XXII.—*The Maltese Fossil Echinoidea, and their Evidence on the Correlation of the Maltese Rocks.* By J. W. GREGORY, B.Sc., F.G.S., F.Z.S., of the British Museum (Nat. Hist.). Communicated by JOHN MURRAY, LL.D. (With Two Plates.)

(Read July 6, 1891.)

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INTRODUCTION.

The rocks which form the Maltese islands have been at various times referred to very different parts of the Cainozoic group. At first they were all assigned to the Eocene, but a further knowledge of their fossils led to the transference of the whole series to the Miocene, in which system they have been included by most English writers. Herr TH. FUCHS, however, who first attempted any precise determination of the horizons of the subdivisions, correlated the Upper Limestone with the Leithakalk * and the Blue Clay with the Schlier,† and included the two lowest beds in the Oligocene. Dr MURRAY, however, in the course of his recent Memoir,‡ has explained the striking palæontological differences between the faunas of the different deposits as due to altered conditions of formation rather than to lapse of time, and seems to follow earlier authors in including the whole series in the Miocene.

The Echinoidea of these deposits were originally described by Dr WRIGHT in 1855,§ with additions and corrections in 1864 ;|| but since that time much work has been done on the allied faunas. Many of the species identified by Dr WRIGHT were only known to

* TH. FUCHS, "Das Alter der Tertiärschichten von Malta," *Sitz. k. k. Ak. Wiss. Wien*, lxx., Abth. 1, 1874, pp. 92-105; "Die Versuche einer Gliederung des unteren Neogen im Gebiete der Mittelmeers," *Zeit. deut. geol. Ges.*, xxxvii., 1885, p. 141.

† TH. FUCHS, "Über den sogenannten 'Badner Tegel' auf Malta," *Sitz. k. k. Ak. Wiss. Wien*, lxxiii., Abth. i., 1876, pp. 67-74, pl. i.

‡ J. MURRAY, "The Maltese Islands, with special reference to their Geological Structure," *Scott. Geogr. Mag.*, vi., 1890, pp. 449-488, pl. i. ii.

§ T. WRIGHT, "On Fossil Echinoderms from the Island of Malta, with Notes on the Stratigraphical Distribution of the Fossil Organisms in the Maltese Beds," *Ann. Mag. Nat. Hist.* (2), xv. pp. 101-127, 175-196, 262-277, pl. iv.-vii. (This paper was also issued in the *Proc. Cotteswold Field Club*, ii., 1855, pp. 55-117, pl. iv.-vii., and some of the species should perhaps really date from that work; but as it happens to make no difference, the more accessible publication only is referred to.)

|| T. WRIGHT, "On the Fossil Echinidae of Malta, with additional Notes on the Miocene Beds of the Island, and the Stratigraphical Distribution of the Species therein, by A. LEITH ADAMS," *Quart. Journ. Geol. Soc.*, xx., 1864, pp. 470-491, pl. xxi. xxii. Professor FORBES had previously published a few lines on the Echinoids, "Report on the Collections of Tertiary Fossils from Malta and Gozo," *Proc. Geol. Soc.*, iv., 1844, pp. 231-232.

him by the meagre descriptions of the *Catalogue Raisonné*, or the indistinct figures of SISMONDA. Hence it is not surprising that in many cases Dr WRIGHT's conception of a species should not have been the same as that of Continental palæontologists. As they had access to the types and enjoyed far greater opportunities for the study of the Oligocene and Miocene Echinoidea than those possessed by Dr WRIGHT, their conclusions have been generally accepted. Additional elements of uncertainty have been introduced into Dr WRIGHT's "Table of the Stratigraphical Distribution of the Echinoderms,"* as it has been found that he included the evidence of specimens sent from Malta, but which had been collected in Sicily and Egypt; and, moreover, it appears probable that many of the identifications upon which that Table was constructed were made by Dr LEITH ADAMS without Dr WRIGHT himself seeing the specimens. Hence a revision of this group of Maltese fossils is now desirable; and an opportunity for this has been afforded by the kindness of J. H. COOKE, Esq., F.G.S., in allowing his large collection of Maltese Echinoderms to be sent to England. As Mr COOKE has preserved the exact horizons of all his specimens, the collection is of especial value. He has further earned the thanks of Echinologists by generously presenting all the new material to the British Museum (Nat. Hist.), where many of Dr WRIGHT's types are now preserved. As it is therefore possible to check the distribution of the species with little chance of positive error, it has been thought advisable to revise the whole group, as by so doing the evidence it affords as to the correlation of the deposits and as to the past physical history of the Mediterranean basin may be more safely discussed. The determination of several doubtful points has been rendered possible by the kindness of the Earl of DUCIE in lending me several of the specimens referred to by Dr WRIGHT. I must also express my best thanks to Sir A. GEIKIE for the loan of and permission to describe some specimens in the Museum of the Geological Survey, to Dr WOODWARD, F.R.S., for allowing me to use some new material in the National Collection, and also to MESSRS W. RUPERT JONES, and BROWN for their kind help when examining the "Leith Adams" collection now in the Museum of the Geological Society.

II. DESCRIPTION OF SPECIES.

Family CIDADRIDÆ.

Genus *Cidaris*, Leske, 1778.

Species 1. *Cidaris melitensis*, Wright, 1855.

Synonymy—

- Cidaris melitensis*, pars T. Wright, 1855, "Foss. Ech. Malta," *Ann. Mag. Nat. Hist.* (2), xv. p. 107, pl. iv. f. 1.
 " " E. Desor, 1858, *Syn. Éch. foss.*, p. 453.
 " " ?A. Gaudry, 1862, *Anim. foss. et Geol. Attique*, Paris, pp. 440, 441, pl. lxiii. f. 10-15,
 " " T. Wright, 1864, *Quart. Journ. Geol. Soc.*, xx. p. 474.

* *Op. cit.*, p. 490.

- Cidaris melitensis*, R. J. L. Guppy, 1866, "Tert. Ech. fr. W. Indies," *Quart. Journ. Geol. Soc.*, xxii. p. 299.
- " " R. Etheridge, 1869, in "Sawkins' Rep. Geol. Jamaica," *Mem. Geol. Surv.*, p. 335.
- " " G. Cotteau, 1875, "Descr. Ech. Tert. St Barth. and Anguilla," *K. Svensk. Vet. Akad. Handl.*, xliii, No. 6, pp. 8-10, pl. i. f. 1-10.
- " " G. Mazzetti, 1879, "Ech. foss. Montese," *Atti Soc. Nat. Modena*, xiii. p. 118.
- " " A. Manzoni, 1880, "Ech. foss. Mol. serp.," *Denk. Ak. Wiss. Wien*, xlii, Abth. 2, p. 186.
- " " A. Manzoni, 1881, "Spugne Mol. mioc. Bolognese," *Atti Soc. Tosc. Sci. Nat.*, v. p. 174.

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Upper Coralline Limestone (common). West Indies—Anguilla Miocene. ? Greece—Munychie (Pliocene), Pireus. Italy—Montese, Modena; Serra di Guidoni, Bologna (*Serpentinosa molassa*).

Remarks.—Specimens of this species are fairly common in the uppermost bed of the Maltese series. Dr WRIGHT referred some plates and spines from the Lower Coralline Limestone to this species, but these are here regarded as a new species, *C. oligocenus*.

Species 2. *Cidaris scillæ*, Wright, 1864.

Cidaris scille, T. Wright, 1864, *Quart. Journ. Geol. Soc.*, xx. p. 474.

Type.—Geol. Soc. Coll.

Distribution.—Malta—Globigerina Limestone.

This species was based by Dr WRIGHT on a specimen now in the collection of the Geological Society, which he identified with the *Cidaris* figured by SCILLA.* This author gives two figures, from the better of which this species is almost certainly distinct. It agrees most closely with *Cidaris adamsi*, Wright, but the miliary region is narrower and the plates larger.

Species 3. *Cidaris avenionensis*, Desmoulins, 1837. Plate I. fig. 1a-c.

Synonymy.—

- Cidaris avenionensis*, Desmoul., 1837, "3^{re} Mém. Ech.," *Actes Soc. Linn. Bordeaux*, ix. pp. 182, 183.
- " " Ag. and Des., 1846, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vi. p. 335.
- " " E. Desor, 1855, *Syn. Ech. foss.*, p. 17, pl. vii. f. 7, 8.
- " " Tournouer, 1868, "Terr. tert. de Rennes et Dinan," *Bull. Soc. géol. France* (2), xxv. p. 381.
- " " Peron, 1868, "Terr. tert. Sud. Corse," *Bull. Soc. géol. France* (2), xxv. p. 672.
- " " J. B. Greppin, 1870, "Descr. géol. Jura Bernois," *Mat. Carte géol. Suisse*, 8^{me} livr. p. 181.
- " " Kaufmann, 1872, "Rigi et Mollasse Gebiet der Mittel Schweiz," *Mat. Carte géol. Suisse*, 11^{me} livr. p. 489.
- " " A. Manzoni, 1873, "Il Monte Titano," *Boll. R. Com. geol. Italia*, iv. p. 17.
- " " Locard, 1873, "Faune terr. tert. Corse," *Bull. Soc. géol. France* (3), i. p. 238.
- " " G. Seguenza, 1873, "Cenni serie terz. di Messina," *Boll. R. Com. geol. Italia*, iv. p. 262.

* *De Corporibus Marinis Lapidescentibus* (1747), ed. 2, 1752, pl. xxiii. xxiv.

- Cidaris avenionensis*, P. de Lorient, 1875, "Ech. tert. Suisse," *Mem. Soc. pal. Suisse*, ii. p. 15, pl. i. f. 8-13.
- " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 235-7, 352, pl. viii. f. 3-7.
- " " ? G. Vasseur, 1881, "Rech. geol. terr. tert. Fr. Occid. I. Bretagne," *Bibl. Écol. Habet. Études*, xxiii., No. 1, p. 375.
- " " Cf. Th. Fuchs, 1883, "Miocæn Fauna Ægyptens," *Palæontogr.*, xxx. Th. ii. p. 64, pl. xxi. f. 9-12.
- " " Bazin, 1884, "Ech. Mioc. moy. Bretagne," *Bull. Soc. géol. France* (3), xii. pp. 35, 36, pl. i. f. 1-14 (var. *sancti-juvati*).
- " " Th. Fuchs, 1885, "Gliederung unt. Neog. Mittelmeers," *Zeit. deut. geol. Ges.*, xxxvii. p. 156.
- " " L. Baldacci, 1886, "Descriz. geol. Sicilia," *Mem. descr. Carta geol. Italia*, i. p. 91.
- Cidaris stemmacantha*, A. Agassiz, 1840, "Ech. Suisses," *Nouv. Mém. Soc. helv. Sci. nat.*, iv. p. 73, pl. xxi. a, f. 4.
- " " A. Agassiz, 1840, *Cat. Ectyp. Ech. Foss. Mus. Neoc.*, p. 10.
- " " G. Mazzetti, 1882, "Ech. foss. Montese," *Ann. Soc. Nat. Modena* (2), xv. p. 112.

Type.—Agassiz's casts, S. 14, S. 22.

Distribution.—Malta—Globigerina Limestone. Brit. Mus., No. 1957, and Geol. Soc. Corsica—Bonifacio (bed, No. 6, "Zone à dents de poissons"). Sicily—(Argille scagliosa Aquitanian), Messina (Langhien). Egypt—Gebel Geneffe; Miocene. Italy—Monte Titano (Aquitanian); Montese (Serpentinosa molassa, Langhien). Switzerland—Ste Croix; La Chaux de Fonds. Molasse (Helvetian). France—Les Angles, Avignon, and St Paul trois Châteaux (Helvetian); St Juvat, Bretagne (Faluns d'Anjou; Upper Helvetian).

Remarks.—Of this species there is a specimen in the British Museum Collection (No. 1957), showing half one sector with a few spines. Of the identification of the species there can be little doubt, though it has not previously been recorded from the island. It differs from *C. adamsi*, Wr., and *C. scillæ*, Wr., by the narrowness of the miliary region; isolated plates have some resemblance to those of *C. melitensis*, Wr., but in the species under discussion there is a greater number of plates in a vertical series, the ambulacra are more sinuous and more granulated; moreover, in *C. melitensis* the height of the plates is more equal to their breadth, and the scrobicular circles are quite distinct. *Cidaris stemmacantha* was based only on spines.

Species 4. *Cidaris adamsi*, Wright, 1864.

Synonymy.—

- Cidaris adamsi*, T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 474-475, pl. xxi. f. 5.
- " " ? I. Cafici, 1880, "Sulla determ. cronol. calcare a selce pir. S. E. Sicilia," *Boll. R. Com. geol. Italia*, xi. p. 501.
- " " Th. Fuchs, 1883, "Miocæn Fauna Ægyptens," *Palæontogr.*, xxx. Th. ii. p. 50.
- " " ? L. Baldacci, 1886, "Descriz. geol. Sicilia," *Mem. descr. Carta geol. Italia*, i. p. 94.

Type.—Brit. Mus., E. 1868.

Distribution.—Malta—Lower Limestone (Tongrian). Sicily—Calcare di Siracusa (Helvetian?). Egypt—Siwah Oasis (Base of Upper Miocene).

Remarks.—This species is sharply marked off from the others by its very wide miliary region, the numerous sharp but small granules of its scrobicular circles, and the coalescence of these circles to a narrow band on the horizontal sutures. It is possible that the specimen found by Baron CAFICI is really one of *C. scillæ*.

Species 5. *Cidaris oligocenus*, n. sp. Plate I., fig. 2-4.

Diagnosis.—Test probably circular; depressed above; turbinate.

Ambulacra very sinuous and narrow; one granule only on each plate, except on a few at the ambitus, which bear a second but much smaller granule.

Interradii: Of large, high plates, 5 or 6 in a vertical series. The scrobicular circles are large, and the tubercles prominent. The scrobicular circles are never quite distinct; near the apical area they fuse to a broad band which separates the two scrobicular areas; but nearer the mouth these areas are confluent. Miliary region narrow. Tubercles perforate and non-crenulate. Spines large, sometimes cyathiform.

Type.—Brit. Mus., E. 3401.

Distribution.—Malta—upper part of Lower Coralline Limestone; Ricasoli. Brit. Mus.; Geol. Soc.; LEITH ADAMS' Coll.

Remarks.—This species belongs to the same group of species as does *C. melitensis*, Wr., from the Upper Coralline Limestone. It clearly differs from this, in that the ambulacra are more sinuous and much narrower. Dr WRIGHT's figure (*Ann.* (2), xv., pl. iv. f. 1, c) shows in his species a series of small granules on each ambulacral plate in addition to the single tubercle of this new species. The narrowness of the miliary region at once separates it from *C. scillæ* and *C. adamsi*. From *C. avenionensis* it may be distinguished by the greater prominence of its scrobicular circles, which are distinct except on the lowest.

I entertain little doubt that this is the species figured by SCILLA in the plates* which Dr WRIGHT quoted as illustrating his species *C. scillæ*. Fortunately, however, Dr WRIGHT's type specimen is preserved in the Museum of the Geological Society, mounted on one of his own tablets, and labelled by himself; the fact that the miliary region was apparently much narrower in the specimen figured by SCILLA, Dr WRIGHT probably attributed to a misrepresentation in the drawing. Now, however, that some plates have been found which agree with those figures, these may be taken as illustrating the new species. Dr WRIGHT's *C. scillæ* may ultimately prove to be only a variety of *C. adamsi*.

* *De Corporibus Marinis Lapid.*, ed. 2, 1852, pl. xxiii. f. 2; pl. xxiii. f. 2; pl. xxiv.

Family ECHINIDÆ.

Genus *Echinus*, Linn., 1758.Species 1. *Echinus duciei*, Wright, 1855.*Synonymy*—

Echinus duciei, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. p. 109, pl. iv. f. 2, a-f.

Psammechinus duciei, Desor, 1856, *Syn. Éch. foss.*, p. 121.

" " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 475.

" " G. Seguenza, 1869, "Posiz. stratig. *Cly. altus*," *Atti Soc. Ital. Sci. Nat.*, xii. p. 658.

" " G. Laube, 1871, "Ech. œsterr.-ung. ober. tert. Ablag.," *Abh. k. k. geol. Reichs.* v. p. 59.

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Upper Coralline Limestone; Garschenthal (second Mediterranean stage, Tortonian). Italy—Pianosa (Tortonian).

Remarks.—In a note by Dr LEITH ADAMS, quoted in Dr WRIGHT's second paper, the absence of this species in the Globigerina Limestone is remarked, and it is recorded in abundance from the Lower Coralline Limestone; these latter specimens, however, belong to a new species, *E. tongrianus*.

Species 2. *Echinus tortonicus*, n. sp. Plate I. fig. 5a-d.

Diagnosis.—Small, circular, very depressed.

Apical disc small; large antero-lateral basals, with a well-marked madreporite on that of the right side. The posterior basals are small. The postero-lateral radials enter the anal ring. One granule on each basal.

Ambulacra: A pair of rows of tubercles in each area; primary tubercles smaller than those of the interradii. A good number of coarse granules down the middle of each area.

Interradii: A vertical row of large primary tubercles down the adambulacral side of each series of plates. Each primary tubercle is surrounded by a circle of granules composed of a horse-shoe-shaped line on the one plate, completed to a circle by a few granules on the lower plate. At the ambitus a large secondary tubercle appears on the inner side of each plate, while a small secondary is developed on the adambulacral side; the latter may be replaced by two coarse granules placed one above the other. The granules are coarse, but sparse.

Dimensions.—Diameter, 20 mm.; height, 6 mm. Ambulacra, width at ambitus, 4.5 mm. Interradii, width at ambitus, 7 mm.

Distribution.—Malta—Upper Coralline Limestone (bed c).

Type.—Brit. Mus., E. 3402.

Remarks.—This species appears to be confined to the upper beds, and the type specimen came from the white limestone at the base of the "Gozo Marble." The prominence of the vertical row of primary tubercles down each side of the interradii gives it a certain resemblance to *Stirechinuss cillæ*, Desmoul. (see p. 627), but from this it is quite distinct. This species may be readily distinguished from *E. duciei*, Wr., which occurs on the same horizon, by the structure of the apical disc and the paucity of primary tubercles. From *E. tongrianus*, to which it is allied by the former character, it may be distinguished by the greater abundance of the tubercles.

The differences in the distribution of the epistroma in the species may be thus diagrammatically expressed (pl. I. f. 5*d*, 6, and 7*d*).

As this species seems to be the representative in the Tortonian of the *E. tongrianus* of the Lower Coralline Limestone, it is named after the horizon of which it is characteristic.

Species 3. *Echinus tongrianus*, n. sp. Plate I. fig. 7*a-d*.

Diagnosis.—Test small, slightly pentagonal, tumid sides; slightly conical.

Apical system small; the antero-lateral basals are large, and push the anus backwards, and exclude the anterior radials from the anal ring. The postero-lateral radials, however, enter the ring.

Ambulacra: The trigeminal arcs are considerably inclined from the vertical. Each area is ornamented by a row of prominent tubercles, practically equal in size to those of the interradii. Miliary granules few.

Interradii: A pair of rows of tubercles down each area; every primary tubercle is surrounded by a scrobicular circle, composed of a crescentic arch, completed adorally by the granules of the adjoining plate. The granules are few in number.

Dimensions.—Diameter, 15 mm.; height, 6 mm.; width of ambulacra at ambitus, 3 mm.; width of interradius at ambitus, 5 mm.

Distribution.—Malta—Oligocene; Scutella, bed of the Lower Coralline Limestone.

Type.—Brit. Mus., E. 3403.

Remarks.—This species may be readily distinguished from specimens of *Echinus duciei*, Wr., by the structure of the apical system (*cf.* WRIGHT, *Ann. Mag. Nat. Hist.* (2), xv., pl. iv. f. 2, *e*), and by the fact that there is but one row of primary tubercles down each side of the interradii. The species is most closely allied to *Echinus biarritzensis* (Cott.) from the "Couches à Rotularia spirulæa"* (*i.e.*, Bartonien) and the "Calcaire à astéries" (Tongrian) of the S. of France. This latter species has, however, a secondary tubercle on each interradiial plate, and the pores are in a nearly vertical row.

