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THE ANNALS
AND
MAGAZINE OF NATURAL HISTORY,
INCLUDING
ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND
CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY
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VOL. VI.—FIFTH SERIES.  
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LONDON:

PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS.

SOLD BY LONGMANS, GREEN, READER, AND DYER; SIMPKIN, MARSHALL,
AND CO.; KENT AND CO.; WHITTAKER AND CO.: BAILLIÈRE, PARIS:
MACLACHLAN AND STEWART, EDINBURGH:
HODGES, FOSTER, AND CO., DUBLIN: AND ASHER, BERLIN.

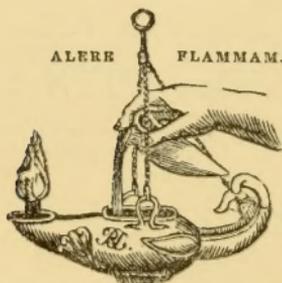
1880.

“Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exulta; malè doctis et barbaris semper inimica fuit.”—LINNÆUS.

“Quel que soit le principe de la vie animale, il ne faut qu’ouvrir les yeux pour voir qu’elle est le chef-d’œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations.”—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. The sylvan powers
 Obey our summons; from their deepest dells
 The Dryads come, and throw their garlands wild
 And odorous branches at our feet; the Nymphs
 That press with nimble step the mountain-thyme
 And purple heath-flower come not empty-handed,
 But scatter round ten thousand forms minute
 Of velvet moss or lichen, torn from rock
 Or rifted oak or cavern deep: the Naiads too
 Quit their loved native stream, from whose smooth face
 They crop the lily, and each sedge and rush
 That drinks the rippling tide: the frozen poles,
 Where peril waits the bold adventurer’s tread,
 The burning sands of Borneo and Cayenne,
 All, all to us unlock their secret stores
 And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.



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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

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

N. Parthenii Giannettasii Ecl. 1.

No. 31. JULY 1880.

I.—*New Species of Crustacea from New Zealand.*
By GEORGE M. THOMSON.

[Plate I.]

THE following notes record the result of observations made on the crustacean fauna of Dunedin Harbour during last summer. Limited as the field is, it has already yielded so many new forms, and this too after most cursory examination, that I anticipate numerous additions will be made to our knowledge by more systematic dredging. The maximum depth of the Bay is probably about 6 fathoms; so that no deep-sea forms are included in the following list.

Group SCHIZOPODA.

Fam. Mysidæ.

Genus MYSID.

Mysis denticulata, n. sp.

Carapace rather short and slender, with a short triangular acute rostrum. Peduncle of the internal (upper) antennæ extending to the extremity of the scale of the external antennæ, second joint very short, third the widest. Scale of external antennæ broad, with a tooth at the outer angle, and long cilia on its inner side and at the extremity. Middle lamella of the

tail entire, toothed on each side, and with two strong teeth at the apex. Lateral laminae exceeding the central one; the inner narrow-lanceolate, acute, and furnished with long hairs on each side; the outer obtuse, with the apical half narrowing, ciliated only at the extremity and on the inside, and with a few stout teeth about the middle of its outer margin. Length 0·5 inch.

Dunedin Harbour, in 4 fathoms.

ISOPODA VAGANTIA.

Fam. Tanaidæ.

Genus PARATANAIS, Dana.

Paratanais tenuis, n. sp. (Pl. I. fig. 1.)

Body slender. Head, when seen from above, narrowing anteriorly, front margin nearly straight. Eyes triangular; peduncles so short as to be hardly visible. Superior antennæ stout; inferior pair about two thirds as long as superior, slender. First gnathopoda stout; mobile finger smooth on the inner margin; immobile finger with a slightly convex inner margin furnished with a few strong hairs, and terminated by two or three stout denticles. Second gnathopoda long and very slender. Two anterior pairs of pereopoda comparatively slender, succeeding pairs stouter. Last segment of abdomen somewhat triangular, with a truncate apex, terminated by two minute setæ. Terminal uropoda with the inner branch four-jointed, and more than half as long as abdomen; outer branch one-jointed, as long as first joint of inner. Length 0·1 inch.

Dunedin Harbour, in 4-5 fathoms, and rock-pools on the coast.

AMPHIPODA NORMALIA.

Fam. Gammaridæ.

Subfam. STEGOCEPHALIDES.

Genus PANOPLEA, n. gen.

Coxæ of the four anterior segments well developed, those of the second pair of pereopoda excavated on the upper part of the posterior margin. Antennæ subequal, without a secondary appendage. Mandibles with an appendage. Maxillipeds with a squamiform process on the ischium. Gnathopoda feeble, almost chelate. Three posterior pairs of pleopoda double-branched. Telson simple, squamiform.

I have formed this genus to include two species which appear to me to be the southern representatives of the Arctic genus *Pleustes*. It differs from *Pleustes* only in the well-developed squamiform plate on the ischium of the maxillipeds, and in the gnathopoda being slender and more or less chelate. In the general appearance of the species, however, there is a very perceptible difference.

1. *Panoplæa spinosa*, n. sp. (Pl. I. fig. 2.)

Cephalon produced into an acute rostrum. Pereion broad, smooth, the dorsal margins of the last segment and of the first two of the pleon produced posteriorly into two spines. Coxæ of the gnathopoda narrow, but deep. Eyes reniform, pale reddish in colour. Superior antennæ longer than the inferior. Both pairs of gnathopoda very slender: first chelate, ischium and carpus long, propodos with a mobile finger articulating at some distance from its setose extremity; second pair nearly chelate, basos very long, propodos fringed with simple hairs on its inferior margin, dactylos articulating almost as in first pair. Pereiopoda increasing somewhat in size posteriorly, squamiform plates of the basa of the last three pairs toothed on their posterior margins. Three posterior pairs of pleopoda subequal; rami of the penultimate pair unequal. Telson subquadrate; extremity slightly excavate.

Colour varying from light to dark brown, thickly covered with black stellate markings. Length 0.45 inch.

Several specimens taken in Dunedin Harbour, in 4-5 fathoms.

2. *Panoplæa debilis*, n. sp. (Pl. I. fig. 3.)

Coxæ less developed than in *P. spinosa*. Pereion tumid; pleon slender, its first two segments and last of pereion produced on their postero-dorsal margins into spines. Cephalon produced into a very short rostrum. Eyes circular, black. Superior antennæ nearly as long as the body, rather longer than the inferior; peduncle very short. Gnathopoda feeble, subchelate: first pair small, basos long, fringed with a row of short spines on the anterior margin, propodos long, dactylos small, transverse; second pair similar in form, but very long and slender. Pereiopoda as in *P. spinosa*, but with the margins of the squamiform plates smooth. Telson rounded at the extremity. Colour uniformly light brown; when examined under a low power of the microscope the whole body is seen to be dotted with reddish-brown star-like marks. Length 0.35 inch.

Not uncommon in Dunedin Harbour, in 4-5 fathoms.

Subfam. *PHOXIDES*.

Genus AMPHILOCHUS, C. Spence Bate.

Amphiloachus squamosus, n. sp. (Pl. I. fig. 4.)

Body broad and thick anteriorly, slender posteriorly. Cephalon depressed anteriorly between the bases of the superior antennæ. Eyes large, deep red in colour; not easily made out owing to the numerous and dense reddish-black spots with which the whole body is covered. Superior antennæ shorter than inferior; peduncle shorter than flagellum, which is seven-jointed and carries two long setæ at the extremity of each joint. (The last joint of the peduncle bears a minute one-jointed appendage.) Inferior antennæ not one fourth as long as body; flagellum slender, longer than the peduncle, smooth. Gnathopoda subequal and similar in form; meros and carpus produced into obtuse lobes, spinous at the extremity; propodos somewhat elongated, with a rounded palm, and a few spines at the point of impingement of the slender falcate dactylos. Pereiopoda slender, subequal. Antepenultimate pleopoda reaching almost to the extremity of the ultimate, smooth; penultimate much shorter, and, together with the posterior (ultimate) pair, having somewhat unequal rami. Length 0·1 inch.

Under a low power of the microscope (a $\frac{2}{3}$) the integument, which is very thin, is seen to be covered with minute scale-like marks and hooks.

Subfam. *GAMMARIDES*.

Genus EUSIRUS, Kröyer.

Eusirus cuspidatus, Kröyer, var. *antarcticus*, n. var.

Several specimens of this crustacean were obtained by the dredge in the harbour; but as they differ in a few points from both the generic and specific description as given in the British-Museum Catalogue, p. 154, I think it advisable to separate them as a distinct variety under the name *antarcticus*. In regard, first, to the generic character, the maxillipeds are certainly not unguiculate, the propodos being obtusely pointed and densely clothed at the extremity with hairs, and the dactylos being obsolete; the cephalon also has a small rostrum. In specific characters it differs in the following respects:—The two posterior segments of the pereion are smooth, not produced back into teeth; the cilia on the flagellum of the superior are usually on every third (not second) articulus, which is also produced downwards into a tubercle: the palm

of both pairs of gnathopoda is defined by a double row of hairs, which are alternately very short, and the point of impingement of the dactylos by a fascicle of short stout spines. The length of the largest specimen obtained by me was only 0·35 inch, whereas the Greenland species is said to be 1¼ inch long.

Still, after taking all these differences into due consideration, there does not seem to be sufficient reason for separating this southern form specifically from the northern species.

Melita tenuicornis, Dana (*Mera tenuicornis*, Sp. Bate,
Paramera tenuicornis, Miers).

This species is not uncommon in the rock-pools along the coast. The animals are dark slaty grey in colour, very slender and compressed in form, swimming very rapidly. The females are remarkable for possessing a hook-like process on the coxal lamellæ of the fourth pair of pereopoda, almost exactly similar to that figured and described by Fr. Müller ('Facts for Darwin,' p. 27) as occurring in *M. insatiabilis*.

Genus MEGAMERA, Spence Bate.

Megamera fasciculata, n. sp. (Pl. I. fig. 5.)

Dorsal surface of the animal quite smooth. Eyes reniform. Superior antennæ nearly one third as long as the animal; first and second joints of peduncle rather short, subequal, third joint very short; flagellum long, very many-jointed, joints transverse and setose; secondary appendage very minute, one-jointed, and terminated by two or three setæ. Inferior antennæ shorter than superior, very similar in the form of the joints of the flagellum. First pair of gnathopoda with carpus and propodos subequal, and *fringed on their lower margin with fascicles of serrated or barbed hairs*; propodos broader at distal extremity than at the base, with a rounded projection at the extremity of the lower margin; palm quite transverse; dactylos not quite as long as palm. Second gnathopoda larger; carpus increasing in width, with numerous fascicles of barbed hairs; propodos longer, lower margin with barbed hairs, upper with several transverse rows of simple hairs; palm rounded; dactylos curved. Pereopoda somewhat increasing in length posteriorly, and with short spines. Posterior pleopoda considerably exceeding the preceding pair. Telson double. Length 0·5 inch.

Numerous specimens taken with the dredge in 4-5 fathoms in Dunedin Harbour; also in rock-pools on the coast both near Dunedin and Christchurch (*Summer*).

Fam. Corophiidæ.

Genus COROPHIUM, Latr.

Corophium contractum, Stimpson.

I obtained two specimens of this species by the dredge in Dunedin Harbour; and its occurrence in this habitat is interesting, as it was originally described from Japan. The description given in the Brit. Mus. Cat. p. 282, which is evidently copied from that given by Stimpson himself, is so meagre, that I have drawn up the following from my specimens, both of which were adult females.

Body much broader than deep. Eyes small. Superior antennæ rather shorter than inferior; first joint stout, produced on its inferior inner margin into two stout teeth; second equal to it in length, slender; third much shorter; flagellum five-jointed, terminated by a bunch of setæ. Inferior antennæ very strong, about one fourth as long as the animal, with a few strong teeth on their inferior margins on the inside. First gnathopoda small; basos with two long setæ; ischium, meros, and carpus fringed with long setæ; propodos rounded towards the extremity, with a convex palm fringed with short hairs; dactylos curved, as long as the palm. Second gnathopoda larger than first; carpus widely convex on its inferior margin, and, together with the more slender propodos, bearing fringes of long setæ; dactylos four-toothed at the extremity of its lower margin. First four pairs of pereopoda diminishing in length posteriorly, but with the basa progressively widening. Fifth pair very long; basos dilated, fringed with long setæ, which are simple on the anterior, and plumose on the posterior margin. Three anterior pairs of pleopoda short and double-branched; three posterior pairs very short, the last pair reaching slightly beyond the telson, flattened, rounded, thickly covered with short hairs, and bearing a few long setæ. Telson broadly triangular, notched at the apex. Length 0·14 inch.

Otago Institute, Dunedin,
Feb. 10, 1880.

EXPLANATION OF PLATE I.

- Fig. 1.* *Paratanaïs tenuis*, × 26. *a*, first pereopod, × 90; *b*, second pereopod, × 90.
Fig. 2. *Panoplaca spinosa*, × 10. *a*, first gnathopod, × 28; *b*, second gnathopod, × 28; *c*, telson, × 28.
Fig. 3. *Panoplaca debilis*, × 10. *a*, telson and pleopoda, × 15.
Fig. 4. *Amphilochnus squamosus*, × 14. *a*, first gnathopod, × 60.
Fig. 5. *Megamara fasciculata*. *a*, first gnathopod, × 26; *b*, second gnathopod, × 26; *c*, posterior pleopoda and telson, × 13; *d*, telson (from above), × 20.

II.—*A Contribution to the Knowledge of the Fish-fauna of the Rio de la Plata.* By Dr. A. GÜNTHER, F.R.S., Keeper of the Zoological Department, British Museum.

[Plate II.]

THE Fish-fauna of the Rio de la Plata and of the large affluents which discharge their waters into that estuary is but little known. On preparing a list of the species described by ichthyologists as occurring in the various parts of this great river-system, I found their number to amount to 153. But so little is known as regards the distribution of the species within the main river and its tributaries that that list utterly failed to fulfil the purposes for which it was drawn up, viz. to elucidate the degree of affinity between the Uruguay, Parana, Paraguay, and the rivers draining the country east of the Cordilleras, and to demonstrate a transition of the fauna of the lower parts into that of the upper—which latter may be supposed to be very similar to that of the San Francisco, so fully described by Dr. Lütken. Therefore it would have been premature to publish such a list, and I propose to limit the present communication to some notes and descriptions drawn up during an examination of a considerable collection of fishes received by the British Museum from Mr. E. White of Buenos Ayres. As a part of these species are identical with those received from the ‘Challenger’ expedition, I have thought it useful to supplement these notes by adding the names of the fishes obtained from the latter source, full descriptions being given in my “Report on the Shore-fishes” procured during that voyage; they are marked in the following notes by the letters *Ch.* The majority of the fishes enumerated in this paper belong to the fauna of the Rio de la Plata proper and of the lowermost portion of the Parana.

CHONDROPTERYGIANS.

1. *Mustelus vulgaris*, M. & H.
2. *Raja platana*, Gthr. [*Ch.*]
3. *Raja microps*, Gthr. [*Ch.*]
4. *Trygon hystrix*, M. & H.

I believe that authors have confounded several species under this name. The true *Trygon hystrix* of the Rio de la Plata has a large eye, the longitudinal diameter of which is two thirds of the width of the cartilaginous space between the eyes; the spiracles are very large, three times the size of the eye; and the tail is considerably longer than the body,

compressed into a crest behind the spine; rather large conical thorns in front of the spine, arranged partly uniserially, partly biserially. Six appendages at the bottom of the mouth behind the teeth.

An adult male, with the disk 10 inches long and broad, from the Parana, has the upper part of the disk ornamented with white ocelli, and nearly the whole of the lower parts of a brown colour.

5. *Trygon brachyurus*, sp. n.

This species differs from *Trygon hystrix* in several important points. The eye is small, its longitudinal diameter being two fifths of the width of the cartilaginous space between the eyes. Spiracles of moderate width, about twice the size of the orbit. Tail much shorter than the body, with a low fin behind the dorsal spine and a very low fold of the skin along its lower side: the thorns in the median line of the tail in front of the spine are very small, arranged in a single series. Five appendages at the bottom of the mouth behind the teeth. Upper parts greyish brown, with a coarse network of blackish streaks; lower parts white, with the margins of the disk blackish.

A female from Buenos Ayres shows the following dimensions:—length of the disk 10 inches, width of the disk 12 inches; length of the tail 9 inches.

5 a. *Trygon reticulatus*, sp. n.

Eye of moderate size, half the width of the cartilaginous space between the eyes. Spiracles scarcely twice the width of the orbit. Tail considerably longer than the disk, with a very low fold above and a still lower one below its terminal half; median line of the tail with a series of thorns of moderate size, irregularly arranged. Four appendages at the bottom of the mouth behind the teeth; upper part brown, with a network of black lines, the meshes being hexagonal and wide; lower parts uniform white.

A male from Surinam has a disk $7\frac{1}{2}$ inches long and $8\frac{1}{2}$ inches broad; the tail is 12 inches.

This is the species which I have described in the 'Catalogue of Fish' as *Trygon hystrix* of Müller & Henle.

6. *Myliobatis aquila*, L.

ACANTHOPTERYGIANS.

7. *Otolithus guatucupa*, C. & V. [Ch.]

8. *Ancylodon atricauda*, Gthr. [Ch.]

9. *Micropogon ornatus*, Gthr. [Ch.]
 10. *Micropogon undulatus*, L.
 11. *Pogonias fasciatus*, Lac.
 12. *Pachyurus furcraeus*, Lac. (= *Corvina Gillii*, Steindachner, 1867).
 13. *Atherinichthys bonariensis*, C. & V.
 14. *Atherinichthys argentinensis*, C. & V.
 15. *Mugil platanus*, sp. n.
- D. 4 | $\frac{1}{8}$. A. $\frac{3}{8}$. L. l. 38. L. tr. 15.

The height of the body is a little more than the length of the head, which is one fourth of the total (without caudal). The snout is broad, the width of the interorbital space being half of the length of the head. Eye with a thick and broad adipose membrane; lips thin. The præorbital leaves only the extremity of the maxillary uncovered. Cleft of the mouth twice as broad as deep; the angle made by the anterior margins of the mandibles is obtuse. The first dorsal spine scarcely longer than the second, and half as long as the head; it is a little nearer to the end of the snout than to the base of the tail. Anal and dorsal fins not scaly; the pectoral fin terminates opposite to the eighth scale of the lateral line; base and posterior margin of the pectoral blackish.

Six specimens from Buenos Ayres, the largest being 18 inches long.

ANACANTHINI.

16. *Solea Jenynsii*, Gthr. (= *Achirus Lorentzii*, Weyenbergh).
17. *Aphoristia ornata*, Lac. [Ch.]

MALACOPTERYGIANS.

18. *Platystoma Orbignianum*, Val.
19. *Piramutana albicans* (= *Arius albicans*, C. & V., = *Arius albidus*, Val., = *Arius moroti*, Val., nec = *Piramutana Blochii*, C. & V.).

In this species pterygoid teeth are constantly absent, the teeth on the palate being reduced to two small separate groups on the vomer. There is no doubt whatever of our specimens being identical with those obtained by D'Orbigny in the Rio de la Plata; therefore Müller and Troschel were wrong in identifying this fish with the *Silurus clarias* of Bloch. The fish described by Lütken as *Pseudariodes albi-*

cans, again, seems to be a different fish, as it is stated to have pterygoid teeth (Lütken, Vid. Medd. Kjöb. 1874, pp. 193-199).

In very young specimens, *i.e.* in specimens from 6 to 8 inches long, the maxillary barbel reaches to the root of the caudal, whilst it reaches only to the anal fin in specimens 10 inches long, and in older examples it is still shorter (*cf.* Steindachner, SB. Ak. Wien, lxxiv. 1877, pp. 599-602).

20. *Piramutana macrospila*, sp. n. (Pl. II.)

D. 1/6. A. 11.

Closely allied to *Piramutana pantherina* and *Piramutana albicans*. Head granulated above; occipital process longer than broad, extending to the dorsal scute. An elliptical patch of pterygoid teeth (Pl. II. D); vomerine teeth none. Eye of moderate size, half the width of the interorbital space; upper jaw longer than the lower; the maxillary barbel reaches to the origin of the anal fin. Adipose fin much longer than the dorsal; but the distance between the two fins is less than the length of the dorsal. Dorsal spine rather longer than that of the pectoral fin, but shorter than the head. Body with four or five longitudinal series of round blackish spots; also the upperside of the head and the dorsal fin are spotted.

One specimen, 15 inches long.

21. *Pimelodus maculatus*, Lac.

22. *Pimelodus gracilis*, Val.

23. *Pimelodus labrosus*, Kröy., Ltk.

24. *Pimelodus platanus*, sp. n.

D. 1/6. A. 12. P. 1/13.

Head covered with thin skin above; occipital process narrow; no prædorsal scute. Adipose fin rather high, its length being two ninths of the total (without caudal) and equal to its distance from the fifth dorsal ray. Maxillary barbels extending to the origin of the adipose fin, the outer ones of the mandible beyond the root of the pectoral.

The height of the body is rather less than the total length (without caudal); the length of the head a little more than one fourth; snout rather long and spatulate, with the upper jaw much projecting beyond the lower. The eye occupies nearly the middle of the length of the head, has free orbital margins, and is about half of the width of the interorbital space; its diameter is one ninth of the length of the head.

The first dorsal and pectoral rays are not spinous. Caudal fin deeply forked. Coloration uniform.

One specimen from the Parana, 13 inches long.

25. *Pimelodus sapo*, Val.

26. *Pimelodus Hilarii*, C. & V.

27. *Pirinampus Pati*, Val.

28. *Arius Commersonii*, Lac.

Very common, and growing to a length of 4 feet and more.

29. *Ageniosus militaris*, Bl.

30. *Doras maculatus*, Val. (= *D. muricus*, Kner).

Common about the shipping, and attaining to a length of more than 2 feet; it seems almost omnivorous, greedily swallowing the offal from ships. The stomach of one was filled with large bones, probably of sheep, pieces of carrots, shells, &c.

31. *Callichthys punctatus*, Bl.

32. *Plecostomus Commersonii*, Val.

33. *Plecostomus alatus*, Casteln.

Received from the Lower Parana.

34. *Plecostomus cordovæ*, sp. n.

D. 1/7. A. 5. P. 1/7. V. 1/5. L. l. 30.

Head very much depressed, its length being nearly two sevenths of the total (without caudal); no ridge between eye and nostril; occiput with a very slight elevation along its middle; nuchal scutes not elevated in the middle, and obtusely bicarinate. The middle of the extremity of the snout is naked; mouth straight, transverse, very broad, stretching from one side of the snout to the other; labial fold rather broad, not notched behind, covered with minute papillæ. Interoperculum without spines. The entire lower surface of the head, thorax, and belly are covered with minute scutes. The length of the base of the dorsal fin is a little less than its distance from the second fin; there are ten pairs of scutes between the two fins. Caudal fin obliquely marginate. The pectoral spine extends to the base of the ventral, and has its extremity covered with very short spines. Seventeen scutes between anal and caudal; the lateral scutes of the body with very indistinct keels, which have no particular armature. Brownish black, with black dots; these are smallest and most numerous on the head, a little larger on the body, and largest and least numerous on the abdomen, the abdominal spots being not quite the size of

the eye. Each ray of the caudal, pectoral, and ventral fins is crossed by a number of short black streaks, whilst the dorsal fin is crossed by six or seven black zigzag stripes.

One specimen, $9\frac{1}{2}$ inches long, from Cordova.

35. *Trichomycterus dispar*, Tschudi (= *T. cordovensis*, Weyenbergh).

Received from Cordova.

36. *Macrodon intermedius*, Gthr. (an = *M. auritus*, C. & V.?).

37. *Curimatus platanus*, sp. n.

D. 11. A. 9. L. lat. 55. L. transv. 12/11.

Allied to *Curimatus Alberti*, but with considerably smaller scales. The height of the body is contained thrice and one third in the total length (without caudal); the length of the head nearly four times. The upper profile is slightly concave above the occiput; snout as long as the eye, the diameter of which is a little more than half the width of the inter-orbital space. An anterior and posterior eyelid. The origin of the dorsal fin is nearer to the extremity of the snout than to the base of the caudal. The pectoral terminates at some distance from the caudal, its length being two thirds of that of the head. Ventral not extending to the vent. Abdomen rounded in front of and behind the ventrals. Scales not ciliated. Silvery; a more or less distinct black spot on the root of the caudal.

Two specimens 6 inches long.

38. *Prochilodus lineatus*, Val.

39. *Anostomus vittatus*, C. & V.

40. *Leporinus obtusidens*, Val.

41. *Tetragonopterus orbicularis*, C. & V.

42. *Tetragonopterus fasciatus*, Cuv. (= *T. Cuvieri*, Ltk., = *T. rutilus*, Jen.).

43. *Tetragonopterus microstoma*, Gthr.

44. *Tetragonopterus petenensis*, Gthr.

From the Rio Negro, Argentine Rep.

45. *Tetragonopterus abramis*, Jen.

46. *Tetragonopterus cordovae*, sp. n.

D. 11. A. 26. V. 8. L. l. 45. L. tr. 9/10.

The height of the body is one third of the total length (without caudal), sometimes a little more or less; the length of

the head one fourth; interorbital space convex, its width being more than the diameter of the eye, which is one fourth of the length of the head. The maxillary extends to, or very little beyond, the front margin of the eye. Origin of the dorsal fin above the root of the ventral. Caudal fin not scaly. There are eight series of scales between the lateral line and the ventral fin. Silvery, sometimes with a dark spot above the commencement of the lateral line; a black caudal spot is generally absent.

Several specimens, measuring from 3 to $5\frac{1}{2}$ inches, were collected in the Rio de Cordova by E. Fielding, Esq.

47. *Brycon orthotænia*, Gthr. (an = *B. Lundii*, Ltk.?).

48. *Chalcinus paranensis*, sp. n.

D. 11. A. 30. V. 7. L. lat. 33. L. transv. $6/3\frac{1}{2}$.

The height of the body is contained twice and two thirds in the total length (without caudal), the length of the head four times. Operculum twice as high as long, reaching nearly to the vertical from the axil of the pectoral. The scales above the lateral line and in the thoracic region are larger than the others. The distance of the origin of the dorsal fin from the root of the caudal is two thirds of its distance from the extremity of the snout. Pectoral one third longer than the head. Silvery; the outer parts of the fins blackish; the middle caudal rays black.

One specimen, 5 inches long, from the Parana.

49. *Anacyrtus argenteus*, Val.

50. *Anacyrtus humeralis*, Val.

51. *Salminus maxillosus*, C. & V.

Attaining to a length of 4 feet.

52. *Xiphorhamphus Jenynsii*, Gthr.

Specimens of this species were probably confounded by Valenciennes with *X. hepsetus*:

53. *Serrasalmo marginatus*, Val.

54. *Serrasalmo pilopleura*, Kner.

55. *Myletes brachypoma*, Cuv.

56. *Engraulis olidus*, Gthr. ✓

57. *Pellona flavipinnis*, Val.

58. *Sternopygus virescens*, Val.

59. *Conger conger*, L. (an = *C. Orbignyanus*, Val.?).

III.—*Description of a new Species of Palinurus.* By T. W. KIRK, Assistant in the Colonial Museum, Wellington, N. Z.

THE specimen described in this paper was obtained by Mr. J. Buchanan, F.L.S., in December 1877, at Whanigaroa, a small harbour on the west coast of the North Island of New Zealand. Six specimens were captured, but only one preserved; this was placed in the Colonial Museum, and, until lately, bore the label "*Palinurus Hugelii*, var. *tumidus*," in the handwriting of Dr. Hector, by whom it has since been intrusted to me for description.

In general appearance this fine species approaches very near *P. Hugelii* from the Indian Ocean. I have, however, carefully compared our specimen with Dr. Heller's description of that species; and it appears to me to possess characters sufficiently distinct to justify its elevation to the rank of a species. I therefore propose to retain Dr. Hector's MS. name, and designate the new species *Palinurus tumidus*, although, perhaps, *giganteus* would be more appropriate, the total length from tip of beak to end of telson being 24 inches, the carapace very much swollen and measuring $21\frac{1}{2}$ inches in circumference.

Dr. Hector informs me that this is the common crawfish at the Sydney market; yet, strange to say, although so large and so common, it does not appear to have been described, the only attempt made to identify it being found in the Sydney Museum, where a specimen bears the label "*Palinurus Hugelii*?"

Palinurus tumidus.

Carapace beaked, much swollen, armed with very blunt depressed spines, some directed forward, others again standing nearly vertical; a double row of small, stout, blunt spines, standing nearly vertical, runs along the posterior edge of the carapace. Beak stout, round, and curved upwards. Supra-orbital spines stout, compressed, turned upwards. Antennal spines stout, somewhat triangular in shape, also turned upwards. Superior antennæ less than the total length of the animal; peduncle armed on its upper and outer surfaces with stout spines. Inferior antennæ smooth, longer than peduncle of superior.

Anterior legs very stout, inferior margin of second joint armed with a row of five or six spines; third joint with a very stout spine at the anterior and another at the posterior extremity, the anterior one being twice the size of the posterior; also a stout triangular spine on the superior distal extremity; fifth joint with a row of six spines on the superior internal angle, the largest and posterior one being directed backwards

to meet the anterior spine of the third joint, a row of three small blunt spines on the inferior angle. Superior margin of distal extremity of last four pairs of legs armed with a spine.

Abdomen very coarsely granulated and punctate. Tail, especially the telson, armed with small spines; telson rounded at the extremity. Anterior margin of each segment of the abdomen produced into a very prominent spine, backed by three or four teeth.

Whole animal destitute of hair, with the exception of the pedipalps and the inferior surface of the terminal joint of each pair of legs.

Colour reddish brown, tinged in many places with yellow. Length 24 inches; circumference of carapace $21\frac{1}{2}$ inches.

Distinguished from *P. Hugelii* by its much larger size, by the beak, supraorbital, and antennal spines being turned upwards, by the telson being less triangular, and rounded instead of scarped.

IV.—*Additions to the List of New-Zealand Marine Mollusca*. By THOMAS W. KIRK, Assistant in the Colonial Museum, N. Z.

Dentalium Huttoni, sp. nov.

Shell white, lustrous; small, curved, rapidly tapering, ribbed, ribs unequal, about eighteen at the anterior end, but diminishing in number towards the apex. Length $\cdot63$ inch, breadth $\cdot1$ inch at the anterior end.

Hab. Wellington.

Named after Prof. Hutton, to whose exertions students of conchology in New Zealand are greatly indebted.

Dentalium ecostatum, sp. nov.

Shell white; nearly straight, smooth, gradually tapering, faintly, distantly, transversely striated. Length $\cdot6$ inch; breadth $\cdot07$ inch at the anterior end.

Hab. Waikanae.

Scalaria wellingtonensis, sp. nov.

Shell white, lustrous; acuminate, imperforate; whorls nine, rounded; varices numerous, thin, about seventeen on the body-whorl; interstices smooth; aperture subrotund. Length $\cdot4$ inch.

Hab. Wellington.

Cylichna zealandica, sp. nov.

Shell white; strong, smooth, faintly longitudinally striated; aperture produced above the spire. Length $\cdot35$ inch.

Hab. Waikanae.

V.—On the Geological Distribution of the Rhabdophora.
By CHARLES LAPWORTH, F.G.S. &c.

Part III. RESULTS.

[Continued from vol. v. p. 369.]

TABLE X. Showing the Vertical Range of the Genera and Species of the British Rhabdophora.

	CAMBRIAN.		ORDOVICIAN.			SILURIAN.					
	Olenus-Beds.	Dictyonema-Beds.	Lower.		Upper.	Lower.		Middle.			
			Lower Zones.	Upper Zones.	Didymograptus-Beds.	Llandello-Bala.	Caradoc-Bala.	Llandoverly Rocks.	Tarannon.	Wenlock.	Ludlow.
Family I. MONOGRAPTIDÆ.											
Group i. (type <i>M. Nilssoni</i> , Barr.).											
<i>Monograptus tenuis</i> , Portl.							*	*	*	*	
— <i>attenuatus</i> , Hopk.							*	*	*	*	
— <i>gregarius</i> , Lapw.							*	*	*	*	
— <i>argutus</i> , Lapw.							*	*	*	*	
— <i>concinus</i> , Lapw.							*	*	*	*	
— <i>intermedius</i> , Carr.							*	*	*	*	
— <i>bohemicus</i> , Barr.							*	*	*	*	
— <i>Nilssoni</i> , Barr.							*	*	*	*	
— <i>scanicus</i> , Tullberg							*	*	*	*	
Group ii. (type <i>M. Hisingeri</i> , Carr.).											
<i>Monograptus leptotheca</i> , Lapw.							*	*	*	*	
— <i>cyphus</i> , Lapw.							*	*	*	*	
— <i>crenularis</i> , Lapw.							*	*	*	*	
— <i>argenteus</i> , Nich.							*	*	*	*	
— <i>Hisingeri</i> , Carr.							*	*	*	*	
— —, var. <i>jaculum</i> , Lapw.							*	*	*	*	
— —, var. <i>nudus</i> , Lapw.							*	*	*	*	
— —, var. <i>rigidus</i> , Tullb.							*	*	*	*	
— <i>nuntius</i> , Barr.							*	*	*	*	
— <i>vomerinus</i> , Nich.							*	*	*	*	

TABLE X. (continued).

	CAMBRIAN.		ORDOVICIAN.			SILURIAN.									
	Olenus-Beds.	Dictyonema-Beds.	Lower.	Upper.		Lower.		Middle.							
			Arenig.	Llandeilo-Bala.	Caradoc-Bala.	Llandovery Rocks.	Tarannon.	Wenlock.	Ludlow.						
	Lower Zones.	Upper Zones.	Didymograptus-Beds.	Glenskiln Beds.	Lower Hartfell.	Upper Hartfell.	Lower Birkhill.	Middle Birkhill.	Upper Birkhill.	Lower Gala.	Upper Gala.	Lower Zones.	Upper Zones.	Lower Ludlow.	Upper Ludlow.
Group iii. (type <i>M. colonus</i> , auct.).															
Monograptus galaensis, Lapw.										*					
— testis, Barr.										*					v.
— dubius, Suess										*					*
— Halli, Barr.										*					*
— colonus auct.										*					*
— leintwardinensis, Hopk.										*					*
— Roemeri, Barr.										*					*
— Salweyi, Hopk.										*					*
— chimæra, Barr.										*					*
Group iv. (type <i>M. priodon</i> , Bronn).															
Monograptus crassus, Lapw.										*					
— clintonensis, Hall										*					
— priodon, Bronn										*					
— —, ? var. Flemingii, Salt.										*					
— —, ? var. ludensis, Murch.										*					
— riccartonensis, Lapw.										*					
Group v. (type <i>M. lobiferus</i> , M ^c Coy).															
Monograptus lobiferus, M ^c Coy										*					
— Clingani, Carr.										*					
— Becki, Barr.										*					
— exiguus, Nich.										*					
— Salteri, Lapw.										*					
— crispus, Lapw.										*					
— proteus, Barr.										*					
— Barrandei, Suess										*					*
Group vi. (type <i>M. Sedgwicki</i> , Portl.).															
Monograptus triangulatus, Harkn.										*					
— fimbriatus, Nich.										*					

TABLE X. (continued).

	CAMBRIAN.			ORDOVICIAN.		SILURIAN.			
	Olenus-Beds.		Dictyonema-Beds.	Lower.	Upper.	Lower.		Middle.	
	Lower Zones.	Upper Zones.	Arenig.	Llandeilo-Bala.	Caradoc-Bala.	Llandovery Rocks.	Tarannon.	Wenlock.	Ludlow.
Monograptus Sedgwicki, <i>Portl.</i>									
— spiralis, <i>Geinitz</i>									
— turriculatus, <i>Barr.</i>									
Cyrtograptus Grayæ, <i>Lapw.</i>									
— Murchisoni, <i>Carr.</i>									
— Carruthersi, <i>Lapw.</i>									
— hamatus, <i>Baily</i>									
— Linnarssoni, <i>Lapw.</i>									
Family II. LEPTOGRAPTIDÆ.									
Group a.									
Leptograptus capillaris, <i>Carr.</i>					*				
— flaccidus, <i>Hall.</i>					*				
Amphigraptus divergens, <i>Hall</i>					*				
— radiatus, <i>Lapw.</i>					*				
Pleurograptus linearis, <i>Carr.</i>					*				
Group b.									
Cænograptus gracilis, <i>Hall</i>					*				
— surcularis, <i>Hall</i>					*				
— pertenuis, <i>Lapw.</i>					*				
— explanatus, <i>Lapw.</i>					*				
Azygograptus cœlebs, <i>Lapw.</i>					*				
— Lapworthi, <i>Nich.</i>		*			*				
Family III. DICRANOGRAPTIDÆ.									
Dicellograptus anceps, <i>Nich.</i>					*				
— caduceus, <i>Lapw.</i>					*				
— complanatus, <i>Lapw.</i>					*				
— divaricatus, <i>Hall</i>					*				
— elegans, <i>Carr.</i>					*				
— Forchhammeri, <i>Geinitz</i>					*				
— furcatus, <i>Hall</i>					*				
— intortus, <i>Lapw.</i>					*				

TABLE X. (continued).

	CAMBRIAN.						ORDOVICIAN.		SILURIAN.				
	Olenus-Beds.		Dictionema-Beds.		Lower Zones.	Upper Zones.	Arenig.	Llandeilo-Bala.	Caradoc-Bala.	Lower.		Middle.	
	Lower Zones.	Upper Zones.	Llandeilo-Beds.	Glenkiln Beds.						Lower Hartfell.	Upper Hartfell.	Llandoverly Rocks.	Tarannon.	Wenlock.	Ludlow.
	Lower Zones.	Upper Zones.	Lower Hartfell.	Upper Hartfell.	Lower Birkhill.	Middle Birkhill.	Upper Birkhill.	Lower Gala.	Upper Gala.	Lower Zones.	Upper Zones.	Lower Ludlow.	Upper Ludlow.
<i>Dicellograptus moffatensis</i> , Carr.								*					
— <i>Morrisi</i> , Hopk.								*					
— <i>patulosus</i> , Lapw.								*					
— <i>sextans</i> , Hall								*					
— <i>pumilus</i> , Lapw.								*					
<i>Dicranograptus Clingani</i> , Carr.								*					
— <i>formosus</i> , Hopk.								*					
— <i>Nicholsoni</i> , Hopk.								*					
— <i>ramosus</i> , Hall								*					
— <i>ziczac</i> , Lapw.								*					
Family IV. DICHOGRAPTIDÆ.													
i. (type <i>D. Murchisoni</i> , Beck).													
<i>Didymograptus bifidus</i> , Hall								*					
— <i>indentus</i> , Hall								*					
— —, var. <i>nanus</i> , Lapw.								*					
— <i>minutus</i> , Torquist								*					
— <i>Murchisoni</i> , Beck								*					
— —, var. <i>furcillatus</i> , Lapw.								*					
— —, var. <i>geminus</i> , His.								*					
ii. (type <i>D. v-fractus</i> , Salter).													
<i>Didymograptus balticus</i> , Tullberg.								*					
— <i>vacillans</i> , Tullberg								*					
— <i>v-fractus</i> , Salter								*					
— <i>Pantonii</i> , M ^c Coy								*					
iii. (type <i>D. patulus</i> , Hall).													
<i>Didymograptus constrictus</i> , Hall								*					
— <i>extensus</i> , Hall								*					
— —, var. <i>euodus</i> , Lapw.								*					
— <i>nitidus</i> , Hall								*					
— <i>patulus</i> , Hall								*					
— <i>similis</i> , Hall								*					
— <i>superstes</i> , Lapw.								*					
— <i>suecicus</i> , Tullberg								*					

TABLE X. (continued).

	CAMBRIAN.						ORDOVICIAN.				SILURIAN.						
							Lower.		Upper.		Lower.		Middle.				
							Arenig.	Llandeilo-Bala.	Caradoc-Bala.	Llandorey Rocks.	Tarannon.	Wenlock.	Ludlow.				
	Olenus-Beds.	Dictyonema-Beds.	Lower Zones.	Upper Zones.	Didymograptus-Beds.	Glenskiln Beds.	Lower Hartfell.	Upper Hartfell.	Lower Birkhill.	Middle Birkhill.	Upper Birkhill.	Lower Gala.	Upper Gala.	Lower Zones.	Upper Zones.	Lower Ludlow.	Upper Ludlow.
<i>Cryptograptus antennarius</i> , Hall.			*	*													
— <i>Hopkinsoni</i> , Nich.			*	*													
<i>Climacograptus cælatus</i> , Lapw.			*	*													
— <i>Scharenbergi</i> , Lapw.			*	*	*	*	*										
— <i>confertus</i> , Lapw.			*	*	*	*	*										
— <i>caudatus</i> , Lapw.			*	*	*	*	*										
— <i>bicornis</i> , Hall			*	*	*	*	*										
— <i>tubuliferus</i> , Lapw.			*	*	*	*	*										
— <i>normalis</i> , Lapw.			*	*	*	*	*	*									
— <i>rectangularis</i> , M ^c Coy			*	*	*	*	*	*	*								
— <i>innotatus</i> , Nich.			*	*	*	*	*	*	*								
Family VII. LASIOGRAPTIDÆ.																	
<i>Lasiograptus Harknessi</i> , Nich.			*	*	*	*	*										
— <i>costatus</i> , Lapw.			*	*	*	*	*										
— <i>retusus</i> , Lapw.			*	*	*	*	*										
— <i>margaritatus</i> , Lapw.			*	*	*	*	*	*									
<i>Hallograptus bimucronatus</i> , Nich.			*	*	*	*	*										
— <i>mucronatus</i> , Hall			*	*	*	*	*										
<i>Glossograptus Hincksi</i> , Hopk.			*	*	*	*	*										
— <i>armatus</i> , Nich.			*	*	*	*	*										
— <i>ciliatus</i> , Emmons			*	*	*	*	*	?									
<i>Retiograptus tentaculatus</i> , Hall			*	*	*	*	*										
Family VIII. RETIOLITIDÆ.																	
(<i>Retiograptus</i>) <i>eucharis</i> , Hall			*	*	*	*	*										
<i>Clathrograptus cuneiformis</i> , Lapw.			*	*	*	*	*										
— <i>Geinitzianus</i> , Hall			*	*	*	*	*										
<i>Gymnograptus Linnarssoni</i> , Tullb.			*	*	*	*	*										
<i>Trigonograptus lanceolatus</i> , Nich.			*	*	*	*	*										
— <i>ensiformis</i> , Hall			*	*	*	*	*										
— <i>truncatus</i> , Lapw.			*	*	*	*	*										
<i>Retiolites Geinitzianus</i> , Barr.			*	*	*	*	*						*	*			
— <i>fibratus</i> , Lapw.			*	*	*	*	*						*	*			
— <i>perlatus</i> , Nich.			*	*	*	*	*		*	*			*	*			
—, var. ? <i>Daironi</i> , Lapw.			*	*	*	*	*		*	*			*	*			
— <i>obesus</i> , Lapw.			*	*	*	*	*		*	*			*	*			

PALÆONTOLOGICAL (Table X).—We now enter upon the zoological or palæontological department of our subject. The Table given above, which has been drawn up from a careful examination and comparison of the data already brought forward, summarizes the results of our present knowledge with respect to the vertical range of the known families, genera, and species of Rhabdophora. It will be advisable to review these results in order, for each family and species in its turn, that the provisional conclusions we advocate may be contrasted by the student with the speculations of former investigators and with the results destined to be developed by future discovery.

Family i. Monograptidæ.

Contrary to the opinions of the earlier palæontologists, it is now clearly apparent that the important family of the Monograptidæ is strictly confined to Murchison's Upper Silurian system. With the exception of the abnormal genus *Azygo-graptus* (Nich. & Lapw.) no unilateral genus of Graptolite has hitherto been detected in strata of older date than the Lower Llandovery. As we have already shown, the numerous specimens of *Graptolithus* (*Monograptus*) *sagittarius*, His., *M. tenuis*, Portlk., and *M. Nilssoni*, Barr., noted by Hall, Salter, Baily, and others from Arenig, Bala, and Llandeilo strata were merely fragments of compound species. Where these palæontologists have given figures of the so-called simple forms, a glance at the illustrative drawings is generally sufficient to satisfy the graptolithologist that they are fractions of compound forms. In other cases, the known presence of bilateral genera, whose broken branches have a superficial resemblance to the unilateral species, in great abundance in the formations from which these supposed simple forms are derived furnishes us with a very natural explanation of these erroneous identifications. It is not impossible that future research will lead to the detection, in the highest zones of the Bala formation, of the forerunners of the prolific Monograptidæ of the Valentian and Salopian rocks. But, in the actual state of our knowledge, *the mere presence of a single species of the Monograptidæ may at once be set down as conclusive evidence of the (Upper) Silurian age of its containing beds.*

The range of the entire family appears to be coextensive with that of the Silurian system proper. Its earliest forms struggle into visible existence near the base of the Lower Llandovery, along an horizon which, in the attenuated Graptolite-bearing deposits of Scotland and Scandinavia, is removed but a few feet from the summit of the underlying

Bala formation. The black muddy sea-bed that occupied the region now covered in part by Britain and Scandinavia seems to have been specially favourable for their development; and the increment in species and individuals is so rapid, that by the time we reach the highest zones of the Llandovery, the family has reached its specific maximum, and possibly even begun its decline. The fact that the succeeding Wenlock and Ludlow formations are more arenaceous in their character, and consequently allow of fewer species being preserved to us, deprives this conclusion of some of its weight. Nevertheless their most prolific zones, even when lithologically identical with the teeming beds of the Llandovery, are invariably so poor in the number and variety of their species, that the highest Llandovery subformation may safely be regarded as the metropolis of the family.

1. *Rastrites*, Barrande.—This peculiar genus, so strikingly individualized by its isolated hydrothecæ, had but a very limited existence. It is confined exclusively to the middle zones of the Valentian formation, being absent from its lowest beds, and disappearing before the highest strata are reached. It apparently makes its earliest appearance in the *M. gregarius* zone of the Upper Birkhill, where the well-known species *Rastrites peregrinus*, Barr., occurs in great abundance, associated with its intimate ally, *M. triangularis*, Harkn. In the succeeding Upper Birkhill zones other species come in, and the genus attains its maximum development. In the overlying Gala Tarannon beds one or two species occur rarely, and in the Lower division only. In the Upper Gala the genus appears to have wholly disappeared.

2. *Monograptus*, Geinitz (*restricted*).—This is the richest and most important of the three genera which compose the family of the Monograptidæ; and its vertical range is so extended that it is coextensive with that of the entire family. The oldest fragments of *Monograptus* detected by myself were found in the lowest (*D. acuminatus*, Nich.) zone of the Lower Birkhill shale of Moffat. It is impossible to refer these interesting fragments to any known species; but there can be no question that they are true Monograptidæ. In no other locality have examples properly referable to the genus *Monograptus* been found so low in the succession.

The genus *Monograptus* possibly culminates along an horizon which is identical with, or but a short distance above, the boundary-line between the Llandovery and the Tarannon. This is far below the line which marks the middle of the

vertical range of the genus. The decrease in species as we pass upwards through the Gala and Tarannon formations seems to be very gradual. The recent researches of Dr. Tullberg in the *Cyrtograptus*-schists of Scania* make it very doubtful whether there was any marked falling-off in species till far on in the Wenlock period.

In the Lower Ludlow of Wales and Scandinavia individuals are still very numerous in certain localities, but the species were few and of few types. Here our knowledge of the genus suddenly fails us; for although fragments of the genus have been met with far within the limits of the Upper Ludlow beds, no species has yet been identified.

The several subgroups of *Monograptus* differ greatly in their vertical distribution.

Group i. (*Nilssoni group*) has by far the longest range. It claims *M. tenuis*, Portlk., and *M. attenuatus*, Hopk., which are the oldest Monograptidæ yet discovered, as well as *M. scanicus*, Tullberg, and *M. Nilssoni*, Barr., which are the characteristic forms of the Lower Ludlow formation.

Group ii. (*Hisingeri group*) approaches the first group in the great extent of its geological range; but its oldest forms descend no lower than the Middle Birkhill, while it is doubtful if any true members of the group live on into the Lower Ludlow.

Group iii. (*colonus group*) is the last to come into being, as it seems to be the last to die out. Its oldest known form (*M. galaensis*, Lapw.) is found at the very base of the Gala group. According to Mr. Linnarsson the fragmentary form in the Gothland sandstones (Upper Ludlow?) is of this type.

Its species are markedly characteristic of Upper Wenlock and Lower Ludlow beds. Of its nine recognized forms eight belong to these horizons.

Group iv. (*priodon group*) contains many forms which, according to the views of the Scandinavian palæontologists, are of doubtful specific value; and it is impossible, in the present state of our knowledge, to separate its distinct species and varieties with certainty. The group agrees closely in its vertical range with the preceding. Its oldest form appears in the highest Birkhill beds, and its most recent in the Upper Ludlow of Shropshire. It includes the only *Monograptus* yet quoted from American rocks, which are remarkably poor in members of this family.

Group v. (*lobiferus group*). This group is characteristic of the Valentian or Llandovery-Tarannon rocks, no single

* Tullberg, Geol. Fören. Förh. 1880, No. 59, Bd. v. No. 3.

species apparently surviving into the Wenlock beds. Its forms appear first in the Middle Birkhill beds, and crowd the Upper Birkhill and Gala beds wherever they are Graptoliferous. In the Upper Gala beds they are as yet unknown.

Group vi. (*Sedgwicki group*) corresponds generally with the foregoing in its vertical range. None of its species is known in the Lowest Birkhill; and only a single form lingers on into the Upper Gala period. The supposed Wenlock examples of this group occasionally quoted by palæontologists are probably fragmentary examples of the genus *Cyrtograptus*, Carr.

Of species of *Monograptus* worthy of notice in this place *M. priodon*, Bronn, is perhaps the most remarkable. If the Swedish palæontologists are correct in their reference of *M. Flemingii*, Salt., and *M. ludensis*, Murch., to this species, it is unequalled in its range, having existed from the close of the Birkhill period to the Middle of the Ludlow.

Monograptus tenuis, Portlock, and *M. gregarius*, Lapw., are the characteristic species of the Llandovery formation. *M. lobiferus*, M'Coy, distinguishes the upper half of the Llandovery formation; and *M. exiguus*, Nich., is peculiar to the lower division of the Tarannon. To this latter subformation also the remarkable species *M. turriculatus*, Barr., is generally restricted. *M. testis*, Barr., is apparently confined to a single zone in the Wenlock formation; and *M. Nilssoni*, Barr., and *M. scanicus*, Tullb., are strictly peculiar to the Lower Ludlow, not only in Britain, but also upon the continent of Europe.

Cyrtograptus, Carr.—Until very recently little was known of this very elegant and peculiar genus. Generally speaking, it is a very rare fossil in Britain, except along certain special horizons. Our oldest forms occur in the Upper Gala beds, where examples are few. In the Lower Wenlock they become more common, especially in the basal zones of *Cyrtograptus Murchisoni*, Carr., and *C. Linnarssoni*, Lapw. A single species has been recognized in the Lower Ludlow formation. In the Gala and Wenlock formations of Scania Dr. Tullberg has recently detected many new species belonging to this genus, which is there, as in Britain, peculiar to the strata above the Lower Gala. It is tolerably certain that similar forms await discovery in the corresponding rocks of Britain, and that this genus will eventually be found to characterize the strata above the middle line of the Gala group, as the genus *Rastrites* distinguishes those below it.

The most remarkable species hitherto detected in Britain is *Cyrtograptus Murchisoni*, Carr., which, as we have already

shown, marks the basal beds of the Wenlock of Siluria, Scandinavia, and probably also of the less carefully studied areas in Central Europe.

Family ii. *Leptograptidæ*.

Like the previous family, that of the *Leptograptidæ* appears to have had but a very limited range in Palæozoic time. None of its species is known to occur in the Cambrian or Silurian. The family is exclusively Ordovician in its range, its oldest genera appearing in the Upper Arenig, and its newest forms vanishing within the limits of the Upper Caradoc.

As a whole, the family is especially characteristic of the Bala formation, numerous species pervading it from its base almost to its summit, while the individuals are distributed with tolerable equality throughout the entire succession.

The two sections into which the family is provisionally divided attain their maxima along widely separated horizons. The species composing the oldest section, which includes *Cænograptus*, Hall, and its allies, culminate and disappear within the limits of the Llandeilo-Bala (Glenkiln) subformation. The species which compose the second section (which includes *Leptograptus*, *Amphigraptus*, &c.), on the other hand, are comparatively rare in the Llandeilo-Bala. They show a rapid increase in numbers and importance as we ascend into the Bala proper; and about the horizon of the Bala Limestone they become, in the Hartfell shales of the south of Scotland, most abundant and characteristic. Here, however, we suddenly lose sight of them; and not a fragment of a species of the *Leptograptidæ* has yet been detected in the higher zone of the Bala or in any more recent formation.

Cænograptus.—The beautiful genus *Cænograptus* of Hall, which we regard as the type of the older section of this family, is unknown outside the limits of the Llandeilo-Bala formation. Of the zone bounded below by the Llandeilo Limestone, and above by the deeper beds of the Caradoc proper, this genus is the peculiar and characteristic fossil. The form *Cænograptus gracilis* of Hall marks these beds everywhere in Britain; and this fixes the systematic position of the *Cænograptus*-bearing strata of Sweden, New York, and Australia. Along this zone the horizontal distribution of this form appears to have been world-wide.

