. IV. figs. 7-9.)

Carapace of the female, as seen from the side, broadly reniform, highest in the middle; height equal to more than half the length; anterior extremity broad and well rounded, posterior narrower, rounded, but emarginate above the middle, owing to the overlapping of the left valve, which is produced below the middle: superior margin boldly and evenly arched, inferior gently sinuated in the middle. Seen from above, compressed, ovate, widest behind the middle; posterior extremity rounded, anterior obtusely pointed; width equal to about two-thirds of the height: end view ovate, pointed above, broadly rounded below. Valves smooth, minutely and closely punctate; right valve crenulated in front and on the posterior portion of the ventral margin; the left valve has a row of small tubercles parallel to and a little within the anterior border: the margins of the valves are considerably incurved along the posterior

portion of the dorsal aspect, forming a distinct longitudinal sulcus when viewed from above. Length $\frac{1}{4}$ inch.

Hab. Rivers Deben and Scheldt, Breydon Water and Lake Lothing, Somerton Broad and dykes on the site of Whittlesea Mere.

The specimens from the last locality are doubtfully referred to the present species. *C. fretensis* is more nearly allied to *C. salina*, Brady, than to any other British species, but differs from it in the less compressed and more distinctly ovate form of the carapace when seen from above, in the peculiar emargination of the posterior margin, in the absence of the peculiar form of contact margin which distinguishes the valves of the latter species, as well as in other characters of form. We have not observed any colour-markings in this species; but those of *C. salina* are also sometimes observed to be wanting.

Genus CYPRIDOPSIS, Brady.

Cypridopsis (?) *Newtoni*, nov. sp. (Pl. VII. figs. 14-16.)

Carapace, as seen from the side, reniform; greatest height in the middle, and equal to a little more than half the length; extremities rounded, the anterior being the broader of the two: superior margin boldly and evenly arched, inferior sinuated in the middle. Seen from above, compressed, ovate, acuminate in front, rounded behind; greatest width situated near the middle, much less than the height. Surface of the shell punctate, and covered with numerous adpressed hairs; colour dull green. Length $\frac{1}{4}$ inch.

Hab. Rivers Nene and Cam, and dykes on the site of Whittlesea Mere.

Our examples of this species are not numerous, and we have not been successful in finding perfect specimens of the contained animal. The postabdominal rami are rudimentary, as in *Cypridopsis*; but the lower antennæ seem to be destitute of the setose brush, which in that genus is usually very long. The species would therefore appear to be an aberrant one; but, without a thorough acquaintance with its internal structure, we think it best for the present to place it in the genus to which it is here assigned. It approaches closely in external appearance to *Cypridopsis villosa* and *Potamocypris fulva*; it is, however, larger than either, is more tumid, less strongly arcuate, and coarser in texture than the former; while the almost equal and well-rounded valves, coarsely hispid surface, and ovate form when seen from above sufficiently distinguish it from the latter: it agrees very much with Fischer's figures of *Cypris prasina*, but is more elongated and more densely hairy.

We have great pleasure in inscribing this species to Prof. Alfred Newton, of Cambridge, whose assistance we have acknowledged in a previous page.

Cypridopsis obesa, B. & R.,

which was described by us from specimens taken in the Mullingar Canal at Dublin, we now believe to be probably a variety of *C. vidua*; but as there is still some doubt on the subject, we hesitate to cancel the name *obesa*. Our Dublin specimens seemed to have little in common with *C. vidua*, except their shape; they were of a uniform brown colour, without any transverse bands; in fact we never even suspected any relationship to *C. vidua*. Since that time, however, we have found specimens which we refer to *C. obesa*, in many places always more or less subject to tidal influence, and have observed that they vary much in colouring, being in brackish water usually of a dirty grey tint, and approaching brown in fresh water; moreover some of those taken at Whittlesea, though brownish in the ground tint, had distinct dark bands, after the manner of *C. vidua*. In some localities both species occurred together; but it is remarkable that *C. vidua*, when it occurred in dredged material, was never otherwise than scarce, whereas *C. obesa* was often exceedingly abundant; on the contrary, gatherings made with the hand-net amongst weeds or in clear water, though often containing *C. vidua* in plenty, never showed a single specimen of *C. obesa*; so that it appears certain that the brilliantly banded *vidua* and the dingy *obesa*, whether we regard them as distinct species or merely as varieties, live often in the same situations, the one on the bottom mud, the other amongst the supernatant weeds.

Genus GONIOCYPRIS, nov. gen.

Valves compressed, subequal, thin, and fragile. Seen from the side, triangular, the inferior margin terminating at each extremity in an acutely produced angle, the superior margin rising to an acute central point; hinge simple. Animal unknown.

Goniocypris mitra, nov. sp. (Pl. VII. figs. 10-13.)

Carapace, as seen from the side, triangular; right valve rather larger than the left; height and length nearly equal; anterior and posterior margins obliquely arched (the anterior the more convex) and meeting in an acute point nearly over the centre of the shell: inferior margin straight, produced downwards at each extremity into an angular point. Seen from above, compressed, ovate, widest in the middle; extremities obtusely and nearly equally pointed; width equal

to half the length: seen from the front, ovate, widest below the middle, pointed above, broadly rounded below. Shell thin, semitransparent, sparingly and minutely punctate, or often perfectly smooth, somewhat granular in appearance. Colour yellowish or reddish brown. Length $\frac{1}{8}$ inch.

Hab. Dykes on the site of Whittlesea Mere, "Whittlesea Dyke;" rivers Nene at Peterborough, Cam at Ely, and Ouse at Lynn; Wroxham, Barton, Somerton, and Ormesby Broads.

Though generally distributed throughout the East-Anglian district, this remarkable species appears to be rather rare as to number of individuals; nor have we succeeded in finding a trace of animal structure in any specimen that we have examined. The minuteness of the shell may perhaps partly account for its apparent rarity; and as we have not met with it except in dredged material, we presume that it is a creeping rather than a swimming species, and probably inhabits exclusively the muddy bottoms of the broads and rivers.

Genus ARGILLÆCIA, G. O. Sars.

Argillæcia (?) *aurea*, nov. sp. (Pl. VIII. figs. 4, 5.)

Carapace, as seen from the side, compressed, subovate, somewhat depressed in front, nearly of the same height throughout; height much less than one-half of the length; extremities rounded, the anterior narrowed and oblique: superior margin straight or very gently convex in the middle, curving gently downwards at each extremity; inferior very slightly convex along its whole length. Seen from above, ovate, acuminate in front, rounded behind; greatest width situated in the middle, and about equal to the height. Surface of the shell quite smooth; colour golden yellow. Length $\frac{1}{5}$ inch.

Hab. River Ouse at Lynn.

But one specimen of this species was noticed; and we place it provisionally only in the genus *Argillæcia*.

Genus CANDONA, Baird.

Candona candida (Müller), var. *tumida*. (Pl. IX. figs. 13-15.)

Throughout the East-Anglian district occurs a form of this species differing from the typical *C. candida* chiefly in its excessive shortness and tumidity. In the female the greatest height is equal to nearly two-thirds of the length, and the width to more than half of the length. Seen from above, the extremities are very abruptly tapered, giving an almost elliptical contour. The male is much more compressed, but more tumid than in the ordinary form of the species. The lucid spots are

arranged in a rosette, five in number, each being broadly cuneate in shape, their apices directed towards the centre of the group.

It is remarkable that *Candona compressa*, Koch, which occurs also very abundantly throughout the district, likewise puts on an excessively tumid form, differing almost as much from the typical form as does the variety of *C. candida* just described (see Pl. VII. figs. 8, 9).

