A REVISION OF THE BRITISH FOSSIL CAINOZOIC ECHINOIDEA.

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I.—INTRODUCTION.

THE Cainozoic Echinoidea were represented in 1843 in Morris's "Catalogue of British Fossils" by a list of three species and of eight genera of which the species were not determined. Even in this meagre list only one of the generic names was correct: of the three species, one was a manuscript name which has been supplanted, another has died the death of a synonym, and the third was an erroneous identification: the genera were no better, and only one of the eight names still stands in the record of the British Cainozoic fauna. But during the eleven years that elapsed before the issue of the second edition of this Catalogue a great advance had been made. The publication of Agassiz and Desor's "Catalogue Raisonné des familles, des genres, et des espèces de la Classe des Echinodermes" (1846-7), [6][1], had given an enormous impetus to the study of this group, both recent and fossil, and laid the foundation on which all subsequent progress in systematic Echinology has been based. One of the first results of their labours was Prof. E. Forbes' "Monograph of the British Tertiary Echinodermata," published by the Palæontographical Society in 1852.

At this time no fossils in England had been more diligently collected than those of the Cainozoics. S. V. Wood had made his great collection from the Crags, and the same deposits had been ransacked by E. Charlesworth, E. H. Bunbury, Col. Alexander and Capt. Brown: the London Clay had been worked by N. T. Wetherell at Highgate, and by J. S. Bowerbank at Sheppey; while F. Edwards, C. Stokes, and J. D'Urban had accumulated a vast mass of material from the Middle and Upper Eocenes of the Hampshire basin. As the Echinoidea from all these deposits were rare and mostly fragmentary, they had been neglected, and Forbes, with full access to all these collections, had a fresh field before him; thus of the nine species he described

[1] The numbers in solid type refer to the Bibliography at the end.

from the Eocenes eight were new. It is therefore unfortunate that Prof. Forbes' Monograph was less satisfactory than was most of his work: it shows the same lack of method, neglect of previous literature, and contempt for all rules of nomenclature that mar his "History of the British Starfish," while it lacks the exquisite humour that has given the latter work such widespread popularity. Hence his Monograph did not stimulate so keen an interest in the fossil forms as the companion volume did in the species now living on our coasts. Nevertheless, Prof. Forbes' work will always remain as the most important contribution to our knowledge of the British Cainozoic Echinoidea, and hardly anything has been added to it. The list of Eocene species stands as Forbes left it, while an examination of the table of the Echinoidea from the Crags, given in Mr. Clement Reid's recent Memoir (39, p. 283) shows that the only addition has been that of two recent species recorded as occurring in the Crags by Messrs. A. and R. Bell in a paper published in the Proceedings of this Association (9, pp. 202, 203, 208, 213, 215, 270).

Since 1852, however, a good deal of fresh material has been accumulated in museums and private collections, and this includes several new species. In connection with the description of these it has been thought advisable to undertake a general revision of the group, for such a course enables the affinities of the successive faunas to be more clearly seen.

Though under each species the present resting-place of its type-specimen has been mentioned, it seems useful to give here a general account of the collections in the various Museums. Whether judged by the number or the historical value of the specimens, the collection of the British Museum (Nat. Hist.) is the most important. The collections of S. V. Wood, J. S. Bowerbank. N. T. Wetherell, Caleb Evans, F. Dixon, and J D'Urban have all found their way thither; while the series of Cainozoic Echinoids has been further enriched by the pick of the specimens from the collection of the late Robert Bell. Messrs. J. Middleton, W. H. Shrubsole, F.G.S., W. J. Lewis Abbott, F.G.S., R. M. Gordon, and D. Robertson, F.L.S., have also generously presented the Museum with interesting specimens. The Museum of Practical Geology must rank next, so far as this group is concerned, since it contains some valuable types from the Crags and nearly all Forbes' Eocene types. The Woodwardian Museum at Cambridge possesses an extensive series of Crag and Eocene specimens, which have yielded much information upon doubtful points of structure. The York Museum contains the Reed collection with the pick of all the Crag specimens collected during the past twenty-five years. In the Wallace collection at the Ipswich Museum there are some splendid specimens, especially of the Spatangoids. The Norwich Museum, besides material which adds fresh evidence as to the distribution of some species, has

some fragmentary remains from the Norwich Crag and Glacial drifts. The Saffron Walden Museum has a few specimens from the Red Crag of Walton; but the Echinoids in this collection cannot compete in interest with its Mollusca.

To the curators and officials of these Museums I must express my best thanks for their courteous help when examining the collections, especially to Mr. E. T. Newton for much valuable assistance in identifying the types at Jermyn Street, and to Mr. W. Reed, F.R.C.S., and Mr. H. M. Platnauer, owing to whose kindness I have had the opportunity of examining the valuable Reed Collection at leisure in London. Finally, I am indebted to Dr. H. Woodward, F.R.S., for permission to describe the new species in the National Collection, to Prof. F. Jeffrey Bell for much help in comparing the fossil with the recent forms, and to Messrs. G. F. Harris and H. W. Burrows for checking the localities of some specimens.

In regard to the synonymy of recent species only records of their occurrence as fossils have been included. The full synonymy of these forms is given by Prof. Agassiz in his "Revision." In a few cases only have the foreign references been given, except for the foundation of the species and the first reference of it to its present genus. The technical terms used in the description of the species are explained in the glossary accompanying Prof. Duncan's "Revision" (**22**, pp. 295-304).

II.—THE EOCENE ECHINOIDEA.

FAMILY **ARBACIIDÆ**.

GENUS *CŒLOPLEURUS*, Agassiz, 1840.

Cœlopleurus wetherelli, Forbes, 1852.

Cœlopleurus wetherelli, Forbes, 1852. Brit Tert. Ech. p. 24, pl. iii. fig. 1.
" " Desor, 1856. Syn. Ech. Foss. p. 98.
Acrosalenia sp., Morris, 1843. Cat. Brit. Foss. p. 47.
Glypticus sp., Morris, 1843. *Op. cit.*, p. 53.
Records.—**35**, p. 75: **31**, p. 331: **46**, p. 595: **32**, p. 13: **38**, vol. ii., pl. xv. f. 6.

Distribution.—London Clay. Sheppey, Hampstead, Highgate.

Type-specimens.—Museum of Practical Geology (xviii. $^{3}_{12}$), British Museum (E 1531).

Remarks.—This species must be compared with *C. spinosissimus* Ag. from the *Calcaire grossier* of the Paris basin, from which it may be distinguished by the greater prominence of the tubercles in the French species and by the fact that the smooth areas at the summit of the interradii are broader and more completely bare. The Upper Eocene species has a few granules on this region.

The occurrence of a genus so typical of the tropical regions of

the Eocene seas is of interest. The species is, however, a dwarfed one in comparison with those of the deposit of the same age in the South of France. The genus lingered on in the Northern Sea ; but *Cœlopleurus spinossissimus* and the two English species all belong to the same group of small ill-developed forms. With the colder conditions of the Barton epoch the genus seems to have finally disappeared from Northern Europe. Prof. Al. Agassiz accidentally quotes it from the English Pliocene.[2]

Cœlopleurus dixoni, n, sp.

Echinus sp., Dixon, Geol. Sussex, 1850, p. 86, pl. ix. f. 27, 29 ; ed. 2, 1878, p. 206, pl. ix. [10] f. 27,29.

Diagnosis.—Form :—Small, round, depressed, but conical. Apical system :—The tubercles are large, depressed, and of uniform size. Ambulacra :—with a double row of uniform tubercles which equal in size those of the interradii. Interambulacra :—at and below the ambitus there is a pair of tubercles on each plate, but above there is only one. These form a row up each side of the interradius, continuous with that of the adjoining area across the ambulacrum by a tubercle on the radial plate. The bare parts of the areas are narrow.

Dimensions.—Diameter 21 mm., height 9 mm.

Distribution.—Bracklesham beds, Bracklesham.

Remarks.—In Dixon's "Sussex" there is given a fairly good figure of an Echinoid from the Upper Bracklesham of Selsea (?). which seems to have hitherto escaped notice. It is, however, unquestionably a *Cœlopleurus*, and the figure is taken as the type of this new species. It belongs to the *C. wetherelli* and *C. spinosissimus* group, but it differs from both. It may be readily separated from the former by the much greater coarseness of the tubercles, especially on the abactinal surface. From the latter, with which it is in closer alliance, it differs in having a circular instead of a sub-pentagonal form, smaller tubercles, and more uniformly-sized tubercles in the ambulacral and interradial areas.

Genus *ECHINOPEDINA*, Cotteau, 1866.

Echinopedina edwardsi (Forbes).

Echinopedina edwardsi, Cotteau, 1866. Rev. Mag. Zool. (2) xviii. p. 262.
" " Duncan, 1889. Journ. Linn. Soc. Zool. xxiii. p. 83.
Echinopsis edwardsi, Forbes, 1852. Brit. Tert. Ech. p. 23, pl. iii. f. 2.
" " Salter, 1856. Dec. Geol. Surv. v. pl. iii. p. 6.
" " Desor, 1856. Syn. Ech. Foss. p. 100.
Records.—**35**, p. 78 ; **31**, p. 352 ; **32**, p. 22 ; **38**, pl. xv. f. 8 ; **27**, p. 633.

Type-specimen—Museum of Practical Geology (xix $\frac{4}{1}$).
Distribution.—Bracklesham series, Bracklesham.

2 Illustr. Cat. Mus. Comp. Zool. vii. p. 752, 1874

Remarks.—The only doubt about this species is as to its geological range. Forbes describes it as a Bracklesham species from Bracklesham and from the upper marine bed at Barton. In the Cat. Coll. Mus. Pract. Geol. it is quoted from both Bracklesham and Hordwell. The specimen from the latter place is too imperfect for satisfactory determination; but the poriferous areas are far narrower than in this genus.

M. Cotteau and Prof. Duncan both describe it as from the London Clay, but this is a mere slip.

The closest ally of this species is the *E. gacheti* (Desmoul.)[3] from the *Calcaire grossier*. The English species differs from the latter by the greater height of the interambulacral plates, which in consequence number fewer in a vertical series: in *E. edwardsi*, moreover, the secondary tubercles form a scrobicular circle with one or two scattered granules in addition. In *E. gacheti* they are more numerous and form double horizontal rows along the plate on each side of the main tubercle.

Family **FIBULARIIDÆ.**

Genus *SCUTELLINA*, Agassiz, 1841.

Scutellina lenticularis (Lamarck) 1816.

