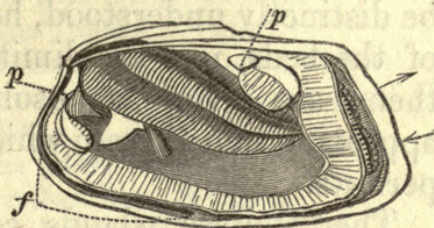


two on each side, long, narrow, deeply plaited, passing from the umbo forwards, uniting behind the byssus and below the adductor, closing the branchial chamber; outer gill linear, composed of a single lamina; inner gill thick, strongly furrowed along the free edge. *Palpi* small, very narrow, pointed, free.

*Cypricardia rostrata*, Lam. From the Philippines.

*Mantle-lobes* united and covered (except the siphonal area) with a wrinkled straw-coloured epidermis. *Siphonal* orifices unequal, anal smallest, fringed. *Pedal* opening (*f*) rather large.

*Foot* very small, compressed, byssiferous. *Gills* long, narrow, deeply lamellated, very unequal; outer gill rather shorter, and only half as wide as the inner, furnished with a narrow plicated dorsal border; its lower mar-



gin free posteriorly, adhering to the inner gill in front; inner gill prolonged between the palpi. *Palpi* small, triangular, plaited inside. *Adductor* muscles each of two distinct elements; anterior *pedal* muscle distinct; *posterior* combined with adductor.

*Cypricardia? solenoides*, Reeve.

*Mantle-lobes* united, margins slightly cirrated behind. *Pedal* orifice rather large. *Foot* very small, compressed, acute-edged, with a large byssal pore near the heel. *Siphons* conical, cirrated externally; orifices cirrated; anal smallest, with a single row of large cirri; branchial with an inner series of large cirri, and very numerous fine cirri outside. *Palpi* moderate, obtuse. *Gills* two on each side, deeply plaited, the ridges grooved; outer gill shorter and narrower; inner gill prolonged between the palpi; gills united posteriorly, their lower margins entirely free.

XII.—On Fossil Echinoderms from the Island of Malta; with Notes on the stratigraphical distribution of the Fossil Organisms in the Maltese beds\*. By THOMAS WRIGHT, M.D. &c., Professor of the Natural Sciences in the Cheltenham Grammar School.

[With four Plates.]

A. Notes on the Maltese beds, with the species they contain.

THE Island of Malta is entirely composed of tertiary rocks of Miocene age, which have been described by Capt. Spratt, R.N.†,

\* Being the substance of a Lecture delivered to the Members of the Cotteswold Club, held at Tortworth Court, September 14, 1854.

† "On the Geology of the Maltese Islands," with Notes on the Fossils by Prof. E. Forbes. Proceed. of the Geol. Soc. London, vol. iv. p. 225.



and surveyed and mapped by the Earl Ducie\*. Through his lordship's kindness, we have been enabled to study a complete suite of Maltese rock specimens, together with an extensive collection of the fossils obtained from them, whilst resident in the island; and it is but just that we should state, at the outset of these remarks, that whatever is valuable in this memoir relating to the stratigraphical distribution of the Urchins and other fossils in these beds, is entirely due to the Earl Ducie, who has most liberally given us all the information he noted on the spot, relative to the range and distribution of the species. It is to be distinctly understood, however, that neither the measurement of the beds, nor the limitation of the range of the fossils in them, are given as absolute truths, but rather as the nearest approximation thereto which the present state of our knowledge permits.

The Maltese islands comprise Malta, Gozo, and Cumino. Malta is seventeen miles in length by seven in breadth; Gozo is nine in length by five in breadth; and Cumino about two in length by one in breadth. The direction of their long axis is S.E. and N.W., which, with the channels, is about twenty-nine miles in length. All the rocks are sedimentary and marine, having a slight inclination from N.E. to E.N.E.; their direction corresponds with that of the Apennines, and with the intermediate line observed in Sicily from the Val di Noto to Polizzi. Numerous faults traverse the N.W. half of Malta and the S.E. of Gozo, which have much disturbed the beds, caused the depressions now forming the north and south channels between Cumino and Malta and Cumino and Gozo, and left the islet of Cumino an isolated fragment of the uppermost beds, which attests the former continuity of the land, before these islands were fractured by subterranean and denuded by aqueous agency. "The mineral deposits," says Capt. Spratt, "composing this group, have a thickness of 800 feet visible above the sea; they lie nearly horizontal, and are conformable, although there is a great diversity of mineral character and condition in the series. None of the deposits are wholly destitute of organic remains; but, on the contrary, they generally contain them in tolerable abundance, and in a good state of preservation." The strata may be divided into five groups, each of which contains fossils that are special to it, very few of the species being common to the whole series. These, in a descending order, are, 1st, *the coralline limestone*; 2nd, *the yellow sand*; 3rd, *the clay*; 4th, *the calcareous sandstone*; 5th, *the hard cherty limestone*.

\* The Earl Ducie kindly presented a copy of this map to Mr. Goodenough, book- and map-seller, Strado Reale, Malta, by whom it is now being published.



No. 1. *The coralline limestone*, consists of a reddish-white calcareous rock, mostly hard and compact, and sometimes changed into an indurated calcareous sandstone. It attains a thickness of 100 feet, but has been much denuded in several localities. Some isolated portions of this bed, from being slightly variegated in colour, were formerly used for certain durable work, under the name of Gozo marble.

*Fossils of No. 1.*

MOLLUSCA.

*Voluta*, cast of a large species.  
*Haliotis*, ditto of a n. sp.  
*Trochus*, ditto.  
*Spondylus quinquecostatus*, *Desh.*  
*Ostrea Boblayei*, *Desh.*  
 — *Virleti*, *Desh.*  
*Pecten Pandora*, *Desh.*  
 — *squamulosus*, *Desh.*  
 — *Burdigalensis*, *Desh.*  
*Arca*, casts of.  
*Cytherea*, ditto.

ECHINODERMATA.

*Cidaris Miletensis*, *Forbes.*  
*Echinus Duciei*, *Wright.*  
*Echinolampas Deshayesii*, *Desor.*  
*Clypeaster crassicoatus*, var. of *C. altus.*  
*Brissus latus*, *Wright.*  
 — *imbricatus*, *Wright.*  
 — *oblongus*, *Forbes, MSS.*  
*Brissopsis Duciei*, *Wright.*  
*Schizaster eurynotus*, *Agassiz.*  
*Pericosmus excentricus*, *Wright.*

BRYOZOA.

*Eschara monilifera.*  
*Escharina*, n. sp.

CORALLIA.

*Stylastræa.*

CRUSTACEA.

Carapaces and chelæ of several species.

No. 2. *The yellow sand*, is sometimes slightly indurated, and has an abundance of greenish-black grains intermixed with it. In some places it abounds with Foraminifera. Enormous numbers of *Lenticulites complanatus*, *Defr.*, the flat side of the shell corresponding with the bedding of the rock, occur in some localities, as in the cliffs of Ramala Bay, Gozo, and in many places in Malta. Intercalated with these Nummulites are banks of oysters, the teeth and vertebræ of fishes, especially those of the great shark, *Carcharodon megalodon*, with the bones of Cetacea. The greatest number of Echinoderms are likewise found in this bed. It varies in thickness from 10 to 40 feet.

*Fossils of No. 2.*

MAMMALIA, determined by  
 Prof. Owen (Forbes).

*Delphinus*, more than one species.  
*Manatus?* bones apparently of this genus.

FISHES, determined by Sir Philip  
 G. Egerton (Forbes).

*Cerax aduncus*, *Agass.*, teeth of.

*Carcharodon megalodon*, *Agass.*, do.  
*Carcharias productus*, *Agass.*, do.  
*Oxyrhina xiphodon*, *Agass.*, do.  
 — *hastilis?* *Agass.*, do.  
 — *Mantelli?* *Agass.*, do.  
*Hemipristis serra*, *Agass.*, do.  
 — *paucidens*, *Agass.*  
 With other undetermined Squalidæ.



