11. *On BRITISH CRETACEOUS PATELLIDÆ and other Families of PATELLOID GASTROPODA.* By J. STARKIE GARDNER, Esq., F.G.S.
(Read January 24, 1877.)

[PLATES VII.-IX.]

A STUDY of this group of Cretaceous Gastropoda, commenced some twelve months since, brought to light unexpectedly so many forms new to our Cretaceous series, some of the genera to which they are referred having, indeed, never before been found fossil, that I have deemed the result of sufficient importance to form the subject of a paper which I now lay before this Society. Conical or patelloid shells make their appearance amongst the earliest known Mollusca; and from them seem to have been differentiated the convoluted forms represented by *Bellerophon*: in the earliest times these two typical forms can hardly be separated one from the other, being linked together by spirally twisted capuliform shells. So impressed does Pictet seem to have been with this that he, in his great work the 'Terrains Crétacés de Ste. Croix,' includes *Bellerophina* in the Fissurellidæ. The families, species of which are here noticed, have been unusually persistent in form, having come down, in some cases, almost unchanged, even specifically, to the present day. The aspect of the group is therefore more recent in appearance than that of any other group of Gastropods from rocks of the same age. Although a considerable advance is here made in our knowledge of these families, from these particular rocks, yet the number of species described from single specimens tells us unmistakably how much more remains to be learned, and the inference is forced upon us that we must still possess, though undiscovered, a far greater variety of representatives of these mollusca. By the absence of many genera from our Cretaceous rocks which are found in earlier rocks, such as *Rimula*, or in contemporaneous rocks of other countries, such as *Fissurella*, *Parmophorus*, *Infundibulum*, *Galerus*, and the upper valves of *Hipponyx*, this inference is greatly strengthened.

The study of these families is perhaps of more importance to the geologist than that of most others of the Gastropoda, as the depth at which each form lived is approximately defined, and their presence or absence is therefore of assistance in understanding the physical conditions under which marine strata have been deposited. For instance, from the complete absence of fissured forms from the Gault and Greensand of Folkestone, Cambridge, and Blackdown, while they are abundantly represented elsewhere in rocks of approximately the same age, we may infer that these seas were shallow. Further remarks are appended to some of the specific descriptions; especially noteworthy are some remarkable cases of mimicry among the Calyptræidæ. A table of genera and species is appended. In this table the * signifies that the genus is altogether new in Cretaceous rocks; †, new to Europe; N, that the species is new. In the

columns an I denotes that the species is described from not more than two specimens, × that the species is comparatively abundant.

	Neocomian.	Gault.	Upper Greensand.	Chalk.
PATELLIDÆ.				
<i>Tectura tenuicosta</i> , D'Orb.	.....	×	I	
— <i>tenuistriata</i> , Seeley.....	.....	I		
— <i>formosa</i> , N	I			
— <i>plana</i> , N	I			
* <i>Helcion</i> Meyer, N	I			
† <i>Anisomyon vectis</i> , N	I			
* <i>Scurria calyptræiformis</i> , N.....	I			
— <i>depressa</i> , N.....	I			
FISSURELLIDÆ.				
<i>Emarginula neocomiensis</i> , D'Orb....	×			
— <i>valangiensis</i> , P. & C.	I			
— <i>puncturella</i> , N	×			
— <i>Gresslyi</i> , P. & C.	.....	.....	×	×
— <i>divisiensis</i> , N	.....	.....	×	
— <i>sanctæ-catharinæ</i> , Passy	.....	.....	×	
— <i>affinis</i> (?), Sby.	.....	.....	.....	I
— <i>ancistra</i> , N	.....	.....	I	
— <i>Meyeri</i> , N	.....	.....	I	
— <i>unicostata</i> , Seeley, MS.....	.....	.....	.....	I
* <i>Puncturella antiqua</i> , N	.....	.....	I	
CALYPTRÆIDÆ.				
<i>Calyptraa Cooksoniæ</i> , Seeley	.....	×		
(<i>C. sanctæ-crucis</i> , P. & C.)				
— <i>concentrica</i> , N.....	.....	×		
— <i>Grayana</i> , Tate.....	.....	.....	.....	I
<i>Crepidula gaultina</i> , Buw.....	.....	×		
— <i>alta</i> , Seeley	.....	I		
— <i>chamæformis</i> , N.....	I			
* <i>Crucibulum giganteum</i> , N	I			
CAPULIDÆ.				
<i>Pileopsis neocomiensis</i> , N	I			
— <i>dubia</i> , N	.....	I		
— <i>Seeleyana</i> , N	.....	.....	I	
<i>Hipponyx Dixoni</i> , Desh., N	.....	.....	I	×

PATELLIDÆ.

TECTURA FORMOSA, sp. n. Lower Greensand. Pl. IX. figs. 10, 11, 11 a.

Shell depressed, thin; apex minute, situated $\frac{1}{3}$ anterior; sculpture consisting of about fifty very finely tuberculated ribs, between which are slight, radiating, simple, parallel striae. Neither the ribs

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nor the striæ are regularly equidistant; the shell near the base possesses short oblique striæ (fig. 11 a).