* "Echinides fossiles des Pyrénées," *Congrès scientifique de France*, sess. xxviii. t. iii., Bordeaux, 1863, pp. 222, 223, pl. I. f. 5-9.

Species 4. *Echinus hungaricus*, Laube, 1871.*Synonymy*—

Echinus hungaricus, G. C. Laube, 1871, "Ech. œsterr.-ung. ob. Tertiärl.", *Abh. k. k. geol. Reichs.*, v. p. 60, pl. xvi. f. 3.

Echinus hungaricus, A. Manzoni, 1880, "Ech. foss. Plioc.," *Atti Soc. Tosc. Sci. Nat.*, iv. pp. 330, 331.

Type—Mus. Buda-Pest.

Distribution.—Hungary—Bid, near Buda-Pest; Leithakalk. Italy—Castell Arquato (Pliocene). Malta—Coll. Geol. Soc.

Remarks.—The collection of the Geological Society contains a specimen of a large *Echinus* 80 mm. in diameter, which agrees fairly closely with the above species. A series of small specimens presents variations suggesting that Professor LAUBE'S type is only a very large *Echinus duciei*. The increase in the horizontal row of tubercles is just what would be expected in an especially well-developed specimen of that species. The Leithakalk form has more tumid sides and a more regularly distributed granulation, and thus it may be a good species. Further material may, however, not unlikely necessitate the abandonment of this species.

Family FIBULARIIDÆ.

Genus *Echinocyamus*, Van Phelsum, 1774.Species 1. *Echinocyamus studeri* (E. Sismonda), 1842. Plate I. fig. 8-10.*Synonymy*—

Anaster studeri, E. Sismonda, 1842, "Ech. foss. Piem.," *Mem. R. Ac. Sci. Torino* (2), iv. p. 44, pl. ii. f. 8, 9.

Fibularia studeri, E. Sismonda, 1842, "App. Ech. foss. Piem.," *Mem. R. Ac. Sci. Torino* (2), iv. p. 388.

Fibularia studeri, Michelotti, 1847, "Foss. Terr. Mioc. Ital. Sept.," *Natuurk. Verh. Holl. maatsch. Wetensch. Haarlem* (3), iii. St. 2, p. 64, pl. ii. f. 17 and 18.

Echinocyamus studeri, Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vii. p. 142.

" " E. Sismonda, 1847, *Syn. meth. anim. invert. pedem foss.*, p. 8.

" " E. Desor, 1857, *Syn. Éch. foss.*, p. 219.

" " A. Gaudry, 1862, "Géol. île de Chypre," *Mém. Soc. géol. France* (2), vii., No. 3, p. 301.

" " A. Manzoni, 1873, "Il Monte Titano," *Boll. R. Com. geol. Ital.*, iv. p. 20.

Distribution.—Malta—Globigerina Limestone (bed b); Brit. Mus. Italy—Superga, near Turin (Helvetian), and Monte Titano (Aquitania). Cyprus—Mavrospilios; Pliocene (*vide* Gaudry).

Remarks.—Had there been only two or three specimens of this species available for examination, no doubt it would have been made a new species, distinguished from

Echinocyamus studeri by the more posterior position of the mouth and the more anterior position of the anus. But the series sent by Mr COOKE, and the specimens previously in the British Museum, show such variations in character that I can find no constant difference between them and the North Italian form. It differs from *Echinocyamus lebesconti*, BAZIN,* by the inframarginal position of the anus in that species. From some varieties of *E. piriformis*, Ag.,† it would be very difficult to distinguish some specimens of the Maltese species. *Echinocyamus triangularis*, TOURNOUER,‡ is another very close ally.

Family CLYPEASTRIDÆ.

Genus Clypeaster, Lamarck, 1816.

Species 1. *Clypeaster altus*, (Leske), 1778.

Synonymy—

- Echinanthus altus*, Leske, 1778, *Add. Nat. dispos. Ech.*, p. 189, pl. liii. f. 4.
 " " Gmelin, 1790, *Syst. Naturæ*, ed. 13, p. 3187.
Clypeaster " Lamarck, 1816, *Anim. sans Vert.*, iii. p. 14, No. 2.
 " " DeFrance, 1817, *Dict. Sci. Nat.*, ix. p. 449.
 " " Deslongchamps, 1824, *Encycl. méth. Zooph.*, p. 199, pl. cxlvi. f. 1, 2.
 " " Marc. de Serres, 1829, *Géogn. Terr. tert.*, p. 157.
 " " Blainville, 1830, *Dict. Sci. Nat.*, lx. p. 197.
 " " Grateloup, 1836, "Mém. géo.-zool. ours. foss. Dax," *Actes Soc. Linn. Bordeaux*, viii. pp. 143, 144, pl. i. f. 5, 6.
 " " L. Agassiz, 1836, "Prod. Mon. rad.," *Mém. Soc. Sci. Neufchatel*, i. p. 187.
 " " Desmoulins, 1837, "3^{re} Mém. Éch.," *Actes Soc. Linn. Bordeaux*, ix. p. 62.
 " " L. Agassiz, 1840, *Cat. Syst. Ectyp. Ech. Mus. Neoc.*, p. 6.
 " " E. Sismonda, 1842, "Ech. foss. Piemonte," *Mem. R. Ac. Sci. Torino* (2), iv. pp. 38, 39.
 " " E. Sismonda, 1844, "Ech. foss. Nizza," *Mem. R. Ac. Sci. Torino* (2), vi. pp. 386, 387.
 " " E. Sismonda, 1842, *Syn. meth. anim. invert. pedem. foss.*, p. 13.
 " " " 1847, " " " " ed. 2, p. 8.
 " " Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vii. p. 130.
 " " G. Michelotti, 1847, "Foss. Terr. mioc. Ital. Sept.," *Natuurk. Verh. Holl. maatsch. Wetensch. Haarl.* (3), iii. St. 2, p. 65.
 " " E. Requier, 1848, *Cat. coquilles Corse*, p. 95.
 " " A. Aradas, 1850, "Monog. Ech. viv. foss. Sicilia," *Atti Ac. Gioen. Sci. Nat. Catania* (2), vi. pp. 209, 210.
 " " R. A. Philippi, 1851, "Clyp. altus, &c.," *Palæontogr.*, i. p. 323, pl. xxxix.
 " " J. Müller, 1854, "Bau der Ech.," *Abh. k. Ak. Wiss. Berlin* (1853), p. 156.
 " " T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 111-114.

* "Sur les Echinides du Miocène moyen de la Bretagne," *Bull. Soc. géol. France* (3), xii., 1884, pp. 37, 38, pl. iii. f. 1-6.

† See, e.g., that figured by R. TOURNOUER, "Recensement des Échinodermes de l'étage du Calcaire à Astéries dans le S. O. de la France," *Actes Soc. Linn. Bordeaux*, xxvii., 1869, pl. xv. f. 2, c and b.

‡ "Étude sur les fossiles de l'étage tongrien (d'Orbigny) des environs de Rennes en Bretagne," *Bull. Soc. géol. France* (2), vii., 1879, p. 467, pl. x. f. 14.

- Clypeaster altus*, Leymerie and Cotteau, 1856, "Cat. Éch. foss. Pyrénées," *Bull. Soc. géol. France* (2), xiii. p. 329.
- " " G. Meneghini, 1857, *Palæont. île Sardaigne*, p. 532.
- " " E. Desor, 1857, *Syn. Éch. foss.*, p. 240.
- " " H. Michelin, 1861, "Monog. Clypeastres foss.," *Mém. Soc. géol. France* (2), vii., No. 2, pp. 122, 123, pl. xxv. f. a-g.
- " " G. Michelotti, 1861, "Études Mioc. infér. Ital. Sept.," *Natuurk. Verh. Holl. maatsch. Wetensch. Haarl.* (2), xv. p. 24.
- " " G. Cotteau, 1863, "Éch. foss. Pyrén.," *Congrès Scien.*, sess. xxviii., t. iii. pp. 245, 246.
- " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 477.
- " " P. Fischer, 1866 (?), in "Tchihatcheff Asie Mineure," *Paléont.*, p. 308, pl. vii. f. 1.
- " " K. Mayer, 1864, in Hartung, *Geol. Beschr. Madeirâ und Pto Santo*, p. 192.
- " " G. Seguenza, 1869, "Intorno la posizione stratigrafica del *Clypeaster altus*," *Lam. Atti Soc. Ital. Sci. Nat.*, xii. pp. 657-661.
- " " A. Locard, 1873, "Faune Terr. tert. Corse," *Bull. Soc. géol. France* (3), i. p. 239.
- " " A. Quenstedt, 1874, *Petref. Deut. Ech.*, III., p. 534.
- " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 269-273.
- " " C. de Stefani, 1877, "Terr. plioc. et mioc. Toscana," *Boll. R. Com. geol. Ital.*, viii. pp. 393, 394.
- " " G. Seguenza, 1879, "Formaz. Terz. prov. Reggio," *Mem. R. Ac. Lincei* (3), vi. p. 87, pl. viii. f. 17.
- " " G. Bukowski, 1889, "Geol. Bau I. Kasos," *Sitz. k. Ak. Wiss. Wien*, xcviii. Abth. i. p. 664.
- Scutella pyramidalis*, Risso, 1826, *Hist. nat. Eur. merid.*, v. p. 284, pl. vii. f. 35.
- " " Blainville, 1830, *Dict. Sci. Nat.*, lx. p. 202.
- " " H. G. Broun, 1832, *Reisen, Th. II., Über Italien*, p. 641.
- Clypeaster* " H. Michelin (non Risso), 1861, *op. cit.*, p. 124, 125, pl. xxvii.
- " " G. C. Laube, 1871, "Ech. œsterr.-ung. ob. Tertiärlablag.," *Abh. k. k. geol. Reichs.*, v. p. 64.
- " " Th. Fuchs, 1874, *Sitz. k. Ak. Wiss. Wien*, lxx. Abt. i. p. 96.
- " " *pars* G. Seguenza, 1879, *op. cit.* (3), vi. p. 86, pl. ix. f. 1 (p. 54?).
- " *portentosus*, Desmoulins, 1837, *op. cit.*, ix. p. 64.
- " " Dujardin, 1840, in Lamarck, *Anim. sans Vert.*, ed. 2, p. 290.
- " " H. Michelin, 1861, "Mon. Clypeastres foss.," *Mém. Soc. géol. France* (2), vii., No. 2, pp. 125, 126, pl. xxviii.
- " " G. Cotteau, 1863, "Éch. foss. Pyrén.," *Congrès Scien.*, sess. xxviii., t. iii. p. 246.
- " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 478.
- " " G. C. Laube, 1871, "Ech. œsterr.-ung. ob. Tertiärlabl.," *Abh. k. k. geol. Reichs.*, v. p. 64.
- " " G. Seguenza, 1879, *op. cit.*, *Mem. R. Ac. Lincei*, p. 86, pl. ix. f. 3 (var. *elator*).
- " *turritus*, L. Agassiz, 1840, *Cat. Syst. Ectyp. Foss. Ech. Mus. Neoc.*, p. 6.
- " " R. A. Philippi, 1851, *op. cit.*, *Palæontogr.*, i. p. 323, pl. xxxviii.
- " " Desor, 1857, *Syn. Éch. foss.*, p. 240.
- " *alticostatus*, H. Michelin, 1861, *op. cit.*, *Mém. Soc. géol. France* (2), vii., No. 2, pp. 126, 127, pl. xxix.
- " " G. C. Laube, 1871, *op. cit.*, *Abh. k. k. geol. Reichs.*, v. p. 64.
- " " A. Locard, 1873, *op. cit.*, *Bull. Soc. géol. France* (3), i. p. 238.
- " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 274, 275.

- Clypeaster alticostatus*, G. Seguenza, 1879, *op. cit.*, *Mem. R. Ac. Lincei* (3), vi. p. 87.
 „ „ G. Bukowski, 1889, "Geol. Bau I. Kasos," *Sitz. k. Ak. Wiss. Wien*, xcvi. Ab. i. p. 664.
 „ *agassizi*, E. Sismonda, 1844, "Ech. foss. Nizza," *Mem. R. Ac. Sci. Torino* (2), vi. pp. 388, 389, pl. ii. f. 5-7.
 „ *insignis*, G. Seguenza, 1879, *op. cit.*, *Mem. R. Ac. Lincei* (3), vi. p. 87, pl. ix. f. 2 a, c, d.
 „ „ var. *acuminatus*, 1879, *op. cit.*, *Mem. R. Ac. Lincei* (3), vi. p. 87, pl. iv. f. 2, 2b.

Type.—56, Q. 17.

Distribution.—Malta—Greensand (common), Upper Coralline Limestone; Dingli, La Binjemma, Ghain Toffika. Corsica—Santa Manza, Aleria, &c. France—Dax, Bordeaux, &c. Austria—Eisenstadt (Leithakalk), Raubstallbrunn (2nd Mediteran.-Stufe). Italy—Nice, Superga (near Turin), San Miniato, Reggio, &c. (Helvetian), Dego (?). Sardinia; Sicily; Kasos; Asia Minor; Crete; Madeira; Cordova; Oran.

Remarks.—*Clypeaster altus* was originally figured by SCILLA,* but he gave no adequate description, and simply referred to it as one "in nonnullis aliis echinis petrefactis." The species was first named binomially by LESKE, but as his figure is less satisfactory than that of SCILLA, reference is usually made to the earlier one. Thanks to the clearness of this, there has been but little confusion as to the main type; but as the species is a very variable one, many names have been given to forms which seem to be best included within it. Several of the best marked of these varieties occur at Malta. DESOR, in the *Catalogue raisonné*, briefly diagnosed a species from Taurus and Crete as *C. tauricus*. From this description WRIGHT identified as such a thick pentagonal form from Malta. Having had the opportunity of examining this specimen, through the kindness of the Earl of DUCIE, in whose collection it now is, I have no hesitation in regarding it as only a massive variety of *C. altus*. There is another specimen in the collection of the Geological Society, labelled *C. tauricus*, by Dr WRIGHT; but this lacks the great tumidity of the anterior margin, which seems to be the most important characteristic shown in MICHELIN's fine figure of *C. tauricus*; and this feature is probably only due to the great size of the type specimen.

Far more unlike the typical form are those described as *C. portentosus*, Desml., *C. pyramidalis* (Risso), and *C. turritus*, Ag.; but these all possess the same fundamental characters, and M. COTTEAU has readvanced the view of their specific identity, suggested by AGASSIZ and DESOR in 1847. A collection in the Museum of Practical Geology contains a fine series of these forms, and a gradual transition between the extreme types can here be traced. *C. alticostatus*, it seems to me, must necessarily follow, though M. COTTEAU has retained it as distinct. The great thickness of the whole test and the prominence of the ambulacral areas seem to be variations correlative with increase in height.

" The var. *portentosus* is common at Malta; there are several specimens in the Museum

* *De Corporibus Marinis Lapid.*, ed. 2, pl. ix. f. 1, 2.

of Practical Geology, one in that of the Geological Society, and Dr MURRAY has presented one to the British Museum.

Species 2. *Clypeaster marginatus*, Lam. 1816.

Synonymy—

- Clypeaster marginatus*, Lamarck, 1816, *Anim. sans Vert.*, iii. p. 14.
 " " Defrance, 1817, *Dict. Sci. Nat.*, ix. p. 450.
 " " Deslongchamps, 1824, *Encycl. meth. Zooph.*, p. 200.
 " " Marc. de Serres, 1829, *Géogn. Terr. tert.*, p. 157.
 " " Blainville, 1830, *Dict. Sci. Nat.*, lx. pp. 197, 198.
 " " Grateloup, 1836, "Mém. géo.-zool. ours. foss. Dax," *Actes Soc. Linn. Bordeaux*, viii. pp. 142, 143.
 " " L. Agassiz, 1836, "Prod. Mon. Rad.," *Mém. Soc. Neufchatel*, i. p. 187.
 " " C. Desmoulins, 1837, "3^{me} Mém. Éch.," *Actes Soc. Linn. Bordeaux*, ix. p. 64.
 " " L. Agassiz, 1840, *Cat. Syst. Ectyp. Ech. Mus. Neoc.*, p. 6.
 " " Fr. Holl, 1843, *Handb. der Petrefactenkunde*, 2nd ed., iv. p. 383.
 " " L. Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vii. p. 131.
 " " E. Requier, 1848, *Cat. coquilles Corse*, p. 95.
 " " A. Aradas, 1850, "Mon. Ech. viv. foss. Sicilia," *Atti Ac. Gioen. Sci. Nat. Catania* (2), vi. p. 214.
 " " T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 114–116.
 " " Leymerie and Cotteau, 1856, "Cat. Éch. foss. Pyrénées," *Bull. Soc. géol. France* (2), xiii. p. 329.
 " " E. Desor, 1857, *Syn. Éch. foss.*, p. 242.
 " " H. Michelin, 1861, "Mon. Clypeastres foss.," *Mém. Soc. géol. France* (2), vii. No. 2, p. 130, pl. xix. f. 1, a–e.
 " " G. Cotteau, 1863, "Éch. foss. Pyrénées," *Congrès Scien.*, sess. xxviii. t. iii. pp. 246, 247.
 " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 478.
 " " A. Locard, 1873, "Faune Terr. tert. Corse," *Bull. Soc. géol. France* (3), i. p. 238.
 " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 263–5.
 " " var. *tenuipetalus*, G. Seguenza, 1879, "Formaz. Terz. Reggio," *Mem. R. Ac. Lincei* (3), vi. p. 88, pl. x. f. 3.
 " " G. Seguenza, 1879, "Formaz. Terz. Reggio," *Mem. R. Ac. Lincei* (3), vi. p. 133.
 " *tarbellianus*, Grateloup, 1836, *op. cit.*, *Actes Soc. Linn. Bordeaux*, viii. p. 142.
 " " C. Desmoulins, 1837, *op. cit.*, *Actes Soc. Linn. Bordeaux*, ix. p. 64.
 ? *folium*, T. Wright (non Ag.), 1855, *op. cit.*, *Ann. Mag. Nat. Hist.* (2), xv. pp. 116, 117.

Type.—57.

Distribution.—Malta—Greensand; Dingli, Gozo. France—Mimbaste (near Dax), Narosse (Landes), Touraine. Corsica—Bonifacio, Sta Manza (lower beds). Italy—Reggio (Tortonian and Helvetian), Sicily.

Remarks.—*Clypeaster marginatus*, with its flattened pentagonal form, sinuous

margin, and large anus, is an easily recognised species. In its young stages it is liable to confusion with *C. folium*, Agassiz, the type of which came from Palermo. Dr WRIGHT recorded this latter species from Malta, on the strength of a specimen in the Earl of DUCIE's collection: it was probably a young form of this species. In the collection of the Geological Society there are four Clypeasters which enable the young stages of *C. altus* and *C. marginatus* to be compared. The two largest specimens are of almost the same size, so that the following measurements may be of interest:—

	<i>C. altus</i> ,	<i>C. marginatus</i> .
Height,	26 mm.	20 mm.
Length,	72 "	72 "
Width,	62 "	67 "
Diameter of anus,	2.5 "	4 (?) "
Shape,	Oval.	Pentagonal; margin more sinuous.

Fam. SCUTELLIDÆ.

Genus *Scutella*, Lamarck, 1816.

Species *Scutella striatula*, Marc. de Serres, 1829.