## MOLLUSCA.

*Nautilus*, 2 sp., undescribed.  
*Scalaria retusa*, *Brocchi*.  
*Voluta*, *Mitra*, *Cypræa*, *Conus*, 2 sp.,  
*Columbella*, *Oliva*, *Natica*, *Turritella*,  
*Turbo*, *Pleurotoma*, *Pyrula*,  
*Phorus*, *Trochus*;—casts only of  
these genera.  
*Ostrea Virleti*, *Desh*.  
—— *navicularis*, *Desh*.  
*Pecten cristatus*, *Bronn*.  
—— *squamulosus*, *Desh*.  
—— *Burdigalensis* and 3 other sp.  
*Arca*, *Isocardia*, *Venus*, and *Tellina*,  
in the form of casts.  
*Terebratula ampulla*, *Brocchi*.  
—— *bipartita*.

## BRYOZOA.

*Cellepora mammillata*.  
*Retepora*.

## ECHINODERMATA.

*Clypeaster altus* et var. *C. turritus*,  
*Leske*.  
—— *marginatus*, *Lamk*.  
—— *folium*, *Agass*.  
*Echinolampas Richardi*, *Desmoul*.  
—— *Kleinii*, *Goldf*.  
*Conoclypus plagiosomus*, *Agass*.  
*Brissus oblongus*, *Forbes*.

## FORAMINIFERA.

*Lenticulites complanatus*, *Defrance*.

## CORALLIA.

*Caryophyllia*. *Fungia*.

No. 3. *The clay bed*, has a dark blue, drab, or a light gray colour, and is much charged with iron. In it are found crystals of gypsum, and occasionally nodules of sulphur. It varies in thickness from 30 to 60 feet. It is the retentive water-bearing stratum of the islands, and all the water falling upon the upper beds percolates through them, and bursts out in springs along their line of junction with the clay. Casts of shells and fragments of bones are very abundant in it; but Echinoderms are comparatively rare.

*Fossils of No. 3.*

## FISHES.

Teeth of *Myliobatis*, *Lamna*, *Charcharias*, and *Euphyllia*, are abundant.

## ECHINODERMATA.

*Spatangus Desmarestii*, *Goldf*.  
*Pericosmus latus*, *Agass*.

## MOLLUSCA.

*Megasiphonia zic-zac*? (allied to the London-clay species).  
*Scalaria*, *Pleurotoma*, *Mitra*, *Cassis*,  
*Rostellaria*, *Conus*, 3 or 4 sp.,  
*Pecten*, *Ostrea*, *Cardita*, *Lucina*.

## CORALLIA.

*Fungia*?

No. 4. *The calcareous sandstone*.—"This bed covers the greater part of the island of Malta. From it nearly all the building stone is procured, and it is likewise the rock from which the Maltese vases are cut. The lower beds abound in Echinoderms. *Scutella* and *Schizaster* are not unfrequent; but *Hemiaster Scillæ* is the most abundant species. These Urchins are often seen standing out in relief on the beach, the sea having worn away the surrounding rock. They are very serviceable in affording a foot-hold on the rocks, which otherwise would be dangerous to land upon." (*Lord Ducie*.) This bed is subdivided by Capt. Spratt into five strata, which he thus describes:—



"D. is a white calcareous sandstone, lying subjacent to the marl, into which it quickly passes, and is from 20 to 30 feet in thickness.

"E. is a bed of fine-grained sandstone, 15 to 20 feet thick, of a reddish-white, and sometimes gray colour. These contain several species of Foraminifera.

"F. a pale yellow calcareous sandstone, often containing flinty nodules, from 30 to 50 feet thick. In some parts it is thinly stratified, and separable into brittle plates of sandstone; but more generally it assumes a closely bound and unstratified character, when it is used for building; but it is very liable to exfoliate on exposure to the weather.

"G. Chocolate-coloured nodules, irregular in figure and size, in calcareous sandstone, with which are mixed casts of shells, Caryophyllia, and other organisms; also fishes' teeth, vertebræ, and coprolites are very abundant. All the nodules are of organic origin; it is, in fact, a bone-bed of considerable extent, for it preserves a very uniform character throughout the islands; but in Gozo it is more developed, and contains more remains; especially in a flat ledge just above the sea-level, under the cliffs of Fort Chambray, and at Marsa il Forno, on the north-east coast, where its durability has checked the encroachment of the sea. Its thickness is estimated at from 2 to 8 feet.

"H. A close-grained, pale yellow sandstone, incapable of being split along the line of bedding. It is extensively quarried for building and other purposes, being easily cut with the knife or saw. Large blocks of it are turned into pillars, vases, balustrades, and other architectural ornaments. This stone is extensively used for building in the islands; and, for the same use, is largely exported to many parts along the shores of the Mediterranean. It attains a thickness of from 40 to 50 feet.

"The stone from which the finely-carved vases are cut, comes from the lower part of this bed, and is obtained near Naxiar. The rock in this locality dries whiter, is finer grained, and more compact than in general."—*Spratt*.

"It is impossible to distinguish between the beds D, E, F, in the above grouping, except in cliff-sections."—*Earl Ducie*.

#### Fossils of No. 4.

##### REPTILIA.

Chelonia, sp.

##### FISHES.

Pycnodus, numerous teeth of this genus, with vertebræ and other bones of this class.

##### MOLLUSCA.

Nautilus, sp. undescribed.

Scalaria Duciei.

Conus, Cyprea, Solarium, Natica, Phorus, casts only.

Pecten laticosta.

— Burdigalensis.

Lucina. Tellina.



## CIRRHIPODA.

Balanus stellaris.

Lepas, sp.

## CRUSTACEA.

Numerous remains of this class.

## ECHINODERMATA.

Schizaster Parkinsonii, Defrance.

Schizaster Desori, Wright.

Spatangus Hoffmanni, Goldf.

Scutella subrotunda, Leske.

—— striatula, Marcel de Serres.

Brissopsis crescenticus, Wright.

Hemiaster Grateloupi, Desor.

—— Scillæ, Wright.

—— Cotteau, Wright.

No. 5. *The hard cherty limestone*, “is a yellowish-white cream-coloured limestone, having sometimes semi-crystalline strata alternating with an oolitic grit or sandstone, apparently composed of minute fragments of shells and corals. It attains a considerable thickness, since nearly 400 feet of it in perpendicular depth is visible on the north-west coast of Gozo.” (*Spratt*.) “This bed forms a high and rocky coast-line on the south end of Malta, and dipping to the north appears about the water-line in the neighbourhood of Valetta and Sliema, forming a barrier to the sea. Probably the softer superincumbent beds have in course of time been worn away, till the appearance of this rock arrested any further encroachment. A *Scutella* invariably marks the junction of this bed with No. 4.” (*Earl Ducie*.) The New Dock is built of this rock, and it is quarried in several places for building purposes, and it is likewise burned for lime.

*Fossils of No. 5.*

The fossils of this bed are imperfectly known, from being obtained with much difficulty. Of Mollusca, casts of *Solarium*, *Conus*, *Phorus*, *Natica*, *Cypræa*, *Pecten*, *Lucina*, and of the Cirrhipoda, *Balanus*, have been recognized in it. Of the Echinodermata, “*Scutella subrotunda*, *Clypeaster*, sp., *Brissus*, sp., identical with that of No. 2. Such is also the case with the *Pectens*.” (*Forbes*.)

We cannot conclude our brief notice of these Maltese deposits without alluding to a similar Urchin bed of the same age in the island of Corsica. Through the kindness of our friend M. Michelin, the eminent zoophytologist of Paris, we received some time since a number of *Echinidæ* from this Corsican deposit, which we have carefully compared with the fine suite of Maltese Echinoderms now before us. Many of the species from Corsica and Malta are identical, although some from both islands are special to each region. From these data we conclude, that the deposits containing the Echinoderms described in the sequel of this memoir are of the Miocene period, and of the same age as the tertiaries of the south of France, the north of Italy, and of Doberg bei Bünde in Westphalia. M. Collomb, an eminent French geologist, lately visited the Urchin bed near



Bonifacio in Corsica, and has given an account thereof in a letter addressed to Prof. Constant Prévost; the following abstract relating thereto will be read with interest:—

“We shall quit now,” says M. Collomb, “the eruptive rocks, and transport ourselves to the south, at Bonifacio, where we have remained some days, to go and see the bed of fossil Urchins. They are found in a fragment of limestone completely enclosed in the granite. Bonifacio is built upon a high escarpment of this limestone, formed of horizontal beds having a coarse structure, full of the fragments of shells, the species of which were indeterminable. This escarpment is incessantly beaten and demolished by the action of the wind and the sea. Upon all this coast the beds overhang, and are worn into caverns by the inroads of the sea.