Hab. We have found the tumid variety of *C. candida* abundantly in the dykes in the neighbourhood of Whittlesea, also in the rivers Nene, Cam, and Scheldt, in Barton Broad, and in the Warn burn, Northumberland. The normal form occurs also constantly throughout Norfolk and Suffolk, and, so far as we know, throughout the kingdom. *Candona compressa* we found in all our East-Anglian gatherings, except those from Hickling Broad and the rivers Bure and Ouse.

The two forms of *C. candida* run into each other so much that it is sometimes difficult to say whether an example should be referred to the species or its variety. The rosulate disposition of the lucid spots, however, and the peculiar reticulation of the posterior portion of the shell (figured in the 'Monograph of Recent British Ostracoda'), are usually visible only in the tumid variety. We are not aware that this form ever occurs in localities entirely uninfluenced by the tides.

Candona Kingsleii, nov. sp. (Pl. IX. figs. 9-12.)

Carapace of the female, as seen from the side, subreniform; greatest height near the middle, and equal to half the length; extremities rounded: superior margin boldly arched, inferior rather deeply sinuated in the middle. Seen from above, ovate, width somewhat less than the height, greatest in the middle; pointed in front, sharply rounded behind. Shell of the male, as seen from the side, more deeply sinuated below; the dorsal margin obscurely sinuated in front of the middle, and more arched than in the female: seen from above, much more compressed: shell thin and fragile, colourless, showing the limbs of the animal distinctly through it. Length of the female $\frac{1}{5}$ inch.

Hab. River Nene; Barton, Horsey, and Hickling Broads; Breydon Water.

The specimens from the last-mentioned locality somewhat differ from the rest, but probably belong to the same species.

It is with much pleasure that we dedicate this elegant species to the Rev. Canon Kingsley, in acknowledgment not only of the great services which he has rendered and is still rendering in popularizing the study of natural history, but also

of his kind assistance in the prosecution of our researches in the Fen-district.

Candona diaphana, nov. sp. (Pl. V. figs. 1-3.)

Carapace of the *male* (?), as seen from the side, elongated, subreniform; greatest height situated behind the middle, and equal to less than half the length; obtusely and evenly rounded in front, obliquely behind; superior margin highest at the posterior third, thence sloping almost in a right line and with a very gentle declivity forwards, very steeply and with a slightly concave curve backwards; inferior margin gently sinuated. Seen from above, compressed, tapering equally and rather suddenly to the extremities, which are pointed; sides subparallel; width scarcely equalling one-third of the length. The hinge-margin of the left valve is suddenly produced towards each extremity into a very conspicuously overlapping curve, the posterior being much larger than the anterior. Shell-structure as in the preceding species. Length $\frac{1}{4}$ inch.

Hab. Ormesby Broad, and the river Nene at Peterborough.

One specimen only from each locality. From the compressed outline and very pronounced characters of the shell, we suppose this to be probably the male. The limbs are not sufficiently preserved to indicate the sexual character through the shell.

Candona hyalina, nov. sp. (Pl. IX. figs. 5-8, and Pl. V. figs. 4-11.)

Carapace of the female, as seen from the side, reniform, highest near the middle; height scarcely equalling half the length; extremities rounded, the posterior obtusely; superior margin well arched, but behind the posterior third distinctly hollowed out and steeply sloping; inferior distinctly sinuated in the middle. Seen from above, ovate, widest in the middle, with acutely and equally pointed extremities; width equal to one-third of the length. Hinge-margin as in *C. diaphana*; the curved projections, however, scarcely so prominent, more so in the male than the female. Shell of the male more compressed; seen from the side, the inferior margin more deeply sinuated; superior margin excessively elevated and gibbous in the middle, behind which it suddenly dips and slopes steeply backwards with a marked concave curve. Shell-structure as in the two preceding species. Superior antennæ sparingly setose, last two joints of nearly equal length, about twice as long as broad, the rest shorter and thicker; inferior antennæ destitute of any proper setose brush, the place of which is occupied in the

male by three short setæ with much thickened bases. Mandibles narrow and weak, but armed with long teeth (fig. 6); branchial appendage formed of one long ciliated seta, and one much shorter and lancet-shaped; second pair of jaws in the female bearing as usual a simple or indistinctly jointed conical palp (fig. 7), in the male a very large abruptly curved hook-shaped appendage; no branchial plate. Mucus-glands (testes?) of the male very small and abnormal in structure, consisting apparently of a thickened cylinder, which is beset with marginal and transverse rows of obscurely radiated tubular or filamentous structure (fig. 10). Copulative organs of exceedingly complex structure, composed chiefly of a large oblong lamina, from which springs a strong hook-shaped process; attached to these are also several other tortuous and spinous or hook-like appendages (fig. 11). Postabdominal rami (fig. 9) well developed; two long and nearly equal terminal claws, and one minute seta; also from the border of the ramus, a little below the middle, one long slender seta. Length of female $\frac{1}{5}$ inch, of male $\frac{1}{8}$ inch.

Hab. Site of Whittlesea Mere; Wroxham, Barton, and Ormesby Broads.

This and the preceding species, *C. diaphana*, have in common two very remarkable characters—the abruptly curved hinge-margin of the left valve, and the gibbous dorsal margin with its hollowed-out posterior termination. Some species described and figured by Fischer (“Ueber das Genus *Cypris*”) very closely approach them; but none, so far as we can judge, are identically the same: those most nearly allied are *Cypris rivularis*, *pellucida*, *fabaeformis*, and *compressa*. The small number of our specimens and the imperfect preservation of their animal structure have prevented our ascertaining as accurately as might be wished many points of their minute anatomy; and though we think it likely that this group might with propriety form the basis of a new genus, for the present we refer them to *Candona*, to which they exhibit the closest resemblance.

Genus METACYPRIS, nov. gen.

Shell moderately strong and thick. Seen from the side, the outline is subrhomboidal, rounded in front, and obscurely angular behind; the posterior portion of the hinge-margins produced angularly. Seen from above, heart-shaped, excessively tumid, widest behind the middle: ventral surface deeply impressed along the central and posterior portions of the median line. Hingement formed on the *right* valve by

a laminated angular projection anteriorly (fig. 7 c), posteriorly by a strong rectangularly produced flange (fig. 7 d, fig. 5 d, and fig. 9 d), from which projects a single sharply cut tooth, the flange itself being continued round the posterior margin of the valve (fig. 9 e); on the *left* valve by a deep sulcus behind, and a shallower one in front (fig. 6 f, g). Except in front and at the supero-posteal angle, the margins of the valves are incurved considerably, so that the actual contact-margins embrace a much smaller area than that of the entire shell; the right valve is larger than the left. Animal unknown.

Metacypris cordata, nov. sp. (Pl. VI. figs. 1-9.)

Carapace excessively tumid and depressed: seen from the side, subovate or subrhomboidal, highest in the middle; height equal to more than half the length: anterior extremity well rounded, posterior obscurely angular: superior margin gently arched, produced at its posterior extremity into an angular process, corresponding in position to the posterior hinge-joint; inferior margin distinctly convex, curving upwards behind, in front rather deeply and abruptly sinuated at its junction with the anterior margin. Seen from above, the outline is heart-shaped, pointed in front; posterior extremity broadly rounded and indented at the junction of the two valves; greatest width situated behind the middle, much greater than the height, and equal to about five-sixths of the length; the lateral margins are boldly curved and somewhat sinuous in the anterior part of their course; end view subreniform, depressed; sides excessively convex; superior margin arched and slightly indented in the middle, inferior deeply sinuated in the middle, where, however, it is encroached on by the downwardly produced anterior margin. Surface of the valves closely set with small rounded impressions, which are arranged in longitudinal rows, running on the ventral surface into interrupted furrows; ventral surface deeply and broadly sulcate along the greater part of the median line. Colour brownish yellow. Length $\frac{1}{10}$ inch.