Scutellina lenticularis, Agassiz, 1841. Mon. des Scutelles, p. 101, pl. xxi. f. 20-23
„ *nummularia*, Agassiz, 1841. *Op. cit.* p. 99, pl. xxi. f. 8-14.
„ *toillieзi ?* Le Hon, 1862. Description succincte de quelques espèces animales des terrains tertiaries éocènes des environs de Bruxelles, p. 9.
Scutella lenticularis, Lamarck, 1816. Anim. S. Vert. 1st ed. vol. iii. p. 10.
„ *nummularia*, Defrance, 1827. Dict. Sci. Nat. vol. xlviii. p. 231.
Echinarachnius lenticularis, Agassiz, 1836. Mém. Soc. Sci. Nat. Neufchatel, i. p. 188.

Distribution.—British—Bracklesham Beds. Foreign—*Calcaire grossier*, France. *Laekenien infér*, Belgium.

Remarks.—*Scutellina lenticularis* is one of the most characteristic Echinoids of the *Calcaire grossier*, and the discovery of two specimens in the Bracklesham beds of the Hampshire basin therefore strengthens the resemblance of the Echinoid faunas of the two deposits. The exact locality of the specimens is unfortunately unknown. They belong to the Edwards Collection, now in the British Museum (49821-2), and were recorded as a new *Echinus*. One of them is half buried in matrix, and this enables Messrs. Harris and Burrows to decide that they are British, and probably from Bracklesham Bay. Those gentlemen are not acquainted with any similar matrix in the Belgian or French Tertiaries. The small size of this species may account to some extent for its rarity.

3 Desmoulins, Études sur les Échinides, 1837, p. 300.

FAMILY SPATANGIDÆ.

DIVISION Prymnadete.

GENUS *HEMIASTER*, Desor, 1847.

Hemiaster bowerbanki, Forbes, 1852.

Hemiaster bowerbanki, Forbes, 1852. Brit. Tert. Ech. pp. 24, 25, pl. iii. f. 6 (*non* 6*e*). Desor, 1857-8. Syn. Ech. foss. p. 375.
Ditremaster bowerbanki, Cotteau, 1887. Pal. Franç. Eoc. Ech. i. p. 426.
non Hemiaster bowerbanki, J. Delanoue, 1868. Compt. Rend. lxvii. p. 706.
Spatangus sp., Prestwich, 1850. Quart. Journ. Geol. Soc. vi. p. 267.
Spatangus (*?H bowerbanki*), Whitaker, 1872. Mem. Geol. Surv. iv. pl. i. p. 585.
Records.—**35**, p. 81 ; **31**, p. 331 ; **46**, pp. 585 and 595 ; **32**, p. 13.

Distribution.—London Clay. Sheppey. Basement-bed; Katesgrove Kiln, Reading, and, *fide* Prestwich and Whitaker, in Sonning Railway-cutting.

Type-specimen.—Museum of Practical Geology (xviii. $\frac{8}{18}$).

Remarks.—The Eocene Spatangoids described by Forbes are rare, very badly preserved, and form the most difficult group of the British Eocine Echinoidea. This species, however, is one of the best known, and the questions as to the sub-division of Desor's genus *Hemiaster* may be conveniently considered in regard to it. M. Munier Chalmas,[4] in 1885 established the genus *Ditremaster* for species of *Hemiaster* with only two genital pores: M. Cotteau [5] has subsequently accepted and enlarged this genus and referred *H. bowerbanki* to it, although Forbes' figure clearly shows the presence of four genital apertures. Prof. Duncan and Mr. Sladen (*23*) have recently subjected the genus *Ditremaster* to very vigorous criticism and emphatically decline to accept it. The arguments they adduce seem to me perfectly unanswerable, proving that the number of generative pores is not of generic or even of a specific value in this group. The species is therefore retained in *Hemiaster*.

Hemiaster prestwichi, Forbes, 1882.

Hemiaster ? prestwichi, Forbes, 1852. Brit. Tert. Ech. p. 25, pl. iii. f. 5. Desor, 1857-58. Syn. Ech. foss. p. 375.
Ditremaster prestwichi, Cotteau, 1887. Pal. Franç. Eoc. Ech. i., p. 426. Records **35**, p. 81 ; **31**, p. 331 ; **46**, p. 595 ; **32**, p. 13.

Distribution.—London Clay. Sheppey.

Type-specimen.—Museum of Practical Geology (xviii. $\frac{3}{13}$).

The objections to the genus *Ditremaster* referred to in the remarks on the previous species apply with equal force to this. Forbes was in doubt as to the genus to which this belongs, and

4 Compt. Rend. 1885, ci, p. 1076.

5 Pal. Franç. Echinides Eocènes; 1887, pp. 411, 412.

suggested it might have to be transferred to *Macropneustes*. His doubts were suggested by the apparent absence of the fasciole; but the condition of preservation amply accounts for this. The whole aspect of the fossil is that of a *Hemiaster*. The species can be easily distinguished from *H. bowerbanki* by the fact that the petaloid portion of the paired ambulacra are nearly flush with the test.

Hemiaster? branderi, (Forbes) 1852 *pars*.

Hemiaster branderianus pars., Forbes, 1852. Brit. Tert. Ech. pp. 25-26, pl. iii. f. 8, a. b. c.
Brissopsis branderiana, Desor, 1857-8. Syn. Ech. Foss. p. 381.
" " Dujardin and Hupé, 1862. Hist. Nat. Zooph. Ech. p. 598.
Trachyaster branderianus, Cotteau, 1887. Pal. Franç. Eoc. Ech. i. pp. 406-7.
Ditremaster " Cotteau, 1887. *Op. cit.* p. 427.
Records.—**35**, p. 81; **31**, p. 352; **32**, p. 29; **27**, p. 633.

Distribution.—Barton Clay. Highcliff, Barton.
Type.—M.P.G., xviii. $\frac{3}{15}$a.
Remarks.—This species was founded by Prof. Forbes on a specimen (pl. iii., fig. 8, a. b. c.) from the Barton Beds, and on one (pl. iii., fig. 8, d. e.) from the London Clay of Haverstock Hill. The material was all so imperfect that neither the descriptions nor figures enabled subsequent palæontologists to get any clear conception of the species. Hence, as a rule, the specimens of *H. branderi* have been included under the one described British species of *Schizaster*, viz., *S. d'urbani;* while *Hemiaster branderi* has been retained for some specimens from the London Clay. Prof. Forbes' specimens belong, not only to different species, but probably to different genera; and, as his description was based on the Barton specimen, this must be regarded as the type, and a new species provided for the Lower Eocene forms.

The species is very imperfectly known and the genus is uncertain. It has been referred by Desor and others to *Brissopsis*, and as Prof. Duncan (**22**, p. 249) records that genus from the English Eocenes, he seems also to have shared in this opinion. As I am unacquainted with any evidence in support of this conclusion the species is here left in *Hemiaster*. If the species were better known it would not improbably have to be transferred to *Schizaster*.

Hemiaster forbesi, n. sp.

(Pl. I, Figs. 4, 5, 6.)

Hemiaster branderianus (pars.), Forbes, 1852. Brit. Tert. Ech. pl. iii. fig. 8 d. 6 e.
" " Morris, 1854. Cat. Brit. Foss. ed. 2, p. 81.
" " Huxley and Etheridge, 1865. Cat. Foss. Mus. Pract. Geol. p. 331.
" " Whitaker, 1872. Mem. Geol. Surv. iv. pl. i. p. 595.

Hemiaster branderianus, Huxley, Etheridge and Newton. Cat. Tert. and Post-Tert. Foss. Mus. Pract. Geol. p. 13.
„ „ Lobley, 1887. Trans. Middlesex Nat. Hist. and Sci. Soc. p. 93.
„ „ J. Prestwich, 1888, Geol. ii. pl. xv. f. 9.

Diagnosis.—Form: an irregular rounded hexagon, broadest at apical disc. In elevation it is seen to be high; the anterior margin is tumid; the posterior interradius is carinate and terminates abruptly in a steep flat slope; the anus is high up on this and can be usually seen from above; anterior furrow broad, and makes a deep notch in the anterior margin.

Apical disc: behind the centre.

Ambulacra: in deep impressions. Anterior furrow, broad and long. Petals of the anterior pair half as long again as those of the posterior; the latter short and blunt.

Fasciole: broad, sinuous, thickening considerably at the ambulacra.

Anus: oval, high up on the posterior slope; visible from above.

Peristome: somewhat far removed from the anterior margin.

Dimensions.—

	mm.
Length	20
Height	13
Diameter	18
Length of antero-lateral ambulacrum ...	8
Width „ „ ...	3
Length of postero-lateral ambulacrum ...	4
Width „ „ ...	1·75
Distance of apical disc from anterior margin	11

Distribution.—London Clay, basement bed. Pinner; ? Hampstead and Sheppey.

Type-specimen.—In British Museum (E 3394).

Remarks.—The specimens on which this species is founded were collected by R. M. Gordon, Esq., from the basement bed of the London Clay at the Metropolitan Railway extension at Pinner, and kindly presented by him to the British Museum. It seems to have been extremely abundant there. Mr. Shrubsole has also presented to the same museum a specimen from Sheppey (E 123) which belongs to this species. It is moreover probable that the fragment from Hampstead figured by Forbes (pl. iii. fig. 8, d. e.), and referred by him to *H. branderi* may also be included here. It is certainly not the same species as the true Barton *H. branderi*.

The species finds its nearest ally in *H. bowerbanki* (Forbes), from which it differs in that the anterior margin is more affected by the groove of the unpaired ambulacrum, the lateral ambulacra are longer and more equal and the posterior margin is more vertical.

Genus *SCHIZASTER*, L. Agassiz, 1847.

Schizaster d'urbani, Forbes, 1852.

Schizaster d'urbani, Forbes, 1852. Brit. Tert. Ech. p. 27, fig. p. 36. No. 1.
" " Desor, 1857-8. Syn. Ech. Foss. p. 390.
" " Cotteau, 1887. Pal. Franc. Eoc. Ech. i. p. 364.
Records.—**35**, p. 89 ; **27**, p. 633 ; **38**, pl. xv. fig. 5 ; **12**, p. 283.

Distribution.—Bracklesham Beds.[6] Alum Bay.

Remarks.—This species, as far as I am aware, is still represented by the two specimens from the Alum Bay which were known to Professor Forbes, and are now in the British Museum. The other records have probably been due to the confusion that has long existed between this species and the *Hemiaster branderi* (Forbes) from Barton. *S. d'urbani* may be recognised by its deep, broad, and flat-bottomed anteal furrow.