“The bed of Urchins is situated at some leagues to the north-east of Bonifacio, towards the roadstead of Santa-Manza, at the limit of the granite. The escarpment itself is here granitic, and the Urchin limestone caps the granite. The bed which contains the most beautiful specimens is only accessible by means of a ladder, and their extraction is difficult.”

The Calcaire à Oursins is only found in three localities in Corsica, at Bonifacio, at Aleria, and at Saint-Florent, and always in small detached beds of inconsiderable extent, which do not extend into the interior of the island. The deposits of Bonifacio and Saint-Florent were the only ones visited by M. Collomb\*. The rock is a light-coloured limestone, sometimes white and soft, or hard and cherty, and contains an abundance of small quartz pebbles derived from the decomposed granite.

### B. Description of the Fossil Maltese Echinoderms.

*Cidaris Miletensis*, Forbes MSS., n. sp. Pl. IV. fig. 1 a-c.

Test oblatelly spheroidal, much depressed at both poles; ambulacral areas undulated, depressed in the centre, with an elevated marginal row of close-set tubercles on each side of the areas; poriferous avenues of the same width as the areas; interambulacral areas rather prominent, with two rows of primary tubercles, about six in each row; mammillary eminences large, each with a circle of boundary granules; spines nearly the diameter of the test in length, tapering from the base to the apex; mouth-opening very large.

*Dimensions*.—Height  $\frac{8}{10}$ ths of an inch; transverse diameter  $1\frac{3}{20}$  inch.

\* Bull. de la Soc. Géol. de France, tom. xi. p. 67 et seq., 2 série.



*Description.*—This is a very rare Urchin in the Maltese beds. It has an oblately spheroidal figure, and is much depressed at both poles; the ambulacral areas, with the poriferous zones, are gently undulated; they measure together  $\frac{3}{20}$ ths of an inch in width; the areal band is depressed in the middle, and its elevated margins are covered with two rows of large equal-sized close-set granules; internal to these are two rows of much smaller granules, and down the centre is a depressed furrow: the poriferous avenues lie likewise in depressions, bounded internally by the marginal granules of the ambulacral areas, and externally by the encircling granules of the primary tubercles: the interambulacral areas are  $3\frac{1}{2}$  times the width of the ambulacral; they form rather prominent convex portions of the test, with from five to six rows of primary tubercles in each of the two rows of these areas: the areolas are large and prominent, the summits are smooth and without crenulations, and the tubercles, which are proportionately large, and with a very small perforation in their summit, stand well out from the body: a circle of larger granules surrounds the base of the mammillary eminences; these circlets are each complete in the two superior tubercles, but one series is common to two tubercles in those near the mouth; the boundary in all, however, is defined, as none of the areolar spaces are confluent: in the centre of the interambulacral areas is a depressed space, which is filled with small close-set granules: the mouth-opening is very large, and that for the apical disc is so likewise: the spines taper gently from the shoulder to their apex; they are round, and sculptured with longitudinal lines; their absolute length is not determinable, as neither of those before us are perfect; they may have attained the length of the diameter of the test.

*Affinities and differences.*—We know so few true *Cidarites* from the tertiary rocks, that materials for comparison fail us. The only species we possess is the *C. Alabamensis*, Morton, from the tertiaries of the U. States, which has nearly straight ambulacra, ten tubercles in each row in the interambulacra, with wide intertubercular spaces between each pair of rows. The Maltese Urchin differs essentially from this species, and may be easily distinguished from it by the concave ambulacral areas, and the marginal rows of tubercles that define these portions of the test. It is somewhat remarkable that we should have discovered so few *Cidarites* in all the Urchin beds that have been so diligently explored in the tertiary beds of Europe.

*Locality and stratigraphical range.*—This species has been found only in bed No. 1, the Gozo marble, where it is rare.



*Echinus Duciei*, Wright. Pl. IV. fig. 2.

Test circular, much depressed : ambulacral areas more than half the width of the interambulacral, with two rows of marginal, nearly equal-sized tubercles throughout, and two other rows within these, extending from the border to the mouth ; one of these inner rows ascends a short way above the border : interambulacral areas with eight rows of tubercles at the border, diminishing to two rows above the others, disappearing or becoming of secondary size ; from the border to the mouth, the eight rows continue of uniform size : the pores are in triple oblique pairs ; between each pair there is a slight ridge of the test, which gives a singular zigzag figure to the poriferous avenues : mouth large and decagonal, base flat : apical disc of moderate size, but not preserved.

*Dimensions*.—Height  $\frac{1}{2}\frac{5}{8}$ ths of an inch ; transverse diameter  $1\frac{1}{2}\frac{7}{8}$  inch.

*Description*.—This beautiful Urchin has been thought to be identical with the *E. Scillæ*, Desmoul., and the one figured by Scilla in pl. 13. fig. 1, pl. 25. fig. 1, and pl. 26. fig. A, B, of his work\* ; but the number of tubercles on each of the plates in our specimen differs from the *Echinus* à *Messana* of that author, who has figured only one large tubercle on each plate of that form. From *E. Scillæ* it is certainly distinct, as we know of no Urchin that is common to the cretaceous and tertiary rocks. The test is circular, much depressed on the upper surface and flat below ; the ambulacral areas are almost  $\frac{4}{10}$ ths of an inch in width at the border, where we count four rows of tubercles ; the marginal rows are very uniform in size and arrangement from the mouth to the disc ; the two internal rows are smaller, and continue from the border to the mouth ; one of these extends a short distance on the sides, but on the upper half of the areas there are only the two marginal rows : the interambulacral areas are  $\frac{7}{10}$ ths of an inch in width at the border ; there are eight rows of tubercles at this point and onwards towards the base, they are nearly of the same size ; but, from the border to the apical disc, the second row, from the ambulacral areas, alone possesses the size the tubercles have at the border ; the tubercles in the others diminish in size, and disappear as the areas become narrower ; above, we find only two marginal tubercles of the primary size, and internal to these, a few of secondary magnitude irregularly set : all the tubercles are raised on mammillary eminences, with areolas around their bases, and numerous large granules fill up all the

\* De Corporibus Marinis Lapidescensibus.



intervening spaces, so that the surface of this *Echinus* has a very tuberculated appearance. The poriferous avenues are on a level with the test; the pores are arranged in triple oblique pairs; between each pair there is a slight elevated ridge; every two ridges of each triple oblique pair of holes is connected by another ridge, which runs at an angle of  $45^{\circ}$  to them; by this arrangement the poriferous avenues exhibit a curious zigzag character through these little elevations of the test in the line of the pedal pores. The base is flattened, the mouth-opening is large and decagonal, and the jaws and teeth are narrow and much curved inwards; the apical disc is absent in all the specimens we have examined; the space for the same is, however, of moderate size.

*Affinities and differences.*—This species may be distinguished from *Echinus Serresii*, Desmoul., from the Molasse de Provence, in having larger tubercles, with less granulation at their base, and the absence of the zigzag ridges between the pairs of pores: from *Echinus dubius*, Agass., another tertiary species from the Molasse of Villeneuve in Provence, it is distinguished by the more uniform size of its tubercles, the depression of the upper surface, and the zigzag ridges of the poriferous zones.

*Locality and stratigraphical range.*—It was collected from bed No. 1, the Gozo marble, Malta, where it is not uncommon. We have dedicated this species to the Earl Ducie, who collected the beautiful specimens we have figured.

#### Family CLYPEASTRIDÆ.

This natural family includes all the Urchins which have a circular, elliptical, or pentagonal form, with a thick test, the surface of which is closely covered with small, nearly equal-sized tubercles sunken in the plates, and surrounded by ring-like areolas; these all carry short hair-like spines. The mouth is large, central and pentagonal, and is armed with five strong jaws which carry the same number of teeth: the anus is posterior, and marginal or inframarginal: the interior of the test is sometimes divided by pillar-like processes of the inner layer of the plates. The dorsal portions of the ambulacral areas have a petaloid form, circumscribed by large poriferous zones; the basal portions are narrow, rectilineal, or branched. The five genital plates form a circle around the madreporiform body, and between these are wedged the five ocular plates. This family includes the genera *Clypeaster*, Lamk., *Laganum*, Klein, *Echinarachnius*, Van Phels., *Arachnoides*, Klein, *Scutella*, Lamk., *Dendraster*, Agass., *Lobophora*, Agass., *Encope*, Agass., *Rotula*, Klein, *Mellita*, Klein, *Runa*, Agass., *Moulinsia*, Agass., *Scutellina*,



Agass., *Echinocyamus*, Van Phels., *Fibularia*, Lamk., *Lenita*, Desor.