This shell differs from *T. tenuicosta* in being more regular and elevated—and by its ribbing, which is more uniform, closer, and most delicately tuberculated. It was found by Mr. Meyer in the Folkestone beds of the Lower Greensands at Shanklin.

The specimen has apparently a perforated apex, and might at first sight be regarded as a *Fissurella*; but even the most careful examination leaves it doubtful whether the perforation is or is not due to accidental abrasion; but the ornamentation, consisting of tuberculated striæ, is so characteristic of *Tectura*, and so different from that of *Fissurella*, which is almost invariably cancellated, that there can be practically little doubt as to which family it belongs to. *Fissurella* is still unknown from British Cretaceous rocks.

TECTURA PLANA, sp. nov. Lower Greensand. Pl. VIII. figs. 27–29.

Shell minute, laterally compressed, very elongated, cup-shaped; apex recurved; posterior region without ribs, but with lines of growth; surface smooth, but under the microscope rugose or weathered. L. 4 millims., b. 2 millims., ht. 2 millims. Unique. Found, by Mr. Meyer, at East Shalford.

The shell could with equal probability be assigned to the *Lepetidæ*, some of which it much resembles; but there are also smooth forms of *Tectura* still existing.

TECTURA TENUICOSTA, D'Orb. Gault. Pl. VII. figs. 19, 20.

Shell oval, depressed, thin; apex acute, subcentral, or $\frac{1}{3}$ anterior; sculpture fine, radiating, irregular ribs, almost absent on the anterior region, crossed by still finer striæ, and occasional lines of growth. The cast is smooth.

This shell seems to characterize the Gault, where it is not uncommon. Sowerby, 'Min. Conch.', figures a cast of this shell from Folkestone, together with a Lias cast, as *Patella levis*. Michelin, in 1834, figured the species in the 'Mémoires Soc. Géol.' vol. iii. pl. 12. fig. 2. D'Orbigny describes it fully, with figures, in the 'Paléont. Franc.' Pictet and Roux have described it as *Acmaea gaultina*, distinguishing this form from *T. tenuicosta* "par son angle apical plus ouvert, et par la position plus antérieure du sommet."

There is little doubt that some smooth limpet-like casts from the Cambridge Greensand are of this species. A rather larger specimen than the average is figured (Pl. VII. fig. 20). It also occurs at Devizes.

Amongst living shells, *T. tenuicosta* most resembles *T. testudinalis*, Müll., Greenland, and *T. Candeara*, D'Orb., from St. Vincent, both of which are extremely variable in height.

TECTURA TENUISTRIATA, Seeley. Gault. Pl. VII. fig. 18.

Minute, thin, higher than the last species, very finely striated. The specimen, still unique, is in the Cambridge Museum. It was

described and figured in the 'Ann. and Mag. Nat. Hist.' for April 1861. The figure is unfortunately not very accurate.

HELCION MEYERI, sp. nov. Lower Greensand. Pl. VII. figs. 8-11.

Cap-shaped, depressed, anteriorly convex, posteriorly excavated; apex recurved, posteriorly projecting beyond the margin; sculpture, about twenty-two strong, rounded, imbricated ribs.

This unique shell was found by Mr. Meyer in the Folkestone beds of the Lower Greensand at Shanklin. It is an undoubted *Helcion*, and represents the earliest known appearance of that genus, which had not previously been found fossil. It bears a distant resemblance to *Emarginula Desori*, P. & C. The figure should have represented the shell as symmetrical.

ANISOMYON VECTIS, sp. nov. Neocomian. Pl. IX. figs. 3, 4, 5.

Oval, slightly quadrate, elevated, thin; apex small, pointed, sub-central, placed rather anteriorly; surface smooth or polished, without radiating ribs or lines, but with concentric, parallel, undulating lines of growth.

This species resembles *Helcion (Acmaea) conicum* of D'Orb., from the Upper Gault, and *Tectura elevata**, Forbes, figured by Stoliczka in the 'Pal. Indica,' but is thinner and more delicate than either.

Anisomyon is a Cretaceous genus, founded by Meek and Hayden †. The specimens just described cannot be examined interiorly; so that the form of the muscular scar is unknown; but the smooth aspect, thin shell, and minute apex leave little doubt they are correctly placed in this genus.

Two specimens are known, which were obtained from the Cracker Rocks of Atherfield, and are now in the Woodwardian Museum.

SCURRIA CALYPTRÆIFORMIS, sp. nov. Lower Greensand. Pl. VII. figs. 15, 16.

Shell ovate, or suborbicular, elevated, convex posteriorly, rather flattened anteriorly; apex anterior, slightly obtuse. The cast near the margin retains traces of fine radiating ribs, but is otherwise smooth, with irregular lines of growth.

The specimen, now in the British Museum, has a *Calyptrea*-like aspect, but resembles most strongly *Scurria mitra*. It is from the Lower Greensand of Seend.

SCURRIA DEPRESSA, sp. nov. Lower Greensand. Pl. VII. fig. 17.

Of the same form as the last species, slightly more depressed, but with an entire margin without the least trace of ribbing; more specimens may establish their identity. Two specimens are in the British Museum, which were found with the last.