Azygograptus.—By far the most remarkable genus at present assigned to this division is the strange form *Azygograptus* (Nich. & Lapw.). It may possibly be shown to belong to the *Dichograptidæ*. In that event the range of the *Leptograptidæ*

would be confined to the Llandeilo and Bala periods, *Azygo-graptus* being the only genus of this family known in the Arenig formation.

Leptograptus &c.—Turning next to the second division of the family, we come to the type genus *Leptograptus*, one of the most puzzling of all the monopronidian Graptolites. So frequently does it throw off extra simple or compound branches both from the arms and sicula, that there is some suspicion that the so-called genera *Pleurograptus*, *Amphigraptus*, &c., as defined by myself, are merely names for permanent varieties of this form. A few examples of *Leptograptus* have been met with in the Middle Llandeilo; but examples of this genus are not common till we pass above the line of the Bala Limestone, where, in the south of Scotland, they are found in extraordinary abundance.

The genera *Pleurograptus* and *Amphigraptus* are Upper Bala forms exclusively, occurring in association with *Leptograptus* in the Lower Hartfell shales in amazing profusion.

The only species of this group deserving special mention here are *Leptograptus flaccidus*, Hall, and *Amphigraptus divergens*, Hall. The former is both a Glenkiln and a Hartfell fossil in Britain and America; the latter is restricted to the Middle Hartfell beds and the corresponding Lorraine shales of New York.

Family iii. *Dicranograptidæ*.

The family of the *Dicranograptidæ*, which is most intimately allied zoologically to that of the *Leptograptidæ*, is almost precisely coincident with that family in its vertical range, its oldest known forms occurring in the Upper Arenig, and its newest in the Upper Bala formation. Like the *Leptograptidæ* also its species are characteristic of the Bala formation. Few forms are found in the Lower Llandeilo or in the Upper Bala; but in the Llandeilo-Bala or Glenkiln zone they are, next to the *Diplograptidæ*, by far the commonest fossils. The family probably culminates here; but though there is a falling off in species there is no decrease in the number of individuals of *Dicranograptidæ* till we reach the Bala horizon of the limestone. Very few forms pass higher in the succession. A few forms are known both in Scotland and South Sweden, in the highest Bala zones, close to the line marking the base of the Silurian, but no *Dicranograptidæ* have hitherto been detected above that limit.

Dicellograptus.—Of the two genera which make up this family the genus *Dicellograptus*, Hopk., is the more prolific in species, and seems to have the more extended vertical and

horizontal distribution. A form belonging to this genus has been met with deep within the Arenig formation; and its most recent species marks the highest known zone of the Bala rocks.

In the Llandeilo rocks of Wales forms of *Dicellograptus* are common; but the genus does not appear to attain its maximum until we reach the higher zones of the Glenkiln shales. In the succeeding Lower Hartfell beds examples occur in countless multitudes on several horizons, but the species are fewer. In the highest Birkhill only two species are known.

The most conspicuous species is *D. sextans*, Hall, which marks the Upper Llandeilo and Glenkiln shales in Wales and Scotland and their equivalents in Scandinavia and in North America. *D. complanatus*, Lapw., and *D. anceps* are the characteristic fossils of the Upper Hartfell beds, as *Dicellograptus Forchhammeri*, Geinitz, is of the Lower Hartfell.

Dicranograptus.—The genus *Dicranograptus* (which is, morphologically, merely a *Dicellograptus* whose branches are conjoined proximally for a portion of their length) is as yet unknown in the Upper Arenig. Its oldest known species is of Llandeilo age. It attains its specific maximum in the Glenkiln zones, only two British species surviving into the Lower Hartfell. In the Upper Caradoc subdivision the genus is as yet unknown.

The most conspicuous species is *D. ramosus*, Hall, an Upper Llandeilo and Glenkiln fossil in Britain. Like its associate *Cænograptus gracilis*, Hall, its horizontal distribution appears to have been almost world-wide.

[To be continued.]

VI.—On the Internal Structure of the Brain of *Limulus polyphemus*. By A. S. PACKARD, Jun.

SEVERAL years ago I attempted to study the brain of the horse-shoe crab (*Limulus polyphemus*), and had it sliced into a large number of sections. Owing to interruptions these sections, made from unstained alcoholic specimens, were not examined. During the past winter I have been able, with the aid of Mr. N. N. Mason of Providence, to take up the study afresh. Mr. Mason has kindly made sections, both transverse and horizontal, stained with osmic acid,—also sections of the brain and supræoesophageal ganglion of the

lobster, stained with picocarmine, for comparison. The following results, then, are based on over two hundred sections of the supræoesophageal ganglion of *Limulus*, but more especially on two brains, which were cut by Mr. Mason each into over fifty sections, from $\frac{1}{1000}$ to $\frac{1}{500}$ of an inch in thickness. The examination of a few sections of the lobster's brain enabled me to comprehend more readily the recent papers of Dietl, Newton, and Krieger on the brain of the Decapodous Crustacea and of the Insecta, and thus gives me a standard of comparison by which to study the topography and histology of the brain of *Limulus*.

General Anatomy of the Brain.—The singular relations of the central nervous system of the adult *Limulus* have been fully described and beautifully illustrated by A. Milne-Edwards; and Dr. Dohrn and myself have described its general anatomy in the larval stage. The central nervous system of *Limulus* consists of an œsophageal collar, mostly made up of six pairs of ganglia, from which nerves are distributed to the six pairs of foot-jaws (gnathopods), while the ring is closed or completed in front by the brain, or what corresponds to the supræoesophageal ganglion of normal Crustacea and insects. In these Arthropoda the brain is situated in the upper part of the head, in a plane parallel to but quite removed from that of the rest of the ganglionic chain; in *Limulus*, however, the brain is situated directly in front of and on the same plane with the rest of the central nervous system. Milne-Edwards states that the œsophageal ring, as well as the posterior part of the nervous system, is enveloped by an arterial coat. He also states that the brain and nerves are enveloped in a similar arterial coat; but this we have failed to find. The brain is protected by a thick membrane ("perineurium" of Krieger) formed of fibrous connective tissue; and the nerves are protected by a continuation of this membrane, as several longitudinal sections of these nerves have taught us. The brain in a *Limulus* 10 inches long, exclusive of the caudal spine, is about 5 or 6 millims. in diameter; it is flattened slightly above, and on the upperside has a shallow median furrow, indicating that it is a double ganglion. Three pairs of nerves and a median unpaired one (the ocellar) arise from the upper third of the anterior face of the brain. The two optic nerves are the largest ones, arising one on each side of the median furrow, so that the fifth to fifteenth sections made by the microtome pass through them. Next below (from above downwards) is the origin of the ocellar nerve, which, as described by A. Milne-Edwards, is single, arising from the median line; on each side, and in nearly the same plane,

arise two tegumental nerves; and directly below a second pair of larger nerves (fronto-inferior tegumental) descend vertically. No nerves arise from the lower half or two thirds of the brain, which is smooth and rounded with no median furrow underneath. It will thus be seen that, as stated by A. Milne-Edwards, there are no antennal nerves, such as exist, as a rule, in Arthropods, except Arachnida. This we have proved, in the same manner as Milne-Edwards, by laying open the arterial coat or modified neurilem, which reaches to the posterior end of the brain, and seeing that the fibres of the nerves sent to the first pair of legs originate quite independently of the brain itself.

Internal Structure and Histology of the Brain.—Transverse sections of the brain throw but little light on the topography, as the nerve-fibres extend horizontally, the nerves being sent out horizontally and from the anterior end only of the brain; hence the examination of nearly two hundred sections threw little light on the topography, and considerable time was spent in a vain and baffling attempt at understanding the geography of this ganglion.

The study of the brain, in sections mounted in consecutive order, finally enabled me to arrive at a tolerably complete idea of the relations of parts; so that I could mentally construct a model of the brain of *Limulus*, and compare it with the normal Arthropod brain.

The histological elements of the brain of *Limulus* are four in number:—1. Large ganglion-cells, filled densely with granules, and with a well-defined nucleus similarly filled and with a granular nucleolus. These cells may be crowded, or loose, with the granules fewer in number, and with loose thick cell-walls; they terminate in large fibres which subdivide. 2. Similar cells, but smaller, with less protoplasm, and like those in the lobster's brain. 3. Nerve-fibres; these, like the large-sized ganglion-cells from which they originate, are stained tawny yellowish brown with osmic acid. These fibres are large, coarse, their granular contents very homogeneous; and they closely resemble the nerve-fibres distributed to the compound and simple eyes. Certain fibres near the origin of the optic nerves are distinctly nucleated at intervals. 4. Rounded masses, consisting wholly of nuclei, enclosed in a network of fibres, which stain dark brown with osmic acid; these bodies form the larger part of the substance of the brain. While staining dark brown with osmic acid, in unstained alcoholic sections these masses are dark or greyish, the substance or fibres enclosing them being whitish by transmitted light. The brain is enveloped by a thick perineurium, formed

of a fibrous tissue and some (probably) elastic tissue, which occasionally penetrates into the brain-substance between the white rounded fungoid masses, forming the meshwork surrounding them. The general topography of the brain of *Limulus* is on a simple plan compared with that of Decapodous Crustacea and insects. The brain is mostly composed of large, irregular, rounded masses or balls of granules, with a thick fungoid or ruffle-like periphery, formed by a layer of secondary, smaller, rounded, granular masses. The centre of the primary masses is stained paler brown by osmic acid. These bodies are often seen in section rounded, but more often are irregular, not closed, spheroids; these dark bodies extend through the brain like ruffles. The lower half or two thirds of the entire brain is apparently filled with these nucleogenous bodies, as we may provisionally designate them. In the upper third of the brain, whence the nerves originate, the larger ganglionic cells and the nerve-fibres appear, and preserve a definite topographical relation to the entire brain. The nucleogenous bodies are confined at the top to each side of the brain; the central and hinder regions are filled with the large ganglionic cells, mixed with numerous much smaller ones; and the mass of nerve-fibres which spring from them becomes larger from the upper third to the top of the brain, where the optic fibres originate. Opposite the beginning of the optic nerves these large nerve-fibres are seen directed towards the origin of the nerves, as if they were the roots, as they undoubtedly are. In the section passing through the ocellar nerve and the tegumentary nerves on each side, the nucleogenous bodies are situated in the front of the brain; but they disappear from the front higher up at the origin of the optic nerves, and occupy a much more restricted area on the sides of the brain. Thus the tract of nerve-fibres on either side of the brain is irregularly wedge-shaped, the apex situated near the centre of each hemisphere, and the base spreading out on the top, thus crowding to the outer walls the nucleogenous bodies.

It would thus appear as if the lower half of the brain were in an indifferent state*, and the dynamic part confined to the upper third, the region giving origin to the nerves of sensation.

* This area, made up of granules and nuclei, seems really to be connective tissue, and to represent the connective tissue in which the ganglia of the embryo of the young larva are imbedded. There seems no reason why the brain should not be partly formed from connective tissue as much as the remaining ganglia, as we have seen them to be in different sections of different ganglia, all or nearly all except the supracæsophageal one.

The asymmetry of the brain is remarkable: the large ganglionic cells are most abundant in the centre behind the middle, and from there to the posterior side of the brain a median line is slightly indicated by the arrangement of the nucleogenous bodies. The tract composed of large nerve-fibres with scattered ganglionic cells on the left side is very much more extensive than on the right.

Comparison with the Brain of other Arthropods.—So wholly unlike, in its form, in the want of antennal nerves, and in internal structure, is the supracæsophageal ganglion or “brain” of *Limulus* to that of insects and the higher Crustacea, that it is very difficult to find any points of comparison.

Histologically, judging by my specimens of the brain of the lobster which are stained with carmine, the brain of *Limulus* agrees with that of other Arthropods in having similar large ganglion-cells; the smaller ganglion-cells, so abundant in the brains of insects and crustacea, are wanting in *Limulus*. There are in *Limulus* no “ballen-substanz” masses homologous with those of the other Arthropods.

Topographically the internal structure of the brain of *Limulus* is arranged on a wholly different type from that of any other Arthropodous type known—so much so that it seems useless to attempt to homologize the different regions in the two types of brain. The plan is simple in *Limulus*, much more complex in Arthropods, especially in the brain of the crawfish as worked out by Krieger, as in the Decapodous brain there arise two pairs of antennal nerves besides the optic pair; and in external form the two types of brain are entirely unlike. The symmetry of the brain of the crawfish, as of the lobster and insects, is marked throughout, each hemisphere exactly repeating in its internal topography the structure of the opposite side; that of *Limulus* is obscure and imperfect.

VII.—On a new Species of Chiton lately found on the British Coasts. By J. GWYN JEFFREYS, LL.D., F.R.S.

*Chiton scabridus**.

BODY thin, semitransparent, of a blood-red colour: *mantle* dirty white: *mouth* small: *foot* lanceolate, only one third the width of the body, tapering rather gradually to a fine point; the sole is marked lengthwise by six red lines, which are

* Rough.

wider and closer together on each side than in the middle; between the foot and the mantle are red patches corresponding with the plates of the shell, and united by a continuous but irregular red line that encircles the body within the mantle: *gills* unequal in length: *girdle* of moderate width, covered with small regular and close-set yellow roundish-oval granules; margin fringed with numerous short spines.

SHELL oval-oblong, somewhat depressed, of a dull hue: *plates* narrow; all except the terminal ones are nearly equal in width; the lateral compartments in each valve are indistinct, and not raised above the middle portion: *sculpture* consisting of minute tubercles, arranged in several longitudinal rows, which are distinctly defined in the middle, and radiate or diverge to the margin on the lateral and terminal spaces; there is no central ridge: *colour* yellowish brown: *beaks* inconspicuous, except on the tail-plate: *inside* glossy, furnished towards each side of all the plates, except the head-plate, with obtusely triangular leaves, which serve to interconnect the plates; margin slightly and irregularly notched. L. 0·2125. B. 0·125.

Hab. Goodrington, Torbay (*Mr. Pidgeon*); Jersey (*Mr. Duprey*). It appears to be rare. I received this species first from Mr. Pidgeon, and considered it a variety of *C. cancellatus*; but subsequent communications from Mr. Duprey have induced me to alter my former opinion. For the description of the animal I am indebted to Mr. Duprey. The shell is not convex or gibbous like that of *C. cancellatus*, and it is somewhat broader in proportion to the length; the rows of tubercles are half the number, and the tubercles are more raised and much coarser, giving a rough or scabrous aspect to the shell; the granules which cover the girdle are more regular in shape and arrangement; and there are some differences in the animal, which are shown by comparing the description of the present species with that of *C. cancellatus*, in the fifth volume of 'British Conchology,' p. 198. Mr. Duprey tells me that he finds *C. scabridus* with *C. cancellatus*, as well as *Rissoa lactea* and *R. striatula*, in the lower part of the littoral zone, living underneath stones. This is a remarkable habitat, and is shared also by *Adeorbis subcarinatus*.

I cannot adopt the artificial system proposed by the late Dr. Gray, Dr. Philip Carpenter, and Messrs. Adams in generically separating our species of *Chiton*. In 'The Genera of Recent Mollusca' *Chiton marmoreus*, Fabricius (under the name of *C. levigatus*, Fleming), is placed with *C. cancellatus* in the genus *Leptochiton* of Gray, because the "mantle-margin" (girdle) is said to be "covered with minute, gra-

nule-like, round, smooth scales, not imbricate;” while *C. marmoreus* is again placed in the genus *Tonicia* of Gray, which is described as having the “mantle simple, horny, naked, smooth, or glabrous.” *C. mediterraneus*, Gray (probably meant for *C. siculus*, Gray, = *C. olivaceus*, Spengler), is placed in both the genera *Lepidopleurus* of Risso and *Leptochiton*. *C. Hanleyi*, Bean, = *C. mendicarius*, Mighels, has the same kind of sculpture as *C. scabridus*, and belongs to the genus *Chaetopleura* of Shuttleworth.

I may mention that *C. cancellatus* was sent me by the late Professor Sars as his *C. alveolus*; but the latter, as since described and figured by his no less eminent son, is a different species.

VIII.—*Report on Specimens dredged up from the Gulf of Manaar and presented to the Liverpool Free Museum by Capt. W. H. Cawne Warren.* By H. J. CARTER, F.R.S. &c.

[Continued from vol. v. p. 457.]

[Plates IV.-VI.]

SPONGIDA.

The descriptions of the Spongida found in and about the Melobesian nodules from the Gulf of Manaar will, so far as they go, be arranged after the classification proposed in my “Notes,” &c. (‘Annals,’ 1875, vol. xvi. p. 128 *et seq.*); so to this I must refer the reader for the characters of the orders &c. respectively.

In the measurement of the spicules it should be remembered that their form is of much more consequence than their dimensions, as the latter may vary:—1st, in different specimens; 2nd, in the same specimens (as they present themselves under all degrees of development); and 3rd, in the same species, where the average largest vary in proportion to their stoutness, the stoutest being the shortest, and *vice versâ*. My measurements are taken from the average largest of the specimens, as *these* may be assumed to represent the ultimate size, and will be given in parts of an inch, for the purpose of conveying an idea of the *relative* rather than the *real* size of the spicules; while, to avoid repetition, it may be stated here, once for all, that, unless otherwise mentioned, they will refer to the *greatest diameters* of the object. It should not be forgotten that all the specimens are *dry*.

CERATINA.

Aplysina purpurea, n. sp.

Form irregular, membranous, hollow, cactiform on the surface. Colour black-purple. Fibre weakly developed, so that, when elementarily examined, nothing can be distinguished beyond a laminated condensation of the membranous structure densely charged with purple pigment-cells like that of *Ianthella flabelliformis*, Gray (Proc. Zool. Soc. Jan. 1869, p. 50), extending among the Melobesian nodules and detritus of the sea-bottom, so as to form an agglomeration in which the contrast of the dark pigment-cells and the purple stain that accompanies them with the whiteness of the fragments over which the sponge may be spreading is very striking, even to the naked eye. In this respect it is very like *A. navus* ('Annals,' 1876, vol. xviii. p. 229, pl. xii. fig. 2).

I also possess a large specimen of a similar sponge from Trincomalee, on the N.E. coast of the island of Ceylon, in which the purple colour is not so dark, but the fibrous structure is almost entirely absent, although the surface is cactiform and drawn up into puckered monticules; so the latter is not always dependent on the presence of fibre. It is pyramidal in shape, compressed, and 5 inches high, with a base also 5 inches long and 2 inches thick.

Aplysina fusca, n. sp.

Massive, digitate, hollow, cactiform on the surface. Colour dark brown. Growing like the last. Fibre well developed, of a light brownish colour, opaque, hollow in its dry state, with the axial cavity largely developed in proportion to its horny investment.

PSAMMONEMATA.

Hircinia arundinacea, n. sp. (provisional).

This imperfect specimen, which is in long stalks about 1-6th inch in diameter and of a light yellow colour, has had its sarcodic parts replaced by the parasite which usually attacks the *Hirciniae* in all parts of the world, viz. *Spongiophaga communis*.

Hircinia fusca, n. sp. (provisional).

Massive, digitate, branched lobate, cactiform on the surface. Colour dark brown. Growing like the species of *Aplysina* above described, but solid and charged with fibre covered with foreign material.

RHAPHIDONEMATA.

The Chalinida are only represented by a mere amorphous fragment not more than an inch in diameter, in which the fibre is resilient as usual, and charged with small acerate spicules only.

Desmacidon Jeffreysii, Bk.

This species, described by Dr. Bowerbank, under the name above given, in his Mon. Brit. Spong. (vol. ii. p. 347, and figured in vol. iii. pl. lxii.), also by the Rev. A. M. Norman under the generic name of *Oceanapia* (Brit. Assoc. Report, 1868, p. 334), is, with a slightly varied form, found in the Gulf of Manaar, where the body portions (for there are two specimens) are not more than an inch in diameter respectively, although the tubular extensions are much branched and upwards of 6 inches in length, covered with an overgrowth of other organisms, together with sea-bottom detritus which nearly obscures the surface both of body and tubes. Internally, however, it is essentially the same as *Desmacidon Jeffreysii*, but with the exception that it contains no flesh-spicules—that is, minute bihamates (*fibulæ*),—thus resembling that from the south coast of Australia, where it also occurs, but more under the British form, viz. turnip-like; while the British form *does* contain the bihamates, as mentioned by Mr. Norman (*l. c.*), and found by myself in the identical specimen figured by Dr. Bowerbank (*l. c.*), although the latter has neither figured nor mentioned them in his description or illustrations (B. S. vol. iii.).

In classification, I feel inclined to place this sponge among the Cavo-chalinida, on account of its fibrous structure charged with simple acerate spicules, and its hollow tubular extensions; but it should, I think, be considered the type of a distinct group.

ECHINONEMATA.

Dictyocylindrus manaarensis, n. sp.

(Pl. IV. fig. 1, a-g.)

Stalk-like, erect, cylindrical, branched dichotomously; branches round, obtusely pointed (Pl. IV. fig. 1). Consistence firm. Colour now dark brown. Surface slightly hispid. Structurally consisting of spicules in juxtaposition, arranged in tufts perpendicularly round a condensed axis of a like nature. Spicules of six forms, viz. :—1, long, smooth, curved, acute, 45 by $1\frac{1}{2}$ -1800th (fig. 1, a); 2, shorter, smooth, curved, acute, proportionately stouter, with inflated

microspined round head, 27 by $1\frac{1}{2}$ -1800th (fig. 1, *b*); 3, hair-like, smooth, acute, about 17-1800ths long (fig. 1, *d*); 4, thick, fusiform, slightly curved, shaft with inflated round and microspined extremities, 17-1800ths long (fig. 1, *c*); 5, flesh-spicule, smooth, tricurvate, 12-6000ths long (fig. 1, *e, g*); 6, flesh-spicule, equianchorate, naviculiform, 4-6000ths long (fig. 1, *f, g*). Nos. 1-4 form, in plurality, the tuft, of which 3 is the most numerous, and all have their long axis respectively outwards; 5 and 6 are plentifully distributed about the base of the tuft. Size of specimen (which is imperfect) about $1\frac{3}{4}$ inch long, stem 1-10th inch in diameter.

Hab. Marine. Growing on hard objects.

Loc. Gulf of Manaar.

Obs. This well accords with the genus *Dictyocylindrus* as established by Dr. Bowerbank. The thick short spicule with inflated and microspined extremities (no. 4) may be considered the echinating form.

Dictyocylindrus sessilis, n. sp. (Pl. IV. fig. 2, *a-d*.)

Massive, convex, sessile, spreading, becoming subhemispherical (Pl. IV. fig. 2). Consistence hard, rigid. Colour light brown. Surface uniformly uneven. Structurally composed of tongue-shaped columns radiating and branching from the base to the circumference, where they are more or less divided, and thus altogether, when dry, present the appearance of a cauliflower, consisting of tufts of spicules densely packed together, and rendered almost inseparable without fracture by their tough sarcodic union. Spicules of three forms, viz. :—1, large, stout, smooth, acute, curved chiefly towards the blunt end, which is slightly larger than the shaft, 45 by 2-1800ths (fig. 2, *a*); 2, thin, hair-like, smooth, acute, about 20-1800ths long (fig. 2, *b*); 3, flesh- or echinating spicule, shaped like no. 1, but spined throughout, sparsely towards the large end, 35 by 2-6000ths (fig. 2, *c, d*). The large acuates are surrounded by bundles of the hair-like ones, having the echinating spicule at their base, to form, all together, the "tuft." Size of specimen about 6-12ths inch high in the centre by $1\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. Growing on hard objects.

Loc. Gulf of Manaar.

Obs. In this, as in many other species of the Echinonemata, the tufts, when dissected out, will be found to be almost identical in form with those of *Microciona atrosanguinea*, Bk., showing not only an alliance between the two genera, but that *Dictyocylindrus* is only a more complicated structure of *Microciona*.

Microcionina.

I intended this family to include Dr. Bowerbank's genera *Microcionia* and *Hymerhaphia* (Brit. Spong. vol. i. pp. 188, 189), chiefly because they are all thin, flat, incrusting and laminiform species, containing respectively a *setaceous* form of spicule, and another more or less allied to the echinating one of the Echinonemata.

The distinguishing character between these two genera, according to Dr. Bowerbank, is that the spicules of *Microcionia* are arranged in tufts or "columns" (ex. gr. *M. atrosanguinea* = *Scopalina*, Sdt.), and those of *Hymerhaphia* are not. But the spiculation is more persistent than the "columns" in many instances, whereby the diagnosis would break down, as the *Microcionia* thus becomes a *Hymerhaphia*. Taking an opposite view of the case, *Hymerhaphia vermiculata*, Bk., of course contains no "columns;" but *H. vermiculata*, var. *erecta* ('Annals,' 1876, vol. xviii. p. 307, pl. xii. fig. 4 &c.), does (that is, "fasciculi"), with identical spiculation; so here the diagnosis of *Hymerhaphia* breaks down. Again, Dr. Bowerbank's *Microcionia carnosa* of 1866 is made identical with *Halichondria plumosa*, Johnston, 1870 (B. S. vol. iii. p. 61), and renamed *Microcionia plumosa*. Now, considering that *Halichondria plumosa* grows up into an erect massive form, it must, according to Dr. Bowerbank's diagnosis, be a *Microcionia* at one time, viz. when flat and incrusting, and at another not—that is, when it is erect and massive; hence I have proposed a group "Plumohalichondrina" for this and similar species, the most remarkable of which that I have seen comes from Port Elizabeth, South Africa, where it appears to be very abundant; it is large, branched, and compressed, like an elk's horn; and they all possess the *angulated* (Bk.) equianchorate, not the naviculiform spicule of *Microcionia*.

Nor is it uncommon to find an Echinonematous sponge beginning in the flat form of a *Microcionia* and then becoming erect, as appears to be the case with *Halichondria plumosa* just mentioned. But while this shows that the "columns" in *Microcionia* are not of much generic value, it also points out that genera formed upon the characters of indigenous species are very likely to break down when applied to world-wide collections; yet the same may be said of the latter until *all* the species of a class are known.

There is still another of Dr. Bowerbank's genera which, both in spiculation and growth, is very nearly allied to these thin, flat, incrusting laminiform sponges, viz. *Hymedesmia*; but here, again, his chief distinguishing character, viz. the

“recumbent” or horizontal position of the linear spicules, seems to me to be by no means constant and often dependent on circumstances. Even in his description of *Hymedesmia stellata* (B. S. vol. ii. p. 150) he uses the term “hispid;” and in the species *Hymedesmia spinatostellifera*, to be hereafter described, I was obliged to seek for an illustration of the entire skeleton-spicule among *erect* or projecting ones in the more protected parts.

Dr. Bowerbank admits that all these three genera, which are given one after another in his ‘British Spongiadæ,’ are very nearly allied; and I now feel much inclined to place them *all* in my group Microcionina, although the Hymedesmina in my classification stand as the ninth group of my Holorhaphidota; but then the species which illustrate it (p. 197), viz. *Hymedesmia Johnsoni*, Bk., and *Desmacidon titubans*, have not the long, setaceous, acute, or spinulate spicule which characterizes Dr. Bowerbank’s original species (viz. *H. radiata* and *H. stellata*, described in 1866, B. S. vol. ii. pp. 149 and 150, and illustrated in 1870, vol. iii. pl. xxviii.), and which, together with its accompaniments, is characteristic of the kind of *Hymedesmia* that I should place in my group Microcionina. *Hymedesmia Johnsoni* and *Desmacidon titubans* would be much better placed alongside with Esperina, where they now are in my classification.

There are, however, species which have not this kind of spiculation, viz. the setaceous acute, &c., ex. gr. *Rhaphidhistia spectabilis* (‘Annals,’ 1879, vol. iii. p. 300, pl. xxvi. figs. 13, 14a); and there are specimens which may be so circumstanced as never to get beyond a thin lamina, although under other conditions they might grow up into erect forms: such is perhaps *Hymedesmia zetlandica*, Bk., judging from its spiculation *in the type specimen* now in the British Museum, which I should be inclined to regard as allied to *Halichondria plumosa*, in which case it would come under my Plumohalichondrina.

Having premised these remarks it will be understood that although hereafter I shall describe the species of *Hymedesmia* found on the Melobesian nodules among the Holorhaphidota, yet I am of opinion that *they* ought to be under the Echinonemata, in the group Microcionina, together with the following ones of *Microcionia* and *Hymerhaphia*.

Microcionia atosanguinea, Bk., and *M. armata*, Bk.

Both these species occur on the Melobesian nodules, now of a red-cinnamon colour, but were probably “blood-red,” like the British specimens of the same sponges when alive. Both

are characterized by the large, setaceous acute, accompanied by a thin one, together with a small clavate-spined spicule (the echinating form), a smooth tricurvedate and a naviculiform, small, equianchorate (flesh-spicules), all arranged in tufts with the flesh-spicules about their base; but the tufts or "columns" are much more developed in the former than in any other species of the kind, whence it was called "*Scopalina*" by Schmidt in 1862. In *M. armata* the tufts are not so strongly developed, but the tricurvedate spicule is unusually so, and in some instances so spread out as to resemble a long, thin, straight acerate with a short abrupt curvature in the centre.

Microciona affinis, n. sp. (Pl. IV. fig. 15.)

This species is very like the type species, *Microciona atrosanguinea*, in spiculation, but is extremely thin, has no tufts ("columns"), and the colour now is whitish yellow. Its chief specific difference, however, lies in the form of the equianchorate, which being extremely abundant and thicker (but not longer), from a greater projection of the central tongue-shaped arm, presents the appearance of being barbed on the inner side of the point, so that when viewed laterally this has much the appearance of a fish-hook (Pl. IV. fig. 15).

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This is one of the species to which I have above alluded, in which the spiculation is essentially like that of the type specimen of Dr. Bowerbank's genus *Microciona*, viz. *M. atrosanguinea*, although it possesses no "columns." The "fish-hook"-like appearance at the end of the central arm of the equianchorate, when viewed laterally, may be owing to a deficiency or hole in the upper part of the falcate septum which ordinarily unites this arm to the shaft, and a corresponding thickening of the septum at this part, which in some instances appears to extend to the shaft itself; but the object is too small for me to state, with any certainty, more than that it presents the "fish-hook appearance" mentioned.

Microciona bulboretorta, n. sp. (Pl. IV. fig. 3, a-e.)

Laminiform, extremely thin, hirsute, spreading. Colour, when dry, whitish yellow. Spicules of four forms, viz. :—1, long, setaceous, smooth, acute, with inflated blunt end turned to one side, 175 by 2-1800ths (Pl. IV. fig. 3, a); 2, the same, but short, and spined halfway up from the blunt end, 30 by 1½-1800th (fig. 3, b); 3, the same, about half the length of the last (fig. 3, d, e); 4, thin, smooth, acute, 40-1800ths long (fig. 3, c). All the spiculation is erect, and no. 4 in tufts

around no. 1. Size variable; that of specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The large inflation of the fixed end, which is turned to one side, occurs in all the spicules except no. 4. There are no anchorates and no tricurvates; so that the spiculation is something like that of *Hymenophyllum clavata*, Bk.; but, as above stated, all the spicules are erect like those of a *Microcionia*, whereas in Dr. Bowerbank's illustration of that species (B. S. vol. iii. pl. xxvi. fig. 4) part, at least, are reclined confusedly; but then, as I have also said before, this may have been occasioned by circumstances, viz. protection or exposure respectively during growth.

Microcionia quadriradiata, n. sp.

(Pl. IV. fig. 4, a-d.)

Laminiform, extremely thin, hirsute, spreading. Colour, when dry, dark brown. Spicules of three forms, viz.:—1, large, setaceous, smooth, acuate, curved chiefly towards the blunt end, which is globular and rather less in diameter than the shaft, from which it is separated by a slight constriction, 75 by 3-1800ths (Pl. IV. fig. 4, a); 2, thin, smooth, acuate, frequently more or less crooked, 25-1800ths long (fig. 4, b); 3, quadriradiate, consisting of three arms radiating at equal angles from a common central point, which, raised and tripod-like, supports the fourth arm in an erect position; all densely and uniformly microspined, $5\frac{1}{2}$ by 6-1800ths (fig. 4, c, d). No. 1, together with tufts of no. 2, projects vertically out of the lamina, which is densely charged with no. 3, whose erect arm thus becomes the *echinating* spicule. Size variable; that of specimen about $\frac{1}{4}$ inch in diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The quadriradiate spicule of this species is almost identical in form with that of *Dictyocylindrus Vickersii* ('Annals,' 1879, vol. iii. p. 292, pl. xxvii. figs. 5-8), where the vertical arm in like manner becomes the *echinating* element or spicule; and the crooked form of the thin acerate is also similar; but the skeleton- or setaceous spicule is different. In the species, however, to which Mr. Thomas Higgin has called attention, and which also grew on a *Melobesia* ("Nullipore"), both the quadriradiate and setaceous spicule are essentially identical; therefore this is a specimen of *Microcionia quadriradiata* from the West Indies ('Annals,' 1877, vol. xix. p. 296, pl. xiv. fig. 9).

Microciona quinqueradiata, n. sp.(Pl. IV. fig. 5, *a-e*.)

Laminiform, extremely thin, hirsute, spreading. Cream-colour. Spicules of four forms, viz.:—1, long, setaceous, curved, simple, acute, 125 by 1-1800th (Pl. IV. fig. 5, *a*); 2, short, thick, acute, curved generally, with blunt end round and a little less in diameter than the shaft, from which it is differentiated by a slight constriction, 33 by 2-1800ths (fig. 5, *b*); 3, thin, slender, simple, acute, 30-1800ths long (fig. 5, *c*); 4, quadriradiate, consisting of four *smooth* pointed arms radiating opposite each other from a common centre that is raised so as to form a four-legged base to the fifth arm, which is erect, longer than the rest, gradually pointed, thickly spined throughout and the spines recurved, 6 by 5-1800ths (fig. 5, *d, e*). Nos. 1-3 are erect, and the latter in greater plurality than the others, while the long, spined arm of the quadriradiate, which is very numerous, forms the echinating part. Size variable; that of the specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This species is in growth, colour, and spiculation very like the foregoing one; but while the quadriradiate or echinating spicule in *M. quadriradiata* is most like that of *Dictyocylindrus Vickersii* (*l. c.*), it is the setaceous and thick, short, acute spicules respectively here which most resemble the spiculation of that sponge.

Microciona curvispiculifera, n. sp.(Pl. IV. fig. 6, *a-d*.)

Laminiform, extremely thin, hirsute, spreading. Cream-colour. Spicules of three forms, viz.:—1, long, setaceous, smooth, acute, curved chiefly towards the blunt end, which is smooth and not differentiated from the shaft, 100 by 1-1800th (fig. 6, *a*); 2, the same, but much shorter, although proportionately stouter, 15 by 1-1800th (fig. 6, *b*); 3, cylindrical, bent in the centre, round at the extremities, smooth at first, becoming when fully formed spiniferous throughout, 15 by $\frac{2}{3}$ -1800th (fig. 6, *c, d*). Nos. 1 and 2 are erect and fixed in a layer of the bent spiniferous spicules, which project outwards so that half of their length, lying parallel with the other spicules, becomes the echinating part. Size variable; that of the specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This species is well-characterized by the bent spicules, many of which present different degrees of smoothness in proportion to the amount of development, which ends in their becoming thickly spinous throughout.

Microciona fascispiculifera, n. sp.
(Pl. IV. fig. 7, *a-g*.)

Laminiform, extremely thin, hirsute, spreading, covered with little bundles of spicules of different lengths respectively (Pl. IV. fig. 7, *g*). Cream-colour. Spicules of four forms, viz.:—1, long, setaceous, smooth, acuminate, curved chiefly towards the blunt end, which is not differentiated from the shaft, 70 by $1\frac{3}{4}$ -1800th (fig. 7, *a*); 2, acerate, hair-like, in bundles, of different lengths below 20-1800ths (fig. 7, *c, d*); 3, spined acuminate, 5-1800ths long (fig. 7, *b* and *e*); 4, minute, simple, bihamate, 2-6000ths (fig. 7, *f*). Nos. 1 and 3 project from a layer formed of nos. 2 and 4, the former in sheaf-shaped bundles of various dimensions lying on the surface. Size variable; that of the specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This species is also well characterized, viz. by the fasciculi of hair-like spicules, which respectively vary from 1-3000th to 1-90th inch in length, and by reflected light under the microscope look very much like minute white sawdust, for which, at first, I mistook them, partly on account of the specimens having been packed in this material that had more or less adhered to them. It is not the first time that I have found a hair-like spiculation of this kind in *Microciona*, as may be seen by a reference to the illustration of *M. minutula* ('Annals,' 1876, vol. xviii. p. 239, *mendose script.* "*pusilla*," pl. xvi. fig. 51, &c.).—N.B. Never pack sponges in cotton wool or sawdust, but place them at once in spirit and water in a jar or keg, with a *vellum* label on them written in *black-lead pencil*.

The presence of sheaf-shaped fasciculi of hair-like spicules looking, as just stated, like minute sawdust by reflected light (Pl. IV. fig. 7, *g*) is a very common feature in different species of *Esperia*, where they often appear to replace the tricurvates. I delineated them first in 1871 ('Annals,' vol. vii. pl. iv. fig. 22), in *Stelletta lactea*, and again in *Esperia socialis* (ib. ib. pl. xvii. fig. 7, *d*, p. 277). Finally in 1874 ('Annals,' vol. xiv. p. 104) I conjectured not only that they were produced in cells like tricurvates similarly developed (ib. ib. pl. x. figs. 3-8), but

that, in some instances, they were identical with the latter; and now they have presented themselves in *Microciona fascispiculifera*, which seems to be a very common species in the Gulf of Manaar, as there are many specimens of it on the Melobesian nodules. This, however, is not the only instance in which the flesh-spicules may be developed together in groups, as we see by the rosettes of inequianchorates, also another common feature of *Esperia*; and I have little doubt that bihamates may be produced in the same way, particularly after considering the illustration of *Hymedesmia zetlandica*, Bk. (Brit. Sponges, vol. iii. pl. xxix.), in which the bihamates are not single, as is usually the case, but in groups like the tricurvates &c. It should, however, be remembered that these spicules are often developed *singly* as well as in groups in their cells ('Annals,' *l. c.* pl. x. figs. 11 and 12). We must view the sheaf-shaped bundles, then, I think, as "flesh-spicules" closely allied to, if not identical with, tricurvates; and therefore they may occur in any kind of spiculiferous sponge; hence it is not strange that we should find them in a *Microciona*, where the tricurvate is such a common flesh-spicule.

Mr. Sollas has proposed for them the name of "trichites" ('Annals,' 1880, vol. v. p. 133), which it would be as well henceforth to adopt, as they are evidently not peculiar to one kind of sponge, and may occur in a great number; so that they should, for convenience of description, have a fixed designation, although, as I have above stated, they seem to me to be but another form of the tricurvate.

Hymerhaphia unispiculum, n. sp.
(Pl. IV. fig. 8.)

Laminiform, extremely thin, hirsute, spreading. Cream-colour. Spicules of one form only viz. large, setaceous, smooth, acute, curved chiefly towards the blunt end, which is hemispherical and a little more in diameter than the shaft, from which it is differentiated by a slight constriction, 70 by $1\frac{3}{4}$ -1800th (Pl. IV. fig. 8). Size variable; that of the specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. *Hymerhaphia unispiculum* is not so remarkable for the form of its spicule, which is common to many species, as for there being no other, in which respect it resembles *Hymedesmia simplicissima*, Bk. (Brit. Sponges, vol. iii. pl. lxxx. fig. 1). It seems to me questionable, however, if this is not

accidental, and that the other spicules, which often accompany a similar form, are, from some cause or another, absent here; the record, therefore, is only made *provisionally*.

Hymerhaphia vermiculata, var. *erecta*.

This, which is but an erect form of *Hymerhaphia vermiculata*, Bk., I found plentifully among the dredgings of the 'Porcupine' from the bed of the Atlantic Ocean between the north of Scotland and the Faroe Islands ('Annals,' 1876, vol. xviii. p. 307, pl. xii. fig. 4, &c.); and it seems to be equally plentiful in the Gulf of Manaar, with this difference only, that the acute spicules are not so large or so setaceous as those in the specimens from the Atlantic sea-bed.

Hymerhaphia clavata, Bk.

Laminiform, extremely thin, hirsute, spreading. Cream-colour. Spicules of four forms, viz.:—1, large, smooth, acute like that of *H. unispiculum*, 100 by 3-1800ths; 2, clavate, nearly straight, with the blunt end differentiated from the shaft by being one third more in diameter, spined throughout, 14 by $2\frac{1}{2}$ -1800ths; 3, the same, but not more than half the size; 4, thin, smooth, acute, 30-1800ths long. All these spicules are erect; and no. 1, which is rather sparse and very large and long, is surrounded by a great number of the fine acuates no. 4. Size variable; that of the specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This is so nearly allied in spiculation to *Hymerhaphia clavata*, Bk., that I think it must be a specimen of the same species; but lest it should not be, I have given the description, merely adding that if it differs from *Microciona* in the absence of the "columns," it certainly comes so near it in the elements and arrangement of its spiculation that it is almost questionable whether it should not be called a *Microciona*.

Hymerhaphia eruca, n. sp. (Pl. IV. fig. 9, a-c.)

Laminiform, extremely thin, hirsute, spreading. Colour light brown. Spicules of three forms, viz.:—1, large, smooth, setaceous, acute, chiefly curved towards the blunt end, which is slightly inflated hemispherically, and slightly differentiated from the shaft by constriction, 70 by $1\frac{3}{4}$ -1800th (Pl. IV. fig. 9, a); 2, vermiculate, acerate, annulated at more or less equal distances by projecting ridges, which here and there are broken or imperfect, 25 by $1\frac{1}{2}$ -1800th (fig. 9, b); 3,

the same, but smaller and smooth, in an earlier stage of development (fig. 9, c). No. 1 projects from a bed of no. 2. Size variable; that of the specimens about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This sponge, in spiculation and arrangement of the spicules, is very like *Hymenophyllum vermiculata*, Bk.; indeed the early form of the caterpillar-like spicule (that is, before the annulations are developed) is precisely like the contort spicule of *H. vermiculata* (fig. 9, c).

Baculifera.

This group was established for receiving a great number of different forms of a sponge both suberitic in its consistence and in the form of its spicules, but Echinonematous in their arrangement, wherefore it was placed in the order Echinonemata. So far as I have had an opportunity of examining these forms they have all had only one and the same form of spicule, which is pin-like, with the head elongated at right angles to the shaft, like that of a crutch, but so peculiar that there is no mistaking it anywhere when once known. The specimens which I have seen chiefly come from the southwest coast of Australia; and the first described were named *Caulospongia verticillaris* and *C. plicata*, by Mr. Saville Kent (Proc. Zool. Soc. 1871), of which the former is in the Liverpool Free Museum, and the latter in the British Museum. I found a small fragment of this group of a light brown, which is the usual colour, in two places on the Melobesian nodules.

HOLORHAPHIDOTA.

Renierida.

Much information is yet needed to make the species in the groups of this family clear; for the acerate form of spicule is so common among them that, unless accompanied by a flesh-spicule, which is seldom the case, the descriptions only of a great number of fully developed specimens can establish the species. Thus in the British Museum there are two species on a large, branched, stony coral from Madeira, both massive and amorphous, one yellow, the other white or colourless; both belong to my group "*Crassa*," from the large size of their spicules. The yellow one has a cylindrical spicule with obtuse ends (sausage-shaped); the white one, a still larger spicule, which is long, thick, fusiform, acerate, more like

that of *Halichondria panicea*—that is, gradually pointed. Now just the same kind of sponges appear on the Melobesian nodules; but although the spicule of the colourless or white species is almost identical with that on the Madeira coral, that of the yellow one, instead of being cylindrical and sausage-shaped, is acerate and sharp-pointed; while there is a third species about the Melobesian nodules, which is dark brown, that *has* a cylindrical obtusely-ended spicule. Under these circumstances all that I can do is briefly to describe them respectively by the terms *yellow*, *white*, and *dark brown*, provisionally—that is, until the species to which they respectively belong shall have been satisfactorily defined.

Reniera, yellow. (Pl. V. fig. 17.)

Massive, lobate. Consistence firm. Colour ochre-yellow. Surface even. Spicule of one form only, viz. smooth, acerate, fusiform, curved, abruptly sharp-pointed, 17 by $1\frac{1}{2}$ -1800th (Pl. V. fig. 17). Colour variable—some specimens being greyish yellow, and others almost white. Size of largest specimen about $2\frac{1}{2}$ inches in its longest diameter.

Reniera, white. (Pl. V. fig. 16.)

Massive, lobate, rising into short tubular processes. Consistence firm. Colour white. Surface even. Spicule of one form only, viz. smooth, acerate, fusiform, curved, gradually pointed, 60 by $2\frac{1}{2}$ -1800ths (Pl. V. fig. 16). Size of largest specimen about 3 inches in diameter.

Reniera, dark brown. (Pl. V. fig. 18.)

Amorphous, growing in small portions here and there in the depressions of the Melobesian nodules. Consistence firm. Colour dark brown. Spicule of one form only, viz. smooth, cylindrical, curved, rounded at the extremities, 23 by 1-1800th (Pl. V. fig. 18). Size of largest specimen about an inch in horizontal diameter.

Reniera fibulifera, Sdt.

This sponge, which seems to be world-wide in its distribution, was represented by a small growth, about 1-16th inch in horizontal diameter, which was identified at the time, but overlooked afterwards, so that there is no slide or mounted specimen of it.

Halichondria albescens, Johnston.

Here and there on the nodules.

Halichondrina.*Halichondria aceratospiculum*, n. sp.(Pl. V. fig. 19, *a-d*.)

There was only a minute trace of this, but sufficient for mounting and for the following description of its spicules, which consist of four forms, viz.:—1, acerate, fusiform, curved, sharp-pointed, thickly spined throughout, 25 by $1\frac{1}{2}$ -6000th (Pl. V. fig. 19, *a*); 2, smooth, acerate, fusiform, curved, slightly inflated in the centre, and gradually pointed, 35 by 1-6000th (fig. 19, *b*); 3, bihamate, simple, 8-6000ths long (fig. 19, *c*); 4, equianchorate, shaft slightly curved, arms linear in appearance, and distinct when viewed laterally, $3\frac{1}{2}$ -6000ths long (fig. 19, *d*).

Obs. This is evidently the spiculation of a variety of *Halichondria incrustans*, in which the flesh-spicules, viz. nos. 3 and 4, are in form identical, while the acerate forms of the larger spicules respectively lead to the designation.

Esperina.*Esperia tunicata*, Sdt.

This consists of a thin fragment, about $\frac{1}{2}$ an inch in horizontal diameter, abounding with the usual Esperian rosettes, composed of the inequianchorate of the species, accompanied by a great number of nondescript forms, which appear to be half-developed inequianchorates that have respectively been generated in separate cells.

Esperia serratohamata, n. sp. (Pl. V. fig. 20, *a-d*.)

Of this sponge, which I have long wished to find, viz. since I published a representation of the peculiar form of the bihamate found among the spicules in one of the chambers of a specimen of *Carpenteria balaniformis* ('Annals,' 1876, vol. xvii. pl. xiii. fig. 10), a minute portion has grown on one of the Melobesian nodules, which has yielded sufficient for mounting and retaining in the dried state respectively. It possesses four forms of spicules, viz.:—1, the usual Esperian skeleton-spicule, smooth, fusiform, sub-pinlike, with oval inflation at the blunt end, 43 by $1\frac{1}{4}$ -6000th (Pl. V. fig. 20, *a*); 2, large, bihamate, serrated on the outside towards each extremity, with the teeth directed backwards, 24 by $1\frac{1}{4}$ -6000th (fig. 20, *b*); 3, tricurved, simple, hair-like, dispersed and in groups, 12-6000ths long (fig. 20, *c*); 4, inequianchorate, small, with the head nearly two thirds of the entire length, 4 by $2\frac{1}{2}$ -6000ths (fig. 20, *d*), dispersed

singly and combined in the form of rosettes respectively. Size of specimen about 1-6th inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The remarkable form of the bihamate, together with the short thick inequianchorate, is distinctly characteristic of this *Esperia*, which is not the case with many other species, in which the spiculation is so much alike that much confusion still exists respecting them.

Hymedesmina.

Hymedesmia stellivarians, n. sp.

(Pl. IV. fig. 10, *a-e*.)

Laminiform, extremely thin, spreading, smooth or hirsute. Colour yellow. Spicules of two forms, viz.:—1, pin-like, smooth, fusiform, with oval head, 32 by 1-1800th (Pl. IV. fig. 10, *a*); 2, globostellate, rays short and conical, or short and capitate, or long and pointed, respectively; hence the designation (fig. 10, *b* and *c*, *d*, *e*). Pin-like spicule incorporated with the bed of stellates where the parts are exposed, more or less erect where protected. Size variable; that of specimen about an inch in horizontal diameter.

Hab. Marine. On *Hircinia fusca*.

Loc. Gulf of Manaar.

Obs. I am inclined to think that the real colour of this species is white, and that its yellow tint has been derived from the brown colouring-matter of the *Hircinia* on which it has grown. It is chiefly distinguished from the following sponge, whose stellate is very similar, by the form and smallness of the linear pin-like spicule.

Hymedesmia Moorei, n. sp. (Pl. IV. fig. 11, *a-c*.)

Laminiform, extremely thin, spreading, smooth or hirsute. Colour glistening white. Spicules of two forms, viz.:—1, pin-like, smooth, fusiform, chiefly curved towards the blunt end, which is spherical, varying to simple uninflated acute, 62 by 2-1800ths (Pl. IV. fig. 11, *a*); 2, globostellate, rays at first long and pointed, with body proportionally small, then short, thick, and conical, with proportionally enlarged body, finally mitre-shaped and microspined, 5-6000ths (fig. 11, *b* and *c*). Where exposed the linear spicule is incorporated with the layer of stellates horizontally, but where protected it is erect. Size variable; that of specimen about an inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. Like the last species but for the form of the skeleton-spicule no. 1. Named after Mr. T. J. Moore, the assiduous Conservator of the Liverpool Free Museum.

Hymedesmia spinatostellifera, n. sp.
(Pl. IV. fig. 13, *a-d.*)

Laminiform, extremely thin, spreading, smooth or hirsute. Salmon-colour. Spicules of two forms, viz.:—1, pin-like, very long and slender, smooth, curved, head at first round and smooth, then elongated transversely by a convex addition to both sides, and, finally, by similar growths all over so as to become tuberoso, shaft 130 by 1-1800th, head much larger than the shaft (Pl. IV. fig. 13, *a* and *b*); 2, stellate, multiradiate, rays conocylindrical, spined in annular rows towards the extremity, fixed on a body which is about one third of the diameter of the whole stellate, 10-6000ths in diameter (fig. 13, *c* and *d*). Linear spicules, where exposed, imbedded among the stellates, but erect and projecting where protected. Size variable; that of specimen extending over the whole of a Melobesian nodule upwards of an inch in diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This species is characterized by its pink or salmon-colour, the peculiar tuberoso form of the head of the linear spicule when fully developed, the large size of the stellate, and the peculiar form and microspination of its rays.

Hymedesmia capitatostellifera, n. sp.
(Pl. IV. fig. 12, *a-c.*)

Laminiform, extremely thin, spreading, sparsely hirsute. Colour snow-white. Spicules of two forms, viz.:—1, pin-like, curved, smooth, long, setaceous, head oval and wider in diameter than the shaft, which is 80 by 1-1800th (Pl. IV. fig. 12, *a*); 2, stellate, with large globular body, multiradiate, rays terminating in a globular, inflated, and spined head with constricted neck, 12-6000ths in diameter (fig. 12, *b* and *c*). Pin-like spicule fixed by its head in the sarcodic layer of the sponge, which is densely charged with the stellates. Size variable, that of specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. This species is characterized by its brilliant snow-white colour, the large size of its stellates, and the peculiar capitulation of their rays.

Hymedesmia trigonostellata, n. sp.

(Pl. IV. fig. 14, *a-d*).

Laminiform, extremely thin, spreading, smooth or hirsute. Colour snow-white, glistening. Spicules of three forms, viz. :—1, acuate, long, thin, smooth, 50 by $\frac{1}{2}$ -1800th (Pl. IV. fig. 14, *a*); 2, pin-like, ensiform, smooth, with inflated fusiform shaft, long neck, and small round head not more than one third of the diameter of the shaft, 25 by 1-1800th (fig. 14, *b*); 3, stellate, quadriradiate, in which three of the rays form a kind of tripod to the fourth, that is erect, thus presenting a triangular appearance; each ray expanded at the extremity by a multifid spinous division, 3-6000ths in diameter (fig. 14, *c, d*). No. 1, sparsely scattered, projects beyond no. 2, which is parquetted in among no. 3 in great abundance, so as to present a smooth glistening surface. Size variable; that of specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The peculiar sword-like form of the pin-like spicule no. 2, together with that of the stellate, characterizes this species unmistakably; while the latter, which always resembles that of *Axos Cliftoni* in the multifid spine-like division of the extremities of its rays, is often rendered still more like it by being sexradiate.

Suberitida.

Suberites vestigium, n. sp. (Pl. V. fig. 21.)

Laminiform, extremely thin, spreading. Colour glistening white, asbestos-like. Spicule of one form only, viz. pin-like, shaft slightly curved and slightly fusiform, head spherical, a little less than the shaft in diameter, 27 by 1-1800th (Pl. V. fig. 21). Spicules confusedly arranged, among which many project irregularly. Size variable, that of the specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine, on hard objects.