Synonymy—

- Scutella striatula*, Marc. de Serres, 1829, *Géogn. Terr. tert.*, p. 156.
 " " L. Agassiz, 1836, "Prod. Mon. Rad.," *Mém. Soc. Neufchatel*, i. p. 188.
 " " Desmoulins, 1837, "3^{re} Mém. Éch.," *Actes Soc. Linn. Bordeaux*, viii. p. 80.
 " " L. Agassiz, 1841, *Mon. Scutelles*, p. 81, pl. xviii. f. 1-5.
 " " Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vii. p. 134.
 " " E. Desor, 1857, *Syn. Éch. foss.*, p. 232.
 " " T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 119-120.
 " " R. Tournouer, 1869, "Recensement Échinod. Calcaire à Astéries," *Actes Soc. Linn. Bordeaux*, xxvii. pp. 278-82.
 " " Benoist, 1885, *Descr. géol. paléont. St Estèphe et de Vertheuil*, p. 62.
 " " G. Cotteau, 1891, *Pal. Franc. Terr. tert. Eoc. Éch.*, II. pp. 240-2, pl. cclxii.
Echinodiscus subrotundus, pars Leske, 1778, *Addit.*, p. 206, pl. xlvii. f. 7.
Scutella subrotunda, pars G. Michelotti, 1861, "Études Mioc. inf. Italie Sept.," *Natuurk. Verh. Holl. maatsch. Wetensch. Haarl.* (2), xv. p. 23.
 " " (non Leske), G. Seguenza, 1879, "Formaz. Terz. Reggio," *Mem. R. Ac. Lincei* (3), vi. 42.

Type.—Ag. Casts, S. 78.

Distribution.—Malta—Lower Coralline Limestone (Oligocene). France—Le Tremble, near Bourg (Mid. Eocene). Gironde—Calcaire à Astéries (Tongrian).

Remarks.—SCILLA, in his *De Corporibus Marinis Lapidescentibus*, gave three figures of a *Scutella* which he called "*Echinus melitensis*," &c.; his name was not binomial, and as it is pre-Linnean, his figures are only of value from the use made of them by later writers. LESKE, in his *Additamenta*, gave a new figure of a Maltese *Scutella* which he

named *Echinodiscus subrotundus*, but he included in the same species specimens from France and Switzerland; thus he gave as references paragraph 229 of DAVILA's Catalogue,* in which specimens from *Aunis* with long petals are expressly mentioned, and ANDREA's figure† which is however of a Maltese specimen. LAMARCK followed LESKE, and applied his name to the common French species. MARCELLES DE SERRES was the first to notice the differences between the specimens from the "Calcaire à astéries" and those of higher horizons: he separated the former as a new species *S. striatula*, keeping the name *S. subrotunda* for the long-petalled forms from the Faluns de Léognan. This was rather unfortunate, as had MARCELLES DE SERRES examined LESKE's figures, he would have seen that it was the species from the higher horizon that required a new name, and that his *S. striatula* was identical with the specimen figured by LESKE as *E. subrotunda*. If we take LESKE's figure as the type, then the use of the names of the French species should be reversed; this, however, would lead to sad confusion, as they are both important zonal fossils. But the wisely-drafted rules of the British Association fortunately enable such a step to be avoided, for as LESKE included both species in his name, it was open to MARCELLES DE SERRES to decide for which one the old name should be retained. No doubt great subsequent confusion would have been avoided had DE SERRES retained *S. subrotunda* for the species originally figured as such, but this need not entail any alteration in the customary interpretation, except that the Maltese species must be known in future as *S. striatula*. The range of the two species has been discussed with care by TOURNOUER.‡

Genus *Heteroclypeus*, Cotteau, 1891.

Species 1. *Heteroclypeus hemisphæricus*, n. sp. Plate I. fig. 11a-c.

Diagnosis.—Test large and massive, nearly circular, the antero-posterior diameter very slightly exceeding the transverse. The base is flat, the sides curve gently to the depressed upper surface. In some cases a tendency to become conical.

Ambulacra: Poriferous zones narrow, but the petals extend to the margin, flush with the test.

Apical system central.

Epistroma: Small granules uniformly scattered over the whole test; each of the small tubercles set in a small scrobicule.

Peristome a little before the centre, transverse, surrounded by a prominent floscelle; the bourrelets are high and strong; the doubled pores in the phyllodes distinct.

Perignathic girdle high.

Anus inframarginal, transverse.

* *Catalogue systématique et raisonné des Curiosités*, iii., Paris, 1767, p. 184.

† ANDREA, *Briefe aus der Schweiz nach Hannover geschrieben*, ed. 2, 1776, p. 40, tab. v. f. g.

‡ "Recensement Échinod. du Calc. à Astéries," *Actes Soc. Linn. Bordeaux*, xxvii., 1869, pp. 278-282.

Dimensions—

		<i>H. semiglobus</i> (33, b), Agassiz's Cast.
Length,	155 mm.	137 mm.
Width,	150 "	136 "
Height,	64 "	66 "
Max. width of poriferous zone,	3 "	3 "
" " interporiferous zone,	17 "	8 "
Apical system, distance from anterior margin,	72 "	69 "
Mouth do. do.	72 "	69 "
Anus, width,	14 "	14 "
" length,	7 "	7 "

Distribution.—Malta—Greensand.

Type.—Brit. Mus., 40368.

Remarks.—This species must be compared with the species (*Galerites semiglobus*) so well figured by GRATELOUP,* and which M. COTTEAU has made the type of a new genus, *Heteroclypeus*.†

The Maltese species differs from the type in that in the latter (1) the mouth is either central or has a slight tendency to become posterior; (2) the form is conical; and (3) there is a slight concavity running round the test just above the margin, so that the edge is thin. Of far greater importance is the fact that the poriferous zones are much wider in *H. semiglobus*, and in the same species the petaloid areas close at but a little distance from the ambitus.

The species is common in Malta, and was identified by Dr WRIGHT as *Conoclypeus plagiosomus*, Ag.; but in this species there is no raised perignathic girdle, and hence it belongs to a different group, and is a true Echinolampad. After having had a specimen from Corsica in the British Museum cut to determine this point, I heard from M. COTTEAU that he had no doubt that AGASSIZ's species was a *Palæolampas*.

Species 2. *Heteroclypeus subpentagonalis*, n. sp.

Synonymy—

Conoclypeus plagiosomus, Laube (non Agassiz), 1871, "Ech. œsterr.-ung. ob. Tertiärl.," *Abh. k. k. geol. Reichs.*, v. pp. 67, 68, pl. xix. f. 3.

Galerites conoideus (non Lamarck), A. Aradas, 1850, "Monog. Ech. viv. foss. Sicilia," *Atti Ac. Gioen. Sci. Nat. Catania* (2), vii. pp. 237, 238.

Conoclypeus " " G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 124, pl. ii. f. 1.

Type.—K. k. geol. Reichs. Wien. Coll. Earl of DUCIE.

Distribution.—Malta—Greensand (Helvetian). Italy?—Montese (Serpentinosa

* "Mémoire de Géo-Zoologie sur les Oursins fossiles (Échinides)," *Actes Soc. Linn. Bordeaux*, viii., 1836, pp. 155, 156 Pl. I. fig. 7.

† "Pal. Franç. Terr. Tert.," *Éoc. Éch.*, ii., 1891, p. 194.

molassa). Austria—Gross Höflein, Oedenburg; Zirknitz, Styria, both in Leithakalk (Tortonian).

Remarks.—Professor G. C. LAUBE, trusting to Dr WRIGHT's identification of the last species, figured as *Conoclypeus plagiosomus*, Ag. "Teste Wright," as he cautiously added—a specimen from the Austrian Leithakalk. His figures, which are very expressive, show that while it belongs to the same genus as the last, a new species must be made for it: it is more conical, the apical disc is more anterior, while the shape is pentagonal, and widest near the posterior end. There is a large specimen from the Earl of DUCIE's collection from Malta, which no doubt belongs to this species, though, as the actinal surface is not preserved, this cannot be decided with certainty.

Family ECHINONEIDÆ.

Genus *Amblypygus*.

Species *Amblypygus melitensis*, Wright, 1864.

T. Wright, 1864, "Foss. Echin. Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 482, 483, pl. xxi. f. 3.

Type.—Brit. Mus., E. 1580.

Distribution.—Malta—Upper Coralline Limestone.

Family CASSIDULIDÆ.

Genus *Breynella*, nov. nom.

In 1855, Dr WRIGHT described a species which he named *Pygorhynchus vasali*: in 1864, he gave a couple of figures of the species, and that of the actinal surface showed the absence of the bare median band characteristic of the genus *Pygorhynchus*. M. DESOR had previously transferred the species to the genus then known as *Echinanthus*, and an examination of the specimen shows the correctness of his opinion. This, therefore, compels a consideration of the questions connected with the different use of the term *Echinanthus* in neontology and palæontology. At present many neontologists follow Professor A. AGASSIZ in using *Echinanthus* for the tumid Clypeasters, while most European palæontologists apply it to a genus of Cassiduloidea. The question aptly illustrates the difficulty accompanying the adoption of pre-Linnean genera; *Echinanthus* was first used by BREYNIUS for all Echinoidea with a central or subcentral mouth, and a marginal or submarginal anus. This definition covered the majority of the irregular Echinoidea, and BREYNIUS figures as belonging to the genus a collection of species now distributed among *Echinolampas*, *Pygorhynchus*, and *Cassidulus*, while his references include *Clypeaster* and *Echinanthus* (*sensu* A. AGASSIZ). The name was first used among post-Linnean authors by LESKE, who apparently took as his type his figure of *Echinanthus humilis*—a synonym, at least in the main, of *Echinus rosaceus*,

Linn. *auct.* (the true *Echinus reticulatus*, Linn.),* a reference to which heads his list of literature. LESKE did not, however, limit his genus with much discretion, and his two other species were a large flat-based *Clypeaster* and an *Echinolampas ovatus*. No great stress however was laid by LESKE on his third species, and he clearly established the genus for the Clypeasters. Hence GRAY, in 1825, abandoned the *Clypeaster* of LAMARCK as a synonym of *Echinanthus*, and the latter term was henceforth largely used by zoologists. J. MÜLLER,† in 1854, showed that the genus *Clypeaster* included species of two very different types of internal structure, but he did not follow his discovery to its logical conclusion, and left both groups in the same genus. It was left to Professor A. AGASSIZ‡ to apply MÜLLER'S discovery to the subdivision of the genus. He restricted *Clypeaster* to the flat-based forms, with *C. subdepressus* as the type, while the species with tumid margins he grouped as *Echinanthus*, with *E. reticulatus* (Linn.) (i.e., *E. rosaceus*, Linn., as actually quoted) as the type. According to the 5th of the British Association Rules for Zoological Nomenclature,§ one is bound to follow Professor AGASSIZ, and this one does without reluctance, as his conclusions certainly seem in accordance with common sense. His own type of *Echinanthus* is that which LESKE seems also to have regarded as the most representative of the genus.

In the late Professor DUNCAN'S "Revision of the Genera of Echinoidea" || he has discussed this question at some length, and it is with great regret that I feel obliged to differ from some of his conclusions. Though Professor DUNCAN admitted that BREYNIUS' use of the term *Echinanthus* was so general that "it is, therefore, useless to prolong the discussion regarding his priority" (p. 149), nevertheless, in a later section of the work he retains the name, with BREYNIUS as the author, for a genus of *Cassidulidæ*. As he follows Professor AGASSIZ in restricting *Clypeaster* to the flat-based large forms, he has founded the genus *Diplotheicanthus* for the tumid species, with *Echinus reticulatus*, Linn., as the type, and a second new genus, *Plesianthus*, for *Echinanthus testudinarius*, Gray. Professor A. POMEL, however, had resuscitated the name *Echinorodum* (one of LESKE'S translations of VAN PHELSUM'S terms) ¶ for the tumid Clypeasters. It is synonymous with Professor DUNCAN'S *Diplotheicanthus*, except that it also includes *Plesianthus*. As VAN PHELSUM'S name has been abandoned, M. POMEL was of course within his rights in employing it, and thus it would have precedence over Professor DUNCAN'S name. In fact, if this name were accepted on VAN PHELSUM'S authority, it would be older than LESKE'S *Echinanthus*; but, as Professor LUTKEN** has shown, LESKE, who first gave it

* See LOVEN, "On the Echinoidea described by Linneus," *Bihang Till. K. Sv. Vet. Ak. Handl.*, xiii. Afđ. No. 5, pp. 172-176.

† "Über den Bau der Echinodermen," *Abh. k. Ak. Wiss. Berlin* (1853), 1854, pp. 153-157, pl. v.

‡ "Revision of Echini," *Ill. Cat. Mus. Comp. Zool.*, No. vii., 1872, pp. 306-310.

§ "When the evidence as to the original type of a genus is not perfectly clear and indisputable, then the person who first subdivides the genus may affix the original name to any portion of it at his discretion, and no later author has a right to transfer that name to any other part of the original genus."—*Brit. Ass. Reports* (1842), 1843, p. 111.

|| *Journ. Linn. Soc. Zool.*, xxiii., 1889, pp. 149-151.

¶ *Classification Méthodique et Genera des Échinides vivants et Fossiles*, Paris, 1883, p. 68.

** CHR. F. LUTKEN, *Bidrag til. Kundskab om Echiniderne*, Vid. Medd. 1863, pp. 116, 117.

a Latinised form, did not accept it, and *Echinorodum* therefore dates only from 1883. Both this and *Diplotheicanthus* have therefore to be abandoned in favour of *Echinanthus*, and it becomes necessary to propose a new name for the genus of Cassiduloidea, which palæontologists have long known as such. The name *Breynella* is therefore proposed for it. .

The following table will show the various uses of the names in question :—

LESKE, 1778.	LAMARCK, 1816.	GRAY, 1855.	DESOR, 1857.	A. AGASSIZ, 1872.	POMEL, 1883.	DUNCAN, 1889.	GREGORY, 1891.
				{ Clypeaster.	Clypeaster.	Clypeaster.	Clypeaster.
Echinanthus.	Clypeaster.	Echinanthus.	Clypeaster.	{ Echinanthus.	Echinorodum.	{ Diplotheican- thus.	Echinanthus.
						{ Plesianthus.	Plesianthus.
			Echinanthus.		Echinanthus.	Echinanthus.	Breynella.

Species 1. *Breynella vasalli* (Wright), 1855.

Synonymy—

Pygorhynchus vasalli, T. Wright, 1855, *Ann. Mag. Nat. Hist.* (2), xv. pp. 271, 272.

" " " 1864, *Quart. Journ. Geol. Soc.*, xx. p. 479, pl. xxii. f. 6.

Echinanthus " E. Desor, 1857, *Syn. Ech. foss.*, p. 296.

" *corsicus*, G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyon* (4), ix. pp. 288–290, pl. xi. f. 1–5.

Type.—Brit. Mus., E. 1581.

Distribution.—Malta—Globigerina Limestone. Corsica—Zone à *Pecten bonifaciensis*.

Remarks.—Dr WRIGHT having persisted in retaining his species in the genus *Pygorhynchus*, in spite of M. DESOR's opinion, it was natural that M. COTTEAU should not have been led to compare his *Echinanthus corsicus* more closely with it. The species agrees very closely with M. COTTEAU's careful figures of this species. The absence of the posterior rostrum which overhangs the anus in *Breynella vasalli* would be alone a specific difference between this and *Pygorhynchus collombi*; and the latter is a true *Pygorhynchus*, so that M. COTTEAU's action in making WRIGHT's species a synonym of this cannot be followed.

Species 2. *Breynella equizonata*, n. sp. Plate II. figs. 1a–c.

Diagnosis.—*Form* oval, flattened posteriorly. Actinal surface flat. The upper surface is regularly rounded. The maximum height is a little behind the apical system. The posterior slope is fairly steep to the low vertical posterior margin. The anterior margin is tumid. The posterior interradius is raised into a blunt rounded ridge.

Apical system very excentric anteriorly; four genital pores.

Ambulacra: Petals short but wide; closed below. The poriferous zones on the two sides of each paired ambulacrum are of unequal length. The outer pores are wider

than the inner series; pores conjugate. The antero-lateral petals shorter than the postero-laterals.

Mouth subcentral; floscelle rather indistinct.

Anus small, oval on the low posterior margin.

Dimensions—

Length,	30 mm.	Posterior ambulacrum, number of pores,	
Width,	26 "	ant. zone,	35
Height,	13 "	Posterior ambulacrum, number of pores,	
Height of posterior margin,	4 "	post. zone,	27
Anterior ambulacrum, length,	8 "	Posterior ambulacrum, length,	10·5 mm.
" width,	3 "	" width,	3 "
Anterior ambulacrum, number of pores,		Mouth, distance from anterior margin,	13 "
ant. zone,	20	Apical system, distance from anterior	
Anterior ambulacrum, number of pores,		margin,	11 "
post. zone,	32		

Type.—Brit. Mus., E. 3404.

Distribution.—Pembroke Camp, Malta—Lower Coralline Limestone.

Remarks.—This species differs from *Breynella vasalli* (Wright) in that the apical system is more anterior, the petals shorter, and the highest point is further from the posterior margin. A perhaps more important point is the great inequality in the length of the poriferous zones in the paired ambulacra. In fact, this may be of generic value. Professor F. JEFFREY BELL has established the genus *Palæolampas** for those species of *Echinolampas* in which the poriferous zones on each side of an ambulacrum are equal in length. If this genus be accepted, as has been done, though with a different interpretation, by M. POMEL† and by Professor DUNCAN,‡ then *Breynella* must be subdivided on the same lines. *Breynella* will be the equivalent of *Palæolampas*, and a new division made to correspond with *Echinolampas*. M. DE LORIO, however, has advanced some weighty objections to the adoption of *Palæolampas*, and as I agree with him, I leave those who believe in the value of this character to apply it to the subdivision of *Breynella*, *Catopygus* and other allied forms.

Genus **Studeria**, Duncan, 1889 (as subgenus).

Species **Studeria spratti** (Wright), 1864, n.d.

Var. *elongata*, n. var.

Synonymy—

Pygorhynchus spratti, Wright, 1864 (name and figure only), "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx., pl. xxi. f. 6.

* "On *Palæolampas*, a new genus of the Echinoidea," *Proc. Zool. Soc.*, 1880, pp. 43-49, pl. iv.

† *Classif. meth. et Gen. des Echinides*, p. 62.

‡ Revision, *Journ. Linn. Soc. Zool.*, xxiii. (1889), p. 194.

Distribution.—Malta—Globigerina Limestone (Coll. Brit. Mus.).

Diagnosis.*—*Form* elongated, cylindrical. The test is widest at a third of its length from the posterior margin; the anterior end is well rounded, and from this the lateral margin curves gently to the widest point; thence there is a straight sharp tapering to the narrow flat posterior margin. Seen from the side the anterior margin is tumid, and the posterior is vertical; the greatest height is near the posterior end. The lower margin is wavy.

Apical system excentric anteriorly; three genital pores.

Ambulacra: Petals almost equal; inner pores smaller than the outer. Petals wide; closed below. The lengths of the poriferous zones on each side of the ambulacra are almost equal.

Mouth large; placed before the centre, in a depression. Phyllodes large and wide; bourrelets very slightly raised.

Anus high on the vertical posterior margin; above a slight groove.

Dimensions—

	Brit. Mus., No. 46,450.	Dr Wright's Figures.
Length,	18 mm.	21 mm.
Width,	15 „	15 „
Height, maximum,	11 „	11 „
„ at post margin,	8 „	8 „
Petals, length,	5 „	6 ? „
„ width,	2 „	2 ? „
„ No. of pores,	12-13	...
Apical system, distance from anterior margin,	7 mm.	9 „

Type.—Brit. Mus., 46,450. Dr WRIGHT's type: locality unknown.

Distribution.—Malta—Globigerina Limestone. Marsa Formo, Gozo—Third Nodule Seam.

Remarks.—The British Museum Collection includes two specimens of a species which, though not quite of the same proportions as that figured by Dr WRIGHT as *Pygorhynchus spratti*, may be regarded as belonging to an elongated variety of that species. The whereabouts of the type of the species is not known.