* Geol. Soc. Museum.

† 'American Journal of Science and Arts,' May 1860 (2nd ser.), vol. xxix.

FISSURELLIDÆ.

EMARGINULA NEOCOMIENSIS, D'Orb. Neocomian. Pl. VIII. figs. 1-6.

Shell oblong, twice as long as high, solid, conical, convex anteriorly, slightly concave posteriorly; apex small, recurved, about $\frac{2}{3}$ posterior; sculpture, 26 to 30 strong narrow principal ribs, and the same number of intermediate ribs, the last varying in prominence in different specimens, and not appearing at all until the shell is well advanced in growth; the ribs are cancellated in full-grown specimens by 25 to 30 elevated lines of growth, which pass over the secondary, but not over the principal ribs (fig. 6a). In two very perfect specimens in the Leckenby collection, Woodwardian Museum, there is a node at every intersection (figs. 1, 2, 2a). The slit is short, and placed rather to the right of the median line. D'Orbigny's figure in the 'Pal. Franç.' has this character rather exaggerated; and it usually occupies a more symmetrical position. Pictet and Campiche had five examples under examination, in all of which the fissure deviated. Amongst the number of specimens which I have examined, the fissure, I find, usually deviates; but the character is not constant. The slit is bordered on each side by a principal rib; the scar forms, between two of the principal ribs, a narrower region than the space occupied by an intermediate rib, and is imbricated transversely. There is no trace of spiral growth in any of the specimens. The cast is smooth, except at the margins, where it bears impressions of all the ribs. The line of fissure presents a broad furrow, extending from near the apex to the margin, in the centre of which is a slightly raised region terminating at the fissure (Pl. VIII. fig. 2).

Although very distinctly characterized, it has been confounded with *E. Guerangeri*, D'Orb., of the Chloritic Marl, from which it is readily distinguished by its greater number of ribs.

Pictet and Campiche, 'Terr. Crét. de Ste.-Croix,' mention a variety which has the primary and secondary ribs equally prominent; there is a similar example in the Woodwardian Museum, from Donnington, Lincolnshire, which has about 54 ribs and a median fissure, and may prove distinct when more specimens are available.

There is apparently no specific difference between the specimen from the Atherfield clay, and one from Speeton, in the Jermyn-street Museum, named *E. fissaria*, Forbes.

The largest specimen I have seen is from Seend, and is in the British Museum (figs. 3, 4), measuring l. 25 millims., b. 18 millims., ht. 13 millims., these dimensions being considerably in excess of those usually met with.

E. neocomiensis, D'Orb., was first described as *E. reticulata* by Leymerie, in 1842, and was figured the next year by D'Orbigny in the 'Pal. Franç. Terr. Crét.' vol. ii. p. 392, pl. 234. figs. 4-8, and again by Pictet and Campeche, 'Terr. Crét. de Ste.-Croix,' pl. xcvii. figs. 9-11.

The species is very generally distributed throughout the Lower Greensand, which it characterizes, and has, no doubt, as wide a

range on the Continent as it has in England. Many specimens have been found at Atherfield, others at Redcliffe, Isle of Wight, Devizes, East Shalford, Sevenoaks, Seend, Donnington, Speeton, Furze Hill, Farringdon, &c.

Stoliczka, in the 'Pal. Indica,' remarks that the furrow in *Sub-emarginula*, Blainv., is lateral, and that this and the other species possessing the lateral emargination might form a subgenus. The character, however, is seen in this species to be inconstant.

EMARGINULA VALANGIENSIS, Pict. & Camp. Lower Greensand. Pl. VIII. figs. 7-9.

The species is described by Pictet and Campiche as being somewhat quadrilateral, and possessing 26 ribs, with intermediate striæ, only the accessory ribs of *E. neocomiensis* being absent. The form of the scar on the cast figured by them differs from that of the species last described. Mr. Meyer has found specimens at East Shalford which may probably belong to this species, but which are unfortunately too imperfect to determine with any degree of certainty.

EMARGINULA PUNCTURELLA, sp. nov. Lower Greensand. Pl. VIII. figs. 10, 11.

Shell minute, oval, cap-shaped, elevated, compressed laterally; apex sharp, recurved, overhanging posterior margin; sculpture, 30 strong ribs, cancellated by transverse lines; each interspace possessing two pits, arranged horizontally in pairs.

The cast shows a fissure extending about $\frac{1}{3}$ the height of the shell, leaving a deep, sulcated scar on the remainder. This scar possesses an elevated median region, with strong imbrications resembling the teeth on a cog-wheel (fig. 11 *b*). The dimensions are, l. 7 millims., b. 5 millims., ht. 4 millims.

This species very much resembles *E. neocomiensis*; and the pits on the cast might be supposed to represent, in but a very slightly modified manner, the more quadrate interspaces between the ribs and striæ of that species. The shell, however, is higher and more compressed, the fissure is relatively longer, and the scar approaches much nearer to the apex. It appears to present certain affinities with *Rimula*.