Hab. Rivers Nene, Cam, and Scheldt, Wroxham and Barton Broads, and Breydon Water. Scarce in all these localities.

We much regret that we have been unable to find a trace of the animal structure of this remarkable species, all our specimens being merely empty shells, the abnormal external characters of which leave no doubt as to the propriety of establishing for it a new genus; but it is not so clear whether it ought to be placed amongst the Cypridæ or the Cytheridæ.

Genus CYTHERE, Müller.

Cythere fidicula, nov. sp.

Carapace, as seen from the side, trapezoidal; height equal to not much more than one-third of the length; extremities narrowly rounded below, above the middle sloping steeply upwards to the short and straight superior margin, which they join at an obtuse angle; inferior margin almost straight, but slightly protruded in front of the middle by a rounded tubercular eminence. Seen from above, elongated, subhexagonal, with parallel sides and obtuse or subtruncate extremities; the two anterior angles well marked, the posterior rounded off; width equal to the height; seen from below, the ventral surface exhibits at its anterior angles two prominent rounded eminences, behind which it becomes slightly constricted, again swelling out into a convex margin behind the middle; the outline on this aspect is thus remarkably fiddle-shaped. End view triangular, apex rounded off, basal angles prominent and acute, sides convex, base concave. Shell marked with irregular and sinuous longitudinal rugæ, which on the concave ventral surface are especially conspicuous. Length $\frac{1}{4}$ inch.

Hab. Estuaries of the rivers Thames, Scheldt, and Meuse; very rare in all these localities. One specimen has also occurred in a dredging from the north of Scotland.

Genus CYTHERIDEA, Bosquet.

Cytheridea torosa (Jones). (Pl. VIII. figs. 6, 7.)

A peculiar form of this species, which occurs commonly throughout Norfolk and Suffolk, but has not yet been found in the recent state elsewhere, requires a few words of notice. It agrees closely with the typical fossil specimens described by Professor Rupert Jones, and differs from the common recent form only in the presence, on the sides of the valves, of several large rounded eminences or tubercles, which are variable as to number and position; but the appearance of a well-marked example may be understood from our figures. The single infero-posteal spine is perhaps less frequently present than in the smooth form. Both the smooth and torose forms occur abundantly in many localities, and sometimes in company, and both exhibit their peculiar characters in very early stages of growth; but there are many grades between perfectly smooth specimens and the strongly marked valves represented in our plate*. We find the *smooth* form (*C. littoralis*, Brady),

* I take this opportunity of withdrawing an opinion recently expressed by me as to the synonymy of the present species, in a paper on the

which we propose to call var. *teres*, commonly in the river-outlets and salt-marshes of Northumberland and Durham, in the rivers Ouse (Yorkshire and Norfolk), Deben, Stour, Cam, Bure, Thames, Scheldt, and Meuse, in all the roads visited by us except Wroxham, in Lake Lothing and Breydon Water, and in the dykes about Whittlesea. The typical *torose* form we have not found at all north of Norfolk; but it occurs in all the broads known to us, except Barton, in Lake Lothing and Breydon Water, and in the river Bure: it thus appears to be peculiar to the East-Anglian district. It is worthy of note that this species has not occurred to us at all in Scotland, except in one gathering from the Clyde near Dumbarton Castle (var. *teres*), though that it is not a strictly southern species is shown by its occurrence abundantly, according to G. O. Sars, in Christianiafjord. It is remarkable also that, though occurring abundantly in the dykes on the site of Whittlesea Mere, it was not found in the closely adjacent river Nene.

Cytheridea inaequalis, nov. sp. (Pl. IX. figs. 1-4.)

Carapace, as seen from the side, subtriangular; greatest height situated in the middle, and equal to two-thirds of the length; anterior extremity broadly rounded, posterior broad, scarcely rounded: superior margin excessively arched, highest in the middle, sloping with a gentle curve towards the front, more steeply behind, where it is obscurely angulated. Seen from above, lozenge-shaped; greatest width in the middle, equal to half the length; extremities obtusely pointed; end view subtriangular, twisted. Right valve very much smaller than the left, its superior and posterior margins obtusely angulated in the middle; anterior margin fringed with a row of eight long and sharp spines directed forwards and downwards; posterior margin having at the lower angle one long and four smaller rudimentary spines: left valve devoid of spinous armature, and overlapping the right throughout its entire circumference. Surface of the shell polished, obscurely

"Crustacean Fauna of the Salt-Marshes of Northumberland and Durham" (see Natural-History Transactions of Northumberland and Durham, vol. iii. p. 125). Not having at that time seen any recent *torose* carapaces, I was led to refer the imperfect specimens in Prof. Rupert Jones's collection to a closely allied species, *C. lacustris* (G. O. Sars), to which it is indeed probable that one or two of Prof. Jones's examples may be referred; but his figures given in the Monograph of the Tertiary Entomostraca clearly represent the form now under consideration. I therefore withdraw the specific name *littoralis*, and revert to the nomenclature adopted in my 'Monograph of the Recent British Ostracoda,' considering the form there called *Cytheridea torosa*, and afterwards *littoralis*, as a variety (*teres*) of that originally described by Prof. Rupert Jones.—G. S. B.

waved, impressed with distant rounded punctures: lips of the valves much thickened and rounded, those of the ventral surface somewhat depressed. Animal unknown. Length $\frac{1}{32}$ inch.

Hab. Dredged in the river Cam at Ely. One specimen only taken.

We have already mentioned that several Ostracoda and some fragments of other animals (*Echinus*-spines and shells of *Balanus*) were met with in our dredgings from the river Cam. The fragments of *Echinus* and *Balanus* must be regarded as fossil, and may have been derived either from some posttertiary deposit or from the Gault. It becomes difficult under these circumstances, where the animal itself is absent, to decide which of the Ostracoda are recent and which fossil specimens; but that from which our present description is taken is altogether so unlike a fossilized shell, being semitransparent, highly polished, and in almost perfect condition as regards the preservation of its spines and surface-markings, that we can scarcely doubt its recentness. If it be really so, it constitutes a most interesting addition to the fauna, not only by reason of its peculiar configuration, but of its occurrence in fresh water. The only known recent species at all nearly resembling it is *C. Sorbyana*, Jones (*dentata*, Sars), which exhibits the same differences in the form of the right and left valves, but differs greatly in general form. Some of the fossil specimens obtained in the river Cam belong to strongly spined and probably deep-sea species. But associated with them occurred examples of several species usually found at the present day living in estuaries or in littoral marine situations: these we regard as being of recent origin; they are as follows:—*Pontocypris trigonella* (?), *Cythere castanea*, *C. villosa*, *C. laticarina* (?), *Cytheridea torosa*, var. *teres*, *Loxococoncha elliptica*, *L. tamarindus*.

Genus LOXOCOCONCHA, G. O. Sars.

Loxococoncha pusilla, nov. sp. (Pl. VIII. figs. 1-3.)

Carapace, as seen from the side, subrhomboidal, nearly equal in height throughout; height equal to half the length; extremities obliquely rounded; superior and inferior margins straight. Seen from above, the outline is regularly ovate, widest in the middle, extremities nearly equally acuminate, width considerably less than the height. Shell delicate and fragile, faintly rugose, and marked also with a few scattered hairs and papillae. Length $\frac{1}{16}$ inch.

Hab. Montrose Basin, Firth of Forth; rivers Wansbeck, Blyth, Deben, Ouse (Norfolk), and Scheldt. Scarce in all these places.