Loc. Gulf of Manaar.

Obs. This species, although very like a *Hymedesmia* in growth and appearance, is also very different in spiculation. As may have been observed, there is no long setaceous spicule here markedly projecting from a layer of smaller ones of a

different form, but the whole composed of one only, viz. pin-like, and that, too, not characterized by any one in particular being longer than the rest. It often presents a bluish-green tint (now dry) like that of a similar species on the rocks here (Buddleigh-Salterton); but the head of the latter is different in form, viz. globoconical followed by an inflated ring like that of *Suberites* (*Halichondria*, Johnston) *carnosa*. It may be remembered that the colour of the British species (which, when fresh, is cobalt-blue) is owing to the presence of a minute parasitic *Oscillatoria*, for which I have proposed the name of "*Hypheothrix cærulea*" ('Annals,' 1878, vol. ii. p. 164). How far this, as well as the British species, may be that which, under other circumstances, grows into a larger and distinct form of *Suberite*, I am not able to state; all that I can say is that both are frequently found under the conditions above mentioned.

Suberites fistulatus, n. sp. (Pl. V. fig. 22, a, b.)

Irregularly globular, elongate, sessile, appendiculate, the appendages consisting of long tubular extensions of different sizes, irregularly scattered over the surface, which is otherwise even. Colour now pinkish brown. Internally cavernous, densely charged with two forms of spicules, viz.:—1, linear, fusiform, slightly curved, and inflated at both ends, which are microspined, 23 by $\frac{1}{2}$ -1800th (Pl. V. fig. 22, a); 2, equianchorate (flesh-spicule), naviculiform, 8-6000ths long, comparatively large and numerous (fig. 22, b). The tubular appendages are prolonged from large vents, which are in connexion with the cavernous structure of the body. Size of specimen 3 inches long, 3 broad, and $2\frac{1}{2}$ high.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar, and Freemantle, S.W. Australia.

Obs. Having found a minute portion of this sponge on one of the *Melobesian* nodules of the Gulf of Manaar, I at once recognized in it the spiculation of the sponge above described, which is in the general collection of Dr. Bowerbank's sponges purchased by the British Museum. The cavernous and cork-like consistence claims for it a place among the *Suberitida*.

Placospongia melobesioides, Gray (Proc. Zool. Soc. Jan. 1867, p. 127, woodcut, fig. 1).

General character largely and irregularly placophorous, hard, petrous, *Geolia*-like, dichotomously branched; branches angulated irregularly and therefore variable in diameter.

Colour white or brown. Surface even, divided into irregular, polygonal, placoid spaces varying in size, under half an inch in diameter, slightly concave towards the centre, raised at the margin, where they meet each other, but do not join. No pores and no vents visible over the placoid spaces themselves, but a line of separation between them where in apposition, through which communication with the interior is obtained. Plates or placoid portions crust-like, composed of siliceous globules, like those of *Geodia*, united together by exceedingly tough fibrous sarcode; subjacent to which is another layer composed of areolar sarcode charged with pin-like spicules, whose points project slightly beyond and between the marginal appositions of the plates respectively; within which, again, is a solid thick axis, *entirely* composed of the same kind of siliceous globules as the plates. Spicules of four forms, viz. :—1, large, pin-like, straight, smooth, shaft subconical and abruptly pointed, head globular, as wide as the thickest part of the shaft, 65 by 1-1800th; 2, siliceous globule, more or less elliptical, compressed slightly in the direction of a hilous depression, which is on one side; surface uniformly consisting of minute stelliform points, more or less multifid and in juxtaposition, being the ends of the radiated crystalline structure of which the interior is composed, 17 by 13-6000ths; 3, a much smaller siliceous globule, which is spherical and covered with minute conical points in juxtaposition, that give it a multiangular appearance, 3-6000ths; 4, smooth, microscopic, siliceous globules, which appear to be originally developed in cells, about 3-6000ths in diameter. No. 2 (siliceous globule), with which no. 3 is sparsely mixed, forms the staple spicule of the hard axis and mail-like plates respectively; while no. 1, the pin-like spicule, is confined to the areolar sarcodic layer between the two, where it is arranged in glistening tufts, whose points, as before stated, project through the line of separation between the plates. The microscopic globules appear to be chiefly situated in the dermal layer. Size of largest specimen (for there are two) about $1\frac{1}{2}$ inch long, 8-12ths inch broad, and 4-12ths thick.

Hab. Marine. Attached to hard objects.

Loc. Gulf of Manaar.

Obs. I have partly described this species from the specimens in the British Museum, one of which was well figured by Dr. Gray (*l. c.*); but the description not being detailed with that minuteness which this remarkable sponge deserves, has led to my making the above additional statements. It will have been observed that the siliceous globule is identical with

that of a *Geodia*, but the rest of the structure so totally different that, wherever located among the Holorhaphidota, it must form a distinct group. The sponge not only grows independently, as above stated, but also parasitically (that is, laminiform over hard objects), yet always presenting the placophorous or mail-plated surface, which is already evident in the smallest of the Manaar specimens, although it is extremely thin and only 1-12th inch in horizontal diameter, with a correspondingly diminutive form of the spiculation, indicating not only that it is a very young specimen, but that the *separation* of the plates from the commencement favours its subsequent enlargement, and thus explains the mode of growth.

Besides this there is a species, or, rather, variety, in which a spinispirular flesh-spicule is added to the foregoing spiculation, consisting of a slightly sigmoid microspined shaft like the flesh-spicule of *Cliona corallinoides*, whose spines afterwards may become elongated, and sometimes multifid at the extremity, so as to present the appearance shown by Dr. Bowerbank (Proc. Zool. Soc. 1874, pl. xlvi. fig. 4). The British-Museum specimen, of which I made a mounting in Canada balsam some years ago, came from "Puntas Arenas" in "Central America," and has been in the collection (as learnt from the registration) since 1850. In my "Notes" I see that it came "off a *Gorgonia*," while that described and called by Dr. Bowerbank "*Geodia carinata*" (*l. c.* fig. 1), now also in the British Museum, is on the same kind of black horny *Gorgonia*-stem from the "South Sea;" hence it is not impossible that both may have come from the tropics; but, be that as it may, these are the only two specimens that I have seen in which the spinispirula is present. It seems, however, to afford corroborative evidence of this sponge being allied to the Suberitida rather than to the Geodina; for when the pin-like spicules and the spinispirulas are seen together, in addition to the structure generally, there is only one link left which causes *Placospongia* to resemble the Geodina; and that is the siliceous ball; so that the characters are far more in favour of the Suberitida than the Geodina. Hence, as before stated, the group of which *Placospongia* may be considered typical should be placed among the Suberitida. I might here mention that in the hilous depression of the siliceous globules of my mounted preparations there is a plug of sarcode, showing the way in which the former are connected with the latter.

Eccælonida.

(Excavating Sponges.)

In the 'Journal of the Royal Microscopical Society' (1879, vol. ii. p. 496) I proposed the name of "Eccælonida" for this family, enumerating thereunder three genera, viz. *Cliona*, *Thoosa*, and *Alectona*, and stating that the skeleton-spicule of *Thoosa* had not been determined. Previously ('Annals,' 1879, vol. iii. p. 352) I had indicated that, judging from the figures which he has given, Hancock had probably based this genus on spicules of some kind of *Samus*. I further added, in the 'Microscopical Journal' (*l. c.* p. 497), that it was not impossible that *Samus anonymus* would ultimately have to come in as a fourth genus of the Eccælonida. All this is now ascertained by the undoubted excavating habit of *Samus anonymus* in some of the Manaar nodules, and the existence of *Thoosa* in others, where no spicule of *Samus*, or any thing like Hancock's figures, is present. New species of *Samus* have also been determined, as well as more Eccælonida, including a new genus—which will now be successively described.

Thoosa socialis, n. sp. (Pl. V. fig. 23, a-c.)

General form (when dry and contracted) a minute sarcodic mass densely charged with the spicules of the species, in which no particular figure or structure can be distinguished. Colour yellowish. Spicules of two forms, viz.:—1, short, thick, nodose, consisting of a central shaft upon which are developed ten globular microspined projections that finally obscure it from their enlargement and approximation, so arranged that one occupies each extremity and the eight others two circular rows respectively in the centre of the shaft, all touching each other when the spicule is fully developed, 8 by 5-6000ths (Pl. V. fig. 23, a); 2, circular, compressed, rough or irregularly microspined and wrinkled, 5 by 4-6000ths (fig. 23, b, c); the latter sparsely mixed among the former. Size of largest specimen about 1-16th inch in diameter.

Hab. Marine. In excavated cavities of the Melobesian nodules, alone or in company with other sponges which have made or have occupied them after they have been made.

Loc. Gulf of Manaar.

Obs. Whether this is the sponge to which Hancock alludes (*l. c.*) or not, he has omitted to mention its accompanying spicule, viz. the cake-like one no. 2; while the presence of the species not only by itself, but together with different other sponges now occupying some of the previously ex-

cavated cavities of the Melobesian nodules, has led me to designate it "*socialis*." The specimen of *Samus anonymus*, to which I have alluded I first found, together with a *Cliona*, in an excavated cavity; and knowing of no other sponge but a *Cliona* that made such cavities, I viewed the *Samus* as an intruder; but now that, in the Melobesian nodules, I have found *Samus anonymus* filling the excavations alone, I am constrained to admit it as a new genus of the Eccælonida. If such shall be found to be the case with *Thoosa*, then also there will be no doubt of its excavating power; but the specimens of it that I have seen have been so minute and so mixed up with other sponges, that at present I consider this only a provisional determination. Had I obtained it as I did the following species, which is equally minute, viz. by solution of the piece of *Melobesia* containing it in nitric acid, I might have seen the sarcode holding the spicules; but in the dried state in which I found it I could only infer its existence from the contracted appearance of the little mass. On account of its presence in specimens of many other sponges from the excavations of the Melobesian nodules that I have mounted in Canada balsam, it seems to me to be very plentiful, but in very minute portions. The larger spicule, no. 1, also exists in the neighbourhood of the Seychelle Islands, as represented in the 'Annals' of last year (vol. iii. pl. xxix. fig. 21).

Dotona pulchella, n. gen. et sp.
(Pl. V. fig. 24, a-d.)

General form (when dry and contracted) a minute sarcodic mass densely charged with the spicules of the species. Colour white. Spicules of three forms, viz. :—1, a cylindrical curved shaft, round at the ends, which are microspined, interrupted throughout by apparently annular lines at equal distances from each other, but which, by alteration of the focus, are found to be parts of a spiral ridge formed of microscopic points, united longitudinally and respectively by striæ, which thus extend throughout the spicule, 12 by $1\frac{1}{2}$ -6000th (Pl. V. fig. 24, a, d); 2, acute, simple, smooth, hair-like, very fine, 20-6000ths long (fig. 24, b); 3, flesh-spicule, minute, consisting of a straight shaft spined over both ends divergingly, and in a ring round the centre, 2 by $\frac{1}{2}$ -6000th (fig. 24, c). Spicules mixed together generally; very variable in size and in various stages of development; the flesh-spicules very minute and sparse. Size of specimen about 1-8th inch in diameter.

Hab. Marine. In excavated cavities of the Melobesian

nodules, sometimes in company with other sponges, and sometimes alone.

Loc. Gulf of Manaar.

Obs. The extreme beauty of the large spicule of this species so attracted my attention while it made its appearance in more or less plurality among the fragments of other sponges which I had mounted, that I determined to look for it *in situ*, feeling almost convinced that it was one of the *Eccælonida*, but which, like *Thoosa socialis*, could, from its minuteness, be only sought successfully with the microscope. This was accomplished at last, but not until I had often relinquished the search as hopeless; and then the fragment was observed to consist of several dilated globular portions of transparent sarcodic membrane united together isthmically, and densely charged with the spicules of the species on their inner surface, so that when contracted in the dried state they gave the little massive appearance above mentioned. It was also in company with a minute fragment of *Thoosa socialis*; but from its form and approach towards the surface-apertures of the excavation in which it existed by little digital processes densely charged with the spicules of the species at their extremities, like those of *Alectona Millari*, there can be no doubt that this is a truly excavating sponge, for whose genus I have proposed the name of "*Dotona*," after another of the sea-nymphs, and "*pulchella*," from its great beauty. The annulation, when examined by alteration of the focus, so that both sides of the spicule may be examined, is found to be formed, as above stated, of a *spiral* ridge whose coils are so close together that at first they resemble annulations (fig. 24, *d*).

Alectona Higginii, n. sp.

(Pl. V. fig. 25, *a-c*.)

Lining excavated cavities in a Melobesian nodule, in the form of a sarcodic membrane charged on the inner side with the spicules of the species. Colour now that of dried sarcodæ—that is, yellowish. Spicules of three forms, viz. :—1, subcylindrical, slightly curved, round at the ends, sausage-like, divided irregularly throughout the body into a number of annular depressions and inflations, the latter of which are microspined, and very variable in form and length, the shortest being the thickest, 5 to 20 by $1\frac{1}{2}$ to $2\frac{1}{2}$ -6000ths (Pl. V. fig. 25, *a*); 2, fine, hair-like, acerate, tending to the form of a tricurvedate, 12-6000ths long (fig. 25, *b*); 3, flesh-spicule, consisting of a straight shaft interrupted towards the centre by eight or more faintly capitate rays radiating circularly from separate points a little nearer to each other than to the extremities of

the shaft; rays equal in length to the distance between the points of radiation and the end of the shaft on each side; all parts of the spicule about the same thinness, which is almost immeasurable; all microspined and all respectively terminated by a globular inflation, 5 by 4-6000ths long (fig. 25, c). Size of largest specimen that of the Melobesian nodule which it infests, viz. $1\frac{1}{4}$ inch in diameter.

Hab. Marine. Excavating nodules formed of the layers of *Melobesia*.

Loc. Gulf of Manaar.

Obs. Like *Alectona Millari*, this is essentially an excavating sponge; for the whole nodule is honeycombed by it; and the largest cavity exposed is one sixth of an inch in diameter, fenestrated towards the surface and in the direction of the other cavities which surround it, so that there can be no doubt of its nature any more than of that of the foregoing species. Then the spiculation being something like that of *Alectona Millari*, and especially the flesh-spicule, I have named it after my friend Mr. Thomas H. Higgin, F.L.S., of Liverpool, who has made such important additions to our knowledge of the Spongida.

Samus anonymus, Gray.

This species, which is common in excavations of the Melobesian nodules, I described and figured in the 'Annals' (1879, vol. iii. p. 350, pl. xxix. figs. 1-4), afterwards stating (Journ. Roy. Microscop. Soc. *l. c.*) that it would probably have to be placed as a new genus among the excavating sponges. The form and frequency with which it occurs in the Melobesian nodules of the Gulf of Manaar has now (as before stated) placed this beyond doubt; therefore I will at once give its generic characters under the name "*Samus*," which was established by Dr. Gray (Proc. Zool. Soc. 1867, p. 526) upon the spicule of an unknown sponge, first figured by Dr. Bowerbank (B. S. vol. i. pl. ii. figs. 41, 42).

SAMUS, nov. gen.

Gen. char.—Sarcode charged with large, coarse, multifid spicules, whose prongs are more or less subdivided according to the species; filling excavated cavities in calcareous structures when fresh, and when dry contracted into masses, through which the prongs of the spicules project in a thorn-like manner; connected with filamentous processes of the same, which occupied the channels of extension; generally accompanied by a flesh-spicule.

Samus simplex, n. sp. (Pl. V. fig. 26, a-c.)

Occurring as just mentioned. Colour that of dried sarcode. Spicules of two forms, viz.:—1, a short shaft with trifid head once divided (trifurcate), the whole expanded at right angles to the shaft, 15 by 3-1800ths (Pl. V. fig. 26, a, b); 2, minute or flesh-spicule, consisting of a straight shaft spined throughout irregularly, spines most prominent towards the ends, 3-6000ths long (fig. 26, c). Size of specimen variable, concurrent with that of the excavated cavity, which may be 1-6th inch in diameter.

Hab. Marine. In excavations of the Melobesian nodules, towards the surface.

Loc. Gulf of Manaar.

Obs. This is the simplest form of *Samus*-spicule that I have met with; hence the designation of the sponge to which it belongs.

Samus (Pachastrella) parasiticus.

(‘Annals,’ 1876, vol. xviii. p. 410, pl. xvi. fig. 50 &c.)

This species, which I formerly called “*Pachastrella parasitica*” (*l. c.*), occurs abundantly in excavations of the Melobesian nodules, accompanied by both forms of its flesh-spicules, viz. the spined bacillar form, fig. 50, *d* (*l. c.*), and the spinispirula, fig. 50, *f* (*l. c.*). Originally I did not know the habitat of *Samus parasiticus*; but seeing that it so much resembled *Dercitus niger*, Gray, in spiculation, and finding the latter in company with a *Cliona* (to which I have before alluded) in excavations of marine calcareous structure (old coral) from the island of Cuba, I at once thought that *Samus parasiticus* must be closely allied to it, and hence gave it the generic name of “*Pachastrella*,” which now should be abandoned for “*Samus*.” At the same time I would here observe that the presence of the spicules of *Dercitus niger* (*Hymeniacion Bucklandi*, latterly *Battersbya Bucklandi*, Bk., 1870) with *Cliona* either shows that *Dercitus niger* is an intruder of this kind occasionally, or that this is part of the habitat of this great, massive, liver-like black sponge so common on our shore-rocks. Be this as it may, there is so much relationship between the *Pachastrella* (Schmidt’s name for the deep-sea species of *Dercitus*, viz. *P. abyssi*) and *Samus*, that hereafter I expect it will be thought desirable to at least make them one group. Hence it also becomes questionable whether my *Pachastrella intexta* (‘Annals,’ *l. c.* p. 409, pl. xv. fig. 41 &c.) does not belong to the same category.

Samus complicatus, n. sp.
(Pl. V. fig. 27.)

I would propose this name for the spicule of a sponge of another species of *Samus*, of which there are several specimens in my mountings of the dust from the root-bunch of *Euplectella cucumer* found in the deep sea about the Seychelle Islands, on account of its extremely complicated form, presenting under the microscope one of the most beautiful objects of the kind that I have ever seen. It consists of four arms, three of which form a kind of tripod to the fourth, which is erect, and all thrice divided again to their extremities (there is no shaft); so that it defies all attempts at delineation, from the complicated state of the branches and the impossibility, from the dimensions of the object, of getting the whole into focus at the same time; hence the illustration (Pl. V. fig. 27) must be regarded as a diagram. There is no doubt of its belonging to a *Samus*, of which there are probably many more species yet to be discovered; indeed the representations given by Dr. Bowerbank, which appear to be similarly quadriradiate (B. S. vol. i. pl. x. figs. 235, 236), also seem to be those of spicules belonging to species of the same genus.

Here I would add that, however much *Samus* and *Pachastrella* may be allied to each other in spiculation, their habitats may be totally different; and when we come to add *Cliona* to the Ecccelonida, we get a heterogeneous mixture of sponges in kind, whatever may be their alliances otherwise; for *Cliona celata* itself, which infests the oyster-shell, may become, when it has destroyed the latter, the free massive Suberite to which Dr. Bowerbank has given the name of *Rhaphyrus Griffithsii*.

[To be continued.]

IX.—*Descriptions of new Species of Asiatic Lepidoptera Heterocera.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

Tribe BOMBYCITES.

Saturniidæ.

1. *Antheræa læpoides*, sp. n.

Primaries above with the basal third dull lake-red, traversed by two irregular saffron-yellow stripes, and with very irregular external edge; central area occupied by a very irregular gamboge-yellow band enclosing the ocellus, which is dull

lake-red with a vitreous central pupil and brownish margin ; an undulated lake-red band bordered on each side by saffron-yellow stripes immediately beyond the central band, and followed by the external third, which is dull lake-red traversed by an ill-defined and interrupted series of bright yellow and grey spots ; an apical, costal, whitish cinereous nebula ; fringe saffron-yellow towards the external angle : secondaries bright gamboge-yellow, paler towards the costal margin ; a lake-red patch at basal third of abdominal border, followed by an abbreviated purplish-red band from the same border to the ocellus, which it encircles ; the ocellus pale cinereous with vitreous pupil ; an undulated arched purplish-brown line just beyond the middle ; an abbreviated arched discal series of lake-red spots, partly connected in the centre and not reaching the costa ; an abbreviated submarginal series of blackish dots : body laky reddish ; head yellow ; collar, centre of thorax, and sides of abdomen pink. Wings below yellow, clouded with gravel-yellow ; the ocelli lilacine, with reddish-edged vitreous pupils ; a purplish-edged continuous undulated discal line ; a submarginal series of slaty grey and purple spots partly bordered with yellow ; apical areas sprinkled with white scales ; a subbasal sinuated purplish and lake-red line : pectus ochraceous, with bright ochreous legs ; abdomen pinky greyish. Expanse of wings 3 inches 11 lines.

Borneo. Type Brit. Mus.

This pretty little species has unusually acuminate primaries ; the coloration is much like that of the genus *Læpa*.

Lasiocampidæ.

2. *Brahmæa rufescens*, sp. n.

Nearest to *B. Wallichii*, but larger, rather paler in colour, with all the wavy black lines on the primaries above more slender and consequently wider apart, the central belt considerably narrower, especially in the centre, with more slender black border ; the black spots on the veins fewer in number ; the circular nut-like patch which terminates the band on the internal area broadly suffused with white, and with only two or three black spots upon it ; the broad subapical area half as wide again, more uniform in tint, the white crescents upon it very indistinct ; subapical black patch trifid ; other submarginal spots wider, more uniform in tint, united along their external (*i. e.* their basal) margins ; external border greyer, more like that of *B. conchifera* : secondaries with narrower basal blackish area, the pale reddish streaks almost as numerous as in *B. Whitei*, the pale central band widening towards

the costa, the wavy discal lines broader than in any other Indian species known to me, the grey nervular streaks slightly more prominent than in *B. Wallichii*; submarginal spots forming a confluent wavy belt, the black line which bounds it externally very slightly interrupted; external border wider. Primaries below with the entire basal area up to the stripe which represents the outer margin of the central belt pale sandy brown, the inner margin of the central belt feebly indicated by a dusky curved streak; the outer stripe bordered externally by a white stripe of the same form, the black discal lines very slender; a regularly sinuated black submarginal line, reminding one of *B. Whitei*: secondaries with the basal area washed with pale sandy brownish; a white belt just beyond the basal area as in the primaries, the other characters also as in the primaries: pectus and base of venter black, remainder of venter testaceous, with a blackish streak along each side. Expanse of wings 6 inches 11 lines.

N.E. Bengal. Type coll. F. Moore.

This handsome moth seems to be in some respects intermediate between the three known Indian species; but the pale basal area of the under surface of the wings is by itself a sufficient character at once to distinguish it from any of them.

Limacodidæ.

3. *Scopelodes sericea*, sp. n.

Allied to *S. unicolor*; wings and body of the same general colour, but the primaries brilliantly sericeous and crossed by three or four irregular indented lines, which (when viewed obliquely) appear to be the margins of irregular reddish bands; the general colour above is sandy yellow, the wings with a rust-red marginal line extending for a short distance into the fringe; fringe of secondaries brilliantly sericeous; the palpi, instead of being black and white as in *S. unicolor*, are reddish orange; the abdomen is sericeous ochreous, with black caudal tuft: the wings below have the costal and apical areas washed with blackish, upon which the veins are ochreous; body as above. Expanse of wings 2 inches 11 lines.

Darjiling (*Lidderdale* and *Sadler*). Type B. M.

4. *Parasa pastoralis*, sp. n.

♀. Primaries above with a large basal sandy-yellowish patch, crossed close to the base by a zigzag red-brown line; a subbasal arched purplish-brown belt, spotted with green and not quite reaching the costal or inner margins; the whole

area between the latter and the external area bright emerald-green, forming an irregular belt constricted below the middle; external area limited internally by a sinuous ferruginous line, sandy-yellowish or testaceous, traversed by a dentate-sinuate submarginal ferruginous line; fringe brownish: secondaries pale stramineous, with pinky brownish fringe: thorax bright green, the shoulders and a dorsal streak brown, abdomen testaceous. Under surface of wings sordid sulphur-yellow, the borders slightly tinted with stramineous, fringe brown: primaries with a ferruginous subcostal diffused streak: body testaceous; anterior coxæ and femora ferruginous, tibiæ banded with purplish brown. Expanse of wings 2 inches 1 line.

Bhotan (*Lidderdale*). Type B. M.

5. *Miresa bracteata*, sp. n.

Primaries with the costal area olive-brown washed with lilacine, interno-basal area fulvous internally, gradually shading into ferruginous, and lastly into olivaceous towards the median vein; the veins across it indicated by lilacine grey scales; a zigzag metallic silver stripe from the subcostal vein near the apex to just beyond the middle of inner margin, the inner angle of the zigzag confluent with a large cuneiform patch of silver just below the end of the cell; disk beyond the silver stripe olive-green, crossed by pale sericeous veins; external border dark red-brown, densely sprinkled with metallic plumbaginous scales; fringe red-brown: secondaries of the male stramineous, slightly washed with dull rose-colour in front; of the female rosy-brownish, with whitish veins and external border, stramineous abdominal border, and ochraceous fringe: thorax bright chrome-yellow; antennæ and abdomen orange-yellow or bright ochreous. Under surface red-brown, with the internal areas of the wings and tail (particularly the caudal tuft of the male) ochraceous; legs chrome-yellow. Expanse of wings, ♂ 1 inch 5 lines, ♀ 1 inch 7 lines.

Darjiling (*Lidderdale*). Type B. M.

Nycteolidæ.

6. *Tyana speculatrix*, sp. n.

Primaries above bright green; costal margin very slenderly lilacine grey; a bright saffron-yellow basal spot on which are two red dots; base of inner margin snow-white, subbasal portion of the same margin yellowish, crossed by a dark red angular marking; centre of the wing occupied by an oblique patch composed of three circular spots, the first and last stra-

mineous with lake-red margins, the central one red sprinkled with ochraceous; fringe yellow at its base, excepting at apex (where it is dark red) yellowish externally: secondaries snow-white, sericeous: abdominal fringe of the male cream-coloured; front of head and base of antennæ rose-pink, vertex of head bright yellow; collar and tegulæ bright yellow, margined in front with plum-colour; thorax bright green; abdomen white (cream-coloured in the male) with a basal red tuft just behind the thorax and between two snow-white tufts; antennæ brown, annulated with white. Under surface sericeous white: primaries pale greenish, yellowish towards the costal and external borders; the central patch pinky white: legs rosy in front; venter of the male cream-coloured. Expanse of wings, ♂ 1 inch 6 lines, ♀ 1 inch 4½ lines.

Darjiling (*Lidderdale*). Type B. M.

Nearest to *T. chloroleuca*, but much more beautiful.

7. *Tyana lancina*, sp. n.

♀. Wings as in the preceding species, excepting that there is no trace of the central patch on the primaries; head chrome-yellow, slightly pink in front, with a white band behind; collar and tegulæ chrome-yellow, with orange anterior margin; thorax yellowish green; abdomen snow-white, with a bright orange tuft in the centre at base; anal segment sordid white; antennæ pink. Primaries below sericeous greenish white with the costal border tinted with pink; fringe cream-coloured, with an orange dot at apex: secondaries sericeous snow-white: body below cream-coloured; the anterior legs rosy cupreous in front. Expanse of wings 1 inch 6 lines.

Bhotan (*Lidderdale*). Type B. M.

Notodontidæ.

HYPERÆSCHRA, gen. nov.

Olemi affine genus; alis autem anticis multo longioribus, margine postico haud excavato, ramis subcostalibus multo magis approximatis; alis posticis subtriangularibus, vena subcostali ramis longe pone cellulam emissis; corpore longiore, capite majore. Gen. typus *H. pallida*.

8. *Hyperæschra pallida*, sp. n.

Whity brown; primaries chalky white, sprinkled with brown towards the inner margin and across the centre of the median interspaces; two irregularly zigzag widely divergent black-brown lines representing the central belt and enclosing a large white reniform spot; two longitudinal black streaks

on the interno-median area from the base to the inner margin of the central belt; a black longitudinal streak interrupted by the reniform spot from the inner line of the central belt to the middle of the disk, where it joins a brown streak on the outer margin; the costa near apex, a short dash beyond the top of the reniform spot, two subapical streaks, and an apical dash blackish brown: thorax reddish brown, greyish in the centre. Primaries and pectus below pale pinky brown: secondaries and venter stramineous, the venter darker than the wings. Expanse of wings 2 inches 3 lines.

Darjiling (*Lidderdale*). Type B. M.

Mr. Moore has an example of this species from Singapore. The genus is allied to both *Peridea* and *Olene*, but in coloration it most nearly resembles *Heterocampa*.

9. *Phalera stigmigera*, sp. n.

Nearly allied to *P. sangana*, but the primaries shorter, broader, with large whitish reniform stigma; the orbicular placed nearer to it and very indistinct; the inner line of the central belt single and more irregular, rather nearer to the base, base of costa sprinkled with white scales; the external angle blackish, so that the spots which terminate the discal stripe are somewhat obscured; the submarginal lunules whitish: body darker, with whiter anal segment and tuft. Under surface greyer, the blackish central fascia of the secondaries angulated at the costal vein. Expanse of wings 3 inches 5 lines.

Bhotan (*Lidderdale*). Type B. M.

10. *Phalera arenosa*, sp. n.

Also allied to *P. sangana*, but the whole ground-colour of the internal half of primaries pale sandy yellow, traversed by the ordinary undulated lines and spots, the costal half much darker, varied with slaty grey in the centre and at apex, the discoidal spots well defined; the secondaries greyer, with blacker external third; the head yellowish instead of snow-white; the body black, with greyish lateral borders to the thorax, and greyish-white bands across the abdominal segments; anal segment pale cinereous. Primaries below blackish, with the usual pale markings: secondaries sordid white, with an abbreviated oblique crinkled black stripe from the costa to the first median branch; a dusky discal nebula: pectus black; the legs with greyish fringes; venter sordid white, with lateral black bands continued from above. Expanse of wings 3 inches 5 lines.

Darjiling (*Lidderdale*). Type B. M.

This species is frequently confounded with *P. sangana* in collections.

11. *Somera lichenina*, sp. n.

Primaries pale emerald-green, sprinkled (particularly towards the base of costal border) with white scales; discoidal spots placed near together, both orbicular and reniform pale grey, 8-shaped, with blackish centres; a very faint indication of an undulated greyish line at basal two sevenths, and a second which crosses the wing just beyond the cell; a more distinct submarginal line, which becomes black above the third median branch; costal border crossed by numerous red-brown oblique dashes; fringe brown, dotted with white: secondaries pale chocolate-colour, with whitish costal area irrorated with grey and pale green, and crossed at apex by two parallel angular grey lines; fringe tipped with whitish: thorax cinereous; antennæ bright ferruginous; abdomen pale chocolate-colour, diffusely banded on the anal segment with emerald-green. Wings below pale chocolate: primaries with the costa, basal and internal areas pale clay-coloured; secondaries with the costal fringe white, the basi-costal area testaceous: body below pale sandy yellowish, anterior legs sprinkled with white scales. Expanse of wings 2 inches.

Borneo. Type B. M.

12. *Callænia elongata*, sp. n.

Nearest to *C. chamomille*, the primaries considerably longer, of a dark cinereous colour washed in front with brown and with black markings as in *C. chamomille*: secondaries sordid semitransparent white, with blackish veins, the costal area broadly washed with pale shining fuliginous brown; a rather broad darker brown external border; fringe white, intersected by an interrupted blackish line: thorax grey; the head blackish, a black crescent on each side of the hood and only separated by the central terminal point of the same; centre of thorax dusky; abdomen whitish brown with dusky dorsal ridge, anus greyish. Primaries below shining fuliginous brown; secondaries white, with the costal and external borders fuliginous: body below greyish brown. Expanse of wings 2 inches 3 lines.

Darjiling (*Lidderdale*). Type B. M.

PRISMOSTICTA, gen. nov.

Trilochæ et *Norasumæ* affine; alis autem anticis costa recta apice projecto, margine externo apud apicem paululum excavato, exinde late convexo, margine interno recto, vena subcostali

quinqueramosa, ramo solum primo ante cellulae finem emisso, aliis longe pone cellulam emissis: alis posticis subtriangularibus, marginibus costali et externo arcuatis, margine abdominali recto, cellula brevi, nervulis disco-cellularibus bisinuatis perobliquis: corpore robusto; capite parvo, perbrevis; antennis modice brevibus, pectinatis; pedibus tenuibus, femoribus lanatis. Gen. typ. *P. fenestrata*.

13. *Prismosticta fenestrata*, sp. n.

Clay-coloured, washed with olivaceous, the secondaries towards apex and anal angle washed with red; two continuous nearly approximated dark brown lines, the inner one of the primaries incurved towards the costal margin, the outer one nearly straight and running to apex, near which it bounds on the inner side a triangular hyaline spot; a dark brown litura on the discocellulars; primaries with the apical border chocolate-brown: body testaceous tinted with olive, antennae whitish. Under surface fulvous; primaries with the external half and secondaries with the external border washed with orange; markings as above; a greyish submarginal diffused stripe. Expanse of wings 1 inch 11 lines.

Darjiling (*Lidderdale*). Type B. M.

In the form of the primaries *Prismosticta* resembles the Geometrid genus *Auzea*.

Cossidæ.

DUOMITUS, gen. nov.

Alæ elongatæ angustæ: anticæ cellula valde elongata, venis falsis quadripartita; vena subcostalis crassa, quinqueramosa, ramo secundo statim ante cellulae finem emisso, tribus autem ultimis pone cellulam emissis; vena discocellularis perobliqua paululum excavata; vena inferior discoidalis ramum quartum medianum fere formans; vena submediana curvata: posticæ cellula medioeri, vena costali crassa, vena subcostali tenui, ramo inferiore venam alteram discoidalem formante, vena ordinaria discoidali ramum quartum medianum fere formante. Antennæ simplices. Corpus formæ consuetæ. Gen. typ. *D. ligneus*.

14. *Duomitus ligneus*, sp. n.

Pale sandy brown; wings sparsely mottled with black, most densely on the external area of primaries, where they form a series of ill-defined hastate streaks between the veins, increasing in length towards the inner margin, and interrupted by white circular spots more or less obscured by grey reticulations; several indistinct black internervular streaks between the subcostal branches; costal margin spotted with black:

secondaries suffused with greyish fuliginous, with reddish-brown veins, fringe between the veins cream-coloured; a few indistinct, confused, submarginal whitish spots, similar to those on the external area of the primaries: thorax whitish at the sides, in front, and along the centre, with black tufts behind the tegulæ; abdomen with blackish sides (except upon the last two segments) and a dorsal longitudinal blackish stripe; pectus black; tarsi sandy whitish; venter sandy yellowish. Wings below pale sandy brown; the markings less distinct than above. Expanse of wings, ♂ 4 inches 2 lines, ♀ 4 inches 6 lines.

Darjiling (*Lidderdale*). Type B. M.

Hepialidæ.

15. *Hepialus marcidus*, sp. n.

Primaries above either pale buff or testaceous, mottled all over with greyish brown; a broad interrupted central belt, spotted with little transverse dashes of the ground-colour, and with blackish spots across its centre, grey or greyish brown, sometimes becoming gravel-yellow upon the inner margin (where it is broken up into three or four unequal spots); a discal band, either grey or gravel-yellow, spotted in the centre with black; margin grey, sinuated internally: secondaries semitransparent greyish brown: body dark greyish brown, with testaceous anus; thorax sometimes reddish. Under surface greyish, the markings obsolete. Expanse of wings, ♂ 1 inch 9 lines, ♀ 2 inches.

Darjiling (*Lidderdale*). Type B. M.

In the examples before me the more brightly coloured form is the male, the greyer form the female; it is possible, however, that much variation of tint may occur in individuals of both sexes.

[To be continued.]

X.—*Contributions towards a General History of the Marine Polyzoa.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Plates IX., X., XI.]

IN the present and following papers I propose to describe and figure a large number of marine Polyzoa from various parts of the world which have hitherto, I believe, escaped notice, and thus to offer a contribution towards that general history of the class which still remains to be written. It is by no

means my intention, however, to confine myself to bare diagnosis. The following points especially may, I hope, receive some elucidation:—(1) geographical distribution—any new localities for known species will be recorded; (2) local variation—the differences exhibited by the same type under differing circumstances will be noted whenever the opportunity presents itself of comparing specimens of the same species from various parts of the world; (3) the limits of variability in each case, and the elements of structure most liable to variation; (4) the true principles of classification. With the descriptions of new forms will be combined notes on such as are little known or misunderstood; and, so far as the space at my command will permit, I shall endeavour to indicate in the case of each genus the number of species already ranked under it, and its geographical range. If I should be able to carry out with any completeness this portion of my programme, these papers will serve as an index to the foreign species which have already been described, as well as an introduction to many that are new.

The classification employed will be that which I have adopted in my 'History of the British Marine Polyzoa,' so far as it applies, and with such modification as may be suggested by an increased knowledge of the morphology of the tribe.

At the close of the series of papers a bibliographical list will be given, containing the principal faunistic and other works which deal with the foreign species of Polyzoa.

I shall commence with an account of a very interesting series of specimens from Madeira, for which I am indebted to Mr. J. Y. Johnson, who is so well known as an investigator of the fauna of that island.

I. MADEIRAN POLYZOA.

Subclass HOLOBRANCHIA, Lankester.

Group *Ectoprocta*, Nitsche.

Order GYMNOLEMATA, Allman.

Suborder CHEILOSTOMATA, Busk.

Family Membraniporidae.

MEMBRANIPORA, Blainville.

Membranipora tenuirostris, n. sp. (Pl. IX. fig. 3.)

Membranipora Flemingii, Waters, Bryoz. Bay of Naples, Ann. Feb. 1879, p. 122, pl. xiii. fig. 2.

Zoecia oval, or broad below and narrowed above (rather

irregular in shape), somewhat produced below the aperture, with a broad strongly crenated border sloping slightly outwards; front wall wholly membranous, with the orifice at the very top of it; an acuminate spine at the bottom of the aperture bending inward, and usually two or three on each side. *Avicularia* distributed over the zoarium in the intercellular spaces, placed near the top of the zoecium at one side; beak straight, raised, slanting upwards, elongate, with a narrow central channel; mandible broad at the base, produced above into a slender vibraculoid spine, slightly curved in towards the tip. *Oecium* rounded, silvery, frosted.

Loc. Madeira, on *Pinna* (*J. Y. J.*); Naples, from just below low-water mark to 40 fathoms (*Waters*).

This is undoubtedly the form figured by Mr. Waters, in his catalogue of the Polyzoa of the Bay of Naples, as *M. Flemingii*. It has, however, no close affinity with that species, but belongs to the same section of the genus as the British *M. curvirostris*, mihi, in which there is no trace of a calcareous lamina in front. The avicularium is a striking feature, with its long slender mandible rising from an expanded subtriangular base. The spines are variable in number; but there are usually two on each side, besides the one at the base of the aperture, which is often tall and acuminate. I have met, however, with four on one side and three on the other. The portion of the zoecium which is produced below the aperture is very commonly concealed by the crowding of the cells.

Membranipora nodulifera, n. sp. (Pl. IX. fig. 2.)

Zoecia slender-oval, elongate, wholly membranous in front; margins thin, set with numerous, small, white nodules. *Avicularia* rather large, elliptical, raised in front, generally placed transversely at the top of each cell on a distinct area; mandible rounded (?). *Oecium* very small and shallow, a mere hood over the extremity of the cell, smooth, projecting in front into a sharp prominent point.

Zoarium forming a very regular and delicate network.

Loc. Madeira (*J. Y. J.*).

The nodulated margins constitute the salient characteristic of this very pretty species.

Membranipora crassimarginata, n. sp.

(Pl. IX. fig. 1.)

Zoecia very large and deep, of a regular oval shape, the margin, from the upper rim to the junction with the membranous area (forming a broad border), very strongly crenate:

no calcareous lamina; spines none. *Avicularia* resembling the ordinary zoœcia in form, sometimes rather smaller, occasionally elongated and narrowed, interspersed among the cells; mandible rounded. *Oœcium* somewhat depressed in front, smooth and glossy.

Loc. Madeira (*J. Y. J.*).

In this fine species the cells are distinguished by their regularity of form, their depth, and the broad strongly crenated borders. The avicularia are remarkable for their close resemblance to the ordinary zoœcium; in dead specimens they are only distinguishable from it by the stout calcareous bar which crosses the area, and on which the mandible works in the living state. They are probably amongst the simplest of the "primary" forms*.

Membranipora granulifera, n. sp. (Pl. IX. fig. 4.)

Zoœcia irregular in shape, usually expanded towards the bottom and somewhat narrowed at the top; area surrounded by a slightly raised smooth edging, the lower portion filled in by a minutely granular calcareous lamina, which is carried up on each side of the aperture; aperture obscurely trifoliate. A pair of acute *avicularia* above it, one placed on each side, the mandibles directed towards one another.

Loc. Madeira (*J. Y. J.*).

In what seems to be the normal condition the zoœcium is broad below and becomes narrower towards the top; but the cells are closely packed together, and there are considerable differences in the shape, which are, no doubt, due to this circumstance; not unfrequently the lower extremity is produced and pointed. A smooth marginal line encloses the area, which, with the exception of the subtrifoliate aperture, is filled in by a beautifully beaded or granulous plate. The two avicularia at the top of the aperture constitute a striking feature, and are constantly present; they are somewhat raised, and are placed one on each side, close to the margin, their pointed extremities directed towards one another and frequently meeting in the centre. There is a total absence of spines in the specimens which I have examined. The species belongs to the *M. Flemingii* group, but is a very well-marked form.

* I have ranged the avicularia under three classes—the *primary*, exhibiting the smallest amount of differentiation, the *secondary* or *transitional*, and the *articulated* (*Hist. of Brit. Mar. Polyzoa, Introduction*).

Membranipora sceletos, Busk.

Lepralia sceletos, Busk, Quart. J. Micr. Sc. 1858, Zoophytol. pl. xx. fig. 3.

This curious species was referred by Busk, who described it from Madeiran specimens, to *Lepralia* of Johnston; but it presents the essential characters of the genus *Membranipora*, and must be ranked under it. I at one time supposed that its nearest affinity was with *Membraniporella*, Smitt; but though the spines meet in the centre of the area and interdigitate, they do not unite so as to form a single piece, nor are they modified into flattened ribs, as in the last-named genus.

There are usually about six spines on each side of the cell, which are very massive, and bend inward abruptly, meeting and interdigitating more or less in the centre. On each side of the orifice is placed a broad and shield-like process (modified spine) bearing some resemblance to the operculum of the Cellulariidae, which has, no doubt, a protective function. Mr. Busk speaks of "an ascending spine at each lower angle of the aperture;" but this is hardly a correct description of the pedunculate lamina or plate which closes in at each side the entrance to the cell. The oecium is rounded, smooth, and silvery.

Family Microporidae.

SETOSELLA, Hincks.

Setosella vulnerata, Busk. (Pl. IX. fig. 5.)

This interesting form occurs amongst the Madeiran dredgings and in considerable plenty. It has hitherto only been recorded from Shetland and the coast of Norway (Bergen), and has not been noticed at any intermediate station.

The primary zoecium is very small, with a subtrifoliate aperture, which occupies more than half the area; that is, it exhibits the Membraniporidan structure. Below the area it is produced and somewhat pointed.

There is a peculiarity in the vibracular cell which has not, I believe, been noticed. One side of the margin is more elevated than the other, and, to some extent, overhangs the area; and in the centre of the projecting portion there is a minute prominence. This probably marks the point where the base of the seta is articulated. The same structure is shown in Busk's figures of *Cupularia*, a genus which is nearly allied to *Setosella* (B. M. Cat. vol. ii. pls. cxiv. & cxvi.). Indeed, in any natural system, these two forms must be closely asso-

ciated. I am not acquainted with any other species of *Setosella*.

Loc. Funchal Bay, in 30 fathoms.

Hab. On small shells and fragments of shell.

Family **Cribrilinidæ.**

CRIBRILINA, Gray.

Cribrilina radiata, Moll, var. (Pl. X. fig. 1.)

Amongst several varieties of this variable species there is one of great beauty which merits special notice. The cells are sometimes much elongated and slender, always delicate in texture, and with a bright and silvery surface. The punctures range continuously across the front wall; and the lines are separated by very inconspicuous ridges; there is no central keel. The triangular space and pore below the orifice are present; but the former is not a prominent feature. The avicularium is of remarkable length, often nearly as long as the cell, narrow and pointed, and not raised (Pl. X. fig. 1). This form has some points in common with the *Lepralia Pouilletii* of Busk, described from a Madeiran specimen; but the latter is destitute of avicularia—a difference, however, of small significance. The *Flustra Pouilletii* of Audouin, with which Busk identifies his Madeiran species, is clearly, in my judgment, a variety of *C. radiata*; and the latter is probably nothing more.

The avicularium of this species is liable to many variations; but I have never seen it so much elongated as it is in the present form.

Of the genus *Cribrilina* few recent species have been recorded. Besides the five which occur on the British coasts (*radiata*, *figularis*, *annulata*, *punctata*, and *Gattyæ*) I only know of three—*Lepralia cribrosa*, Heller, allied to the last-named, *Flustra Jaubertii*, Audouin (probably), and *Cribrilina floridana*, Smitt—which are referable to it. The last may be a mere variety.

Family **Microporellidæ.**

MICROPORELLA, Hincks.

Microporella decorata, Reuss.

Lepralia decorata, Reuss, Foss. Pol. d. Wien. Tertiärbeck. 89; Manzoni, Bryoz. foss. Ital. Contr. 2, p. 4, pl. x. fig. 25.

Zowcia ovate, separated by deep sutures, highly calcified,

the walls of great thickness, round the edge a conspicuous row of punctures, often channelled; orifice raised, with the peristome somewhat thickened, arched above, almost straight below, rather taller than broad, with about nine marginal spines; in the centre of the front wall, about one third the length of the cell below the orifice, a large circular or elliptical pore, often with a number of nodules about it, and shielded on one side by a low calcareous ridge; on the other side a very large pointed *avicularium*, directed upwards, and reaching to about the middle of the orifice; sometimes an *avicularium* on each side. *Ovicium* very prominent, gibbous in front, partially invested towards the base with one or more layers of a dense whitish crust.

Loc. Madeira, in 30 fathoms (*J. Y. J.*).

Range in Time. Vienna basin (*Reuss*); Italian Pliocene (*Manzoni*).

Lepralia decorata, *Reuss*, is a characteristic member of the present genus, ranking alongside our British *M. violacea*. It has hitherto only been known as a Tertiary fossil; but it seems, judging from the number of specimens amongst Mr. Johnson's dredgings, to be far from uncommon at Madeira, and is a very interesting addition to the recent fauna.

It is a very thick-walled species, and, in its older states, presents a very coarse and rugged appearance, the surface being covered with nodules and bosses or traversed by ridges. In some cases the central pore is in great part surrounded by a continuous wall. The punctures are sometimes diffused over the whole surface; often they are arranged concentrically in two or more series. There is generally only a single *avicularium*; but cells frequently occur which are armed with two, and in some specimens almost every cell has one on each side. In young and fresh specimens the texture is delicate and the surface glossy and of a greyish-white colour.

As in *M. violacea*, there is often a striking diversity in the size of the zoecia within the limits of the same colony. There seem to be no differences of any moment between recent and fossil examples; *Manzoni's* figure of the species is very characteristic.

I am not in a position to give an exhaustive list of the published species which rank under this genus (*Microporella*). The following are all that occur to me at present as belonging to it:—the four British species, *M. ciliata*, *Malusii*, *impressa*, and *violacea*, of which the first two have a very wide range of distribution; *Lepralia californica*, *Busk*, and *L. personata*, *id.*, both of which are probably vars. of *M. ciliata*;

Lepralia bicristata, id. (Cape Horn), *L. diadema*, Macgillivray, and *L. ceramia*, id. (Australia); *Porina serrulata*, Smitt, and *P. subsulcata*, id. (Florida); and *Lepralia plagiopora*, Busk (Florida and the Crag), which seems to be a mere variety of *M. violacea*.

Family Myrionozoidæ (part), Smitt.

SCHIZOPORELLA, Hincks.

Schizoporella sanguinea, Norman.

This species, which has occurred on our south-western coasts, attains a remarkable size and beauty in the only Madeiran example which I have seen. The zoœcia are perfectly white and porcellaneous, the walls of great thickness and pierced by circular, shaft-like pores. The orifice is large; and its peculiar structure is admirably displayed. The avicularia are much more numerous than I have seen them before, and are of two kinds; they are placed on each side of the orifice:—one raised, with an acute or subacute mandible, usually set transversely almost in a line with the lower lip; the other oval, generally depressed or subimmersed, with a rounded mandible, directed upwards, placed most commonly towards the upper part of the orifice. The positions are not quite constant; but in a large proportion of cases they are as I have described them. The oval avicularium has not, I believe, been noticed before in this species.

Range of Distribution. Britain, south-west; Mediterranean; Madeira; Florida, deep water.

Schizoporella biaperta, Michelin.

The range of this species also is extended to Madeira. A study of Mr. Johnson's specimen shows that the small lateral avicularium is often replaced by a large spatulate one, as in the kindred *S. armata*, mihi. Usually the peristome is elevated round the front and sides of the orifice; and in this respect also an approach is made to the last-named species. There are about five marginal spines*. The surface of the zoœcia is rather coarsely granulous, whereas in the British specimens which I have examined it is smooth and polished.

Range of Distribution. England (south-east); Guernsey;

* This character is omitted in the account of this species in my Hist. of the Brit. Polyzoa (vol. i. p. 255), not having been noticed in any British example.

Mediterranean ; Madeira, 30 fms. (*J. Y. J.*) Floridan sea ; Arctic sea.

Family *Escharidæ* (part), Smitt.

LEPRALIA (part), Johnston.

Lepralia Pallasiana, Moll. (Pl. X. fig. 3.)

The oecia of this handsome and common species have not hitherto been noticed. It is extremely abundant on our southwestern coasts ; but amongst the multitude of specimens examined no trace of an ovicell has occurred to me. No writer on the Polyzoa, so far as I am aware, has described them ; but they are present on a specimen from Madeira. They are very shallow, almost semilunate in form, and closely united to the cell above.

Lepralia Kirchenpaueri, Heller.
(Pl. IX. figs. 7, 7 a.)

Var. *teres*.—*Zoecia* more or less lozenge-shaped, quincuncial, well defined, surface smooth ; orifice arched above, decidedly constricted a little above the lower margin (which is straight) by two prominent denticles, much taller than broad ; peristome slightly raised and somewhat thickened ; a small oval or roundish *avicularium* (or *vibraculum*) on each side, a little below the orifice (generally), placed on a slight eminence. *Oecium* rounded, smooth, with a rib round the front of it.

Loc. Funchal Bay, 30 fms. (*J. Y. J.*).

It seems better to rank this form as a variety of Heller's species, though there are several points of difference between the two. In the Madeiran specimens the zoecium is perfectly smooth, whereas in *L. Kirchenpaueri* from the Adriatic the surface is described as "wrinkled and punctured," and Manzoni has figured it from Mediterranean examples with the punctures disposed in distinct radiating furrows. This very marked sculpture certainly contrasts strongly with the simplicity of the Madeiran form ; but the superficial characters of the cell-wall are liable to wide variations. A more important difference perhaps is found in the oecium, which is described by Heller as only slightly elevated and traversed by radiating ribs ; in the Madeiran species it is by no means depressed and has a smooth surface, the front of which is enclosed by a prominent ridge. In the latter, too, the oral extremity of the cell is much less decidedly narrowed than it is represented by Heller and (more especially) by Manzoni.

The appendages placed one on each side below the orifice are described as avicularia by Heller; but Manzoni states that they are really vibracula. They do not occur in a perfect condition on any of the Madeiran examples; but, from the appearance which they present, I should infer that the latter is the correct view of them.

On the whole, I am inclined to regard the present form as a rather strongly marked variety of Heller's *L. Kirchenpaueri*. It seems to bear a close relationship to *Escharella setigera*, Smitt (Floridan Bryozoa, pt. 2, p. 58, pl. x. fig. 206).

The following are referable to the genus *Lepralia*, as limited by Smitt:—*L. foliacea*, *Pallasiana*, *adpressa*, *hippopus*, *edax*, and (with less certainty) *pertusa* and *polita* (all British); *lata*, Busk (probably identical with *adpressa*), *Kirchenpaueri*, Heller (Adriatic), *Poissonii*, Audouin, *inornata*, Smitt, *cleidostoma*, id., *turrita*, id. (Florida), *depressa*, Busk (Ægean sea). I should also feel inclined to rank with the foregoing the following Floridan species, which are placed by Smitt in his genus *Escharella*, viz. *E. Audouinii*, *rostrigera*, and *setigera* (see Flor. Bryozoa, pt. 2, figs. 56–58).

PORELLA, Gray.

Porella nitidissima, n. sp. (Pl. X. fig. 2.)

Zoecia depressed, disposed in linear series, rectangular, bounded by raised lines; a row of large foramina round the margin, surface punctured and with nodulous ridges, crystalline and lustrous; orifice not raised, arched and expanded above, contracted below, inferior margin straight, frequently a swelling under it; a round avicularium within it. On each side of the orifice, immediately above the lower margin, a small oval avicularium, placed on a prominence and encroaching on the mouth, so as to give it a trifoliate appearance. *Ozecium* depressed, half immersed, roughened or granulous.