The general form of the specimen, the vertical character of the posterior margin, and the shape of the anus show that this species cannot be retained in the genus *Pygorhynchus*, but must be removed from the alliance of *Cassidulus* to that of *Catopygus*. From the type of this latter alliance this species differs in that the extrapetalous pores are in a single series, and it therefore belongs to Prof. DUNCAN's subgenus *Studeria*. The character seems to me, however, of fully generic value.

Mr COOKE has collected two specimens, which agree closely with those in the British Museum, from the third nodule of the Globigerina Limestone, and the other specimens seem also to have been derived from this horizon.

* Dr WRIGHT having omitted to describe this species, only naming it on the explanation of the plates, a diagnosis is here given.

Genus **Echinolampas**, Gray, 1825.Species 1. **Echinolampas hemisphæricus** (Lamarck), 1816.*Synonymy*—

- Clypeaster hemisphæricus*, Lamarck, 1816, *Anim. sans Vert.*, iii. p. 16.
 " " Defrance, 1817, *Dict. Sci. Nat.*, ix. p. 450.
 " " Deslongchamps, 1824, *Encycl. méth. Zooph.*, p. 201.
 ? " " Marc. de Serres, 1829, *Geog. Terr. tert.*, p. 157.
 ? " " Blainville, 1830, *Dict. Sci. Nat.*, lx. p. 198.
 " " Grateloup, 1836, "Mém. géo.-zool. ours. foss. Dax," *Actes Soc. Linn. Bordeaux*, viii. pp. 146, 147.
Echinolampas " L. Agassiz, 1836, "Prod. Mon. Rad.," *Mem. Soc. Sci. Neufchatel*, i. p. 187.
 " " " 1840, *Cat. Syst. Ectyp. Ech. Mus. Neoc.*, p. 5.
 " " " and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vii. p. 165.
 " " A. Gras, 1848, *Descrip. Oursins foss. Isère*, p. 52.
 " " Requier, 1848, *Cat. coquilles Corse*, p. 96.
 " " A. Gras, 1852, *Cat. corps organisés dep. de l'Isère*, p. 47.
 " " Delbos, 1855, *Essai descrip. géol. bassin de l'Adour*, p. 337.
 " " Leymerie and Cotteau, 1856, "Cat. Éch. foss. Pyrénées," *Bull. Soc. géol. France* (2), xiii. p. 335.
 " " E. Desor, 1857, *Syn. Éch. foss.*, p. 307.
 " " G. Meneghini, 1857, *Paleont. île Sardaigne*, pp. 529, 530.
 " " A. Gaudry, 1862, *Mem. Soc. géol. Fr.* (2) vii. No. 3, p. 301.
 " " G. Cotteau, 1863, "Éch. foss. Pyrénées," *Congrès Scien.*, sess. xxviii, t. iii. p. 268.
 " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 480.
 " " C. Desmoulins, 1869, "Specif. noms légitimes de 6 Echinolampes," *Actes Soc. Linn. Bordeaux*, xxvii. p. 315.
 " " G. Seguenza, 1869, "Posiz. stratig. *Clyp. altus*," *Atti Soc. Ital. Sci. Nat.*, xii. p. 658.
 " " A. Locard, 1873, "Faune Terr. tert. Corse," *Bull. Soc. géol. France* (3), i. p. 238.
 " " A. Manzoni, 1873, "Il Monte Titano," *Boll. R. Com. geol. Italia*, iv. p. 19.
 " " var. *linki*, Goldf., G. C. Laube, 1871, "Ech. œsterr.-ung. ob. Tertiärabl.," *Abh. k. k. geol. Reichs.*, v. p. 66, pl. xviii. f. 3.
 " " var. *rhodensis*, G. C. Laube, 1871, *op. cit.*, p. 66, pl. xviii. f. 2.
 " " var. *linki*, L. Loczy, 1877, "Ech. a. d. Neogen Abl. Weisser Körosthales," *Termsez. Fuz.* I. p. 64.
 " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 281, 282.
 " " G. Seguenza, 1879, "Formaz. Terz. prov. Reggio," *Mem. R. Acc. Lincei* (3), vi. pp. 43, 55.
 " " A. Manzoni, 1880, "Ech. foss. Plioc.," *Atti Soc. Tosc. Sci. Nat.*, iv. pp. 332, 333.
 ? " " A. Manzoni, 1881, "Spugne Mol. mioc. Bolognese," *Atti Soc. Tosc. Sci. Nat.*, v. p. 174.
 ? " " G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 123.

Echinolampas linkii, Goldf., 1829, *Petref. Germ.*, i. lief 2, p. 133, pl. xlii. f. 4.

„ „ Agassiz and Desor, 1847, *op. cit.*, t. vii. p. 166.

„ „ Desor, 1857, *Syn. Éch. foss.*, p. 309.

Clypeaster semiglobus, Grateloup, 1836, *op. cit.*, *Actes Soc. Linn. Bordeaux*, viii. p. 145, pl. i. f. 7.

Type.—No. 34.

Distribution.—Malta—Upper Coralline Limestone, Ghain Toffica, Greensand. Corsica—Cadelabra. France—St Paul trois Chateaux, Couronne Martigues; near l'Isère (Helvetian); Marrossé, Landes (Faluns blues). Italy—Pianosa (? Tortonian); Castel Arquato (Pliocene); ? Montese (Serpentinosa molassa, Langhian) *fidè* Mazzetti. Austria—Kalksburg, Soskut, &c. (Second Mediteran-Stufe). Cyprus. Asia Minor.

Species 2. *Echinolampas manzoni*, n. sp.*

Synonymy.—

Echinolampas richardi (non Desmar), T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 124, 125.

„ *laurillardii* (non Ag. and Des.), T. Wright, 1864, "Foss. Echinod. Malta," *Quart. Journ. Geol. Soc.*, xx. p. 480.

„ *depressa* (non Gray), A. Manzoni, 1880, "Ech. foss. Mol. serp.," *Denk. k. Ak. Wiss. Wien*, xlii. Abt. 2, pp. 186, 187, pl. i. f. 4-15.

„ „ (non Gray), A. Manzoni, 1881, "Spugne Mol. mioc. Bolognese," *Atti Soc. Tosc. Sci. Nat.*, v. p. 174.

„ „ (non Gray), G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 123.

Diagnosis.—*Form* elongated, well rounded in front, produced into a prominent rostrum behind; sides flat. Seen from the side it is high and conical. The apex is coincident with the apical system, and excentric anteriorly. The whole abactinal surface is well rounded and tumid. The lower margin is wavy; the anterior margin is tumid, while the posterior is lower, as from the apical system there is a long gradual backward slope. The actinal surface is concave around the mouth.

Apical system: Excentric anteriorly; four genital pores irregularly arranged.

Ambulacra: The length of the poriferous zones is very unequal in all the ambulacra. In the anterior ambulacrum either the right or left side of the petal may be the longer. In the antero-lateral petal the posterior pair are nearly twice as long as the anterior pair. In the postero-lateral the proportion is reversed.

The petaloid areas are wide, the pores small, round, and nearly equal.

Epistroma: Of uniform tubercles of the ordinary size; evenly scattered.

Mouth subcentral, but a little before the anterior; situated in the centre of a depressed area. Pentagonal in shape; phyllodes broad; bourrelets low and inconspicuous.

Anus oval, transverse; on a conspicuous rostrum.

* M. POMEL suggested this name in 1883 (*Genera*, p. 62), but gave no diagnosis, and appears to have subsequently abandoned it, so it may be dismissed as a list name only.

Dimensions—

	Manzoni, pl. i. f. 4, 5.	B. M., 24,621.
Length,	56 mm.	34 mm.
Width,	51 „	28 „
Height,	35.5 „	17 „
Petal of anterior ambulacrum, length,	22 „	11 „
„ „ width,	6 „	3 „
„ „ No. of pores, right side,	32	...
„ „ „ left side,	22	...
Petal of antero-lateral ambulacrum : length,	21 mm.	10 „
„ „ width,	6 „	3 „
„ „ No. of pores, anterior side,	18	...
„ „ „ posterior side,	30	...
Petal of postero-lateral ambulacrum, length,	21 mm.	11 „
„ „ width,	5 „	3 „
„ „ No. of pores, anterior side,	28	...
„ „ „ posterior side,	16	...
Mouth, distance from anterior margin,	mm.	15 „
Apical system,	27 „	15 „

Type.—Brit. Mus., 24,621; MANZONI's figure (pl. i. f. 14).

Distribution.—Malta—Nodule Seams of Globigerina Limestone. Italy—Serpentina molassa of Serra di Guidoni, Bologna.

Remarks.—This species has been rather unfortunate. MANZONI, impressed by the resemblance of the ambulacra to those of the West Indian *Echinolampas depressa*, Gray,* identified this as the same species. Though it belongs to the same group of species, the two, however, seem clearly distinct, as M. DE LORIO† has already suggested. The species with which it is perhaps most closely allied is the *Echinolampas angulatus*, MÉR., from the same horizon in Tuscany. M. DE LORIO has pointed out the differences between them in his elaborate description of this species.‡ From *E. richardi* and *E. laurillardii*, with which it was confused by Dr WRIGHT, it differs in the great inequality of the poriferous zones. The same character serves to distinguish it from *Echinolampas scutiformis* (Leske).

Species 3. *Echinolampas wrighti*, n. sp.*Synonymy—*

- Echinolampas deshayesi* (non Desor), T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 122–124, pl. iv. f. 3.
 „ *hayesianus* (non Desor), T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 480.

* "Description of two new Genera and some new Species of Scutellidæ and Echinolampidæ in the Collection of the British Museum," *Proc. Zool. Soc.*, xix., 1851, p. 38.

† "Description des Échinides des environs de Camerino (Toscane)," *Mém. Soc. Phys. Hist. Nat. Genève*, xxviii., No. 3, 1882, p. 16.

‡ *Ibid.*, pp. 13–18, pl. ii. iii. f. 1, 2.

Diagnosis.—*Form* oval; slightly flattened at both ends; depressed; highest at the apical system, which is a little excentric anteriorly.

Ambulacra: Petals long, narrow, and tapering gradually at each end. Outer pores small slits; inner, small and round. Poriferous zones almost equal on each side. Ambulacra nearly equal.

Epistroma: Of coarse granules.

Mouth oval; floscelle very imperfectly developed.

Anus large, oval; a slight tendency to form a rostrum.

Dimensions—

Length,	52 mm.	Ambulacra, postero-lateral length,	16 mm.
Width,	46 "	" " width,	5 "
Height,	20.5 "	Apical system, distance from anterior margin,	23 "
Ambulacra, antero-lateral, length,	15 "	Mouth, distance from anterior margin,	23 "
" " width,	4.5 "		

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Greensand (Helvetian).

Remarks.—This species differs from *Echinolampas deshayesi*, Desor, in that the form is much more depressed and the petals are much shorter. Thus in the specimen from Corsica figured by M. COTTEAU, the length, breadth, height as 100:92.4:56.6, whereas in this species the proportion is as 100:90.5:38. The differences in the petals is still more conclusive.

Species 4. *Echinolampas hayesianus*, Desor, 1847.

Synonymy—

- Echinolampas hayesianus*, E. Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vii. p. 166.
 " " E. Desor, 1857, *Syn. Éch. foss.*, p. 308.
 " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 283-4, pl. x. f. 2-4.
 " " G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 123.
Echinanthus " D'Orbigny, 1854, "Note rect. divers genres Éch.," *Rev. Mag. Zool.* (2), vi. p. 24.
 " " D'Orbigny, 1855, *Pal. Franc. Terr. Cret.*, vi. p. 296.
 non *Echinolampas deshayesi*, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 122-4, pl. iv. f. 3.
 " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 480.

Type.—V. 17.

Distribution.—Malta—Globigerina Limestone; Nodule Seam No. 4; Fommer Reh. Corsica—Cadelabra (Helvetian?). Oran and Cartagena. Italy—Montese (Langhian; Serpentinosa molassa; *fide* Mazzetti).

Remarks.—This species is somewhat doubtfully retained in the Maltese fauna on the strength of an imperfect specimen collected by Mr COOKE. It was recorded from Malta by Dr WRIGHT, and M. COTTEAU has accepted the figure given in the *Annals* as correctly identified. Nevertheless, I feel bound to cast Dr WRIGHT's specimen out of this species owing to the great difference in shape and in the length of the petals. In M. COTTEAU's admirable figure the petaloid portions of the ambulacra are seen to reach nearly to the ambitus when the specimen is examined from above, whereas in Dr WRIGHT's figure of the upper surface of his specimen, the petals close at some distance from the margin. Moreover, DESOR in his diagnosis (*Synopsis*, p. 308), says that the species is "renflée, subconique;" Dr WRIGHT describes his specimen as "depressed at the dorsal surface," and "dorsal surface not so elevated as in *E. scutiformis*." One has only to look at the following measurements and compare them with those of *E. scutiformis* (notice especially the specimen described by M. COTTEAU) to see that Dr WRIGHT's specimen is of a different species. As I have failed to identify it with any described form, a new species must be founded to receive it.

Dimensions—

	Length, mm.	Breadth, mm.	Height, mm.
Specimen from Corsica (M. Cotteau),	53	49	30
„ Malta (Cooke's Coll.),	35	30	19
„ „ (<i>E. deshayesi</i> , Wr.),	21	19	8

Species 5. *Echinolampas posterolatus*, n. sp.

Echinolampas scutiformis, T. Wright, 1864 (*non* Leske), "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 481, 482, pl. xxi. f. 4.

Diagnosis.—*Form* elliptical, well rounded; widest at the posterior part of the postero-lateral interradii; highest point coincident with the apical system. The anterior slope is short and curved, the posterior is long and gradual.

Apical system excentric anteriorly; four genital pores.

Ambulacra: Petals long, extending more than two-thirds of the distance to the ambitus. In the anterior the interporiferous area is narrow and the left poriferous zone the shorter. In the antero-lateral petals the interporiferous area is wide, owing to the curve of the posterior poriferous zone; the anterior zone is straighter and shorter. In the postero-lateral pair the anterior poriferous zone is the longer and more curved.

Interradii: The postero-lateral pair occupy an exceptionally large amount of lateral margin. The posterior interradius is depressed.

Mouth in a deep depression, before the centre.

Anus transversely oval, almost marginal.

Dimensions—

Length,	85 mm.	Ambulacra : antero-lateral—length of antero-poriferous zone,	25 mm.
Width,	78 „	Ambulacra : antero-lateral—length of post-poriferous zone,	30 „
Height,	38 „	Ambulacra : antero-lateral—width,	8.5 „
Apical system : distance from anterior margin,	37 „	„ postero-lateral—length of antero-poriferous zone,	39 „
Ambulacra : anterior—length of right poriferous zone,	30 „	„ postero-lateral—length of post-poriferous zone,	34 „
Ambulacra : anterior—length of left poriferous zone,	27 „	„ postero-lateral—width,	8.5 „
Ambulacra : anterior—width,	7 „		

Type.—Brit. Mus., E. 1865.

Distribution.—Malta—Lower Coralline Limestone (Oligocene).

Remarks.—This specimen was well described and figured by Dr WRIGHT in the work above cited; but for reasons already given (p. 609), it is considered by the writer that this is not the same species as that which Continental palæontologists accept as *E. scutiformis*, Leske. It differs from this in the more depressed form, the anterior position of the apical disc, and the absence of the rostrum. From *E. suessi*, Laube,* which has been recorded† on the corresponding horizon in Sicily, it may be readily distinguished by the more central position of the apical disc in Dr LAUBE'S species.

Family SPATANGIDÆ.

Division Prymnadetes.

Genus *Hemiaster*, Desor.Species 1. *Hemiaster cotteaui*, Wright, 1855.*Synonymy*—

- Hemiaster cotteaui*, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 190, 191, pl. vii. f. 2.
 „ „ E. Desor, 1858, *Syn. Éch. foss.*, p. 375.
 „ „ T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 483.
 „ „ G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 117.
Opissaster „ Pomel, 1883, *Classif. meth. et genera Ech.*, p. 38.

Type.—Brit. Mus., E. 1584 (?).

Distribution.—Malta—Globigerina Limestone. Italy—Montese (Serpentinosa molassa).

Remarks.—In retaining this species in *Hemiaster*, it is not intended to suggest that

* "Vicentinische Ech.," *Denksch. k. Ak. Wiss. Wien*, xxix. Abt. ii. p. 24, pl. iv. f. 2.

† L. BALDACCIO, *Mem. desc. Carta geol. Italia*, i. p. 109; A. DE GREGORIO, 1881, *Fauna Argille Scagliosa di Sicilia*, Palermo, p. 11, pl. i. f. 2.

this genus should not be subdivided, though doubt is expressed as to the value of the characters upon which M. POMEL has based his subdivisions. The writer has previously had to refer to this subject,* and is still unable to accept the genera of MM. POMEL and MEUNIER-CHALMAS. In the case of the present species, at least, it is advisable to leave it in *Hemiaster*, as the structure of the apical disc is not known with certainty. A specimen labelled as the type of this species came into the possession of the British Museum in the Wright Collection, but this is more depressed than it should be if Dr WRIGHT's measurements are correct; it, however, agrees closely with the figure. This specimen has distinctly four genital pores.

Dr LEITH ADAMS identified a series of specimens from the Upper and Lower Coralline Limestones, as well as from the Globigerina Limestone, as belonging to this species; but I have only been able to obtain satisfactory evidence of its existence in the last bed.

Species 2. *Hemiaster scillæ*, Wright, 1855.

Synonymy—

Hemiaster scillæ, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 191-193, pl. vii. f. 1.

" " E. Desor, 1858, *Syn. Éch. foss.*, p. 375.

" " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 483, 484.

Opissaster " Pomel, 1883, *Classif. meth. et gen. Ech.*, p. 38.

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Nodule Seams in Globigerina Limestone. Seam No. 4 at Fommer Reh.

Remarks.—The nearest ally of this species appears to be *Hemiaster rotundus*, LAUBE,† and the differences between them have been pointed out by Professor LAUBE. But this latter species Professor POMEL places in *Trachyaster*, and it seems to me that *Hemiaster scillæ* really agrees more with the diagnosis of that genus than with that of *Opissaster*; thus the form is globular instead of cordiform, and there are four (? three) genital pores, and not only a couple. It differs from both genera in the central position of the apical disc. The only specimens in the British Museum Collection do not enable the structure of the apical system to be clearly determined, but it appears to be ethmophract; and hence the species may be allowed to remain in *Hemiaster*.

The largest specimen I have seen is 39 mm. long, 36 mm. broad, and 34 mm. wide.

Species 3. *Hemiaster vadosus*, n. sp. Plate II. fig. 6a-d.

Diagnosis.—*Shape*—Well rounded, but with a slight tendency to become hexagonal.

* "Some Additions to the Australian Tertiary Echinoidea," *Geol. Mag.*, 1890 (3), vii. p. 489; and "A Revision of the British Cainozoic Echinoidea," *Proc. Geol. Ass.*, 1891, xi. p. 21.

† "Ech. oesterr.-ung. ob. Tertiärlabl.," *Abh. k. k. geol. Reichs.*, v., 1871, pp. 68, 69, pl. xviii. f. 6.

There is no notch in the anterior margin. The posterior margin is high, and nearly vertical. The greatest width is at a third of the length of the test from the anterior end. When seen from the side it appears high, and with tumid sides; there is a slight depression below the anus. The highest point is close to the posterior margin; thence there is a gentle slope forward to the steep, well-curved anterior margin.

Ambulacra: Petals broad, short, and but slightly depressed; anterior ambulacrum narrow; the depression disappears where crossed by the fasciole. The antero-lateral ambulacra are broad, shallow, and blunt; one and a half times as long as the postero-lateral. These are curved backward beside the raised posterior interradius.

Interradii: The postero-lateral pair are wide near the apical system; the corresponding portions of the antero-lateral pair are sharp, and bear coarser tubercles than elsewhere.

Fasciole wide, distinct, and fairly regular in its course.