Schizaster corneti ? Cotteau, 1880.

Mém. Cour. Acad. Roy. Sci. Belgique, xliii. fasc. 3, p. 63-4, pl. v., figs. 6 and 7.

Distribution.—British—Thanet Beds, E. of Canterbury. Foreign—*Landenien infer*, Belgium.

Remarks.—Mr. Jas. Horsley found, in the Thanet beds, east of Cambridge, three specimens, which he presented to the British Museum (39,972). The specimens are not only in the condition of mere casts, but they have been considerably distorted by pressure. Hence it is impossible to determine them with certainty. The smallest specimen suggests the reference of the specimens to the species of *Schizaster* found in the corresponding beds in Belgium. The well-rounded anterior margin, the sharp tapering posterior end, the broad anterior groove, and the position of the apical disc, are all points of agreement with this species : the great height of the crushed largest specimen, however, throws some doubt on the identification.

Schizaster cuneatus, n. sp.

(Pl. I. Figs. 1 ,2, 3.)

Diagnosis.—Form : hexagonal in shape, with rounded angles. In elevation the anterior end is seen to be depressed, with a long flat slope, while posteriorly it is high and carinate. The posterior margin is vertical.

Apical system : posterior.

Ambulacra : deeply impressed. The anterior is a broad, long furrow with parallel sides, deeply notching the anterior margin. The antero-lateral ambulacra curve forward and the petaloid portions extend to about half-way to the ambitus. The petals of the postero-lateral ambulacra are short and blunt, and are close to the median keel.

6 Bristow, Geol. Isle of Wight, 1862, p. 124, marks this species from the Lower Greensand ; but that is obviously a slip.

Interradii: the postero-laterals are the widest; the antero-laterals and the posterior interradii forming high, narrow ridges near the apical system.

Epistroma: of close-set granules, generally uniform, but largest at the anterior margin. Fascioles: a sinuous peripetalous fasciole and a lateral one which runs from the former just behind the end of the antero-lateral petal.

Spines long and delicate, most of them on the actinal plastron curved, and some spoon-shaped.

Peristome: anterior reniform in shape; labrum well developed.

Anus: oval, high on the vertical posterior margin.

Dimensions.—

	mm.
Length	26
Breadth, at anterior third	23
,, at posterior third	25
Height	17
Ambulacra: length of anterior petal ...	9
,, breadth ,, ,, ...	3
,, length of posterior petal ...	5
,, breadth ,, ,, ...	2
Distance of apical disc from anterior margin	1·7

Distribution.—London Clay, Bognor. ? Hampstead Well, B.M. (E. 1695).

Type-specimen.—Cambridge Museum ($\frac{d, 1. 18.}{P.}$)

This species belongs to the group of which *Schizaster vicinalis*, Ag. and Des.[8] from the Upper Eocene of the South of France and North Italy is a convenient type. Its main features are the flat, gradual, anterior slope from the high carinate posterior, which gives it, when viewed from the side, a wedge-shaped form, as suggested in its name. From *S. vicinalis* it differs in that in the foreign species the anterior slope has a more rounded surface, the antero-lateral ambulacra are more than twice as long as the postero-lateral, and the test is somewhat narrower. From *S. leymeriei* Cott.[9] it differs in the fact that that species is widest in front instead of behind.

This new species must also be compared with *S. buanesensis* Cott.[10] from the Lower Eocene of the Landes. They agree in general proportions, but in the French species the apical disc is nearer the centre, and the shape is more rounded.

The only English species with which *S. cuneatus* could be confused is *S. branderi* (Forbes). The latter may be recognised by its more depressed form, the shortness and breadth of the

8 Cat. Rais. Ann. Sci. Nat. Zool. (3) viii. 1847, p. 21.

9 Catalogue des Echinides Fossiles des Pyrénées: Bull. Soc. Geol. France (2) xiii. 1856. p. 341.

10 Pal. Franç. Echinides Eocènes, vol. 1887, pp. 294-5, pl. lxxxviii. fig. 6-8.

postero-lateral ambulacra, and the shape of the anterior ambulacrum.

Division PRYMNODESMIA.

Genus *MARETIA*, Gray, 1855.

Maretia grignonensis (Desmarest), 1836.

Maretia grignonensis, Cotteau. Mém. cour. Acad. Coy. Sci. Belg. 1880, xliii. fasc. 3, p. 75.
Spatangus grignonensis, Demarest, 1836, in Desmoulins' Tableaux Synonymiques, p. 390.
„ *omalii*, Galeotti, 1837, Mém. sur la constitution géologique de la province de Brabant, p. 191, pl. suppl. fig. 1.
Forbes, 1852. Brit. Tert. Ech., p. 28, pl. iii. fig. 9.
„ *omaluisi*, Dewalque, 1868. Prodr. d'une description géol. de la Belgique, p. 408.
„ *archiaci*, Agassiz and Desor, 1847. Ann. Sci. Nat. Zool. (3), viii. p. 8.
Hemispatangus grignonensis, Desor, 1857-8. Syn. Ech. foss., p. 416.
„ *archiaci*, Desor, 1857-8, *Op. cit.* p. 416.
Records.—**35**, p. 89 ; **27**, p. 633.

Distribution.—British: Barton beds, Barton. Foreign: *Calcaire grossier*, Paris basin; *Ypresien supér.*, Brabant; *Bruxellien*, *Laekenien*, and *Wemmelien*, Belgium; Upper Eocene, Hungary; Germany (Samland).

Type-specimen.—Museum of Practical Geology (xix. $\frac{5}{1\frac{1}{2}}$a).

Remarks.—Fragments only of this species are known from the English deposits, and these were all collected at Barton. Forbes identified them as *Maretia omali* Gal., a synonym of *Maretia grignonensis* (Desm.), a species with which he was well aquainted. Some additional fragments have been found, but, though they prove that it is a true *Maretia*, they afford no additional evidence as to the accuracy of the specific determination.

Genus *EUSPATANGUS*,[11] Agassiz, 1847.

Euspa angus hastingiæ, Forbes, 1852.

Euspatangus hastingiæ, Forbes, 1852. Brit. Tert. Ech., p. 26-7, pl. iii. fig. 7.
Records.—**35**, p. 79 ; **31**, p. 352 ; **32**, p. 29 ; **27**, p 633 ; **38**, pl. xv. f. 7.

Distribution.—Barton beds, Barton.

Type-specimen.—Museum of Practical Geology.

This species remains as Prof. Forbes left it. The only specimens are in the Museum of Practical Geology. Though the species has been well diagnosed and figured by Forbes, it has escaped the notice of foreign palæontologists. It is a very close ally of *E. ornatus* (Defr.),[12] the commonest species in the Eocenes of the south of France, Italy, and Spain.

Euspatangus excentricus, n. sp.

Diagnosis.—Form : cordate elongated ; widest half-way along the test, tapering gently to the posterior margin ; a broad, shallow

11 The name was often spelt Eupatagus.

12 In Brongniart, Géologie des environs de Paris, 1822, pp. 86 and 389, pl. v. fig. 6.

groove slightly interrupting the anterior margin. In elevation it is seen to be depressed, terminating abruptly at both ends. The vertex is about half-way from the ends and behind the apical disc.

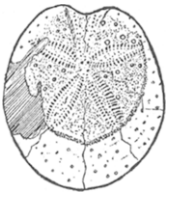

Fig. 1. Euspatangus excentricus.

Apical system: with four large genital pores, situated at $\frac{1}{3}$ length of the test from the anterior margin.

Ambulacra: flush with the test. The anterior with small pores is inconspicuous in the shallow anteal groove. The antero-lateral pair is very narrow close to the apical disc, with very small pores; the petaloid portion then expands by the curvature of the anterior zones, which curve back again towards the posterior, and close the petal by an acuminate point. In the posterior pair the two halves of each petal are more equal and similar; both being slightly convex, enclosing an interporiferous area which tapers gently in both directions.

Interradii: the posterior area is elevated, but rounded so as to make no approach to a keel.

Epistroma: a few large, deeply scrobiculate tubercles in each of the paired interradii.

Fasciole: subanal, not seen. The presence of a peripetalous fasciole is indicated by the structure of the test and distribution of the tubercles.

Anus: high on the posterior vertical margin; oval in shape.

Distribution.—Barton beds, Barton.

Type-specimen.—British Museum (49820).

Dimensions.—

	mm.
Length	23
Height	9
Breadth	21
Length of antero-lateral petal	8
Width „ „	2
Length of postero-lateral petal	9
Width „ „	2·5
Distance of apical system from anterior margin	6

Remarks.—Of the Eocene species of *Euspatangus* which M. Cotteau has enumerated in his recent valuable revision of the genus this species differs from nearly all in the very excentric position of the apical disc. This is at one-third the length of the test

from the anterior margin. It most closely resembles a specimen of *E. antillarum*, Cott., figured by M. Cotteau ;[13] but the English species may readily be distinguished by its cordate form, its oval anus, and the absence of large tubercles in the unpaired interradius. The Indian *E. rostratus* has a very different form, while *E. beyrichi* has an unusual irregularity of form and distribution of the tubercles.

The following species and records have been based either on spines or indeterminable fragments, and hence for comparison with other faunas are valueless.

Cidaris websteri, Forbes, 1852.

Cidaris websterianus, Forbes, 1852. Brit. Tert. Ech. p. 22, pl. iii. f. 4.
Records.—**31**, p. 352 ; **46**, p. 595 ; **32**, p. 29 ; **33**, p. 90 ; **27**, p. 633.

Distribution.—London Clay ; Hampstead (*fide* Whitaker and Lobley. Barton beds ; Barton (Spine, t., M.P.G.)

"Echinus" (!) dixoni, Forbes, 1852.

Echinus dixonianus, Forbes, 1852. Brit. Tert. Ech. p. 22, pl. iii. f. 3.
Records.—**31**, p. 353 ; **32**, p 29 ; **27**, p. 633.

Distribution.—Bracklesham beds (hard bed), Bracklesham. Barton beds, Barton (Spine, t. M.P.G.)

Miscellaneous Indeterminable Species.

Diadema sp., Oldhaven beds (**46**, p. 581).
Echinus spines, Thanet Sands, Pegwell Bay (**46**, p. 575).
Schizaster sp., Thanet Sands, Pegwell Bay, and near Canterbury (**46**, p. 575).
Spatangus sp., London Clay (upper sandy bed), Hampstead (**33**, p. 89).

The British Museum also possesses Echinoid spines from Barton and Bracklesham, and from the London Clay at Islington.