Loc. Madeira (*J. Y. J.*).

The real shape of the orifice in this species is masked by the two lateral avicularia, which project over it, one on each side, and make it appear distinctly trifoliate. Before their development it presents the characteristic form of the genus, such as we have it in *P. concinna*, Busk. The surface of the zoecium is much depressed and very bright and glossy. There are frequently nodulous processes on the ovicell.

Five British species of this genus have been described.

SMITTIA, Hincks.

Smittia marmorea, Hincks. (Pl. IX. fig. 6.)

? *Lepralia arrogata*, Waters, Bryoz. Bay of Naples, Ann. & Mag. Nat. Hist. ser. 5, iii. (1879) p. 39.

Several fine specimens of this form occur on Mr. Johnson's slides; and they enable me to speak with confidence as to its complete distinctness from *S. cheilostoma*, Manzoni.

Seven British species of this genus have been described. *Lepralia marionensis*, Busk (from Marion Island), belongs to it, and probably *L. galeata*, id., from the Falkland Islands.

Range of Distribution. Cornwall; Guernsey; ? Bay of Naples; Madeira (*J. Y. J.*).

PHYLACTELLA, Hincks.

Phylactella lucida, n. sp. (Pl. X. fig. 4.)

Zoecia somewhat flask-shaped, smooth, and subhyaline, ovate below, rather tumid, distinct, the peristome much elevated, forming an erect, neck-like extension of the cell, surrounding the front and sides of the orifice; margin thin, bearing 5-8 spinous projections, the central one stout, and supporting a minute oval avicularium; a groove round the base of the peristome; orifice suborbicular.

Loc. Madeira, on shell (*J. Y. J.*).

Before the development of the raised peristome the zoecium is simply ovate, with a plain suborbicular or slightly elliptical orifice. When fully formed, the erect neck-like extension nearly equals in length the rest of the cell; it is not continued round the upper margin of the orifice. The edge is slightly everted, and bears a variable number of spinous projections, and an aviculiferous process in the centre. The texture is very delicate, and the surface perfectly smooth.

This form is referred with some doubt to *Phylactella*; it differs from the other known members of the genus in the more erect and tubular character of the raised peristome, and the presence of aviculiferous processes.

Besides the species already noted as occurring in Madeira, the following have been identified amongst Mr. Johnson's specimens:—

Aetea recta, Hincks.

Cribrilina punctata, Hassall.

Membraniporella nitida, Johnston.

Range. Kara sea; North sea; Britain (*passim*); France, S.W.; Bay of Gibraltar; Madeira.

Microporella Malusii, Audouin.

One of the most widely distributed forms.

Chorizopora Brongniartii, Audouin.

Range. British Isles ; France, S.W. ; Mediterranean and Adriatic ; Madeira.

Schizoporella auriculata, Hassall.

Very widely distributed.

Schizoporella armata, Hincks.

Range. England, S.W. ; Algiers ; Madeira.

Schizoporella venusta, Norman.

Range. Guernsey ; Madeira ; Florida.

Mastigophora Hyndmanni, Johnston.*Lepralia adpressa*, Busk.

Range. England, S.W. ; Mediterranean ; Madeira ; Chiloe ; Mazatlan.

Lepralia pertusa, Esper.*Phylactella labrosa*, Busk.

In a series of papers which appeared in the 'Quarterly Journal of Microscopical Science' some years since, Mr. Busk published a list of Madeiran Polyzoa which he had received from Mr. Johnson, and described a considerable number of new forms. About fifty species were recorded as occurring off the island, of which eighteen (or about a third) are also British. In the present paper twenty-five species are added to the Polyzoan fauna of Madeira, raising the whole number to about seventy-five ; and of these seventeen are British ; so that thirty-five species, or nearly one half of those recorded in these papers from the island, are common to it and our own coasts*. Of these, eight (or about a quarter) are confined to the south-western or south-eastern (Hastings) portions of the English coast, whilst about a third have been found in the Crag.

* A large proportion of these have been found in the Mediterranean.

II. FOREIGN MEMBRANIPORINA.

Family Membraniporidae.

MEMBRANIPORA, Blainville.

a. Species with a membranous front wall.

Membranipora albida, n. sp. (Pl. X. fig. 5.)

Zoecia set closely together, oval, wholly membranous in front; border crenate, with a somewhat sharp edge or margin, destitute of spines. *Avicularia* numerous, scattered over the zoarium, placed in somewhat rectangular hollow spaces amongst the cells, which they partially fill; base of avicularium depressed, the beak raised, curved towards one side, extending to the top of the hollow (or avicularian cell), traversed by a narrow central groove; mandible expanded and somewhat crescentic at the base, above slender, curved, spine-like. *Ooecium* small, shallow, subarcuate, finely frosted (almost smooth).

Loc. Singapore, on *Tubipora musica* (Mr. Moore, Liverpool Free Museum).

This species, of which the avicularium is the most marked feature, is allied to the British *M. curvirostris*, mihi, from which, however, it is distinguished by the total absence of spines, the form of the ooecium, and the very different character of the avicularian appendages.

Membranipora plana, n. sp. (Pl. XI. fig. 2.)

Zoecia large, oval, distinct, surrounded by a narrow border, which is rounded and finely crenate, sometimes slightly produced below the aperture and pointed; front wall wholly membranous, very much on a level with the margin of the cell, so as to give a flattened appearance to the surface of the zoarium. *Avicularia* scattered, placed in somewhat lozenge-shaped intercellular spaces; beak elongate, straight, occupying the centre of the area, traversed by a narrow groove which expands towards the lower extremity; mandible with an enlarged base, above it setiform, slightly curved at the top. *Ooecium* rounded, rather large, frosted.

Loc. Australia (Miss Jelly).

This species and the preceding are really much more distinct than they might appear to be from a comparison of the descriptions.

A reference to the figures will show the amount of the difference between them. *M. plana* is specially characterized by the large size of its zoecia and the flatness of its surface.

Membranipora armifera, n. sp. (Pl. XI. fig. 5.)

Zoëcia ovate, wholly membranous in front, margin smooth, two spines at the top; on each side, just below the upper margin, an acute *avicularium* standing out very prominently and somewhat obliquely from the edge of the aperture; the mandible directed straight outwards. *Oœcium* (?).

Loc. Gulf of St. Lawrence, on *Flustra membranaceo-truncata*, Smitt (*Dr. Dawson*).

Allied to the Arctic *M. Sophiae* of Busk, from which it differs in the character of the avicularium and the absence of the lateral spines. The avicularia are placed horizontally on the top of very prominent brackets rising from the margin of the cell on each side, which are somewhat carinate in front. The extremity of the acute mandible points outwards. Not unfrequently there is a large raised avicularium at the base of the cell.

Membranipora horrida, n. sp. (Pl. X. fig. 6.)

Zoëcia oval; aperture occupying the whole of the front, with a membranous covering, margins thin; three or four spines on each side, of which the uppermost pair are tall, stout, and erect, the rest smaller, acuminate, somewhat bent in over the aperture; a large *avicularium* at the bottom of the zoëcium, placed transversely, and usually extending some way up one side of the cell, very slightly raised; mandible elongate, linguiform, occasionally replaced by a small avicularium with short mandible. *Oœcium* rounded, smooth, with an arched rib in the front.

Loc. California (*Miss Jelly*).

The marked character of this species is the large linguiform avicularium at the base of the cells; it has a tendency, however, to revert to a smaller and more usual form.

Membranipora Carteri, n. sp. (Pl. XI. fig. 8.)

Zoëcia membrano-calcareous, ovate, wide and patulous, suberect, disposed in linear series; margin thin and smooth, two very stout clavate spines at the top, and two somewhat smaller placed one on each side about halfway down the cell. *Avicularia* sparingly developed, capitate, articulated, rounded behind (not elongate), with a short slightly bent beak; placed on one side of the cell, immediately below the spine at the top. *Oœcium* (?).

Loc. Australia, incrusting weed (*Mr. H. J. Carter*).

This form has a special interest, as being the only known *Membranipora* which possesses a fully developed bird's-head

appendage identical in structure with that of the genera *Bugula* and *Bicellaria**. In other respects it exhibits points of affinity with the last named. The zoarium is but slightly calcified; the zoecia are disposed in lines, and are in some degree suberect and overlap one another above. The avicularia are placed in the same position as those of *Bugula*, which they exactly resemble. Altogether the species has much the general appearance of a decumbent *Bugula*, whilst at the same time it is technically an undoubted *Membranipora*. It helps to connect the two types. The spines are massive, subclavate, white and polished, and constitute a striking feature.

I have much pleasure in dedicating this very interesting form to so able a naturalist as my friend Mr. Carter.

Membranipora pura, n. sp. (Pl. XI. fig. 3.)

Zoecia large, more or less ovate, closely united, surrounded by a perfectly smooth border, which slopes up to a ridge-like marginal line; front wall wholly membranous; at the top of the cell two stout spinous processes, one on each side, which are frequently united by an elevation of the margin (forming a wall between them). *Avicularia* none. *Occium*(?). *Zoarium* white, smooth, glossy, subhyaline.

Loc. Australia or New Zealand (*Miss Jelly*).

It would be almost impossible to frame a description of this form that would be sufficient in itself to ensure certain identification; a figure is indispensable. The same may be said of great numbers of species; in the case of the Polyzoa, at least, the practice cannot be too much reprobated of publishing new names unaccompanied by a recognizable figure of the form intended.

In *M. pura* the cells are of large size, sometimes regularly oval, sometimes broad-ovate, arched above and with the lower margin somewhat flattened, sometimes expanded above and narrowing off slightly towards the lower extremity. They are closely soldered together, so that there is only an inconspicuous furrow between the contiguous margins; the border is quite smooth, without any trace of beading or crenature. The screen-like elevation of the peristome between the two spines at the top is a good diagnostic mark, but it is not present on all the zoecia.

* *M. minax*, Smitt (*M. princeps*, mihi), is furnished with an avicularium which has the form of the "bird's head;" but it is fixed (destitute of a basal joint) and wholly calcareous, instead of being partly corneous and partly calcareous. *M. Carteri* is the only species in which the perfect "articulated" appendage has yet been met with.

Perhaps one of the most characteristic features of the species is the glossy smoothness and whiteness of the zoarium.

Membranipora villosa, n. sp. (Pl. X. fig. 8.)

Zoecia membrano-calcareous, elongate, rectangular, disposed in lines, with a membranous front wall, margins thin; inner surface of the cell-wall crenate; two acuminate spines, one on each side at the top, and frequently a broad, membranous, strap-like process between them, usually a smaller spine on each side a little below the top; front wall covered with delicate spinules. *Avicularia* none. *Oœcium* (?).

Loc. California, incrusting weed (*Miss Jelly*).

This species is remarkable for the profusion of spinous processes with which it is furnished. The zoecia seem to be very slightly calcareous; and the spines are simply membranaceous, and, when dried, are more or less shrivelled and bent. In the centre of the upper margin there is often one of the broad, strap-like spines which are so characteristic of the species; they run to a point above, and in the dry state are flattened and present a bright and glossy surface.

The front wall is rather thickly covered with slender sharply-pointed spinules.

a'. Cell prolonged below the aperture.

Membranipora distorta, n. sp. (Pl. X. fig. 7.)

Zoecia ovate or subturbinata, prolonged below the aperture, quincuncial, disposed with great regularity; walls white and rather silvery, covered with minute perforations; aperture oval, occupying about three fourths of the front of the cell, with membranous covering, surrounded by a smooth, thickened, and somewhat sinuated rim, bearing three spines, two a little below the top, which almost meet across the area, and one near the bottom on the outer side, calcareous towards the base, with membranaceous extremities; the zoecia as if heeled over towards the inner side, so that the aperture appears somewhat distorted, the lower extremity pointing inwards and in contact with the wall of the neighbouring cell; at the top of each cell a smooth semicircular space, slightly hollowed, enclosed by a narrow edging, forming a kind of alcove. *Avicularia* none. *Oœcium* (?). *Zoarium* branched; branches of varying width.

Loc. Ceylon, on weed (*Miss Jelly*).

This is a remarkably beautiful species, and I have hesitated to give it a name which might seem to imply the contrary. Of course it merely refers to the curious twist of the cells,

which adds to the picturesqueness without at all impairing the beauty of the species.

The zoœcia are turned over, as it were, towards the inner side; and on this side, of course, no cell-wall is to be seen, the margin of the aperture lying close against the neighbouring cell, whilst on the opposite a considerable tract of it is visible. In most of the branches a central line of zoœcia is traceable, which are straight and of the usual appearance; and on each side of this line the zoœcia turn inwards towards it, so that those on the opposite sides face one another.

The wall below the aperture is prettily ornamented with minute punctures. The sinuated appearance of the margin of the aperture is caused by the spines, which exhibit a curious peculiarity: the lower portion is solid; but the points are simply membranous, and in the dried state have either shrivelled up or disappeared.

There is an evident affinity between this interesting form and the common *M. pilosa*, Linn.

b. With a calcareous lamina.

Membranipora nitens, n. sp. (Pl. XI. fig. 4.)

Zoœcia quincuncial, somewhat pyriform, expanded above and narrowed downward, prolonged below the aperture, closely united to one another; walls smooth and glassy; aperture ovate, occupying rather more than half the front of the cell, with a thin smooth margin, covered in by a very transparent membrane, which lies on a level with the edge, a very shallow calcareous expansion at the very base of the aperture; on each side, immediately below the upper margin, a small white tubercle; the portion of the cell below the aperture bearing a single large boss or nodule, white and polished. *Avicularia* none. *Oœcium* (?). *Zoarium* lobed or branched.

Loc. Australia, on a Polyzoon (*Miss Jelly*).

This Australian form is certainly distinct from the South-Atlantic *M. tuberculata*, Bosc (which is so commonly found on the Gulf-weed), though it may be said to belong to the same section of the genus. The general appearance of the zoarium is bright and glossy, and is due in part to the polish of the calcareous portions, and in part to the shining surface of the membrane which closes the cells. The latter lies quite on a level with the top of the margin, and extends to the very bottom of the aperture, covering the slight calcareous plate. The two small white tubercles immediately below the upper margin are constantly present. There is a considerable prolongation of the cell below the aperture; and this portion is almost entirely

occupied by the single prominent boss. This is somewhat truncate above, and has a semicircular or wedge-shaped outline below.

Membranipora delicatula, Busk. (Pl. XI. fig. 1.)

Biflustra delicatula, Busk, Crag Polyzoa, p. 72, pl. i. figs. 1, 2.

? *Biflustra denticulata*, Smitt, Floridan Bryozoa, pt. ii. p. 18, pl. iv. figs. 89-91 (not *Membranipora denticulata*, Busk).

Zoecia quincuncial, quadrangular (the upper angles often rounded), sometimes elongate, sometimes short and broad, margins granulated transversely, about a quarter of the area below occupied by a delicate lamina, finely granular, which bears on its upper margin a projecting lobe or denticle (frequently absent) set with minute spines or prickles, lamina sometimes carried upwards to a slight extent along the inner edge of the area, which occasionally bears a few denticulate processes; aperture ovate or elliptical, more or less frequently a low blunt knob at each of the upper angles, sometimes only a single knob, often none. *Avicularia* none. *Oocidium* (?).

Loc. Florida, incrusting weed (*Miss Jelly*).

Range. Crag; Australia; ? Manilla; Florida.

This seems to be the *Biflustra delicatula* of Busk (an Australian and Crag species), although, in some points, the two differ; and on this account I have given a description and figure of the Floridan form. The latter is simply incrusting, whereas the former is erect and foliaceous; but this is not a point of any significance, as the two states commonly enter into the same life-history. Busk makes no mention of the nodules; but they are often absent; nor of the denticles, which in the fossil would probably not survive, and are frequently wanting in the Floridan specimens. The transverse granulation, too, on the border of the cells is much more marked, as represented in Busk's figure, than in the latter. But all these differences amount to little, and there can be no doubt of the identity of the two forms. I am also inclined to think that the Floridan species described and figured by Prof. Smitt under the name of *Biflustra denticulata** is the same thing. It is true he does not mention the "serrated denticle" on the edge of the lamina; but though, when present, it is a very striking feature, it is often undeveloped or very partially developed, and I have seen large tracts of the crust in which scarcely one was to be found. The figures, too, do show a

* This must be accounted quite distinct from Busk's *Membranipora denticulata*, a Mazatlan form, described in Carpenter's 'Catalogue of Mazatlan Mollusca in the British Museum' (1855-57), p. 1.

slight spinous elevation on the margin of the lamina. Prof. Smitt (though doubtful) is inclined to identify his Floridan species with *M. tuberculata*, Bosc*; but this, though belonging to the same group and exhibiting the same general facies, is, in my judgment, essentially distinct. I shall give hereafter figures of *M. tuberculata*, which I have from various parts of the Atlantic and also from California. In *M. delicatula* the form of the cell is normally quadrangular and elongate; but there are many irregularities: very commonly the angles are obliterated above, and the upper part of the cell is rounded; there are also diversities in size. The nodules at the upper angles of the aperture are very inconstant; they sometimes occur on only a few cells in a colony; at best they are rather small blunt knobs.

The genus *Biflustra* was originated by D'Orbigny and adopted by Busk for forms with a Membraniporidan cell and an erect foliaceous or ramose growth; that is, it was constituted to represent a mere variation in colonial habit. Smitt has retained the name, but with a very different and, it seems to me, rather vague application. He says, "The quadrangular shape of the zoœcia, as well as their strong, unusually high, and hardly calcificated and granular margins, in most cases will make the Biflustridan type recognizable." He also remarks that "the most striking characteristic for this family . . . will be the relatively great size of the zoœcia" (Flor. Bryoz. pt. 2, p. 17). These characters, I confess, seem to me to be much too vague and unimportant to stand as the criteria of a family group; whilst, on the other hand, D'Orbigny's generic diagnosis, though definite enough, being based on mere colonial habit, and not on any difference in the structure of the zoœcium, can hardly be maintained, if the later views of Polyzoan classification are sound. For the present I shall rank the species of *Biflustra* (both of Busk and Smitt) under *Membranipora*.

? *Membranipora trifolium*, S. Wood, var. *minor*.
(Pl. XI. fig. 6.)

Zoœcia somewhat pyriform, slightly narrowed above, expanded in the middle and tapering off below, closely united; the lower half of the area filled in by a granulated lamina, which is carried up on each side of the aperture, where it is slightly crenate; aperture obscurely trifoliate, margins scarcely raised, not beaded. Frequently a small *avicularium* on the lower

* Floridan Bryozoa. pt. 2, p. 18. He expressly states, however, that he leaves "the question yet undecided."

part of the lamina; mandible pointed, directed upward. *Oœcia* (?).

Loc. Bahia, on shell (*Miss Jelly*).

This form is referred doubtfully to *M. trifolium*. The cells are smaller than in that species; the margin is less elevated and exhibits no distinct crenature; the lamina is more strongly calcified. It seems better, however, to rank it for the present as a variety, though the locality may suggest a doubt as to its identity with *M. trifolium*, which has hitherto only been known as a northern form (Britain, north; Norway; Arctic Sea; Labrador).

Membranipora antiqua, Busk. (Pl. XI. fig. 7.)

Membranipora antiqua, Busk, Quart. Journ. Micr. Sc. vi. p. 262, pl. xx. figs. 1, 2.

This species is described by Busk as being furnished with vibracula; but the remarkable appendages which occur, placed on distinct areas, and distributed amongst the zoœcia, are in reality avicularia, though of very peculiar structure. The fixed beak is long and somewhat falciform, with a rather broad central groove; the mandible expanded and subtriangular at the base, above tapering and setiform. Along one side of the mandible extends a membranous expansion, which is broad and spreading for about two thirds of the length, and narrows off into a mere edging near the top. What the precise use of this curious structure may be it is difficult to say: it certainly renders the appendage quite unfitted for any prehensile work; but it may make it a more efficient organ of defence.

The orifice in this species is surrounded by a narrow solid border, and the operculum is fully developed and works on a distinct hinge.

- c. With a membranous front wall, the orifice surrounded by a border; operculum with a distinct hinge.

Membranipora mamillaris, Lamouroux.
(Pl. X. fig. 9.)

Zoœcia elongate, rectangular, with membranous front wall, margins thin and smooth; orifice surrounded by a raised, somewhat thickened border, taller than broad, arched above, slightly narrowed towards the top; lower margin straight; operculum with a distinct hinge, of a dark horn-colour; on each side of the orifice a stout blunt spine, white and lineated longitudinally. *Avicularia* interspersed amongst the cells, placed at the top of a rectangular area, the fixed portion

(beak) made up of two opposed calcareous plates, which slope up to a central groove, narrow and linear above, expanded towards the base; the mandible elongate, triangular below, running out into a slender pointed process. *Oæcium* (?).

Loc. Australia, incrusting weed.

This species was long ago described by Lamouroux. I have figured it in order to show the remarkable avicularium, which has not hitherto been specially noticed. It illustrates very strikingly the homological nature of this appendage: the area on which it is placed exactly resembles that of the ordinary zoœcia, except that it is a shade smaller; the avicularium itself occupies the position of the orifice, of which it is plainly a modification. The basal subtriangular portion of the mandible is the equivalent of the opercular valve; the setiform process into which it is prolonged above is the superadded element. The calcareous plates which enclose the groove into which the mandible falls are a modification of the calcareous border of the zoœcial orifice, and possibly of the lateral spines.

The very definite character of the operculum in this species and the thickened border by which it is enclosed are points of much significance. The orifice is very much that of the Escharine (Smitt) or old Lepralian group. We have in this form and others like it an intermediate stage between the simple Membraniporidan structure and that of the Microporidæ, in which a similar orifice is associated with the complete calcification of the front wall. It may be a question whether the structural peculiarities of the present species should not be made the basis of a distinct generic group*.

It may be noted that on the outskirts of the colony abnormal cells are sometimes met with, in which the space usually filled by the orifice and the two spines is occupied by a broad, continuous, calcareous plate, stretching from wall to wall across the entire width of the zoœcium.

Membranipora transversa. (Pl. XI. fig. 9.)

Zoœcia elongate, rectangular, disposed in regular transverse (and longitudinal) series; aperture occupying more than half the front of the cell, with a wholly membranous covering; margin thin, smooth; orifice arched above, lower margin slightly curved outwards, surrounded by a definite border, on each side a very stout blunt spine, white and lined

* In the normal *Membranipora* the orifice is a simple semicircular opening in the front wall, and the operculum only differs from the membranous covering in being of slightly firmer substance; it does not work on a distinct hinge.

longitudinally; front of the cell much elevated immediately below the aperture, and on the summit of the elevated portion two massive subtriangular nodules, their apices about meeting in the centre (occasionally uniting so as to form a wall across the cell), lined transversely; below the rising the cell slopes abruptly to the base. *Avicularia* infrequent, distributed over the zoarium, placed at the base of a cell, immediately under the nodules; mandible triangular, sloping upwards. *Oœcium* (?).

Loc. Australia, incrusting stem of weed (*Miss Jelly*).

This species belongs to the same section as the last.

The cells are arranged with great regularity; and the elevated portions bearing the large nodules form prominent transverse ridges across the zoarium. *M. transversa* seems to be nearly related to *M. Woodsii*, Macgillivray*; but the latter is destitute of the peculiar elevation of the front wall and the nodules. *M. dispar*, Macgillivray, is another Australian species belonging to the same group.

SIPHONOPORELLA, nov. gen.

Der. σίφων, a tube, and πόρος.

Gen. char.—*Zoœcia* with raised margins, front depressed, in part membranaceous; a small calcareous tube with wide mouth placed at one side of the lamina below the aperture, and opening into the cavity of the cell. *Zoarium* (in the only known species) incrusting.

We have no clue at present to the function of the curious tubular structure with which each cell is furnished in this form; but we may infer, I think, from its constancy and definite position, that it bears some not unimportant relation to the economy. It is a very marked structural element, and seems well entitled to stand as the characteristic of a generic group. In the only known species the tube is somewhat horn-shaped, expanded towards the mouth, and attenuated towards the base. I have not been able to ascertain whether or not it communicates with the chamber which occupies the lower portion of the cell.

Siphonoporella nodosa, n. sp. (Pl. XI. fig. 10.)

Zoœcia subquadrangular, oblong, slightly arched above, prolonged below the area, arranged pretty regularly in longitu-

* "Description of some new Genera and Species of Australian Polyzoa; to which is added a list of species found in Victoria. By P. H. Macgillivray, A.M., M.R.C.S.," Trans. & Proc. Roy. Soc. Victoria, vol. ix. (1868) pt. 2, p. 130.

dinal series, closely united; area broad-ovate, occupying usually about three quarters of the front of the cell, the lower half filled in by a minutely granular lamina, which slopes steeply up to the top of the inferior portion of the cell; aperture occupying the upper half, somewhat semicircular, with a membranous covering, margin thin and smooth, sometimes of a brown colour; in one corner of the aperture, between the wall of the cell and the lamina, a small horn-shaped tube, opening out below by a wide mouth into the cavity of the cell, and tapering off towards its upper extremity; the portion of the cell below the area elevated, bearing several (one to five) prominent polished nodules, wall smooth and glossy. *Avicularia* none. *Oocia* (?).

The principal variation to which this extremely interesting form seems to be liable is in the number of the nodular processes. Occasionally the produced lower portion of the cell is altogether obliterated, and the area extends to the top of the neighbouring zoecium. In such cases a single nodule occurs on the line of junction, or sometimes two. But usually there is a considerable space below the area, which is crowded with the glossy tubercles; they are sometimes separated by delicate raised white lines. The zoecia are *deep*; and the cell-wall seems to rise a good deal above the level of the membranous covering of the aperture. The zoarium has a bright and shining appearance.

EXPLANATION OF THE PLATES.

PLATE IX.

- Fig. 1.* *Membranipora crassimarginata*, n. sp. 1 a, elongated avicularian cell and oecium.
Fig. 2. *Membranipora nodulifera*, n. sp.
Fig. 3. *Membranipora tenuirostris*, n. sp.
Fig. 4. *Membranipora granulifera*, n. sp.
Fig. 5. *Setosella vulnerata*, Busk (Madeira).
Fig. 6. *Smittia marmorea*, Hincks.
Fig. 7. *Lepralia Kirchenpaueri*, Heller, var. 7 a. Oecium.

PLATE X.

- Fig. 1.* *Cribrilina radiata*, var.
Fig. 2. *Porella nitidissima*, n. sp.
Fig. 3. *Lepralia Pallasiana*, with oocia.
Fig. 4. *Phylactella lucida*, n. sp.
Fig. 5. *Membranipora albida*, n. sp.
Fig. 6. *Membranipora horrida*, n. sp.
Fig. 7. *Membranipora distorta*, n. sp.
Fig. 8. *Membranipora villosa*, n. sp.
Fig. 9. *Membranipora mamillaris*, Lamx., with avicularium.

PLATE XI.

Fig. 1. *Membranipora delicatula*, Busk.

Fig. 2. *Membranipora plana*, n. sp.

Fig. 3. *Membranipora pura*, n. sp.

Fig. 4. *Membranipora nitens*, n. sp.

Fig. 5. *Membranipora armifera*, n. sp.

Fig. 6. *Membranipora trifolium* (?), var. *minor*.

Fig. 7. *Membranipora antiqua*, Busk. A zoecium, with avicularium, showing the membranous expansion along the mandible.

Fig. 8. *Membranipora Carteri*, n. sp.

Fig. 9. *Membranipora transversa*, n. sp.

Fig. 10. *Siphonoporella nodosa*, n. sp.

[To be continued.]

XI.—Descriptions of a new Cicindelid and a new Cetoniid from East Africa. By CHARLES O. WATERHOUSE.

ABOUT two years ago I described (Ann. & Mag. Nat. Hist. 1877, xx. p. 424) a new genus of Cicindelidæ which I called *Styphloderma*. The British Museum has just received a second species of this interesting genus from Mpwapwa, East Africa. I propose to call it

Styphloderma lævicolle.

Nigrum, nitidum; thorace lævi; clytris ovalibus, granulis elongatis dense tectis, politis; margine ipso anguste cyaneo. ♀.
Long. 12 lin.

This species resembles *S. asperatum*, but has the elytra more regularly ovate and a little less depressed at the suture. The head and thorax are quite smooth, the latter having no trace of the granules at the front and hinder margins as in *S. asperatum*. The sculpture of the elytra is somewhat the same, except that the surface is shining, and the asperities are not sharp posteriorly, but are elongate, lanceolate.

Hab. E. Africa, Mpwapwa.

Cetoniidæ.

EUTELESMUS, n. gen.

♂. Clypeus nearly parallel at the sides, as long as broad, concave, biemarginate at the apex. Anterior tibiæ simple, with the common excision at the base below; four posterior tibiæ unarmed. Mesosternal process flat, parallel, truncate

(or very slightly arcuate) at the apex. Club of the antennæ very long, slightly curved. General form nearly of *Stephanorrhina guttata*.

This genus is remarkable for the tridentate anterior margin of the clypeus, which is concave above, and for the very large club to the antennæ. I propose to place it next to *Rhanzania*.

Eutelesmus simplex, n. sp.

Nitidus, castaneus; thorace scutelloque olivaceis, clytris lævibus, pedibus piceis æneo tinctis.

Long. $11\frac{1}{2}$ lin.

Clypeus sparingly and obscurely punctured; the three apical teeth are short, the lateral ones a little more acute than the middle one. Thorax dark olive-green, nearly black, sparingly punctured. Elytra dark brown, smooth. Legs long, coppery brown, tinted with green here and there; the anterior tibiæ slender, a little narrowed before the apex; the basal joint of the anterior tarsi very short. Sterna clothed with fulvous pubescence. Abdomen broadly impressed in the middle.

Hab. E. Africa, Dar-es-Salaam.

A single example in Colonel Shelley's collection.

BIBLIOGRAPHICAL NOTICES.

Zoological Classification: a Handy Book of Reference, with Tables of the Subkingdoms, Classes, Orders, &c. of the Animal Kingdom, their Characters, and Lists of the Families and principal Genera.

By FRANCIS P. PASCOE, F.L.S. Second Edition, with Additions and a Glossary. Small 8vo. London: Van Voorst, 1880.

To prepare a "*Systema Naturæ*" after the Linnean model, in the present state of science, would be a task from which the boldest of naturalists would shrink. Even a "*Systema Animalium*" would defy the powers of any one man, however industrious; and we know from experience that systematic works carried to groups so low as genera usually take several years in their production, even when confined to a single tolerably extensive *order* of animals. Any such book extended to the whole animal kingdom must of necessity occupy several considerable volumes, and would by no means constitute what Mr. Pascoe desires his present work to be, namely "a handy book of reference."

The first edition of Mr. Pascoe's '*Zoological Classification*' appeared about three years ago; and we are glad to see that its success

has been so great as to induce the author to make this second enlarged issue. The general nature of its contents is perhaps sufficiently explained in its rather detailed title as given above; so that we need do little more than indicate the mode in which the author has carried out his design. His object has evidently been to compile from the most trustworthy authorities a something equivalent to the notes which any of us might wish to prepare for his own use, for reference while going about to zoological museums, or when engaged in the study of books and memoirs on zoological subjects, of course keeping down the size of his book so as to render it a convenient pocket companion. With this view, after a few preliminary remarks on the general classification of animals, the theory of descent, &c., he proceeds to tabulate and briefly characterize the subkingdoms, classes, and orders of the animal kingdom, including both fossil and recent forms, and finally under each order gives a list of the more important genera arranged under their respective families, the latter, however, not characterized. Notwithstanding the extreme conciseness with which the whole subject is treated, the author generally indicates not only the bare characters by which the different groups are to be distinguished, but also certain interesting points in the structure, habits, or development of the animals composing them, and, not content with merely mentioning the author whose opinion he adopts, usually, in cases of doubt, or where different views are extant, discusses briefly the opinions which he has not followed. This has the double advantage of furnishing a considerable amount of useful information to the reader, and of getting rid of the difficulty which must always be experienced in the use of many a systematic handbook in which the author treats his classification as if it were the sole one possible. As regards the classification here actually adopted, it is, of course, like all other classifications, open to criticism here and there; but, taken as a whole, it may certainly be regarded as holding a fairly middle line among the modern zoological systems, and thus, in itself, is very satisfactory. Of course so small a book can afford no space for illustrations.

Mr. Pascoe has added considerably to the value of his work in the present edition by appending to it a glossary of terms, which, notwithstanding some few defects, will prove useful, not only to beginners, but, in many cases, even to more advanced students. In days gone by the comparative anatomists and outdoor naturalists used heavily to reproach the systematic zoologist, and especially the so-called "closet naturalist," with his fondness for a complicated terminology; but all the efforts of all the closet naturalists from the time of Linneus downwards were quite unable to produce such a rich harvest of terms as have sprung within the last twenty years from the prolific brains of the anatomists. We cannot help feeling that much of this complex and daily increasing terminology is quite unnecessary; but it exists and will be used, and many

readers who have been puzzled with the new names applied to parts of animals, or used as the designations of phenomena in their life-history, will be glad to hear that a very great number of them are intelligibly explained in Mr. Pascoe's glossary. In fact the book as it stands may be heartily recommended to all who want a useful, portable, and trustworthy compendium of systematic zoology.

A Monograph of the Silurian Fossils of the Girvan District in Ayrshire. By H. A. NICHOLSON, M.D., D.Sc., &c., and R. ETHERIDGE, Jun., F.G.S. Fasciculus II. 8vo. Pp. 137-234, plates x.-xv. Edinburgh: Blackwood and Sons, 1880.

THE second fasciculus of the above work, although not so extensive as the first part as regards the plates and letterpress, is equally interesting. It is occupied wholly with the Crustacea from the Silurian rocks of Girvan, and contains descriptions of the remaining Trilobita, continued from the first part, as well as of the forms referred to the Phyllopora, Cirripedia, and Ostracoda, which groups, however, will be further supplemented in the third part, in consequence of additional material recently collected, embracing either new species, or adding to the already available information as to forms previously described.

The descriptions include about 40 species of Trilobita, 4 Phyllopora, 1 Cirripede, and 8 Ostracoda; the notes on the latter group have been furnished by Prof. T. Rupert Jones.

This part contains a table showing the geographical distribution (in twenty-three localities) of the species of Crustacea in the Girvan district, and some general remarks on the stratigraphical relations of the species as a whole, more especially in regard to the evidence afforded by them of the age of the beds in which they occur: and these are referred to the Caradoc, Lower Llandovery, and Upper Silurian formations.

In comparing the range of corals and crustacea it will be observed there is an increase in the number of localities yielding Trilobites, or other orders of Crustacea, over those from which corals have been obtained. Whether this result will be maintained after additional researches remains to be seen. "It is, however, noteworthy that at certain localities where the coral-fauna has been found to be copious, the Crustacea are correspondingly scarce, and *vice versa*."

The Plates, with the exception of pl. xv., which is faint, are well executed; and the authors have spared no labour to render the descriptions and references as exhaustive as possible, by the careful comparison of original specimens, figures, and descriptions of previously described similar forms.

MISCELLANEOUS.

Researches on the Occurrence of Intestinal Worms in the Intestinal Canal of the Horse. By H. KRABBE.

As the horse is spread over the greater part of the inhabited world, and its conditions of existence are so varied, it is to be supposed that, like man and the dog, it is not afflicted everywhere, or with the same frequency, with the same intestinal worms. To determine as exactly as possible what are, in Denmark, the Entozoa that occur in the horse, and especially in his intestinal canal, I have, during the last four years, examined 100 old horses which have been killed between September and April in the Veterinary School of Copenhagen, to serve for anatomical purposes.

In these 100 horses I found in the intestinal canal:—

<i>Tænia perfoliata</i>	28 times.
— <i>mamillana</i>	8
<i>Ascaris megalcephala</i>	16
<i>Strongylus armatus</i>	86
— <i>tetracanthus</i> (in 67 out of 86 horses)	78
<i>Oxyuris curvula</i>	2

In all the stomach contained larvæ of *Æstrus* in larger or smaller quantity; and *Filaria papillosa* was, from time to time, met with suspended from the intestines which had been removed.

Tænia perfoliata, Goeze.—The number of these Tapeworms was usually less than 25; sometimes there were more—for example, twice between 100 and 200, and once more than 400. In general they were lodged only in the cæcum; but the colon sometimes contained isolated specimens, and four times I found some, generally young individuals, dispersed in the small intestine.

Tænia mamillana, Mehlis, was always lodged in the small intestine. There were usually less than 25, but sometimes more, up to 72. This tapeworm was first described and figured by Gurlt in his 'Lehrbuch der pathologischen Anatomie der Haus-Säugethiere' (1831), vol. i. p. 380, pl. ix. figs. 7, 11; but this must have escaped Dujardin, who, in his 'Histoire naturelle des Helminthes' (1845), although he frequently quotes Gurlt's work, gives, under the article *T. perfoliata*, a description and figures (p. 580, pl. xi. figs. 1–7) of *T. mamillana*. Hence these two species have been confounded by several French authors (Davaine, Baillet).

Tænia plicata, Rudolphi, did not occur in the horses that I have examined; but Abildgaard has described and figured it in the 'Zoologia Danica' (vol. iii. 1789, p. 50, pl. 110. fig. 1), and states that he had met with as many as 5 in one horse. He adds, however, that this tapeworm was not frequent, and that it was rarer than *T. perfoliata*, Rud.

Ascaris megalcephala, Cloquet.—The greatest number found in a horse was 11; it was always lodged in the small intestine.

Strongylus armatus, Rudolphi, has never been observed in the

small intestine. I have met with it especially in the cæcum, and in smaller numbers in the first part of the colon, where it was usually represented by large individuals of a dark reddish-blue colour. The number was usually less than 25; but I once counted nearly 200. Out of 1409 specimens that I examined, 1029 were females and 380 males.

Strongylus tetracanthus, Mehlis.—I had examined 14 horses without detecting this worm in them, when, on washing some fragments of the mucous membrane of the colon, I found an enormous quantity of it in the contents of the intestine, which had remained adhering to the membrane. By adopting the same process I afterwards ascertained its presence in greater or less number in most of the horses, in the cæcum and, especially, in the colon. The females were seldom more than 12 millims. long, although they often contained ova.

Oxyuris curvula, Rudolphi, was found in the dilated portion of the upper branch of the convolution of the colon, once to the number of 6, and a second time of 150 specimens. Among the latter there was a male that measured 7 millims. in length.

In Iceland Dr. Thorvald Jonsson, of Isafjord, has, at my request, had the kindness to examine the intestines of some horses in search of Entozoa; and in 5 of them, all about twenty years old, he found the worms only in the upper part of the large intestine, but in great quantity in all, and especially in one of them. These worms, of which he has sent me some, consisted in part of *Oxyuris curvula* (about 60 individuals, among which were two males), and in part of an innumerable quantity of *Strongylus tetracanthus*, which reached as much as 14 millims. in length. *Oxyuris curvula* also occurs in the Danish West-India islands; and the museum of the Veterinary School possesses specimens from St. Thomas*.—*Oversigt over det Kongl. Danske Videnskabernes Selskabs Forhandlinger*, 1880, p. 33, and *Bulletin*, p. 9.

The Platysonidæ. By Dr. R. H. TRAQUAIR, F.R.S.E.

In an important memoir, read last year before the Royal Society of Edinburgh, and now just published in its Transactions, Dr. Traquair discusses at length the structural characters and affinities of certain genera of old fossil fishes, the position of which has been very variously decided by different authors. Of known genera we have here *Eurymotus* and *Platysomus*, Agass., *Mesolepis* and *Eury-somus*, Young, and *Cheiroodus*, M'Coy; and the author characterizes two new genera under the names of *Benedenius* † and *Wardichthys*.

* To these parasites of the horse the author adds *Diplostomum ægyptiacum*, Cobbold, found in Egypt, and remarks that the extant information as to the Entozoa of the horse and ass, especially with regard to their geographical distribution, is very scanty.

† This name will have to be changed, as there is already a Cetacean genus *Benedenia*, founded by the late Dr. Gray in 1864.

These genera have been placed in very different positions, but have generally been regarded as allied either to the Palæoniscidæ or to the Pycnodonts. Prof. Young of Glasgow has proposed to arrange them, with the latter, in a special suborder of Ganoids, under the name of Lepidopleuridæ—an arrangement which has met with considerable acceptance. Dr. Traquair discusses the views put forward by different authors, and then proceeds to a description of the characters presented by the genera above mentioned, which he shows to form a connected series, and proposes to include in a distinct family, Platysomidæ. He discusses at some length the affinities of this family to the principal groups to which its members have been thought to show relationships, and comes to the following conclusions:—

“1. That the Platysomidæ are specialized forms which have, if the doctrine of descent be true, been derived from the Palæoniscidæ. Their structure presents us simply with a modification of the Palæoniscoid type; and wherever the Palæoniscidæ are placed in the system, thither the Platysomidæ must follow.

“2. The resemblances between the Platysomidæ and the Dapediidæ and Pycnodontidæ are mere resemblances of analogy and not of real affinity. The Dapediidæ are related not to the Palæoniscidæ or Platysomidæ, but to the other semiheterocercal Ganoids of the Jurassic era (*Lepidotus* &c.); and the Pycnodonts are highly specialized forms, whose general affinities point in the same direction.”

Prof. Traquair regards the Palæoniscidæ and Platysomidæ as belonging to the Acipenseroid suborder of Ganoids.—*Trans. Roy. Soc. Edinb.* vol. xxix. pp. 343-391, pls. iii.-vi.

On the Nervous System of Idothea entomon.

By M. E. BRANDT.

The nervous system of *Idothea entomon* presents fourteen ganglia—three cephalic ganglia, seven ganglia of the trunk, four postabdominal ganglia.

The only naturalist who has investigated the nervous system of *Idothea* is H. Rathke*; but his investigations are not exact. He describes a single cephalic ganglion (he did not see the others); he took the subœsophageal ganglion for the supræœsophageal, and he does not correctly describe the nerves which issue from it.

The supræœsophageal ganglion consists of six parts: it has two median lobes, or the hemispheres, which give off two nerves for the inner antennæ; two antennary lobes, which send off the nerves of the outer antennæ; and two external or optic lobes, which bear the nerves of the eyes. The œsophageal collar is short, very thick, and furnishes two nerves for the labrum (*nervi labii superioris*). The subœsophageal ganglion, which is small, furnishes three pairs

* Neue Schriften der naturf. Gesellsch. in Danzig, 1820, p. 109, pl. iv. fig. 2.

of nerves, as in insects—two for the labium (*nervi labii inferioris*), two for the maxillæ (*nervi maxillares*), and two for the mandibles (*nervi mandibulares*). The third ganglion of the head, which I propose to name the *pedomaxillary ganglion*, rests upon a peculiar lamina, the *pedomaxillary plate**, and it furnishes one pair of nerves for the two jaw-feet (*nervi pedomaxillares*). The trunk possesses seven ganglia; that is to say, there is a ganglion for each segment. The first ganglion of the trunk is very small, although larger than the pedomaxillary ganglion; all the other ganglia of the trunk have the same volume. From each of these ganglia originates a pair of nerves for the feet—connectives separate from the nerves for the muscles and the skin of the segment, as described by H. Rathke. In this respect the pedomaxillary ganglion perfectly resembles those of the trunk; for, besides the nerves of the jaw-feet, it emits two other nerves for the posterior part of the head. It would seem, as shown by the innervation and the presence of a distinct ganglion, that the posterior part of the head of *Idothea* is a thoracic segment amalgamated with the head. The latter is therefore an imperfect cephalothorax, but still morphologically different from the heads of insects. There are four postabdominal ganglia, which are much smaller than the ganglia of the trunk; the last is the largest; the others are of equal size. The first, second, and third only furnish one pair of nerves for the corresponding segments: while the last emits four pairs of nerves. There is also a sympathetic nerve, represented by an unpaired trunk, placed between the connectives of the ganglionic chain, and interrupted by the ganglia—that is to say, exactly the same as that which F. Leydig has described in *Porcellio scaber* †, Rathke saw it, but did not recognize it as the sympathetic.—*Comptes Rendus*, March 22, 1880, p. 713.

On a Peculiar Modification of a Parasitic Mite.

By M. MÉGNIN.

In a great many insects parasitic on plants, the female, when ready to deposit her eggs or to give birth to larvæ, is seen to cover herself with a cottony or byssoid secretion, which serves not only to protect herself, but also to preserve her progeny from any injury during the first period of life. This is observed in most cochineal insects and in the woolly Aphis.

Certain Arachnida, also plant-parasites, possess the same peculiarity; and a species of *Tetranychus* has received its name (*T. telarius*) precisely on this account. In this case the cottony secretion of the mite forms a true nidification, destined to protect the

* E. Brandt, 'Ueber eine Cephalothoracalplatte des gemeinen Schachtwurmcs (*Idothea entomon*),' St. Petersburg, 1877.

† Vom Bau des thierischen Körpers (Tübingen, 1864), p. 251; and Tafeln zur vergl. Anat. pl. vi. fig. 7.

ova during the various phases of incubation and hatching; for the female does not remain fixed during oviposition like the *Coccidæ* and the *Aphis* above mentioned, but lays successively in several nests.

Up to the present time nothing of this kind had been observed among the *Acarina* parasitic upon animals; but chance has just made me the witness of an exactly similar fact upon a bird. I was preparing to dissect an American Grosbeak (*Cardinalis fulgens*, Bonap.), when, having stripped off the feathers of the thorax, I was struck by the presence of numerous white spots with which the naked median and sternal part of the skin which covers the lower part of the breast was sprinkled. I have preserved this portion of the skin stretched upon a plate of glass.

Under the lens these little white patches have the aspect of small spots of mould; but under the microscope, especially after soaking in glycerine, which renders them diaphanous, these spots are found to be composed of a fine tissue, beneath which appears a group of eggs in different stages of incubation, empty egg-shells, and small yellow *Acarines* in process of escaping from these envelopes, or which have already escaped from them. These *Acarines* are nothing but octopod larvæ, which, from the anatomical characters of the rostrum and legs, it is easy to recognize as belonging to the species which I have named *Cheyletus heteropalpus* in a memoir devoted to the description of a new group of *Acarina* parasitic on Rodents and Birds, with which I have established a tribe of *Cheyletides parasites* *.

In his fine investigation of the anatomy and physiology of the plumicolous *Sarcoptides* †, Professor C. Robin has shown that these deposit their eggs in small masses at the axils of the barbs of the feathers. I thought that my parasitic *Cheyletides* acted in the same manner, seeing that they live with them and even hunt after them; but I had never met with their eggs, which are remarkable and very large (0.18×0.11 millim.), with those of the plumicolous *Sarcoptides*. The observation which I have just described shows how these eggs are laid and what precautions the *Cheyletides* take to protect them—a fact which singularly approximates them to the *Tetranychis*, with which, moreover, they are allied by their organization. It shows, in addition, that the larvæ of this species are octopod when first hatched—a character which is not possessed by those of the *Tetranychis*, nor even by those of the wandering *Cheyletides*, such as *Cheyletus eruditus*.—*Comptes Rendus*, June 7, 1880, p. 1371.

* Journ. de l'Anat. et Physiol. 1878.

† *Comptes Rendus*, April 30, 1868.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 32. AUGUST 1880.

XII.—*On a remarkable Form of Pedicellaria, and the Functions performed thereby; together with General Observations on the Allied Forms of this Organ in the Echinidæ.* By W. PERCY SLADEN, F.L.S., F.G.S.

[Plates XII. & XIII.]

THE following peculiarities in the structure of certain pedicellariæ appear to have been undescribed.

In *Sphærechinus granularis* (Lamk.), A. Ag., the *pedicellariæ globiferae** are very much larger than the other forms of pedicellaria upon the same animal, and are of enormous size when compared with the usual relative proportions of this appendage in other species of *Echini*. The special fea-

* I am unwilling to follow those writers who ignore altogether the old names by which the different forms of pedicellariæ were originally described, and who anglicize the colloquial French terms applied by Valentin, although there can be no doubt whatever about the special form to which each of Müller's terms belonged, the figures and descriptions given in the 'Zoologia Danica' being perfectly recognizable and characteristic. The following tabulation of the original nomenclature and the subsequent one used by the French *savants* will save much tedious reference:—

Pedicellaria, O. F. Müller (Zool. Dan.).

O. F. Müller (1788).		Valentin (1841).		Perrier (1869).
<i>P. globifera</i>	=	p. gemmiforme	=	p. gemmiforme.
<i>P. triphylla</i>	=	p. ophicéphale ou buccal	=	p. ophicéphale.
<i>P. tridens</i>	=	p. tridactyle	=	p. tridactyle.

ture to which I wish to draw attention is the presence of a remarkable glandular organ upon the stem or pedicel of the *ped. globifera* of *S. granularis*, situated between the middle portion of the shaft and the distal extremity to which the valvate head is attached. Normally the presence of this organ is superficially manifest as a conspicuous dilatation upon the shaft. When examined with a lens of low power the dilatation is found to possess a tripartite form, apparently in correspondence with the divisions of the head of the pedicellaria; and near the upper portion of each of the three sections or separate sacculi there is to be seen a small foramen or pore, through which a glairy mucous matter is extruded as occasion requires.

The discharge of mucus, it should here be mentioned, is not solely confined to these organs upon the stem; for a similar secretion is also copiously ejected from the saccular head of the *pedicellaria globifera*, under certain conditions which will hereafter be referred to.

These circumstances led the author, whilst studying at the Zoological Station at Naples, to pay some attention to the subject; and it is upon the notes and preparations there made that the present communication is in a large measure based.

When a specimen of *S. granularis* is placed in fresh water, the animal frequently throws off a considerable quantity of slime or mucus, as if in an endeavour to free itself from the obnoxious environment. This exudation is found to proceed from the *pedicellariæ globifera*; and, so far as I have been able to observe, I am disposed to think that its origin is referable entirely to these appendages. It may be remarked in passing, however, that this procedure is not confined to the species under notice, nor yet to the group of the "regular" Echinoidea; for *Echinocardium* and some species of starfish may be seen to behave in a similar manner when subjected to the same treatment; indeed the discharge from the Spatangoid is much more copious than in the case of *S. granularis*.

The *pedicellariæ globifera* of *S. granularis* are readily distinguishable from the accompanying *ped. triphyllæ* and *ped. tridentes*, which are found upon the same test. Apart from their larger size, the head has the appearance of being fleshy and globose; and the jaw-pieces or valves are enveloped in large membranous sacs; whilst the distal extremity of the internal calcareous skeleton-frame is sharply bent at a right angle from the main axis of the jaw-piece, and attenuated into a long, sharp, tooth-like process or fang that protrudes from the saccular development just mentioned, and which, when the pedicellaria is closed, meets in the centre with the

corresponding processes of the companion jaw-pieces. The stem is rigid throughout, and contains a calcareous shaft that traverses the entire length, and to which the head of the pedicellaria is directly attached. Near the middle portion of the stem is the large, inflated, gibbous, sac-like swelling previously mentioned; and, considering its very prominent and conspicuous character, it seems surprising that its occurrence in this common Mediterranean species should not have been more generally observed.

The Glandular Sacculi of the Stem.—The description of the pedicellaria will commence most conveniently at this part. The sacculi of the stem-dilatation are generally disposed in an irregular subspiral manner round the shaft, the apices of the three being never, so far as I am aware, all equidistant from the extremity of the shaft. After removing the pedicellaria from the test and rendering the tissues sufficiently clear for the transmission of light, it will be apparent that each of the sacculi contains an elongate ovoid or subcordiform mass, the upper portion of which terminates at the pore. By this method of examination no vessels of any kind are seen to open into the internal masses, either from above or below, and they have the appearance of simply lying upon the central rod and being held in position by attachment around the foramen (Pl. XII. fig. 4).

On dissecting away a portion of the investing membrane the mass can be readily displaced from within the sacculus with a fine needle-point; and it then has the appearance of a white, spongy, reticulated substance with a denser central portion within and a number of moderately large, elongated pink cells distributed over its surface, and through the substance itself, external to the central mass (fig. 3). In order to arrive at the ultimate structure of this body recourse must be had to other methods of investigation. I have found that sections are unquestionably the best means of attaining this end, although it is a very difficult matter to cut them of the requisite thinness, in consequence of the hard and gritty character imparted to the inner mucous mass by the chemical action of the various preservative and staining reagents which it is necessary to employ. On account of the nature of the mucus, some fluids are altogether inapplicable; picro-sulphuric acid or fresh water may be cited as examples; and, indeed, so sensitive does the mucus appear to be, that even when specimens that have been preserved in alcohol for more than a year are placed in water, the sacculi swell to many times their normal size and burst in a few moments.

I have found it to be the most satisfactory method of pre-

paration to place the pedicellariæ, immediately after removal from the test, in alcohol of 70 per cent. acidulated with 2 per cent. of HCl; and then, when decalcification has been effected and all traces of the acid thoroughly removed by repeated washings, to stain in hæmatoxylin.

A transverse section through the stem-dilatation (Pl. XII. fig. 8) presents the following series of tissues:—

1. Epithelial nucleated cells of the investing membrane;
2. A neuro-muscular layer with granular fusiform cells distributed here and there;
3. Tissue with numerous large colourless cells;
4. A layer of large areolar spaces and gland-cells and ducts;
5. The central mass, composed of a very finely reticulated substance, densely filled up with mucous matter (Pl. XII. fig. 8). A longitudinal section through the organ indicates the distribution of these tissues, and also that the structure enumerated above belongs essentially to the gland-sac, with the exception of the epithelial layer of the common investing membrane.