Apical system excentric posteriorly; three genital pores; ethmophract, madreporite small and raised.

Anus elongated, oval; placed above a depression in the posterior margin. Anus just visible from above.

Mouth strongly bilabiate.

Dimensions—

Specimen from Citta Vecchia.			<i>Hemiaster scillæ</i> , from Nodule Bed.	
Length,	.	16.5 mm.	28	mm.
Height,	.	14 "	23	"
Width at anterior third,	.	16 "	25	"
" posterior "	.	14 "	23.5	"
Maximum,	.	...	27*	"
Apical system: distance from anterior margin,	.	9.5 "	13*	"
Mouth: distance from anterior margin,	.	4.5 "	9.5	"
Antero-lateral ambulacrum: length,	.	5 "	10*	"
" " width,	.	2.5 "	4	"
" " number of pores (post. zone),	.	16	...	"
Postero-lateral: length,	.	3 mm.	45*	"
" width,	.	1.5 "	3	"
" number of pores (anterior zone),	.	...	...	"

Distribution.—Malta—Globigerina Limestone (beds *b*, &c.). Citta Vecchia—Nodule Seam No. 4, Fommer Reh.

Remarks.—This pretty little species may be readily distinguished from *Hemiaster scillæ*, which also occurs in the nodule seams, by the fact that in the latter species the apical system is slightly before the centre, the greatest width is across the same point, and that the greatest height is at some distance from the posterior margin. The measurements above quoted, especially those marked by an asterisk, bring out the principal points of difference; but in addition to these there is the greater depression of the petals in *H. scillæ*.

Professor LOVEN has pointed out that the Echinoids that inhabit deep water have their petals less impressed than those that live in shallower seas. If this character can be relied on, then the zones on which this species occurs may mark periods of especial depression in the Maltese area. The species may, in fact, be the deep-sea representative or variety of *H. scillae*. Apart from the other varieties, the difference in the petals seems quite of specific value. The species, however, helps to throw doubt on the advisability of classifying the Spatangoids into those with flush petals (Spatangidæ), and those with depressed petals (Brissidæ), as is at present done by some eminent foreign Echinologists. A character that may be independently acquired at any time by a mere migration to deeper water is not one that can be adopted as a family character.*

This species agrees more closely with *Hemiaster gibbosus*, A. Ag.,† than with any fossil species that I know. It differs from this deep-sea form in that this has the posterior margin more vertical, and the maximum width at the posterior end (see Professor A. AGASSIZ'S figure, No. 6). As the apical disc is ethmophract, it belongs to *Hemiaster* even as limited by M. POMEL.

Genus *Pericosmus*, Agassiz, 1847.

Species 1. *Pericosmus latus* (Agassiz), 1840.

Synonymy—

Micraster latus, L. Agassiz, 1840, *Cat. Syst. Ectyp. Foss. Mus. Neoc.*, p. 2.

Pericosmus (Hemiaster) latus, Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), t. viii. p. 19; t. vi. pl. xvi. f. 1.

" " T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 193-5.

" " E. Desor, 1858, *Syn. Éch. foss.*, p. 396.

" " K. Mayer, 1864, in *Hartung Geol. Beschreib. Madeira und Porto Santo*, p. 193.

" " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 487.

" " A. Locard, 1873, "Faune terr. tert. Corse," *Bull. Soc. géol. France* (3), i. p. 238.

" " A. Manzoni, 1873, "Il Monte Titano," *Boll. R. Com. geol. Italia*, iv. p. 20.

" " G. Cotteau, 1877, "Faune terr. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 316-318.

" " A. Manzoni, 1880, "Ech. foss. Mol. Serp.," *Denk. Ak. Wiss. Wien*, xlii. abt. ii., p. 187, pl. ii. f. 16, 17.

" " G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 115.

* S. LOVEN, "On *Pourtalesia*, a Genus of Echinoidea," *Kongl. Svensk. Vetensk. Ak. Handl.*, n.s., xix., No. 7, 1883, p. 95.

† AL. AGASSIZ, "Preliminary Report on the Echini of the Exploring Expedition of H.M.S. 'Challenger,'" *Proc. Amer. Acad.* (Boston, 1879), xiv. p. 210. AL. AGASSIZ, "Report on the Echinoidea dredged by H.M.S. 'Challenger' during the years 1873-1876," *Challenger Reports, Zool. III.*, No. 1, 1881, pp. 184-186, pl. xx. f. 5-16.

- Pericosmus latus*, Th. Fuchs, 1885, "Gliederung unt. Neog. Gebiete Mittelmeer," *Zeit. deut. geol. Ges.*, xxxvii. p. 141.
- Hemiaster latus*, E. Requier, 1848, *Cat. coquilles île de Corse*, p. 96.
- Schizaster grateloupi*, E. Sismonda, 1842, "Mon. Ech. foss. Piemonte," *Mem. R. Ac. Sci. Torino* (2), iv. p. 25, pl. ii. f. 1, 2.
- " " E. Sismonda, 1842, *Syn. meth. anim. invert. pedem. foss.*, p. 13.
- " " R. Hoernes, 1875, "Fauna Schliers Ottnang," *Jahrb. k. k. geol. Reichs.*, xxv. p. 389.
- " " Th. Fuchs, 1877, "Geol. übers. jung. Tertiärbild. Wiener Beckens," *Zeit. deut. geol. Ges.*, xxix. p. 663.
- Hemiaster* " Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), viii. p. 19.
- " " E. Sismonda, 1847, *Syn. meth. anim. invert. pedem. foss.*, ed. 2, p. 8.
- ? *Brissopsis* " Ippolito Cafici, 1880, *Boll. R. Conn. geol. Italia*, xi. p. 501.
- ? " " L. Baldacci, 1886, "Descriz. geol. Sicilia," *Mem. descr. Carta geol. Italia*, i. p. 94.

Distribution.—Malta—Globigerina Limestone. Corsica—Bonifacio; St Florent. Sicily (?)—Calcare di Siracusa (Tortonian). Italy—Colline de Turin (Helvetian). Nice. Monte Titano (Aquitanian). Bologna; Montese; Serpentinosa molassa (Schlier). Austria—Ottnang (Schlier). Madeira.

Types.—Ag. Casts, M. 23, T. 40.

Remarks.—Owing to the imperfection of much of the material and of SISMONDA's figure of *S. grateloupi*, and the fact that AGASSIZ's cast of this species (T. 40) appears to be missing from the set available for reference, I am only able to express a somewhat doubtful opinion upon this species. M. COTTEAU, who has given the synonymy with care, has followed DESOR in merging SISMONDA's *S. grateloupi* in *Pericosmus latus*; he, however, omits any reference to WRIGHT's *Brissopsis grateloupi*, so that he appears to have suspected that Dr WRIGHT's identification was erroneous. The Maltese specimen is certainly distinct from *P. latus*, by the absence of the notch on the anterior margin.

In the collection of the Geological Society there is a specimen labelled by WRIGHT as *Pericosmus latus*, and it agrees fairly well with the cast of AGASSIZ's type of that species, and with M. COTTEAU's careful description. It differs, however, from the specimens identified by Dr WRIGHT as *Brissopsis* (or *Hemiaster*) *grateloupi* by the prominence of the anterior furrow, the conical form (when seen from the side), and the less-marked divergence of the antero-lateral petals. The high posterior interradius of the *B. grateloupi*, Wr., is the best character for their separation; this species has a form much like that of *Micraster coranguinum*, while *P. latus*, Wr., may be compared with the form of *Epiaster gibbus*. It therefore follows either that WRIGHT was wrong in referring his specimens to *S. grateloupi*, Sism., or else MM. DESOR and COTTEAU were wrong in making this a synonym of *P. latus*. As the English palæontologist did not enjoy the same opportunities for the study of this group as were possessed by these two eminent Continental Echinologists, it seems wisest to accept their decision, especially as there are differences between the Maltese specimens and SISMONDA's figure. A new species, therefore, has to be made for the forms referred by WRIGHT to *Brissopsis grateloupi* (Sism.).

Professor LAUBE has clearly indicated* the differences between *Pericormus altus* and his *P. affinis*, from the Leithakalk.

Species 2. *Pericormus coranguinum*, n. sp. Plate II. figs. 3 and 4a, b.

Synonymy—

Hemiaster grateloupi, T. Wright (*non* Sism.), 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 189, 190.

Brissopsis " T. Wright (*non* Sism.), 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 484.

Diagnosis.—*Form*—Species large, as wide as long, nearly circular, anterior margin not indented by the anterior furrow, or very slightly so. Sides tumid. Seen from the side, the posterior margin is vertical, and from the summit of this the posterior inter-radius rises very slightly to the highest point just behind the apical disc. From this point the anterior slope is somewhat steep to the well-rounded anterior margin. There are a couple of prominent areas in the lower posterior margin, separated by a broad but shallow depression which runs up to the anus.

Ambulacra: Paired petals long, deeply impressed, and subequal in length. The anterior ambulacrum is shallow, and disappears at or is continued only as a very slight depression below the fasciole. The antero-lateral petals are strongly divergent; at the lower ends they curve forward slightly. The posterior pair are a little shorter than the others, and curve back towards the ridge of the posterior interradius.

Apical System central; four genital pores; ethmolysian; the posterior part of the madreporite greatly expanded.

Fascioles: The peripetalous is well marked, but the lateral indistinct.

Anus oval; high on the vertical posterior margin.

Mouth bilabiate; very near to the anterior margin.

Dimensions—

	Type Specimen.		Type Specimen.
Length,	50† mm.	Mouth, distance from anterior margin,	9 mm.
Width,	60† "	Antero-lateral ambulacrum, length, .	23 "
Height,	36 "	" " width, .	4 "
" of posterior margin,	33 "	Postero-lateral ambulacrum, length, .	18 "
Apical system, distance from anterior margin,	29 "	" " width, .	4.5 "

Type.—Brit. Mus., E. 3405.

Distribution.—Malta—Globigerina Limestone.

* "Ech. osterr.-ung. ob. Tertiärl." *Abh. k. k. geol. Reichs.*, v. 1871, p. 68, pl. xvii. f. 2.

† The length has been reduced by crushing; a specimen that better retains its shape gives a length of 62 mm. and a width of 60 mm.

Remarks.—This species differs from *P. affinis*, Laube,* from the Leithakalk, in several characters; in the Austrian species the length is greater than the width, the apical disc is more posterior, and the posterior border overhangs the anus, instead of being vertical. From *P. callosus*, Manz.,† from the Bologna Schlier, and the Molassa serpentinoso of Montese and Africa, it differs in the greater depth of the anterior furrow in *P. callosus*, and in the lower elevation of the posterior margin. The species is in some ways more allied to *P. altus* (Ag.), but the differences between them have been already pointed out.

Genus **Schizaster**, L. Agassiz, 1847.

Species 1. **Schizaster parkinsoni** (Defrance), 1827.

Synonymy—

- Spatangus lacunosus* (pars), Parkinson, 1811, *Organic Remains*, iii. p. 29, pl. iii. f. 12.
 „ *parkinsoni*, Defrance, 1827, *Dict. Sci. Nat.*, t. l. p. 96.
 „ „ C. Desmoulins, 1837, “3^{re} Mém. Ech.,” *Actes Soc. Linn. Bordeaux*, ix. p. 240.
Schizaster „ Agassiz and Desor, 1847, *Cat. rais. Ann. Com. Sci. Nat. Zool.* (3), viii. p. 22.
 „ „ T. Wright, 1855, “Foss. Echinod. Malta,” *Ann. Mag. Nat. Hist.* (2), xv. pp. 266, 268, pl. v. f. 3.
 „ „ G. Meneghini, 1857, *Paléont. île de Sardaigne*, p. 534.
 „ „ E. Desor, 1858, *Syn. Éch. foss.*, p. 392.
 „ „ T. Wright, 1864, “Foss. Echinidæ Malta,” *Quart. Journ. Geol. Soc.*, xx. p. 484.
 „ „ P. Fisher, 1866, in “Tchihatcheff Asie Mineure,” *Paléont.*, p. 310.
 „ „ G. L. Laube, 1871, “Ech. œsterr.-ung. ob. Tertiärlag.,” *Abh. k. k. geol. Reichs.*, v. p. 70.
 „ „ G. Cotteau, 1875, “Descrip. Ech. tert. îles St Barth. et Ang.,” *K. Svensk. Vet. Ak. Handl.*, xiii. No. 6, p. 6.
 „ „ G. Cotteau, 1876, “Ech. tert. îles St Barth. et Ang.,” *Bull. Soc. géol. France*, (3), v. p. 130.
 „ „ G. Cotteau, 1877, “Faune tert. Corse,” *Ann. Soc. Agr. Lyons* (4), ix. p. 303, 304.
 „ cf. „ W. Dames, 1877, “Ech. vicent. veron. Tertiärlag.,” *Palæont.*, xxv. p. 64.
 „ „ G. Cotteau, 1877, “Observ. sur les foss. terr. tert. moy. Corse,” *Bull. Soc. géol. France* (3), vi. p. 74.
 „ „ G. Cotteau, 1882, “Desc. Ech. foss. Cuba,” *Ann. Soc. géol. Belge*, ix. Mem., pp. 38, 41.
 „ *goldfussi*, L. Agassiz, 1840, *Cat. Syst. Ectyp. Ech. foss. Mus. Neoc.*, p. 3.
 „ „ E. Requien, 1848, *Cat. coquilles Corse*, p. 96.
 „ *raulini*, Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), viii. p. 22.

Types.—P. 89. P. 94. R. 23. R. 24. R. 82.

Distribution.—Malta—Globigerina Limestone (especially bed b). Corsica—Sta Manza (Zone à *P. bonifaciensis*). Sardinia—Porto Torres. France—Martigues, St Paul trois Châteaux (Helvetian). Italy—Schio Schichten? (Aquitanian). Austria—Kalksburg,

* LAUBE, *op. cit.*, p. 68, pl. xvii. f. 2.

† A. MANZONI, “Ech. foss. Schlier Bologna,” *Denksch. k. Ak. Wiss. Wien*, xxxix., Abt. 2, p. 155, 156, pl. i. f. 4-7, pl. ii. f. 8, 9.

second Med. Stufe (Tortonian). Asia Minor—Near Tarsus. West Indies—Anguilla, Matanzas, Cuba (Miocene?).

Remarks.—The range in time is therefore from the Aquitanian to the Tortonian, but in the former case the record is given with doubt; and, as Professor LAUBE gives no figure or description, some hesitation may be felt at accepting it in the uppermost division of the Miocene. But from its great range in space, a correspondingly long life must be granted to this species. It is one of the most shallow-water species found in the Globigerina Limestone, and has not yet been recorded from the Italian or Austrian Schlier.

Species 2. *Schizaster desori*, Wright, 1855.

Synonymy—

- Schizaster desori*, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 264, 266, pl. vi. f. 3 a-c.
- " " E. Desor, 1858, *Syn. Éch. foss.*, p. 391.
- " " G. Michelotti, 1861, "Études Mioc. infér. Ital. Sept.," *Natuurk. Verh. Holl. maatsch. Wetensch. Haarl.* (2), xv. p. 22.
- " " G. Meneghini, 1857, *Paléont. Île de Sardaigne*, pp. 534, 535.
- " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 485.
- " " G. C. Laube, 1871, "Ech. oesterr.-ung. ob. Tertiärlag." *Abh. k. k. geol. Reichs.* v. p. 71.
- " " E. Pavay, 1874, "Foss. Seeigel Ofner Mergels," *Magys. Foldt. Intez. Evk.*, iii. p. 282, f. 3, p. 284.
- " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 305, 306.
- " " A. Manzoni, 1880, "Ech. foss. Mol. serp.," *Denk. Ak. Wiss. Wien*, xlii. Abt. 2, pp. 188, 189, 190, pl. iii. f. 29, 30.
- " " Ippolito Cafici, 1880, *Boll. R. Com. geol. Italia*, xi. p. 501.
- " " A. Manzoni, 1880, "Geol. Bologna," *Ann. Soc. Nat. Modena* (2), xiv. p. 22.
- " " G. Mazzetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 116, pl. iii. f. 4.
- " " L. Baldacci, 1886, "Descriz. geol. Sicilia," *Mem. descr. Carta geol. Italia*, i. p. 94.

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Globigerina Limestone. Corsica—Sta Manza. Sardinia. Austria—Baden Tegel (Tortonian). France—Martigues (Helvetian). Sicily—Calcare di Siracusa (Tortonian). Italy—Dego? (Aquitanian). Bologna and Montese, Modena (serpentinosa molassa).

Species 3. *Schizaster scillæ* (Desmoul.), 1837.

Synonymy—

- Spatangus scillæ*, C. Desmoulins, 1837, "3^{re} Mém. Ech.," *Actes Soc. Linn. Bordeaux*, ix. p. 238.
- Schizaster* " Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), viii. p. 21.
- " " Leymerie and Cotteau, 1856, "Cat. Ech. foss. Pyrénées," *Bull. Soc. géol. France* (2), xiii. p. 341.

- Schizaster scillæ*, E. Desor, 1858, *Syn. Éch. foss.*, pp. 389-90.
- " " G. Cotteau, 1862, "Ech. foss. Pyrén.," *Congrès Scient.*, Sess. xxviii., t. iii. p. 294.
- " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 484.
- " " P. Fischer, 1866 (?), in "Tchihatcheff Asie Mineure," *Paléont.*, p. 310.
- " " R. J. L. Guppy, 1866, "Tert. Ech. W. Indies," *Quart. Journ. Geol. Soc.*, xxii. p. 301.
- " " R. Etheridge, 1869, in "Sawkins' Report Geol. Jamaica," *Mem. Geol. Surv.*, p. 335.
- " " G. Seguenza, 1869, "Posiz. stratig. *Olyp. altus*," *Atti Soc. Ital. Sci. Nat.*, xii. p. 658.
- " " G. C. Laube, 1871, "Ech. osterr.-ung. ob. Tertiarabl.," *Abh. k. k. geol. Reichs.*, v. p. 71.
- " " G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 298-301.
- " " G. Cotteau, 1877, "Observ. foss. terr. tert. moy. Corse," *Bull. Soc. géol. France* (3), vi. p. 74.
- " cf. " W. Dames, 1877, "Ech. vicent. veron. Tertiarabl.," *Palæontogr.*, xxv. p. 64.
- " " G. Cotteau, 1880, "Descr. Éch. Tert. Belg.," *Mem. cour. Ac. roy. Brux.*, xliii. fasc. 3, pp. 69-71, pl. vi. f. 3.
- " " G. Cotteau, 1881, "Note sur Éch. terr. tert. Belgique," *Bull. Soc. géol. France* (3), ix. pp. 215-219.
- " " Fr. Coppi, 1881, "Le Marne Turchine ed i loro fossili nel Modenese," *Ann. Soc. Natur. Modena*, xv. fasc. 1, p. 27.
- " " G. Cotteau, "Descr. Ech. foss. île de Cuba," *Ann. Soc. géol. Belgique*, ix. Mém., pp. 35-38.
- " " G. Mazetti, 1882, "Ech. foss. Montese," *Atti Soc. Nat. Modena* (2), xv. p. 116.
- " " E. Fournier, 1890, *Esquisse géol.-envir. Marseille*, p. 93.
- Spatangus lacunosus*, (pars) Leske, 1778, *Addit. Dispos. Echinod.*, p. 227, pl. xxvii. f. a.
- " *canaliferus*, Grateloup, 1836 (non Lamarck), "Mém. géo.-zool. ours. foss. Dax," *Actes Soc. Linn. Bordeaux*, viii. pp. 169, 170.
- Schizaster eurynotus*, L. Agassiz, 1840, *Cat. Syst. Ectyp. Ech. Foss. Mus. Neoc.*, p. 2.
- " " E. Sismonda, 1844, "Ech. foss. Nizza," *Mem. R. Ac. Sci. Torino* (2), vi. pp. 371-2, pl. ii., f. 2-3.
- " " Agassiz and Desor, 1847, *Cat. rais. Ann. Sci. Nat. Zool.* (3), viii. p. 21.
- " " Requien, 1848, *Cat. coquilles Corse*, p. 96.
- " " T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 262-264.
- " " G. Meneghini, 1857, *Pal. île de Sardaigne*, p. 533.
- " " A. Locard, 1867, "Faune terr. tert. Corse," *Bull. Soc. géol. France* (3), i. p. 238.
- " " A. Quenstedt, 1874, *Petrefactenkunde Deutsch Echinod.*, iii. p. 672, pl. lxxxix. f. 6.