GENUS CLYPEASTER (Lamarck, 1816).

Form oval, inclining to pentagonal, rostrated before, truncated behind; upper surface more or less inflated, sometimes campanulate, conical or subconical; inferior surface flat, always concave around the mouth, with five straight simple ambulacral furrows proceeding from the angles of the mouth to the border; the dorsal portion of the ambulacral largely petaloid, greatly exceeding the interambulacra in size, and forming elegant leaf-like expansions, in general convex, arched, and prominent; bounded on each side by large poriferous zones, the pores of which are wide apart and united by transverse sulci; the apical disc formed of five genital plates at the summits of the interambulacra, with five ocular plates alternating with them; in the centre of this circle is the spongy madreporiform body, of a pentagonal figure: tubercles uniform in size and very numerous, equally distributed over the test; summits perforated, and surrounded by very deep areolas; mouth symmetrical, central, pentagonal, lodged in a concave depression in the middle of the base; auricles composed of ten distinct auricular processes set in pairs: the jaws form a pentagonal pyramid, composed of ten separate pieces, truncated at the summit, which is bordered by a subcircular band; teeth five, large, and bent: anus small, round, and inframarginal: interior of the test with a number of pillar-like processes towards the border. All the species of this genus live in the seas of warm latitudes, or are found fossil in the tertiary rocks only. We have six living and twelve fossil species.

*Clypeaster altus*, Leske, sp.

SYN. *Echinus* à *Melita*, Scilla, Corp. Mar. pl. 9. figs. 1, 2.

*Echinanthus altus*, Leske, Klein, Echinoderm. apud Leske, No. 48. p. 189. pl. 53. fig. 4.

*Echinus altus*, Gmelin, Linné by Turton, vol. iv. p. 149.

*Clypeaster altus*, Lamarck, Hist. Nat. des Animaux sans Vertèbres, 2nd ed. tom. iii. p. 290; Deslongchamps, Encycl. t. ii. p. 199; Defrance, Dict. Sc. Nat. t. ix. p. 449; Blainville, Man. d'Actin. p. 216; Desmoulins, Echinides, no. 7. p. 216; Agassiz and Desor, Cat. rais., Ann. Sc. Nat. tom. vii. p. 130; Sismonda, Ech. Foss. Nizza, p. 46; Ech. Foss. Piem. p. 40; Grateloup, Mem. Foss. Oursins de Dax, p. 41.

Test oblong; anterior border convex; lateral borders undulated; posterior border squarely truncated; marginal fold more or less thickened; dorsal surface elevated into a dome shape; vertex nearly central; ambulacral areas largely petaloid, their base extending nearly to the margin: base flat; mouth large



and pentagonal, with a deep sulcus extending from the angles to the border, and corresponding to the middle suture of the ambulacral areas: anus small, round, and submarginal: granulations larger and more prominent at the base than on the dorsal surface.

*Description.*—This beautiful *Clypeaster* has been so long known, that it seems unnecessary to give any lengthy details of its structure; although it may be remarked, however, that we are not aware that a detailed description of the species exists. It was first introduced to notice through the figure of Scilla, and the specimens before us belong to the same type as that given in his work. Many of the Maltese varieties of this species, however, are remarkable for their deviation from this typical form; the dorsal surface in them rises into a campanulate shape, and the circumference becomes almost round. These varieties constitute the *Clypeaster turritus*, Agass., from the Miocene of Dax, and the *Clypeaster Agassizii*, Sismonda, from beds of the same age near Nice. We have before us a similar conical variety from Malta, belonging to the Museum of the Bristol Institution; and others, collected by the Marchioness of Hastings, are in the Jermyn Street Museum.

All the specimens in Earl Ducie's cabinet, with one exception, belong to what we regard as the typical form. This remarkable exceptional specimen agrees with the brief notice of *C. Tauricus*\*, Desor:—"Très grande espèce, allongée, pentagonale, à bord fortement renflé. Zones porifères très large à leur extrémité. Tert. du Taurus, île de Crète." If we are correct in referring all these varieties to *C. altus*, it follows that this species has a wide range of deviation from what we take to be its typical form; but these limits of variation are probably not greater in this than in some other species of Urchins. The following table shows the relative dimensions of three forms,—the typical, the conical, and the flattened and tumid varieties:—

Forms.	Length.	Breadth.	Height.
Type specimen .....	5 inches.	$4\frac{1}{20}$ inches.	$2\frac{1}{5}$ inches.
Conical, var. <i>a.</i> ....	$5\frac{8}{10}$ „	$5\frac{3}{10}$ „	$4\frac{1}{10}$ „
Tumid, var. <i>b.</i> ....	$6\frac{6}{10}$ „	$5\frac{6}{10}$ „	$2\frac{4}{10}$ „

The ambulacral areas are largely petaloid, nearly equal in length and width; they are rounded, widely open below, and extend over four-fifths of the dorsal surface in the type form, over nearly three-fourths in the conical form, and over almost four-fifths in the tumid varieties; in all, the areas form

\* Cat. raisonné des Echinides, Ann. Sc. Nat. tom. vii. p. 131.



prominent convex elevations of the test, which are bounded by wide poriferous avenues, composed of two series of simple pores united by oblique grooves; the internal series of pores are round, the external series are elongated transversely in the direction of the grooves; the pores at the end of the avenues are much more so than those of the summit; the apical disc is small, and occupies the centre of the dorsal surface, lying in a slight depression formed by the bending-in of the summits of the areas; those of the single area, and the antero-lateral and postero-lateral areas of the left side, being rather more prominent than those of the right side of the test. The madreporiform body occupies the whole surface of the disc, the ocular and genital plates being quite indistinguishable from the general structure of the test; the five genital pores pass obliquely into the interior, at a short distance from the disc.

The base is flat, and the mouth lies in a very deep depression in the centre of the under surface; the opening is pentagonal, its wide walls being formed by the incurving of the basal portions of the areas; from each of the angles of the pentagonal opening, a deep furrow passes outwards towards the margin of the test, and becomes continuous with the median suture of the ambulacral areas. The jaws are absent in all the specimens we have examined. The anus is a small round aperture, situated near the posterior margin of the base of the test; in some specimens it is elongated in the transverse diameter, and measures about  $\frac{6}{20}$ ths of an inch across. The tubercles are nearly of the same size on the upper surface, and their summits are level with the test, so that the areolas which surround them are excavated out of the superficial layer of the calcareous plates. The intertubercular surface is ornamented with a microscopic granulation, disposed in circles around the areolas of the tubercles, and filling up all the intervening spaces. The tubercles at the base are larger and more closely set together than those on the dorsal surface; a row of five or six tubercles is seen on each of the interfissural bands of the poriferous avenues.

*Affinities and differences.*—*C. altus* has many traits in common with *C. rosaceus*. In the general outline, in the size, form and extent of the ambulacral areas, there is much resemblance; but the campanulate form of the dorsal surface, the smallness of the apical disc, and the truncature of the posterior border constitute differences which may be traced through all the varieties *C. altus* assumes. The thickness of the marginal fold, and the great development of the ambulacral flower, when compared with the thinness of the border and the limited extent of the ambulacra, distinguish at a glance *C. altus* from *C. Tarbellianus*, *C. marginatus*, and *C. scutellatus*. The dome-shaped upper



surface of *C. umbrella*, with its flattened ambulacral areas and convex prominent interambulacral spaces, its star-like apical disc and small mouth-opening, widely distinguish this species from *C. altus*. The affinity, however, is very near between *C. altus* and *C. crassicostatus*, the principal difference consisting in the more prominent rib-like prominence of the ambulacral areas.