Its small size and peculiar shell-structure distinguish it readily from *L. elliptica* and *tamarindus*, with which alone it could be confounded.

Loxoconcha fragilis, G. O. Sars. (Pl. X. fig. 3.)

Loxoconcha fragilis, G. O. Sars, Oversigt af Norges marine Ostracoder, p. 65.

Shell of the female, seen from the side, subrhomboidal; greatest height situated in front of the middle, greater than half the length; anterior extremity rounded, posterior produced below into a short obliquely truncated process; superior margin moderately arched over the eyes, thence sloping backwards; inferior sinuated in the middle, convex behind. Seen from above, compressed; greatest width situated in front of the middle, and much less than the height; posterior extremity slender and produced. Shell of the male narrower; length equal to twice the height; superior margin nearly straight and horizontal; posterior extremity obtusely rounded below. Valves excessively thin and fragile, almost transparent, ornamented sparingly with very small tubercles and but slightly hairy. Antennæ very slender; second joint of the superior short, much shorter than the united lengths of the two following, and shortly pilose on the anterior margin, last three joints much elongated and nearly equal; third joint of inferior antennæ very narrow, its anterior margin smooth, without any setæ. Feet very slender, second joint of the last pair about equal to the conjoined length of the two following. Copulative organs of the male obtusely produced in front. Eyes confluent. Length of female $\frac{1}{16}$ inch.

Hab. Montrose Basin and Budle Bay.

The few specimens of this species which have occurred to us consist only of separated valves, from one of which our figure was drawn*. The description given above is taken from G. O. Sars.

Genus CYTHERURA, G. O. Sars.

Cytherura propinqua, nov. sp. (Pl. X. figs. 1, 2.)

Carapace, as seen from the side, subrhomboidal, approaching *C. similis* in shape; greatest height situated in the middle, and equal to about half the length; anterior extremity well and evenly rounded, posterior produced in the middle into an obtuse subtruncate process: superior margin evenly arched, inferior straight or very slightly sinuated. Seen from above, compressed ovate, slender and acuminate in front, broadly mucronate behind; greatest width behind

* Since this was written we have found perfect examples in a Scottish dredging.

the middle, and very much less than the height. Animal unknown. Length $\frac{1}{10}$ inch.

Hab. Thames estuary.

Genus POLYCHELES, nov. gen.

Shell fragile, structureless. Carapace oblong, higher behind than in front; lucid spots ten to twelve, linear-oblong or wedge-shaped, arranged in a subradiate manner in front of the centre of the valve. Seen from the side, compressed, oblong, subovate: seen from above, ovate, acuminate in front, obtusely rounded behind. Valves unequal, the right much larger than the left. Limbs of the animal very short and stout, strongly armed with short curved claws and bristles; superior antennæ six-, inferior four-jointed, and bearing strong terminal claws; mandible simple, weak (having no palp?), armed at the extremity with four or five small slender teeth; first maxilla composed of a broad, squarish basal portion, from the distal border of which spring eight long and strong curved setæ, and from its anterior extremity a long biarticulate digit, which terminates in four curved claws, two of which are long, and two short; second maxilla consisting of four digits, the anterior larger and stouter than the rest, biarticulate, and terminating in four slender claws, the other three single-jointed, small and slender, each terminating in two long setæ; at the base a large branchial plate surrounded by about thirty plumose processes. First pair of legs small, almost rudimentary, four-jointed, second and third five-jointed, the third much the longest, its last joint armed with two strong curved claws and one shorter seta; the longer of the two claws twice the length of the shorter. Abdomen ending in a short conical process. Copulative organs of the male of complex structure, the basal portion (on each side) consisting of a subrhomboidal acuminate lamina, the apical portion of an irregularly shaped plate produced laterally into an aliform process, and on the distal margin into a short, strong hook. Female probably viviparous.

Polycheles Stevensoni, nov. sp. (Pl. VII. figs. 1-7, and Pl. X. figs. 4-14.)

Carapace of the female, as seen from the side, oblong, depressed in front, height equal to more than one-third of the length; extremities obliquely rounded, anterior narrowed, posterior broad and obtuse: superior margin nearly straight, curving downwards in front of the middle; inferior slightly sinuated in the middle. Seen from above, ovate-acuminate, widest near the posterior extremity, greatest width about equal to

the height; posterior margin indented in the middle at the junction of the two valves: end view nearly circular. Shell of the male somewhat more compressed, when seen from above, having the greatest width near the middle. The right valve much overlaps the left, especially in the middle of the ventral margin. Superior antennæ excessively short and stout, the joints much broader than long, except the last two and the first, whose breadth and length are nearly equal; all the joints except the first armed with very strong curved setæ, the longer of which are nearly equal in length to the last five joints of the antennæ, the shorter equal to the last two joints. Inferior antennæ also very short and stout; terminal claws nearly straight, with upturned extremities; last joint very short, with two stout, equal, apical spines; penultimate with three apical spines of equal length and one short seta, antepenultimate with one long and one rather shorter seta; basal joint thicker, having two slender setæ rising from independent bases. Joints of the second and third feet gradually decreasing in length from the first to the last; the longer of the two terminal claws equal in length to the three preceding joints; second and third joints armed on the posterior margins with several short sharp setæ or prickles. The shell is pellucid or milk-white, often slightly granular in appearance, and showing through it the limbs of the animal, as well as the ova and fully developed young. The infero-posteal angle of the shell is beset with a dense tuft of microscopic beaded hairs (fig. 14). Length $\frac{1}{16}$ inch.

Hab. Whittlesea Dyke, and on the site of Whittlesea Mere; the rivers Nene, Cam, Ouse, Deben, and Scheldt; Lake Lothing and Breydon Water; and the broads of Wroxham, Barton, Horsey, Hickling, Somerton, Ormesby, and Oulton.

A most extensively distributed and abundant species throughout the East-Anglian district, the only gathering in which we failed to find it being that from the river Bure, which it may be said was made under very unfavourable circumstances. Except in the river Scheldt, *P. Stevensoni* has not yet been found outside of this district, where its great abundance in many situations renders its apparently restricted habitat the more striking. This species, with *Goniocypris mitra* and *Metacypris cordata*, may be looked upon as the salient feature of the peculiar Fen fauna. We have much pleasure in dedicating it to Henry Stevenson, Esq., the accomplished author of the 'Birds of Norfolk,' to whose kind interest in the objects of our visit to the district we are indebted for much of our success.

TABLE I. Distribution of Ostracoda.—Group I. River-estuaries, England and Scotland.

	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.
	River Clyde.	Montrose Basin.	Budle Bay.	Warn Burn.	River Aln.	River Coquet.	River Wansbeck.	River Blyth.	River Ouse at Goole.	River Humber.	River Deben.	River Slour.	River Thames.	River Fowey Harbour.
<i>Cypris</i>														
<i>incongruens, Ramdohr.</i>														
<i>fretansis, nov. sp.</i>														
<i>tumefacta, nov. sp.</i>						*								
<i>compressa, Baird</i>	*						*							
<i>ovum (Jurine)</i>														
<i>levis, Müller</i>														
<i>reptans (Baird)</i>														
<i>gibba, Ramdohr</i>														
<i>Cypridopsis</i>														
<i>obesa, Br. & Rob.</i>														
<i>aculeata (Liljeborg)</i>	*													
<i>Potamocypris</i>														
<i>fulva, Brady</i>	*	*												
<i>Candona</i>														
<i>candida (Müller)</i>														
<i>— var. tumida</i>														
<i>lactea, Baird</i>														
<i>albicans, Brady</i>														
<i>detecta (Müller)</i>	*													
<i>Pontocypris</i>														
<i>mytiloides (Norman)</i>														
<i>trigonella, G. O. Sars.</i>														
<i>acupunctata, Brady</i>			?											
<i>Cythere</i>														
<i>pellucida, Baird</i>	*													
<i>castanea, G. O. Sars</i>	**	**	**	*		*								*
<i>porcellanea, Brady</i>	*	**	**											*
<i>macallana, J. & R.</i>			**											*
<i>tenera, Brady</i>														*
<i>lutea, Müller</i>		*					*							**

TABLE I. (continued).