In the longitudinal section of the stem neuro-muscular bands may be seen traversing its length, and bead-like bands of granular fusiform bodies, connected at the extremities by delicate fibres, immediately underlying the cuticular epithelium. Although I was at first sight disposed to regard these as simple pigment masses, I am now inclined to consider them more intimately connected with nerve-structure. That they are different from the true pigment masses will be seen on examining a specimen from which the colour has not been discharged—the cells of these latter being much less regular in shape and much more numerous, and not united into the same longitudinal bead-like bands by the delicate fibres referred to above.

The calcareous shaft occupies only a small space in the centre of the stem, and is surrounded by a considerable thickness of nucleated connective tissue. The granular (nerve?) cells are found to be densely crowded immediately above the glandular sacculi. The foramen of the sacculus is surrounded by a strong sphincter muscle. The whole investing membrane of the *pedicellaria globifera* (head, stem, and saccular dilatation alike) is indurated on its outer surface with a large number of small, curved, calcareous spicules somewhat resembling the letter C in form, and having a slightly thickened or rounded knob-like termination at each extremity.

It occasionally happens that a *pedicellaria globifera* may be met with which is devoid of the glandular sacculi upon its stem; and no difference would at first sight be noticed between

this and the stem of one of the pedicellariæ upon which no such dilatation is known to occur. It will be found, however, on examination under the microscope, that the foramina are nevertheless present and occupy the same position as that which they would hold in one of the sac-bearing stems, and appear to be normal in every way (Pl. XII. fig. 6). I am led, therefore, to regard these as simply cases in which the glands of the sacculi are aborted from some cause or other; but how this state of things has come about I am quite unable to say.

Head of the Pedicellaria globifera.—Mucus, as previously stated, is extruded from the head or jaw-portion of the *ped. globifera*. As the anatomy of the soft parts of these organs has never been described in detail, it will be found a subject well worthy of attention on the present occasion, and will assist in the elucidation of the functions performed by these well-known and yet obscure appendages.

The structure of the calcareous framework of the head of this form of pedicellaria is familiar to most possessors of microscopes, and has been frequently figured. It is at once readily recognizable from that belonging to the *triphylla* or *tridens* form of pedicellaria. Each of the three valves or jaw-pieces of the *ped. globifera* in question is of remarkably elegant form, somewhat resembling a mandolin in shape. The basal portion is large and swollen out, presenting a convex surface outwardly and a concave one inwardly, a delicate median keel or partition separating this latter into two hollow chambers. The basal portion occupies fully one third of the height of the jaw-piece. The upper portion consists of a delicate shaft proceeding from the upper part of the basal shield in the prolongation of its median axis; it is somewhat quadrangular in section, and slightly tapers towards the upper portion; the extremity is finely pointed into a tooth-like process, which is roundly curved at a right angle to the axis of the piece and directed inwards; immediately where the curve is completed the shaft becomes somewhat constricted, and is then slightly expanded again prior to the commencement of the delicate tapering towards the tip, the expanded portion being channelled and presenting the appearance of two or more lateral lamellæ merged together to form the tip or tooth-like fang. The valves of the *pedicellaria globifera* are attached immediately to the upper part of the calcareous shaft of the stem. The whole head is invested with a very considerable development of soft parts, and presents, when closed, the appearance, so aptly described

by Valentin, of the corolla of a flower "asleep" for the night*.

Each jaw-piece is invested in a membranous sac, which gradually swells out from the tip to the base, where it presents a very inflated appearance, and merges into the general sac of the whole head, the only portion of the calcareous shaft that is visible being the fang or tooth-like process, which is left naked and protruding from the apical portion of the sac. On the upper surface of the fang the investing membrane does not lie perfectly close to the shaft; but an aperture is formed on either side, through which mucus is expelled.

No trace of the two external sac-like formations that are found in the *pedicellariæ globiferæ* of many other *Echini* is visible to superficial view in those of *Sphærechinus granulæris*, the whole valve being enveloped in a single, highly inflated, membranous sac.

The valves of the pedicellaria can be opened and closed, the expansion being generally maintained until the inner surface of the valves is at right angles to the shaft, and the inner areas of the three jaws together form a plane flat surface at right angles to the stem. When in this position the fang is usually retracted, or, perhaps more correctly, hidden within the sac-like sheath (Pl. XII. figs. 3-5). At the slightest touch or irritation the jaws immediately close, and, under certain circumstances, a flow of mucus takes place from the apertures above mentioned.

Recourse must now be had to dissection and sections in various directions, to enable us to treat further on the anatomy of the organs under consideration.

On examining a longitudinal section through the pedicellaria the following tissues will be observed:—1. The fine investing membrane composed of epithelial cells; 2. A stratum with a few distributed nerve-cells; 3. The walls of a large saccular body bounded by a moderately thick layer of horizontally disposed muscular fibres; 4. Within this a widely reticulated tissue terminating in follicular gland-cells, closely aggregated and forming a layer internal to the wall of the sac, fully one third of its diameter in breadth at the median part (Pl. XIII. fig. 9). A serial range of sections, together with careful dissection of a single valve, will show that the glandular sac is divided on its upper portion by a fine partition into two chambers, both opening into the basal portion of the sac, and that these are disposed one on either

* Monographies d'Echinodermes, "Anat. du genre *Echinus*," p. 48.

side of the median line, and open at the apex of the valve on the sides of the fang as above mentioned, whence the discharge of the mucous or glairy matter secreted by the glands of the sac takes place. This sac (or double sac more accurately) is placed external to, or upon the outward side of, the central calcareous shaft of the jaw-piece. The three valves are held together by strong bands of muscles, which are attached within the hollow cavity of the basal portion, the muscular impressions being clearly perceptible on either side of the median ridge after the calcareous skeleton has been cleaned in a strong potash solution. Nerve-centres with fibres running into each valve, communicating with these muscles, may be traced in the middle of the basal portion of the head immediately above the upper extremity of the central shaft of the stem.

When the jaws or valves of the pedicellaria are opened wide, the inner margin of the base of the internal skeleton, the lower part of the free edge of the partitional keel of its basal cavity, and the extreme tip of the fang, all fall in one and the same plane, which is at right angles to the stem of the pedicellaria (Pl. XII. fig. 4). Owing to the stretching of the investing membrane a flat surface of triangular outline is thus presented, which resembles fancifully the contour of an old-fashioned three-cornered hat, the edges being somewhat loose and overturned (Pl. XII. fig. 5). In the centre of this inner surface of the expanded valves are three, small, oval-shaped cushions, approximated at their bases, and one lying upon the median keel of each of the valve-frames (Pl. XII. fig. 5, and Pl. XIII. figs. 9, 10). These organs, which are finely papillate and richly supplied with nerve-fibres (as will be found indicated in the section in Pl. XIII. fig. 12), are presumably of sensorial (*i. e.* tactile) function, and act, in all probability, as the communicators of the advent of any foreign or irritating element. When the *Echinus* is alive and at rest in a congenial environment the jaws of the pedicellaria are extended, the whole appendage swaying gently to and fro as if in search of, and in readiness for, a coming enemy.

Functions of the Pedicellariæ globiferæ.—Respecting the functions of pedicellariæ, around which subject there still remains so much doubt, I shall, in the present communication, chiefly confine my remarks to the *ped. globiferæ*—the form that has been under examination.

It would appear that one of the principal physiological actions, and that which distinguishes the present from each of the other forms of pedicellariæ, consists in the discharge of

mucus. This takes place, in the species we have been discussing (*viz. Sphærechinus granularis*), both from the head of the pedicellaria and from the sacculi of the stem.

A careful study of these organs in the living state, and a comparison of the habits of other Echinoderms, have led me to formulate the following explanation of the functions subserved by the *pedicellariæ globiferae*; and although I am not at present able to do more than offer it as a suggestion, the facts that have laid the foundation for this conclusion are incontrovertible, whilst the argument deduced therefrom would appeal to the judgment by virtue of its reasonableness alone, even if it were unsupported by the collateral evidence of which we are in possession.

It has previously been remarked that a *Sphærechinus granularis*, when placed in fresh water, throws out a glairy mucous matter that envelops the test; and the author has seen the same discharge take place when the urchin was placed in a vessel of sea-water different from that which it had previously occupied. This discharge comes from the *pedicellariæ globiferae*; and the opinion has already been stated that these appendages are the source to which it is entirely due.

The reason of the discharge is evidently an attempt on the part of the animal to free itself from unpleasant surroundings. The prime cause, I am inclined to think, lies in the explanation that the function of these pedicellariæ is that of removing grit, sand, dirt, or other offensive matter from the surface of the animal.

From the manner of the arrangement of parts upon the surface of a sea-urchin, it can readily be imagined that a natural tendency must exist towards the accumulation of all such substances amongst the many crevices and interstices on the body-surface, between crowded spines, ambulacral suckers, and pedicellariæ. Yet it will be found that the *Echinus* is generally wonderfully clean. In my opinion the ciliary epithelium is altogether insufficient to effect this; and the duty devolves upon the *pedicellariæ globiferae*, the following being the manner in which the work is performed.

When the tactile cushion of the pedicellaria comes into contact with a tangible object of foreign matter, the valves close and a discharge of mucus takes place, wherewith the obnoxious object is covered. When the hold of the jaws is again relaxed the irritating substance remains entangled in a cloud of the glairy exudation, ready to be easily disengaged from the surface of the animal by a few movements of the neigh-

bouring spines, and is finally carried off by the ordinary currents of the water in which the *Echinus* lives.

A similar process may be observed with the greatest ease to be carried out by *Astropecten*; and this I have been able to verify many times by placing a specimen of the common *A. aurantiacus* in a large flat vessel, convenient for observation, and, when covered with sea-water, sprinkling some fine sand and mud over its dorsal area. In the course of a short time most of this will have been carried away by the action of the paxillæ and by the lateral papillated grooves, whilst such particles as have resisted this operation will be found enveloped in a glairy pellicle, which is gradually and by very slight motion drawn into a narrow band extending over the median line of each ray. This is then disengaged from the surface entirely, and is finally cast off by the slightest movement the starfish may make.

Without some such process it would be difficult to see how so intricate a structure as the paxillary area could be kept free from the collection of dirt and foreign matter, as the interspaces under the extended spinelets of the paxillæ form what would naturally become a receptacle for such accumulation.

Without entering further into detail on the present occasion as to the source of the mucous discharge in *Astropecten* (as I hope shortly to communicate some observations upon that point), I may say that I feel little hesitation, after a careful study of the facts above recorded, in regarding this as a strictly homologous case with that of *Sphærechinus*, and valuable for our present purpose in exemplifying the manner in which the operation is effected in that Echinoderm.

Relations, Immature Stages, and probable Origin of the Saccular Organ of the Stem.—At present I am unable to offer any satisfactory reason why there should be the two distinct sources of mucous secretion in *Sphærechinus granularis*, viz. from the sacs of the valves of the head and from the sacs upon the stem. Very probably the secretion may be of different composition from the two sets of glands. Indeed this supposition would seem to be confirmed by the difference in their histological details, as well as by the frequent (chemical?) change which is found to take place in the sacculi of the stem and the deposition of crystalline matter therein during preparation, a state of things which I have never met with in the sacs of the head of the pedicellariæ.

At first sight it may appear anomalous that such a well-marked peculiarity as the presence of the stem-sacculi should apparently be possessed only, so far as my present knowledge

goes, by *Sphærechinus granularis*. But from a study of the development of the sacculiferous *pedicellariæ globifera* of this species and of the structure of the ordinary form of *ped. globifera* in other *Echini*, I am inclined to consider that this is perhaps not so abnormal after all, and that the occurrence may be explained by derivation and advanced development.

Hitherto the *ped. globifera* of *Echini* have been simply described as possessing a globose fleshy head attached immediately to the calcareous shaft of the stem, both head and stem being alike covered with a common investing membrane. No mention has been made of the detail of the special anatomy of these parts.

The *pedicellaria globifera* of *Echinus melo* may be taken as a typical form for our present purpose. The superficial differences which at once strike the attention are the comparatively smaller size, the presence of two external and visible sacculi on the outer portion of each valve of the head, the gradual widening or expansion of the investing membrane of the stem immediately under the head, and the absence of any trace of sacculi on the stem.

A longitudinal section of this pedicellaria shows the gland-bearing sac of the valve, its muscular investment, the tactile cushion, the powerful muscles of the valves, and the attachment upon the distal extremity of the stem-rod. Each of these parts is referable to a similar structure already enumerated when treating of the section of the pedicellaria of *Sphærechinus granularis*; and for the present purpose it will not be necessary to indicate the special modifications they present in this form. The expanded portion of the investing membrane of the pedicellaria immediately underneath the head in *E. melo* demands, however, especial attention.

Within this expansion there is seen to occur immediately below the gland-sac of the valve an irregular, more or less coarsely cellular cavity or space, which is filled with mucous matter (Pl. XIII. fig. 13, *x*), and from which there appears to be an opening leading on to the inner surface of the calcareous axis of the valve-frame, by which means the mucus is probably conducted on to the under (?) side of the fang (Pl. XIII. fig. 13). I am unable to state positively at present whether the mucus is secreted originally within this chamber or not; for although a few large cells with long connective fibres may be seen within the mucous mass of the cavity, I cannot say whether they are gland-cells or not; and the doubt is also further increased by indications of what may probably turn out to be an opening between the gland-sac of the valve and the cavity in question. However this may be, there

would seem to be little doubt that the lower chamber is the homologue of the stem-sacculus in *Sphærechinus granularis*; and that such is actually the case would appear to receive demonstration when the immature stages of the *pedicellaria globifera* of *S. granularis* are taken into consideration.

In examining a young example of *S. granularis* it will be found that, in addition to a goodly number of large and apparently fully grown sacculiferous *pedicellariæ globifera*, there is also a considerable proportion of the same *pedicellariæ* that are immature. It will be noted in these that the distance of the stem-sacculi from the valvate head is in relation to the size or stage of growth that the *pedicellaria* has attained; and also that, in the small examples, the size of the stem-sacculi is proportionally very much larger than in the fully grown organ, the dilatation on the stem not unfrequently exceeding the diameter of the head of the *pedicellaria*. Still earlier stages may be found in which the stem-sacculi are situated immediately beneath and touching the head (Pl. XIII. fig. 7), the dense white contents of the swollen sacculi being perceptible through the transparent investing membrane, and the outer surface being mottled with fine scarlet specks, whilst the contour of the stem-dilatation is globular and often exceeds in breadth that of the head (Pl. XII. fig. 7).

I have not yet been able to study these early phases of the *pedicellaria globifera* as thoroughly as is desirable; for in the simple spirit-preparations, which are unfortunately the only ones that I possess of these stages, the delicate and very sensitive nature of the mucus-gland has defied that method of preparation, and I am in consequence unable to say any thing at present as to the internal and minute anatomy of this early form of the *pedicellaria*. The drawing, of which fig. 7 is a reproduction, was made from a fresh specimen, immediately after removal from the test. That this stage represents the adult form of the *pedicellaria globifera* in *E. melo*, will be at once suggested by a reference to the figures here given.

A number of small bodies are also present upon the test which appear to be a still more primitive stage of our *pedicellaria*, in which the organ is represented by a minute clubbed stem; but I am at present unable to say definitely whether these bodies are really the normal primitive stage of the sacculiferous *pedicellariæ globifera*, or whether they are simply abnormal shafts upon which only the stem-sacculi have been developed.

Admitting that the phases of growth of the *pedicellariæ* correspond with the stages above enumerated, the conclusion is almost unavoidable that the *pedicellaria globifera* of *Sphæ-*

rechinus granularis, with its mucus-sacculi situated midway upon the stem, is a form derived and developed from the simple and more compact condition of the organ, such as is presented in the pedicellaria of the *E. melo* type, and of which the early immature phase of the *Sphærechinus granularis*-pedicellaria, which has the mucus-sac situated immediately below the valvate head, is the representative.

In sequence to these conclusions it is perhaps not straining the argument too far to adduce it as an indication of the ancestry of the latter species from some more primitive *Echinus* type.

On the Functions of the Pedicellariæ of Echinus in general.—The observations above recorded and the conclusions deduced therefrom may lead not inaptly to a few remarks on the companion forms of pedicellariæ. Mr. Alexander Agassiz was, I believe, the first who by actual observation assigned the true function of any of these organs. He stated that he had watched the pellets of exuviæ being passed along the test and removed from the body of the *Echinus* by means of pedicellariæ. Unfortunately Mr. Agassiz leaves the matter without saying which of the forms of this appendage was the agent employed. I also have seen the same operation performed; and it was always the *pedicellariæ tridentes* that came into use for the purpose; indeed the most superficial examination would suggest that these alone could be employed for such a service, neither the *p. globiferæ* nor the *p. triphyllæ* having valves capable of grasping so large a body as the ejected pellets in question. On the other hand the jaws of the *p. tridentes* are admirably fitted for the purpose; and that this is the chief use of that form of pedicellaria there seems but little doubt.

The use of the *pedicellariæ globiferæ* has been indicated in the preceding pages.

Lastly we have the *ped. triphyllæ*. Unfortunately my own observations have not yet enabled me to make out their special function with any degree of certainty; but their small size, as well as their general behaviour, lead me to the decided impression that their principal use is that of seizing the smaller particles of foreign matter, which of necessity have eluded the more rigid as well as more specially organized forms above mentioned, and of casting their captures either directly away from the test or, perhaps more probably, into the mucous pellicle formed by the discharge of the *pedicellariæ globiferæ* under the circumstances previously noted. That the *ped. triphyllæ* should be used, as some writers have maintained,

for the capture of passing organisms for the purpose of food, or even for their retention until decomposition has set in and the accompanying crowds of infusoria have been produced, seems to me highly improbable when we take into account the character and behaviour of the pedicellariæ themselves and the constantly moving currents of water which the environment of the sea-urchin naturally presupposes, irrespective of any consideration as to the kind of food required by the animal. Besides this, if it were the case that these pedicellariæ were put to such a use, the jaws or head-valves would frequently be found filled with decaying matter—a circumstance which, so far as my own observations go, very seldom, if ever, happens.

EXPLANATION OF THE PLATES.

PLATE XII.

- Fig. 1.* *Pedicellaria globifera* of *Sphærechinus granularis*. The valves of the head nearly closed. The glandular dilatation on the stem is somewhat distended; and one of the sacculi is seen disrupted by the action of very dilute spirit. $\times 13$.
- Fig. 2.* Head of another example of the same form of pedicellaria, placed slightly obliquely to show the under portion. The valves are closed; and their sacculi are more ample towards the extremities than in the previous figure. $\times 13$.
- Fig. 3.* The same form of pedicellaria with the valves of the head expanded. A portion of the investing membrane of the stem-dilatation has been cut away; and the internal glandular body of one of the sacculi is seen displaced. $\times 13$.
- Fig. 4.* Another example in which a portion of the investing membrane has been removed, in order to show the glandular body *in situ*. The head is represented in outline, and the position of the internal calcareous skeleton of the valve is indicated. $\times 13$.
- Fig. 5.* The same form of pedicellaria, expanded as in figs. 3 and 4, and seen from above, showing the position of the tactile cushions. $\times 13$.
- Fig. 6.* The stem of a *pedicellaria globifera* in which the stem-sacculi are wanting, the foramina only being present. $\times 13$.
- Fig. 7.* Immature stage of *pedicellaria globifera* from a young specimen of *Sphærechinus granularis*. $\times 24$.
- Fig. 8.* Transverse section through one of the sacculi of the stem of *pedicellaria globifera*: $\times 470$. *a*, epithelium; *b*, neuro-muscular layer; *c*, cellular layer; *d*, gland-cells and ducts; *e*, mucous mass.

PLATE XIII.

- Fig. 9.* Longitudinal section through the head of the *ped. globifera* of *S. granularis*, cut slightly oblique: $\times 57$. *a*, epithelium; *b*, thin layer of connective tissue with isolated nerve-cells; *c*, muscular wall of the sacculus; *d*, gland-cells; *e*, muscles of the valves; *f*, muscles in connexion with the tactile cushion; *g*, the tactile cushion.

- Fig. 10.* Transverse section through the head of the same form of pedicellaria, cut slightly oblique: $\times 57$. The letters have the same signification as in fig. 9.
- Fig. 11.* A portion of the glandular sacculus of the valve, more highly magnified: $\times 470$. Letters same as in fig. 9.
- Fig. 12.* Longitudinal section of the tactile cushion: $\times 235$. Letters same as in fig. 9.
- Fig. 13.* Longitudinal section of the *pedicellaria globifera* of *Echinus melo*: $\times 57$. *a*, the glandular sac of the valve; *x*, the secondary mucus-sac.

XIII.—*Gastrosaccus spiniferus*, *Göës*, newly described and figured. By the Rev. T. R. R. STEBBING, M.A.

[Plate III.]

Family **Mysidæ**.

Genus **GASTROSACCUS**, Norman.

The animal is transparent, with dendritic markings on certain parts, in particular on the last pereon- and the first and third pleon-segments, and a large patch on each side of the marsupial pouch. From the eyes to the extremity of the tail it is less than half an inch long.

Between the eyes is a short, longitudinally grooved, blunt rostrum, beneath which, and produced beyond it, is a pointed frontal process; from this to the cervical groove is about a third of the dorsal, a fourth of the lateral, length of the carapace. The large dorsal sinus of the carapace has its inner part margined with eight spines directed backwards, slightly converging, a little bent downwards at their tips; the central are the longest, the lateral very small; behind them there is a small slit in the margin, making a sort of spine-like lobe. The first four pleon-segments are nearly cylindrical, somewhat compressed at the sides; the last of the four ends dorsally in a small keeled adpressed prolongation. The fifth segment is dorsally carinate, the keel ending in a slightly upturned membranous process of small size, convex, pointed at the end; its length once and a half its breadth at the base. From the base of the pleon the body narrows rather rapidly backwards to the end of the fifth segment; from this point the sixth segment slightly widens towards the telson; it is cylindrical, nearly equal in length to each of the two segments preceding it; the second and third are the shortest.

The large epimeron of the first pleon-segment, which is so characteristic in the females of this genus, differs from the corresponding part as figured by Sars for *Gastrosaccus sanctus* and *G. Normani*, in that its hinder point of attachment is not at the hinder lateral angle of the segment, but very near to its front margin, whence its edge slopes back to an angular termination at the hinder lateral angle of the second segment. Its shape, instead of being oval, might rather be described as an irregular lozenge-form. The curved lower margin is folded under the marsupium; the front margin is microscopically serrate. It may be well to notice that the extreme transparency of the parts makes it very difficult to follow the overlapping outlines of this epimeron, the carapace, and the marsupium. Seen from below, the marsupial pouch ends anteriorly in an equilateral triangle. With the notable distinction already mentioned, the shape of the carapace and its surface-markings bear a close resemblance to those described by Prof. G. O. Sars for *G. sanctus*.

The eyes are black, with short, thick, cylindrical stalks, without dendritic markings, bulging a little on the inner side; they project slightly beyond the edges of the carapace.

The upper antennæ have the first joint of the peduncle long, stout, and cylindrical; on the outer anterior edge it ends in a minute process. The second joint is short, longer on the inner side, where it has two small hairs, than on the outer, along which are ranged three incurved spines, of which the foremost is the largest. The third joint is half the length of the first, and not quite twice that of the second, with its anterior edge sharply truncate between the two filaments, within the base of the outer one directing forwards a little conical process. The filaments (as, indeed, the whole of these antennæ) bear the closest likeness to those of *G. sanctus*; in that species, however, the spines of the second joint of the peduncle are figured as straight, not incurved.

The scale of the lower antennæ reaches nearly to the end of the peduncle; it has its outer edge straight and smooth, the spine-like termination nearly level at its point with the front of the rounded anterior margin, which, as well as the inner margin, is closely set with long plumose setæ. The peduncle reaches nearly to the end of the second joint of the upper antennæ. The shape and ornamentation and the filament agree with the descriptions of *G. sanctus*. The upper lip is helmet-shaped, ending in a long thin spike; it is dendritically marked.

The palps of the mandibles have the first joint short; the

second is long, rather stout and sinuous, set on the outer edge with straight cilia. The third joint is three quarters the length of the second, much thinner, straight, set with numerous feathered cilia on the outer edge, and with three or four on the inner; at the apex a curved cilium projects forward; from this the margin is obliquely truncate on the outer side, and set round with small backward-curved spines close together, from the midst of which group runs out another spine twice the length of its companions, with its principal curve directed forwards, and having at the back of this curve a little brush of hairs.

The number of joints in the so-called tarsus of the pereopods varies from eight to twelve; they are ornamented with long plumose setæ; there is also a small thorn at the extremity of each joint. In some at least, perhaps in all, of these limbs there is a thorn on each side of the extremity of each joint. There appears to be also a minute rudiment of a finger, or a rudimentary joint additional to the numbers mentioned. The swimming-palps are furnished with very long, highly plumose setæ; the flat broad basal joint on the anterior side runs out into a rounded lobe.

The pleopods in the female, which alone is here described, resemble those in the cognate species; the first pair have the shape which Mr. Norman has compared to that of a thigh-bone. Some three or four plumose setæ stand out near the somewhat dilated end of the peduncle. The rami are both small, the inner with three or four setæ, the outer (which is shorter and more pointed) with one or two.

The telson is about as long as the sixth segment, its breadth at the base more than a third of its length; it becomes narrower towards the distal end, which has a narrow deep incision, the curving sides and curved apex of which are set round with fine spines close together, decreasing as they run up the incision. There are eight thorns on each side of the telson, all more or less curved, the pair at the base standing out at a considerable angle, the last and penultimate pairs, both of which are large and long, being directed backwards in a line with the margin.

The inner laminæ of the uropods are broadly lanceolate, reaching nearly as far as the tips of the terminal spines of the telson; they are densely fringed with long plumose setæ on both margins; there are also ten spines on the underside—a long and a short one on the swollen part at the base containing the round otolith, the other eight on the inner edge, the third from the base shorter and a little further from the edge than the rest.

The outer laminae are rather shorter than the inner, with twelve long incurved spines on the outer side; the truncated end and the inner sides are adorned with very long plumose setae. The telson and uropods are semitransparent, displaying all over a fine honeycomb pattern.

This little species I found last August (1879) at Banff, while turning up thin slices of sand at low tide in search of sessile-eyed crustaceans. I had proposed to name it in honour of Professor G. O. Sars, whose finely and fully illustrated monograph on the Mysidæ has set forth the group with a clearness, both of writing and figuring, quite in keeping with the delicate transparency of the animals described; but the Rev. A. M. Norman, from figures which I sent him of the spined dorsal sinus, identified it with the *Gastrosaccus sanctus* of his Shetland Dredging Report, 1868. That species is described as equivalent to *Mysis spinifera* of Goës, and as having the dorsal sinus "elegantly scalloped." This expression did not, in the first instance, represent to my mind the spine-like ornamentation of the carapace already described. I was fortunate, therefore, in being able to obtain Mr. Norman's own interpretation of it. It is curious that Goës makes no remark upon this striking characteristic. In other respects my specimens tally so closely with his description and Mr. Norman's, that I should not feel justified in putting forward a new name for the species. The only point that might raise a doubt is, that both the authors named are inclined to identify the species they have in view with the *Mysis sancta* of Van Beneden, whereas that author figures the fifth abdominal segment of his species without the very spine which gives its name to *Gastrosaccus spiniferus*. Van Beneden leaves the description of his species almost a blank; and the figures which he gives might, quite within the bounds of possibility, roughly represent the corresponding parts of three or four different species*. All that can be said is that they do not disagree with the *Gastrosaccus sanctus* fully and minutely described and figured by Sars, while they present one essential point of distinction from the description by Goës of *Mysis spinifera*.

* On my submitting the question of nomenclature to Monsieur van Beneden himself, he replied, with courteous promptitude, that for a decision it would be necessary to compare the actual specimens described both with one another and with a series of others of various ages and both sexes. In the absence of means for doing this, he inclines to Mr. Norman's view, which, as I have stated above, was to unite *G. sanctus* and *G. spiniferus*.

EXPLANATION OF PLATE III.

Gastrosaccus spiniferus.

D, dorsal view.	C, cephalon, showing rostrum and frontal process, with the eyes.
L, lateral view.	<i>ppp.</i> 5, penultimate pereopod.
T, telson.	<i>plp.</i> 1, first pleopod.
<i>a. s.</i> , upper antenna.	<i>plp.</i> 2, second pleopod.
<i>a. i.</i> , lower antenna.	<i>car.</i> , lateral view of dorsal spines of carapace.
<i>sc.</i> , scale of lower antenna.	<i>l.s.</i> , life size.
L, labrum, with palps of mandibles.	

XIV.—*Note on the Perognathus bicolor of Gray.*

By EDWARD R. ALSTON, Sec. L.S.

TWELVE years ago the late Dr. J. E. Gray described a *Perognathus bicolor* from Honduras*. He stated that it was black above, with uniform bristly fur, and gave the habitat as "Honduras (*Sallé*)," adding "There is a spiny rat from Honduras with a longer tail and smooth front teeth, agreeing in colour with the above."

In 1876, when writing to my friend Dr. Elliott Coues on the United-States specimens of Geomyidæ in the British Museum, I made the following casual observation on this species, which I did not suppose would have come within the limits of the 'Monograph of the North-American Rodentia,' but which he included with the quotation from my letter:—"P. *bicolor*, Gray (from Honduras), appears to be a good species, but has been curiously badly described. It is dark brown above, not black; and though the fur is sparse and somewhat harsh, it is not in the least bristly! Gray seems to have had both this specimen and his *Heteromys melanoleucus* in his hands when he wrote, and to have confused one with the other" †.

Having since had occasion to revise the species of this family, I find that I had greatly underrated the depth of error into which Gray had sunk on this occasion. Mr. Oldfield Thomas has drawn my attention to the fact that the fragmentary skull of the type specimen is preserved, under its old misnomer of *Perognathus monticola*; and this proves that the animal is a *Heteromys*, perfectly identical with Gray's "spiny rat with smooth front teeth." Moreover, by a reference to the original registers, Mr. Thomas finds that these specimens were not sent by *Sallé* from Honduras, but by

* P. Z. S. 1868, p. 202.

† Mon. N.-Am. Rodent. p. 515.

Dyson from Venezuela. As the species will therefore not come within my limits in the 'Biologia Centrali-Americana,' and as I have been led, to some extent, to indorse one of the gravest of Gray's errors, I have thought it best to make these corrections here, concluding with a more accurate description of the animal. It appears to differ from its known congeners, not only in colour, but in the total absence from its fur of the flattened channelled spines which are characteristic of all the species of the genus except *H. anthophilus* (F. Cuv.)*, a doubtful form, described from a single immature example, which Prof. Peters believes to owe the softness of its pelage to its youth †.

Heteromys bicolor.

Perognathus bicolor, Gray, P. Z. S. 1868, p. 202 (descr. orig.).

Ears with the notch apparently bounded by two lobes; tail clad with short fine stiffish hairs; fur rather long, sparse, with no under-fur, somewhat harsh, but not in the least bristly. Colour above uniform dark brown, which extends to the outside of the limbs; feet dusky, edges of cheek-pouches and all the lower parts white, the hairs all uniform in colour throughout their length. Approximate measurements (of the mounted specimen)—length of head and body about 3·75 inches, of tail 3 inches, of hind foot 1 inch.

Hab. Venezuela (*Dyson, Mus. Brit.*).

XV.—Descriptions of new Species of Asiatic Lepidoptera Heterocera. By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

[Continued from p. 69.]

Tribe GEOMETRITES.

Euschemidæ.

16. *Euschema regalis*, sp. n.

Primaries deep purple; three parallel longitudinally oblique whitish dashes at the base, the third emitted from near the base of inner margin; three transversely oblique series of pale greenish-blue spots, the first consisting of three, the second of seven, the third of four spots, some of which, however, are only

* = "Sacomys anthophile," Dents des Mamm. p. 187, Mém. du Mus. x. p. 419, pl. xxvi.

† Monatsb. Ak. Berl. 1874, p. 356.

separated by the nervures, the fifth and sixth of the middle series partially confluent: secondaries with the basal third sericeous snow-white, the anal fourth and three spots on the outer margin bright golden yellow; the apical area pale blue; a large patch at the end of the cell, the veins on the disk, an irregularly undulated discal belt, and a series of oval spots, large and marginal towards apex, smaller and submarginal towards anal angle, all deep purple: body chalky white, the back of collar and centre of thorax crossed by dark purple bands; pectus and posterior portion of venter bright yellow; antennæ cupreous, with black pectinations. Expanse of wings 2 inches 10 lines.

Malacca. Type B. M.

17. *Euschema proba*, sp. n.

Pale sericeous bluish grey, with purple bands and spots as in *E. pugnataria** of Java, but the bands more slender; antennæ pale red-brown, with blackish pectinations; front of head flesh-tinted with purplish central spots; back of head, collar, and thorax slightly greenish, and therefore more sordid in tint than the wings; abdomen bright cadmium-yellow, greyish spotted with purple in the centre towards the base; centre of pectus and venter bright cadmium-yellow, legs and sides of pectus greyish, the legs touched here and there with purple. Wings below slightly greenish; the internal area of primaries washed with purple; a subapical costal whitish-brown streak. Expanse of wings 2 inches 9 lines.

♂, Borneo; ♀, Darjiling. Type B. M.

This is not the first instance which I have noticed of specific identity between examples from Borneo and Darjiling; in such cases it is probable that the range extends all through N.E. India, Moulmein, and the Malay Peninsula.

Urapteridæ.

18. *Urapteryx clara*, sp. n.

Allied to *U. podaliriata*; wings white, sericeous, with the fringe red internally and grey externally: primaries triangular, the costal border crossed by fine black striations; the central third of the wing enclosed between two slightly divergent golden-brownish stripes, a slender line of the same colour half-way between them at the end of the cell; a few fine scattered testaceous striæ upon the subapical area: secondaries with the submedian vein and a stripe nearly parallel to it, running

* *E. Horsfieldii*, Moore, Cat. Lep. E. I. C. ii. pl. viii. A. fig. 7.

straight from the subcostal furca to the first median branch, and thence curving inwards to the abdominal margin, golden-brownish; a few scattered striations of the same colour upon the disk, and a streak of it above the tail, limited externally by a grey-and-black line and a dot of the same colours; tail distinctly shorter and wider than in *U. podaliriata*, and with red fringe. Wings below white, more or less cream-coloured; markings obsolete. Expanse of wings 2 inches 3 lines.

N.E. Himalayas (*Lidderdale*).

19. *Decetia arenosa*, sp. n.

Primaries above sandy yellow, densely irrorated with minute grey striations, which, however, are less numerous upon the centre of the disk, where there seems to be a yellowish belt tapering towards the costa and enclosing two or three rounded grey spots; two pale-edged gravel-reddish parallel oblique lines, the first subbasal, the second central and extending at its upper extremity almost to the apex: secondaries greyish brown, with darker striations and four conical dark grey discal spots in a straight line; costal area dull white; a dull gravel-red line across the basal third: thorax sandy greyish; abdomen of the same colour in the centre, but with orange sides and anus. Wings below grey, with bright ochreous borders; body orange. Expanse of wings 1 inch 11 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

Nearest to *D. rufifrontata*.

20. *Decetia rufescens*, sp. n.

Dark flesh-coloured, washed, excepting on costal border of secondaries, with smoky grey: primaries crossed from middle of inner margin to apex by a dark chocolate-brown stripe, terminating at apex in a small quadrate black spot; fringe red: secondaries crossed at basal third by a deep-red stripe; two alternating abbreviated discal series of black dots; fringe red: head red; body slightly yellowish in the dorsal region. Wings below salmon-coloured, the primaries crossed from apex almost to inner margin by an oblique slate-coloured stripe; apical spot interrupted upon the costa by a yellow spot; fringe yellow tipped with blackish; pectus salmon-coloured, venter yellow. Expanse of wings 1 inch 9 lines.

Sarawak. Type B. M.

21. *Oxydia calamina*, sp. n.

Stramineous, wings more or less tinted with olivaceous: primaries covered with minute grey striations, with three

oblique equidistant costal olivaceous dashes, followed by a fourth rather nearer to the third; the first of these dashes forms the commencement of an irregular dusky subbasal line; an oblique angulated ill-defined blackish line from inner margin, where it commences in a blackish smudge, to apex, where it terminates in a greyish-white furcate character resembling the letter *y*; disk beyond the oblique line clouded with olivaceous and marked with a large rounded greyish-white spot and an oblique dash of the same colour; external area whitish in the centre; an ill-defined blackish apical marginal line; fringe ferruginous: secondaries speckled with dark grey, crossed near the base by a very ill-defined zigzag greyish line; disk crossed by a pale-bordered greyish line: head and antennæ black; abdomen very pale. Wings below golden sandy yellow, speckled with black, crossed by two black lines corresponding to those of the upper surface, but sharply defined and bordered here and there with ferruginous: primaries with the apex grey above the black line; costal dashes ferruginous, more or less black-speckled; black discocellular dots to all the wings: legs and venter black-speckled; knees and tarsi blackish. Expanse of wings 2 inches 4 lines.

Darjiling (*Lidderdale*).

Allied to *O. platyptera*, "*Chærodes*" *translinquens*, and "*Chærodes*" *transponens*.

Ennomidæ.

PHENIX, gen. nov.

Pyrrhia affine genus, forma alarum simili; ramis autem omnibus medianis bene separatis (secundo et tertio haud approximatis).
Gen. typ. *P. iris*.

22. *Phœnix iris*, sp. n.

Purple, sericeous; wings transversely striated with dull lake-red, and crossed from apex of primaries to abdominal margin of secondaries by a regular oblique pale green band enclosing a sap-green stripe; fringe dull lake-red: secondaries with the costal area pale brick-red; abdomen with the sides reddish and crossed by a pale yellowish band; head red-brown; antennæ with black pectinations. Under surface bright brick-red, wings striated with grey; fringe brown: primaries with white internal area; an abbreviated and ill-defined oblique greyish streak from the apex. Expanse of wings 1 inch 7 lines.

Darjiling (*Lidderdale*). Type B. M.

23. *Epione gynopteridia*, sp. n.

Sandy yellow : primaries sparsely striated with ferruginous and crossed by a slightly darker central belt bounded by angulated ferruginous lines, which diverge towards the costa ; apex (not including the fringe) ferruginous : secondaries with the basal area sparsely mottled with grey ; a central triangular band of testaceous, partly edged with grey and partly with ferruginous ; apical border and one or two streaks at the anal angle testaceous ; a small black dot on the centre of the second median interspace ; head and sides of abdomen golden yellow, collar testaceous ; antennæ brown. Under surface golden yellow ; wings mottled with ferruginous and crossed near the middle by a dark ferruginous line bounding internally a diffused and irregular copper-red belt ; fringe testaceous : primaries crossed near the base by an angulated dark red-brown line : palpi and anterior coxæ ochraceous ; legs with the tibiæ and tarsi testaceous. Expanse of wings 1 inch 4 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

Has the general aspect of the genus *Gynopteryx*.

24. *Rumia sulphurea*, sp. n.

Primaries above bright sericeous sulphur-yellow, mottled with grey ; the base of costa, two subbasal bands diverging from one point at the inner margin and, with the costal border, forming an irregular annulus, the centre of inner border and a discal series of irregular ill-defined spots decreasing in size from inner border to costa, an irregular reniform spot, and a few small ill-defined spots on the costa ferruginous : secondaries paler yellow, with a small dark brown discocellular spot ; a series of small grey dots beyond the middle of the disk, indistinctly united by a slender undulated line of the same colour ; external area, particularly towards the anal angle, mottled with ferruginous : thorax bright sulphur-yellow ; shoulders and palpi ferruginous ; abdomen paler. Under surface bright sulphur-yellow, markings paler than above. Expanse of wings 1 inch 9 lines.

Darjiling (*Lidderdale*). Type B. M.

25. *Endropia lugens*, sp. n.

Olivaceous, wings transversely striated with whity brown : primaries with two widely separated angulated olive-brown lines, edged with lilacine white, and diverging towards the costa ; between these lines an interrupted olive-brown diffused stripe ; an interrupted discal zigzag lilacine-white line, the sinuations of

which are filled in here and there internally with blackish; one or two lilacine spots on the outer margin; fringe tipped with lilacine: secondaries with no inner olive-brown line: head white; palpi and sides of abdomen orange; antennæ greyish brown. Under surface deep gamboge-yellow, the wings sparsely striated with reddish ferruginous, and crossed by a broad discal belt of the same colour, limited internally by a sharply defined plumbaginous and dark ferruginous straight line, externally sinuated and partially bounded by diffused plumbaginous patches; fringe as above; a black dot at the end of each cell; primaries with an indication of an angular red line at basal third. Expanse of wings 1 inch 7 lines.

Darjiling (*Lidderdale*). Type B. M.

26. *Garæus cruentatus*, sp. n.

Closely allied to *G. mactans**, but the primaries acuminate and with distinctly sinuated outer margin, as in *G. specularis*†; in colour it is considerably darker, blood-red mottled with blackish; crossed by a blackish discal stripe enclosing a grey line, and with a grey zigzag submarginal line; primaries with an irregularly zigzag subbasal blackish line, followed upon the costa by two widely separated oblique blackish dashes: secondaries with three or four widely separated yellow dots; a hyaline white dot near the base of the first median interspace: thorax greyish brown, rosy at the back; collar grey, abdomen sordid rose-red. Under surface fuliginous brown, striated with darker brown, and sprinkled with grey scales (particularly the secondaries); a grey-edged dark brown discal line, and a zigzag grey submarginal line: secondaries with two or three scattered fulvous dots. Expanse of wings 1 inch 6 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

27. *Ellopiæ pulchra*, sp. n.

Allied to *E. formosa*‡, but half as large again and somewhat different in pattern: wings sericeous grey: primaries with the costal border, including two cuneiform patches of nearly equal size, the subapical fringe and two spots near the base of the second median interspace gamboge-yellow; subcostal area, base, and a broad oblique belt (only separated by

* *Endropia mactans*, Butl. Ill. Typ. Lep. Het. iii. pl. xlviii. fig. 3. The genus *Garæus* is very closely allied to *Endropia*.

† Moore, P. Z. S. 1867, p. 623, pl. xxxii. fig. 3.

‡ Ill. Typ. Lep. Het. ii. pl. xxxv. fig. 8.

an oblique dusky line from the basal area) laky purplish densely mottled with orange; a discal series of three or four purplish-edged orange spots between the second median branch and the inner margin: secondaries with sericeous white costal area; abdominal area mottled before the middle with laky cupreous; a tapering, externally diffused, reddish-orange streak from the abdominal margin to the end of the cell, confluent, at its commencement, with a broad external border of the same colour, but which gradually breaks up into little reddish striæ as it recedes from the anal angle towards the costa: body laky red; vertex of head and antennæ sulphur-yellow. Under surface sericeous creamy whitish; the markings of the upper surface seen indistinctly through the wings: primaries with sulphur-yellow costa and ochraceous subapical area; subapical fringe golden-yellow; rest of fringe and externo-discal area cupreous: secondaries with the external border pale cupreous or dull golden. Expanse of wings 2 inches 2 lines.

N.E. Himalayas (*Lidderdale*).

28. *Orsonoba pallida*, sp. n.

Allied to *O. clelia**, but much smaller, the outer margin of the primaries much less sinuated, not at all so below the third median branch; altogether paler, the prevailing colour being creamy white; costal half of primaries grey, the markings very nearly as in *O. clelia*; all the bands testaceous, the oblique dashes across the costal border of the primaries blackish brown; secondaries with the hyaline spot at the end of the cell elongated, transverse, margined with testaceous instead of black. Expanse of wings 1 inch 11 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

29. *Auxima restitutaria*, var. *ægrola*.

Much smaller than the typical form, olivaceous brown instead of red, and with a much more feeble rosy reflection; the markings, however, all similar. Expanse of wings 2 inches 6-10 lines.

Darjiling (*Lidderdale*). Type B. M.

This form was well represented in Dr. Lidderdale's series, and was separated by him from the typical *A. restitutaria*: it may, perhaps; be a race of that species; but I am rather inclined to regard it as merely a common variety.

* Cramer, Pap. Exot. iii. pl. cclxxxviii. figs. B, C.

Boarmiidæ.

30. *Hemerophila virescens*, sp. n.

Nearest to *H. creataria*, but the primaries with subangulated outer margin; upper surface pale laky brown, clouded, striped, and spotted with sap-green; wings densely striated with black; fringe ferruginous; black discocellular lunules: primaries crossed at basal third by an irregularly angulated green stripe, and at apical third by a green-edged zigzag black line; a discal series of subconfluent green crescents, the six uppermost ones intersecting an abbreviated series of large black spots; a black marginal line interrupted at the veins: secondaries crossed before the middle by an ill-defined black stripe, and beyond the middle by an irregular series of pale reddish spots partly defined with black internally; a discal series of elongated black-edged green spots; a marginal series of black lunules: body laky brown; back of palpi, head, and collar black; abdomen mottled with blackish. Under surface sericeous laky brown: wings indistinctly striated with darker brown, a spot at the end of each cell; primaries with a belt beyond the middle and a patch at apex formed of cream-coloured striations; secondaries with a creamy apical patch, crossed by a sinuated brown submarginal line. Expanse of wings 3 inches 3-6 lines.

Darjiling (*Lidderdale*). Type B. M.

31. *Boarmia plumalis*, sp. n.

Whity brown, mottled with smoky brown; two widely sinuated central black-brown lines, the outer one dentate-sinuate and followed by a similar but less defined line or stripe; an undulated white submarginal stripe, bounded internally towards costa of primaries and anal angle of secondaries by large blackish spots; a marginal series of black lunules: primaries with a subbasal arched blackish line; two ill-defined parallel blackish stripes at basal fourth: antennæ widely plumose, the pectinations being extremely long and curved outwards; back of collar and posterior half of abdomen black, anus testaceous. Under surface whity brown; wings with blackish discocellular lunules, a dusky postmedian undulated line, and traces of a dusky submarginal line; front of pectus brownish. Expanse of wings 2 inches 9 lines.

Darjiling (*Lidderdale*). Type B. M.

In pattern most like *B. lunifera*.

32. *Hypochroma crocina*, sp. n.

Primaries above sap-green, more or less clouded with blackish, speckled with black; the two ordinary black lines

very slender, bordered internally with pale brown, externally with a slender whitish line, and forming a series of well-defined black spots upon the veins; a bifid, white, subapical spot and a marginal series of black spots: secondaries crocus-yellow; a large, rounded, black spot at the end of the cell; a clavate subapical black streak; external border, excepting at apex and anal area, sap-green, speckled with black, and traversed by a very indistinct, partially blackish-edged, whitish dentate-sinuate line; a marginal series of elongated black spots: body above sap-green, yellowish in front; abdomen with yellow sides. Under surface of wings sericeous crocus-yellow; a large jet-black patch at the end of each cell, followed in the primaries by an abbreviated white belt; these wings also with a black spot below the origin of the first median branch, external area broadly black but not so intense as on the two spots, a white patch at apex and another at the external angle, fringe spotted with white and grey: secondaries with a spot on the first median interspace; the subapical black streak as above; a marginal series of small black spots; fringe greenish, spotted with blackish: pectus cream-coloured, yellow at the sides; tibiae and tarsi banded with black; venter crocus-yellow. Expanse of wings 2 inches 4 lines.

Darjiling (*Lidderdale*). Type B. M.

Allied to *H. leopardinata* of Moore.

33. *Hypochroma vigens*, sp. n.

Sap-green* ; wings transversely striated with slender darker lines, fringe tipped with rose-colour: primaries crossed by the two ordinary black lines, which are very slender and bordered with reddish on one side and whitish on the other; discocellulars slenderly black; disk beyond the outer undulated black line reddish, crossed by a series of diffused olivaceous spots followed by white dots; a white apical patch stained here and there with green; a slender undulated black marginal line: secondaries with the outer undulated black line as in the primaries, with reddish internal and white external margins; discocellulars blackish; a black undulated marginal line; an interrupted undulated white submarginal line: centre of thorax and dorsal abdominal tufts tinted with pink, each tuft placed in the centre of a slender, blackish, n-shaped marking. Under surface sericeous creamy white; wings crossed by a broad, irregular, yellowish-edged, dark brown discal belt: primaries with a diffused streak connecting the belt with the outer margin upon the radial inter-

* The type is somewhat faded; but the green colour can still be seen with the help of a lens.

spaces; an oblique black discocellular litura. Expanse of wings 2 inches 1 line.

Darjiling (*Lidderdale*). Type B. M.

34. *Gnophos æreus*, sp. n.

Bronzy green, sprinkled here and there with bluish white and mottled with black: wings with brown fringes, slightly speckled at the base with bluish white, and traversed by a dark brown line; a marginal undulated blackish line; a submarginal series of blackish lunules, speckled internally with bluish-white scales; the two usual irregularly sinuated blackish lines indicating the central belt, the inner one obsolete on the secondaries; a blackish spot on the discocellulars; primaries with a blackish subbasal line: abdomen brownish. Wings below brownish grey, sericeous, with darker discocellular dots, undulated discal line, and diffused discal belt; apex of each of the wings whitish; a marginal series of conical blackish spots, base of fringe whitish: body below pale smoky brown. Expanse of wings 2 inches 3 lines.

Darjiling (*Lidderdale*). Type B. M.

Allied to *G. muscosaria*.

35. *Argidava punctata*, sp. n.

Sordid white; primaries crossed by six oblique series of black dots, the second series consisting of four, of which the second is larger and forms the discoidal stigma or discocellular spot, the last series marginal. Under surface creamy white, sericeous; all the wings with a grey discocellular spot, a dentate-sinuate discal line, a submarginal series of indistinct spots; primaries with a marginal series of blackish dots, with golden-yellow costal margin and apex; legs and venter pale testaceous. Expanse of wings 1 inch 5 lines.

Darjiling (*Lidderdale*). Type B. M.

Allied to *A. maculata*.

Geometridæ.

36. *Tanaorhinus smaragdus*, sp. n.

Bright green, above sea-green, wings with snow-white fringe; a discal slightly irregular series of snow-white spots; an olive-green stripe, bordered externally with white, slightly undulated in the primaries just beyond the middle: primaries with a second angular line, edged internally with white at basal fourth; an olive-green discocellular dot: body in the type ochreous, with the exception of the collar, a series of lateral spots on the abdomen and the anal tuft*; two or three

* But probably, when quite fresh, the body is wholly green above, like the wings.

dorsal dots and the sides of the abdomen snow-white; antennæ with ferruginous pectinations. Wings below pale emerald-green, with an indistinct discal series of sap-green spots; primaries also with a straight postmedian stripe of the same colour; veins white; fringe sap-green tipped with white: body white, yellowish in front. Expanse of wings 2 inches 5 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

37. *Geometra grata*, sp. n.

Emerald-green; wings sparsely striated with golden orange: primaries with the costal margin pinky whitish, crossed by dark brown striæ and dots; two widely separated, inarched, subparallel golden-orange lines, the inner one distinctly irregular, the outer one very slightly so; fringe tipped with white: secondaries with the costal border, abdominal margin, and the outer half of the fringe upon the outer margin snow-white; a transverse, diffused, golden-orange stripe just before the middle: palpi, antennæ, and front of collar pinky white; abdomen creamy white, greenish at base. Under surface sericeous white, the wings showing a tint of green owing to the transparency of their texture; costal border creamy; the numerous striæ of the upper surface indistinctly visible; a curved greyish line just beyond the middle; minute blackish discocellular dots: pectus green in front. Expanse of wings 1 inch 10 lines.

Darjiling (*Lidderdale*). Type B. M.

Nearest to *G. dentisignata* of Moore.

[To be continued.]

XVI.—*Report on Specimens dredged up from the Gulf of Manaar and presented to the Liverpool Free Museum by Capt. W. H. Cawne Warren.* By H. J. CARTER, F.R.S. &c.

[Continued from p. 61.]

[Plates VII., VIII.]

Geodina.

To facilitate an understanding of the complicated spiculation of a typical *Geodia*, and thereby to save repetition in description hereafter, the following definitions are premised, viz. :—

1. The "zone-spicule." This is generally the largest of all and trifid at its external extremity, where the arms, either

simple or subdivided, are for the most part spread out among and support a layer of siliceous balls or globules on the surface, called the "cortex" or petrous crust; while the shaft is directed perpendicularly inwards; and thus, in juxtaposition, it forms in combination around the *Geodia* a more or less distinct zone, whence its name.

2. "Body-spicule." This, which is acerate, fusiform, smooth, and curved, is generally the next in size to the zone-spicule, but by far the most numerous, as it is not only the staple spicule of the body, but, when associated with the zone-spicules, lies parallel with them, projects into the cortex, and thus adds to the strength of the zone generally, as well as the cortex.

3. "Forks" and "anchors." These are essentially anchoring-spicules, and, from the embryo upwards, are, as a matter of course, projected beyond the surface. They are trifid; but whereas in the "fork" the arms or prongs are produced, they are recurved in the "anchor," while the shaft in both, which is very long, depends for its length upon the distance the heads are beyond the *Geodia*. From their great delicacy and brittleness, they are for the most part broken off, especially the anchor-heads; their presence among the zone-spicules preparatory to their exertion is thus frequently the only evidence, of their existence; and here they appear to be for any purpose but that of "anchoring" or fixing the *Geodia*. Hence their office is often overlooked.

4. "Siliceous globule." This is developed in the interior, where it may be seen in all stages of growth till fully formed, when it appears to be transferred to the surface, where, in combination, it forms the cortex or petrous crust, in which there are no *young* forms. In its earliest stage of development, or when it is but just visible, it appears to be stelliform; the rays then become multiplied, extended, and hair-like; after which, as they grow outwards, they become united into a crystalline mass, which finally assumes a more or less compressed, spheroidal, or elliptical form; meanwhile a hilous depression becomes apparent on one side; and finally the rest of the surface is covered by little stelliform bodies in juxtaposition, which are respectively supported by the rays, now undistinguishably consolidated into a crystalline mass.