III.—PLIOCENE.

Family CIDARIDÆ.

Genus *CIDARIS*, Leske, 1778.

Cidaris sp.

Distribution.—Coralline Crag, Sutton.

Remarks.—The genus *Cidaris* is rare in the Pliocene, and as the parts of the test are loosely attached together, it is usually known only by disconnected plates and spines. A few such have been found in the English Crags ; most of them being rolled and worn plates belonging to Chalk species but there are a few which do not agree in structure with any of those from that horizon. As the genus certainly lived in the Belgian Pliocene seas these plates were probably derived from a Crag species.

13 Cotteau, K. Svensk. Vet. Akad., Handl. xiii., No. 6, 1875, pl. vii. fig. 12.

Three plates and the same number of spines from the Coralline Crag of Sutton (Wood Coll. B.M.E. 577) give us some idea of the characters of the species, which was a close ally of *Cidaris belgica*, Cott., though differing from it in several characters. The remains, however, are too fragmentary for any description to be given by which it would be possible to determine whether plates from other parts of the test, that may be discovered, belong to this species or not. The occurrence of the specimens is therefore merely recorded as showing the existence of the genus in the English Crags.

Family **TEMNOPLEURIDÆ.**

Sub-Family **Glyphocyphinæ.**

Genus *TEMNECHINUS*, Forbes, 1852.

The genus *Temnechinus* is one of the most interesting of those found in the English Crags. It was founded by Forbes for four species, which were all limited to those deposits. Others, however, from other formations, have since been added to it. Thus, Prof. Duncan and Mr. Sladen have referred to it a series of species from the Indian Miocene and Pliocene, and Prof. A. Agassiz has described a recent form from the West Indies. Desor, however, had in 1856 founded a genus *Opechinus* for the Indian species and for one from Java, *Opechinus percultus*, Desor.[14] Prof. Duncan, in his valuable memoir on the genus *Pleurechinus*, dismissed *Opechinus* as "valueless" and as due only "to the chances of the growth of ornamentation."[15] In conjunction with Mr. Sladen, in the Palæontologica Indica, and again in his "Revision of the Genera" (p. 108),[16] Prof. Duncan followed the same course. But though Prof. Duncan's work first established a satisfactory classification of this group of Echinoids, and clearly demonstrated the fundamental differences between the pits of *Temnechinus* and *Temnopleurus*, it is possible that he and his colleague have under-estimated the differences between the typical species of *Temnechinus* and those for which *Opechinus* was founded. Prof. von Zittel has preferred to retain both genera;[17] and as the Crag and the living Atlantic species form one closely-allied group, while the Oriental species form another, it seems to me that this is the wisest course. The differences between the two groups of species may be only due to the disposition of the raised epistromal ribs, but these affect so materially the whole aspect of the tests, and the epistroma plays so prominent a part in the classification of the Glyphocyphinæ that it is convenient to express the differences in this way.

14 Of which *Pleurechinus javanus*, Martin; ("Die Tertiärischichten auf Java," Leiden, 1880, Anhang, p. 2, fig. 1, 1 a and b), is a synonym.

15 "On the genus *Pleurechinus*, L. Ag.; its classification, position, and alliances." Journ. Linn. Soc. Zool. xvi. 1882, p. 449.

16 Ser. xiv. vol. i. pt. 3, fasc. iii. 1884, p. 122.

17 Palæontologie, Bd. 1, lf. 3, 1879, p. 506.

In the "Revision of the Genera," Prof. Duncan includes *Temnechinus* in the sub-family Temnopleurinæ, but I would suggest its transference to the Glyphocyphinæ, owing to the complete absence, at least in the genus as here limited, of the true pits of the former sub-family. In the paper on *Pleurechinus* Prof. Duncan says emphatically that "*Temnechinus*, Forbes, has no true pits," and again that in it "none of the remarkable minute structures of the test of *Temnopleurus* are present."[18] But, as Prof. Duncan shows in his diagnoses of the two sub-families in the Revision, it is the presence of true pits that is characteristic of the Temnopleurinæ; the possible occasional presence of a pit that is somewhat deep but does not undermine the test not being sufficient to outweigh the identity in structure between the fossettes of *Temnechinus* and those of *Glyphocyphus* or *Zeuglopleurus*.

Temnechinus woodi (L. Agassiz), 1846.

Temnopleurus woodii, L. Agassiz, 1846. Ann. Sci. Nat. Zool. (3) vi. p. 360.
" *excavatus*, Wood (name only), Morris, 1843. Cat. Brit. Foss. p. 60.
Temnechinus excavatus, E. Forbes, 1852. Brit. Tert. Ech. pp. 6, 7, pl. 1, f. 1.
" " " " Dec. Geol. Surv. No. iv. pl. 1.
" " Desor, 1856. Syn. Ech. Foss. p. 106, pl. xvii. f. 6, 7.
" " Gregory. 1891. Ann. Rep. Yorksh. Phil. Soc. p. 38.
" *melocactus*, E. Forbes, 1852. Brit. Tert. Ech. pp. 7, 8, pl. i. f. 2.
" " " " Dec. Geol. Surv. No. iv. pl. i. p. 4.
" " Desor, 1856. Syn. Ech. Foss. p. 106.
" *turbinatus*, E. Forbes, 1852. Brit. Tert. Ech. pp. 8, 9, pl. iii. f. 11.
" " " " Dec. Geol. Surv. No. iv. pl. i. p. 4.
" " Desor, 1856. Syn. Ech. Foss. p. 106.
Temnopleurus, sp. S. V. Wood, MS. 1843. Morris' Cat. Brit. Foss. p. 60.
Records.—**35**, p. 90; **31**, p. 368; **32**, p. 50; **38**, pl. xv. f. 14; **39**, p. 283. fig. 6, p. 40.

Distribution.—Coralline Crag; Orford, Ramsholt, Sutton, Waldingfield. Red Crag; Boyton, Butley, Foxhall, Sudbourn, Sutton, Waldringfield, Woodbridge.

The "*Marsupial Pouches.*"

The majority of the Crag Temnechini are marked by a series of five depressions at the summits of the interradii, and these are connected by a circular depression which surrounds the apical disc; in these depressions the epistromal ridges are not developed, so that the fossettes ("sutural pits" of Forbes) are confluent. In other forms these depressions were absent and the sutural pits separate over the whole test, and these forms were at the same time much higher. The former set Prof. Forbes named *Temnechinus excavatus* (a name, however, anticipated by *T. woodi* [L. Ag.]) and the latter *T. melocactus*. Forbes gave no suggestion as to the possible nature of these depressions, the first light upon this

18 Journ. Linn. Soc. Zool. xvi. p. 454.

subject being given by M. de Loriol, who described and figured a specimen of *Tripneustes variegatus*, from Mauritius, with a similar series of structures, and this specimen, it is interesting to note, is very much depressed in its general form. Prof. F. Jeffrey Bell has kindly shown me a series of similar specimens of the same species in the British Museum Collection. There can be no doubt that the differences in this case are not of specific value, and, though the Crag specimens are far more regularly affected than those from Mauritius, it is probable that they are due to the same cause. This is rendered still more likely by the discovery of a similar series of depressions in some specimens of *Echinus henslowi* from the Red Crag. As to the cause of the depressions there is no very definite information; but as the specimens of *Tripneustes variegatus* in this condition do not seem uncommon it is to be hoped that one will be dissected, and the regularity of the depressions in the Crag specimens renders it in the highest degree improbable that they are pathological malformations. As they occur on the interradii, just below the openings of the genital glands, it is probable that they are marsupial pouches, such as occur in some Spatangoids (see, *e.g.*, the remarks on *Schizaster d'urbani*, Forbes, p. 24 *supra*). It should be pointed out that in the previously known cases of the presence of these marsupial pouches, they are always developed on the ambulacra instead of on the interradii, and it might be thought at first that this presented a difficulty to the acceptance of the hypothesis; but it must be remembered that the ambulacral tube feet of the upper surface are of far less value, at least as locomotory organs, to the Spatangoids than to the regular Echinoids; the deep excavation of the areas would not interfere with the branchial function of the tube feet affected in the former, though it would be fatal to their powers of assisting in locomotion in the latter. Hence it is only natural that while in the Spatangoids the marsupial depressions are hollowed out of the ambulacra, in the Temnopleuridæ and Echinidæ the interradii are the regions made to accommodate these structures. The fact that the specimens of the recent *Tripneustes variegatus* with these pouches are less abundant than the normal forms may show either that this species is only exceptionally viviparous, or that the depressions are of a different nature in this case. Their irregularity in the British Museum specimens suggests that possibly they may be mere monstrosities, as M. de Loriol has supposed. If the explanation of these depressions that has been suggested is correct, then *Temnechinus excavatus* is the female, and *Temnechinus melocactus* the male of the species *Temnechinus woodi* (L. Ag.). But Prof. Forbes has noted another difference between the two than those connected with this sexual dimorphism. Thus, he emphasized as one of the important points of distinction between the two species, that in *T. excavatus* the width of an ambulacrum was to that of an interradius as one to two, whereas

in *T. melocactus* the proportion was two to three. But Prof. Forbes knew of only three specimens of the latter; whilst I have measured twenty specimens. There is a range in relative width of the two areas in the *excavatus* type from 5 : 7 to 5 : 11, and in the *melocactus* or male type of from 5 : 75 to 5 : 10. Similarly, though the former is usually more depressed, the proportion of height to diameter varies from 5 : 8 to 5 : 13, while in the latter of from 5 : 7 to 5 : 10. Hence neither of these characters are of any use as a specific distinction, and the two species may be merged.[19]

Prof. Forbes founded two other species, *T. globosus*, for a couple of specimens from Ramsholt, and *T. turbinatus*, for an immature Red Crag form. The latter is certainly only a young *T. woodi* (*i.e.*, *T. melocactus*, Forbes), while the latter is probably distinct. There are two additional specimens of it in the York Museum.

Temnechinus globosus, Forbes, 1852.

Temnechinus globosus, Forbes, 1852. Brit. Tert. Ech. p. 8, pl. i. f. 3.
" " " Dec. Geol. Surv. No. iv. pl. i. p. 4.
" " E. Desor, 1856. Syn. Ech. foss., p. 106.
" " H. Nyst, 1868, in Dewalque Prodr. descr. Géol. Belgique, p. 433.
" " A. Agassiz, 1870. Illustr. Cat. Mus. Comp. Zool., No. vii. pl. viii. fig. 30.

Records.—**35**, p. 90; **31**, p. 368; **32**, p. 50; **39**, p. 283.