	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.
	River Clyde.	Montrose Basin.	Budle Bay.	Warn Burn.	River Aln.	River Coquet.	River Wansbeck.	River Blyth.	River Ouse at Goole.	River Humber.	River Deben.	River Stour.	River Thames.	Fowey Harbour.
Cythere														
albomaculata, Baird	**	*	*				*	**	*	**	**		***	*
viridis, Müller		*	**				*	**					***	**
convexa, Baird		*	**				*	**	*	**	**		***	**
villosa (G. O. Sars)	*	*	**		*		*	**	*	**	*		***	**
gibbosa, B. & R.		*	**		*		*	**	*	**	*		***	**
cicatricosa, G. O. Sars		*	*		*		*	**	*	*	*		***	**
Robertsoni, Brady		*	*		*		*	**	*	*	*		***	**
fuscata, Brady		*	*		*		*	**	*	*	*		***	**
tuberculata, G. O. Sars		*	*		*		*	**	*	*	*		***	**
finmarchica, G. O. Sars		*	*		*		*	**	*	*	*		***	**
cuneiformis, Brady		*	*		*		*	**	*	*	*		***	**
fidicula, nov. sp.		*	?		*		*	**	*	*	*		***	**
angulata (G. O. Sars)	*	*	*		*		*	**	*	*	*		***	**
antiquata (Baird)		*	*		*		*	**	*	*	*		***	**
Whiteii (Baird)		*	*		*		*	**	*	*	*		***	**
sempunctata, Brady		*	*		*		*	**	*	*	*		***	**
Limnocythere														
inopinata (Baird)	*			**	**	**	**	*			*	*	**	**
Cytheridea														
papillosa (Bosquet)	*						*	**	*		*	**	**	**
torosa (Jones)							*	**	*		*	**	**	**
— var. teres	**						*	**	*		*	**	**	**
lacustris (G. O. Sars)							*	**	*		*	**	**	**
elongata, Brady							*	**	*		*	**	**	**
cornea, B. & R.							*	**	*		*	**	**	**
Eucythere														
declivis (Norman)										*			*	*
Argus (G. O. Sars)	*									*			*	*
Xestoleberis														
aurantia (Baird)			*		*		*	*	*		**	**	**	**
depressa, Sars			*		*		*	*	*		**	**	**	**
Loxoconcha														
impressa (Baird)					*	*	*	**	*	*	**	*	**	**
elliptica, Brady					**	*	*	**	*	*	**	*	**	**
tamarindus (Jones)		**	**		*	*	*	**	*	*	**	*	**	**
guttata (Norman)			*		*	*	*	**	*	*	**	*	**	**
multifora (Norman)			*		*	*	*	**	*	*	**	*	**	**
fragilis, G. O. Sars	*	*	*		*	*	*	**	*	*	**	*	**	**
pusilla, nov. sp.		**	**		*	*	*	**	*	*	**	*	**	**
Cytherura														
nigrescens (Baird)		**	**		*	*	*	**	*	*	**	*	**	**
similis, G. O. Sars		*	*		*	*	*	**	*	*	**	*	**	**
propinqua, nov. sp.		*	*		*	*	*	**	*	*	**	*	**	**
flavescens, Brady		*	**		*	*	*	**	*	*	**	*	**	**
cuneata, Brady		**	**		*	*	*	**	*	*	**	*	**	**
striata, G. O. Sars		*	*		*	*	*	**	*	*	**	*	**	**
angulata, Brady		*	*		*	*	*	**	*	*	**	*	**	**
Robertsoni, Brady	*	*	*		*	*	*	**	*	*	**	*	**	**
gibba (Müller)		*	*		*	*	*	**	*	*	**	*	**	**
simplex, nov. sp.		*	*		*	*	*	**	*	*	**	*	**	**
producta, Brady		*	*		*	*	*	**	*	*	**	*	**	**
undata, G. O. Sars		*	*		*	*	*	**	*	*	**	*	**	**
acuticostata, G. O. Sars		*	*		*	*	*	**	*	*	**	*	**	**
cellulosa (Norman)		*	**		*	*	*	**	*	*	**	*	**	**
Cytheropteron														
latissimum (Norman)		*	*		*	*	*	**	*	*	**	*	**	**
nodosum, Brady		*	*		*	*	*	**	*	*	**	*	**	**
Sclerochilus														
contortus (Norman)		*	*		*	*	*	**	*	*	**	*	**	**
Cytherideis														
subulata, Brady		*	*		*	*	*	**	*	*	**	*	**	**
Paradoxostoma														
variabile (Baird)	*	*	*		*	*	*	**	*	*	**	*	**	*
abbreviatum, G. O. Sars		*	**		*	*	*	**	*	*	**	*	**	*
ensifforme, Brady		*	**		*	*	*	**	*	*	**	*	**	*
Fischeri, G. O. Sars		*	**		*	*	*	**	*	*	**	*	**	*
hibernicum, Brady		*	**		*	*	*	**	*	*	**	*	**	*
flexuosum, Brady		*	**		*	*	*	**	*	*	**	*	**	*
Normani, Brady		*	*		*	*	*	**	*	*	**	*	**	*
pulchellum, G. O. Sars		*	*		*	*	*	**	*	*	**	*	**	*
Polycheles														
Stevensoni, nov. gen. & sp.		*	*		*	*	*	**	*	*	**	*	**	*

TABLE II. Illustrating the distribution of Ostracoda.—Groups II. and III. English Fen-district and Holland.