*Stratigraphical position.*—This is the most abundant of all the Maltese Urchins. It is collected from bed No. 2, the yellow sand, associated with *C. Tarbellianus*, *Echinolampas Richardi*, and the other Echinoderms enumerated in the palæontological résumé given in the introduction to this memoir. The test is very well preserved in most specimens. Those from the sand with black particles are in the finest preservation. In this stratum the Urchins are accompanied with *Terebratula ampulla*, *Pecten squamulosus*, *P. Burdigalensis*, *Ostrea Virleti*, *O. navicularis*, and masses of *Lenticulites complanatus*, with *Cellepora mammillata*, *Escharina monilifera*, and other Bryozoa.

It has been collected from the Miocene beds of Port-de-Bouc, Saint-Miniato, Tuscany; Nice, Turin, Ile de Crète, Ile de Caprée; Bonifacio, Corsica; Oran. The Maltese specimens are contained in the British Museum, Geological Museum, Jermyn Street, and Bristol Museum; that from the Ile de Caprée is in our cabinet.

*History.*—First figured by Scilla, in 1670. The list of synonyms prefixed to this article exhibits the various epochs in its history. In none of the works we have consulted is any detailed description of the species given.

*Clypeaster marginatus*, Lam.

SYN. Scilla, Corp. Mar. tab. 11. fig. inferior.

*Clypeaster marginatus*, Lam. An. sans Vert. tom. iii. p. 290, 2nd ed.; Deslongchamps, Encycl. Méthod. t. ii. p. 200; Defrance, Dict. Sc. Nat. t. ix. p. 450; Blainville, Man. Act. p. 216; Grateloup, Foss. Ours. p. 40; Agassiz and Desor, Cat. raisonné, t. vii. p. 131; Desmoulins, Etudes des Echinides, no. 12. p. 218.

Test large, depressed, subpentagonal; margin thin, broad, and expanded; outline of the border undulated; ambulacral areas short, oval, and convex, rising abruptly from the thin border, and forming a dome-shaped elevation in the centre of the dorsal surface; base flat; mouth-opening small and pentagonal, with five simple sulci extending from the angles thereof to the margin; anus small, round, and submarginal.

*Dimensions.*—Antero-posterior diameter  $6\frac{7}{10}$  inches, breadth  $6\frac{4}{10}$  inches, height at the centre  $1\frac{8}{10}$  inch, thickness of the margin about  $\frac{1}{8}$ th of an inch.



*Description.*—This magnificent Urchin was figured by Scilla. The specimens before us agree very well with his drawing, although the foreshortening of the dorsal surface does not give a sufficient elevation to the ambulacral dome. The expansion of the margin, and thinness thereof, make a marked distinction between this and other cognate forms. The figures given by Grateloup of his *C. Tarbellianus* so exactly resemble the large specimen before us, belonging to the Bristol Museum, that we no longer doubt that species being a variety of *C. marginatus*. This species, like *C. altus*, exhibits much deviation from what may be considered to be its type form. A long and attentive study of the *Echinidae* has shown us, that such difference of outline is the rule, and not the exception, in the group; and that specific characters must be drawn from organic structure, and not merely from outline, if we wish our species to have a permanent place in the register of Nature's forms. The ambulacral areas are gracefully petaloid, rounded at the base and tapering towards the apex; they are convex and prominent, and extend about half-way between the vertex and the border, the test rising into a dome-shaped elevation in the region of the ambulacral areas. From the base of the areas to the circumference the margin is thin and expanded, and in this respect resembles a *Scutella* much more than a *Clypeaster*. The interambulacra between the poriferous avenues form convex elevations, which give a stellate character to the central dome, all the more conspicuous as it rises abruptly from the thin expanded margin, which is almost destitute of any elevation. The tubercles are larger on the basal than on the dorsal surface. In only one of the specimens before us is the inferior surface exposed. The base is flat. The pentagonal mouth is much smaller than in *C. altus*. In a specimen before us, measuring  $4\frac{7}{10}$  inches in length, the mouth-opening is  $\frac{7}{20}$ ths of an inch in diameter; the oral lobes curve inwards and form the interspaces thereof. Acute narrow ambulacral grooves pass outwards to the circumference.

*Affinities and differences.*—The thin and broadly expanded border of *C. marginatus*, with its short ambulacra, and central dome rising suddenly from the middle of the test, form a group of characters which enable us readily to distinguish this species from its congeners, with one exception, *C. Tarbellianus*. The excellent figures of this Urchin, given by Grateloup in his able Memoir\*, we have compared with two forms of *C. marginatus* from Malta, and we confess our inability to distinguish the differences between them and the author's type-figure. Agassiz

\* Mém. sur les Ours. Foss. de Dax, p. 40. pl. 1. fig. 5-6.



and Desor consider them to be the same, and we agree with their conclusion.

Grateloup observes, in describing *C. marginatus*, "We ought not to confound this species with that which I have described (*C. Tarbellianus*), with which it has great affinities of form, figure, and size. Its test has also a summit *très-renflé*, convex, and more elevated than in *C. Tarbellianus*; but its border is a little less *évasé*, and much less *tranchant*. The ambulacras are equally shorter, more *redressés*, and of a more oval and acute form." We have only to observe, that the characters here cited vary in different individuals, and at most amount to that limit of variation which we have already observed is seen in all species of Urchins, where a number of individuals of the same form are assembled for comparison.

*Stratigraphical range*.—This species is found in bed No. 2, the yellow sand, associated with *C. altus* and the other forms enumerated from that stratum; it has been found likewise in the Miocene beds of Touraine, Landes, Naros, Bonifacio, Santa Manza, Corsica; and Dax.

*History*.—First figured by Scilla, and afterwards by Leske. Fine specimens are contained in the Mus. Jermyn Street, British Museum, Bristol Museum, and the Collection of the Earl Ducie. The specimen in our cabinet is from Santa Manza, and was sent us by M. Michelin.

#### *Clypeaster folium*, Agassiz.

SYN. *Clypeaster folium*, Agassiz and Desor's Cat. rais., Ann. Sc. Nat. tom. vii. p. 131.

Test subheptagonal, much depressed; borders thin and sharp like *Scutella*; the petaloid ambulacra short, open, and expanded below; acutely lanceolate at the apex; ambulacral rosette small, and rising gently from the middle of the dorsum; poriferous zones lie in angular depressions; apical disc small, with a central prominent madreporiform tubercle.

*Dimensions*.—Antero-posterior diameter  $1\frac{17}{20}$  inch, transverse diameter  $1\frac{15}{20}$  inch, height  $\frac{3}{10}$ ths of an inch.

*Description*.—The general outline of this little Urchin, with the structure of its ambulacral rosette, clearly prove it to be a *Clypeaster*, whilst its depressed dorsal surface and thin border show it to have affinities with *Scutella*. Its outline is subheptagonal, with the anterior border slightly produced; the petaloid ambulacral areas are short and widely expanded below, tapering and acutely lanceolate above; their apices closely approach at the vertex, and meet at the circumference of the madreporiform



tubercle; the poriferous zones lie in angular depressions of the test, which, added to the convexity of the ambulacra, give a much greater relief to the petaloidal star than in other congeneric forms; the rosette formed by the petaloid portions of the ambulacra is small, being only a little more than one-half the diameter of the antero-posterior axis. The two rows of pores in the poriferous zones diverge gently from each other from the apex to the base, and there are from thirty to thirty-six pairs of holes in each zone. At the junction of the test-plates there are slight depressions on the surface, corresponding to the sutures between the same; the tubercles are small and set rather closely together, and the intervening granulation is quite microscopic; the border is exceedingly thin and entire; the base is concealed by firmly adherent matrix, which cannot be removed without fracturing the test.

*Affinities and differences.*—*C. folium* is allied to the young condition of *C. marginatus*, but the general flatness of the dorsal surface, and the absence of the campanulate elevation of the ambulacra in that species, added to the greater wideness of the basal opening of the petaloid ambulacral areas, and the more angular depression in the poriferous zones, afford points of comparison whereby these two species may be distinguished from each other: the thinness of the border and flatness of the dorsal surface are diagnostic characters by which it may be known from its congeners.