Types.—P. 86.

Distribution.—Malta—Upper Coralline Limestone; Dingli; Wardeia. Corsica—Sta Manza, Bonifacio. Sardinia; Morea; Nemroun; Asia Minor. France—Grand Vallat, near Marseilles (Helvetian); Perpignan (Pliocene). Austria—Badener Tegel (Tortonian). Italy—(?) Schio Schichten (Aquitanean); Montese (Langhian, serp. mol.); Pianosa (Tortonian?); Modena (Piacentino); Nice, Asti, Bologna (Pliocene); Palermo? (Astian). Belgium—Antwerp (Scaldisian). West Indies—Anguilla; Cienfuegos, Cuba (? Miocene).

Genus **Prenaster**, Desor, 1853.Species 1. **Prenaster excentricus**, Wright, 1855.*Synonymy*—

Pericosmus excentricus, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 195, 196.

Prenaster ,, T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 487, pl. xxii. f. 3.

Types.— ?

Distribution.—Malta—Upper Coralline Limestone (Brit. Museum).

Genus **Brissus**, Leske, 1778.Species 1. **Brissus latus**, Wright.*Synonymy*—

Brissus latus, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 181, 183, pl. v. f. 1.

 ,, E. Desor, 1858, *Syn. Éch. foss.*, pp. 404, 405.

 ,, T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 485.

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Upper Coralline Limestone (Coll. Brit. Mus., Geol. Soc.).

Species 2. **Brissus imbricatus**, Wright, 1855.*Synonymy*—

Brissus imbricatus, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 183, 184.

 ,, T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 486, pl. xxii. f. 2.

 ,, G. Seguenza, 1869, "Posiz. stratig. *Clyp. altus*," *Atti Soc. Ital. Sci. Nat.*, xii. p. 658.

 ,, *scillæ*, (*pars*) E. Desor, 1858, *Syn. Éch. foss.*, pp. 403, 404.

Type.—Brit. Mus., E. 1867.

Distribution.—Malta—Upper Coralline Limestone. Italy—Pianosa (Tortonian?).

Remarks.—Dr WRIGHT gave no figure of this species with his original diagnosis, and M. DESOR was led by this to suggest that it was a synonym of *Brissus scillæ*, Ag., which is itself a synonym of *B. unicolor*, Leske.* Dr WRIGHT's figure, however, in 1864, shows that the two species are very distinct.

* *Cat. rais. Ann. Sci. Nat. Zool.*, 1847 (3), viii. p. 13.

Species 3. *Brissus tuberculatus*, Wright, 1864.

"Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 486, 487, pl. xxii. f. 1.

Type.—Brit. Mus., E. 1866.

Distribution.—Malta—Upper Coralline Limestone.

Species 4. *Brissus oblongus*, Wright, 1855.*Synonymy*—

Brissus oblongus, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 184, 185, pl. v. f. 2.

,, *cylindricus*? E. Desor, 1858, *Syn. Éch. foss.*, p. 404.

,, " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 485.

Type.—Brit. Mus., E. 1562.

Distribution.—Malta—Upper Coralline Limestone and Globigerina Limestone (?).

Remarks.—DESOR suggested that this species might be the same as *B. cylindricus*, Ag.; but the original diagnosis of this species lays stress upon its resemblance to *B. columbarius* (Lam.),* (*i.e.*, *B. unicolor*, Leske), from which this species is very different. Nevertheless Dr WRIGHT, in his later work on the Maltese Echinoidea, accepted the suggestion unreservedly, and abandoned his species. But as an examination of some Brissi from the Palermo Pliocenes has led me to place *B. cylindricus* as a synonym of *B. unicolor*,† it is necessary to resuscitate Dr WRIGHT's species.

The type specimen has been so thoroughly scraped that no trace of tubercles or fascioles remains; nevertheless the species is well marked. On the evidence of some imperfect specimens of an allied species, Dr WRIGHT recorded *B. cylindricus* from the Lower Limestone. These, however, seem to differ from the typical form in the more anterior position of the mouth. Mr COOKE's collection includes a very typical specimen from the lower horizon of the Upper Limestone at Entaleb.

Species 5. *Brissus depressus*, n. sp. Plate II. fig. 2.

Diagnosis.—*Form* depressed, elliptical; anterior margin thin.

Apical system not very excentric anteriorly; four genital pores.

Antero-lateral ambulacra very divergent, almost in a straight line; in broad but shallow depressions. *Postero-lateral ambulacra* are narrower and more depressed, and curve outwards at the end, though the general direction is backward, close to the keel of the posterior interradius. The anterior ambulacrum is very narrow, slightly raised, and with very small pores.

Interradii: The antero-lateral pair are very wide up to the apical system; the posterior interradius is narrow and keeled.

* Lamarck, *Anim. sans Vert.*, iii., 1816, p. 30.

† "Revision of the British Fossil Cainozoic Echinoidea," *Proc. Geol. Ass.*, xii., 1891, p. 41.

Fascioles: The peripetalous is very sinuous; in the antero-lateral interradii it makes either one or two sharp inward bends. The subanal is distinct.

Mouth close to the anterior margin; strongly bilabiate.

Dimensions (average of five specimens)—

Length,	66 mm.	Postero-lateral ambulacra: length,	19 mm.
Width,	56 "	Distance of apical system from anterior	
Antero-lateral ambulacra: length,	24 "	margin,	27 "

Type.—Brit. Mus., E. 3428.

Distribution.—Malta—Upper Coralline Limestone.

Remarks.—This species differs from *B. oblongus*, Wr., the only form on the island with which it could be confused, by the less excentric position of the apical system and by the much greater width. In the former character it tends to approach *Brissopsis*.

Genus *Metalia*, Gray, 1855.

Species 1. *Metalia melitensis*, n. sp. Plate II. fig. 5 *a-c*.

Diagnosis.—Test of moderate size, thin, depressed; the posterior margin is continued back as a projection overhanging the anus. Actinal surface flat, except for a prominence on the posterior end of the amphisternum. The outline is well rounded, except that the anterior border is flattened and very slightly indented. The highest part of the test is half-way between the apical system and the posterior margin.

Apical System excentric in front.

Ambulacra: Anterior in a very shallow groove; pores small and few. Antero-lateral strongly divergent; pores large and close. Petals closed; interporiferous areas of medium width. Postero-lateral pair much the longer; pores smaller and closer. Interporiferous areas proportionally narrower. Petals almost flush with the test. Of the six pairs of pores on each side of the area within the subanal fasciole, only four pairs are well marked.

Anus transverse.

Mouth rather far from the front margin; semilunar.

Dimensions—

Length,	49 mm.	Antero-lateral ambulacra: length,	15 mm.
Height,	19 "	" " width,	5 "
Width,	45 "	Postero-lateral " length,	17 "
Apical system: distance from anterior		" " width,	6 "
margin,	18 "	Inter-subanal plastron: width,	8 "
Mouth: distance from anterior margin, 12 "		" " height,	14 "

Type.—Coll. Mus. Pract. Geol.

Distribution.—Malta—Globigerina Limestone.

Remarks.—Of the species with which this has been compared it agrees most with

Metalia loveni (Cott.) from the Eocene (?) of St Barthélemy,* but from this it may readily be distinguished by the greater depth of the anterior groove and the absence of the overhanging posterior projection in the West Indian species. In both of these points this new species more resembles *Metalia elegans* (Agassiz, M.S.; † Archiac ‡), but in that species the apical system is more central, and the anterior ambulacra less divergent and equal in length to the posterior pair. Dr DAMES § has described as *Metalia* cfr. *elegans*, Ag., a specimen from the Schio Schichten in which the apical system is excentric anteriorly; this is very likely to be the same as the Maltese species. It occurs on approximately the same horizon, whereas ARCHIAC's type came from a much lower bed. But as Dr DAMES includes among his synonyms the figures of Von SCHAUROTH's || referred to *B. elegans*, they may be distinct. The Coburg type is clearly different, and the figures show it to be a true *Brissopsis* allied to *B. crescenticus*, Wr.; but as Professor DAMES' opinion is not one that can be lightly disregarded, probably the specimen shows structures missed by Von SCHAUROTH's artist.

Genus *Brissopsis*, L. Agassiz, 1840.

Species 1. *Brissopsis duciei*, Wright, 1855.

Synonymy—

- Brissopsis duciei*, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 185-7, pl. vi. f. 1.
 " " E. Desor, 1858, *Syn. Éch. foss.*, p. 379.
 " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, p. 484.

Type.—Coll. Earl of DUCIE.

Distribution.—Malta—Upper Coralline Limestone.

Species 2. *Brissopsis crescenticus*, Wright, 1855.

Synonymy—

- Brissopsis crescenticus*, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. p. 187, pl. vi. f. 2.
Toxobrissus " A. Gaudry, 1862, "Géol. île de Chypre," *Mém. Soc. géol. France* (2), vii. No. 3, p. 300.

* G. COTTEAU, "Ech. tert. Iles St Barthélemy et Anguilla," *K. Svensk. Vet. Ak. Handl.*, xiii., No. 6, 1875, pp. 41, 42, pl. viii. f. 7, 8.

† *Brissopsis elegans*, Agassiz, 1840, *Cat. Syst. Ectyp. Foss. Ech. Neoc.*, p. 3.

‡ D'ARCHIAC, "Description des fossiles du groupe nummulitique recueillis . . . aux environs de Bayonne et de Dax," *Mém. Soc. géol. France* (2), iii., 1850, p. 424, pl. x. f. 20.

§ W. DAMES, "Die Echiniden der vicentinischen und veronesischen Tertiärlagerungen," *Palæontographica*, xxv., 1877, p. 70.

|| C. von SCHAUROTH, *Verzeichniss der Versteinerungen im Herzoglichen Naturalien Cabinet zu Coburg*, Coburg, 1865, p. 192, pl. xi. f. 2.

- Brissopsis crescenticus*, G. Cotteau, 1877, "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix. pp. 312-14.
 " " Th. Fuchs, 1885, "Gliederung unt. Neogen Mittelmeers," *Zeit. deut. geol. Ges.*, xxxvii. p. 157.
Toxobryssus " E. Desor, 1858, *Syn. Éch. foss.*, p. 400, pl. xlii. f. 6-8.
 " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 487.
 " " G. Mazzetti, 1879, *Ann. Soc. Nat. Modena*, xiii. p. 188.
 " " A. Manzoni, 1880, "Ech. foss. Plioc.," *Atti Soc. Tosc. Sci. Nat.*, iv. p. 334.

Type.—Brit. Mus., E. 1583.

Distribution.—Malta—Globigerina Limestone. Corsica—Sta Manza (lower beds), and Zone à *P. cristatus*, and Zone à *Cerites* et *Pleurotomes*. Italy—Castell Arquato (Pliocene?); Modena (Moll. marmosa). Cyprus—Hagia Phylla (Mioc.).

Remarks.—This species appears most closely to resemble some varieties of *B. ottnangensis*, Hoernes,* especially some of those figured by M. DE LORIOI,† but the confluence of the lateral ambulacra is a very distinctive feature in the Maltese species.

Genus *Spatangus*, Leske, 1778.

Species 1. *Spatangus delphinus*, DeFrance, 1827.

Synonymy.—

- Spatangus delphinus*, DeFrance, 1827, *Dict. Sci. Nat.*, t. 1, p. 96.
 " " Blainville, 1834, *Man. Actinol.*, p. 204.
 " " C. Desmoulins, 1837, 3^{me} "Mém. Ech.," *Actes Soc. Linn. Bordeaux*, ix. p. 256.
 " " L. Agassiz, 1840, *Cat. Cyst. Ectyp. Ech. Foss. Mus. Neoc.*, p. 2.
 " " Agassiz and Desor, 1847, *Cat. rais. Sci. Nat. Zool.* (3), viii. p. 7.
 " " E. Desor, 1858, *Syn. Éch. foss.*, p. 421.
 " " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 488, 489, pl. xxii. f. 4.
 " " P. de Loriol, 1875, "Ech. Tert. Suisse," *Mem. Soc. pal. Suisse*, ii. pp. 134, 135, pl. xxiii. f. 1.
 " " G. Mazzetti, 1882, "Ech. foss. Montese," *Ann. Soc. Nat. Modena* (2), xv. p. 115, pl. iii. f. 5.
 " *desmaresti*, T. Wright, 1855 (*non* Goldf.), "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. p. 104, 272-3.

Type.—M. 20.

Distribution.—Malta—Upper Coralline Limestone and Greensand. France—St Paul trois Châteaux (Helvetian). Switzerland—Les Verrières (Helvetian). Italy—(?) Montese (Langhian, serp. molassa).

Remarks.—This species has often been regarded as synonymous with *S. corsicus*, Des., but M. COTTEAU ‡ regards them as quite distinct, and enumerates a series of characters

* R. HOERNES, "Die Fauna des schliers von Ottnang," *Jahrb. k. k. geol. Reichs.*, xxv., 1875, pp. 389-91, pl. xii. f. 4, pl. xv. f. 2-7.

† P. DE LORIOI, "Description des Échinides des environs de Camerino (Toscane)," *Mém. Soc. Phys. Hist. Nat. Genève*, xxviii., No. 3, 1882, pl. iii. f. 4-7.

‡ "Faune tert. Corse," *Ann. Soc. Agric. Lyons* (4), ix., 1877, p. 340.

which seems quite sufficient to establish the separation. Dr EBERT has discussed * the relations of this species and *S. desmaresti*, Münst.

Species 2. **Spatangus pustulosus**, T. Wright, 1864.

Synonymy—

- Spatangus pustulosus*, T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. p. 489, pl. xxi. f. 2.
 „ „ Ippolito Cafici, 1880, *Boll. R. Com. geol. Italia*, xi. p. 501.
 „ „ Th. Fuchs, 1885, "Gliederung unt. Neogen Mittelmeers," *Zeit. deut. geol. Ges.*, xxxvii. p. 157.
 „ „ L. Baldacci, 1886, "Descriz. Geol. Italia," *Mem. descr. Carta geol. Italia*, i. p. 94.
 „ *aequidilatatus*, G. Mazzetti, 1882, "Ech. foss. Montese," *Ann. Soc. Nat. Modena* (2), xv. pp. 113, 114, pl. iii. f. 6.

Type.—Brit. Mus., E. 1675.

Distribution.—Malta—Globigerina Limestone; Greensand (COOKE'S Coll.). Sicily—Calcare di Siracusa. Italy—Montese (?); (Langhien). Greece—Eubœa.

Genus **Euspatangus**, L. Agassiz, 1847.

Species 1. **Euspatangus de konincki** (Wright), 1855.

Synonymy—

- Spatangus de konincki*, T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 178–181.
Euspatangus „ T. Wright, 1855, *ibid.*, p. 274.
 „ „ E. Desor, 1858, *Syn. Éch. foss.*, p. 415.
 „ *konincki*, T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, p. 487, pl. xxii. f. 5.

Type.—E. 1582.

Distribution.—Malta—Blue Clay (*vide* Dr WRIGHT)—Globigerina Limestone.

Remarks.—Dr WRIGHT also records this species from the Lower Coralline Limestone, but I have seen no specimen from that horizon.

Genus **Sarsella**, Pomel, 1883.

Species 1. **Sarsella duncani**, n. sp.

Synonymy—

- Spatangus hoffmanni*, T. Wright, 1855 (*non* Goldf.), "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 176–178.
 „ *ocellatus*, T. Wright, 1864 (*non* DeFrance), "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, pp. 487, 488, pl. xxi. f. 1.

* Th. EBERT, "Die Echiniden des Nord und Mitteldeutschen Oligocäns," *Abh. geol. Specialk. Preussen*, ix., Abt. 1., 1889, pp. 55, 56.

Diagnosis.—*Form* cordate, a broad shallow notch on the anterior margin; it tapers slightly to the posterior margin, which is abruptly truncated. Seen from the side it is seen to be depressed, and with a wavy margin produced by a depression around the apical system and the carinate posterior interradius. The latter overhangs posteriorly.

The actinal surface is flat, but bulging at the posterior margin.

Ambulacra: Anterior widest with minute pores; interrupted by the internal fasciole. Antero-lateral large, extending quite two-thirds of the distance to the ambitus; the pores of the anterior zone disappear close to the apical system. The direction of the antero-lateral pair is very divergent. The postero-lateral ambulacra curve back beside the keel, and bend outwards at the lower ends. The paired petals are flush with the test.

Apical system excentric anteriorly; four genital pores. Ethmolysian.

Peristome excentric in front; mouth semilunar.

Epistroma: Abactinally a number of large tubercles set in deeply sunk scrobicules on the paired interradii; some coarse granules occur on the anterior ambulacrum; in addition to these, there is a granulation of uniform minute granules. Actinally, there is a broad bare band with a few granules, and on either side an area covered with deeply scrobiculate tubercles.

Fascioles: Internal fasciole sinuous, forming a key-shaped area with the apical system in the centre of the expanded part. There are eight pairs of large pores on either side of the area within the subanal fasciole.

Anus large, oblong, overhung by the posterior interradius.

Dimensions—

Length,	55 mm.	Antero-lateral ambulacra: No. of pores	
Width,	51 "	in ant. zone,	10-11
Height,	20 "	Posterior ambulacrum: length,	19 mm.
Apical system: distance from anterior margin,	21 "	" " width,	6 "
Mouth: distance from anterior margin,	13 "	" " No. of pairs of pores in ant. side,	22
Antero-lateral ambulacra: length,	14 "	" " No. of pairs of pores in post. side,	20
" " width,	5 "		
" " No. of pores in post. zone,	13		

Type.—Brit. Mus., E. 3406.

Distribution.—Malta—Globigerina Limestone.

Remarks.—This species was originally identified by Dr WRIGHT as *Spatangus hoffmanni*, Goldf., and subsequently as *S. ocellatus*, DeFr., but the occurrence of the internal fasciole necessitates its removal to the *Lovenia* group. This was pointed out by Professor DUNCAN,* and the species is accordingly named after him. DEFRANCE's species is a true *Spatangus*.

This species differs from *Sarsella peroni* (Cott.)† by the shape of the internal fasciole, and the proportions of the pore areas in the antero-lateral ambulacra.

* Revision, *Journ. Linn. Soc. Zool.*, xxiii., 1889, p. 265.

† G. COTTEAU, *Ann. Soc. Agric. Lyons* (4), ix., 1877, pp. 334, 335, pl. xvi. f. 3-4.

Sarsella anteroalta, n. sp. Pl. II. figs. 7 and 8.

Diagnosis.—*Form* elliptical, but with the anterior margin flattened, and but slightly furrowed by the anterior ambulacrum. The test is depressed, with a thin margin posteriorly; at the anterior end it is tumid, and the whole of the anterior ambulacrum is upon a broad raised area. The highest point is in front of the apical system. The posterior interradius is somewhat carinate.

Ambulacra: The anterior is in a broad shallow groove upon the top of a raised area. In addition to the adjoining interradii, parts of the antero-lateral ambulacra take part in the formation of this raised area. The paired ambulacra are in broad shallow depressions; in the front pair the anterior poriferous zone is very short, as the pores are not continued up the steep, almost vertical wall of the raised area. The posterior pair also terminate abruptly against the fasciole.

Apical system: Four large genital pores; ethmolysian; the madreporite is continued far behind the posterior pores.