5. "Stellates." There are always two forms of stellates, both of which are very minute—but one much smaller than the other; and this is chiefly confined to the surface, where it densely charges and thus strengthens the pore-bearing dermal sarcode. The other or larger form is chiefly confined to the sarcode of the interior (for they are both flesh-spicules), where

it presents itself much less plentifully; but, from its much larger size, the less number of its rays and their greater length, together with their irregular disposition around the centre, it is for the most part easily distinguished from the smaller ones, although they may also be, in greater or less number, present in the neighbourhood; still it seems to me to be but an enlargement of the latter.

6. "Dermal acerate" or "acuate." In addition to the dermal stellate there is frequently a minute linear spicule on the surface, which may be acerate or acuate in form according to the species, and whose use, as it projects beyond the dermal sarcode, may be, as in other instances, through elevation and depression, to exert some influence over the functions of the pore.

Geodia perarmata, Bk. (Pl. VI. figs. 32, *a-d*,
33, *a-f*, 34, *a-c*, and 35, *a-d*.)

General form spheroidal. Colour grey. Surface uniformly wrinkled (now dry) and cribriform (Pl. VI. fig. 32). Pores minute and numerous in the dermal sarcode, giving to the surface its cribriform structure (fig. 34). Vents small, scattered singly or grouped here and there. Spicules of seven forms, viz.:—1, the zone-spicule, whose head consists of three arms, each of which is furcated, and all expanded at right angles to the shaft after the division of the arms, which at first are slightly inclined forwards, shaft 280 by 6-1800ths, head 50-1800ths in diameter (figs. 33, *a*, and 34, *a*); 2, body-spicule, smooth, fusiform, acerate, curved, 200 by 4-1800ths (fig. 33, *b*); 3 and 4, fork and anchor, arms or prongs respectively about 5-1800ths long (fig. 33, *c*); 5, siliceous globule, 7-1800ths in diameter (fig. 33, *d*); 6 and 7, external and internal stellates respectively, the former 2-6000ths and the latter 6-6000ths in diameter, the rays in both radiating from a small body or central nucleus (fig. 33, *e, f*). Zone-spicules projecting beyond the petrous crust (fig. 35, *c, d*), and so supporting the dermal sarcode charged with its stellates (fig. 35, *a*) as to leave an interval of 1-30th inch between it and the former, thus traversed by the shafts of the zone-spicules (fig. 35, *b, d*, and 32, *a-c*). Petrous crust 1-60th thick (fig. 32, *c*). The other spicules arranged as before mentioned. Size of largest specimen 1 inch in diameter.

Hab. Marine. Free or attached to hard objects.

Loc. Gulf of Manaar.

Obs. The distance between the dermal layer and the petrous crust in this species is both remarkable and instructive. It is remarkable because it is so unusual—and instructive be-

cause it points out the relation and function of this layer, which, in most specimens, is so absorbed into the petrous crust as to be undistinguishable from it; while the futility of attempting to circumscribe the uses of any thing in the Spongida is also shown by the head of the zone-spicule, generally considered to be for supporting the petrous crust, here passing beyond it so as to support alone the dermal sarcode. Of course, all that passes in through the pores must go into this subdermal interval or chamber previous to passing into the body of the sponge; moreover there are the same hourglass-shaped holes in the petrous crust as those which I so minutely described and illustrated several years ago in *Pachymatisma Johnstonia*, Bk. ('Annals,' 1869, vol. iv. p. 12, pl. ii. figs. 11, 12). It is not my object here to trace the progress of this material in through the petrous crust; but I cannot help thinking that the larger holes or vents in the dermal layer are, in all probability, the openings of the terminal canals of the excretory system, which *pass through the chamber entire*, so that their contents may not be mixed with the incoming ones through the pores.

This kind of dermal layer I described and figured many years ago in *Spongilla* under the name of "investing membrane" ('Annals,' 1857, vol. xx. p. 24, pl. i. fig. 1, *bbb*), showing that it is the seat of the dermal pores, while it is supported on the ends of spicules which, projecting from the parenchyma of the sponge, form a hollow space between it and the latter, into which the water and its contents are received before passing further into the interior. Moreover it is shown that the terminal canal of the excretory system *is* continued *through* this space or chamber *entire*, so that its contents may not mix with those of the chamber (*ib. ib.* fig. 1, *g*), which I have assumed to be the case in *Geodia perarmata*. And lately, again, I have represented it in a marine sponge, viz. *Halichondria simulans* ('Annals,' 1874, vol. xiv. pl. xxii. fig. 34, *ee*); while Dr. J. Millar has called attention to its existence over the Hexactinellida, where it is supported in a similar way, strengthened by a square lattice-work of hexagonal flesh-spicules, just as in *Geodia perarmata* it is supported on the heads of the zone-spicules and strengthened by the addition of stellate flesh-spicules.

Although these parts are not all illustrated in Dr. Bowerbank's description and illustrations of his *Geodia perarmata* (Proc. Zool. Soc. Jan. 7, 1873, p. 8, pl. ii. figs. 1 &c.), still the spiculation there given is so like that of the Manaar specimens that, taking into consideration his statement (p. 9), that the heads of the zone-spicules are "projected

through the stratum of siliceous ovaria (globules)," I think that, although the locality, being not known, may be different, there can be no doubt that the Manaar specimens are identical with it in species; and therefore I have used Dr. Bowerbank's name. The minute acerate dermal spicule to which he alludes I have not seen.

Geodia areolata, n. sp. (Pl. VI. figs. 36, *a-g*, and 37.)

General form globular. Colour now light cinnamon externally. Surface more or less regularly areolated by lines of minute echinating acerates fixed by one end in the dermal sarcode, otherwise charged with minute stellates and closely applied to the subjacent petrous crust, one of whose holes may frequently be seen in the centre of the areolar interstice (Pl. VI. fig. 37). Pores minute and numerous in the dermal sarcode, giving it a cribriform structure. Vents in groups, or scattered here and there singly. Internal structure consisting of the usual kind of spiculation distributed throughout an areolar sarcode, more confused and compact towards the centre, but presenting no defined nucleus. Spicules of eight forms, viz. :—1, the zone-spicule, with trifid head expanded at nearly right angles to the shaft, 200 by 5-1800ths, head 40-1800ths in diameter (fig. 36, *a*); 2, large, smooth, fusiform, acerate, curved, 150 by 3-1800ths (fig. 36, *b*); 3 and 4, fork and anchor, arms respectively about 5-1800ths long (fig. 36, *e*); 5, siliceous globule, 21 by 16-6000ths (fig. 36, *d*); 6 and 7, external and internal stellates respectively, the former 1-6000th and the latter 4-6000ths in diameter (fig. 36, *e, f*), in form much the same as in the last species; 8, minute dermal acerate, 60-6000ths long (fig. 36, *g*). Spicules arranged in the usual way, viz. the heads of the zone-spicules spread out in the inner part of the petrous crust, which is 1-35th inch in thickness. Size of largest specimen about an inch in diameter.

Hab. Marine. Free or attached to hard objects.

Loc. Gulf of Manaar.

Obs. This chiefly differs from the last species in the areolated form of the dermal layer, arising from the presence of reticulated lines of minute echinating acerates, its contact with the petrous crust, the form and position of the heads of the zone-spicules, and the cinnamon colour externally.

Geodia ramodigitata, n. sp. (Pl. V. fig. 31, *a-f*.)

General form cylindrical, digital, occasionally branched (Pl. V. fig. 31). Colour grey. Surface (which is much worn)

covered here and there by the remains of a cribriform dermal membrane charged with minute stellates. Pores producing the cribriform structure of the dermal layer. Vents in groups or scattered singly here and there. Internal structure the same as that last mentioned, thickening towards the axis of the cylinder. Spicules of seven forms, viz.:—1, zone-spicule, with trifid arms expanded at right angles to the shaft, which measures 160 by 4-1800ths, and head 24-1800ths in diameter (fig. 31, *a*); 2, body-spicule, acerate, curved, smooth, fusiform, 126 by 4-1800ths (fig. 31, *b*); 3 and 4, fork and anchor, arms respectively about 4-1800ths long (fig. 31, *c*); 5, siliceous globule, 10 by 8-1800ths long (fig. 31, *d*); 6 and 7, external and internal stellates respectively, the former 1-6000th and the latter 8-6000ths in diameter (fig. 31, *e* and *f*). The zone-spicules have their heads in the petrous crust, which is 1-16th inch in diameter. Size of largest specimen about 5 inches long, largest part of cylinder $\frac{1}{3}$ inch in diameter.

Hab. Marine. Free or attached.

Loc. Gulf of Manaar.

Obs. This species, besides differing from the rest in shape, has larger siliceous globules and larger internal stellates. It is more or less covered by detritus (bits of shells &c.) and small calcareous organisms, which have become attached to and grown upon it, respectively, during the time it has been carried about by currents at the bottom of the sea.

Geodia globostellifera, n. sp. (Pl. VI. fig. 38, *a-f*)

Globular. Colour grey. Surface more or less covered with detritus as in the last species. Spicules of seven forms, viz.:—1, the zone-spicule, with trifid thin arms expanded laterally at right angles to the shaft, which is 122 by $1\frac{1}{2}$ -1800ths, and head 36-1800ths in diameter (Pl. VI. fig. 38, *a*); 2, body-spicule, acerate, curved, smooth, fusiform, 170 by $1\frac{1}{2}$ -1800ths (fig. 38, *b*); 3, fork (no anchor could be found), arms 8-1800ths long (fig. 38, *c*); 4, siliceous globule, spheroidal and oval respectively, about 5-1800ths in diameter (fig. 38, *d*); 5, *globostellate*, consisting of a spherical body covered with short conical points or rays, $1\frac{1}{2}$ -1800th in diameter (fig. 38, *e* and *g*); 6 and 7, external and internal stellates respectively, the former 1-6000th and the latter 8-6000ths in diameter (fig. 38, *f* and *h*). Spicules arranged as in the foregoing, and the *globostellate* mixed up with the siliceous globules of the petrous crust. Size of specimen about $\frac{3}{4}$ inch in diameter.

Hab. Marine. Free or attached.

Loc. Gulf of Manaar.

Obs. The spiculation of this is very much like that of the last species, viz. *G. ramodigitata*; but the addition of the globostellate (no. 5), which is also present in an embryonic specimen of the same species, with an entire absence of pin-like spicules in both instances, whose presence would immediately claim for it a Hymedesmid origin, seems to indicate that it is produced by the *Geodia* itself, and thus distinguishes the latter from all other species that I have yet encountered. This form of globostellate, however, is so unusual in *Geodia*, and so common about the Manaar specimens with one or more Hymedesmids, of which it forms the basal layer (ex. gr. *H. stellivarians* &c.), that I can hardly suppose it would be present in *Geodia* under any other circumstances. Still, from what has been stated, and my inability to find *any traces* of a pin-like spicule in the midst of the petrous crust where these globostellates are present, I am unable to regard it otherwise than as a product of the *Geodia*, where it may be an enlarged form of the dermal stellate. Another character of this species is the great number of "fork" spicules that project through its surface, among which I have not been able to discover a single "anchor-head."

Stelletta euastrum, Sdt. (Pl. VII. fig. 41, a-l.)

Laminiform, thin; growing parasitically over groups of *Siliquaria anguina*, and therefore presenting no definite form. Colour greyish white (Pl. VII. fig. 41). Surface even. Pores minute in the dermal sarcode. Vents in groups or scattered singly here and there. Spicules of five forms, viz.:—1, the zone-spicule, with simple trifid head or with the arms more or less divided (that is, the prongs of the furcation more or less lengthened), the whole expanded laterally at right angles to the shaft, which is from 20 to 40 by 4-1800ths, head 27-1800ths in diameter, both shaft and head being very variable in form and size (fig. 41, *b*); 2, body-spicule, acerate, smooth, curved, fusiform, 60 by 2-1800ths (fig. 41, *c*); 3, siliceous globule, discoid, irregularly elliptical, very thin, the hilous depression hardly discernible, and the stellate ends of the radiated structure scattered thickly but *separately* over the surface, about 17 by 9-1800ths and about 3-1800ths thick (fig. 41, *d, g, k, l*); 4, acerate (flesh-spicule), curved, microspined, more or less inflated in the centre (fig. 41, *e, g, h*); 5, stellate, 2-1800ths in diameter (fig. 41, *e, g, i*). Siliceous disks gathered together in a thin layer on the surface, but the rest of the spicules mixed together apparently indiscriminately and confusedly throughout the body; the zone-spicule

in form, size, and position the most irregular of all. Size of largest specimen, of which there are several, that of the group of *Siliquaria*, about $2\frac{1}{2}$ inches in its long diameter, compressed.

Hab. Marine. Parasitic on *Siliquaria*.

Loc. Gulf of Manaar.

Obs. This species was first named by Schmidt, who obtained the specimen from Lacaze-Duthiers, who, again, got it from La Calle, on the north coast of Africa, near Algiers (Schmidt, Spong. Küste v. Algier, 1868, p. 20); no description of it, however, is given beyond the spiculation, of which I examined a mounted type specimen in the British Museum.

The disk is, *mutatis mutandis*, identical with the siliceous globule in development, structure, and location, while the imperfectly formed zone-spicule and its irregular location puts one in mind of *Pachymatisma Johnstonia* (so abundant on our coasts); still it appears to me to be more nearly allied to *Geodia* than to *Stelletta*; and therefore I have placed it, like *Pachymatisma*, among my *Geodina*. Schmidt, as above stated, has given it the generic name of "*Stelletta*," adding, by way of designation, "*euastrum*," from the large and beautiful form which some of the stellates attain in the specimen from La Calle, but which do not occur in that of the Gulf of Manaar—although they will be seen to do so in the Australian form (fig. 42, *c*), which I will now describe, as it gives us more of the internal structure than is to be found on the laminiform growth over the group of *Siliquaria* (fig. 41).

Stelletta euastrum, Sdt., S.W. Australian specimen, Fremantle. (Pl. VII. fig. 42, *a-c*.)

Ovular, now wrinkled from being dry; 3 inches long by $1\frac{1}{2}$ inch in diameter. Colour white externally—that is, the colour of the petrous crust,—pale yellow internally, which is the colour of the sarcode (Pl. VII. fig. 42). Surface even, dimpled, poriferous throughout (fig. 42, *b b*). Vents of different sizes scattered here and there (fig. 42, *a a a*). Dermal layer composed of the disks before mentioned, mixed with both forms of the flesh-spicule, about 1-360th inch thick, surrounding a pale yellow widely areolated body-structure charged with the spicules of the species and, if anywhere, less condensed in the centre than towards the circumference; thus, in the absence of any zonular arrangement and central condensation like that of a typical *Geodia*, this species is identical with *Pachymatisma Johnstonia*, Bk. Possessing much the same kind of spiculation as the Manaar specimen, it has, in addition, the large and beautiful stellate (fig. 42, *c*)

"*euastrum rota*," Sdt., which seems to be always quadri-radiate with rays of equal length, viz. 12-6000ths, spined over the outer half, and parting at the same angle from the centre of union, where there is no body. But this spicule is confined to the parenchymatous structure, of which there being none or very little in the Manaar specimen from its thin, parasitic, laminiiform growth, may account for its absence there; while the same kind of smaller and more radiated stellates, about half the size in both specimens, are equally abundant, in the dermal layer especially.

Besides *Stelletta euastrum* there are two other species with discoid siliceous globules in the Adriatic, which Schmidt has named respectively *S. discophora* and *S. mamillaris* (Spong. Adriat. Meeres, 1862, pp. 47, 48, Taf. iv. fig. 5, and Taf. v. fig. 1, respectively), of which there is a specimen (for they both appear to me to be the same species) in the British Museum, obtained by Mr. Saville Kent from the coast of Portugal; and from this, together with Schmidt's illustrations, it is evident that the same kind of discophorous layer on the surface, the absence of the zonular arrangement of the spiculation and that of the "forks and anchors," so characteristic of *Geodia*, exists in all, with a badly-developed condition of the zone-spicule (which, as above stated, varies in the form of its head from trifid to trifurcate, and in that of its shaft from long to short, pointed and obtuse), scattered here and there amongst the rest of the spicules without any apparent regularity whatever. In short, the structure is as different from that of a *Geodia* as it is specifically characteristic of *Pachymatisma Johnstonia* and *Caminus vulcan*, Sdt. (*op. et loc. cit.*). All of these, therefore, although belonging to the Geodina, should constitute a different group from *Geodia* proper.

Stellettina.

The chief difference between the Stellettina and Geodina is the total absence of the "siliceous globule" in the former, whether spheroid or discoid, leaving nothing but the "dermal stellates" to rest upon the zone-spicules &c., which are for the most part similarly arranged to those of *Geodia*, although seldom with such characteristic regularity.

Stelletta tethyopsis, n. sp.
(Pl. VI. fig. 39 and 40 a-f.)

General form subhemispherical and sessile, or spheroidal and free (Pl. VI. fig. 39). Colour grey. Surface uniformly hispid from the projection of the forks and anchors, beneath

which may be seen the heads of the zone-spicules supporting the dermal sarcode charged with its stellates. Pores in the dermal layer. Vents not seen, probably owing to contraction and dryness. Internal structure very compact on account of all the spicules lying close and nearly parallel to each other as they uninterruptedly converge from the circumference to a point in the centre, where there is no nucleus (fig. 39). Spicules of five forms, viz. :—1, the zone-spicule, consisting of an extremely long, smooth, slightly curved shaft and trifid head trifurcated, of which the three arms advance obliquely forwards at an angle of 45° with the shaft, and the rest turn off at right angles to it, shaft 625 by 5-1800ths, head about 30-1800ths in diameter (fig. 40, *aa*); 2, body-spicule, also extremely long, acerate, smooth, slightly curved fusiform, 625 by 4-1800ths (fig. 40, *bb*); 3, forks and anchors largely developed, of which the arms respectively are about 10-1800ths long (fig. 40, *c*); 4 and 5, external and internal stellates, the former about 1- and the latter 4-6000ths in diameter (fig. 40, *e, f*), both multiradiate and without central nucleus or body—that is, their rays radiate from a central point which is not differentiated,—the internal stellate, as is usual in *Stelletta*, very faintly developed, and the rays fewer and longer than those of the external one. Largest specimen sessile, about two inches in horizontal diameter at the base and $\frac{3}{4}$ inch high, somewhat umbonate; but a considerable portion appears to have been left on the rock where it grew.

Hab. Marine. Free or fixed.

Loc. Gulf of Manaar.

Obs. This is a very beautiful species, from the compactness and regularity of its structure internally, which also causes it to closely resemble *Tethya cranium* (the type of my Tethyina), hence its designation; but its spiculation is that of a *Stelletta*. The head of the zone-spicule is subject to great variety in form, sometimes assuming that of the "fork" greatly enlarged (fig. 40, *d*). It is stated above that a considerable part of the base was probably left on the rock where it grew, since I know by experience, on the S.E. coast of Arabia, that a sponge possessing this kind of structure contracts so forcibly when alive and fixed on the rock where it may be growing, that it can only be got off in portions with hammer and chisel!

Tisiphonia nana, n. sp. (Pl. VII. fig. 43, *a-e*.)

Laminiform, thin, or filling up the depression in the Melobesian nodule where it may be growing. Colour white. Surface even. Spicules of four forms, viz. :—1, large trifur-

cate with very short conical shaft, 6 by 3-1800ths, head 50-1800ths in diameter (Pl. VII. fig. 43, *a, b*); 2, acerate, smooth, fusiform, curved, 27 by 1-1800ths (fig. 43, *c*); 3, acerate flesh-spicule, smooth, fusiform, curved, inflated in the centre, 4-1800ths long (fig. 43, *d, e*); 4, stellate flesh-spicule 4-6-rayed, rays microspined, 3-6000ths (fig. 43, *d, e*). The large trifurcate spicule is parquettted in amongst the rest so as to form a smooth even surface over an areolar structure, whose thickness varies with the subjacent depressions of the Melobesian nodule over which the sponge is growing. Size about one third of an inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. Dwarfed as this variety is, one can see by its spiculation, although modified by its habitat on the surface of the Melobesian nodule, that it belongs to the *Stelletina*. The trifurcate head, although necessarily with an extremely short shaft, indeed hardly more than a short cone (fig. 43, *b*), and the acerate spicule no. 2, are equivalent to the zone- and body-spicule in *Geodia* respectively; while the central inflation of the acerate flesh-spicule, although not microspined, and the tendency in the stellate to assume a spinispirulate form, ally it to the *Tethea muricata* of Bowerbank, the synonymy of which I have already published ('Annals,' 1878, vol. ii. p. 174); but I find that, in this article, I have omitted to mention that my dear old friend, Dr. J. E. Gray, in a note to me, dated 3rd January, 1871, foreshadowed what I have therein chiefly stated, viz. that "Bowerbank's figures of the spicules of his *Tethea muricata* (B. S. vol. i. figs. 304, 305) are probably those of *Tisiphonia*, *Wyvillethomsonia* and *Dorvillia* respectively," which is now proved to be the case by Dr. Bowerbank's own words and his illustrated description of *Tethea muricata* (Proc. Zool. Soc. 1872, p. 115, pl. v. figs. 1-6).

The first mention of the name *Tisiphonia* for a sponge occurs in Sir Wyville Thomson's paper on *Holtenia Carpenteri* (Phil. Trans. vol. 159, p. 712), read before the Royal Society on the "17th June, 1869," where, without more than the letters "n. g." after it, he gives it as one of the genera illustrating his "suborder Leptophlea." Subsequently we have the name "*Wyvillethomsonia*" proposed as a generic appellation for the same species by Dr. P. Wright in January 1870; and then comes Schmidt's of "*Stelletta*" in the month of May following, ending with that of "*Dorvillia*" by Mr. Saville Kent in Dec. 1870.

Now it is evident that no one but Dr. Gray had seen that

this was a form of Dr. Bowerbank's *Tethea muricata* up to the date above mentioned; or if so, no one ever noticed it publicly. Still it is equally evident that *Tisiphonia*=*Dorvillia* is sufficiently different from *Tethea muricata* to require specific distinction; at the same time that *Tethea muricata* is not a species of *Tethea*, but one of *Stelletta*, as Schmidt has made it from his examination of the Florida specimen.

Furthermore, we find Dr. Bowerbank multiplying the varieties of this sponge under the names *Ecionemia compressa*, *Hymeniacidon placentula*, and *Normania crassa* respectively (B. S. 1874, vol. iii.), all of which specimens (now in the British Museum) I have had the opportunity of examining. Hence, when we find the species (varieties) of a sponge so numerous, it becomes necessary to make a group of them under a specific name; and as Sir Wyville Thomson's use of "*Tisiphonia*" claims priority in this respect, I have applied it generically to the species above described, and shall apply it *provisionally* to the two following ones, merely observing that, while I consider them all varieties, the human mind can never remember them without specific distinction. Nature does not require this aid.

Tisiphonia annulata, n. sp. (provisional).
(Pl. V. fig. 28, *a-d.*)

Massive, charged with the spicules of the species, without apparent regularity. Colour white. Spicules of three forms, viz. :—1, quadriradiate, arms equal in size, radiating at equal angles from a common centre, annulated throughout with alternate inflations and depressions, the former microspined and sometimes broken or incomplete in the annulation, arm 17 by $1\frac{1}{2}$ -1800ths (Pl. V. fig. 28, *a* and *d*); 2, acerate, smooth, fusiform, curved, 63 by $1\frac{1}{2}$ -1800ths (fig. 28, *b*); 3, spinispirulate flesh-spicule, 3-6000ths long (fig. 28, *c*). Spicules arranged confusedly in an areolated sarcode; nos. 1 and 3 in great abundance and of various sizes, the former below and the latter above their stated measurements respectively. Size of specimen about 1-12th inch in diameter.

Hab. Marine. Growing on hard objects, in the present instance among the minute detritus attached to the specimen of *Stelletta euastrum* (Pl. VII. fig. 42).

Loc. Gulf of Manaar.

Obs. This sponge was found growing in the place just mentioned. The facies of the spiculation appears to me to be that of a variety of *Tisiphonia*; and if so, the quadriradiate spicule is, with the exception of the annulation, like that given by Dr. Bowerbank of *Normania crassa* (B. S. vol. iii. pl. lxxxi.

fig. 5) ; but the characteristic acerate flesh-spicule (viz. microspined and centrally inflated) is absent, although the spinispirula is not, but abundantly present.

The chief interest, however, of this specimen is in the annulated quadriradiate form, on account of its resemblance to the fossil spicule from the Upper Greensand of Haldon Hill, near Exeter, which I represented in 1874 ('Annals,' vol. vii. pl. ix. figs. 44, 45), as it may not only throw some light on the nature of the sponge which bore this, but also on the other moniliform spicules so common in the cavities of the chalk-flints of Oxfordshire and perhaps elsewhere, but first represented from some Irish specimens by Mr. Joseph Wright, F.G.S., in the Belfast Nat. Hist. Field-Club Report for 1873-74 (pl. ii. figs. 4, 5).

Tisiphonia penetrans, n. sp. (provisional).
(Pl. VII. fig. 44, *a-d*.)

Amorphous, taking the form of the excavation of the Melobesian nodule in which it may be growing. Colour white. Spicules of three forms, viz. :—1, acerate, curved, smooth, fusiform, 27 by 1-1800ths (Pl. VII. fig. 44, *a*) ; 2, the same form, but much smaller, 6-1800ths long (fig. 44, *b*) ; 3, stellate flesh-spicule, variable in the number and position of its rays, often quadriradiate, rays microspined, 4-6000ths in diameter (fig. 44, *c, d*). Size varying with that of the excavated cavity in which it may be growing.

Hab. Marine. In excavations previously made by lithodomous sponges.

Loc. Gulf of Manaar.

Obs. There is still less in this to identify directly with the spiculation of *Tisiphonia* than in the foregoing species ; but the *facies* here also strikes me as being allied to this genus. Although found in the excavated cavities of the Melobesian nodule, I doubt if it made the cavities itself ; for they often contain a heterogeneous mixture of different forms of spicules which come from as many different kinds of sponges that in my examinations I have never met with, some of which are extremely beautiful and not less remarkable, *ex. gr.* figs. 29, 30 (Pl. V.). They are generally, too, enclosed in a transparent membranous investment, which must be the remains of the living organism that not only gathered them together and enclosed them, but dragged them into some of the minutest channels of the excavation in the nodule. What was the nature of that organism, Foraminiferal or Spongioid, future observation may determine.

Lithistina.

In describing the Lithistids it is absolutely necessary to have specimens which possess the last-formed dermal layers in addition to a portion of the fully formed internal structure, because these are the parts which are most characteristic of the species; hence, although we may not possess the fully developed *entire* form, the thinnest layer, provided it contains the parts mentioned, will be sufficient to determine the species; for these will ever be the same, although the adult form of the sponge itself may be different. So that, while the specimens on the Melobesian nodules of the Gulf of Manaar are so small that, comparatively, they hardly amount to much more than traces of structure which may attain a large and definite form in the deeper sea, still, so far as they go, they will enable us to predict what they may attain in that situation.

For the most part, they have grown over the layers of *Melobesia* from which the nodules have been chiefly formed, while in many instances they themselves have been overgrown by one of the Microcionina that have been described; but, whether overgrown or not, as the spiculation of a Lithistid, for the most part, is so locked together that even boiling in pure nitric acid does not separate its parts, so in this way it has been easy to free the Lithistid not only from the calcareous *Melobesia* on which it rests, but from the *Microcionia* covering it, to such an extent as to cause it to come out under this treatment in a clean, perfect, and beautiful form. I have stated "for the most part," because it may be easily conceived that the elements of which a Lithistid is composed are not inextricably locked together until they have undergone a certain amount of development, and therefore, being more or less united by sarcode until this occurs, they are, up to this time, *separable* by boiling in nitric acid. Such is more particularly the case with the Lithistids whose structure commences in disks (*viz.* the *Discodermiæ*), which disks we shall hereafter find to be gradually transformed into their branched and complicated spiculation. But even here, under the boiling in nitric acid, all the separated parts can be easily retained, and, when mounted in Canada balsam, present, when *thus separate*, a much better view of their gradationary development than when *in situ*, where they lie more or less obscured in layers one over another as they are formed. The term "interlock" is here used advisedly; for whereas in the vitreous Hexactinellida the spicules are cemented together by the addition of glassy fibre, no such thing occurs in the Lithistida, whose spicules are united by *mere apposition* of the expanded ends of their filigreed branches (Pl. VIII.

fig. 51, *i*), or by an *interlocking, inseparable* without fracture, of the filigree of one branch with that of another (Pl. VIII. fig. 48, *k k k* and *l*). At least I have not yet seen *direct union* between the parts of one spicule with those of another in a Lithistid.

Although most of these Melobesian nodules present one or more growths of Lithistida upon them respectively, yet it is only in one or two instances out of the seven species that I have found that two different ones have been observed on the same nodule; while so abundant are they that it is hardly possible to mount a fragment of any other sponge on the nodule without finding in it spicules of a Lithistid.

Of the "seven species" three may be termed "*Corallistes*," because they do not appear to commence their growth in discoid elements; while the opposite is the case with the other four, which will be termed "*Discodermia*." Of course, in describing and illustrating them, my observations will be confined to their structure, since they must be regarded as only little growths or traces, as before stated, of the entire sponges; while the illustrations, on the other hand, must be considered as diagrams after nature, for such is the intricacy of Lithistid structure that it is almost hopeless to attempt any thing beyond catching the specific character and representing this as near to nature as possible. Having premised these remarks, we will begin with the *Corallistes*.

CORALLISTES.

Corallistes aculeata, n. sp. (Pl. VII. fig. 45, *a, b*.)

Surface characterized by the presence of erect spike-like processes (Pl. VII. fig. 45), which, when the structure is torn to pieces, are respectively found to be supported on three arms, which are tubercled and repeatedly subdivided into branches until they end in a filigree consisting of minute *angular* processes, which interlock with those of the neighbouring spicules (fig. 45, *a*). Spike conical, elongated, sub-sinuuous, 1-333rd long by 1-120th inch in diameter at the base, more or less cononodose, tubercles more or less in circular lines round the lower two thirds of the spike (fig. 45, *a, b*). Internal structure composed of spicules of the usual Lithistid form, consisting of four arms, each of which is repeatedly divided and subdivided into branches until they end in the way above mentioned. Size of largest specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The spike supported on three arms diadem-like and uniformly distributed over the surface is the characteristic feature of this species. There is a small specimen of it in the British Museum, about 6-12ths inch in diameter, which came from the neighbourhood of Kendrick Island, south of Japan (lat. $24^{\circ} 13' N.$, and long. $136^{\circ} 13' E.$), presented by Dr. J. Gwyn Jeffreys.

Corallistes verrucosa, n. sp.
(Pl. VII. fig. 46, *a*, *b*.)

Surface characterized by the presence of short, tuberoso cones (Pl. VII. fig. 46), which, when the structure is torn to pieces, are respectively found to be supported on three arms tubercled and repeatedly subdivided into branches until they end in a filigree consisting of minute *angular* processes which interlock with those of the neighbouring spicules (fig. 46, *a*). Cone consisting of a pyramidal heap of tubercles about 1-666th inch high and 1-750th inch in diameter at the base (fig. 46, *a*), which is triangular and, for the most part, composed of three tubercles larger than the rest, triangularly placed and situated respectively opposite the *reentering* angles *between* the arms (fig. 46, *b*). Internal structure composed of spicules of the usual lithistid form consisting of four arms, each of which is repeatedly divided and subdivided into branches until they end like the one above mentioned. Size of specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. There is nothing particular about this species beyond the form of the surface-processes, which, at the same time that they present a distinguishing feature, afford the only remarkable difference between it and *C. aculeata*.

Corallistes elegantissima, n. sp.
(Pl. VII. fig. 47.)

The spicules of this species (if it is a distinct one) were only found in microscopic groups in two places on the same nodule as *Discodermia papillata* (which will presently be described), where they were chiefly in the midst of, and thus protected by, the acerate spicules of a species of *Reniera* that had overgrown them. To describe a Lithistid spicule where there is no particular character is, from its intricateness, almost impossible; therefore I must refer the reader to the illustration, which is a careful drawing to measurement of one of these elegantly beautiful objects, merely adding that

the terminations are not round like those of most *Discodermiæ*, but pointed, prong-like, and angular, as they are delineated (Pl. VII. fig. 47).

·Discodermida.

Finding that the Discodermida grow by the transformation of a simple disk on the surface to the complicated structure of the interior, I have endeavoured to illustrate this in a series of figures which are taken from a portion that was boiled to pieces in nitric acid and the residue mounted in Canada balsam (Pl. VIII. fig. 48, *d*, &c.). Indeed all the species have been studied in this way, when the gradationary forms of the disk thus separated render it very easy, as before stated, to see and follow the changes of form which it undergoes; besides which, this may be corroborated by looking at the specimen *in situ* in its natural state through a microscope (Pl. VIII. fig. 48, *a, b, c*). In addition to the disks the Discodermida appear to be always characterized by one or more forms of minute flesh-spicules in great abundance, of which a curved acerate, or straight bacillar one, microspined, is perhaps the most prevalent (fig. 48, *h*, and 49, *c, d*); but these are not confined to the dermal sarcode in which the disks are developed and imbedded, although apparently most abundant there (fig. 48, *a*, &c.), but almost as plentifully distributed throughout the whole structure. Again, the filigreed ends of the branches of the full-formed spicule are *not angular*, but *more or less spherical*, like bunches of grapes interlocked with one another, after the manner of the clasping of hands (fig. 48, *l*). At the same time, however, I am not able to explain the fact that in *Kaliapsis cidaris*, Bk. (Proc. Zool. Soc. 1869, pl. xxv. fig. 2, &c.), of which I possess some good specimens *in situ*, and which is a genuine *Discodermia*, a "diadem-like" form of spicule similar in this respect to that of *Corallistes aculeata*, exists *under* the discophorous layer. I do not pretend to follow this transformation of the disk, which is succeeded, as usual, by the fully formed Lithistid spicule of the interior, but now only to announce the circumstance. In specimens of *Corallistes aculeata*, *in situ*, the spikes may be seen without any disks whatever, even when the surface is overgrown and thus protected by a *Microciona*; nor in the mounted residue after boiling in nitric acid of specimens of this species is there a trace of a disk under any kind of form to be observed; while in most specimens of *Discodermiæ* the *Microciona* grows upon the disks themselves.

In describing the structure of the different species of Discodermida, I shall commence with the disks, as these are the

first-formed parts, and follow the structure on by description and illustration to the full development of the spicule, finally giving a magnified view of the form of the filigreed termination characteristic of each species.

Discodermia papillata, n. sp.
(Pl. VIII. fig. 48, *a-l.*)

Surface even, discophorous, disks horizontal; structure papillated throughout, accompanied by a bacillar microspined flesh-spicule (Pl. VIII. fig. 48, *a, b, c*). Colour yellow internally. Outer layer of last-formed disks more or less circular, micropapillated in the upper, and bearing the rudiment of a spine (the shaft) in the centre of the lower surface, the smallest disk observed being circular, and about 1/3000th inch in diameter (fig. 48, *b* and *d*); the next layer larger and more indented on the margin; after this the disk becomes branched, the spine or shaft fully formed (fig. 48, *e*), and the papillæ enlarged and extended over the branches (fig. 48, *f*); finally the staple spicule of the interior is produced (fig. 48, *i*), where the shaft may be observed to be trifidly divided and subdivided until it ends in the filigree, with which it interlocks with its neighbours (fig. 48, *k k k*) on all sides by botryoidal or grape-like terminations (fig. 48, *l*)—the original papillæ, now still more enlarged and extended over the shaft and branches, presenting over the former a wart-like appearance (fig. 48, *i*), probably influencing this character of the development throughout,—a similar development taking place at the inner end of the shaft, by which, both on the outer and inner side, the filigree is interlocked with corresponding portions of similar spicules; and thus the structure presents internally an increase of bulk by successive layers, as the breaking-up of a piece of fully-formed Lithistid testifies. Papillæ at first microscopic, finally becoming conical (fig. 48, *g*). Bacillar spicule elliptical, elongated, microspined throughout, about 3/6000ths long (fig. 48, *h*). Largest specimen about an inch in horizontal diameter, filling up the depressions of the Melobesian nodule over which it grows, and extending into the crevices and cavities made by excavating sponges that may be underneath.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. I have thus summarily described the development of this discodermid sponge, so that it will not be necessary to repeat it in the other species more than the occasion demands; at the same time it should be remembered that the varieties in the structure of the elementary parts of a Lithistid are practi-

cally unlimited. Again, it frequently happens that the discophorous layer has disappeared from some cause or other, and that the surface is *then* formed by that condition of development where the disk has passed into a branched state, in which the branches, curving over each other, leave interspaces charged with the bacillar flesh-spicule (Pl. VIII. fig. 48, *a*, and 50 *a*, &c), which causes it to assume the appearance given by Dr. Bowerbank of his *Dactylocalyx Prattii* (Proc. Zool. Soc. 1869, pl. v. figs. 6–11), and the same in *Theonella Swinhoei*, Gray (*ib.* 1868, p. 565), both of which specimens, now in the British Museum, I have examined and find the *discophorous layer absent*. Nor is this to be wondered at, from what I have stated of the instability of this layer until the disks have become transformed into the interlocking spicules; still there are no papillæ on the spicules of *Dactylocalyx Prattii* or of *Theonella Swinhoei*, which distinguishes them from *Discodermia papillata*; but although the flesh-spicule is elliptical elongate in *Dactylocalyx Prattii*, and bent in the middle in *Theonella Swinhoei*, this is not sufficient for specific distinction between them; nor is the flesh-spicule generally to be depended on in this respect; so, with this difference only, I think, as Dr. Bowerbank has concluded (*op. et l. cit.*), that *Dactylocalyx Prattii* and *Theonella Swinhoei* must be considered the same species. Yet there is a large, vase-like specimen to which I have before alluded, and which comes from the seas about the Philippine Islands, in which the flesh-spicules (for there are two forms) may be considered of some specific value, since here the usual acerate curved microspined and centrally inflated flesh-spicule is accompanied by another equally plentiful, viz. a short thick ellipsoidal form also microspined, not unlike the same kind of flesh-spicule in *Pachastrella abyssii*, Sdt.

Discodermia aspera, n. sp.
(Pl. VIII. fig. 49, *a-i.*)

Surface even, discophorous, disks horizontal (Pl. VIII. fig. 49, *a, b*). Structure asperous, spinous, accompanied by an acerate microspined flesh-spicule (Pl. VIII. fig. 49, *a, b*). Colour grey. Discophorous structure and transformation much the same as in the last-described species, only that the margin of the disk soon becomes denticulated (fig. 49, *c*), and the papillæ pass into spines, as indicated by the four gradationary diagrams (fig. 49, *g*); and in the transformed disk (fig. 49, *f*) the irregularly lobed and denticulated margin, together with the spines on the surface, give that asperous appearance which more or less influ-

ences the subsequent development of the fully formed spicules of this Lithistid even to the end (fig. 49, *h*), in which the filigreed terminations are not grape-like as in the foregoing species, but subangular (fig. 49, *i*). Papillæ at first microscopic, then enlarged, after which they become united by intervening straight linear ridges, then elevated and compressed, and finally divided into spine-like processes (fig. 49, *g*), which more or less characterize the fully formed spicules (fig. 49, *h*). Flesh-spicule acerate, curved, microspined, about 5-6000ths long (fig. 49, *e*), plentifully distributed over the disks (fig. 49, *a*) and throughout the structure. Size about 1 inch in horizontal diameter, filling up the depressions on one side of a Melobesian nodule about this size.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The asperous character of the spiculation of this species, arising from a transformation of the original papillæ of the disk into spinous processes, as above mentioned and illustrated (fig. 49, *g*, &c.), chiefly distinguishes it. As the specimen for the most part is very much worn, I should, but for the boiling in nitric acid of a portion which had been protected by having been overgrown by a *Reniera*, have been entirely ignorant of its discophorous character and the peculiar spinous transformation of the papillæ of the disks to which I have alluded, which seems to continue its influence on to the fully formed structure.

Discodermia spinispirulifera, n. sp.

(Pl. VIII. fig. 50, *a-h*.)

Surface even, discophorous; disks horizontal; structure loose, accompanied by *two* forms of flesh-spicule, viz. an acerate and a spinispirula (Pl. VIII. fig. 50, *a, b, c*, and *e, f*). Colour white. Discophorous structure and transformation much the same as in the foregoing species, only that, instead of papillæ, the disk presents *faint* circular concentric lines (fig. 50, *d*), and, previously to passing into the branched form, show an irregularly lacerated margin in which the foreshadowed divisions of the full-formed spicule assume the most whimsical proportions and appearances (fig. 50, *i*), finally producing a branched spicule repeatedly subdivided as before until the ends become filigreed into subglobular processes (fig. 50, *g*). Flesh-spicule of two forms, viz.:—1, comparatively large, acerate, curved fusiform, microspined, about 20-6000ths inch long (fig. 50, *e*); and the other, 2, a minute spinispirula, consisting of a sinuous shaft covered with thin spines about the same length as itself, arranged over it in an echinating, spiral

manner, 3-6000ths of an inch long (fig. 50, *f*),—the former plentifully distributed over the disks, as before mentioned, and but little less so throughout the rest of the structure, while the latter sparsely accompanies it. Size of largest specimen about $\frac{1}{4}$ inch in horizontal diameter, and the thickness of the depression on the nodule where it may have grown, often extending into the cavities formed by excavating sponges.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. The remarkably shreddy character of the advanced form of disk (fig. 50, *i*) and the presence of the spinispirular flesh-spicule, together with the comparatively large size of its companion the acerate flesh-spicule, distinctly separate this from the other species of *Discodermia*. It may be remembered that the flesh-spicule of *Dactylocalyx Masoni*, Bk., is a spinispirula (Proc. Zool. Soc. 1869, pl. vi. fig. 4).

Discodermia lævidiscus, n. sp.

(Pl. VIII. fig. 51, *a-i*.)

Surface even, discophorous, disks horizontal, structure areolar, accompanied by an acerate flesh-spicule (Pl. VIII. fig. 51). Colour yellow internally. The disks here, which also present a great number of faint lines, like those of the foregoing species, are depressed in the centre (fig. 51, *b, c*). They undergo similar transformation to those of the foregoing species (fig. 51, *e*), passing at last into the fully formed spicule of the interior (fig. 51, *h h*), whose terminations appear to be more in expanded, irregular surfaces, for the sake of union by apposition with their neighbours, than in filigree processes interlocking (fig. 51, *i*). Flesh-spicule acerate, curved, fusiform, microspined, about 8-6000ths long (fig. 51, *f, g*), plentifully distributed over the disks (fig. 51, *a*) and throughout the interior, as in the foregoing species. Size of specimen about $\frac{1}{4}$ inch in horizontal diameter.

Hab. Marine. On hard objects.

Loc. Gulf of Manaar.

Obs. When viewed *in situ* (fig. 51) the depressions in the centres of the disks, which are rather less in diameter than those of the other species, together with the concentric lines, added to the comparative absence of filigree terminations in the fully formed spicule, and the yellow colour of the interior, are sufficient to distinguish it from the other species; while the absence of papillæ on the disks causes it to

differ from *D. papillata* and *D. aspera*; the absence of the shred-like transformation of the disk (although in both instances there are no papillæ on it), together with the presence of the spinispirular flesh-spicule, causes it to differ equally from *D. spinispirulifera*.

The following is a list of organisms in and about the Melobesian nodules from the Gulf of Manaar above mentioned:—

ALGÆ (calcareous).

Melobesia (?) polymorpha, lamini- form.	Melobesia, quadrangular-celled, lamini-form, ? sp.
— polymorpha, nulliporiform.	Flabellaria opuntia.

FORAMINIFERA.

Sessile.

Polytrema miniaceum.	Carpenteria monticularis.
— cylindricum.	Gypsina melobesioides.
— mesentericum, n. sp. <i>Loc.</i>	— vesicularis.
unknown, not Gulf of Manaar.	— —, var. spheroidalis.
Carpenteria utricularis.	

Subsessile.

Rotalia spiculotesta.	Orbitolites marginalis.
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Free.

Calcarina calcar, var. hispida, n. var.	Cysteodictyina compressa, nov. gen. et sp.
Alveolina sinuosa, n. sp.	Ceratestina globularis, nov. gen. et sp.
Amphistegina.	— tessellata, n. sp.
Holocladina pustulifera, nov. gen. et sp.	

SPONGIDA.

Ord. ii. CERATINA.

Aplysina purpurea, n. sp.	Aplysina fusca, n. sp.
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Ord. iii. PSAMMONEMATA.

Hircinia arundinacea, n. sp.	Hircinia fusca, n. sp.
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Ord. iv. RHAPHIDONEMATA.

Chalina ? sp. (young).	Desmacidon Jeffreysii, <i>Bk.</i>
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Ord. v. ECHINONEMATA.

Pluriformia.

Dictyocylindrus manaarensis, n. sp.	Dictyocylindrus sessilis, n. sp.
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Microcionina.

- | | |
|---------------------------------------|---|
| Microcionia atrosanguinea, <i>Bk.</i> | Microcionia curvispiculifera, n. sp. |
| — armata, <i>Bk.</i> | Hymenophoria vermiculata, var.
erecta. |
| — affinis, n. sp. | — unispiculum, n. sp. |
| — bulboretorta, n. sp. | — clavata, n. sp. |
| — quadriradiata, n. sp. | — eruca, n. sp. |
| — fascispiculifera, n. sp. | |

Baculifera.

Caulospongia, *Kent*, ? sp.

Ord. vi. HOLORHAPHIDOTA.

Thalyosa.

Reniera ? sp. Brown and white.

Crassa.

Reniera ? sp. Yellow and yellow- ish grey.	Reniera ? sp. White.
	— ? sp. Dark brown.

Fibulifera.

Reniera fibulifera, *Schmidt*.

Halichondrina.

Halichondria aceratospiculum, n. sp.	Halichondria albescens, <i>Johnston</i> .
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Esperina.

Esperia tunicata, <i>Schmidt</i> .	Esperia serratohamata, n. sp.
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Hymedesmina.

Hymedesmia stellivarians, n. sp.	Hymedesmia spinatostellifera, n. sp.
— Moorei, n. sp.	— trigonostellata, n. sp.
— capitatostellifera, n. sp.	

Suberitida.

Suberites vestigium, n. sp.	Suberites angulatus, <i>Carter</i> .
— fistulatus, n. sp.	

Placospongida.

Placospongia melobesioides, *Gray*.

Eccelonida.

Thoosa socialis, n. sp.	Samus (Pachastrella) parasiticus, <i>Crtr.</i>
Dotona pulchella, n. sp.	— complicatus, n. sp. Sey- chelles.
Alectona Iligini, n. sp.	
Samus anonymus, <i>Gray</i> .	
— simplex, n. sp.	

Geodina.

Geodia perarmata, <i>Bk.</i>	Geodia globostellifera, n. sp.
— areolata, n. sp.	Stelletta euastrum, <i>Schmidt</i> .
— ramodigitata, n. sp.	

Stelletina.

Stelletta tethyopsis, n. sp.
Tisiphonia nana, n. sp.

Tisiphonia (prov.) *annulata*, n. sp.
 — (prov.) *penetrans*, n. sp.

Lithistina.

Corallistes aculeata, n. sp.
 — *verrucosa*, n. sp.
 — *elegantissima*, n. sp.
Discodermia papillata, n. sp.

Discodermia aspera, n. sp.
 — *spinispirulifera*, n. sp.
 — *lævidiscus*, n. sp.

Ord. viii. CALCAREA.

Gen. Leucortis indica, *Häckel*. Imperfect.

SPICULES OF UNKNOWN SPONGES.

HYDROIDA.

Hydradendrium spinosum, nov. gen. et sp.

ACTINOZOA.

Alcyonaria.

Rhizoxenia, *Ehr.*, ? sp.
Spongodes, *Lesson*, ? sp.

Tubipora reptans, n. sp.

POLYZOA.

A great variety of species undetermined.

TUNICATA.

SYNASCIDLÆ, Giard.

Tribe i. *Didemnidæ* (with spicules).

Leptoclinum, *Milne-Edwards*. White, incrusting.

GASTEROPODA.

Siliquaria anguina.

Type specimens of all the above organisms, dry and mounted in Canada balsam respectively, may be found in the Liverpool Free Museum, under the designation of "Manaar Collection of 1879, presented by Captain H. Cawne Warren."

EXPLANATION OF THE PLATES.

N.B. To avoid repetition, the measurements are to be considered parts of an inch throughout.

If the *scale* is not given in figures, the following indications should be remembered:—

"Sc. A" means 1-24th to 1-1800th inch.

"Sc. B" means 1-24th to 1-6000th.

"Sc. C" means 1-12th to 1-6000th.

"Sc. D" means 1-48th to 1-1800th.

Where the spicule is fusiform and perhaps curved, a trapezoidal figure has often been given to it for convenience in delineation, although the proportions are maintained; the detail otherwise must be sought for in the letterpress.

Dotted lines and dots are generally intended to represent spination.

PLATE IV.

- Fig. 1. *Dictyocylindrus manaarensis*, n. sp., nat. size: *a, b, c, d*, linear spicules; *e*, tricurvate; *f*, equianchorate (Sc. A); *g*, more magnified view of *e* and *f*.
- Fig. 2. *D. sessilis*, n. sp., nat. size: *a, b, c*, linear spicules (Sc. A); *d*, more magnified view of *c*.
- Fig. 3. *Microciconia bulboretorta*, n. sp., spiculation of: *a, b, c, d*, linear spicules (Sc. A); *e*, more magnified view of *d*.
- Fig. 4. *M. quadriradiata*, n. sp., spiculation of: *a, b*, linear spicules; *c*, quadriradiate (Sc. A); *d*, more magnified view of *c*.
- Fig. 5. *M. quinqueradiata*, n. sp., spiculation of: *a, b, c*, linear spicules; *d*, quinqueradiate (Sc. A); *e*, more magnified view of *d*.
- Fig. 6. *M. curvispiculifera*, n. sp., spiculation of: *a, b*, linear spicules; *c*, curvilinear spicule (Sc. A); *d*, more magnified view of *c*.
- Fig. 7. *M. fascispiculifera*, n. sp., spiculation of: *a, b, c*, linear spicules; *d* is *c* fasciculated (Sc. A); *e*, more magnified view of *b*; *f*, bihamate (Sc. B); *g*, large spicules and fasciculi of *c*, *in situ* (diagram).
- Fig. 8. *Hymerhaphia unispiculum*, n. sp.: one form of spicule only (Sc. A).
- Fig. 9. *H. eruca*, n. sp., spiculation of: *a*, erect linear spicule; *b*, caterpillar-like spicule; *c*, the same, but early stage, resembling the contort spicule of *Hymerhaphia vermiculata*, Bk. (Sc. A).
- Fig. 10. *Hymedesmia stellivarians*, n. sp., spiculation of: *a*, linear spicule (Sc. A); *b*, stellate (Sc. B); *c, d, e*, various forms of ray, more magnified (diagram).
- Fig. 11. *H. Moorei*, n. sp., spiculation of: *a*, linear spicule (Sc. A); *b*, stellate (Sc. B); *a*, ray, more magnified.
- Fig. 12. *H. capitatostellifera*, n. sp., spiculation of: *a*, linear spicule (Sc. A); *b*, stellate (Sc. B); *c*, ray more magnified.
- Fig. 13. *H. spinatostellifera*, n. sp., spiculation of: *a*, linear spicule; *b*, different forms of head (Sc. A); *c*, stellate (Sc. B); *d*, ray, more magnified.
- Fig. 14. *H. trigonostellata*, n. sp., spiculation of: *a, b*, linear spicules (sc. 1-12th to 1-1800th); *c, d*, stellates (Sc. C).
- Fig. 15. *Microciconia affinis*, n. sp.: equianchorate, to show hook-like appearance of central arm (Sc. C).

PLATE V.

- Fig. 16. *Reniera* ? sp., white, spicule of (Sc. A).
- Fig. 17. *Reniera* ? sp., yellow, spicule of (Sc. A).
- Fig. 18. *Reniera* ? sp., dark brown, spicule of (Sc. A).
- Fig. 19. *Halichondria aceratospiculum*, n. sp., spiculation of: *a*, linear, acerate, spined; *b*, linear, acerate, smooth, inflated in the centre; *c*, bihamate; *d*, equianchorate (Sc. B).
- Fig. 20. *Esperia serratohamata*, n. sp., spiculation of: *a*, linear spicule; *b*, serrated hamate; *c*, tricurvate; *d*, inequianchorate (Sc. B).
- Fig. 21. *Suberites vestigium*, n. sp., spicule of (sc. 1-12th to 1-1800th).
- Fig. 22. *S. fistulatus*, n. sp., spiculation of: *a*, linear spicule (sc. 1-12th to 1-1800th); *b*, equianchorate, lateral and front views (Sc. B).