*Locality and stratigraphical position.*—The only specimen we know from Malta is that contained in Earl Ducie's collection; it was obtained from bed No. 2. We have another specimen before us, kindly sent by M. Michelin from the Miocene terrain of Balistro, in the Gulf of Santa Manza, Corsica. Agassiz and Desor, on the authority of M. Deluc, give the tertiary of Palermo as the locality of their specimen.

*History.*—This species is enumerated in the 'Cat. rais.' of Agassiz and Desor, and stated to be "espèce très plate, à bords tranchant." A detailed description of this interesting form is now given for the first time.

#### Genus SCUTELLA (Lamarck, 1816).

Form in general suborbicular, extremely depressed, almost always discoidal, more or less enlarged behind; border often tranchant, disc entire, margin lobed; posterior border truncated; upper surface slightly convex; ambulacral flower small, with elegant, flat, blunt leaves; poriferous zones forming nearly a closed arch around them at their base; genital pores four, set around the spongy madreporiform body; base flat; mouth small,



central, and pentagonal, with five ramose ambulacral furrows, sometimes branched, passing from the mouth to the border: tubercles microscopically small and very numerous; test thick, interior divided by pillar-like processes: auricles five; jaws forming a more or less elevated star composed of five distinct pieces, each formed by the organic union of two elements; teeth five, linear, and horizontal. This genus, as now limited, contains only fossil species, one of which is from the chalk of Georgia, United States; all the others are from the tertiary rocks.

*Scutella subrotunda*, Leske.

**SYN.** *Echinus Melitensis*, Scilla, De Corp. Marin. tab. 8. figs. 1-3.  
*Echinodiscus subrotundus*, Leske apud Klein, tab. 47. fig. 7. p. 206.  
*Echinus subrotundus*, Gmelin, Linné by Turton, vol. iv. p. 152.  
*Scutella subrotunda*, Lamarck, Animaux sans Vert. 2nd ed. tom. iii. p. 284; DeFrance, Dict. Sc. Nat. tom. xlviii. p. 230; Desmoulins, Etudes des Echinides, no. 24. p. 232; Grateloup, Ours. Foss. pl. 1. fig. 1. p. 36; Agassiz and Desor's Cat. rais., Ann. Sc. Nat. tom. vii. p. 132.

Test very flat, suborbicular; dorsal surface slightly convex; ambulacral areas exceeding in length the semi-diameter of the disc; base slightly concave; mouth central; anus marginal; ambulacral sulci bifid and branched.

*Dimensions.*—Antero-posterior diameter  $2\frac{8}{10}$  inches, transverse diameter  $3\frac{2}{10}$  inches, height  $\frac{7}{20}$ ths of an inch.

*Description.*—The test of this delicate Urchin is extremely flat; it has an irregular suborbicular discoidal form, with a thin sinuous margin; the dorsal surface is regularly and gently convex. The ambulacral areas are more than half the length of the diameter of the test; they are of an oblong form, lanceolate above, and more obtuse below. The pores in the avenues are widely apart; those in the inner series are round, whilst those in the external series terminate in slits that extend about half way across the interporiferous spaces. The apical disc is large, and the elements thereof are intimately soldered together. The madreporiform tubercle occupies the centre, and the four genital pores are pierced at unequal distances around it; the anterior pair are smaller and closer together than the posterior pair; the five ocular pores are very small. The margin of the disc is very thin, and has a sinuous outline; five of the curves thereof correspond to the ambulacral areas, and those appertaining to the postero-lateral areas are the deepest and best defined; a small notch indicates the site of the anal opening. The ventral surface is slightly concave. The mouth, about two lines in diameter, is central and subpentagonal; from the angles thereof, five ambu-



lacrul sulci radiate outwards, which soon become bifid, each trunk becoming dichotomously branched in old individuals. The anal opening is round, about half the diameter of the mouth, and is situate near the posterior border. The tubercles are small, and closely placed together; they are nearly of a uniform size on the dorsal surface.

*Affinities and differences.*—*S. subrotunda* so closely resembles *S. striatula*, *S. Faujasii*, and *S. producta*, that it requires an attentive study to discover the differences between them. As we possess single specimens only of these forms, determined and presented to us by M. Michelin of Paris, we are certain of their identity with the types they represent. The test is narrower before, and the ambulacral areas are much smaller in *S. striatula* than in *S. subrotunda*; the ambulacral areas are wider, their bases and apices are more obtuse, their sides flatter, and their terminations are more truncated, and the anus further from the border in *S. producta* than in *S. subrotunda*; the test is more convex on the dorsal surface, the apical disc is wider, the margin is thicker, the base flatter, and the anal aperture much further from the border in *S. Faujasii* than in *S. subrotunda*; the test is more produced posteriorly, the margin is more sinuous, the ambulacral areas are more equally lanceolate at the base and apex, the inner row of pores of the same curve more gracefully outwards, and the anus is further from the border in *S. Brongniartii* than in *S. subrotunda*. The size and pyriform shape of the ambulacral areas, the absence of sinuosities in the margin, and the greater convexity of the dorsal surface, distinguish *S. Paulensis* from *S. subrotunda*.

*Stratigraphical range and distribution.*—This species is not uncommon in the calcareous sandstone bed No. 4, and in the junction beds of No. 5, the hard cherty limestone, at Malta. It is found likewise "in the marine calcaire grossier in the environs of Bordeaux; at Bazas, Léognan, Gradignan, Douai, in Dauphiné; in Tourraine; in Anjou; at Montpellier." (*Grateloup*.)

*History.*—The table of synonyms shows the phasis of the history of this species, although other forms have been mistaken for it: in fact, the species of *Scutella* approach each other so closely, that, without an authentic series of specimens for comparison, similar mistakes may be made. This Urchin is found in all the public collections. The specimens before us are from Malta and Léognan.

*Scutella striatula*, Marcel de Serres.

SYN. *Scutella striatula*, Marcel de Serres, Géognosie des Terrains Tertiaires, p. 156; Desmoulins, Etudes des Echinides, no. 25.



p. 234 ; Agassiz, Monogr. des Scutelles, tab. 18. fig. 1-5. p. 81 ;  
 Agassiz and Desor's Cat. raison., Ann. Sc. Nat. tom. vii. p. 134.  
*Scutella subrotunda*, Grateloup, Mém. Ours. Foss. tab. 1. fig. 1. p. 36.

Test very flat, suborbicular ; dorsal surface very slightly convex ; ambulacral areas small, short and narrow, less than the semi-diameter of the disc ; base nearly flat ; mouth central ; anus marginal ; ambulacral sulci bifid.

*Dimensions*.—Antero-posterior diameter  $2\frac{7}{10}$  inches, transverse diameter  $2\frac{9}{10}$  inches, height  $\frac{7}{20}$ ths of an inch.

*Description*.—This Urchin so nearly resembles *S. subrotunda*, that it may be doubted whether it is entitled to rank as a distinct species, or ought rather to be considered as a variety of that form. The two specimens before us are from localities widely apart from each other. One is from the Miocene terrains of Terre-Nègre, near Bordeaux, the other from the calcareous sandstone of Malta. Still the similarity exhibited by these specimens, and the persistence of those characters which have been considered as specific, incline us to think that *S. striatula* may be distinct from *S. subrotunda*. The ambulacral rosette is small ; the areas are short, narrow and lanceolate, and are less than the semi-diameter of the test ; the apical disc is small ; the madreporiform tubercle is prominent and central ; the granulations are almost microscopic ; the base is flat ; the mouth is small and central, and the anus marginal ; the ambulacral sulci are bifid ; the margin of the test is thin, and the sinuosities well marked. Let the student compare these characters with the detailed description of *S. subrotunda* given in the preceding article.

*Locality and stratigraphical range*.—It was collected from bed No. 4, the calcareous sandstone at Malta, where it is not common. Our French specimen is from the middle tertiaries of Terre-Nègre.

#### Genus ECHINOLAMPAS (Gray, 1835).

Test of an elongated or subdiscoidal form ; petaloid portion of the ambulacral areas large, generally elevated into convex leaves, contracted towards the base, where they cease to rise above the level of the test ; inferior surface concave towards the mouth, which is median, symmetrical, pentagonal, and surrounded by five lobes ; basal portions of the ambulacra with five short poriferous zones around the mouth ; anus transversely oblong and inframarginal ; apical disc small and excentral, five genital and five ocular plates placed around the madreporiform body ; tubercles small, uniform and numerous, sunk in the test, and surrounded by ring-like areolas. Three species are living in the seas of warm latitudes ; the others are fossil, mostly in



the tertiary rocks. A few are found in the upper stages of the cretaceous series.