Fascioles: The internal fasciole is broad and distinct; it crosses the anterior ambulacrum at about a third of the length of this from the anterior margin; it is continued back on the upper part of the sides of the raised area, and extends for some distance behind the apical system, the two halves meeting at an acute angle on the posterior interradius. The details of the subanal are not discernible.

Anus on the thin posterior margin.

Epistroma: A few large tubercles, with deep scrobicules, occur in the antero-lateral interradii, and in the extreme anterior corner of the posterior pair.

Dimensions—

	B. M., E. 3420.	E. 3421.
Length,	26 mm.	30 mm.
Width,	24 „	28 „
Height,	6 „	8 „
Distance of apical system from anterior margin,	11 „	13 „
Antero-lateral ambulacra: number of pores in anterior zone,	5	7
„ „ „ „ posterior „	9	11
Postero-lateral „ „ „ „ anterior „	9	10
„ „ „ „ posterior „	10	11

Type.—Brit. Mus., E. 3420, 3421.

Distribution.—Malta—Globigerina Limestone; bed *b* at Dueira.

Remarks.—This species may be readily distinguished from any other *Sarsella* by the depressed condition of the ambulacra, a character especially marked in the youngest specimens. If the division into Spatangidæ and Brissidæ be accepted, including in the former those with flush and in the latter those with depressed petals, then a new genus must be created for this species. But in all other respects it is a true *Sarsella*, and it is here allowed to remain in this genus; the reasons for this have been already stated on

p. 613 when considering *Hemiaster vadosus*. As *Sarsella duncani* occurs on the same horizon, the two species must be compared. The following table shows the marked distinctions between these species:—

	<i>Sarsella duncani</i> .	<i>Sarsella antero-alta</i> .
Petals,	Flush.	Depressed.
Posterior interradius, . . .	Carinate.	Not carinate.
Maximum height, . . .	Posterior.	Anterior.
Posterior margin, . . .	Overhanging.	Vertical.
Postero-lateral ambulacra, . .	Long, sinuous.	Broad, blunt; not sinuous.
Internal fasciole,	Key-shaped; blunt behind.	Sides straight, ending behind as an acute angle, and further from the apical system.

III.—MISCELLANEOUS RECORDS.

Family ECHINIDÆ.

Genus *Stirechinus*, Desor, 1856.

Species 1. *Stirechinus scillæ* (Desmoulins), 1837.

Synonymy—

- Echinus scillæ*, C. Desmoulins, 1837, "3^m Mém. Ech.," *Actes Soc. Linn. Bordeaux*, ix. p. 136.
Stirechinus scillæ, Desor, 1857, *Syn. Ech. foss.*, p. 131.
 " " J. Seguenza, 1868, "Formation Zancleène," *Bull. Soc. géol. France* (2), xxv. p. 476.
Echinus " T. Wright, 1864, "Foss. Echinidæ Malta," *Quart. Journ. Geol. Soc.*, xx. pp. 475, 476.
 " *costatus*, Agass., 1846, *Cat. rais. Ann. Sci. Nat. Zool.* (3), vi. p. 370.

Type.—(*E. costatus*), V. 26.

Remarks.—Dr WRIGHT described a specimen as *Echinus scillæ*, which is apparently the above species; and the fact that he placed his own name after it was probably only an inadvertence. A specimen of *Stirechinus scillæ* from the Sicilian Zanclean is included in Dr LEITH ADAMS' Collection, and this may have led to the mistake.

Family CLYPEASTRIDÆ.

Genus *Clypeaster*, Lamarck, 1816.

Species 1. *Clypeaster reidi*, Wright, 1855.

- Clypeaster reidi*, T. Wright, 1855, *Ann. Mag. Nat. Hist.* (2), xv. p. 268–70.
 " " Michelin, 1861, "Mon. Clypeastres foss.," *Mém. Soc. géol. France* (2), vii., No. 2, p. 124, pl. xxvi.

The type specimen of this species, a very close ally of *C. gibbosus*, is preserved in the British Museum; the condition of preservation of the specimen, however, suggests that

it came from Sicily or Corsica rather than from Malta. It has been recorded from the latter by M. COTTEAU * and by G. SEGUENZA from Calabria,† but has not apparently been since obtained from Malta. There is no specimen in Mr COOKE'S Collection; hence it does not seem advisable to retain it on the Maltese list.

Species 2. *Clypeaster gibbosus* (Risso), 1826.

Synonymy—

Scutella gibbosa, Risso, 1826, *Hist. Nat. Europe merid.*, v. p. 284.

Clypeaster gibbosus, Marc de Serres, 1829, *Géogr. terr. tert. France merid.*, p. 157.

„ „ Th. Fuchs, 1874, *Sitz. h. Ak. Wiss. Wien*, lxx., Abth. 1, p. 96.

This species is quoted by Herr FUCHS from the Greensand, but I have seen no specimen from Malta.

Species 3. *Clypeaster melitensis*, Michelin, 1861.

“Mon. Clypéastres foss.,” *Mém. Soc. géol. France* (2), vii. p. 129.

This species was founded on some internal casts, and it is probable that they came from Egypt. There are no specimens in any English collection from Malta in a similar condition of preservation.

Species 4. *Clypeaster latirostris*, Agassiz, 1840.

Synonymy—

Clypeaster latirostris, L. Agassiz, 1840, *Cat. Ect. foss. Ech. Mus. Neoc.*, p. 6.

„ „ T. Wright, 1864, “Foss. Echinidæ Malta,” *Quart. Journ. Geol. Soc.*, xx. p. 479.

Family SCUTELLIDÆ.

Genus *Scutella*, Lamarek, 1816.

Species 1. *Scutella subrotunda*, *pars* Leske, 1778.

This species has been recorded from Malta in mistake for *S. striatula*. Dr WRIGHT, however, recorded both species in his earlier paper;‡ but as he abandoned *S. striatula* in his later list, it is probable that he recognised that only one species occurred on the island. The reasons why this was given as *S. subrotunda* have been already mentioned.

* “Faune tert. Corse,” *Ann. Soc. Agric. Lyons* (4), ix. pp. 275–278.

† “Formaz. terz. Reggio,” *Mem. R. Acc. Lincei* (3), vi. p. 88, pl. x. f. 2.

‡ *Ann. Mag. Nat. Hist.* (2), xv. pp. 118–120.

Family CASSIDULIDÆ.

Genus *Echinolampas*, Gray, 1825.Species 1. *Echinolampas kleini* (Goldfuss).*Synonymy*—*Clypeaster kleini*, Goldfuss, 1829, *Petref. Germ.*, p. 133, pl. xlii. f. 5.*Echinolampas kleini*, Desmoulins, 1837, "3^m Mém. Ech.," *Actes Soc. Linn. Bordeaux*, ix. p. 192." " T. Wright, 1855, "Foss. Echinod. Malta," *Ann. Mag. Nat. Hist.* (2), xv. pp. 121, 122.

Remarks.—This species is recorded by Dr WRIGHT from the Greensand. The identification of the specimen seems subsequently to have caused Dr WRIGHT some misgivings, as the species is not mentioned in his later paper. The Earl of DUCIE has kindly lent me the specimen, and I not only question the specific determination, but whether it ever came from Malta. The condition of preservation is very different to that of any Maltese fossil I have seen, and it is probable that it came from Sicily. It is a close ally of the *Echinolampas hofmanni*, Desor, from the Pliocenes of that island. Dr TH. EBERT,* in his recent elaborate description of this species, makes no mention of Dr WRIGHT's record, so he apparently does not accept it.

Family SPATANGIDÆ.

Genus *Brissus*, Leske, 1778.Species *Brissus cordieri*, L. Ag., 1847.*Cat. rais. Ann. Sci. Nat. Zool.* (3), viii. p. 14.

This species is recorded by M. DESOR† from Malta, but I have seen no specimen referable to it.

IV.—DISTRIBUTION OF THE ECHINOIDEA.

The list in the Table annexed includes 46 species, of which 23 are peculiar to the Maltese beds; in the Upper Coralline Limestone there are 15 species, and in the Greensand 6, of which 2 also occur in the upper horizon. The Blue Clay has so far yielded but one recognisable species, but a fragment of a *Clypeaster* is of interest, as showing the shallower water in which this bed was deposited. The one species identified also occurs in the Globigerina Limestone, where it is associated with 20 other species. The Lower Coralline Limestone has yielded 6 Echinoids, none of which occur in the higher beds. Dr WRIGHT mentions several as ranging through the whole series, and though this is not impossible, I have seen no sufficient evidence. And in the south

* TH. EBERT, "Die Echiniden des Nord- und Mitteldeutschen Oligocäns," *Abh. geol. Specialk. Preussen und Thür.*, St., ix., Abt. 1, 1889, pp. 39, 43, pl. ii. f. 1-3; iii. f. 1, 2; x. f. 1.

† *Syn. Ech. foss.*, p. 404.

No.	Species.	Author.	Malta.					Corsica.	Italy.				France.	Switzerland.	Austria.	Miscellaneous.
			Up. Cor. Limestone.	Greensand.	Blue Clay.	Globigerina Limestone.	Low. Cor. Limestone.		Calabria and Sicily.	Molassa ser- pentinosa.	Molassa marnosa.	Miscella- neous.				
1	<i>Cidaris melitensis</i> ,	Wr.	-							-						W. Indies, Greece.
2	„ <i>scillæ</i> ,	„														
3	„ <i>aventonensis</i> ,	Desml.				-		6	A.L.	-		A.L.	H.	H.		Egypt.
4	„ <i>adamsi</i> ,	Wr.										-				Egypt.
5	„ <i>oligocenus</i> ,	Greg.					-									
6	<i>Echinus duciei</i> ,	Wr.	-									Tt.			Tt.	
7	„ <i>tortonius</i> ,	Greg.	-													
8	„ <i>hungaricus</i> ,	Laube				?						P.			Tt.	
9	„ <i>tongrianus</i> ,	Greg.					-									
10	<i>Echinocyamus studei</i> ,	(Sism.)				-						A.H.				Cyprus (Pl.).
11	<i>Clypeaster altus</i> ,	(Leske)	-	-				-	H.			H.			Tt.	Crete, Asia Minor, Madeira, &c.
12	„ <i>marginatus</i> ,	Lam.		-				2	Tt. H.							
13	<i>Scutella striatula</i> ,	M. de Serr.		-			-						Tg.			
14	<i>Heteroclypeus hemi- sphaericus</i> ,	Greg.		-												
15	„ <i>subpentagonalis</i> ,	„		-						?					Tt.	
16	<i>Amblypygus melitensis</i> ,	Wr.	-													
17	<i>Breynella vasalli</i> ,	(„)				-		3								
18	„ <i>equizonata</i> ,	Greg.					-									
19	<i>Studeria spratti</i> ,	(Wr.) (fig.)				-										
20	<i>Echinolampas hemi- sphaericus</i> ,	(Lam.)	-	-				6		?		Tt. P.	H.		Tt.	Cyprus, Asia Minor, &c.
21	„ <i>manzoni</i> ,	Greg.				-				-						
22	„ <i>wrighti</i> ,	„		-												
23	„ <i>hayesianus</i> ,	Des.			-					-						
24	„ <i>posterolatus</i> ,	Greg.					-									
25	<i>Hemiaster cotteaui</i> ,	Wr.				-					-					
26	<i>Hemiaster scillæ</i> ,	„				-										
27	„ <i>vadosus</i> ,	Greg.				-										
28	<i>Pericosmus latus</i> ,	(Ag.)				-		3.4	-		-	A. H.			Sch.	Madeira.
29	„ <i>coranguinum</i> ,	Greg.				-										
30	<i>Schizaster parkinsoni</i> ,	(Defr.)				-		3				A.				
31	„ <i>desori</i> ,	Wr.				-		-				A.			Tt.	Sardinia.
32	„ <i>scillæ</i> ,	(Desml.)	-					3.4 5			-	Tt. P.	H. H. Pl.		Tt.	Belgium (Pl.), W. Indies, Sardinia, Asia Minor, &c.
33	<i>Prenaster excentricus</i> ,	(Wr.)	-													
34	<i>Brissus latus</i> ,	Wr.	-													
35	„ <i>imbricatus</i> ,	„	-													
36	„ <i>tuberculatus</i> ,	„	-													
37	„ <i>oblongus</i> ,	„	-													
38	„ <i>depressus</i> ,	Greg.	-													
39	<i>Metalia melitensis</i> ,	„	-			-										
40	<i>Brissopsis duciei</i> ,	Wr.	-													
41	„ <i>crescenticus</i> ,	„	-			-		4.5				P. ?				Cyprus.
42	<i>Spatangus delphinus</i> ,	Defr.	-													
43	„ <i>pustulosus</i> ,	Wr.				-								H.		Greece.
44	<i>Euspatangus de konincki</i>	(„)				-										
45	<i>Sarsella duncani</i> ,	Greg.				-										
46	„ <i>anteroalta</i> ,	„				-										

A., Aquitanian; H., Helvetian; L., Langhian; P., Pliocene; Sch., Schlier; Tg., Tongrian; Tt., Tortonian. The Nos. in the column for Corsica refer to M. Locard's six divisions.

of France, where the conditions varied much less than in Malta, we find, as TOURNOUER says, that "the Faluns of Léognan and of Saucats contain scarcely anything in common with the fauna of the Calcaire à Astéries or of Gaas."*

The number of species peculiar to the islands is very high, and might lead one at first to suppose that species had been made on too minute differences; but a closer comparison of these with their nearest allies in other parts of the Mediterranean basin shows that they are as a rule separated by very distinct characters. The same feature is noticed in the corresponding beds in Italy and Corsica. The Echinoids described by M. COTTEAU from the latter number 45 species, of which 21 are confined to the island; while the interesting little fauna described by M. DE LORIOU, from Tuscany, contained 8 new species, and only two which were known elsewhere, and one of these is doubtful. When we consider the wide distribution of the species of lower and of higher horizons, this localisation of the deep-sea species is of great interest.

V. THE CORRELATION OF THE MALTESE BEDS.

The Miocene deposits of the Mediterranean basin have been classified upon two different principles. On the one hand, Professor SÜSS showed, in 1866,† that the richly fossiliferous sands and limestones of the Vienna basin, then known as the "Mediterranean stage," belonged to two different epochs in the Miocene era, and that they were shallow water beds separated by a deposit formed at a much greater depth. The two former he grouped as the first and second "Mediterranean-Stufen," and to the intermediate bed he applied the term "Schlier."‡ Later workers have filled in the details, and, though not without opposition, as that of Dr STUR in Austria,§ and of Professor CAPELLINI|| in North Italy, have shown that Professor SÜSS's classification has given the clue to the unravelling of the sequence of the varying deposits of the Cainozoic group of the Eastern Mediterranean. Foremost amongst these geologists is Herr TH. FUCHS, who, in conjunction with KARRER¶ in the Vienna basin, supported by MANZONI** and MAZZETTI†† in Romagna,

* "Note stratigraphique et paléontologique sur les faluns du département de la Gironde," *Bull. Soc. géol. France* (2), xix, 1862, p. 1069.

† Untersuchungen über den Character der oesterreichischen Tertiärlagerungen. I, "Ueber die Gliederung der tertiären Bildungen zwischen dem Mannhart, der Donau und dem äusseren Saume des Hochgebirges," *Sitz. k. k. Ak. Wiss. Wien*, liv., 1866, Abt. 1, pp. 87-149.

‡ *Ibid.*, p. 118.

§ Dr STUR, "Beiträge zur Kenntniss der stratigraphischen Verhältnisse der marinen Stufe des Wiener Beckens," *Jahrb. k. k. geol. Reichs.*, xx., 1870, pp. 303-342. "Zur Leithakalk-Frage," *Verh. k. k. geol. Reichs.*, 1871, pp. 230-234.

|| G. CAPELLINI, "Sui terreni terziari di una parte del versante settentrionale dell' Appennino," *Mem. Acc. Sc. Instit. Bologna* (3), vi., 1876, pp. 587-621. "Sulle marne glauconifere dei dintorni di Bologna," *Boll. R. Com. geol. Italia*, viii., 1877, pp. 398-406; and *Rendic. Acc. Sci. Ist. Bol.*, 1877, pp. 110-121.

¶ TH. FUCHS and F. KARRER, "Geologische Studien in den Tertiärbildungen des Wiener Beckens," No. 1-21; *Jahrb. k. k. geol. Reichs.*, Bd. xviii.-xxv.

** A. MANZONI, "Lo Schlier di Otnang nell' Alta Austria e lo Schlier delle colline di Bologna," *Boll. R. Com. geol. Italia*, vii., 1876, pp. 122-132. "Geologia della provincia di Bologna," *Ann. Soc. Nat. Modena*, xiv., fasc. 1, 1880, pp. 1-33. "Gli Echinodermi fossili dello Schlier delle colline di Bologna," *Denk. k. Ak. Wiss. Wien*, xxxix., Th. 2, 1879, pp. 149-164, pl. i.-iv. "Echinodermi fossili della Molassa serpentinoso e supplemento agli Echinodermi dello Schlier delle colline di Bologna," *ib.*, xlii., Th. 2, 1880, pp. 185-190, pl. i.-iii.

†† G. MAZZETTI, "La molassa marnosa delle montagne Modenesi e Reggiane e lo Schlier delle colline Bolognese," *Ann. Soc. Nat. Modena*, xiii., 1879, pp. 105-126.

and alone* in Greece, Asia Minor, Malta, and North Africa, has proved that Professor Süss's classification could be applied over a much larger area than that for which it was originally proposed. At the same time, he has established the synchronism of beds which, formed of different materials, and under very dissimilar conditions and depths, along the steep shores of Miocene Italy, or in the deep gulfs of the Vienna basin, now yield different faunas, and had been assigned to different epochs. Thus he and his collaborators have taught us that near Vienna the Leithakalk is the littoral representative of the Baden Tegel; along the Apennines the Schlier is the deep-sea continuation of the *Molassa marnosa* and *Molassa serpentinoso*; and in Sicily the Astian is, in part at least, the shore deposit of the Zanclean. He, in fact, worked out among the Mediterranean Miocenes the same principles which have been applied with such brilliant results by Professor LAPWORTH† to the "Sequence of the Southern Uplands" of Scotland.

But while Herr FUCHS was thus engaged in the more central part of the Mediterranean basin, ANDRUSOV was proving the applicability of the same classification in the extreme East by finding in the Crimea and around Stavropol that the "black clay with Meletta" contained *Pecten denudatus*, and other species characteristic of the Schlier, while the overlying Chokrah Limestone yielded the fauna of the second "Mediterranean Stufe."‡ The physical history of the Mediterranean, as revealed by these researches, has been summarised by Professor Süss himself in his well-known essay on the "Mittelmeer," § while later we owe a brilliant sketch of the same subject to the master hand of the late Professor NEUMAYR.¶ Further details and sketch-maps of the eastern part of the area have been given by Professor INOSTRANZEV.¶

But in the western part of the Mediterranean basin the Vienna classification has not met with such general acceptance. The system worked out by Professor Carl MAYER in Liguria has not only held its ground there, but been adopted in France and Spain on the one side, and as far south as Algeria on the other; while, even in the Vienna basin, the accepted classification has been severely criticised in a couple of weighty papers by Dr A. BITTNER,** whose arguments may show that the differences between the two "Mediterranean Stufen" in the most typical area are less clearly marked than has been thought. Though FUCHS has shown that the Maltese sequence is in agreement with that

* Vide the series of papers by TH. FUCHS, *Sitz. k. k. Ak. Wiss. Wien*, lxi.-lxxvii.

† C. LAPWORTH, "On the Ballantrae Rocks of South Scotland, and their place in the Upland Sequence," *Geol. Mag.* (3), vi., 1889, pp. 20-24, 59-69.