- Fig. 23.* *Thoosa socialis*, n. sp., spiculation of : *a*, sceptrelliform spicule ; *b*, compressed globular spicule (Sc. C).
- Fig. 24.* *Dotona pulchella*, n. sp., spiculation of : *a*, chief spicule ; *b*, fine hair-like acute ; *c*, flesh-spicule (Sc. C) ; *d*, portion of *a*, more magnified, to show by the dotted faint line on the opposite side that the apparent annulations form part of a *spire*.
- Fig. 25.* *Alectona Higgini*, n. sp., spiculation of : *a*, chief spicule ; *b*, fine hair-like acerate, subtricurvate ; *c*, flesh-spicule (Sc. C).
- Fig. 26.* *Samus simplex*, n. sp., spiculation of : *a*, lateral view of main spicule ; *b*, horizontal view of head (Sc. A) ; *c*, flesh-spicule (Sc. C).
- Fig. 27.* *S. complicatus*, n. sp. : main spicule, horizontal view, upperside (Sc. A).
- Fig. 28.* *Tisiphonia annulata*, n. sp., spiculation of : *a*, annulated quadri-radiate ; *b*, linear acerate (Sc. A) ; *c*, flesh-spicule spinispirulate (Sc. C) ; *d*, portion of *a*, more magnified.
- Fig. 29.* Verticillately spined cylindrical spicule of unknown sponge abundant in excavated cavities of the Melobesian nodules (Sc. B).
- Fig. 30.* Pin-like spicule with spinated extremities and head turned to one side, of unknown sponge found in similar cavities of the Melobesian nodules (Sc. A).
- Fig. 31.* *Geodia ramodigitata*, n. sp., nat. size : *a*, zone-spicule ; *b*, body-spicule ; *c*, fork and anchor ; *d*, siliceous globules, round and oval respectively ; *e*, stellates of both localities, viz. external and internal (Sc. D) ; *f*, stellates, more magnified.

PLATE VI.

- Fig. 32.* *G. perarmata*, Bk. Section through the centre, nat. size : *a*, dermal layer ; *b*, interval between the dermal layer and petrous crust ; *c*, petrous crust ; *d*, body or interior.
- Fig. 33.* The same, spiculation of : *a*, zone-spicule ; *b*, body-spicule ; *c*, fork and anchor ; *d*, siliceous globules, round and oval ; *e*, external and internal stellates (Sc. D) ; *f*, more magnified views of *e*, respectively.
- Fig. 34.* The same. Dermal layer viewed from within : *a*, head of zone-spicule ; *b*, pores in dermal layer, with stellates in the lower half ; the latter represented by the dots (diagram).
- Fig. 35.* The same. Vertical section of dermal layer, subdermal chamber, and adjoining part of petrous crust : *a*, dermal layer charged with stellates ; *b*, subdermal chamber or interval ; *c*, part of petrous crust ; *d d*, heads and adjoining shafts of zone-spicules (diagram).
- Fig. 36.* *G. areolata*, n. sp., spiculation of : *a*, zone-spicule ; *b*, body-spicule ; *c*, fork and anchor ; *d*, siliceous globules, round and oval ; *e*, external and internal stellates ; *g*, dermal acerate (Sc. D) ; *f*, stellates, more magnified.
- Fig. 37.* The same, portion of surface, more magnified, to show areolation and position of dermal acerates (diagram).
- Fig. 38.* *G. globostellata*, n. sp., spiculation of : *a*, zone-spicule ; *b*, body-spicule ; *c*, fork (no anchor seen) ; *d*, siliceous globules, round and oval ; *e*, globostellate ; *f*, external and internal stellates (Sc. D) ; *g*, more magnified view of *e* ; *h*, more magnified views of *f*.
- Fig. 39.* *Stelletta tethyopsis*, n. sp., torn off from the base (nat. size).
- Fig. 40.* The same, spiculation of : *a a*, zone-spicule ; *b b*, body-spicule ;

c, fork and anchor; *d*, occasional form of zone-spicule; *e*, external stellate; *f*, internal stellate (Sc. D). The dotted lines at the bottom of *a a* and *b b*, respectively, are to show that they are continuations of the same spicules, which, upon this scale, are too long for the Plate.

PLATE VII.

- Fig. 41.* *Stelletta euastrum*, Sdt., parasitic on a group of *Siliquaria anguina*: *a a*, mouths of the *Siliquariæ* (nat. size); *b*, zone-spicule; *c*, body-spicule; *d*, siliceous disk; *e*, minute acerate flesh-spicule; *f*, minute stellate flesh-spicule (Sc. D); *g*, more magnified views of *d*, *e*, and *f*, respectively (sc. 1-48th to 1-6000th); *h*, still more magnified view of acerate flesh-spicule, to show that it is microspined and inflated in the centre; *i*, more magnified view of ray of stellate, to show that it is microspined; *k*, more magnified view of portion of disk, to show form and position of stelliform points on surface; *l*, still more magnified views of point, lateral and direct, respectively.
- Fig. 42.* The same, Australian specimen: *a a a*, vents; *b b*, pores in the crust (nat. size); *c*, spined stellate (quadriradiate) (Sc. B).
- Fig. 43.* *Tisiphonia nana*, n. sp.: *a*, zone-spicule, viewed from above, as seen *in situ*; *b*, the same, lateral view (observe the extremely short shaft); *c*, body-spicule; *d*, acerate flesh-spicule and stellate (Sc. D); *e*, more magnified view of the same.
- Fig. 44.* *T. penetrans*, n. sp.: *a*, body-spicule; *b*, acerate flesh-spicule and stellate (Sc. A); *c*, more magnified view of stellate (Sc. C); *d*, still more magnified view of ray of same.
- Fig. 45.* *Corallistes aculeata*, n. sp. Oblique view of surface, showing spikes (Sc. about A): *a*, spike-spicule, lateral view; *b*, base of the spike, broken off, viewed from above (Sc. B). (Diagrams.)
- Fig. 46.* *C. verrucosa*, n. sp. Oblique view of surface, showing verrucous cones (Sc. about A): *a*, verrucous cone-spicule, lateral view; *b*, base of the cone, viewed from above (Sc. B). (Diagrams.)
- Fig. 47.* *C. elegantissima*, n. sp., spicule of (sc. 1-48th to 1-6000th).

PLATE VIII.

- Fig. 48.* *Discodermia papillata*, n. sp. Portion of surface viewed from above: *a*, disks covered with minute, fusiform, bacillar flesh-spicules; *b*, the same without the flesh-spicule; *c*, subjacent spiculation (Sc. about D); *d*, five figures to show the transformation into the surface-spiculation seen at *c*; *e*, shaft of disk; *f*, papillæ on disk; *g*, fully formed papillæ, more magnified; *h*, fusiform bacillar flesh-spicule, much magnified; *i*, ultimate form of spicule of the interior; *k k k*, interlocking of the ends of the branches with those of neighbouring spicules; *l*, characteristic form of "interlocking," much magnified. (Diagrams.)
- Fig. 49.* *D. aspera*, n. sp. Portion of surface viewed from above: *a*, disks covered with minute, acerate, curved, fusiform flesh-spicules; *b*, the same without the flesh-spicule (Sc. about D); *c*, more magnified view of disk, showing denticulated margin and papillæ; *d*, acerate flesh-spicule (Sc. D); *e*, the same, more magnified; *f*, more advanced form of disk, in which the papillæ are transformed into spines, more or less divided; *g*, four diagrams, showing the transformation of the papillæ into the spinous condition; *h*, ultimate form of spicule of the interior;

i, characteristic form of the interlocking end of the branch, much magnified. (Diagrams.)

Fig. 50. *D. spinispirulifera*, n. sp. Portion of surface viewed from above: *a*, disks covered with acerate, curved, fusiform, and spinispirulate flesh-spicules; *b*, the same without the flesh-spicules; *c*, subsurface spiculation (Sc. A); *d*, four figures showing the gradual transformation of the disk into the subsurface spiculation *c*; *e*, magnified view of the acerate flesh-spicule; *f*, the same of the spinispirula; *g*, ultimate form of spicule of the interior; *h*, characteristic form of interlocking extremity of branch, much magnified. (Diagrams.)

Fig. 51. *D. levidiscus*, n. sp. Portion of surface viewed from above: *a*, disks covered with the acerate, curved, fusiform flesh-spicule; *b*, the same without the flesh-spicule (Sc. about D); *c*, upper surface of disk, more magnified, to show its smoothness, faint, concentric, circular lines and depression; *d*, under surface of the same, to show spine or shaft; *e*, more advanced form of same, showing subdenticulated border; *f*, acerate flesh-spicule (Sc. D); *g*, the same, more magnified; *h h*, ultimate form of spicule of interior; *i*, union of branches by simple apposition.

XVII.—*Note on the Genus Heteropora.*

By ARTHUR WM. WATERS, F.G.S.

I HAVE noticed lately in several reviews an error with regard to *Heteropora* to which it seems advisable to call attention lest it creep into the literature of the subject. The confusion is perhaps the most glaring in a review of Nicholson's 'Tabulate Corals,' in 'Nature' (March 25th)—a review which has a certain family likeness to a notice of the same book which appeared in the 'Academy' some time before, signed by Mr. Moseley, where the same mistake occurs.

In the notice in 'Nature' the reviewer says, "Some, as *Heteropora*, are, according to the late researches of Mr. Busk, of Bryozoan affinity." This shows that the points raised by Mr. Busk have not been appreciated; for the genus *Heteropora* was created by Blainville for some cretaceous fossil Bryozoa, and the genus, as palæontologists are well aware, was very abundant in the Jurassic, Cretaceous, and Tertiary periods, occurring frequently in the English Crag; but no living forms had been described until I drew attention to two living species, from Japan and Australia, in a paper with plate, "On the Occurrence of Recent *Heteropora*," in the Journ. of the Roy. Micro. Soc., May 14, 1879, in which I alluded to the minute perforations of the calcareous walls. This is of interest as being a somewhat similar structure to that of some of the so-called tabulate corals, but is not, as some seem to

suppose, in any way confined to *Heteropora*, but is a general characteristic of the Cyclostomatous Bryozoa. Shortly after the publication of my paper, Mr. Busk published an interesting account, with figures, of a species from New Zealand, to which Professor Nicholson refers in the book in question. Mr. Busk here gave a description of the species, and took it for granted that the genus was understood to be Bryozoan.

I may allude to another point, by way of caution. I was first led to study *Heteropora* by seeing, in the species I first had under observation, a deceptive appearance which I supposed, until I made sections, was due to transverse dissepiments. In recent species, in specimens from the Crag, from the Chalk of Belgium and France, and the Jurassic of Switzerland, I have been similarly misled, as when I have prepared sections I have never found any thing like septa; but M. J. Haime and Mr. Busk have both found these dissepiments; and Mr. Busk, in consequence of my remarks, confirms his previous observations. It will, however, be seen that great care is required; and it will be satisfactory if authors will say how the examination was made when they describe this structure in new species.

Professor Ehrenberg also called some true corals *Heteropora*; but the genus has not been retained, and should not cause any confusion with the well-known genus of Bryozoa. There is at present great confusion regarding the group of allied Bryozoa which we may have to call the Heteroporidæ, with which many forms described by D'Orbigny under his group *Clausa* will have to be included.

XVIII.—*Reply on the Term "Bryozoa."*

By A. W. WATERS, F.G.S.

MR. HINCKS replied to my remarks on the terms Bryozoa and Polyzoa, in the February number of the 'Annals,' and also to the same effect in his recent work on the British Polyzoa, in a manner which is to me exceedingly satisfactory, as it gives so many quotations from Thompson's original paper, and thus the question is more fully before the public. I consider the grounds for using the term Bryozoa are thereby strengthened instead of weakened, and shall therefore continue to use the term I have already adopted, but without any intention of constantly attacking those who disagree with me, as I have no wish to be led away from more serious work in

too constantly repeating my opinions on the name; but there is one point which, except for absence abroad, I should sooner have pointed out; that is, if we take the fourth paragraph on page 129, and substitute for Polyzoæ Thompson's own definition as it appears in the title, we get, "Animals of some Cellulariæ, Tubuliporæ, and Flustraceæ proved to be *new animals discovered as inhabitants of some Zoophytes.*"

It is, as Mr. Hincks sees, according to our present ideas unmeaning; but this and the sentence quoted, I can only repeat, seem to me to show most clearly that he means by Polyzoa a single polypide.

The question has been put so ably by the writer of a review of Mr. Hincks's recent book in 'The Popular Science Review' for April 1880, that I should quite hope that this may induce Mr. Hincks and some of his followers to again consider the question. This writer says that he cannot agree that Thompson used the name as a class designation, and not the name of a merely structural element, and considers that it was used by Thompson as the mere name of a single zooid, and that he was following the practice of some of the older systematists, such as Linnæus, who uses the term Hydra to designate what he calls "flores." My friend Mr. Hincks apparently thinks the position he holds is quite clear, and feels strengthened by the fact that some of his friends still believe in the name they are now accustomed to; while to me it still seems equally clear that Thompson used the term for a single polypide; and I have the support of many friends whose judgment I value.

Prof. Rupert Jones has also replied to my note in the 'Annals;' and I quite agree that he would have been more correct if he had written "Polyzoa, Busk," instead of "Polyzoa, Thompson." I said that in Ehrenberg's "Die Coral. d. R. Meeres" I did not find any indication of the Foraminifera being included. Prof. Jones points out that they were included in a paper written six years later; and it is quite true that Ehrenberg, at this time, while fully recognizing the difference between Polythalamia and Bryozoa, made an extraordinary blunder with regard to their classificatory relationship; but the term was no longer his private property, and any mistake he made after having definitely established the group does not invalidate his previous classification.

XIX.—*Description of a new Species of Helicidæ from New Zealand.* By EDGAR A. SMITH.

IN 'The Zoologist' for the year 1879, on page 61, are published a few observations upon a specimen of this species, which I then conjectured to be merely an abnormal growth of *Paryphanta Hochstetteri*. Lately, however, through the liberality of Mr. Justice Gillies of Auckland, New Zealand, the British Museum has become possessed of a second example of this interesting shell. The very remarkable characteristic, the flexibility of its substance, I formerly considered might have been produced by its having been reared in some situation where the creature was unable to procure sufficient carbonate of lime for the production of an internal shelly lining. Mr. Gillies, however, informs me that this pliability of structure is a constant feature in all the specimens he has seen, and that they never attain to the size of the adult *P. Hochstetteri*. Such being the case, and taking into consideration other differences of form and sculpture, I now feel no hesitation in describing this as a new and very interesting species.

Helix (Paryphanta) Gilliesii.

Shell umbilicated, compressed, pliable, smooth and rather glossy, exhibiting lines of growth and obsolete spiral striation upon the upper surface; colour dark chestnut, varied with spiral yellowish lines of different widths and number in different specimens. Spire depressed, probably not prominent at the apex, which is crushed into the cavity of the penultimate whorl in the two specimens before me. Whorls about five or six, very slightly convex, the last large, obtusely keeled in the crushed state of the dead shell, but rounded when inflated, not united at the suture to the previous volution for some distance from the aperture; the latter is oblique, brown within, and without a shelly lining. Peristome thin, the upper margin (viewed laterally) oblique, arcuate, not united to the columellar extremity by the slightest vestige of a callosity.

Greatest diameter 35 millims., smallest 28 millims. Height of crushed specimen about 7 millims., of one stuffed out with wool about 14 millims.

Hab. Whakamarama range of mountains, north-west of Nelson.

All the specimens known to Mr. Gillies have been found in a crushed condition, and containing more or less dried mud.

XX.—*Synopsis of the Species of Chœradodis, a remarkable Genus of Mantodea common to India and Tropical America.* By J. WOOD-MASON, Officiating Superintendent Indian Museum, and Professor of Comparative Anatomy, Medical College, Calcutta*.

THE paper, of which the following is an abstract, will be published in full as soon as the illustrations (which have been drawn on the wood under my supervision and sent to London to be cut) are returned to this country.

The remarkable distribution of this genus of Mantodea is exactly paralleled by that of another genus of Orthoptera, namely *Mastax*, species of which, from the southern slopes of the Peruvian Andes, have recently been described by Dr. S. H. Scudder.

The nearest allies of *Chœradodis* are the Australian *Orthoderas*, which its young "larvæ" resemble in the form of the pronotum.

Genus CHÆRADODIS, Serville.

A. Fore femora without a black blotch on the inner side.

1. *Chœradodis strumaria*.

Chœradodis strumaria, Madame Mérian, Ins. de Surinam, 1726, tab. 27, ♀ et nympha; Roesel von Rosenhof, Der monatlich-herausgegebenen Insecten-Belustigung, 2ter Theil, 1749, Locust. tab. iii. fig. 1 et 2, ♀ et nympha (copied from Mérian).

Mantis strumaria, Linn. Syst. Nat. Ins. t. i. pt. ii. 1767, p. 691. no. 13, ♀; Fabr. Ent. Syst. ii. 1793, p. 18. no. 21.

? *Mantis cancellata*, Fabr. loc. cit. 23; Stoll, Spectres et Mantes, pl. xi. fig. 42, ♀; Lichtenstein, Trans. Linn. Soc. Lond. vol. vi. p. 25.

Chœradodis cancellata, Serville, Hist. nat. des Orthopt. 1839, p. 206, ♀.

Crawrusa cancellata, Burmeister, Handb. d. Entom. 1839, Band ii. p. 542 (Syn. Serv. et Stoll, fig. 75, exclus.).

Chœradodis cancellata, Saussure, Mant. Améric. p. 19, ♂ ♀.

Hab. Cayenne (♀, *Serville*), Surinam (♀, *Mérian*, *Stoll*; ♂ ♀, *Saussure*).

B. Fore femora with a black blotch on the inner side.

(a) *The blotch on the lower half of the joint* (American).

In the females of the following two species, the posterior angles of the pronotal expansions are broadly rounded, and are not produced backwards beyond the level of the hinder end of the primitive pronotum.

* Communicated by the Author, having been read before the Asiatic Society of Bengal on June 2, 1880.

2. *Chæradodis rhombicollis*.

Mantis rhombicollis, Latr. in Voy. de Humboldt, Zool. Ins. p. 103, pl. 39, figs. 2, 3, ♂.

Chæradodis peruviana, Serville, Hist. Nat. des Orthopt. 1839, p. 207, ♂.

Chæradodis strumaria, Stål, Syst. Mant. 1877, p. 15, ♂ ♀.

The blotch commences, in both sexes, near the base of the femur, extends through the unguis groove nearly to the middle of the joint, and is there succeeded by a marginal row of black points in contact with the bases of alternate spines.

Hab. ♂ ♀, Guayaquil, in the collection of the British Museum; nymph, Santa Fé de Bogotá, in the collection of the Indian Museum, Calcutta; New Granada (♂ ♀, Stål).

3. *Chæradodis Servillei*, n. sp.

♀. Closely allied to the preceding, from which it differs in having the marginal field of the tegmina proportionally narrower, and in the smaller size, as well as in the different shape, of the femoral blotch, which is small and oval, commences just beyond the unguis groove, and is followed by a marginal row of small black points.

Hab. 2 ♀, Cache, Costa Rica, in the collection of Messrs. Godman and Salvin; nymph, Chiriqui, in the collection of the Indian Museum, Calcutta.

In the females of the next two species, and, in all probability, in that of *C. rhomboidea* also, the posterior angles of the pronotal lamellæ are rounded angulate and produced backwards, so that the hinder end of the primitive pronotum projects in the bottom of an angular emargination.

4. *Chæradodis laticollis*.

Chæradodis laticollis, Serville, Revue, p. 24; Hist. Nat. des Orthopt. 1839, p. 208, pl. iv. fig. 2, ♀; Saussure, Mantes Améric. p. 20, ♀.

Chæradodis strumaria, id. ib. p. 18, ♂.

Chæradodis laticollis, Stål, Syst. Mant. 1877, p. 17, ♀.

The blotch is situated, in both sexes, just beyond the unguis groove, is oblong-rhomboidal in shape, and is followed by two black points on the bases of alternate spines; there is a fuscous speck at the end of the stigmatal spot of the tegmina; and the antero-lateral margins of the pronotal lamellæ are arcuate or convex, especially in the female.

Hab. 5 ♂, 5 ♀, Ecuador (*Buckley*), in the collection of the Indian Museum, Calcutta; Peru (♀, Stål); Cayenne (♀, Serville et Stål); Surinam (♂, Saussure).

5. *Chæradodis Stålii*, n. sp.

Differs from the preceding in the shape of the blotch (which is pointed at both ends and commences in the unguis groove, and on either side of which the femur is pale luteous yellow instead of being clouded with fuscous), in being without a fuscous speck at the distal end of the stigma, in its shorter and differently shaped facial shield, and in having the antero-lateral margins and the lateral angles of the pronotal expansions sinuous-concave and more broadly rounded off respectively.

Hab. 1 ♂, 4 ♀, Ecuador (*Buckley*), in the collection of the Indian Museum, Calcutta.

6. *Chæradodis rhomboidea*.

Mantis rhomboidea, Stoll, *Spectres et Mantes*, pl. xi. fig. 45, ♂.

The male insect from Pará, in the British Museum, agrees neither with Saussure's description (*loc. supra cit.* p. 18) nor with any of the specimens in the Indian Museum; it more nearly approaches Stoll's figure, agreeing therewith in the points in which it differs from them.

The blotch commences in the unguis groove, thence extending as far along the femur as in the preceding four species; but it is not followed by a marginal row of black points. The pronotal lamellæ have no posterior angles.

Hab. ♂, Pará, in the collection of the British Museum. A nymph, from Ega, in the same collection, probably also belongs to this species.

This species is most nearly allied to *Ch. laticollis*.

(β) *The blotch on the upper half of the joint* (Indian).

7. *Chæradodis squilla*.

? *Mantis cancellata*, Fabr. *Ent. Syst.* ii. 1793, p. 18.

Chæradodis squilla, Saussure, *Mél. Orthopt.* t. i. 3^e fasc. p. 161, pl. iv. figs. 3, 3a, ♂ et nymphæ; Lucas, *Ann. Soc. Entom. Fr.* 5^e sér. t. ii. 1872, p. 32, ♀.

Hab. India generally, from Ceylon (♂ et nymphæ, *Saussure*; larva, in I. M. Calc.), Madras (♀, *Lucas*), Central India (in coll. Hop. Oxon.), to the banks of the Killing river, in the N. Khasi hills, on the north-east frontier (nymph, *A. W. Chennell*).

Obs. A specimen of this species in the British Museum is erroneously marked "Brazil."

XXI.—Description of a new Species of *Cynopterus* (*Ptenochirus*) from Sarawak. By G. E. DOBSON, M.A., M.B., &c.

Cynopterus (*Ptenochirus*) *Lucasii*, n. sp.

About the size of *Cynopterus brachysoma*. Ears short, not half the length of the head, triangular, with an obtuse tip, the outer and inner margins almost equally convex above, not margined with white. Face as in *C. marginatus*; but the nostrils do not project so much, and the groove and naked prominences on the upper lip are also comparatively much shorter. Upper and lower lips internally fringed with papillæ, as in other species; palate with five divided and five undivided ridges.

Wing-membrane from the base of the first toe on the back of the foot; calcaneum extremely short and feeble; tail short and very slender, projecting by more than half its length beyond the deeply emarginated membrane. Thumb and second fingers with well-developed claws.

Fur short, on the back and shoulders dark reddish brown, on the head and neck ashy at the extremities; beneath light yellowish grey. On the upper surface the fur scarcely extends upon the wing-membranes, and a few hairs appear upon the forearm and upon the base of the interfemoral membrane; beneath, some fine scattered hairs extend outwards upon the wing-membrane behind the humerus and one third the length of the forearm.

Dentition—*i.* $\frac{4}{2}$, *c.* $\frac{1-1}{1-1}$, *pm.* $\frac{3-3}{3-3}$, *m.* $\frac{1-1}{2-2}$ = 28 teeth.

Upper incisors separated by intervals from each other and also from the canines, directed vertically downwards, slender, cylindrical, acutely pointed, the outer pair smaller in cross section, and scarcely equalling more than half the length of the inner pair; lower incisors short, subacutely pointed, in the centre of the narrow space between the outer margins of the bases of the canines, and separated from each other by a narrow interval; canines moderate, without basal projections; first upper premolar small and short, in the centre of the space between the canine and second premolar, with a blunt crown directed slightly forwards, just rising above the gum, and not equalling the cingulum of the second premolar in vertical extent; second upper premolar well developed, exceeding the canine in cross section at the base; third premolar equal to, or slightly greater than, the preceding in cross section; molar about three fourths the size of the third premolar, flat-crowned,

scarcely rising above the gum. First lower premolar small, but larger than the first upper; second premolar considerably larger than the canine in cross section, and nearly equal to it in vertical extent; third again larger, but with a short external cusp; first molar less than the last premolar, about three fourths its size, flat-crowned; second molar much smaller, scarcely more than half its antero-posterior diameter, and level with the gum.

The skull presents no peculiarity; zygomatic arches well developed, postorbital processes of the frontals short and very acute at their extremities; no prominent sagittal ridge.

Length of an adult, head and body, 3·2 inches, tail 0·4, head 1·2, eye from tip of nostril 0·4, ear 0·55, forearm 2·3, thumb 0·8, second finger 1·45; third finger—metacarp. 1·55, 1st ph. 1·0, 2nd ph. 1·5; fifth finger—metacarp. 1·45, 1st ph. 0·75, 2nd ph. 0·75; tibia 1·0, calcaneum 0·2, foot 0·58.

Hab. Saráwak, Borneo.

The above description has been taken from one of four male specimens preserved in alcohol from the collection of Ward's Museum, Rochester, New York, U. S. A. All agree remarkably closely in measurements and in other respects.

It may be seen from the description that this species is very much smaller than the only other known species of the subgenus *Ptenochirus*, namely *C. Jagorii*, Ptrs., from the Philippine Islands, from which it differs also in the form of the extremity of the muzzle and in the relative position and size of the teeth.

The specimen from which I have taken the above description was kindly forwarded to me by Mr. Frederic A. Lucas, who had correctly recognized it as representing a hitherto undescribed species; and I have therefore much pleasure in connecting his name with it.

XXII.—*On Bats from Old Calabar.* By OLDFIELD THOMAS, F.Z.S., Assistant in the Zoological Department, British Museum.

THROUGH the kindness of Dr. J. A. Smith, of Edinburgh, the British Museum has recently received a small collection of Bats obtained at Old Calabar by Dr. A. Robb, of the United Presbyterian Mission at that place.

The collection consists of four specimens of *Epomophorus comptus*, All., concerning which Dr. Smith has himself pub-

lished a most valuable notice*, one specimen each of *Nycteris grandis*, Ptrs., *Vesperugo nanus*, Ptrs., a new species of *Vesperugo*, a new species of *Kerivoula*, and an immature specimen of a species allied to, or identical with, *Vesperugo Kuhlii*, Natt., but which is not in a condition to be certainly determined.

The following are descriptions of the new species above referred to:—

Vesperugo (Vesperus) brunneus.

Muzzle broad and flat above, the glandular prominences well developed increasing its width. Ears rather shorter than the head, laid forward they reach to about half-way between the eye and the tip of the nose; inner margin faintly convex, tip broadly rounded off; outer margin evenly convex, an angular emargination opposite the base of the tragus, basal lobe elongated.



Tragus of medium length, inner margin straight, tip obliquely truncated; outer margin also straight, nearly parallel with the inner; basal lobule small, triangular.

Wings from the base of the toes; postcalcanal lobe well developed; tail entirely contained in the interfemoral membrane.

Fur above and below dark brown.

Outer upper incisors minute, barely one third the height of the large unicuspidate, inner incisors, and about one fourth the size in cross section at the base; no trace of a first premolar. Lower incisors rather crowded, overlapping, at right angles to the direction of the jaw; second lower premolar about twice as long as the first, and about equal to the anterior cusp of the first molar.

Length (of the type, a female, preserved in alcohol)—head and body 1''·8, tail 1''·35, head 0''·6, ear 0''·55, tragus 0''·2, forearm 1''·33, third finger 2''·27, fifth finger 1''·6, tibia 0''·5, foot 0''·35.

Vesperugo brunneus appears to be most nearly allied to *V. capensis*, Sm.; but it differs from that species by its unicuspidate inner upper incisors, and also, as well as from all the other species of the subgenus, by its very peculiarly shaped tragus. The only species of the genus that have a tragus at

* Proc. Roy. Phys. Soc. April 1880, p. 362.

all like it are *V. vagans*, Dobs.*, and, in a much lesser degree, *V. maurus*, Blas.; but these species have a very different dentition, possessing a minute first upper premolar and other characters of the subgenus *Vesperugo*.

Kerivoula Smithii.

Ears of medium length, laid forward they extend about one tenth of an inch beyond the end of the muzzle; inner margin very strongly convex, its centre being over a point halfway between the eye and the tip of the nose; outer margin with a deep emargination just below the tip. Tragus slender, tapering, with a very small triangular lobule at the base, succeeded above by a shallow emargination, as shown in the woodcut; from the angle above this emargination the sides slope evenly to the tip, which is acutely pointed.

Fur, above and below, greyish brown, the tips of the hairs shining grey.



Wings to the base of the toes.

Distribution of fur much as in *K. lanosa*, Sm., with the exception of the marginal fringe to the interfemoral, of which there is no trace in this species.

Inner upper incisors long, with a distinct posterior secondary cusp at a point about two thirds of their height; the outer upper incisors just equal the secondary cusp of the inner incisors, and have also a distinct internal posterior secondary cusp, whose tip is about half as high as the main cusp; upper premolars bearing the usual proportions to each other, the third being the largest and the second the smallest, the first being just intermediate in size. First and second lower incisors trilobate, outer ones unicuspidate; lower premolars equal.

Length (of the type, an adult male, in spirit)—head and body 1^{''}.55, tail 1^{''}.7, head 0^{''}.58, ear 0^{''}.55, tragus 0^{''}.3, forearm 1^{''}.3, thumb 0^{''}.27, third finger 2^{''}.7, fifth finger 1^{''}.9, tibia 0^{''}.55, foot 0^{''}.25.

This species belongs to Dr. Dobson's second section of the genus †, characterized by the presence of a basal lobe to the tragus; this lobe, however, is very small as compared with that of the other species of the section.

In addition to the characters of the tragus, which might

* Ann. & Mag. Nat. Hist. 1879, iv. p. 135.

† Cat. Chir. B. M. p. 332.

easily be overlooked in a dried specimen, *K. Smithii* differs from *K. brunnea* and *K. lanosa* by the absence of an inter-femoral fringe, from *K. africana* by the presence of a secondary cusp on the outer upper incisors, and from *K. ærosa* by the comparatively large size of the same tooth. All the other species hitherto described are from the Oriental Region.

I propose to name this species after the donor of this most acceptable addition to the national collection of Chiroptera.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

April 14, 1880.—Robert Etheridge, Esq., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "On a new Theriodont Reptile (*Chiorhizodon orenburgensis*, Twelvt. r.) from the Upper Permian Sandstone of Kargalinsk, near Orenburg, in South-eastern Russia." By W. H. Twelvetrees, Esq., F.L.S., F.G.S.

The above measures are cupriferous, and rest on limestone with Zechstein fossils. Associated with the remains of Saurians and Labyrinthodonts are *Calamites*, *Lepidodendron*, *Aroides crassispatha*, Conifers, and a *Unio*. The specimen noticed in this paper is apparently the dentary part of the left mandibular ramus, with the crowns of a canine, an incisor, and ten of the molars. The author describes the characteristics of these and the mode of implantation in the jaw, which accords with that described by Prof. Owen in *Titanosuchus ferox*. The characters of this specimen resemble those of the genus *Rhopalodon*; but as there are some marked differences, the author proposes to name it *Chiorhizodon orenburgensis*.

2. "The Classification of the Tertiary Period by means of the Mammalia." By Prof. W. Boyd Dawkins, M.A., F.R.S., F.G.S., Professor of Geology in Owens College.

The author, after some introductory remarks on the value of Vertebrata and Invertebrata in classification, pointed out that the Mammalia become of especial value in the Tertiary period, undergoing more rapid change than the other classes, from their being, as it is happily termed, *en pleine évolution*. He discussed the characteristics of each of the great periods, as defined and limited by their Mammalia, pointing out that throughout the Eocene these frequently exhibit relations more or less marsupial. Indeed it is not till the close of the Lower Miocene that the traces of this relationship are lost. In the Middle Miocene *Sus*, *Cervus*, *Antilope*, *Felis*, *Lutra*, and *Castor* appear for the first time, and the higher Apes were present in European forests. In the Upper Miocene

Camelopardalis, *Gazella*, *Hycæna*, and *Hystrix* appear. During the Pliocene several important genera disappear from the world or from Europe—among the latter the Apes, at the close of the Upper Pliocene. Oxen, Horses, Bears, and Elephants appear. Great changes took place in the Pleistocene: seven species survived into it which are now extinct; and of new comers there were fourteen living and seven extinct species. *Cervus megaceros* is the sole survivor from the Pleistocene to the prehistoric period which has since become extinct. The paper concluded with some remarks on the latter part of the first and the second period, which, however, as forming the subject of previous notices, was treated more briefly. The author remarked that a study of the development of the Mammalia renders it hopeless to expect to find Man in the Eocene or Miocene, and improbable in the Pliocene.

April 28, 1880.—Robert Etheridge, Esq., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "Description of parts of the Skeleton of an Anomodont Reptile (*Platypodosaurus robustus*, Ow.) from the Trias of Graaff Reinet, South Africa." By Prof. Owen, C.B., F.R.S., F.G.S.

The author referred to some Triassic reptiles from South Africa, already described by him, as showing certain resemblances to implacental Mammals. Another still more interesting indication of such resemblances is furnished by some remains from Graaff Reinet received from Mr. E. J. Dunn. These consist of some thoracic vertebræ with portions of ribs, a sternal bone, a scapula, and a right humerus, found imbedded in one mass of rock, and of a femur and phalanges and a pelvis in another mass.

The author described these bones in detail. The vertebræ were said to agree most nearly with those of *Dicynodon* and *Oudenodon*. The supposed sternal bone is of a rounded hexagonal form, and is regarded by the author as the anterior bone of the sternum proper, which is usually unossified in recent lizards, but well ossified in *Ornithorhynchus*. In the scapula also the author pointed out resemblances to that bone in *Ornithorhynchus*. The humerus in its general proportions, and especially in the great development of its ridges, was also shown to resemble the same bone in the Monotremes. The ungual phalanges were described as broad and obtuse, probably constructed to bear claws adapted for digging, as in *Echidna*; the femur also resembles that of the last-named animal.

The author remarked upon these approximations to the Monotrematous Mammalia, in allusion to which he proposed the name of *Platypodosaurus robustus* for this animal, the humerus of which was $10\frac{1}{2}$ inches long and nearly 6 inches broad at the distal end. He also alluded to the interesting problems opened up by the study of these South-African reptiles, in connexion with their possible relationships to the low implacental Mammalia of New Guinea, Australia, and Tasmania.

2. "Note on the Occurrence of a new Species of *Iguanodon* in the Kimmeridge Clay at Cumnor Hurst, three miles west of Oxford." By Prof. J. Prestwich, M.A., F.R.S., F.G.S.

The pit in which the occurrence of *Iguanodon* was discovered was worked in Kimmeridge Clay at the foot of an outlying mass of Lower Greensand forming an isolated hill. The Portland beds, which occur at Shotover, are here wanting. The bones were found in a thin sandy seam intercalated in the clay, and traversing the hill, at least 15 feet below the Greensand. The skeleton was probably almost entire; but, as attention was not directed to it until nearly all the clay had been removed, many bones were lost and others injured. Several vertebræ of *Ichthyosaurus* were found in the same seam, and the characteristic *Gryphæa virgula* occurred in profusion. The clay above and below contained fossils of Kimmeridge types. The author stated his opinion that land probably lay to the south-west of the Oxford district.

3. "On *Iguanodon Prestwichii*, a new Species from the Kimmeridge Clay." By J. W. Hulke, Esq., F.R.S., F.G.S.

In this paper the author described in detail the remains of *Iguanodon* found at Cumnor Hurst in the Kimmeridge Clay, as described in the preceding paper. They illustrated nearly every part of the skeleton of an immature individual, adding greatly to our knowledge of the variation of the vertebræ in the several regions of the vertebral column, and of the structure of the head and hind limbs. In the latter, both the tibia and the fibula articulate (as in embryo birds) with the os calcis, which bone is now first identified in *Iguanodon*. The sacral vertebræ were only four in number; and the species further differed from the Wealden *Iguanodon Mantelli* in the simpler character of the serration of the teeth, of which the lamellæ are not mamillated, and in having the vertebræ of the trunk and sacrum not so compressed. The author named the species *Iguanodon Prestwichii*.

MISCELLANEOUS.

On the Organization and Development of the Gordii.

By M. A. VILLOT.

IN again treating of this interesting subject, which has constantly occupied me for the last eight years, I propose to make known certain facts which had escaped my former observations, and to remove the doubts which the latter have left in the minds of several naturalists.

The detailed descriptions and the figures that I have given of the first larval form of *Gordius* have been recognized as correct by the observers who have followed me. I have, however, an omission to make good. I forgot to say, in my monograph, that the three styles with which the trunk is armed are moved by the same number of

special muscles. These three muscular ribbons start from the base of the styles, and are inserted upon the well-marked constriction which separates the body from the tail. They cause the movements of protraction and retraction of the trunk, which are completely independent of those performed by the rest of the head. The latter are effected by means of the cylindrical subcutaneous muscle, which at the same time gives motion to the circlets of hooks.

I insist upon this fact, that the first larval form of the *Gordius* differs greatly from that of the Nematoid worms. In these latter, even including the aberrant genera (*Mermis* and *Sphærulearia*), the embryo and the larva are represented by the type of the Anguilulæ (*Rhabditis*). Now it would need a great effort of the imagination to refer the larva of *Gordius* to this type. The order Gordiacei, as established by Von Siebold, cannot therefore be retained by zoologists, who nowadays attach the greatest importance to the characters furnished by embryogeny and morphogeny.

The second larval form differs from the first as much as the latter differs from the sexual form. It is characterized essentially by the loss of the styles, the shedding of the hooklets, and the disappearance of the annulations.

Each of the two larval periods includes two very distinct phases, that of parasitism and that of aquatic existence; but these two phases do not in each case occur in the same order. In its first larval form the young *Gordius* passes from aquatic life to the state of a parasite; in its second larval form it quits its post to return to the water. The two phases of parasitism, although immediately succeeding one another, differ essentially. So long as the first phase lasts, the young worm, enclosed in its cyst, remains motionless and does not appear to take any nourishment or to grow at all. During the second, on the contrary, it is free, lives at the expense of its host, and becomes very rapidly developed.

It has been supposed hitherto that the passage from the first larval form to the second is connected with a migration, a change of host. The observers who saw larvæ of *Gordius* encyst themselves in larvæ of Ephemeriidæ supposed that the Dyticidæ swallowed these encysted larvæ with their prey, and that the young *Gordii* developed themselves in the visceral cavity of their new host. For this hypothesis, which is still classical, I substituted another which appeared to me of more general application. I said that the *Gordii* parasitic upon fishes proceed from larvæ previously encysted in various species of Tipulidæ, the larvæ of which likewise lived in the water; and I founded my argument upon the consideration that fishes are, in general, very fond of those insects. Both hypotheses are contradicted by the well-ascertained fact that the two larval forms of the *Gordii* live indifferently in the various aquatic hosts indicated. I therefore now regard it as very probable that the two phases of the parasitism of the *Gordii* are accomplished in one and the same host.

Observation also proves that the larvæ of the *Gordii* do not select their host. They encyst themselves and become developed in the most different animals (Batrachians, fishes, Crustaceans, Arachnids,

insects, and mollusks). It is therefore by no means the case, whatever may have been said, that the larvæ of the *Gordii* are parasites peculiar to insects. As regards fishes, these, as I have asserted, are perhaps the animals which harbour these larvæ most frequently and in the greatest number. It is only necessary to open a few individuals belonging to the species that I have indicated to become convinced of the reality of this fact.

It is none the less evident that the normal hosts of the *Gordii* are all animals exclusively or temporarily aquatic. Water is, in fact, the normal medium of the *Gordii*. It is in the water that they become adult and that they reproduce; it is in the water that their larvæ live at first on their escape from the egg; and it is also in the water that their migration must be effected.

The parasitism of the larvæ of the *Gordii* in terrestrial animals has an essentially abnormal and exceptional character; and in order to explain it we must have recourse to very peculiar conditions. In countries of plains these are realized by the periodical inundations of the great streams and by the systematic irrigations to which the natural or artificial meadows are subjected throughout the summer. In the mountains, and upon inclined ground generally, matters are different. Brooks and torrents only too frequently escape from their beds. The storms of rain which are so frequent in these regions form actual sheets of water which carry away every thing in their course—soil, plants, and animals. Many terrestrial insects (Carabidæ, Mantides, grasshoppers, and locusts) must perish in this way; and the worms which they contain, being set at liberty, have only to abandon themselves to the stream. Thus we often find young *Gordii* in the very primitive reservoirs, hollowed out of the trunk of a tree, which serve the mountaineers to collect drainage-water.

The frequency of the larvæ of *Gordii* in insects, which is usually objected against my views, is more apparent than real. It must be borne in mind that the insects are represented by a great number of species, and that they are sought after by most naturalists.—*Comptes Rendus*, June 28, 1880, p. 1569.

On a new Species of Dasyurus from New Guinea.

By M. A. MILNE EDWARDS.

The collections which have been made of late years in New Guinea indicate resemblances previously unsuspected between the fauna of that great island and that of Australia. Many mammals which were thought to be peculiar to New Holland have been found upon the land of the Papuas; and among the more remarkable I may cite the Echidnas, represented by two very distinct forms, the true Phalangiers and the dwarf and flying Phalangiers, the Cuscus, the Kangaroos, the Bandicoots, and the Phascogales. But hitherto the Australian true Carnivorous types had not been indicated in New Guinea. This gap has just been filled up by the discovery at the Arfak Mountains of a representative of the genus *Dasyurus*. Several species of this small group were already known in Australia—some attaining the size of a cat (such as *Dasyurus*

macrourus), the others smaller (namely *Dasyurus Geoffroyii*, *viverrinus*, and *hallucatus*). All are readily recognizable by the white spots of their fur.

The new species, which I designate *Dasyurus fuscus*, is smaller than the *Dasyures* already described by zoologists; its size does not exceed that of a large rat. Its fur is of a very dark brown colour, especially on the upper parts; it becomes lighter on the flanks and the sides of the head. The throat, breast, and belly are yellowish. Small, white, rounded spots, regularly disposed, are observed on the upper part of the body and on the flanks, shoulders, and thighs; they are indistinct on the head, and are wanting on the limbs and tail. These spots are smaller than in any other *Dasyure*. The ears are short, broad, and scarcely hairy. The tail is long, cylindrical, and brown; it is not bushy like that of *Dasyurus viverrinus* and *Geoffroyii*. The fore feet bear five toes, armed with sharp claws; the first toe is the smallest of all, the second and third are nearly equal, and the fifth is shorter than the fourth. The hind foot is furnished with a very short thumb without a nail, like that of *Dasyurus hallucatus*; the other four toes are long, well separated from each other, and terminated by sharp claws. The body from the muzzle to the base of the tail measures 0.23 metre; the tail 0.19 metre.

Dasyurus fuscus was found on the Arfak Mountains, at the entrance of the Bay of Gelwinck, on the north coast of New Guinea, by the collectors of M. Bruijn of Ternate; and the Museum of Natural History has acquired the specimen. It is interesting to find that the Australian species which it most nearly approaches, *Dasyurus hallucatus*, in which the hind feet are also furnished with five toes, is only met with towards the northern extremity of Australia.

In Australia the *Dasyures* vary much in colour; some are black, others tawny, others greyish; and for a long time it was erroneously believed that these differences characterized so many species. It is probable that, when we know the *Dasyurus fuscus* of New Guinea better, we shall find differences of the same kind in the tints of its fur.—*Comptes Rendus*, June 28, 1880, p. 1518.

Gynandromorphous Specimens of Cirrochroa aoris.

By A. G. BUTLER, F.L.S. &c.

In part ii. of the 'Transactions of the Entomological Society' for the present year (pp. 113–117, pl. ii.) Professor Westwood has described and figured two gynandromorphous specimens of the genus *Cirrochroa*; but as the Professor does not state distinctly in what collection these singular examples exist, it may be useful to record the fact that they are in the British Museum, and were collected by Dr. Lidderdale.

It is well known that the butterflies collected by Dr. Lidderdale were obtained over a considerable area; and therefore it is not surprising to find that the two specimens above referred to are referable to different, though nearly allied, local races. The true *C. aoris* is represented by fig. 3 of the plate.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 33. SEPTEMBER 1880.

XXIII.—*On the Pentastomum polyzonum of Harley; with a Note on the Synonymy of the allied Species.* By F. JEFFREY BELL, M.A.

THE interest and importance which attach to an exact knowledge of the history and distribution of all entozoic parasites induce me to give as careful a description as is possible of two specimens of a species of *Pentastomum* which were lately forwarded to the British Museum by Mr. W. E. Dawes. They had been taken from a "boa constrictor" which had been in Wombwell's menagerie. Unfortunately the skin was not examined while in a condition in which the species could be definitely distinguished; but Dr. Günther is satisfied that the specimens were taken from an African python; they are said to have been found in the "flesh of the body" as well as "within the intestines."

As in so many other branches of zoology, the question of synonymy still hampers the progress of investigation; and it will be necessary to direct attention to the names of several of these Arachnoid forms which are known to be parasitic in the Ophidia.

The most common entozoon of this genus would appear to be the *P. proboscideum* of Rudolphi, to which I should be inclined to give rather the name of *P. crotali*; for the synonymy of Diesing*, and of Rudolphi himself †, seem to me to

* Monog. *Pentastoma*, p. 21.

† Entoz. Synopsis, p. 434.

be conclusive as to the point that the credit of first describing and naming this species belongs to Alexander von Humboldt*. At any rate I am quite certain that there is no justification at all to be found for the name adopted by M. Ménégin in his just published and valuable handbook on parasites †; for the name of *moniliforme* was not given by Diesing till the year 1836, and was then given to what is either a very well-marked variety of *P. proboscideum*, Rud., or, as is more probable, and as Leuckart ‡ imagines, a species distinct from that more common form.

The peculiarly unsatisfactory representation of the creature given by M. Ménégin, is not obscure as to one point only, the moniliform character of the example figured (*t. c.* fig. 62, A); so far, however, as a judgment on this point can be given from the specimens of this species which already exist in the national collection, and which were named by no less eminent a zoologist than the late accomplished Dr. Baird, it seems pretty certain that this moniliform appearance is an unusual and not a typical occurrence among examples of this Ophidian entozoon.

P. teretiusculum, Baird §, is one of the few species described since the publication of Leuckart's essay; but it is quite distinct from the creature now under investigation.

P. annulatum, from the Egyptian cobra (*Naja haje*), was described and figured by Dr. Baird in 1853 ||; but it is not mentioned in the synopsis of species which concludes Leuckart's essay (1860) ¶. Unfortunately it does not form a portion of the national collection; and it is impossible to say whether, with the twenty-eight rings with which Dr. Baird credits it, the length should be stated at $2\frac{1}{4}$ inches or at 3**.

In the year 1857 Dr. George Harley read before the Zoological Society a paper entitled "On the Anatomy of a new Species of *Pentastoma* found in the Lung and Air-sac of an Egyptian Cobra." This cobra was the "*Naja haje*;" and

* See Humboldt and Bonpland, Voyage, ii. 1, p. 301.

† Les Parasites et les maladies parasitaires (Paris, 1880).

‡ Bau u. Entw. der Pentastomen, p. 154.

§ P. Z. S. 1862, p. 114.

|| P. Z. S. 1853, p. 22.

¶ I fancy Dr. Baird's work must have been unknown to Prof. Leuckart; for I find no reference to *P. megacephalum*, described in the same paper and figured in the Museum catalogue of Entozoa by Dr. Baird (1853).

** The latter statement as to its length was made by Dr. Edwards Crisp in what appears to have been a verbal communication to the Zoological Society (P. Z. S. 1853, p. 68); the type seems to have been in the possession of the Society, and to have passed, on the dispersal of their museum, into the hands of the naturalist just named.

the paper justifies its title by dealing only with the anatomy of the new species, of which the author gives no technical zoological description. He does, however, give a figure of it; and as that figure was drawn by Mr. Ford, there is no need to say that it is excellent. The parasite is represented as of the natural size, *i. e.* 94 millims. long, and at the rings about 5 millims. wide; there are, as I count them, 27 of these rings.

When we compare this figure with the description and figure given by Dr. Baird (*t. c.* p. 22), we shall, I think, be led to conclude, with Dr. Harley*, that the species are identical; and we shall therefore have to regard the term *multicinctum* of the latter author as synonymous with the earlier term *annulatum*.

Dr. Harley concludes his paper with a reference to another form, of which he provides us with an admirable figure. His only account of it is a slight comparison of its characters: it is "shorter and thicker, has only nineteen strong projecting rings instead of twenty-seven, and its tail is conical and not cleft." It was found in the collection of Dr. Sharpey, but had no history connected with it. For this species Dr. Harley proposed the name of *polyzonum*.

As Leuckart's definition was drawn up from Harley's paper without the inspection of any specimens, I add the following description, drawn up from the two specimens forwarded by Mr. Dawes:—

The specimens are two in number, both female, and respectively 73 and 55 millims. long; they are of a cream-white colour; and the integument is, at regular intervals, produced into an encircling ridge, so that the animal is divided externally into a number of rings; the general character of these cannot perhaps be better defined than in the words of Diesing, "cute externâ in formâ præputii;" and this is especially true of the terminal division. The head is square, and measures, in the larger specimen, 5 millims. either way. On its inferior surface and quite at the anterior edge there are four elongated slits, taking a slight direction outwards; and each of these is provided with a single largish hook, sharply recurved at its extremity. The small circular dot-like mouth is about 1·5 millim. from the anterior edge of the head.

Of the succeeding rings there are nineteen in both specimens; the general width of the body at the rings is 7·5 millims.; and the intervening parts are about 5 millims. wide. It is

* "I think it probable, however, that the animal which he [Dr. Baird] described is one of the same species as I have obtained specimens of."

only quite at the end of the body that any tapering becomes apparent, and the last ring does not extend onto the ventral side.

When this description is compared with the figure supplied by Dr. Harley it is impossible to detect any difference; that learned naturalist does not state definitely whether the creature is figured of its natural size (it there measures 68 millims.); but we may trust Mr. Ford to have represented its general proportions, and to have given exactly the number of its rings; these are nineteen in number, or exactly the same as in the specimens sent by Mr. Dawes. The figures, then, given by Dr. Harley being so completely recognizable, I have great pleasure in applying to these creatures the name given in his plate, and thereby to credit the British Museum with two specimens of the species *P. polyzonum*, Harley.

In conclusion, the discussion of the characters of these two species seems to me to give a value to the number of the rings which a less critical examination would hardly have induced us to suspect.

XXIV.—*New Neotropical Curculionidæ*.—Part III.

By FRANCIS P. PASCOE, F.L.S. &c.

AMBATINÆ.

Ambates elegans.
— *cretifer*.

PRIONOMERINÆ.

Themeropis divergens.
Camptochirus ornatus.
— *abstersus*.
— *angustus*.

ZYGOPINÆ.

Mnemyne, n. g.
— *viduata*.

TRYPETINÆ.

Trypetes politus.

PERIDINETINÆ.

Peridinetus distinctus.
— *cretaceus*.
— *cinctus*.

BARIDIINÆ.

Glycaria, n. g.
— *tetrasticta*.
Anexantha, n. g.
— *castanea*.
Azygides, n. g.
— *stygius*.
Madarus crassirostris.

Ambates elegans.

A. ellipticus, fuscus, supra utrinque linea flava marginali, elytris que maculis flavis, ornatus; pedibus rufo-ferrugineis. Long. 4 lin.

Hab. Macas.

Dark brown, with a line of pure yellow scales extending from the rostrum, over the eye, and along the sides of the prothorax and elytra, nearly meeting its fellow at the apex,

the elytra within the lines dotted with small oblong patches of yellow scales; rostrum slender, curved, ferruginous, with three raised lines anteriorly; antennæ ferruginous, the club black, first joint of the funicle shorter than the second; prothorax closely punctured, a slight carina at the apex; scutellum glossy black; elytra striate, interstices impunctate; legs somewhat slender, reddish ferruginous.

Allied to *A. 4-lineatus* (Fab.), but broader, more elliptic, with spotted elytra and longer legs, differently coloured. *A. rufipes*, Kirsch, has, *inter alia*, a stout rostrum, very slightly curved. In these and several others the elytra are abruptly deflexed on the sides.

Ambates cretifer.

A. oblongus, subparallelus, nitide niger; clytrorum maculis quinque, et prothoracis metathoracisque lateribus, dense albo-squamosis. Long. $4\frac{1}{2}$ lin.

Hab. Chontales.

Oblong, somewhat parallel at the sides, glossy black; the sides of the prothorax, five spots on the elytra (one apical and two on each at the sides), and the metathorax, except in the middle, covered with chalky white scales; rostrum rather slender, slightly elongate, finely punctured; antennæ ferruginous, second joint of the funicle twice as long as the first; prothorax convex above, minutely punctured; scutellum transverse; elytra not abruptly deflexed at the sides, seriate-punctate, the punctures small, oblong; beneath glossy black, scaleless, except the sides of the metathorax, and a large space on each side of the third abdominal segment, which are covered with chalky scales; legs glossy black, the hind tibiæ on the lower internal edge fringed with white hairs.

This species has the aspect of a *Hilipus*, from which it differs generically in its ascending mesothoracic epimera.

Themeropsis divergens.