*Echinolampas Kleinii*, Goldf.

SYN. *Clypeaster Kleinii*, Goldfuss, Petrefact. Germaniæ, tab. 42. fig. 5. p. 133.

*Echinolampas Kleinii*, Desmoulins, Etudes des Echinides, p. 346. no. 14; Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. vii. p. 166.

Test ovato-orbicular in the outline, with the posterior border slightly produced; dorsal surface convex, posterior half more elevated than the anterior; ambulacral areas unequal, usually on a level with the general surface, but sometimes more convex and prominent than the rest of the test; apical disc excentral and anterior; base concave; mouth excentral and anterior; anus inframarginal; both mouth and anus transversely oblong.

*Dimensions*. — Antero-posterior diameter  $2\frac{9}{20}$  inches, transverse diameter  $2\frac{15}{20}$  inches, height  $1\frac{9}{20}$  inch.

*Description*. — This Urchin has been well figured by Goldfuss, and is a very characteristic fossil of the Miocene tertiary beds of Westphalia, where it appears to be common. The specimen before us is the only one we know from Malta. The circumference is nearly ovato-orbicular, slightly inclining to an obsolete pentagon, with the posterior border most produced. The dorsal surface is highly convex, the posterior half being much more so than the anterior. The ambulacral areas are unequal, as regards length, width and development; the single anterior area is the shortest and narrowest, the antero-laterals are next in size, and the postero-laterals are the most fully developed; they have all a lanceolate form, with blunt apices. The surface of the areas is on a level with that of the interambulacra, in the specimen before us; but in some of the Westphalian Urchins the ambulacral areas form convex projections on the surface of the test. The poriferous avenues, extending down more than two-thirds of the dorsal surface, are well marked in our specimen, and lie in depressions of the test; they consist of two series of pores; the internal holes are round, the external run into oblique slits that have a direction upwards and inwards; the pores on the right and left sides of the areas do not always correspond in length; thus, the anterior pores in the antero-lateral areas are often only half as long as those on the posterior side of the same areas, and we see a similar inequality, although not to the same extent, in those of the single ambulacrum. The anterior and posterior pair of the interambulacral areas are much alike in



form and development; but the single interambulacrum is different, it forms a more convex eminence than the others above, and is produced into a slight caudal appendage behind. The apical disc is small and excentral, situated nearer the anterior border. The madreporiform body occupies the centre, around which the four genital holes are pierced. The base is concave; the mouth is nearer the anterior border, is transversely oblong, and surrounded by five lobes, formed by the termination of the interambulacra; the posterior single lobe is the largest; the anterior pair are next it in size, and the lobes of the posterolateral areas are the smallest and most contracted. Between the five oral lobes, the poriferous terminations of the ambulacral areas form petaloidal depressions, which are perforated with numerous holes; these run out and form lines which indicate the basal boundaries of the areas. The anus is transversely oval,  $\frac{4}{10}$ ths of an inch in its long diameter, is more convex on its anterior than its posterior border, and is situated close to the margin; it is rather larger than the mouth-opening. The tubercles are small, uniform in size, and closely set together on the dorsal surface, and longer and more widely apart on the base.

*Affinities and differences.*—The great convexity of the dorsal surface, the greater elevation of the posterior than the anterior half thereof, the inflated ridge-like eminence formed by the single interambulacrum, and the well-defined character of the poriferous avenues, form a group of characters by which *E. Kleinii* is distinguished from its congeners. It has many points of resemblance in common with *E. ovalis*; but the greater length of the ambulacral areas in this species makes a marked distinction between them; moreover, in *E. Kleinii* the base is concave, whilst in *E. ovalis* it is convex; the latter form is likewise flatter and more oval, and its apical disc more excentral than in *E. Kleinii*.

*Stratigraphical position.*—Collected at Malta, from bed No. 2, where it is very rare. It is found, according to Goldfuss, in the Miocene beds at Bünde, Osnabruck, Astrapp, and Merminghüfen, in Westphalia.

*History.*—Admirably figured and well described by Goldfuss. The only Maltese specimen we have seen of this species is that collected by the Earl Ducie, which is in his lordship's museum.

*Echinolampas Deshayesii*, Desor, sp. Pl. IV. fig. 3 a-d.

SYN. *Echinolampas Hayesiana*, Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. vii. p. 166.

Test oval, depressed; ambulacral areas narrow; the poriferous zones contracted, without apparent connecting transverse sulci;



apical disc small and nearly central; base convex; mouth and anus large.

*Dimensions.*—Antero-posterior diameter  $2\frac{1}{10}$  inches, transverse diameter  $1\frac{9}{10}$  inch, height  $\frac{8}{10}$ ths of an inch.

*Description.*—The form, size and structure of the ambulacral areas afford the best guide to a knowledge of the numerous species of this group. The Urchin before us has an oblong form, depressed at the dorsal surface, convex at the base, and slightly produced posteriorly. The ambulacral areas are narrow at their widest part; they are about one-sixth the width of the posterolateral interambulacra at the border. The poriferous zones are narrow, and extend rather more than half-way down the dorsal surface; the pairs of pores are placed closely together, and the slit or sulcus, which in general unites the inner and outer series of pores together, is absent in this species, or at all events is not apparent in the individuals before us; the holes of both rows are nearly of the same size. The interambulacral areas are wide; the antero-lateral are the narrowest; the single interambulacrum is slightly produced in the region of the anal opening. The apical disc is small, and situated near the centre of the test, rather nearer the anterior than the posterior border. The disc consists of a central madreporiform spongy body, around which the genital and ocular plates are arranged in a circle; their sutural lines of union, however, are concealed, and can only be seen in weathered specimens. The base is convex; the mouth is very large, and lies in a deep depression opposite the vertex; it is surrounded with five oral lobes of small size, with intervening petaloidal depressions, perforated with holes in pairs. The interambulacrum is slightly produced posteriorly. The anus is a large transversely oblong opening, situated near the margin. The border of the test is rather obtuse. The tubercles are of uniform size on the dorsum, and are larger and less numerous than in *E. Kleinii*.

*Affinities and differences.*—This species resembles much *E. scutiformis*, but is distinguished from it by the greater narrowness of the ambulacral areas, and the absence of the transverse slits or sulci by which the pairs of pores in these avenues are in general united. The tubercles are more abundant on the dorsal surface in *E. Deshayesii*, and the dorsal surface is not so much elevated in that species as it is in *E. scutiformis*.

*Locality and stratigraphical range.*—This species was collected from bed No. 2, the yellow sand, at Malta. Desor gives the "Tert. moyen. d'Oran (Algérie) et de Carthagène (Catalogue)" as his localities; and we have received from M. Michelin of Paris a specimen from the Miocene terrain of Balistro, Cor-



sica, which has enabled us to identify the Maltese Urchin, and make out the preceding description, the first given of this pretty form.

*Echinolampas Richardi*, Desmarest.

SYN. *Scutum ovatum Issyaviense*, Klein, Echinodermatum, tab. 20. fig. a, b, § 77. p. 29 (?).

*Clypeaster Richardi*, Desm. Dict. Sc. Nat. t. liv. tab. 5. p. 12, spec. ined. in litt. ; Grateloup, Mem. Echid. Foss. tab. 1. fig. 8 a, b, p. 44.

*Echinolampas Richardi*, Desmoulins, Etudes sur les Echinides, p. 342. no. 4.

*Echinolampas Laurillardii*, Agassiz and Desor, Ann. Sc. Nat. t. vii. p. 165.—Scilla, Corp. Mar. tab. 11, top figure, showing the base only.

Test oblong, produced posteriorly, rounded before, flattened laterally, caudate posteriorly ; dorsal surface convex, elevated ; base concave ; mouth central ; anus inframarginal, lodged in a caudal process of the interambulacrum ; ambulacral areas narrow, with contracted poriferous zones.

*Dimensions*.—Antero-posterior diameter  $1\frac{7}{10}$  inch, transverse diameter  $1\frac{9}{20}$  inch, height  $\frac{17}{20}$ ths of an inch.