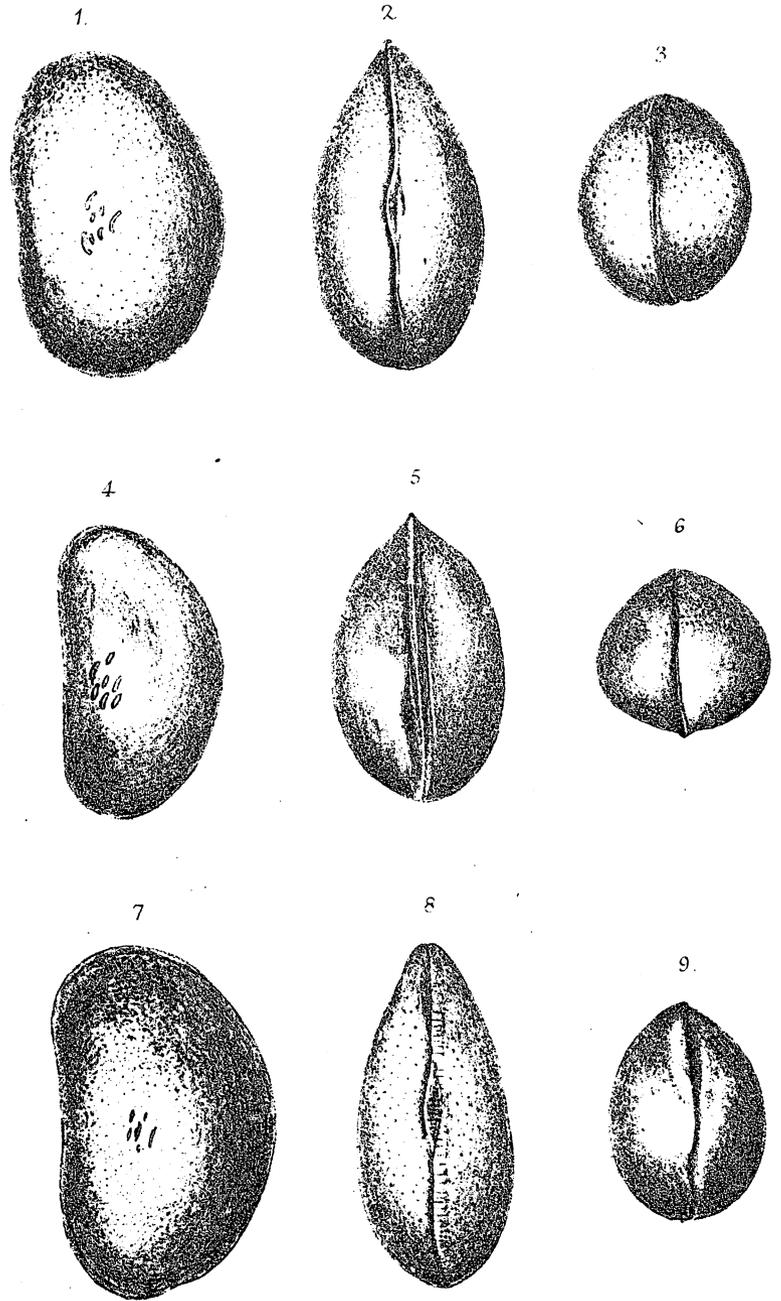
	O.	F.	Q.	R.	S.	T.	U.	V.	W.	X.	Y.	Z.	Aa.	Bb.	Cc.†	Dd.†	Ee.†
	Site of Whitlocka Mere.	Whitlocka Dyke.	River Nene.	River Cam.	Wroxham Broad.	Barton Broad.	Horsy Mere.	Hickling Broad.	Somerton Broad.	Ormesby Broad.	Oulton Broad.	Lake Lothing.	River Bure.	Breydon Water.	River Ouse (Norfolk).	River Scheldt.	River Maas.
<i>Cypris</i>																	
<i>virens</i> (Jurine)	*
<i>obliqua</i> , Brady	*	*
<i>ventricosa</i> , nov. sp.	*
<i>irensis</i> , nov. sp.	*	*	**
<i>salina</i> , Brady	**	**	**	**	**	**	**	**
<i>grana</i> (Jurine)	**	..	**	**	**	**	**	**	**	**
<i>levis</i> , Müller	**	*	**	**	*	**	**	**	**	..	*	*	..	**
<i>compressa</i> , Baird	**	**	**	**	**	**	*	..	**	**	**	**	*	**	..	*	..
<i>striata</i> , Brady	**	**	**	**	**	..	**
<i>repans</i> (Baird)	**	**	*	**	*	**	..	**	**	*	..	*	..	**
<i>serata</i> (Norman)	**	..	**	**	..	**	..	**	**	**
<i>flava</i> , Ramdohr	**	**	**	**	**	*	*	**	**	..	*	**	..	**	*
<i>Cypridopsis</i>																	
<i>flava</i> , Müller	**	..	**	**	**	**	**
<i>obesa</i> B. & R.	**	**	**	**	**	**	**	**	**	*	*	*	..	*
<i>apiculata</i> (Lillyborg) ..	**	**	**	**	..	*	**
<i>Newtoni</i> , nov. sp.	**	..	**	*	**	**	**	..	*	**
<i>Metacypris</i>																	
<i>striata</i> , nov. sp.	*	*	..	**	**
<i>Pandocypis</i>																	
<i>flava</i> , Brady	*	..	**	**
<i>Cardona</i>																	
<i>caudata</i> (Müller)	**	**	*	**	**	**	**	**	**	**	**	..	**
— var. <i>tumida</i>	**	*	*	**	..	**	**	**	**	**	..	**
<i>lancea</i> , Baird	**	**	**	**	**	**	*	**	**	**	**	*	..	*	*
<i>dentata</i> (Müller)	*	*	*	*
<i>lancea</i> , Brady	**	**	**	**	**	**	*	..	*	*	**	*	..	**	*	..	*
<i>compressa</i> , Koch	**	*	**	**	**	*	**	..	*	*	**	*	..	**	*
<i>disparana</i> , nov. sp.	*	*	**
<i>angelii</i> , nov. sp.	**	*	*	**
<i>lyalina</i> , nov. sp.	*	*	*	*
<i>Gonocypis</i>																	
<i>flava</i> , nov. sp.	*	**	*	*	**	*	*	**	*
<i>Nordstromas</i>																	
<i>montanus</i> , Müller	*
<i>Pandocypis</i>																	
<i>inflata</i> (Norman)	*
<i>signifera</i> , G. O. Sars	?	*	..
<i>marginatata</i> , Brady
<i>Apiculata</i>																	
<i>inflata</i> , G. O. Sars
<i>inflata</i> (Brady)
<i>inflata</i> , nov. sp.
<i>Cythera</i>																	
<i>pellucida</i> , Baird	*
<i>inflata</i> , G. O. Sars	**	*	..	*	*	*	**	**	**	**	**	**	**
<i>postinflata</i> , Brady	*	*	**	**	**	**	**	**
<i>levis</i> , Brady	*
<i>levis</i> , Müller
<i>inflata</i> , G. O. Sars	*	..	*	**	**
<i>inflata</i> , Brady	**	**	..	*	*	..	**	**
<i>inflata</i> , G. O. Sars	*	**	**
<i>inflata</i> (G. O. Sars)	**	**
<i>inflata</i> , Baird	*
<i>inflata</i> , nov. sp.
<i>inflata</i> (G. O. Sars)
<i>Robertsoni</i> , Brady
<i>inflata</i> , Brady
<i>inflata</i> , Brady
<i>inflata</i> , Brady
<i>inflata</i> , Baird	*

† In the last three columns we have not attempted to indicate the comparative frequency of the species.

TABLE II. (continued).