Distribution.—British: Coralline Crag, Ramsholt. Belgium—Diestien and Scaldisien (*fide* Nyst: a record never since confirmed).

Type-specimen.—British Museum (E. 583).

Family ECHINIDÆ.

Genus *ECHINUS*, Linn., 1758.

Echinus woodwardi, Desor. 1846.

Echinus (*Psammechinus*) *woodwardi*, Desor, 1846. Cat. Raiss. Ann. Sci. Nat. Zool. (3) vi. p. 369.
Psammechinus woodwardi, Desor, 1856. Syn. Ech. foss. 1856, p. 121.
" " G. Dollfus, 1875. Bull. Soc. Géol. France (3) iii. p. 474.
" " " 1880. Bull. Soc. Géol. Normandie, vi. p. 515.
Echinus lamarcki, Forbes, 1852. Brit. Tert. Ech. pp. 2-4, pl. i. f. 4.
" " Desor, 1856. Syn. Ech. Foss. p. 123.
" " H. Nyst., 1868, in Dewalque. Prod. Descr. Géol. Belgique, p. 433.
" *sp.* H. B. Woodward, 1881. Geol. Norwich, p. 54.
" *sp.* Cl. Reid, 1882. Geol. Cromer, p. 66.

Records.—**35**, p. 79; **31**, p. 368; **32**, p. 49; **38**, xv. f. 16; **37**, p. 123; **39**, p. 283; **30**, p. 39.

19 Since writing the above, I have had the advantage of discussing the matter with Mr. Sladen, whose opinion on the group is of especial value, owing to his experience with the Indian species. I am glad to find that he agrees with me on all three points, *viz.*, that *Opechinus* is generically distinct from *Temnechinus*; that both belong to the Glyphocyphinæ; and that the depressions in *T. woodi* are marsupial.

Distribution.—British: Coralline Crag, Aldborough; Broom Hill; Diss; Gedgrave; Iken; Layston Rd.; Orford; Ramsholt; Sudbourne; Sutton. Red Crag, Butley; Valley Farm, Sudbourne; Walton. Norwich Crag, Lower, Bramerton; Kirkby. Norwich Crag, Upper, Bramerton. Chillesford Crag, Aldeby. Weybourne Crag, E. Runton (Spines, M.P.G.). Foreign: Conglomérat à Térébratules des Bohons, Normandy (*fide* Dollfus).

Remarks.—Desor's original description was meagre, and made no mention of the most reliable character by which the species can be distinguished from its near ally *Echinus esculentus*, Linn., the commonest sea-urchin of British seas. The characteristic Crag species can be recognised by the granule between the pores; and the tuberculation is moreover far more prominent than in the recent form. As there can be no doubt of the species that Desor intended, his name must supersede that of Forbes, though the former failed to recognise the identity of the two species. *E. nysti*, Cott, which was originally referred to this species is unquestionably a very close ally.

Echinus esculentus, Linn., 1758.

Echinus esculentus, Linn., 1758. Syst. Nat. ed. 10, 1758, p. 663.
" " Gregory, 1891. Ann. Rep. Yorksh., Phil. Soc. p. 39.
Echinus sphæra, O. F. Muller, 1776. Prodr. Zool. Danic., p. 235, n. 2845.
[For detailed Synonymy of recent form see A. Agassiz, Revision of Echini Illustr. Cat. Mus. Comp. Zool. No. vii., 1872, p. 122-23].

Distribution in Pliocene.—Coralline Crag, Gedgrave; Orford, St. Erth (?). Chillesford Crag, Sudbourne.

Remarks.—This species is now the commonest Echinoid on the coasts of the west of Europe, but no reliable record has been previously made of its occurrence in deposits older than the Pleistocene. At least two good specimens have been found in the Crags, the one preserved in the Wallace Collection at Ipswich, and the other in the Reed Collection at York. The former is a large specimen, 19 mm. in diameter, and 9·5 mm. in height. There are some plates and spines in the Cambridge Museum from the Crag at St. Erth, labelled as *E. sphæra*; but the plates are oligoporous, and lack the granule between the pores, so that it is quite possible that they belong to this species.

Echinus miliaris, P. L. S. Müller, 1767.

Echinus miliaris, P. L. S. Müller, 1767, in Knorr. Deliciæ Naturæ selectæ, Nuremburg; p. 130, pl. D, f. 1.
" " A. Bell, 1872. Proc. Geol. Assoc. ii. p. 270.
" " C. Reid, 1890. Plioc. Brit. p. 283.
" " J. W. Gregory, 1891. Ann. Rep. Yorksh. Phil. Soc. p. 39.
[For Synonymy, see A. Agassiz, Illustr. Cat. Mus. Comp. Zool., No. vii., 1872, p. 125].

Distribution in Pliocene.—Coralline Crag, Orford. Red Crag, Foxall.

Remarks.—Of this well-known recent species there is a specimen from the Crag in the British Museum, to which it was presented by Mr. Bayfield. It differs from the recent forms in the greater uniformity of the secondary granules, but this is not a character of specific value. The occurrence of the species in the Crags was first noted by Mr. A. Bell. A second specimen belongs to the York Museum.

Echinus woodi, Desor, 1856.

(Pl. II, Fig. 8).

Echinus woodi, Desor, 1856. Syn. Ech. Foss., p. 124.
„ „ Gregory, 1891. Ann. Rep. Yorksh. Phil. Soc. p. 40, pl. i. f. 8.
„ *melo ?* Forbes, 1852. Brit. Tert. Ech. p. 4, pl. iii. f. 10.
„ „ A. and R. Bell, 1872. p. 203.
„ „ C. Reid, 1890. Plioc. Brit. p. 283.

Distribution.—Coralline Crag, Sutton, Orford.

Type-specimen.—British Museum (E. 567).

Forbes figured a fragment from the Wood Collection, which he referred to the characteristic Mediterranean species *E. melo*, Lam. Desor subsequently based a new species on this specimen, as he doubted the correctness of the identification. The species is known only by the type, and a specimen in the York Museum; but as the tuberculation is different to that of the Mediterranean species, Desor's doubts were well justified. I am not aware of any evidence of the existence of *Echinus melo* in the English Pliocene.

Echinus lyelli, Forbes, 1852.

Echinus lyelli, Forbes, 1852. Brit. Tert. Ech. p. 4, pl. i. f. 5.
„ „ Desor, 1856. Syn. Ech. Foss. p. 124.
Records.—**35**, p. 79; **39**, p. 283.

Distribution.—Coralline Crag, Ramsholt.

Type-specimen.—British Museum (E. 580).

Remarks.—This species is also still known only by the type, and in consequence there is nothing to add to Forbes' description. He remarks that the spines are unknown, but he figures one (fig. 5^e). The tuberculation is very different to that of any other Crag species.

Echinus charlesworthi, Forbes, 1852.

Echinus charlesworthi, Forbes, 1852. Brit. Tert. Ech. p. 5, pl. i. f. 6.
Psammechinus „ Desor, 1856. Syn. Ech. Foss. p. 121.
Arbacia sp. S. V. Wood, MS., 1843. Morris, Cat. Brit. Foss. p. 48.
Records.—**35**, p. 79; **31**, p. 368; **32**, p. 50; **39**, p. 283; **30**, p. 39.

Distribution.—Coralline Crag, Ramsholt, Sutton.

Type-specimen.—British Museum (E. 582).

Remarks.—This is the commonest species of the group of small *Echini* (sub-genus *Psammechinus*) which is such a striking feature in the Pliocene Echinoid fauna. It is allied to *E. monilis*. The tuberculation of this and the next species are well shown diagrammatically, in Forbes' figures.

Echinus henslovi, Forbes, 1852.

(Pl. II, Fig. 2, 3, 4).

Echinus henslovi, Forbes 1852. Brit. Tert. Ech. p. 5, pl. i. f. 7.
„ *henslovi*, Gregory, 1891. Ann. Rep. Yorksh. Phil. Soc., 1890, p. 40, pl. i. figs. 2, 3, 4.
Psammechinus henslovi, Desor, 1856. Syn. Ech. Foss. p. 121.
Records.—**35**, p. 79 ; **47**, p. 31 ; **39**, p. 283.

Distribution.—Red Crag, Walton (fairly common).
Type-specimen.—British Museum (40182).
Remarks.—As already remarked in the notes on *Temnechinus woodi*, the same phenomenon of sexual dimorphism has been discovered in this species. The female has been described and figured in the Rep. Yorksh. Phil. Soc. 1890.

Echinus sphæroideus, (Cott.), 1880.

(Pl. II, Fig. 5, 6).

Psammechinus sphæroideus, Cotteau, 1880. Mém. Acad. roy. Belgique xliii., pp. 20-22, pl. ii. f. 1, 5.
„ „ Mourlon, 1881. Géol. Belgique ii., p. 235.
Echinus „ Nyst. MS. 1868, in Dewalque Prod. descript. géol. Belgique, p. 433.
„ „ Van den Broeck, 1878. Esquisse géol. and pal. des dépôts pliocenes des environs d'Anvers, p. 135.
„ „ J. W. Gregory, 1891. Ann. Rep. Yorksh. Phil. Soc. 1890, p. 41, pl. i. f. 5, 6.

Distribution.—British—Red Crag, Boyton. Belgium—Diestien and Scaldisien.

Echinus paucimiliaris, J. W. Gregory, 1891.

(Pl. II, Fig. 1).

Ann. Rep. Yorksh. Phil. Soc. 1890, p. 39, pl. i. fig. 1.

Distribution.—Red Crag, Butley. York Museum.

[**Echinus nortoni**, A. Bell, MS.

This name was given by Mr. A. Bell to a specimen from the lower part of the Red Crag at Walton, in the Collection of H. Norton, Esq., F.G.S., of Norwich ; it was recorded in Proc. Geol. Ass. ii., 1872, p. 208, but has neither been figured nor described, and the specimen cannot now be traced.]

Family **ECHINOMETRIDÆ.**

Genus *STRONGYLOCENTROTUS*, Brandt, 1834.

Strongylocentrotus drobachiensis (O. F. Müller), 1776.

Echinus drobachiensis, O. F. Müller, 1776. Prodr. Zool. Dan. p. 235.
Strongylocentrotus „ A. Agassiz, 1872. Ill. Cat. Mus. Comp. Zool. vii. pp. 162-3.
Toxopneustes „ L. Agassiz, 1846. Cat. Rais. Ann. Sci. Nat. Zool. (3), vi. p. 367.
Records.—**7**, p. 217; **8** p. 452; **9**, p. 213; **39**, p. 283.