*Description*.—The specimen before us is so much injured on the dorsal surface, that we are unable to give a detailed description of this species, which appears to be not uncommon at Malta. The ambulacral areas are narrow ; the pores lie in contracted zones, and the pairs are unconnected by sulci ; the avenues extend more than half-way down the sides of the test ; the dorsal surface is elevated and convex, rounded before, and sloping gradually from the vertex to the posterior border ; the apical disc is very excentric, and placed near the anterior border ; the circumference of the test is of an irregular oblong figure, round before, flattened on the sides, and produced behind : the base is undulated by the elevations of the interambulacra and the depressions of the ambulacral areas ; the single interambulacrum is prolonged backwards, and is truncated at the sides and at the posterior border, which gives it a caudate form. The mouth is nearly central, and is sunk in a deep depression ; it is transversely oblong, and is surrounded by five oral lobes, having five petaloidal depressions of the ambulacral areas, with three pairs of pores in each petal between them ; the anus is larger than the mouth-opening, and is situated at the inframarginal border of the caudate process of the interambulacrum ; it has a transversely oblong form, and is more convex before than behind. The Urchin figured by Grateloup is much larger than the Maltese specimens that have come under our notice ; but



the central mouth-opening and the form of the interambulacrum induce us to think that it is only a gigantic variety of *E. Richardi*, and not *E. Kleinii*, as supposed by Desmoulins. The identity of this species with Klein's *Scutum ovatum Issyaviense* may or may not be correct, as the figures of fossils in that work are not in every case to be depended on.

*Affinities and differences.*—*E. Richardi* has some resemblance to *E. Kleinii*, but the narrow ambulacral areas, the flattened sides, and produced caudate interambulacrum in *E. Richardi* afford points of distinction by which these allied forms may be readily distinguished from each other. In *E. Kleinii* the base is more concave, the mouth nearer the anterior border, and with larger oral lobes than in *E. Richardi*. The dorsal surface presents other points of difference: in *E. Kleinii* the posterior half of the test is the most elevated, whilst in *E. Richardi* it slopes rather abruptly downwards from the vertex to the truncated posterior border.

*Locality and stratigraphical range.*—It was collected from bed No. 2, at Malta; the specimen before us is the only one in Earl Ducie's cabinet. The Geological Museum in Jermyn Street possesses an interesting series of this form, which are all from the same island. Grateloup found the large variety at Dax, in the "faluns bleus de Narrosse," and adds that it is found likewise at Paris, Montpellier?, Bordeaux, and the Vicentin: Desmoulins adds St. Paul-trois-Châteaux (Drome) as another locality.

#### Genus CONOCLYPUS (Agassiz, 1839).

Test thick, hemispherical or oval, and always much elevated; ambulacral areas above long, wide, converging at the summit, a little contracted below; mouth median, symmetrical, pentagonal, and surrounded by five large lobes; base flat, basal portion of the ambulacra with poriferous zones around the mouth-opening; anus inframarginal, sometimes transversely oblong. The species are all fossil, and belong mostly to the tertiary rocks: one is found in the Maestricht chalk. This genus is nearly allied to *Echinolampas*. The character upon which M. Agassiz relied as diagnostic between *Conoclypus* and that genus, the direction of the anus, which is stated\* to be elongated in the antero-posterior diameter in *Conoclypus*, and in the transverse diameter in *Echinolampas*, does not hold good in all the species.

#### *Conoclypus plagiosomus*, Agassiz.

SYN. *Conocylus plagiosomus*, Agassiz and Desor, Cat. rais., Ann. Sc. Nat. 3rd series, tom. vii. p. 168.

Test thick, large, highly convex; border acute; outline round,

\* Ann. Sc. Nat. tom. vii. p. 167.



inclining to oblong, being slightly compressed on the sides; ambulacral areas narrow, even with the interambulacra; poriferous zones very narrow; the inner and outer pores nearly equal in size, and extending through three-fourths of the areas; base concave; mouth nearly central, with large oral lobes; anus large, transversely oblong and inframarginal.

*Dimensions.*—Antero-posterior diameter 6 inches, transverse diameter  $5\frac{8}{10}$  inches, height 3 inches.

*Description.*—This noble Urchin has been mistaken for *C. conoideus*, Lamk., as in form, size, and some of its general characters it resembles that type species; but the eye of the practised zoophytologist detects, in the structure and narrowness of the poriferous zones, an organic character sufficient to enable him to separate it from that species. The general outline of the base is round, inclining to oval from the gentle compression of the sides thereof; the dorsal surface is much elevated and highly convex, and the vertex is situated in front of the centre of the dome; the ambulacral areas are nearly one-fourth the width of the interambulacral areas at the border, and are level with them; they are nearly of a uniform width throughout, becoming lanceolate at their upper fifth: the poriferous avenues are very narrow, and extend three-fourths of the distance between the apex and the border: the pores in the avenues are only about one line apart, and are united by short slits directed obliquely upwards and inwards at nearly equal spaces apart from the base to the apex; the pores in the outer and inner series in each zone are about the same size throughout: the narrowness of the poriferous avenues forms a very important character in this species, by which it is distinguished from an allied form, *C. conoideus*. The interambulacra are of a triangular form; the antero-lateral are the smallest, and the postero-lateral and single interambulacrum of about the same size are the largest: the apical disc is small, and situated nearer the anterior than the posterior border, which occasions a slight difference between the angle of inclination of the anterior and posterior sides of the test: the centre of the disc is occupied by a prominent button-like spongy madreporiform body, around which the genital and ocular plates are arranged, but their lines of suture can only be distinguished in weathered specimens, or by removing the superficial layer of the plates. The entire surface of both areas is covered with tubercles, very much alike both as regards size, form, and irregularity of arrangement; the only parts exempt from tubercles are the interporiferous septas of the avenues: the base is concave: the mouth is situated in the centre of the disc, and is surrounded by five large prominent lobes: the ambulacra form petaloid depressions between the oral lobes, in which a number of pores



are clustered together in pairs. The anus is a large, transversely oblong opening, placed immediately beneath the posterior margin; from it to the mouth an elevated ridge of the test runs: the single interambulacrum is slightly produced posteriorly where the anus terminates: the tubercles are larger, and placed at greater intervals apart on the base than on the dorsal surface: the marginal fold of the test forms an acute angle, and on the border thereof the tubercles are clustered closer together in greater numbers, with smaller interspaces between them, than in any other part of the skeleton.

*Affinities and differences.*—This species very much resembles in form and size *C. conoideus*, but it is readily distinguished from it by the following characters: the ambulacral areas are smaller, the poriferous zones are narrower, and the outer and inner pores of each pair are nearly of the same size, whilst the septas between the pores are thicker; the dorsal surface is not so much elevated, the base is concave, the anus is large and transversely oblong, and the mouth possesses very prominent oral lobes.

*Locality and stratigraphical range.*—This Urchin was collected at Malta, from bed No. 2. The fine specimen before us belongs to the Bristol Institution; we possess one, through the kindness of M. Michelin, from the celebrated Urchin bed of Balistro (Corsica); it is found likewise in the “Molasse du Cap Couronne près Martigues.” (*Michelin.*)

[To be continued.]

### XIII.—Notes on British Zoophytes, with descriptions of new species. By the Rev. THOMAS HINCKS, B.A.

[With two Plates.]

#### NEW SPECIES OF SERTULARIA.

THE beautiful form which I am about to describe has hitherto been found, so far as I am aware, only in the Shetland seas. Two specimens in fine condition, and fortunately laden with vesicles, were obtained by Miss Cutler amongst the refuse of Mr. Barlee's dredge. To her great liberality I am indebted for one of these specimens (as for many other interesting zoophytes), and for the opportunity of presenting a figure and description of the species to the readers of the ‘Annals.’

#### Genus SERTULARIA.

##### *S. alata* (Hincks).

Pinnate, blackish-brown, highly varnished; *pinnæ* winged; *cells* opposite, adherent below, the upper part suddenly divergent,





Wright, Thomas. 1855. "XII.—On Fossil Echinoderms from the Island of Malta; with notes on the stratigraphical distribution of the fossil organisms in the Maltese beds." *The Annals and magazine of natural history; zoology, botany, and geology* 15, 101–127. <https://doi.org/10.1080/037454809495402>.

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