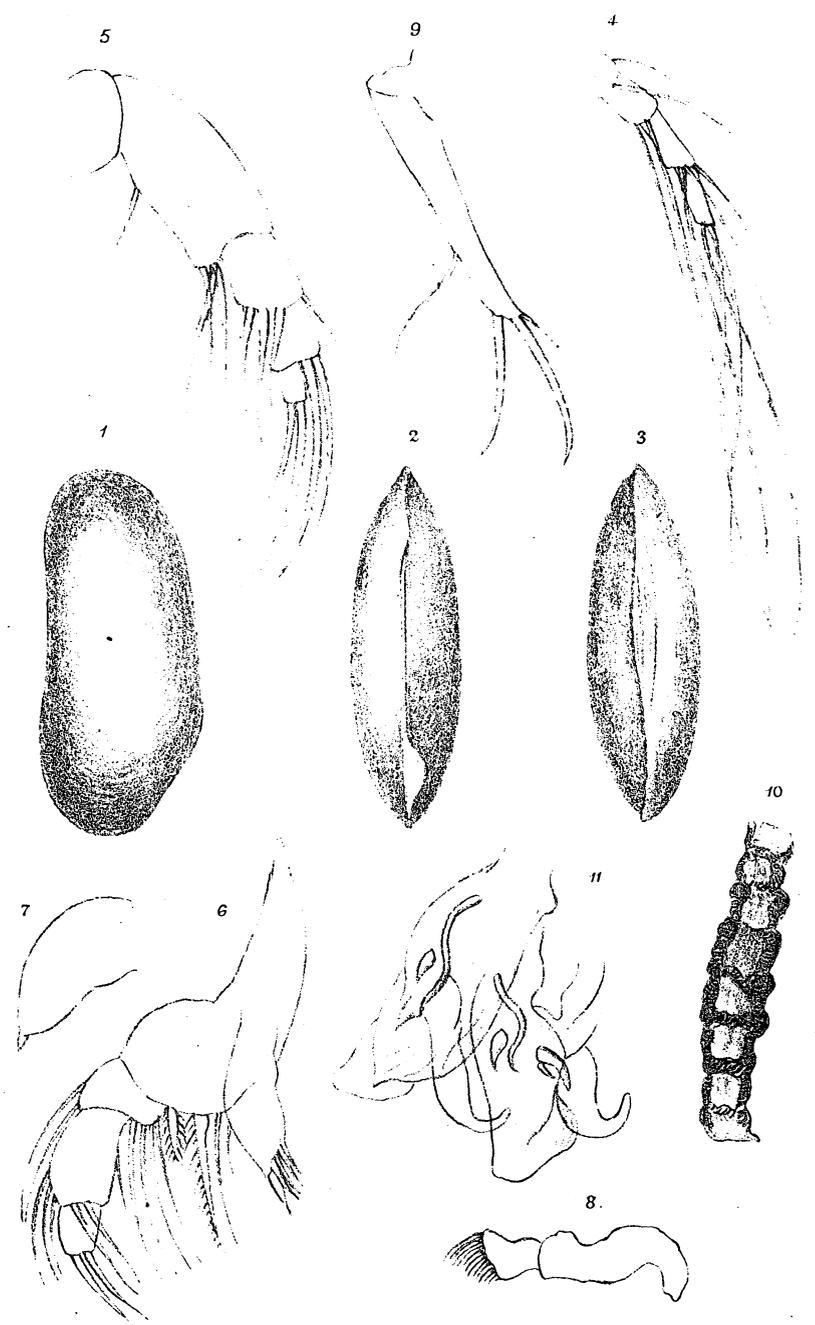
	O.	F.	Q.	R.	S.	T.	U.	V.	W.	X.	Y.	Z.	A a.	B b.	C c. †	D d. †	E e. †
	Site of Whittlesea Mere.	Whittlesea Dyke.	River Nene.	River Cam.	Wroxham Broad.	Barton Broad.	Horsey Mere.	Hickling Broad.	Somerton Broad.	Ormesby Broad.	Oulton Broad.	Lake Lothing.	River Bure.	Breydon Water.	River Ouse (Norfolk).	River Scheldt.	River Maas.
<i>Cybere</i>																	
<i>semipunctata, Brady</i>	*		
<i>acerosa, Brady</i>	*	
<i>Lizincythere</i>																	
<i>popinata (Baird)</i>	**	**	**	**	***	***	**	***	**	**	**	**	**	*	*	*
<i>Sancti-Patricii, B. & R.</i>	*	**	**	*	*	*	*
<i>monstrifica (Norman)</i>	**	*	*	*	*	*	*
<i>Cyberidea</i>																	
<i>torosa (Jones)</i>	**	***	***	***	**	***	**	***	***	*	*	*
<i>var. teres</i>	**	*	**	***	***	***	**	***	**	***	***	*	*	*
<i>leucostriata (G. O. Sars)</i>	**	*	*	*
<i>elongata, Brady</i>	*	*	*
<i>normea, B. & R.</i>	*	*	*
<i>inæqualis, nov. sp.</i>	*	*	*	*
<i>Eucythere</i>																	
<i>Argus (G. O. Sars)</i>	*	*	*
<i>leclivis (Norman)</i>	*	*	*
<i>Xestoleberis</i>																	
<i>argentata (Baird)</i>	**	*	*	*
<i>Luzonochia</i>																	
<i>impressa (Baird)</i>	*	*	*	*
<i>elliptica, Brady</i>	*	**	***	*	*	*	*
<i>geminata (Norman)</i>	**	**	***	***	**	*	*	*
<i>amarindus (Jones)</i>	*	*	*	*
<i>pusilla, nov. sp.</i>	*	*	*	*
<i>multifora (Norman)</i>	*	*	*
<i>Cytherura</i>																	
<i>virgescens (Baird)</i>	*	**	*	*	*	*
<i>similis, G. O. Sars</i>	*	*	*
<i>ovata, Brady</i>	*	*	*
<i>flavescens, Brady</i>
<i>ovata, G. O. Sars</i>	*
<i>angulata, Brady</i>
<i>ovata, Brady</i>	*
<i>Robertsoni, Brady</i>	*	*
<i>ovata, G. O. Sars</i>	**	*
<i>ovata, Brady</i>
<i>ovata, G. O. Sars</i>	*
<i>ovata, Brady</i>
<i>ovata, G. O. Sars</i>	*
<i>Cytheropteron</i>																	
<i>marginatum (Norman)</i>
<i>marginatum, Brady</i>
<i>marginatum, G. O. Sars</i>
<i>marginatum, Brady</i>
<i>Cyberidella</i>																	
<i>subulata, Brady</i>	*	*	*	*
<i>Scherzeri</i>																	
<i>marginatum (Norman)</i>
<i>var. abbreviatum</i>	*
<i>Palaemonostoma</i>																	
<i>marginatum (Baird)</i>	*	**	*
<i>marginatum, G. O. Sars</i>
<i>marginatum, Brady</i>
<i>marginatum, G. O. Sars</i>	*
<i>marginatum, Brady</i>
<i>marginatum, Brady</i>
<i>Polydora</i>																	
<i>Sarseni, nov. gen. & sp.</i>	**	*	**	**	**	**	**	***	**	***	*	*
<i>Polydora</i>																	
<i>compressa, B. & R.</i>	*

† In the last three columns we have not attempted to indicate the comparative frequency of the species.



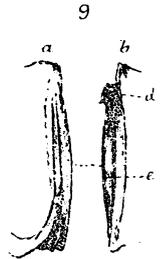
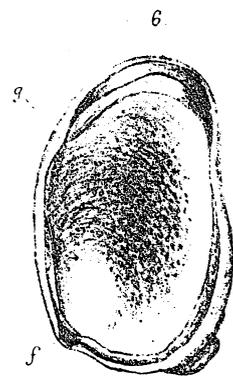
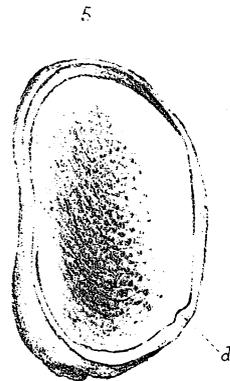
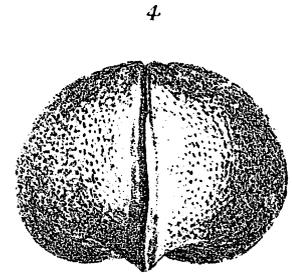
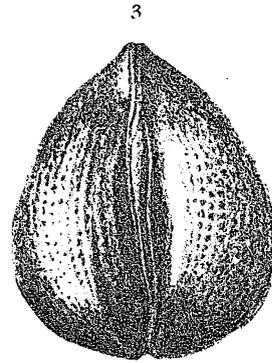
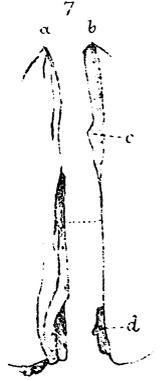
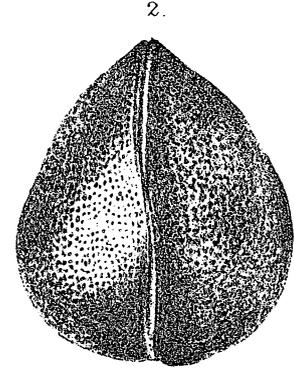
G. S. Brady del. et lith.