Distribution.—Coralline Crag, Aldborough (Cambridge Museum). Norwich Crag, Suffolk.

The Cambridge Museum possesses a fine specimen of a *Strongylocentrotus*, from the Coralline Crag of Aldborough, which differs from typical specimens of *S. drobachiensis* in having fewer ambulacral granules; but, considering the great variability of this species, it is advisable to include the Crag form within it. The specimen is 65 mm. in diameter and 29 mm. in height. The species is new to the Crag fauna. The specimen which Mr. A. Bell has recorded from the Red Crag of Butley belongs to another genus.

Strongylocentrotus lividus has been recorded from the Chillesford Crag [A. Bell, **9**, p. 215] but I have not been able to verify the record.

Sp. 2. **Strongylocentrotus scaber**, Gregory, 1891,

(Pl. II, Fig. 7.)

(Ann. Rep. Yorksh. Phil. Soc. pp. 41, 42, pl. i. f. 7.)

Distribution.—Coralline Crag, Aldborough.
Type-specimen.—York Museum (Reed Coll.).

Family **FIBULARIIDÆ.**

Genus *ECHINOCYAMUS*, Van Phelsum, 1774.

Echinocyamus pusillus (O. F. Müller), 1776.

Spatangus pusillus, O. F. Müller, 1776. Prod. Zool. Danica, p. 236.
Echinocyamus pusillus, Gray, 1825. Ann. Phil. x. p. 429.
„ „ Forbes, 1852. Brit Tert. Ech. pp. 10, 11. pl. i. f. 8-15.
„ „ Desor, 1857. Syn. Ech. Foss. p. 218.
„ „ H. Nyst. in Dewalque, Prod. descrip. géol. Belgique, p. 433.
Echinocyanus suffolciensis, L. Agassiz, 1841. Mon. Scut. pp. 129-30, pl. xxvii. f. 9-13.
„ „ E. Forbes, 1852. Brit. Tert. Ech. p. 11, pl. i. f. 16.
„ „ Desor, 1857. Syn. Ech. Foss. p. 218.
„ *hispidulus*, E. Forbes, 1852. Brit. Tert. Ech. pp. 11, 12, pl. i. f. 14. a. b. c.
„ „ Desor, 1857. Syn. Ech. Foss. p. 219.

Echinocyanus oviformis, E. Forbes, 1852. Brit. Tert. Ech. p. 12, pl. i. f. 17, 18.
" " Desor, 1857. Syn. Ech. Foss. p. 219.
" *forbesi*, Cotteau, 1880. Mém. cour. Acad. roy. Sci. Belg. xliii. p 42, pl. iii. f. 23-8.

Records.—E. pusillus: **35**, 78; **31**, 371; **37**, 332; H. Nyst. in Dewalque Prod. descrip. géol. Belgique, 433; **8**, 452; **9**, 213, 215; **32**, 62; G. Dollfus, 1880, Bull. Soc. géol. Normandie, vi. p. 519; **49**, 54; **38**, pl. xv. f. 12; **39**, 283; **30**, p. 42.
E. suffolciensis: **35**, 78; **31**, 371; **47**, 31; **32**, 62; **49**, 54; **39**, 283.
E. hispidulus: **35**, 78; **31**, 368; **47**, 31; **32**, 50; **7**, 217; **39**, 283.
E. oviformis: **35**, 78; **31**, 368; **47**, 31; **32**, 50; **7**, 217; **39**, 283.

Pliocene Distribution.—British: Coralline Crag, Orford; Ramsholt; Sutton. Red Crag, Alderton; Butley; Hollesley; Valley Farm, Sudbourne; Sutton; Walton. Norwich Crag, Beccles. Chillesford Crag, Aldeby. Foreign: Diestien and Scaldisien, Belgium. Conglomérat à Térébratules, Gourbesville, Normandy.

Remarks.—Prof. Forbes recorded four species of *Echinocyamus* from the Crag: the old *E. pusillus*, L. Agassiz' *E. suffolciensis*, and two new species. The whole of the types studied by Forbes are now in the British Museum, and a careful examination of these, and of a large series of others from the Crags has suggested that they are all but one species. Prof. Prestwich suggested, in 1871,[20] that *E. suffolciensis* was only a variety of *E. pusillus*, and this seems to be also the case with Forbes' two species. Both *E. oviformis* and *E. hispidulus* are mainly based on the position of the anus, which is a most unreliable character in this group, as it varies so much with age. In *E. oviformis* the anus is inframarginal, and the test very small, both characters suggesting that it is only a young form. In *E. hispidulus* the tuberculation is described as minute; but this feature varies considerably, and in this form is not sufficiently marked to warrant specific separation. This and *E. suffolciensis* seem to be only depressed pentagonal varieties, and a complete series of forms intermediate between them and the normal *E. pusillus* can be easily obtained.

As far as can be judged from the figures and descriptions *E. forbesi*, Cott., may also be included in *E. pusillus*.

Genus *RHYNCHOPYGUS*.

Rhynchopygus woodi (Forbes, 1852).

Echinarachnius woodi, Forbes, 1852. Brit. Tert. Ech. pp. 12, 13, pl. ii. f. 56.
Rhynchopygus woodi, J. W. Gregory, 1890. Geol. Mag. (3) vii. pp. 300-3.
Pourtalesia sp. A. Agassiz, 1883. Mem. Mus. Comp. Zool. x. No. 1, p. 91.
Records.—**35**, p. 78; **9**, p. 197; **39**, p. 283.

Distribution.—Coralline Crag: Layston Road Pit, Aldboro'. Red Crag: Bullock Yard Pit; Walton (?) Suffolk.

Type-specimens.—British Museum (E 602, E 3207).

20 Quart. Journ. Geol. Soc. xxvii. p. 349.

Remarks.—This species was based on a couple of fragments from the Red Crag, which always attracted a good deal of attention, as they obviously belonged to a genus not now living in the British area. Still greater interest was aroused in them by the suggestion of Prof. A. Agassiz, that they were the remains of a Pourtalesian,[21] an opinion more definitely repeated in the Report on the Blake Echini, though Profs. Lovén and Bell had expressed doubts as to its truth.[22]

Another fragment having been found by Mr. W. J. Lewis Abbott, F.G.S., in the Coralline Crag at Aldboro', the present writer was able to demonstrate that the species was one of *Rhynchopygus*.

All the specimens known are in the British Museum (Nat. Hist.).

Genus *ECHINOLAMPAS*, Gray, 1825.

Echinolampas subrostratus, n. sp.

Diagnosis.—Form: ovoid, well rounded at the anterior end, but prolonged into a slight rostrum at the posterior. It is widest at about one-third the length of the test from the posterior end: it thence tapers gently forward till level with the ends of the petals of the anterior ambulacra, when it curves sharply round. In elevation it is seen to be depressed, with tumid margins, especially well rounded at the anterior end. The highest point is slightly behind the centre.

Apical disc: excentric anteriorly.

Ambulacra: the petals are tumid, expanded above the level of the test: they reach nearly to the ambitus. The poriferous areas are of unequal length: in the antero-lateral pair those of the posterior sides are the longest; whilst in the postero-laterals the anterior pair is the longer.

Anus: oval; inframarginal at the end of a slight rostrum.

Mouth: opening in a depression, slightly before the centre. Phyllodes well developed. (A rudimentary perignathic girdle.)

Dimensions.—

	mm.
Length	44
Width at anterior third	31
Width at posterior ,, ...	34
Height	24
Distance of apical disc from anterior margin	19
Ambulacra: length of antero-lateral ...	17
,, width ,, ...	4 5
,, length of postero-lateral ...	22
,, width ,, ...	5

21 Chall. Rep. Zool. iii. No. 1, p. 1881, p. 30.

22 "On Pourtalesia," Kongl. Svensk. Vet. Akad. Handl. (New Ser. xix. No. 7, 1883, (p. 86).

Distribution.—Coralline Crag. Suffolk.

Type-specimen.—British Museum (E 1530).

Remarks.—This species is based on a specimen in the Natural History Museum. As it is completely overgrown by Bryzoza it is impossible to determine the structure of the apical disc or the nature of the tuberculation. The species belongs to the group of which *E. affinis* (Goldf.)[23] is a convenient type. Among the species which are more of the same age, it must be compared with *E. lycopersicus* Guppy, from the Upper Cainozoic of the West Indies. From this, which has been admirably illustrated by M. Cotteau,[24] it may be distinguished by its greater proportional length to breadth, by the greater excentricity of the apical system, and the greater irregularity of the poriferous zones.

Amongst recent Echinolampads it most resembles *E. depressus*, Gray,[25] also from the West Indies. With this it agrees in its elongated form, the less excentricity of the mouth compared with the apical disc, the tendency towards an anal rostrum, and the inequality of the poriferous zones. *E. subrostratus* may be distinguished from this species by the greater breadth of its postero-lateral interradius, by the more advanced position of its apical system, and by the narrowness of the test.

Genus *AGASSIZIA*.

Agassizia æquipetala, n. sp.

(Pl. I, Fig. 7.)

Diagnosis.—Form: of fairly large size; elongated, elliptical, somewhat narrow at posterior end. Seen in elevation it presents on the abactinal side a regularly-rounded but depressed outline; the highest point being slightly behind the apical system.

Apical system: slightly antero-central, ethmolysian, with four large genital pores.

Ambulacra: anterior, flush with the test and with very small pores. The lateral pairs are strongly divergent and very slightly depressed: the pores are large and the petaloid portions extend nearly to the ambitus.

Epistroma: tubercles perforate and non-crenulate, of medium size, uniform, sparsely scattered. Spines: fine, often curved, marked by delicate reticulate ridges.

Arms: high on the truncate posterior margin.

Fascioles and actinal side unknown.

23 Petref. Germ. 1829, p. 134, pl. xlii. f. 6.

24 Ech. Tert. Isles St. Barth. and Anguilla, K. Svens. Vet. Akad. Handl. xiii. No. 6, pl. iii. f. 22-26.

25 Compare with the figures given by A. Agassiz, Blake Echini, Mem. Mus. Comp. x. No. 1, pl. xvi.

Dimensions.—		mm.
Length	... ...	38
Width	... ...	33
Height	... ...(about)	17
Ambulacra : length of antero-lateral	...	15
,, ,, postero-lateral	...	17
,, width of antero-lateral	...	3
,, ,, postero-lateral	...	3

Distribution.—Coralline Crag : Aldboro'.

Type-specimen.—British Museum (33645).