‡ N. I. ANDRUSOV, "Gheologicheskaya izsledovaniya v zaradnoi polovinye Kerchenskagho polyostrova proizvedennuiya lyetom 1884 ghoda," *Zap. Novoross. Obshch. Est.*, xi., pt. 2, pp. 117, 118, 121; see also "O tretichnikh otlozheniyakh Daghestana," *Trud. St. Pet. Obshch. Est.*, xix., pt. 2, 1888, p. xv; and "O kharaksherye Miotzenobuikh oadkov Kpuma," *Trud. St. Pet. Obshch. Est.*, xvii., pt. 2, 1886, pp. 59-61.

§ E. SÜSS, *Das Antlitz der Erde*, i., 1885, pp. 375-414.

¶ M. NEUMAYR, *Erdgeschichte*, ii., 1887, pp. 515-522.

¶ A. INOSTRANZEV, *Gheologhiya*, ii., 1887, pp. 394-396.

** A. BITTNER, "Ueber den Charakter der sarmatischen Fauna des Wiener Beckens," *Jahrb. k. k. geol. Reichs.*, xxxiii., 1883, pp. 131-150. "Zur Literatur der österreichischen Tertiärlagerungen," *ib.*, xxxiv., 1884, pp. 137-146. "Noch ein Beitrag zur neueren Tertiärliteratur," *ib.*, xxxvi., 1886, pp. 1-70. Also "Neue Daten über den Charakter und die Herkunft der sarmatischen Fauna," *Verh. k. k. geol. Reichs.*, 1891, pp. 195-8.

of Austria,* no attempt seems to have been made to apply this classification to the six divisions of the Miocene adopted by M. LOCARD† in Corsica. The Maltese beds seem, in fact, to have been on the border line between two areas, in which different sequences of conditions have necessitated two different classifications of the deposits of the middle part of the Cainozoic era. Hence it may be of interest to see how far the Maltese beds can be correlated with those of the two halves of the Mediterranean region, and see what light the Echinoidea throw on the physical condition of the period.

The precise correlation of beds in islands with those of other areas is rarely entirely free from some doubt, as the final appeal to stratigraphy cannot be made. But in the case of the Maltese beds there is an additional source of uncertainty, as the comparison frequently has to be made between deposits laid down under very different conditions; the slight variations produced by age may be completely overshadowed by differences due to altered circumstances, and hence the evidence of palæontology must be accepted with considerable caution. Thus in Malta the calcareous marls, with fish teeth, &c., occur near the base of the series, and the great Clypeaster beds above; but in Corsica the succession is reversed. As an area subdivided, its fauna must have withdrawn to shallower regions, whence, on its re-elevation into more favourable zones, they returned to oust the deeper forms that had temporarily supplanted them. Hence the area in question affords illustrations of a series of "colonies," though their migrations must have been limited to a much shorter period of time than in the cases, now discredited, for which this theory was originally proposed.

Before any correlation of the Maltese subdivisions can be attempted with much chance of success, their faunas must be studied with greater care than has apparently been devoted to any of the invertebrates except the Foraminifera and the Echinoidea. As the latter are good zonal fossils, the evidence they afford may be more reliable than that of other groups, at least until far more care has been bestowed on the mollusca than has as yet been done. The Echinoidea, moreover, now offer the additional advantage that their distribution in the Maltese series is known with greater certainty than previously, owing to the care with which Mr J. H. COOKE has collected these fossils. As in the list compiled by Dr WRIGHT‡ specimens from Sicily, and probably Egypt, have been included, and errors both of specific identification and of geological horizons seem to have occurred, it has not been accepted as evidence in the compilation of the table of distribution.

The following table gives the succession of the Maltese beds. It has been kindly compiled for this paper by Mr COOKE. The names are those proposed by Dr MURRAY, to whose Memoir reference is made for further details, and especially the microscopic structure of the rocks.

* *Sitz. k. Ak. Wiss. Wien*, lxx., Abth. i., 1874, pp. 92-105.

† A. LOCARD, "Description de la Faune des Terrains tertiaires moyens et supérieurs de la Corse," *Ann. Soc. Agric. Lyons* (4), ix., 1877, pp. 345-360.

‡ *Quart. Journ. Geol. Soc.*, 1864, vol. xx. p. 490.

Table of Maltese Strata.

Upper Coralline Limestone (300 feet),	{	a. White Coralline Limestone. b. Reddish-yellow Limestone. c. Soft White Limestone.	} "Gozo Marble."
Greensand (35 feet), Blue Clay (40 feet),	{	a. Indurated Yellow Sand. (Clypeaster bed.) b. Friable Black Sand.	
Globigerina Limestone (250 feet),	{	a. White rotten Limestone. (Fossils badly preserved.) 1st Nodule seam. b. Fine hard-grained Limestone. 2nd Nodule seam. c. Compact semi-crystalline Limestone. 3rd Nodule seam. d. Yellowish soft Limestone. (Fossils well preserved.) 4th Nodule seam.	
Lower Limestone (500 ft.),	{	a. <i>Scutella</i> bed. b. Hard compact Limestone.	

It is fortunate that the Maltese series of deposits begins and ends with shallow water limestones, which admit of comparison on equal terms with their representatives on the mainland. The succession which is of most value for this purpose is that so well described by SEGUENZA in his elaborate Memoir, "Le Formazioni Terziarie nella Provincia di Reggio (Calabria)." *

There are rocks in Sicily which seem to agree more closely lithologically with those of Malta, but their Echinoidea have not been so well monographed. The Calabrian series is of special value, as it includes a succession of littoral deposits from the Tongrian to the Tortonian, that is, throughout both the Oligocene and Miocene systems. In the Tongrian there we find *Scutella striatula*, Marc de Serr. (recorded, however, as *S. subrotunda* †), which is the best-known fossil of the Lower Coralline Limestone. It is the most characteristic species of the Tongrian throughout the Mediterranean basin; in France it occurs in the Calcaire à Astéries, while the true *S. subrotunda* (Leske, *pars*) is the typical species of the Faluns of Léognan (i.e., the base of the Langhian). Similarly in the Vicentin district the latter occurs in the Schio Schichten (Aquitanian), and *S. tenera*, Lbe. (a very near ally of *S. striatula*), is the representative of the older species in the Lower Oligocene. Similarly other Echinoids from the Lower Coralline Limestone have their nearest allies in the Tongrian fauna; thus *Echinus tongrianus*, Greg., most resembles *E. biarritzensis*, Cott., from the Calcaire à Astéries in the south of France, and from the Castel Gomberto beds of Vicentin (both of which are Tongrian). Unfortunately, the larger bed of this division in Malta is so hard that the fossils have not been so well collected as from higher horizons, and the specimens are usually covered by the limestone; but, so far as the fauna is known, it appears to be certainly Oligocene and probably Tongrian. It may have been that the *Scutella striatula* fauna lived on longer in the south

* *Atti. R. Ac. Lincei*, 3^a Ser. Mem., vol. vi., 1879, pp. 1-446, pl. i.-xvii.

† See the remarks on this species, *ante*, p. 597-98.

than in the north, and thus it may in part have been synchronous with the Aquitanian ; but it appears to be clearly homotaxial with the Lower Oligocene. That some considerable lapse of time intervened between this and the Upper Coralline Limestone is indicated by the fact that when the same genera reappeared, with the return of the old conditions, they were always represented by new species.

The Upper Coralline Limestone does not contain many Echinoidea, but the Greensand (the *Heterosteginakalk* of FUCHS) yields a large number of Clypeasters. These may be included in two species—*Clypeaster altus* and *C. marginatus*. The former species is represented by several well-marked varieties, such as *C. pyramidalis*, *C. portentosus*, *C. alticostatus*, *C. turritus*, and *C. tauricus* (?). The same species, with the same varieties, are found in Calabria in the Helvetian, and they seem sufficient to determine this horizon. BALDACCI, moreover, has assigned the *Heterostegina* Limestone of Syracuse, the Sicilian representative of the Greensand, to the Helvetian.* Two horizons may thus be regarded as fairly settled, while the Upper Coralline Limestone may be readily dismissed as the Tortonian, both from its superposition to the Helvetian and the agreement of its fossils with those of the Leithakalk, as shown by Herr FUCHS.†

It is thus obvious that the Globigerina Limestone and the Blue Clay together represent the Aquitanian (Upper Oligocene) and the Langhian (Lower Miocene); and no doubt it would be very convenient to follow FUCHS in drawing the line between these two systems at the change in the lithological character of the deposits. This change Dr MURRAY‡ has shown to be due to some change in the physical conditions of the area, whereby a larger proportion of clastic material was introduced into the sea in which the higher deposit was being laid down. This is probably, as Dr MURRAY has said, owing to elevation into a shallower zone. It is of interest to inquire whether this alteration of level exactly coincided with the opposite change whereby the littoral and land deposits of the Ligurian Aquitanians and the Viennese Sotzka and Eggenburg Schichten were replaced by the deep-sea Langhians and Schlier.

Herr FUCHS' conclusions as to the correlation of the Blue Clay and of the Globigerina Limestone were based on 18 species of mollusca in the former, and on two in the latter. The Echinoidea of the lower horizon, numbering 21 species belonging to 14 genera, would appear to offer much better data. Of these species, 9 are peculiar to the Maltese islands, and so are of little value, while, on the other hand, 4 species may be neglected, as their range is so extensive both in time and space. Thus *Schizaster parkinsoni*, e.g., lived from the Aquitanian to the Tortonian, and has been found from the West Indies, on the one side, to Eastern Asia Minor, on the other.

As a result of Herr FUCHS' identification of the Globigerina Limestone with the Aquitanian, one is led to compare its Echinoids with those from this series in Italy. Not one of the species occurs in the Aquitanian of Reggio, but that is possibly due to the fact

* "Descrizione geologica dell' Isola Sicilia," *Mem. descr. Carta geol. Italia*, i., 1886, pp. 93, 108.

† *Sitz. k. k. Ak. Wiss. Wien*, lxx., Abth i., pp. 95, 96.

‡ *Scott. Geogr. Mag.*, vi. p. 480.

that only shore deposits are there represented. The absence of the Maltese species (except two widely distributed forms doubtfully recorded) from the Vicentin beds is of more value. The same genera occur there, such as *Pericosmus*, *Metalia*, *Spatangus*, *Sarsella*, &c., but they are represented by different species.*

The Echinoid faunas with which that of the Globigerina Limestone has most in common are those of the Schlier and the Zone à *Pecten bonifaciensis* in Corsica. To the former it is allied by the presence of several species in both deposits and by a general resemblance of others. Thus 9 species also occur in the Schlier or its shore deposits—the “*Serpentinosa molassa*” and “*Molassa marnosa*” of Northern Italy. The number is not a large one, but remembering the limited distribution of the species of Echinoidea in these and corresponding deposits of the same age, and comparing the general characters of the two faunas, one is led to accept the evidence as of more value than the actual numbers would suggest. Moreover, the Echinoidea of the Globigerina Limestone differ completely from those of the beds above and below the Schlier, so that, if they do not represent this formation, there is nothing in the Vienna basin with which they can be compared.

The evidence afforded by the fauna of the Zone à *Pecten bonifaciensis* in Corsica is of considerable value on this question. Seven of the Echinoidea of the Globigerina Limestone occur in Corsica: four of these occur in the Zone à *Pecten bonifaciensis*, and two of these, with another species, occur in the Zone à *Pecten cristatus*; one is found in the Zone à *Cerites* et *Pleurotomes*, one in the Zone à *dents de Poissons*, and one is unplaced. Hence it is clearly to the two first zones that the Globigerina Limestone is allied. Now the mollusca of the former of these two zones agree more closely with those of the Eggenberg Schichten than with any other bed in the Viennese series; thus the short lists given by LOCARD† and FUCHS‡ from these horizons have five species in common. The Zone à *Pecten cristatus* is similarly the equivalent of the Grunder Schichten, though it contains some species characteristic of a higher level. Now the Eggenberg Schichten are below, and the Grunder Schichten above, the Schlier, so that this last seems to have no definite representative in Corsica. Nevertheless, as far as the evidence of palæontology goes, the Zone à *Pecten cristatus* appears to be the equivalent of the Maltese Blue Clay; but the Maltese beds contain species, such as *Pecten denu-datus*, characteristic of a lower horizon; and the intermingling in the Zone à *Pecten cristatus* of some of the species of the Badner Tegel would also suggest that the Corsican is the later of the two deposits.

But in considering the Blue Clay apart from the Globigerina Limestone, it should be remarked that this is done only owing to the convenience of separating a bed so very different lithologically. There seems hardly any reason palæontologically to separate

* See List by W. DAMES, “Die Echiniden der Vicentinischen und Veronesischen Tertiärlagerungen,” *Paläontogr.*, xxv., 1877, pp. 93, 94.

† *Op. cit.*, p. 347.

‡ *Zeit. deut. geol. Ges.*, xxix., 1877, pp. 661, 662

this bed from the underlying limestone, and its stratigraphical relations also show the intimate relations between the two. Dr MURRAY* describes the Blue Clay as being 35 feet thick in some places, while elsewhere it is wholly wanting, and sometimes a gradual transition can be traced from the clay into the limestone. It would thus appear to represent merely a local argillaceous phase of the Globigerina Limestone produced during the elevation of the Maltese area into the shallower zones in which the later formations were laid down.

The equivalents of the Globigerina Limestone, with its overlying cap of Blue Clay, may then be tabulated as follows:—

Corsica.	Malta.	Vienna Basin.	Series.
Zone à <i>Pecten bonifaciensis</i> ,	{ Lower Globigerina Limestone,	(Sotzka Schichten),	Aquitanian.
	{ Upper " "	{ Horner " "	{ Langhian.
Zone à <i>Pecten cristatus</i> ,	Blue Clay,	{ Schlier,	{ Helvetian.
Zone à <i>Cerites</i> et <i>Pleurotomes</i> ,	Greensand,	Grunder Schichten,	

It seems only by the recognition of the dual affinities of the Globigerina Limestone Echinoidea that one can explain the association of two groups of species having characters of the faunas of different depths. The Corsican species and their allies are a set of forms that might be expected on the deeper slopes at a little distance from the mainland, while the small elongated *Echinolampas*, the *Studeria*, the thin-tested fragile *Sarsella anteroalta*, and the ethmophract *Hemiasiter vadosus*, indicate a much greater depth. There is nothing so truly abyssal as the *Cleistechinus* described by M. DE LORIO† from the Tuscan Schlier, but the whole facies of this latter group of Maltese species has a deep-sea aspect. The occurrence of these two groups of Echinoidea in the same deposit appears to indicate that Malta was on the border-line between two parts of the Mediterranean basin which had a different physical history. It seems that the Maltese area must have undergone alternate elevations and depressions. With the former, the shallow-water types from the north-west entered the district, and were supplanted by species from the deeper eastern sea as subsidence again set in. When the elevation became permanent, the deeper forms finally left the Maltese area and survived only in the deeper seas of the Adriatic.

These considerations therefore suggest that, instead of the deep-sea deposits of the Globigerina Limestone of Malta, the Langhien of Liguria, the Schlier of Vienna, the Zone à dents de poissons of Corsica, the Black Clay with *Meletta* of Southern Russia, &c., being on one horizon, and representing a period of regional submergence, they mark only a series of local subsidences of basins which in the main were isolated from one another by areas of shallow sea. Thus may be explained the high proportion of peculiar species in each of these limited areas, while the general resemblance of the faunas may be due

* *Op. cit.*, pp. 465, 466.

† "Description des Echinides des environs de Camerino (Toscane)," *Mém. Soc. Phys. Hist. Nat. Genève*, xxviii, No. 3, 1882, pp. 27-30, pl. i., f. 12-14.

mainly to the influence of similar conditions acting on the allied littoral faunas from which these were derived. In some places it appears rather as if a wave of depression had travelled northward, and some of the deeper species may then have followed it in its course; but in other cases the action seems to have been a strictly local change of level.

If the lower part of the Globigerina Limestone be accepted as Aquitanian, then the Maltese area was the first to sink, the subsidence commencing there at the end of the Tongrian, and though there were periods of slight uplift marked by the coarser limestones and the occasional abundance of such species as *Schizaster parkinsoni*, the permanent re-elevation did not come till late in the Langhien; hence it seems that, as part of the Globigerina Limestone is Miocene and part Oligocene, there is in Malta no such sharp line of division between these two systems as can be drawn elsewhere. Further north in Liguria the maximum subsidence was not established till towards the close of the Maltese depression, and it was perhaps still later on the other side of the Apennines. Probably the deposition of the Schlier was not commenced at the same time as the base of the Langhien, while it certainly seems to have lasted longer, and to represent also a part of the Helvetian series; and similar beds of later age indicate that the same conditions still prevailed, though over more limited areas. Above the shore deposits which crept out seaward over the gradually-rising Schlier occur the Badner Tegel and the Pteropod Marls of Tortona, represented on the other side of the Apennine axis by the Corsican Zone à dents de poisson. And later still than these Tortonian deposits the "Tegel" of Monte Vaticano and the Zanclean of Sicily continue through the Pliocene the record of the conditions of the deeper basins of the Mediterranean Sea.

EXPLANATION OF PLATES.

PLATE I.

- Fig. 1. *Cidaris avenionensis*, Desmoul., Globigerina Limestone, Malta. B.M., E. 1957. Fig. 1a, Part of actinal side; nat. size. Fig. 1b, Ambulacral plates enlarged. Fig. 1c, Spine on the same slab.
- Figs. 2, 3, and 4. *Cidaris oligocenus*, n. sp., Lower Coralline Limestone, Malta. Figs. 2 and 3, Spines. B.M., E. 3409. Fig. 4a, Ambulacrum and interradius; nat. size. Fig. 4b, Ambital ambulacral plates enlarged. B.M., E. 3401.
- Fig. 5. *Echinus tortonicus*, n. sp., Upper Coralline Limestone, Malta. B.M., E. 3402. Fig. 5a, Abactinal surface, $\times 2$ dia. Fig. 5b, Side view; nat. size. Fig. 5c, Apical system. Fig. 5d, An ambital interradial plate, magd.
- Fig. 6. *Echinus duciei*, Wright. Ambital interradial plate.
- Fig. 7. *Echinus tongrianus*, n. sp., Scutella, bed of Lower Coralline Limestone, Malta. B.M., E. 3403. Fig. 7a, Abactinal surface, $\times 2$ dia. Fig. 7b, Side view; nat. size. Fig. 7c, Apical system. Fig. 7d, Ambital interradial plate, magd.
- Figs. 8, 9, and 10. *Echinocyamus studei* (E. Sism.), Globigerina Limestone, Malta. Figs. 8 and 9. B.M., 75,687. Fig. 10a, b, c, $\times 4$ dia. B.M., E. 3427.
- Fig. 11. *Heteroclypeus hemisphaericus*, n. sp., Greensand, Malta. B.M., 40,368. Half nat. size.

PLATE II.

- Fig. 1. *Breynella equizonata*, n. sp., Lower Coralline Limestone, Pembroke Camp, Malta. B.M., E. 3404. Nat. size.
- Fig. 2. *Brissus depressus*, n. sp., Upper Coralline Limestone, Malta, B.M., E. 3428.
- Figs. 3 and 4. *Pericosmus coranguinum*, n. sp., Globigerina Limestone, Malta. Fig. 3, Abactinal surface. B.M., E. 3405. Fig. 4a, Posterior view of another specimen. B.M., E. 3429. Fig. 4b, Lateral view of the same.
- Fig. 5. *Metalia melitensis*, n. sp., Globigerina Limestone, Malta. Mus. Prac. Geol.
- Fig. 6. *Hemiaster vadosus*, n. sp., Globigerina Limestone, Malta. Fig. 6a, b, c. B.M., E. 3422. $\times 2$ dia. Fig. 6d, Apical system of the same specimen.
- Figs. 7 and 8. *Sarsella anteroalta*, n. sp., Globigerina Limestone, Malta. B.M., E. 3420-1.

Mr J. W. GREGORY ON MALTESE FOSSIL ECHINOIDEA.—PLATE I.

MR J. W. GREGORY ON MALTESE FOSSIL ECHINOIDEA.— PLATE II.