W. West imp.



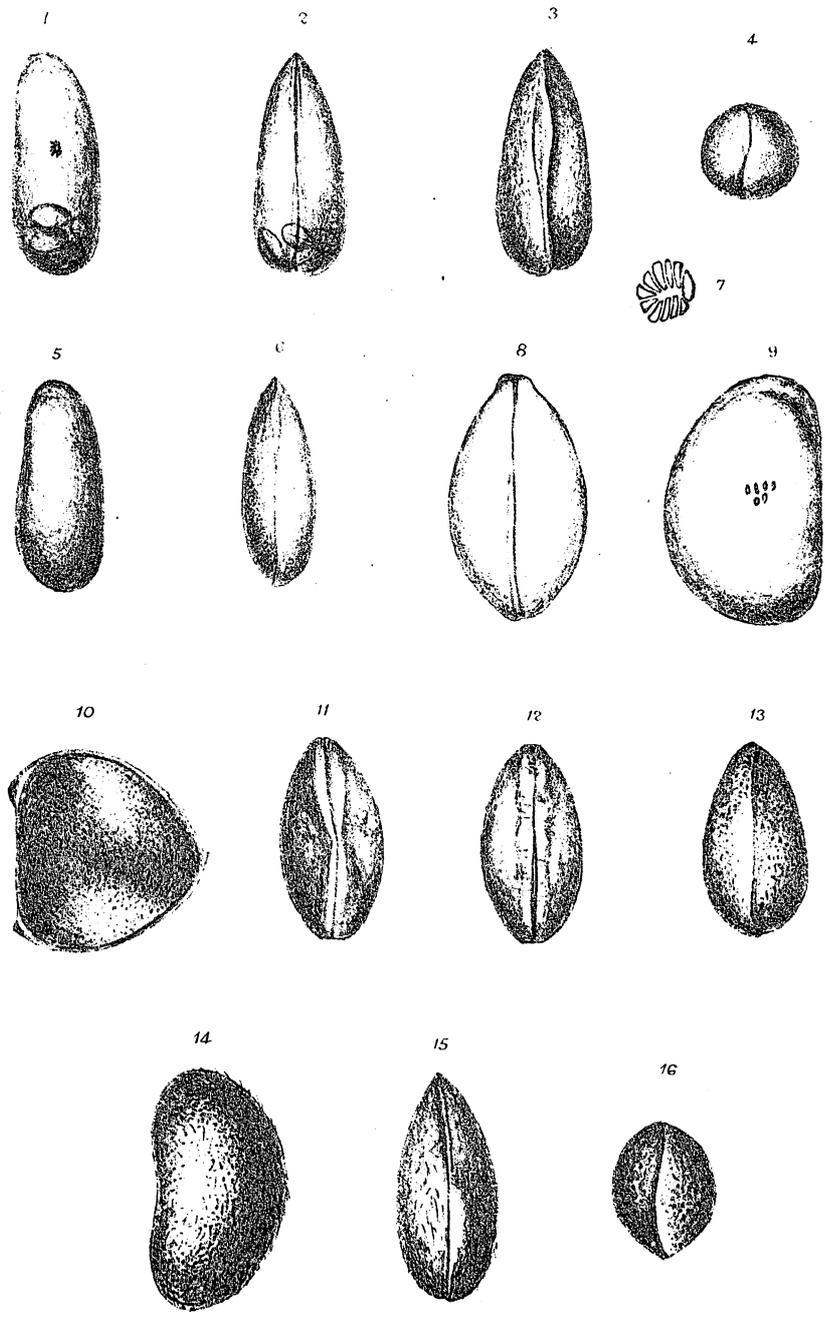
G. S. Brady del. et lith.

W. West imp.



G. S. Brady del et lith.

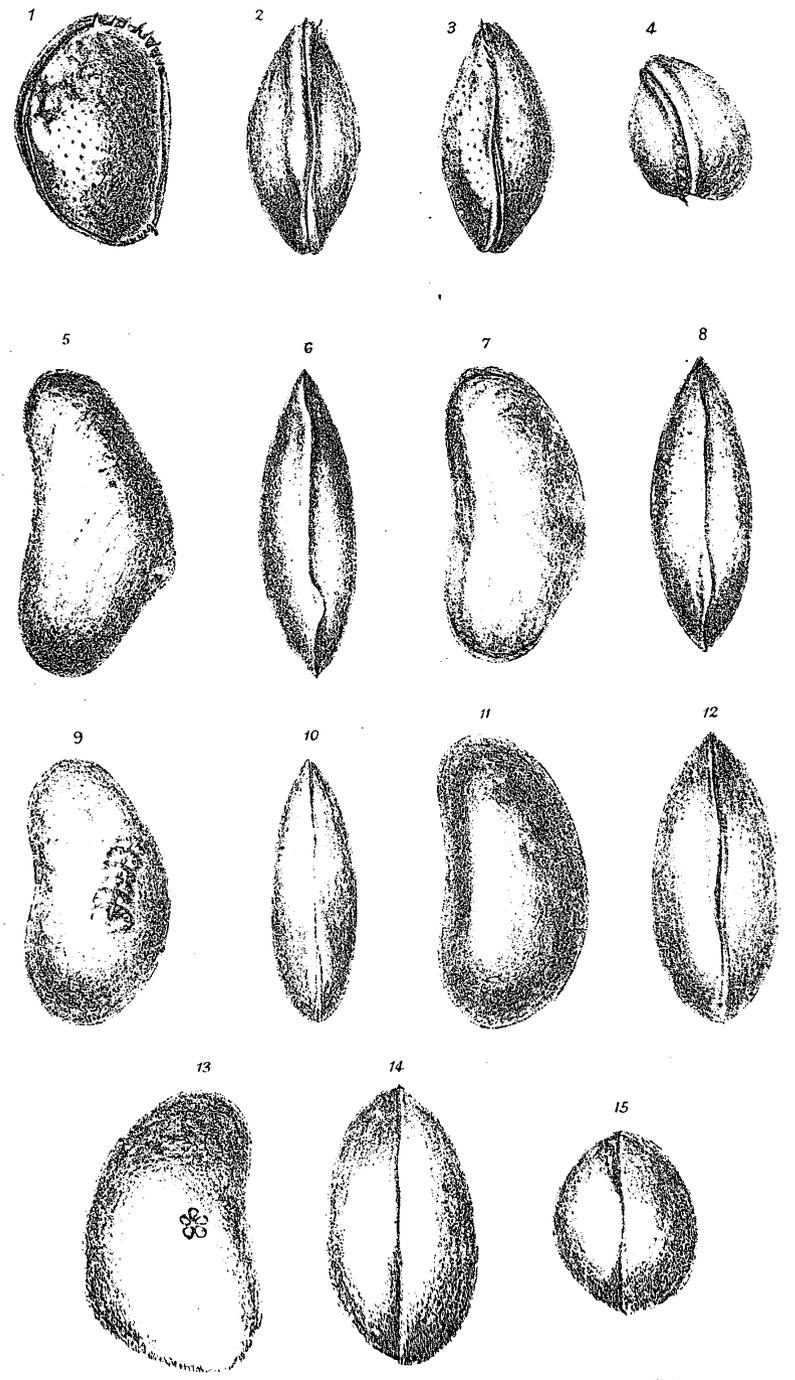
W. West imp.



G. S. Brady del. et lith.

W. West imp.

C. C. L.



G. S. Bissell del et lith

W. West imp