Remarks.—The genus *Agassizia* is not known from modern seas, except in the North American province, where it is represented by a species in the Antillean region, and by another on the west coast. Some fossil species are also known from the West Indian Cainozoics, though the precise horizon of these is as yet uncertain. The European species once attributed to this genus have now been referred elsewhere, and the only previously-recorded evidence of its existence in the Old World is a species from the Egyptian Miocene.[26] The discovery of a true *Agassizia* in the English Pliocenes is therefore an interesting addition to the evidence which connects the Crag Echinoid fauna with that of the present West Indian seas. In spite of the imperfect preservation of the fossil there is no doubt of its generic position ; the fact that, owing to a slight weathering, the fascioles cannot be traced being negative evidence of little value. In regard to its affinities, just as it has been seen that the closest ally of *Rhynchopygus woodi* is the living West Indian *R. caribbearum* (Lam.), so this species most resembles *Agassizia excentrica* from the same area. From this species it can be distinguished by its being more depressed, and especially by the fact that in the Pliocene species the petaloid portions of the ambulacra are nearly equal in length ; whereas in the recent species they are strikingly unequal. The former, moreover, has the summit coincident with the apical disc. The two species agree, however, in the central position of the latter.

A. æquipetala must also be compared with *A. porifera* (Rav.)[27] from South Carolina ; this species may be identical with *A. excentrica*, as suggested by Prof. A. Agassiz,[28] and, if so, the latter name must be abandoned. It differs, however, from the new species in that the ambulacra are depressed, and the shape of the test is very different. *A. æquipetala* also differs from *A. clevei*

26 "*Agassizia zitteli*, Th. Fuchs. Beiträge zur Kentniss der Miocæn Fauna Ægyptens und der libyschen Wüste." Palæontographica xxx. Th. 1, p. 62, pl. vi. f. 5-8.

27 E. Ravenal, Echinidæ, Recent and Fossil of South Carolina. Charlestown, 1848, p. 4 and fig. 5, 6 : and M. Tuomey and F. S. Holmes, "Pleiocene Fossils of S. Carolina." Charlestown. No. 1, 1855, pp. 5, 6, pl. i. f. 5, pl. ii. f. 4.

28 A. Agassiz. Ill. Cat. Mus. Comp. Zool. vii. 1872, p. 353.

Cott.[29] in that in this species the apical disc is excentric posteriorly and the paired ambulacra are consequently very unequal.

GENUS **BRISSUS**, Gray, 1825.

Brissus unicolor (Leske), 1778.

Spatangus brissus, var. *unicolor*, Leske. Addit. Klein. p. 248, pl. xxvi. fig. B.C.
Brissus unicolor, A. Agassiz, 1872. Ill. Cat. Mus. Comp. Zool. No. vii., pp. 97, 357.
" " F. J. Bell, 1879. Proc. Zool. Soc., pp. 249-52.
Brissus scillæ, L Agassiz, 1835 Mém. Soc. Sci. Nat. Neuchâtel i. p. 185.
" " " 1847. Cat. Rais. Ann. Sci. Nat. Zool. (3) viii. p. 13.
" " E. Forbes, 1852. Brit. Tert. Ech. pp. 15, 16, pl. ii. f. 4.
" " E. Forbes, 1856. Dec. Geol. Surv. No. v. pl. x.
" " E. Desor, 1858. Syn. Ech. Foss. p. 403.
Brissus dimidiatus, L. Agassiz, 1847. Ann. Sci. Nat. Zool. (3) viii. p. 13.
" *cylindricus* " " " " " " " "
" *? cordieri* " " " " " " " "
Spatangus carinatus, Lamarck, 1816. Anim. sans. vert. iii. p. 30.
Brissus " J. E. Gray, 1825. Ann. Phil. 1825, p. 431.
Records.—*B. unicolor*, **30**, p. 42; *B. scillæ*, **35**, p. 73; **31**, p. 368; **9**, p. 202; **32**, p. 50; **38**, pl. xv. f. 15; **39**, p. 283.

Distribution in Pliocene.—British: Coralline Crag, Aldborough; Iken; Orford; Ramsholt; Sudbourne. Foreign: Astien; Palermo.

Remarks.—*Brissus scillæ* was a species founded by L. Agassiz on the figure given by Scilla of a Mediterranean specimen.[30] This differed from what was then regarded as the typical *B. carinatus*, Lam., in the vertical border, the flatness of the posterior interradius, and the disposition of the fascioles. The specimen figured by Forbes agreed in these three points with Scilla's figure, so that he adopted Agassiz' name. At the same time he followed the great French echinologist in including in this species Brissi from the Miocene of Malta, *B. tuberculatus*, and *B. imbricatus* Wr.,[31] which are, however, clearly distinct.

Prof. A. Agassiz' knowledge of the earlier literature of the century enabled him to show that his father's species had been anticipated by *B. unicolor*, which dates back to its first post-Linnean definition by Leske in 1778. The relations of this species, and its close ally *Brissus carinatus* (Lam.), were carefully considered by Prof. A. Agassiz in his "Revision,"[32] and he concluded that the two could be distinguished by several characters.

Prof. Jeffrey Bell[33] readvocated the views expressed by Salter[34]

29 G. Cotteau, "Description des Echinides Tertiaires des Isles St. Barthélemy et Anguilla." K. Svensk. Vet. Akad. Handl. xiii. No. 6, 1875, pp. 33, 34, pl. vi. f. 2-10.

30 Scilla. De Corporibus marinis, pl. iv. f. 2, 3.

31 Wright, T., "On the Fossil Echinidæ of Malta." Quart. Journ. Geol. Soc. xx. p. 486, pl. xxii. figs. 1, 2.

32 Ill. Cat. Mus. Comp. Zool. vii. p. 357.

33 Proc. Zool. Soc. 1879, pp. 249-52.

34 Dec. Geol. Surv. No. v. pl. x. p. 2.

in 1855, by urging that the two species should be united, as none of the points relied on for the separation were constant in a large series of specimens; and, moreover, that the most striking difference, *viz.*, that in *B. carinatus* there are two re-entering angles in the course of the fasciole across each anterior interradius, while in *B. unicolor* there is only one, does not hold for single specimens, as in some one side conforms to the *B. carinatus* and the other to the *B. unicolor* type.

M. de Loriol[35] has, however, subsequently thrown the weight of his influence on to the side of the separation of the two species, regarding the presence of a keel in *B. carinatus* as a good distinctive character; whilst a second character he finds in the fact, that in this species the anus is only visible from below, and in *B. unicolor* from above.

The Crag specimens strongly support the views of Salter and Bell. The species is usually very carinate (see, *e.g.*, Dec. Geol. Surv. No. v. pl. x. f. 3), so that, judging by this character, it would go with *B. carinatus;* but the flexure of the fasciole agrees with *B. unicolor*, while the truncation of the posterior margin varies so much that in some cases the anus can be seen from above, and in others it cannot. As, then, the Crag specimens belong to one species by one character, to the other by the second, and to either by the third, the wisest course seems to include them all under the name *B. unicolor*. Salter, it may be remarked, quoted a *B. carinatus* from Mauritius with a posterior border that was almost vertical.

Genus **SPATANGUS.**

Spatangus purpureus, O. F. Müller, 1776.

Spatangus purpureus, O. F. Müller, 1776. Prod. Zool. Dan. p. 236.
„ „ Forbes, 1852. Brit. Tert. Ech. pp. 13, 14, pl. ii. f. 3.
„ „ Desor, 1858. Syn. Ech. Foss. p. 419-20.
„ *reginæ*, Gray, 1851. Ann. Mag. Nat. Hist. (2) vii. p. 130.
„ „ Forbes, 1852. Brit. Tert. Ech. p. 14, pl. ii. f. 2.
„ „ Desor, 1858. Syn. Ech Foss. p. 420.
„ *rhodi?* Cotteau, 1876. Rev. Mag. Zool. (3) iv. pp. 323-5, pl. ii. f. 4.
„ *sp.* J. Morris, 1843. Cat. Brit. Foss. p. 58.
Records.—S. purpureus: **35**, p. 89; **9**, p. 213, 215; **39**, p. 283; **30**, p. 42.
S. reginæ: **35**, p. 89; **31**, p. 368; **32**, p. 50; **39**, p. 283.

Distribution in Pliocene.—British: Coralline Crag, Aldborough; Orford; Ramsholt; St. Erth? Red Crag, Sutton; Walton?; Woodbridge; Chillesford; Loc.? Foreign: Antium; Palermo; Rhodes, &c.

Remarks.—The identification of the species of the genus *Spatangus* is usually somewhat difficult, as it is on a combination of characters rather than on any single feature that any conclusions

35 Catalogue raisonné des Echinodermes recueillis par M. V. de Robillard à l'ile Maurice. Mém. Soc. Phys. Hist. Nat. Genève, xxviii., No. 8, 1883, p. 47.

can be based. When, therefore, the specimens are fragmentary, as, owing to the fragile nature of the tests of these forms, is too often the case, it becomes difficult, if not impossible, to determine the species with certainty. Prof. Forbes referred most of the fragments he studied to *S. purpureus*, but one he identified as *S. regina*, Gray. This species has, however, been merged by "neontologists" in the former, and there seems no reason why the Crag specimens should not share the same fate. *S. grandis*, Forbes; *S. meridionalis*, Risso; and *S. spinossissimus*, Ag. and Desor, may also go to enlarge the Müllerian species, while *S. rhodi*, Cotteau, is very close, if not identical, to some Crag varieties.

Spatangus raschi, Lovén, is, however, clearly distinct, and there are one or two Crag fragments (*e.g.* the actinal half of a small specimen 53 mm. long, by 50 mm. wide, in the Reed Collection at York), which may turn out to belong to this species. But none of the specimens show the whole of the anterior half, so that it is uncertain whether they possessed the steep anterior slope as well as the great height, which are the essential features of *S. raschi*. Until better specimens are known, it seems wisest to leave them all in the one species.

Genus **ECHINOCARDIUM**, Gray, 1825.

Echinocardium cordatum (Penn.), 1777.

Echinus cordatus, T. Pennant, 1777. Brit. Zool. iv. p. 58, pl. xxxiv. f. 75.
Amphidetus sp., J. Morris, 1843. Cat. Brit. Foss. p. 47.
„ *cordatus*, Forbes, 1852. Brit. Tert. Ech. pp. 16, 17, pl. ii. f. 1.
Echinocardium cordatum, Desor, 1858. Syn. Ech. Foss. p. 407.
? Amphidetus sartorii, L. Agassiz, 1847. Ann. Sci. Nat. Zool. (3) viii. p. 12.
Records.—Amphidetus cordatus: **35**, p. 71; **39**, p. 283. *E. cordatum:* **30**, p. 42.