The specimens figured are selected from several found by Mr. Meyer at East Shalford, and represent the shell natural size and magnified; the ornamentation being drawn from a cast, is shown in elevation instead of depression.

EMARGINULA GRESSLYI, Pict. and Camp. Upper Greensand to Grey Chalk. Pl. VIII. figs. 12, 13, 16-18.

Shell ovate, or rounded, rather depressed; apex subcentral or $\frac{2}{3}$ posterior, slightly recurved; sculpture, about 200 fine ribs, crossed by still finer transverse lines, and marked also by lines of growth. The reticulations, which are very delicate, have no nodes at the intersections. The fissure is long, extending one fourth or more between margin and apex, and leaving on the rest of the distance a raised, ridge-like scar, which is sometimes depressed centrally.

This species is very variable in general form. The largest specimen figured measures, l. 25 millims., b. 19 millims., ht. 8 millims. and was obtained from the east-bed of the Grey Chalk near Dover (figs. 12, 13). Another from the Chalk Marl of the Isle of Wight is proportionally higher, measuring 19, 14, and 9 millims. respectively (figs. 16, 17). Other specimens more nearly resembling Pictet and Campiche's figure (Terr. Crét. de Ste.-Croix, pl. xcviii. fig. 10) are from the Cheddington Chloritic Marl (fig. 10); whilst another from Devizes is nearly orbicular. These differences of form are, no doubt, partly caused by pressure.

The excellent figure of *E. pelagica*, in Passy's 'Géol. de la Seine Inférieure,' is, if any reliance can be placed on figures unaccompanied by descriptions, taken from a specimen of the same species as that here figured from the Grey Chalk; but D'Orbigny's figure of *E. pelagica* has an altogether different appearance. I have not seen the original specimens; but should they be identical, Passy's name, published in 1832, would have priority. *E. flexuosa*, De Ryckh., resembles our species, but has the ribs flexuous.

EMARGINULA DIVISIENSIS, sp. nov. Upper Greensand. Pl. VIII. figs. 19, 20.

Shell ovate, convex anteriorly, flattened posteriorly; apex sub-central. The cast, which alone is known, bears traces of numerous ribs, reticulated by lines of growth, the ribbing being coarser than that of *E. Gresslyi*. The fissure is very short, leaving a deep and wide depressed region, very different in appearance from the raised fissural scar of the species last described.

From Devizes, now in the British Museum.

EMARGINULA SANCTÆ-CATHARINÆ, Passy. Upper Greensand. Pl. VIII. figs. 21, 22.

Shell in form like a Phrygian cap, compressed laterally, convex anteriorly, much hollowed out posteriorly; apex beak-like and recurved, overhanging the posterior margin; sculpture, about 28 ribs, two or three of which are stronger than the rest, reticulated by finer transverse lines. The fissure is short, narrow, and very distinct; fissural scar broad, depressed, with a narrow central ridge. The dimensions of the figured specimens from Whitenore are, l. 12 millims., b. 9 millims., ht. 10 millims. There is no doubt that our shell is identical with the *E. sanctæ-catharinæ* of Passy, described in the 'Géol. de la Seine Inférieure,' 1832, p. 335, pl. xvi. fig. 1, the figure, however, being extremely obscure; and in the 'Pal. Franç.' vol. ii. p. 395, D'Orbigny describes the species as possessing 14 or 15 elevated ribs, alternating with others less prominent.

In England it occurs in the Chloritic Marl of Wilts and Dorset; and specimens are in the British and Jermyn-street Museums. In France it is common to the Mediterranean basin and the Gulf of the Loire, and has therefore a wide range. The European *E. rosea* appears to be its living representative.

EMARGINULA ANCISTRA, sp. nov. Upper Greensand. Pl. VIII. figs. 23, 24.

Very elevated, Phrygian-cap-shaped, compressed laterally, hollowed out under the beak in form of a semicircle; apex much recurved, pointing downward and projecting considerably beyond the posterior margin; sculpture, 8 principal and about 14 subordinate ribs, reticulated by fine transverse lines of growth, the sculpture being most distinct anteriorly, whilst the posterior region is nearly smooth. The fissure is long and narrow; the fissural region nearly flat, slightly depressed, smooth, and bordered by two raised ribs.

This well-marked form is quite distinct from all others of our Cretaceous rocks. *E. dubisiensis*, P. & C., resembles it slightly, but has a more inrolled apex, and differs in its ornamentation.

The species is described from a unique fossil from Roundway, near Devizes, in the Bowerbank collection at the British Museum. *E. capuliformis*, now living in the Mediterranean, is of smaller size, but identical in form with this species.

EMARGINULA MEYERI, sp. nov. Chloritic Marl. Pl. VIII. figs. 14, 15.

Shell cap-shaped, very elevated, laterally compressed, the sides being almost flat, convex anteriorly, much hollowed out posteriorly; apex sharp, beak-like, recurved, overhanging posterior margin. Fissure short; the fissural scar is broad and depressed, but with a very slight median elevation or ridge. The cast has traces of rather coarse ribs reticulated with transverse lines, which are closer together than the ribs.