Distribution in Pliocene.—British: Coralline Crag, Boyton (spines); Ramsholt; Sutton. Red Crag, Aldborough Waterworks; Valley Farm, Sudbourne; Sutton (?); Walton; Chillesford Crag; Alderby.

Remarks.—The test of this species is so fragile, that in most localities fragments only have been found; but nevertheless, the tuberculation is so characteristic that these can be safely determined. At Walton some perfect specimens have been found with all the spines attached.

The synonymy of this species is fairly straightforward, provided no attempt be made to introduce pre-Linnean names. If, however, we follow the example of some eminent French palæontologists, as has recently been done in England, and accept the names of Breynius, we must alter both the generic and specific names of this fossil. In 1732 Breynius gave an admirable figure of this Echinoid, and of species belonging to three other genera, and

to this *omnium gatherum* he applied the term, "*Echinospatangus cordiformis*." In his description he first treats of the species under discussion, and calls it "*vulgatissimus*," so that he obviously regarded this as the type. Hence, if the first two words of Breynius' descriptive sentences are to be accepted as names, then clearly *Echinocardium cordatum* must be abandoned in favour of *Echinospatangus cordiformis*, and a fresh name found for the common Lower Cretaceous fossil at present known as such. But these changes, and others that would follow a consistent introduction into modern binomial nomenclature of pre-Linnean terms, need not be made, as in accordance with the British Association rules such names may be allowed to rest undisturbed in their dusty tombs.

Miscellaneous Records.

Diadema? sp., Iron Sandstone. Lenham Wood, **48**, p. 334; **46**, p. 601; **39**, p. 58.
Strongylocentrotus lividus (Müll.). Norwich Crag, **9**, p. 215.

IV.—THE PLEISTOCENE ECHINOIDS.

In Prof. Forbes' Monograph no Pleistocene species were recorded, and our knowledge of them is mainly due to the workers among the Scotch Glacial Deposits. In addition to these there are a few post-Glacial species found in the various raised beaches and the Belfast so-called "Pliocene" clays. The whole of the Pleistocene forms are identical with existing species and they will be fully described by Prof. F. Jeffrey Bell in his forthcoming Catalogue of the British Echinodermata. There are, in addition, a number of derived fragments in various Pleistocene deposits, such as at Copford, but these may be excluded.

A. The Glacial Species.

But for the marine clays associated with the Glacial deposits of the south of Scotland, and especially in the Clyde Valley, the list of Echinoids from this series would be very meagre, and would probably include only *remanié* material. The specimens are fragmentary, but the plates in most cases admit of identification.

ECHINIDÆ.

GENUS *ECHINUS*, Linn. 1758.

SPECIES 1. **Echinus esculentus**, Linn. 1758.

For Synonymy see *ante*, p. 33.
Records.—E. esculentus: **1**, 336 (1).
„ *E. sphæra:* **18**, iii. 124 (2), iv. 44 (3), 133 (4); **45**, 262 (5); **43**, 26 (3).

Distribution.—Scotch Glacial series: Loch Lomond (1); Loch

Gilp (2); Garvel Park, near Greenock (3); Kilchattan, Bute (4); Gourock (5).

[*Echinus norvegicus*. Dub. and Koren, 1846. K. Vetensk, Akad, Handl. 1844 (1846) pp. 268-272, pl. ix. fig. 33-39. This species has been recorded in some manuscript lists, but I have seen no specimens of it from any British deposit.]

SPECIES 2. **Echinus woodwardi**, Desor, 1846.

For Synonymy see *ante*, p. 32.

Distribution.—Mid-Glacial. Hopton, Billockby, and quarter of a mile north of Sockford Hall. Spines, Norwich Museum.

The spines from these localities have probably been derived from the Crags; and the idea of a similar origin for the mollusca of the same beds and of other drifts seems to be steadily gaining ground. The spines at Billockby are accompanied by others of such species as *Cidaris clavigera*, *C. serrifera*, &c., which have unquestionably been derived from the Chalk.

FAMILY **ECHINOMETRIDÆ.**

GENUS *STRONGYLOCENTROTUS*, Brandt. 1834.

Strongylocentrotus dröbachiensis (O. F. Müller).

For Synonymy see *ante*, p. 36.

Records.—*Echinus drobachiensis*—**18**, ii. 282 (1), iii. 117 (2), 124 (3), 323 (4), 326 (5), 328 (6), 330 (7). 333 (8), 340 (9), iv. 44 (10), 133 (11), v. 35 (12); **42**, 296 (13), 308 (14); **45**, 262 (15); **43**, 26 (10).

" *E. (Strongyl.)* " **44**, 270 (16).

" *Echinus*, n sp., **18**, iii. 114, 115, pl. 1 (2).

Distribution.—Crinan (6); Cumbrae College (2); Dalmuir (1); Duntroon (7); East Tarbet, Loch Fyne (4); Garnock Water (13); Garvel Park (10); Gourock (15); Greenock (16); Kilchattan, Bute (11); Kyles of Bute (12); Loch Gilp (3), Misk Pit, near Kilwinning (14); Old Mains, Renfrew (8); Paisley (9); West Tarbet (5).

Messrs. Crosskey and Robertson, after consultation with Prof. Sars, figured some worn plates which they referred to a new species of *Echinus*. On enquiry of Mr. Robertson, he told me that he had since concluded that the plates in question were those of *Strongylocentrotus dröbachiensis;* and, as he has kindly presented the original specimens to the British Museum, he has enabled me to express agreement with this opinion.

FAMILY **SPATANGIDÆ.**

GENUS *ECHINOCARDIUM*, Gray, 1825.

Echinocardium, sp.

Record.—*Amphidotus*, sp., **18**, iv. p. 133.

Distribution.—Kilchattan Tile Works, Bute.

GENUS ? Sp ?

Record.—*Spatangoid*, plates and spines; **45**, 262.

Distribution.—Gourock.

V.—THE POST-GLACIAL.

FAMILY **ECHINIDÆ.**

GENUS *ECHINUS*, Linn. 1758.

Echinus miliaris, P.L.S. Müller, 1771.

For Synonymy see *ante*, p. 33.
Record.—*Echinus lividus*—31. 78.

Distribution.—Pleistocene Clays. Belfast Lough (*e.g.*, Brit. Mus. 56835).

Echinus esculentus, Linn. 1758.

Records—*Echinus sphæra*—40, 199.

Distribution.—Cumbrae.

FAMILY **FIBULARIIDÆ.**

GENUS *ECHINOCYAMUS*, Van Phelsum, 1774.

Echinocyamus pusillus (O. F. Müller), 1776.

For Synonymy see *ante*, p. 36.
Records.—*E. pusillus*, Prestwich, 1878, in Dixon Geol. Sussex, ed. 2 p. 87 (1).
A. Bell, 1878 „ ed. 2, p. 54 (2), 32, 85 (2).

Distribution.—Airsford Pit (1); Waterford Sand Pit, Goodwood Park (1); Mud Deposit, Selsea (2).

FAMILY **SPATANGIDÆ.**

GENUS *SPATANGUS*, O. F. Müller, 1776.

Spatangus purpureus, O. F. Müller, 1776.

For Synonymy see *ante*, p. 42.
Record.—Dixon, 21, ed. 2, p. 54.

Distribution.—Mud Deposit, Selsea.

GENUS *ECHINOCARDIUM*, Gray, 1825.

Record.—*Amphidotus*, sp., 40, 199.

Distribution.—Cumbrae.

VI.—STATISTICAL SUMMARY.

In the following summary species based on spines are excluded, as they afford no basis for real comparison. Some doubtful records in distribution are also omitted.

In Prof. Forbes' Monograph eight species were described from the Eocene. These still stand, with the addition of four new species, and of two species new to England. Of these fourteen species, one comes from the Thanet Sand, five from the

VI.—TABLE OF DISTRIBUTION.

I. EOCENE.

SPECIES.	Author.	Thanet Sands.	LONDON CLAY.						BRACKLESHAM SERIES.			BARTON SERIES.		
			Bognor	Hampstead	Highgate	Pinner	Reading	Sheppey	Alum Bay	Brackles-ham	Stubbington	Alum Bay	Barton	White Cliff Bay
Cælopleurus wetherelli	Fbs.			—	—			—						
„ *dixoni*	Greg.									—				
Echinopedina edwardsi	(Fbs.)									—			?	
Scutellina lenticularis	(Lam.)									—				
Hemiaster bowerbanki	Fbs.						—	—						
„ *prestwichi*...	„							—						
„ *branderi*	„										?		—	
„ *forbesi*	Greg.			—		—		—						
Schizaster d'urbani	Fbs.								—					
„ *corneti*	Cott.	—												
„ *cuneatus*	Greg.		—											
Maretia grignonensis...	(Desmar.)												—	
Euspatangus hastingiæ	Fbs.												—	
„ *excentricus*	Greg.												—	

II. PLIOCENE.

SPECIES.	Author	CORALLINE.										RED CRAG.											NORWICH CRAG.			CHILLESFORD CRAG.	WEYBOURNE CRAG.
		Aldboro	Diss	Gedgrave	Iken	Orford	Ramsholt	Sudbourne	St. Erth	Sutton	Waldringfield	Aldboro'	Alderton	Boyton	Bullock Yd.	Butley	Foxhall	Hollesly	Sudbourne	Sutton	Waldringfield	Walton	Woodbridge	Beccles	Bramerton	Kirkby	Aldeby	E. Runton
Cidaris sp.																											
Temnechinus woodi	(L. Ag.)																										
„ *globosus*	Fbs.																										
Echinus woodwardi	Des.																										
„ *esculentus*	Linn.								?										?								
„ *miliaris*	P. Mull.																										
„ *paucimiliaris* ...	Greg.																										
„ *woodi*	Des.																										
„ *lyelli*	Fbs.																										
„ *charlesworthi* ...	„																										
„ *henslowi*	„																										
„ *sphæroideus*	(Cott.)																										
Strongylocentrotus dröbachiensis	(O.F.M.)																							?			
„ *scaber* ...	Greg.																										
Echinocyamus pusillus ...	(O.F M.)																										
Rhynchopygus woodi	(Fbs.)																					?					
Echinolampas subrostratus ...	Greg.	?																									
Agassizia æquipetala	Greg.																										
Brissus unicolor	(Leske)																										
Spatangus purpureus	O.F.M.								?																		
Echinocardium cordatum ...	(Penn.)																										