In general form this shell rather resembles *E. stenosoma*, De Ryckholt, but is more concave in front and rather longer in proportion to its elevation; *E. stenosoma* has 36 ribs and 16 transverse lines, which produce a vertically elongated cancellation, with nodes at the intersections.

We are indebted to Mr. Meyer for the discovery of this and many other interesting forms. It is from near Lyme Regis.

EMARGINULA UNICOSTATA, Seeley, MS. Upper Chalk. Pl. VIII. figs. 25, 26.

Thin, ovate, Phrygian-cap-shaped, compressed laterally, hollowed out posteriorly; apex acute, recurved, overhanging posterior margin; sculpture reticulated, consisting of ribs and lines of growth, the ribs being most strongly marked on the anterior region, whilst under the apex they are hardly visible. The fissure is very short; the fissural scar is in the form of a ridge, between two narrow depressions.

This species very strongly resembles *E. sanctæ-catharinæ*, but is more depressed and more finely ornamented, and the ribs are about twice as numerous. They both have affinities with *E. loculata*, De Ryckh., which, however, has fewer and less regular ribs, and with *E. Desori*, P. & C.

It was discovered in the Upper Chalk, at Norwich, and is preserved in the Woodwardian Museum at Cambridge.

EMARGINULA AFFINIS, Sby.

This is probably identical with *E. sanctæ-catharinæ*. It is figured in Dixon's 'Geology of Sussex.'

PUNCTURELLA ANTIQUA, sp. nov. Upper Greensand. Pl. IX. figs. 6-9.

Conical, cap-shaped; apex blunted, excentric; anterior region inflated, posterior hollowed out; shell thick, ornamented with about 60 radiating ribs, which become finer towards the posterior region. The cast presents posteriorly a central groove or depression extending from margin to summit. In this depression is a longitudinal, narrow, fissure-like scar, extending from the margin about $\frac{2}{3}$ of the way up, and terminating above, at the deepest part of the depression, in a small, raised, pipe-like protuberance, which has filled in the perforation. The second specimen figured does not show the depression so prominently; but in this case the shell is not completely removed, and still partly fills it up; the scar, however, is present. The depression has been caused by the internal shelly plate, characteristic of the genus, which answers probably a somewhat similar purpose to that of the internal septum in other genera. Some of the Eocene *Fissurellæ* are also thickened at the foramen, which is then excentric; but in *Fissurella* the fissure, if not apical, is immediately under and in front of the apex, whilst in *Puncturella* it is always placed behind the apex.

These specimens, which are from Devizes, are of especial interest, as they carry far back into Cretaceous times a genus which had hitherto not been met with fossil except in Glacial deposits. There are but few living *Puncturellæ*; *P. cucullata*, from Oregon, is the nearest known representative of our species. The specimens are in the British Museum.

The genus *Fissurella* is not represented; and its absence is the more remarkable as nine species are recorded from foreign Cretaceous rocks, and it is well represented in the Tertiaries. It may be noticed, as a possible explanation of the absence of both *Patella* and *Fissurella*, that the strictly littoral habits of these two great genera may have precluded their being buried, under ordinary conditions, with other Mollusca, in the deeper Cretaceous seas. The genus *Emarginula*, on the contrary, is a deep-water form, and is found more or less abundantly in most of the divisions of the Neocomian, Upper Greensand, and Chalk. Its absence in the Gault is confirmatory evidence of the shallowness of that sea, whilst its presence in the Upper Gault of Switzerland agrees with the character of the associated fauna. The scarcity of living species of *Emarginula* and their former abundance, has led to the idea being expressed by several authors that it is dying out and being replaced by *Fissurella*. The genus *Rimula*, not uncommon in the Oolites, is still unrepresented in subsequent rocks until it is met with in the Tertiaries.

The family of Siphonariidæ is only represented in Cretaceous times by *S. antiqua*, Binkhorst, from the Upper Chalk of Limburg.

CALYPTRÆIDÆ.

CALYPTRÆA COOKSONIÆ, Seeley. Gault.

Shell elevated, cap-shaped, wider than high, longer than wide, inflated, rounded anteriorly, flattened posteriorly; apex posterior, recurved; septal scar variable, rectangular or U-shaped, narrow. The cast only is known, which is marked by fine lines of growth.

This shell is known only from Cambridge, where it is frequently found inside the last chambers of Cephalopoda.

It was figured in 1861 by Seeley, in the 'Ann. and Mag. of Nat. Hist.' as a *Crepidula*, and almost at the same time by Pictet and Campiche as *Calyptrea sanctæ-crucis*. Seeley's name would seem to have priority, as that part of Pictet's work was published after 1861.

The form of the scar indicates a relationship with *Calyptrea* rather than *Crepidula*. Pictet's figures, if really of one species, show the shell to be variable in height and in the form of the scar. Further specimens may unite it with *Crepidula gaultina*, Buv.

CALYPTRÆA CONCENTRICA, sp. nov. Gault. Pl. VII. figs. 27-30.

Unsymmetrical, cap-shaped, irregular, elevated; sulcated concentrically, like an *Inoceramus*, without radiating marks; apex recurved, acute, projecting beyond, and overhanging, posterior margin.

This shell bears so great a resemblance to *Inoceramus concentricus* that it has been hitherto overlooked by all collectors. The mimicry by this and other Calyptræidæ of the prevailing Monomyarian bivalves of the age in which they lived, is continued at the present day, as in the cases of *Calyptrea niveata*, Lessoni, plana, dilatata, squamosa, fimbriata, and many others, which can hardly be distinguished from small species of oysters. This mimicry, we may suppose, is protective, and enables the mollusk, which from the thinness of its shell might otherwise be selected by the boring carnivora in preference to the thicker-shelled *Ostreæ*, to escape. Other deep-water limpets are peculiarly open to attacks of this kind.

Specimens are not uncommon in the nodule-bed of the Gault at Folkestone.

CALYPTRÆA GRAYANA, Tate. Chalk. Pl. VII. fig. 25.

"Shell ovate, conical, elevated, summit slightly recurved, ornamented by numerous angular raised ribs, decussated by flexuous and inequidistant lines of growth."

The description is taken from the 'Quart. Journ.' vol. xxi. (1865), p. 38, pl. iii. figs. 8, 8 b. These figures are twice nat. size, and are inaccurate in this respect, that they represent the lines of growth which decussate the ribs too regularly arranged, there being in reality only occasional and very irregular lines of growth. The ribs or, more properly, striæ are almost invisible without the aid of a lens, there being as many as thirty to every 5 millims. breadth of shell, with interspaces between them of about three times the

width of the ribs. The scar, which is immediately under the apex, is very open, and is unsymmetrical.

The specimen is from the Upper Chalk of Kilcorrig, Lisburn, and is preserved in the Jermyn-street Museum.

CREPIDULA GAULTINA, Buvignier. Gault. Pl. VII. figs. 21-23.

Shell small, thin, suborbicular, inflated and rounded, sometimes as high as wide, more frequently depressed; smooth, without radiating lines, but with irregular folds of growth; apex minute, posterior, in front of the septum, spiral, easily detached, marked with strong lines of growth. The scar seen on the casts is directly under the apex, and resembles a widely opened V, or, more correctly, a distant bird in flight. The position of the septa can be traced externally on the shell itself by slight ridges. The fry was perfectly helicoid and finely ribbed.

It is found in the Gault of Folkestone, and at Cambridge, attached to shells of Ammonites, and has been met with in the Gault of France and Switzerland.

It has been figured by Buvignier, in the 'Stat. de la Meuse,' by Pictet and Campiche, and by Jukes-Browne (Quart. Journ. Geol. Soc., May 1875).

The depressed form only has been met with as yet at Folkestone; but the amount of depression, depending entirely, as it does, on the position in which the shell, when living, was fixed, has no specific value. A larger series may unite the species with *Calyptraea Cooksonia*.

CREPIDULA ALTA, Seeley. Gault.

Shell smaller, and relatively higher than that of *C. gaultina*, with the septal scar less open.

This is the *Galericulus altus* of Seeley, a genus founded on a unique specimen in the Woodwardian Museum. The genus *Galericulus* is characterized, according to Seeley, by a second septum near the base of the shell. The scar considered to indicate this septum, however, is very much to the right of the median line, and, as already pointed out by Jukes-Browne, is probably an accidental indentation, as it is difficult to see the use of a second septum in the economy of the living mollusk, and nothing analogous exists in recent genera. The figure and description are in the 'Ann. and Mag. Nat. Hist.' for April, 1861. It may, probably, be only a variety of *C. gaultina*, and should, I think, be eventually removed from our list.

CREPIDULA CHAMÆFORMIS, sp. nov. Lower Greensand. Pl. VII. figs. 12-14.

Unsymmetrical, capuliform, depressed; apex posterior, recurved, spiral (?), projecting beyond the margin; posterior region much excavated under the apex; aperture irregular; surface rugose, with lines of growth.

This shell is very like *C. grandis*, from Japan, and resembles a

Chama in aspect; its mimicry of the Neocomian *Ecogyra* is almost as remarkable as that of the common Gault *Inoceramus* by *Calyptræa concentrica*. A unique specimen, from Donnington, is preserved in the Cambridge Museum. *Crepidulæ* first appear in Cretaceous rocks.

CRUCIBULUM GIGANTEUM, sp. nov. Lower Greensand. Pl. IX. figs. 1, 2; Pl. VII. figs. 3, 4.

Orbicular, patelliform, depressed, height equal to $\frac{1}{5}$ the length; apex obtuse, central or subcentral; posterior region slightly hollowed out, anterior very slightly concave; surface irregularly marked with lines or folds of growth, without ribs. The scar is deeply impressed, and extends sinuously from near the margin, about half-way to the apex, forming a sharp bend, something like a Greek epsilon.

The larger specimen shows only a slight depression along the scar-line, but appears to be specifically the same as the one from Shanklin, although it has the apex less central. The larger specimen is from Hythe, and in my collection; the smaller, from Shanklin, is in the Jermyn-street Museum.

The genus is here, for the first time, recorded as Cretaceous.

CAPULIDÆ.

PILEOPSIS NEOCOMIENSIS, sp. nov. Lower Greensand. Pl. VII. figs. 1, 2.

Orbicular, depressed; rather compressed laterally, giving the aperture a slightly pentagonal aspect; apex small, acute, recurved, not spiral, about $\frac{5}{6}$ posterior; surface irregularly marked with concentric lines of growth, with a texture similar to that of *Ostrea*.

The shell is from the Tealby limestone of Donnington, and is in the Woodwardian Museum; the surface is pitted by the pisolitic iron-stained grains which largely compose the matrix of the stone in which it was found. It is an undoubted *Pileopsis*, and strongly resembles the British *P. ungarica*.

PILEOPSIS DUBIA, sp. nov. Gault. Pl. VII. fig. 24.

Shell thin, orbicular, scutiform, very depressed, with minute flexuous striæ; apex subcentral, spiral (?). The muscular impression can be traced; and there is no sign of septum.

The specimen upon which the present species is founded is unique. It was obtained at Folkestone, and is in my collection. It resembles *Patelloidea*, which has not hitherto been noticed fossil.

PILEOPSIS SEELEYANA, sp. nov. Upper Greensand. Pl. VII. figs. 5-7.

Shell rather thick and suborbicular, scutiform, depressed; apex subcentral, slightly anterior; margin entire, laminated; shell very finely and evenly striated, the striæ being only visible by aid of a strong lens.

This is the only patelliform Gastropod from the well-known Blackdown beds, and is unique. The original is in the British Museum.

The shells of *Pileopsis* are very variable, attaching themselves to foreign objects, of which they frequently take the impression, as in the case of strongly radiated bivalves &c. *P. squamæformis*, from the Paris-basin Eocene, takes the crescentic form of the aperture of *Fusus longævus* when fixed inside the aperture of that shell. The genus is peculiarly interesting geologically, being the nearest representative of the Silurian cap-shaped shells, which range upwards to the Lias. Although absent in the Jurassic, it is well represented in the Lower Cretaceous rocks, Pictet and Campiche enumerating ten species in their list.

HIPPONYX DIXONI, Deshayes. Upper Greensand and Chalk. Pl. IX. figs. 12, 13.

Shell-base in the form of a solid cylinder of irregular growth, at the extremity of which is apparent the peculiar muscular impression special to the genus *Hipponyx*.

The name was suggested by Deshayes for the irregular body figured in Dixon's 'Geology of Sussex,' pl. xxvii. fig. 8, without specific description or name. Similar specimens are not uncommon in the White Chalk, and are preserved in most collections. Eocene and Recent forms alike sometimes deposit a series of bases, one over another, but none to the same extent, or so shiftingly, as appears in the Cretaceous form. It may be that, as at the bottom of the Chalk sea stones or rocks were rare, the excessive and heavy deposit served the animal in lieu of them, and formed an anchorage; the shifting may have taken place to escape burial or silting-up. The Greensand specimen from Cambridge, in the Woodwardian Museum, is very solid, the last base being deeply hollowed out, like a basin.

The genus makes its first appearance in Cretaceous rocks, and is met with in the Chalk of Normandy and the Maestricht limestone. *Capulus dunkerianus*, D'Orb., is the only upper valve yet discovered which could belong to these bases.

EXPLANATION OF THE PLATES.

PLATE VII.

- Figs. 1, 2. *Pileopsis neocomiensis*, sp. nov. Lower Greensand. Tealby; Woodwardian Museum.
 Figs. 3, 4. *Crucibulum giganteum*, sp. nov. Neocomian. Shanklin; Jermy-street Museum.
 Figs. 5, 6, 7. *Pileopsis Seeleyana*, sp. nov. Blackdown; British Museum. (Fig. 5, magnified.)
 Figs. 8, 9. *Helcion Meyeri*, sp. nov. Magnified. Lower Greensand; Mr. Meyer's collection.
 Figs. 10, 11. The same, natural size.
 Figs. 12, 13, 14. *Crepidula chamaeformis*, sp. nov. Neocomian, Seend; British Museum.
 Figs. 15, 16. *Scurria calyptraeformis*, sp. nov. British Museum.

- Fig. 17. *Scurria depressa*, sp. nov. Same locality.
 Fig. 18. *Tectura tenuistriata*, Seeley. Gault, Cambridge; Woodwardian Museum.
 Figs. 19, 20. *Tectura tenuicostâ*, D'Orb. Gault, Folkestone; Gardner collection.
 Figs. 21, 22, 23. *Crepidula gaultina*, Buvignier. Gault, Folkestone; Gardner collection.
 Fig. 24. *Pileopsis dubia*, sp. nov. Gault, Folkestone; Gardner collection.
 Fig. 25. *Calyptrea Grayana*, Tate. Upper Chalk, Ireland; Jermyn-street Museum.
 Fig. 26. *Helcion*, sp.? Buck Hill, Bedfordshire, probably derived from the Kimmeridge Clay.
 Figs. 27, 28, 29, 30. *Calyptrea concentrica*, sp. nov. Gault, Folkestone.

PLATE VIII.

- Fig. 1. *Emarginula neocomiensis*, D'Orb. Neocomian specimen from the Leckenby collection. Atherfield.
 Fig. 2. Ditto, side view.
 Fig. 2a. Part of same, enlarged.
 Fig. 3. Ditto, specimen from the British Museum. Seend.
 Fig. 4. Ditto, side view.
 Figs. 5, 6. Specimens from the Jermyn-street Museum. Atherfield.
 Fig. 6a. Part of same, enlarged.
 Figs. 7, 8, 9. *Emarginula valangiensis*, Pict. & Camp. Neocomian. Mr. Meyer's collection. East Shalford.
 Figs. 10, 11. *Emarginula puncturella*, sp. nov. Neocomian. Mr. Meyer's collection.
 Figs. 11a, 11b, 11c. The same, enlarged.
 Figs. 12, 13. *Emarginula Gresslyi*, Pict. & Camp. Grey Chalk. Gardner collection.
 Figs. 14, 15. *Emarginula Meyeri*, sp. nov. Chloritic Marl, Lyme Regis. Mr. Meyer's collection.
 Figs. 16, 17. *E. Gresslyi*. Lower Chalk, Isle of Wight. Jermyn-street Museum.
 Fig. 18. Ditto. Upper Greensand, Devizes. Jermyn-street Museum.
 Figs. 19, 20. *E. divisiensis*, sp. nov. Upper Greensand, Devizes; British Museum.
 Figs. 21, 22. *E. sancte-catharinae*, Passy, from the Chloritic Marl of Whitmore; Jermyn-street Museum.
 Figs. 23, 24. *E. ancistra*, sp. nov. Upper Greensand, Roundway, near Devizes; British Museum.
 Figs. 25, 26. *E. unicostata*, Seeley, MS. Upper Chalk, Norwich; Woodwardian Museum.
 Fig. 27. *Tectura plana*, sp. nov., nat. size. Neocomian. Mr. Meyer's collection.
 Figs. 28, 29. The same, enlarged.

PLATE IX.

- Figs. 1, 2. *Crucibulum giganteum*, sp. nov. Neocomian, Hythe; Gardner collection.
 Figs. 3, 4, 5. *Anisomyon rectis*, sp. nov. Neocomian, Atherfield; Woodwardian Museum.
 Figs. 6, 7, 8, 9. *Puncturella antiqua*, sp. nov. Upper Greensand, Devizes; British Museum.
 Figs. 10, 11. *Tectura formosa*, sp. nov. Lower Greensand, Shanklin. Mr. Meyer's collection.
 Figs. 12, 13. *Hipponyx Dixoni*, Deshayes. Chalk; Jermyn-street Museum.

DISCUSSION.

Prof. SEELEY remarked that the paper raised questions both large and small. The author's inferences with regard to depth of seas and questions of old physical geography were of great importance, if they could be established. He infers, from the presence of certain shells, that the Gault was deposited in shallow, and the Greensand in deep water; but this was opposed to all evidence of a physical kind, and was therefore untrustworthy. Coarse deposits are formed near the shore, and finer ones at greater distances; therefore the Gault must have been formed in deeper water than the Upper Greensand. Prof. Seeley also maintained that the occurrence of similar species did not necessarily imply similarity of conditions, and that therefore no inference as to physical conditions could be drawn from extinct species of marine fossils.

Mr. CHARLESWORTH made a comparison of the old limpets with those of the present day, and, in connexion with the author's remarks upon the apparent mimicry presented by the Cretaceous species, stated that neither in the later Tertiary deposits which he had especially studied, nor on existing beaches, had he ever found a limpet bored by carnivorous Gastropoda after their well-known fashion.

Mr. MEYER said that, with respect to the comparative depths of the Gault and Greensand seas, he agreed with the author, for two reasons:—one derived from the fauna, namely that Brachiopoda, which are usually held to be inhabitants of deep water, abound in the Greensand, but are almost entirely absent in the Gault; the other from the mineral condition of the two deposits, as he believed that while the immediate shore-line of the Greensand was rocky, in part Portlandic, yielding sand rather than clay, the shore-line of the Gault was mainly Kimmeridgian, yielding clay rather than sand. This would partly account for the difference in mineral condition.

Mr. PRICE said that in estimating from palæontological data the approximate depth of the Gault sea, he found that the lower part of the formation was deposited in shallow water, the middle in deeper, and the upper part in still deeper water, until the oceanic conditions of the Chalk were nearly reached.

The AUTHOR, in reply, said that he could not agree with Prof. Seeley. The Greensand of Cambridge and Blackdown possess none of these Mollusca; and the Greensand of Warminster, with its numerous Echini, is certainly a deep-water formation. The Gault is known to be a shallow-water deposit. At the same time it was to be admitted that our knowledge of the Cretaceous Limpets is exceedingly imperfect, a great number of the species described being founded on unique specimens. He regarded the Limpets as representing the most ancient form of the Gastropod shell, the simple capuliform shell gradually passing into the convoluted form, such as *Bellerophon*, which Pictet had included among the Limpets. The persistence of the type is therefore exceedingly remarkable.