T. fusco-umbrinus, pedibus quatuor posticis omnino rufo-testaceis; elytris apicem versus gradatim latioribus, singulis pone medium tuberculo conspicuo ad latera instructis. Long. $1\frac{1}{2}$ lin.

Hab. Parana.

Opaque umber-brown; rostrum slightly carinate at the base; eyes not contiguous; antennæ testaceous; prothorax granulate-punctate; scutellum cordate-triangular; elytra short, much broader towards the apex, the shoulder obliquely angled, sulcate, marked with oblong shining depressions, on each clytron behind the middle and towards the side a

strongly marked conical tubercle, inclining outwards; distal half of the anterior tibiæ and their tarsi, and the intermediate and posterior legs, reddish testaceous.

Differs from *T. fimbriatus* in the sculpture, form of the elytra, and particularly in the two diverging tubercles.

Camptochirus ornatus.

C. subovalis, latiusculus, rufo-fuscus; elytris plagiis duabus ochraceis albo-marginatis, una rotundata basali, altera irregulari apicali, ornatis; rostro modice robusto; scutello transverso. Long. $3\frac{1}{2}$ lin.

Hab. Columbia.

Suboval, rather broad and depressed, chocolate-brown, with two large ochraceous spots, margined with white, on the elytra—the one rounded, basal, nearly enclosing the scutellum, the other apical and irregular or constricted in the middle; rostrum robust, slightly curved, scarcely as long as the prothorax, and sharply carinate at the base; antennæ brown, the funicle not longer than the club, the last five joints very transverse; prothorax rather longer than broad, narrowed anteriorly, granulate-punctate, a triangular ochreous spot at the base; scutellum transverse, rounded behind; elytra much broader than the prothorax, the sides subparallel, rounded posteriorly, striate, covered with a short thick tomentum; beneath dark brown, the sides of the thorax closely covered with ochreous hairs.

This and the next species will form a distinct section of the genus, characterized by the short broad elytra, without tubercles.

Camptochirus abstersus.

C. subovalis, brevis, fere omnino castaneo-fuscus; rostro tenuiore; scutello cordato. Long. $3\frac{1}{4}$ lin.

Hab. Para.

Shorter than the preceding and proportionally broader, dark chestnut, but lighter at the base and along the sutural region of the elytra; rostrum rather slender and nearly straight, slightly carinate at the base; funicle and club short; prothorax covered above with a dense tomentum, the sides bare and punctured; scutellum small, cordate; elytra broader than the prothorax, oblique at the shoulders, the sides subparallel, the apex broadly rounded, sulcate; interstices flattened; body beneath and legs sparsely hairy; tarsi fulvous.

Camptochirus angustus.

C. fuscus, sublinearis; elytris elongatis, parallelis, prothorace vix latioribus. Long. 2 lin.

Hab. Columbia.

Sublinear, dark brown, with scattered minute white hairs; rostrum twice as long as the head; antennæ fulvous, inserted behind the middle, first and second joints of the funicle equal in length; prothorax slightly longer than broad, narrowed anteriorly, and rather coarsely punctured, towards the apex two large but slightly elevated tubercles; scutellum narrowly elongate, covered with white hairs; elytra parallel, more than twice as long as broad, flattish above, somewhat truncate and abruptly rounded behind, punctate-striate, the punctures linear with bluish intervals; body beneath glossy brown; anterior tarsi and intermediate and posterior tibiæ and their tarsi fulvous.

A remarkable form, but with scarcely sufficient characters to warrant generic separation.

MNEMYNE.

Rostrum elongatum, arcuatum, basi ampliatum; *scrobes* pone medium incipiunt. *Antennæ* graciles; *scapus* oculum haud attingens. *Prothorax* normalis, basi bisinuatus. *Elytra* subcordata, humeris carinatis. *Rima* pectoralis usque ad abdomen protensa, apice aperta. *Pedes* elongati; *femora* dentata; *tibiæ* rectæ, compressæ, unguiculatæ; *tarsi* breves; *ungues* simplices, divaricati. *Abdomen* segmentis duobus basalibus ampliatis.

This genus is unique among the Zygopinæ in having the pectoral canal prolonged on the metasternum, and terminating close to the first abdominal segment. In other respects there is no structural difference, except of a secondary character; but the whole aspect and colour of, at present, the only species, is highly peculiar.

Mnemyne viduata.

M. ovalis, nigra subnitida; antennis ferrugineis; scutello niveo-squamoso. Long. $2\frac{1}{2}$ lin.

Hab. Para.

Oval, black, with few scales; head depressed above between the eyes, the latter with the margin concave on each side of the depression, contiguous in front; rostrum slender, smooth, angular and punctured at the base; antennæ ferruginous; scape short; funicle with the second joint about four times the length of the first, the third and fourth equal and together as long as the first, the last three shortly turbinate;

club ovate; prothorax a little broader than long, subconic, grooved along the anterior margin, reticulately punctured, except three black velvet-like spots at the base, each puncture bearing a white hair-like scale; scutellum round, white; elytra subcordate, the base irregular, raised above the prothorax, carinate at the shoulder, concave transversely behind the scutellum, and convex beyond, covered with silvery approximate scales, partially varying according to the light, striæ nearly obsolete or marked chiefly by larger scales, but more distinct posteriorly, and their interstices raised; body beneath black, with scattered white scales; legs sublinear, elongate, especially the posterior pair; tibiæ straight, compressed; tarsi with the third and fourth joints ferruginous, the penultimate narrowly lobed.

Trypetes politus.

T. oblongus, depressus, nitidissime niger; prothorace impunctato; elytris parallelis, supra obsolete striatis, postice lineis elevatis acutis instructis. Long. 7 lin.

Hab. Chyavitos (Eastern Peru).

Oblong, depressed, glossy black; rostrum slender at the base, gradually broader to the tip; prothorax not broader than the elytra, impunctate; scutellum short, somewhat rounded; elytra with a sutural stria on each, a few sharply raised short lines posteriorly, which, at the sides, extend nearly to the middle; body beneath and legs black, shining.

At once distinguished from its two congeners by its smooth prothorax and elytra.

Peridinetus distinctus.

P. oblongo-ovatus, nitide niger, prothorace utrinque, elytrorum macula obliqua laterali, dense niveo-squamosis. Long. $4\frac{1}{4}$ lin.

Hab. Mexico.

Oblong-ovate, glossy black, the sides of the prothorax, a large oblique spot on each elytrum directed from the side backwards and approaching the suture, and the sides of the metathorax closely covered with pure white scales; rostrum moderately robust, smooth; first joint of the funicle much longer than the second, club elongate-ovate, pointed; between the eyes an oblong deeply impressed fovea; prothorax finely punctured; scutellum transverse, rounded behind; elytra finely striate, the striæ with linear punctures, the interstices minutely punctured; body beneath black, scaleless, except the sides of the metathorax; legs with small scattered white scales; tibiæ subsinuate.

This species resembles an *Ambates*. *Ephimerus*, Schönh., unknown to Lacordaire, should be placed in this subfamily.

Peridinetus cretaceus.

P. oblongo-ovatus, nitide niger, prothorace utrinque, elytrorum maculis duabus anticis obliquis lateralibus, duabus posticis triangularibus, dense cretaceo-squamosis. Long $4\frac{1}{2}$ lin.

Hab. Chontales.

Oblong-ovate, glossy black, the sides of the prothorax, a large oblique spot directed from behind forwards and approximating at the suture, and posteriorly a triangular spot continuous with the apex, except at the suture, and sides of the metathorax densely covered with chalky white scales; rostrum moderately robust, smooth; antennæ pitchy; first and second joints of the funicle equal in length, club ovate; between the eyes an oblong fovea; prothorax finely punctured; scutellum transverse, slightly rounded behind; elytra finely striate, the striæ with linear punctures, the interstices impunctate; body beneath glossy black, scaleless, except the sides of the metathorax; tibiæ subsinuate.

Closely allied to the preceding, but, *inter alia*, the elytra longer and narrowing more gradually to the apex, and the two basal joints of the funicle about equal in length.

Peridinetus cinctus.

P. breviter ellipticus, niger opacus, supra utrinque linea flava marginali ornatus. Long. 3 lin.

Hab. Ega.

Shortly elliptic, covered above with an opaque black tomentum, the front of the head and sides of the prothorax and elytra above with a continuous line of pure yellow scales; rostrum moderately stout, slightly keeled at the base; first joint of the funicle rather longer than the second; prothorax somewhat broader than long; scutellum transverse, broadly rounded behind, concave above; elytra subcordate, slightly convex above, the striæ hidden by the tomentum; body beneath black, slightly glossy; legs with scattered white hair-like scales.

This pretty little species resembles such forms of *Ambates* as are allied to *A. quadrilineatus* (Fab.).

GLYCARIA.

Rostrum validum, arcuatum, basi compressum; *scrobes* subapicales. *Antennæ* graciles, articulo secundo funiculi quam primum brevior. *Prothorax* subcylindricus, apice paulo productus. *Scutel-*

lum distinctum. *Elytra* breviuscula, prothorace multo latiora. *Propectus* profunde incisus. *Mesosternum* subtrilobatum. *Abdomen* segmentis tribus intermediis extus angulatis, tertio quartoque brevioribus. *Pedes* mediocres; *coxæ* anticæ contiguæ. *femora* crassiuscula, infra dentata; *tibiæ* flexuosæ, apice unguiculatæ; *tarsi* articulo ultimo elongato; *ungues* bifidi.

With some hesitation I place this genus in Lacordaire's "groupe *Centrinides*." Like *Scambus* it has the anterior *coxæ* contiguous; and the bifid claws are common to several *Centrini*, in which, however, the character becomes of rather secondary value. The specific name is in allusion to the four little white prominences at the base of the elytra.

Glycaria tetrasticta.

G. *ovalis*, fusca, albo varia; prothorace elytrisque tuberculatis. Long. $1\frac{2}{3}$ lin.

Hab. Brazil.

Ovate, pitchy brown; head, rostrum, prothorax, four tubercles at the base of the elytra and the apex closely covered with small white scales; rostrum stout, compressed, and strongly curved at the base, broader towards the tip; antennæ ferruginous, the first joint of the funicle stouter than the others, club oblong, distinct; prothorax parallel at the sides, contracted anteriorly, two small tubercles at the apex and two in the middle, the base bisinuate; scutellum ovate; elytra moderately convex, subseriate-punctate, four oblong flattish tubercles at the base and two larger, elevated, compressed, on the third interstice, the fifth and seventh also more or less elevated or unequal, apex rounded; body beneath glossy brown, with scattered whitish scales; femora varied with white; tibiæ and tarsi ferruginous, basal joint of the latter nearly as long as the two next together.

ANEXANTHA.

Rostrum validum, arcuatum; *scrobes* apicales. *Antennæ* crassiusculæ, funiculi articulis duobus basalibus subæqualibus, cæteris transversis, clava distincta. *Prothorax* latitudine paulo longior, ad latera rotundatus. *Elytra* oblonga, prothoracis basi paulo latiora, humeris rotundatis. *Propectus* profunde incisum. *Mesosternum* subtriangulare, elevatum. *Abdomen* segmentis intermediis rectis. *Pedes* breviusculi; *coxæ* anticæ basi contiguæ; *femora* crassa, fortiter dentata; *tibiæ* arcuatæ, unguiculatæ; *tarsi* articulo ultimo elongato; *ungues* bifidi.

Although this differs from the following genus in the most important characters of a deeply incised propectus and bifid

claws, both genera must be referred to Lacordaire's "groupe *Madoptérides*" on account of their narrow prosternum, the coxæ being contiguous. The backward direction of the scrobes places it in the subfamily Baridiinæ. The type resembles in form and colour *Phlæophagus æneopiceus*, but is about eight times the bulk, *i. e.* twice as long.

Anexantha castanea.

A. anguste oblonga, omnino nitide castanea; rostro subseriatim punctato; prothorace inæqualiter vage punctato; elytris seriatim tenuiter punctatis. Long. $2\frac{1}{2}$ lin.

Hab. Parana.

Narrowly oblong, reddish chestnut, with a few whitish hairs mostly confined to the punctures; head between the eyes transversely impressed; rostrum coarsely punctured, the punctures at the sides placed in irregular striæ, the interstices distinctly raised; funicle a little longer than the scape; prothorax rather coarsely punctured behind, but the punctures gradually smaller towards the apex; scutellum rounded; elytra subcylindrical, slightly depressed towards the base, seriate-punctate, the punctures small and but slightly impressed, apex rounded; legs with very fine scattered hairs.

AZYGIDES.

Rostrum capite haud longius, cylindricus, *scrobes* obliquæ; *antennæ* breves, in medio rostri insertæ, articulo basali funiculi magno, cæteris brevissimis, clava majuscula. *Prothorax* subquadratus, antice angustior. *Elytra* elongata, parallela. *Pedes* antici majusculi, cæteri breves; *femora* inermia; *tibiæ* brevissimæ, anticæ sinuatæ, mucronatæ; *tarsi* latiusculi, articulo ultimo unguiculo unico; *coxæ* anticæ subapproximatæ. *Propectus* leviter excavatum. *Abdomen* segmento secundo longiusculo.

The peculiarity of this genus lies in the single claw, a rare character among the Curculionidæ. Its nearest ally seems to be *Parallelosomus*. There is a very slight depression on the prosternum, while the anterior coxæ are nearly approximate at the base.

Azygides stygius.

A. angustus, elongatus, parallelus, niger nitidus; elytris basi et pone medium maculis duabus niveo-squamosis ornatis. Long. $2\frac{1}{3}$ lin.

Hab. Parana.

Narrowly elongate, the sides parallel, black, shining, and without scales, except two spots at the base and two behind the middle composed of pure white scales; rostrum scarcely

curved; eyes large, round; antennæ ferruginous; prothorax remotely punctured at the sides and in front, more closely at the base; scutellum quadrate; elytra parallel with the thorax, finely striate, the interstices flat, each with a row of oblong or linear punctures; body beneath with scattered whitish scales; tarsi ferruginous, the claw-joint only slightly exerted.

I may mention here that M. Fauvel's genus *Trigonopterus*, which, as the name was preoccupied, he in 1872 changed to *Trigonus*, is identical with *Idotasia*, which I published in this work in April 1871 (ser. 4, vol. vii. p. 261). Lacordaire saw nothing in the description that recalls "un Baridiide," with which M. Fauvel had connected it. It is, in fact, with several other genera, related to *Arachnopus* among the Zygo-pinæ. M. Fauvel's species (*Trigonopterus insignis*) is distinct from the nine or ten now known; but his name, both generic and specific, is misleading. It is from New Caledonia, and should stand as *Idotasia insignis* (Fauv.). M. Fauvel published his description in the "Bulletins" of a local society in Normandy.

Madarus crassirostris.

M. oblongo-ellipticus, supra leviter convexus, niger nitidus; rostro breviusculo, subvalido; elytris subtiliter punctato-striatis; femoribus muticis. Long. $4\frac{1}{2}$ lin.

Hab. Chontales.

Oblong elliptic, slightly convex above, glossy black; rostrum rather stout, scarcely longer than the prothorax, almost obsoletely punctured; antennæ black, first two joints of the funicle nearly equal in length, the rest very short; prothorax conical, longer than broad, finely and remotely punctured; scutellum very short, broadly triangular; elytra very delicately punctate-striate, the interstices broad and flat, the apices rounded and leaving the pygidium entirely uncovered, the latter closely punctured; body beneath finely punctured; a well-marked impressed line on the metasternum; post-coxal portion of the prosternum broadly emarginate; legs with a sparse yellowish pubescence; femora not toothed.

A much narrower species than *M. corvinus* (Fab.), with a shorter rostrum, broader scutellum, and striated elytra.

XXV.—On the Geological Distribution of the Rhabdophora.

By CHARLES LAPWORTH, F.G.S. &c.

Part III. RESULTS.

[Continued from p. 29.]

Family iv. Dichograptidæ.

This important group is at once the most prolific and the most compact of all the families of the Graptolites. Although it contains more than one third of all the recognized genera of the Rhabdophora, no one can turn over the beautiful plates which adorn Hall's classical memoir on the "Graptolites of the Quebec Group," in which the majority of its forms are figured, and fail to be struck with the decided family likeness which pervades them all. The type of calycle remains substantially invariable throughout all its component genera; and I doubt not that the identity of this feature in the compound family of the Phyllograptidæ will eventually compel us to regard it as also naturally belonging to the same subgroup; for its more fully known species are, morphologically, nothing more than *Tetragrapti* whose branches, instead of remaining free, are united dorsally throughout the whole of their extent.

So far as our present knowledge enables us to judge, it appears that the Dichograptidæ constitute the most ancient family of the Rhabdophora. The earliest examples appear in the upper zones of the Lingula flags; and the family includes all the Cambrian forms of Rhabdophora hitherto discovered. Although but few species are yet quoted from these ancient deposits, it is certain that many await discovery; for the family reaches its maximum, both in genera and species, in the lower zones of the succeeding Arenig formation. In the typical beds of this age, as exhibited in the strata of Skiddaw, Scania, and Pt. Levis, all the genera, with but one or two dubious exceptions, occur in association. In the succeeding dark shales, which in Britain and Scandinavia are, at present, provisionally assigned to the Upper Arenig and Lower Llandeilo, few complex genera occur, and some species of the simplest genus *Didymograptus* alone survive; but these are found in incredible multitudes. This genus is represented by an occasional individual as late as the epoch of the Upper Llandeilo (Glenkiln), when the family appears to have become wholly extinct.

Didymograptus &c.—The simplest genus (*Didymograptus*) appears to have been the most prolific of the family, and the most extended in its vertical range. Its oldest known species

(*Didymograptus sparsus*, Hopk., and *D. pennatulus*, Hall) are found in the lowest Arenig strata of St. David's, at the base of the Ordovician of that region. Its most recent form hitherto detected (*D. superstes*, Lapw.) is by no means uncommon in the earlier beds of the Glenkiln (Llandeilo-Bala) shales of South Scotland.

Of this genus several well-marked subgroups are recognizable, distinguishable by the general shape of the polypary; but our knowledge of their range is not as yet sufficient to enable us to draw any reliable conclusions respecting their individual existence in time or space. One group, however—that of *D. Murchisoni* (*geminus*)—is remarkable, as its forms are essentially characteristic of the great dark-shale zone of the Arenig-Llandeilo, in which they are everywhere the preponderating fossils.

Tetragraptus.—The four-armed genus *Tetragraptus*, Salt., stands next to *Didymograptus* in abundance of species and individuals. Its range, however, is peculiarly circumscribed, none of its forms occurring outside the limits of the lower or typical zones of the Skiddaw-Arenig formation, which it characterizes not only in Wales, but also in England, Scandinavia, and North America.

Complex Genera.—Of the more complex genera of the Dichograptidæ we recognize two artificial groups, viz. (a) those in which the mode of origin of the branches is regularly dichotomous, and (b) those in which it is lateral or irregular. The regular genera are as yet exclusively Skiddaw-Arenig forms. The irregular genera range from the Cambrian to the middle of the Llandeilo. The former group claims the highly complex genus *Loganograptus*, Hall, the horizontal distribution of which is world-wide. To the latter group belongs the most ancient genus of the Dichograptidæ—the genus *Bryograptus*, Lapw., which is supposed to be exclusively characteristic of the *Olenus*-beds of the Upper Cambrian.

Family v. *Phyllograptidæ*.

I take this family next in order, from its undoubted relationship to the foregoing, and from its general similarity in geological distribution. Its single genus appears to be restricted exclusively to strata of so-called Arenig age. None of its species are known to occur above or below the provisional limits assigned to this formation in any of the widely separated regions where they have been recognized hitherto. The genus culminates along the same general zone of the typical Skiddaw-Arenig as its ally *Tetragraptus*; but instead

of characterizing a single subdivision only, it has a vertical range at least as extensive as that of the entire formation itself. The oldest form hitherto detected was collected by Mr. Hopkinson in the lowest zones of St. David's. The youngest species occur in profusion in the *Phyllograptus*-beds (Upper Arenig) which overlie the *Orthoceras* Limestone of Scania.

Family vi. *Diplograptidæ*.

This family is especially remarkable for the great extent of its vertical range. Its most ancient examples occur at the very threshold of the Ordovician; and its latest species do not finally disappear until we reach the summit of the first division of the Silurian proper.

It is difficult to fix upon the exact horizon where this family attains its greatest numerical expansion. In the Upper Llandeilo and in the Lower and Upper Bala it is equally prolific in individuals; several local horizons in each of these three subdivisions could be instanced where examples are so abundant that they almost hide the faces of the beds from sight. In the earlier Arenig and Lower Llandeilo individuals are of comparatively rare occurrence. In the later Lower and Middle Llandovery, though they are less abundant as a rule than in the Llandeilo-Bala strata, they nevertheless dispute the pre-eminence with the *Monograptidæ*. In the succeeding Taranon or Gala-Llandovery, specimens are generally few and far between. In the Wenlock and Ludlow formations they are wholly wanting.

Diplograptus &c.—The two most important genera of the family (*Climacograptus* and *Diplograptus*) agree in their vertical range with the entire family, appearing, culminating, and disappearing together. It is impossible to decide which is the more abundant. In the Bala rocks the numerical excess in species probably belongs to *Diplograptus*, in individuals to *Climacograptus*.

Of species, the form identified by myself with *Diplograptus foliaceus*, Murch., has probably the most extended vertical and horizontal distribution. It is found in abundance everywhere in higher Llandeilo and Lower Bala strata. In the Lower and Upper Bala its place is taken by *D. truncatus*, Lapw.

The subgroups *Cephalograptus*, Hopk., *Petalograptus*, Suess, and *Dimorphograptus*, Lapw., are all exclusively Llandovery in range. The beautiful forms *Cephalograptus cometa*, Geinitz, and *Petalograptus folium*, His., mark the middle zones of the Valentian throughout Western Europe and Britain.

Of the genus *Climacograptus*, Hall, perhaps *Climacograptus bicornis*, Hall, is the most widely distributed. It agrees precisely in its vertical range with *Diplograptus foliaceus*, Murch.

The conventional genus *C. scalaris*, His., sp., unites by its so-called varieties the Ordovician and Silurian systems. They make their appearance in the Middle Bala, and die out in the higher Llandovery.

Cryptograptus.—The genus *Cryptograptus*, Lapw., is unknown above the Bala Limestone. Forms allied to *Cryptograptus tricornis*, Carruthers, are abundant in the Glenkiln zones.

Family vii. *Lasiograptidæ* (or *Glossograptidæ*).

We now enter upon very unsafe palæontological ground. The family of the *Lasiograptidæ* is merely an assemblage of diprionid genera, certainly more closely allied among themselves than they are, on the one hand, to the typical *Diplograptidæ*, and, on the other, to the forms at present grouped in the *Retiolitidæ*. They agree with the former in their general external features and in the continuity of the epiderm, while they differ from them in certain details of internal structure, and in the form and position of the reproductive processes. In these latter respects they agree with typical *Retiolitidæ*.

Retiograptus, Hall.—The oldest genus referable to this family is the peculiar form *Retiograptus* of Hall, which appears to combine in its polypary the marginal meshwork of *Lasiograptus* and the lateral spurs of *Glossograptus*. Only two forms are known, and both are of Arenig age. One, *R. tentaculatus*, Hall, occurs in the Quebec group; the other has been figured by Mr. R. Etheridge, Jun., from the corresponding beds in Australia.

Glossograptus, Emmons.—This genus ranges from the base of the Arenig to the horizon of the Bala Limestone. Its peculiar forms are very abundant on certain horizons in the Llandeilo of Sweden. In Britain it is usually a rare fossil.

Lasiograptus, Lapw.—This genus (which includes only those forms in which the reproductive sacs appear to have been protected by a continuous series of marginal meshes) has not hitherto been quoted from Arenig rocks. It is abundant in the Upper Bala, above which it is unknown.

Hallograptus, Carr.—The title of *Hallograptus* was suggested by Mr. W. Carruthers for forms like *Diplograptus? bimucronatus*, Hall, in which the gonosome is provided with scopulate reproductive processes. The genus as thus defined is strictly Llandeilo-Bala in range on both sides of the Atlantic.

Family viii. *Retiolitidæ*.

Of all the families of the *Rhabdophora* this has the greatest vertical extension. Its known range extends from the base of the Ordovician to the middle of the Silurian proper. It must, however, like the previous family, be regarded as being essentially an artificial group, including genera of very uncertain zoological relationships.

Trigonograptus, Nich.—The oldest of the genera provisionally referred to this family is the genus *Trigonograptus*, Nich., with very thin continuous or punctate epiderm and faintly marked-off hydrothecæ. It is purely an Arenig genus.

Gymnograptus, Tullberg.—This is certainly most intimately allied to the foregoing, standing in some respects between it and the typical *Lasiograptidæ*. It is abundant in Scania, in the Llandeilo beds, but has not hitherto been recognized in Britain.

Clathrograptus, Lapw.—Is one of the rarest of fossils in the Llandeilo-Bala (Glenkiln) of Scotland and New York. Its relationship to the strange complex form *Retiograptus eucharis*, Hall (*Grapt. Quebec Group*, pl. xiv. fig. 9), is probable, but uncertain.

Retiolites.—The genus *Retiolites* proper (*Gladiolites* or *Gladiograptus*), with its reticulate periderm and faintly-marked thecal walls, ranges from the Lower Bala into the Upper Wenlock.

The only known Ordovician example of the genus (*Retiolites* (*Neurograptus*) *fibratus*, Lapw.) is remarkable for its strong central virgula. Its gonosome is furnished with lateral reproductive appendages (scopulæ), similar to those of *Hallograptus*, Carr.

Retiolites Geinitzianus is the most widely distributed species of the family. In Britain it ranges from the base of the Tarannon to the higher Wenlock, and is a common and characteristic fossil in the corresponding strata in Scandinavia and Central and Southern Europe.

Part IV. CONCLUSION.

We have now completed our survey of the available data bearing upon the distribution of the *Rhabdophora* in space and time, and of the more important conclusions to which they appear to point. It only remains, finally, to indicate the chief propositions which these results seem to place outside the pale of future controversy, or render so highly probable that they may be provisionally accepted as true.

The novelty and complexity of the subject constitute a sufficient apology for the multiplicity of the evidences brought forward in the earlier portion of this paper, and for the detailed indication of the several results that may safely be deduced therefrom. The widespread disbelief in the value of the Graptolite as a geological index is hardly likely to be overthrown by any thing short of a perfect demonstration of the contrary opinion. I have therefore felt it necessary to adduce all the more important facts and arguments which appear to me to substantiate my views, that the evidences may be weighed collectively and in detail by each student for himself personally, and the way cleared for a new and more correct departure in this regard.

Our present knowledge of the details of the physical and palæontological succession of the British Proterozoic rocks is admittedly superficial. Much painstaking and extended research is necessary before we shall be prepared to say with confidence what are their most natural subdivisions, and what are their special and peculiar fossils. That some of our rock-formations will be found in future to be of far greater value in the geologic scale than is now admitted is tolerably certain; but, at present, it is impossible to guess either in what respects our received classification is deficient, or what groups have been ignorantly assigned an exaggerated and unnatural importance.

Nor is the zoological department of our subject less tentative and imperfect. The absence in the fossil Graptolites of those soft parts of the animal which are of such primary importance in the determination of the inter-relationships of their modern allies among the Hydrozoa, forces us to rely exclusively upon elements of classification derived from the less-reliable peculiarities of their hard skeletons. This gives a character of uncertainty to our schemes of arrangement, which is felt most keenly by the graptolithologist, as he is forced to look upon his larger divisions as only doubtfully permanent in their composition and gradation. On the other hand, his smaller groups, which, from his special training are to him more a matter of instinct than of logical demonstration, are less easy of acceptance by the average palæontologist, who, recognizing the simplicity in structure and close resemblance in externals among all the Rhabdopora, looks upon the minute criteria by which the graptolithologist classifies his families, genera, and species as being frequently trivial in character and not always available in application.

In all these respects our two scales (the geological and the zoological) are pretty much upon a par. In both we recognize

a few major divisions of wide extent and vague limits. In both we find these larger sections subdivided into a series of minor groups, more rigidly defined, separable in their turn into still smaller sections of strata, or grouplets of life-forms, the comparative importance of which varies within certain very small limits dependent upon local convenience or personal equation. In both, however, if we eliminate all the controverted matter and have respect merely to acknowledged facts, enough remains to satisfy us that many of the grander outlines of our subject are even now clearly discernible. Future investigation must take origin from our present standpoint. While, therefore, much will long remain a matter for individual opinion, it may be expected that future research will tend mainly to give clearness and completeness to our present schemes of classification, repairing their deficiencies by the intercalation of new members, and substituting the definiteness of exact knowledge for the vagueness of partial ignorance and provisional opinion.

Of the imperceptible but ceaseless growth of this clearer knowledge we have an instance in the present study, which has served to bring insensibly into prominence many facts pointing to a more convenient grouping of the Rhabdophora themselves than that hitherto in use among palæontologists. Having regard to the most probable alliances and geological distribution of the various genera of the Rhabdophora recognized to this date, we find that they are most satisfactorily classified for the purposes of comparison in four main groups, each of which is composed of an association of allied genera, in which the polypary is constructed of a fundamental and special element or elements variously combined. The first group may be said to consist of simple and complex forms of the genus *Monograptus*; the second of variously modified forms of the biserial genus *Diplograptus*; the third of simple, complex, and compound modifications of the bilateral genus *Didymograptus*; and the fourth of similar variations of the genus *Dicellograptus*.

The most circumscribed of these groups (Monograptæ) is composed solely of the family of the Monograptidæ. The great systematic importance of this family clearly entitles it to divisional rank. It is the only section of the Rhabdophora in which all the component genera possess both unilateral and uniserial polyparies. To this section Hopkinson's title of Monoprionidæ should in future be restricted.

The second group (Diplograptæ), which is founded on *Diplograptus* as a type, and includes the three families of the Diplograptidæ, Lasiograptidæ, and Retiolitidæ, has the

longest vertical range, and claims the most varied forms of the Rhabdophora. It is the only division in which all the families have biserial or diprionidian polyparies; and to this section alone the title of Diprionida can be properly applied.

The third group (Didymograptæ) finds its type in the genus *Didymograptus*, and includes all the genera at present arranged in the two families of the Dichograptidæ and Phyllograptidæ, according as their polypiferous branches are free or conjoined. The form of the calycle and the mode of growth of the polypary in all these genera is essentially similar; and they appear to be most naturally grouped in one and the same primary division. The calycle is a conical sac expanding outwards toward the aperture, which opens outwardly, well outside the ventral margin of the polypary; while in all the typical genera the sicular angle is the wider or outer "angle of divergence." Hence we may suggest for them the alternative title of the "Exoprionida."

Finally we have a fourth section (Dicellograptæ), which includes the families of the Dicranograptidæ and Leptograptidæ, and of which the genus *Dicellograptus* is emphatically the type. In all its component genera the calycle is free, narrow, and flattened inwards upon the cœnosarcal canal, and the aperture opens inwards either wholly (Dicranograptidæ) or in part (Leptograptidæ) within an excavation dug in the ventral margin; while the sicular angle is invariably the smaller or inner angle of divergence. To this group, therefore, the discretionary title of Endoprionida may be conveniently applied.

Turning next to our geological scale of the Lower Palæozoic rocks, we see that it is composed of the three grand rock-systems of the Cambrian, Ordovician*, and Silurian, the boundaries of the middle system alone being defined with tolerable exactness. The fossiliferous portion of the Cambrian, again, is provisionally separable into a Lower or Paradoxidian division, and an Upper or Olenidian division. The Ordovician falls most naturally into two main divisions—a Lower or Arenig division, and an Upper or Bala division—the line of demarcation between them passing through the middle of the so-called Llandeilo formation. Lastly, the Silurian is most conveniently regarded as being composed of three members—a Lower or Llandovery-Tarannon (Valentian) division, a Middle or Wenlock-Lower-Ludlow (Salopian) division,

* I have employed the title of *Ordovician* for the Lower Silurian of Murchison throughout the whole of this paper for the sake of uniformity. I prefer, however, the shorter and more euphonious title of *Ordovian*, which I have generally employed elsewhere. (C. L.)

and an Upper or Upper-Ludlow-Downton (Downtonian) division.

Subordinate to these are the formations and subformations generally recognized among geologists.

Placing these zoological and geological scales in juxtaposition (see Table XI.), we recognize immediately that most intimate correspondence between life-type and time-epoch which is inevitable upon any theory of gradual evolution. Our grandest zoological groups do not, it is true, fit in individually with the several rock-systems; but the time-ranges of our chief generic types admit of rigid localization and admeasurement upon our geological scale, and form a series which may be paralleled with that of our recognized subformations with wonderful accuracy. On a general review of all these correspondences, as detailed in the foregoing pages, it is evident that they establish the following propositions:—

(i.) The *Rhabdophora*, or true Graptolites, are exclusively Lower-Palæozoic fossils, coming into visible existence in the Upper Cambrian, and disappearing from sight in the Upper Silurian.

(ii.) They attain their maximum, both in genera and species, about the middle of this range, *i. e.* in the Llandeilu formation; and there is a gradual decrease in forms in proportion as we pass upwards or downwards from this horizon.

(iii.) The three grand groups of the *Didymograptæ*, *Dicellograptæ*, and *Monograptæ* are so restricted in their vertical range that each distinguishes a certain portion of the ascending succession of formations. The *Didymograptæ* are essentially Lower-Ordovician fossils, the *Dicellograptæ* Upper-Ordovician, while the *Monograptæ* are confined exclusively to the Silurian proper.

(iv.) With but two exceptions, each of the families of the *Rhabdopora* ranges through a fraction only of the entire succession of the Lower Palæozoic rocks, nowhere exceeding in vertical extent that of an entire system. The *Dichograptidæ* are Upper-Cambrian and Lower-Ordovician fossils; the *Phyllograptidæ* are exclusively Arenig; the *Leptograptidæ* and *Dicranograptidæ* are essentially Upper-Ordovician; while the *Lasiograptidæ* are as rigidly confined to the Ordovician itself as the *Monograptidæ* are to the succeeding Silurian.

(v.) Among the genera this limitation in time is carried out even more minutely. *Loganograptus*, *Tetragraptus*, *Dichograptus*, *Retiograptus*, and several others are exclusively Arenig genera. *Pleurograptus*, *Amphigraptus*, *Cænograptus*, &c. are peculiar to the Bala. *Rastrites* distinguishes the Valentian, and *Cyrtograptus* the Salopian.

TABLE XI. Showing the Vertical Distribution of the Trilobes, ramulies, and genera of the Monograptoida in the chief Graptolite Zones of the Lower Palaeozoic Rocks.

	ORDOVICIAN.				SILURIAN.			
	Lower.		Upper.		Lower.		Middle.	
	Arenig.	Llandiello.	Caradoc.		Llandovery.	Tarannon.	Wenlock.	T. Ludlow.
1. <i>Hydrograptus</i> zone.								
2. <i>Tetragraptus</i> zone.	*	*	*	*	*	*	*	*
3. <i>Didymog. bifidus</i> z.	*	*	*	*	*	*	*	*
4. <i>Didymog. Murchisoni</i> z.	*	*	*	*	*	*	*	*
5. <i>Cœnog. gracilis</i> z.	*	*	*	*	*	*	*	*
6. <i>Dicranog. Clingant</i> z.	*	*	*	*	*	*	*	*
7. <i>Pleurog. linearis</i> z.	*	*	*	*	*	*	*	*
8. <i>Dicellog. complanatus</i> z.	*	*	*	*	*	*	*	*
9. <i>Dicellog. anceps</i> z.	*	*	*	*	*	*	*	*
10. <i>Diplog. acuminatus</i> z.	*	*	*	*	*	*	*	*
11. <i>Diplog. vestitus</i> z.	*	*	*	*	*	*	*	*
12. <i>Monog. gregarius</i> z.	*	*	*	*	*	*	*	*
13. <i>Monog. spiriferus</i> z.	*	*	*	*	*	*	*	*
14. <i>Rastrites marinus</i> z.	*	*	*	*	*	*	*	*
15. <i>Monog. exiguus</i> z.	*	*	*	*	*	*	*	*
16. <i>Cyrtog. Graye</i> z.	*	*	*	*	*	*	*	*
17. <i>Cyrtog. Murchisoni</i> z.	*	*	*	*	*	*	*	*
18. <i>Cyrtog. Linnarsson</i> z.	*	*	*	*	*	*	*	*
19. <i>Monog. festis</i> z.	*	*	*	*	*	*	*	*
20. <i>Monog. Nilsson</i> z.	*	*	*	*	*	*	*	*

Section A. MONOGRAPTA (MONOPRIONIDA).

Family I. Monograptidæ.

- Genus 1. *Rastrites*, Barr.
- 2. *Cyrtograptus*, Carr.
- 3. *Monograptus*, Geinitz.

Section B. DICELLOGRAPTA (ENDOPRIONIDA).

Family II. Dicellograptidæ.

- Genus 4. *Dicellograptus*, Hoptk.
- 5. *Dicranograptus*, Hall.

Family III. Leptograptidæ.

- Genus 6. *Amphigraptus*, Lapw.
- 7. *Pleurograptus*, Nich.
- 8. *Leptograptus*, Lapw.
- 9. *Cœnograptus*, Hall.
- 10. *Azygograptus*, Nich.

Section C. DIDYMOGRAFTA (EXOPHRONIDA).

Family IV. Dichograptidae.

- Genus 11. *Didymograptus*, *McCoy* *
12. *Tetragraptus*, *Salt.* *
13. *Dichograptus*, *Salt.* *
14. *Loganograptus*, *Hall* *
15. *Clonograptus*, *Hall* *
16. *Clematograptus*, *Hopk.* *
17. *Tennograptus*, *Nich.* *
18. *Trichograptus*, *Nich.* *
19. *Schizograptus*, *Nich.* *
20. *Goniograptus*, *McCoy* *
21. *Bryograptus*, *Lapw.* *

Family V. Phyllograptidae.

- Genus 22. *Phyllograptus*, *Hall.* *

Section D. DIPLOGRAPTA (DIPHRONIDA).

Family VI. Diplograptidae.

- Genus 23. *Diplograptus*, *McCoy* *
- Subgen. *Cephalograptus*, *Hopk.* *
- Dimorphograptus*, *Lapw.* *
24. *Climacograptus*, *Hall* *
25. *Cryptograptus*, *Lapw.* *

Family VII. Lasiograptidae.

- Genus 26. *Retiograptus*, *Hall.* *
27. *Glossograptus*, *Emmons* *
28. *Hallograptus*, *Carr.* *
29. *Lasiograptus*, *Lapw.* *

Family VIII. Retiolitidae.

- Genus 30. *Trigonograptus*, *Nich.* *
31. *Gymnograptus*, *Tullb.* *
32. *Clathrograptus*, *Lapw.* *
33. *Retiolites*, *Barv.* *

(vi.) Descending to the species of Rhabdophora we find that instead of ranging through enormous thicknesses of rock, as hitherto supposed, they are so restricted in vertical distribution that few have a more extended range than that which is covered by a single formation in the vertical series; while the vast majority are peculiar to a single subformation, or mark certain special horizons outside of which they are wholly unknown. As might have been anticipated, the forms which have the greatest longevity present us with the greatest number of recognizable varieties, while the species of shorter range rarely show any notable departure from the primitive type.

(vii.) The ascertained restriction of the divisions, families, and genera of the Rhabdophora in time necessarily gives to the collective Graptolitic fauna of each of the subsystems or major formations of the Lower Palæozoic rocks a special and distinctive aspect that renders it capable of immediate identification all over the world. The Arenig division is recognizable at a glance by its crowds of Phyllograptidæ and Dichograptidæ; the Bala by the absence of these families and the presence of multitudes of Dicellograptæ and Diplograptidæ; the Valentian by the absence of the former and the presence of the latter in association with Monograptidæ; and the higher Silurians by the absence of the Diplograptidæ and the presence of Monograptidæ alone.

(viii.) The further restriction in time and vertical extension of the species and varieties of the Rhabdophora places in our hands the material available for a more minute subdivision of the formations of the Lower Palæozoic rocks than has hitherto been attempted. These subdivisions or Graptolite horizons answer roughly to the Ammonite zones of the Jurassic rocks of Europe, and will, in all probability, prove of equal value in the correlation of widely separated deposits. At present the following zones are recognizable, many of them of extraordinary geographical range:—

Upper Cambrian.

1. *Zone of Bryograptus Callavei, Lapw.*—In the Upper Cambrian we know as yet only a single Graptolitic zone, that of the *Olenus*-beds of Scania and their extra-Scanian representatives. It may be termed the zone of *Dichograptus (?) tenellus*, Linnrs., or *Bryograptus Callavei*, Lapw. As I have already indicated, we are almost totally ignorant of the details of its Graptolitic fauna. It seems to be characterized, however, by similar forms of Dichograptidæ in Scania, Norway, Shropshire, and the Malvern Hills.

Lower Ordovician.

2. *Zone of Tetragraptus (bryonoides, Hall)*.—This is the typical Quebec or Skiddaw Graptolite zone. It is strikingly individualized by the exclusive possession of all the known forms of the genus *Tetragraptus*, Hall. The genera *Loganograptus*, Hall, *Clonograptus*, H., *Schizograptus*, Nich., and *Dichograptus*, Salt., are all probably peculiar to this zone, as are also the species *Didymograptus extensus*, Hall, *D. penatulus*, Hall, and the only known examples of *Retiograptus*, Hall. This zone is recognizable at St. David's, Shelve, Skiddaw, Norway, Scania, and in North America and Australia, everywhere distinguishable by the same group of forms.

3. *Zone of Didymograptus bifidus, Hall*.—This zone finds its typical representative in the Upper Skiddaw beds of the Lake District and in the "*Phyllograptus* beds" of Scania. It is most especially marked by the presence of *Phyllograptus*, in association with geminiform *Dichograpti* of the group typified by *D. bifidus*, Hall. From the zone below it is distinguishable by the extreme rarity of compound *Dichograptidæ*. Its peculiar fossils are *D. bifidus*, Hall, *D. minutus*, Tullberg, and some forms of *Diplograptus*, such as *Climacograptus confertus*, Lapw. Many of its commonest forms in Britain appear to be survivals of those of the underlying zone, such as *Phyllograptus angustifolius*, H., *P. typus*, Hall, *Didymograptus patulus*, Hall, *D. affinis*, Nich., *D. Nicholsoni*, Lapw., &c. The zone has been identified at Llavirn near St. David's, at Tyobry, at Shelve, in Cumberland, and in Scania and Darlarne.

4. *Zone of Didymograptus Murchisoni, Beck (geminus, His.)*.—This is the typical Upper-Llandeilo Graptolitic zone of Murchison, but both physically and palæontologically it appears to be most distinctly allied to the foregoing Upper Arenig zone. It is characterized mainly by the exclusive presence of the form which gives it its name, by the total absence of the genus *Phyllograptus*, and by a few distinctive *Diplograptus*, of which the best-known is *Climacograptus cœlatus*, Lapw.

The zone is recognizable by position, mineralogical character, and fossils in Britain at Llandeilo, Builth, Shelve, Aberciddy, Pont Seiont, in Scandinavia near Christiania, in Scania, and in Brittany and Portugal.

Upper Ordovician.

In Wales the Upper Ordovician is separated from the Lower by a series of grits and trap-rocks with possible uncon-

formity. Of the very lowest beds of the Upper Division we as yet know little with certainty. The deepest zone recognizable at the present time is the

5. *Zone of Cœnograptus gracilis, Hall (or of Dicellograptus sextans, H.).*—This is typically developed in the lower portion of the Glenkiln shales of the south of Scotland. It is the first of the Dicellograptid zones, and is well particularized by the peculiar genus *Cœnograptus*. Only a single Dichograptid (*D. superstes*, Lapw.) survives. Dicranograptidæ are abundant, *Dicranograptus ziczac*, Lapw., *D. formosus*, Hopk., *Dicellograptus sextans*, Hall, *D. intortus*, Lapw., are peculiar, and several Diplograptæ, such as *Hallograptus bimucronatus*, Nich., *H. ? mucronatus*, Hall, *Diplograptus Whitfieldi*, H., &c. This zone was first recognized by Hall in the Normans-Kill beds of the valley of the Hudson. In Britain it occurs near Builth, at Portmadoc; in Scandinavia in the Middle Graptolite schists of Scania; and, in all probability, also exists in the Ordovician rocks of Australia.

6. *Zone of Dicranograptus Clingani, Carr.*—This includes the dark shales that are supposed to underlie the Bala Limestone of North Wales, and finds its most perfect type in the Lower Hartfell shales of the south of Scotland. Its peculiar forms are *Dicranograptus Clingani*, Carr., *Dicellograptus Forchammeri*, Geinitz, *Lasiograptus Harknessi*, Nich. It is well developed at Conway, North Wales, at Moffat (Lower Hartfell), at Girvan, in the north of Ireland, in Scania at many localities, and in the lower beds of the Lorraine shales of North America.

7. *Zone of Pleurograptus linearis, Carr.*—This zone in all probability includes the horizon of the Bala Limestone of North Wales and of its equivalent the *Chasmops* Limestone of South Sweden. It is remarkable in Scotland for the abundance of Leptograptidæ it affords, the genera *Amphigraptus* and *Pleurograptus* being almost strictly confined to this zone. Its peculiar Moffat forms are *Leptograptus capillaris*, Carr., *Amphigraptus divergens*, Hall, *Diplograptus quadrimucronatus*, Hall, *Climacograptus tubuliferus*, Lapw., all of which, with their Moffat associates, mark the same zone in Girvan, in County Down, at Rostånga in Scania, and apparently also in the Hudson-River group of North America.

8. *Zone of Dicellograptus complanatus, Lapw.*—The strata that lie between the zone of *P. linearis*, Carr., and the summit of the Ordovician system form in South Scotland two very distinct zones, though few Rhabdophora have yet been described from them. The lowest zone is that of *Dicellograptus complanatus*, Lapw., which contains but few peculiar

forms in addition to its characteristic species. It is recognizable in the same stratigraphical position and affording the same fossils at Moffat (Barren Mudstones), at Girvan, in County Down, at Rostånga in Scania in the lower part of the *Trinucleus*-schist, and in Westrogothia.

9. *Zone of Dicellograptus anceps*, *Nich.*—The final zone of the Ordovician system is everywhere characterized by *D. anceps* in the Moffat area and in the district of Girvan (Drum-muck beds). According to Dr. Tornquist it holds the same place and fossils in the *Trinucleus*-beds of Dalarne.

Silurian System.

10. *Zone of Diplograptus acuminatus*, *Nich.*—This is the oldest recognizable zone of the Silurian in the Moffat area, where there is no physical line of demarcation at the summit of the Ordovician. In Girvan, where the line of separation is most strongly marked, the same zone is still recognizable. Its palæontological characters, so far as the *Rhabdophora* are concerned, are decidedly negative. The *Dicellograptus* have become extinct, and the *Monograptus* have not yet appeared. The only forms present are *Diprionida*. *Diplograptus acuminatus* and *Climacograptus normalis*, Lapw., mark the zone in Moffat and in Girvan. In Sweden it includes the typical beds of the Brachiopod schists, which are similarly marked by an abundance of *C. normalis*, unaccompanied by members of other Graptolitic families.

11. *Zone of Diplograptus vesiculosus*, *Nich.*—This must be regarded in the light of an introductory zone to the following. In the typical region of Moffat it contains an abundance of the fossil which gives it its name, together with the first forms of *Monograptidæ* (*M. tenuis*, Portlock, and *M. attenuatus*, Hopk.). It includes the Lower *Pentamerus* Limestones of Girvan, and has been identified in the north of Ireland.

12. *Zone of Monograptus gregarius*, *Lapw.*—Whether we have respect to the abundance and variety of its Graptolitic fauna or to the wide geographical range, this zone must be considered the most important in the Llandoverly rocks. In the Birkhill area it is capable of division into two sub-zones—the lower marked by the presence of *Monograptus triangulatus*, Harkn., and the upper by the presence of *Rastrites peregrinus*, Barr. The peculiar species that distinguish the zone may be gathered from a study of Table VII. *M. gregarius*, Lapw., *M. fimbriatus*, Nich., *Diplograptus physophora*, Nich., *M. leptotheca*, Lapw., are especially characteristic. The zone yields the same fossils at Girvan, at Pome-roy and Coalpit Bay in the north of Ireland, in Bornholm,

at Tosterup in Scania, in Westrogothia, and in the schists of Dalarne—in Thuringia, Bohemia, the Eastern Alps, France, and Spain.

13. *Zone of Monograptus spinigerus, Nich.* (Sedgwicki, *Portlock*).—This zone overlies the former throughout the greater part of its extended geographical range; and the fossils of both have been intermingled in published lists. It is distinguished from the *M. gregarius* zone by the presence of *M. spinigerus*, Nich., *M. Hisingeri*, Carr., *M. intermedius*, Carr., *M. argutus*, Lapw., *Diplograptus cometa*, Geinitz, *D. palmeus*, Barr., &c. It is recognizable in the Moffat and Girvan areas, in Ireland at Pomeroy, in the Coniston Mudstones, at the Devil's Bridge, Cwn Symlog, &c. in Mid Wales, at Kongslena in Westrogothia, &c.

14. *Zone of Rastrites maximus, Carr.*—In many respects this must be regarded as the zone of transition into the succeeding formation. Its fauna is essentially a compound of that characteristic of the more strikingly separated beds above and below. It ought in all probability to be regarded as forming the base of the Tarannon group. Its most striking species are *Rastrites maximus*, Carr., and *Monograptus crassus*, Lapw., the first of the forms of the type *M. priodon*, Bronn. The zone has a wide range in South Scotland, and has been doubtfully recognized in Mid Wales, Scania, and Dalarne.

15. *Zone of Monograptus exiguus, Nicholson.*—This is the typical Tarannon or Gala zone of Britain. The thin graptoliferous seams found occasionally in the thick zones of flagstones and purple-and-green shales of this formation are often matted with entangled groups of the characteristic form of the zone. *M. galaensis*, Lapw., *M. crispus*, Lapw., *M. turriculatus*, Barr., *M. Salteri*, Lapw., are generally peculiar. The remainder are survivors from the Birkhill zones or forerunners of the Wenlock-Ludlow fauna. Of the latter, *Retiolites Geinitzianus* is very rare, while varieties of *M. priodon* are common.

The zone is typified by the Lower Gala series of South Scotland and the *Crossopodia* beds of Girvan. It is recognizable in Ireland in the shales of Tieveshilly, in Wales in the Tarannon shales of Conway, and in the Lake District in the Knock beds. It has been recognized by Dr. Tornquist in Dalarne; its fossils have been detected by Mr. Linnarsson at Motala in Ostrogothia and elsewhere. It seems to be present also in Thuringia and Bohemia.

16. *Zone of Cyrtograptus Grayæ, Lapw.*—The upper division of the Gala group is marked off from the lower division

by the total absence of *Diplograptidæ*, and by the presence of many Wenlock forms, such as *Monograptus vomerinus*, *M. riccartonensis*, &c. Strata with a similar transitional fauna occur in Girvan, and form the earlier zones of Tullberg's *Retiolites* Skiffar in Scania (Tullberg, Geol. För. Förh. 1880, N. 59, B. 5. N. 3).

Wenlock-Ludlow Series.

17. *Zone of Cyrtograptus Murchisoni, Carr.*—The base of the Wenlock series of Builth is formed by a highly fossiliferous series of shales crowded with *C. Murchisoni*, *M. vomerinus*, Nich., and a few survivals of the Grieston fauna. The same fossiliferous zone has been met with in Shropshire, in the valley of the Dee, North Wales, in Denbighshire, and more doubtfully in the Lake District. It is well developed in the succession at Rostånga in Scania, and is present also in Bohemia.

18. *Zone of Cyrtograptus Linnarssoni, Lapw.*—The Wenlock shales of Shropshire have not yet been minutely separated into their natural divisions; but two fairly distinct zones are already recognizable in their British or foreign equivalents. To the lowest of these zones belong the strata near Builth which succeed the *C.-Murchisoni* beds, and afford *C. Linnarssoni*, Lapw., and a few other peculiar forms. It is possible that the *C.-Carruthersi* bands of the Riccarton beds of South Scotland belong to this general horizon; but as yet the typical *Cyrtograptus* has not been detected within them. The middle beds of the *Cyrtograptus* Skiffar of Scania have a corresponding Graptolite fauna.

19. *Zone of Monograptus testis, Barr.*—In the highly prolific graptolitic rocks of the south of Sweden the highest zone that can with certainty be assigned to the equivalents of the British Wenlock shales is characterized by the beautiful form *Monograptus testis*, Barr. Its commoner associates are abundant forms in the Wenlock of Britain; but the typical fossil itself has not hitherto been detected here. The zone is recognizable in Bohemia, Thuringia, and France.

20. *Zone of Monograptus Nilssoni, Barr.*—The highest and most important graptolitic zone of the Wenlock-Ludlow formation is that which lies between the Wenlock and Aymestry Limestones of Siluria and forms the Lower Ludlow shales of Murchison. Its beds are of great thickness both in Britain and Scandinavia, and will probably in the future be found divisible into several distinct zones. This is shown by its collective fauna, which is specifically very distinct from that of the Wenlock shales. The most prolific form of the zone

is the *M. colonus* (of authors), which is peculiar, as also are *M. Ræmeri*, Barr., *M. scanicus*, Tullberg, and many others. This zone is magnificently developed in Britain and in the south of Sweden, and is recognizable in Norway, Bohemia, Bretagne, and the south of France.

It is not pretended that each of the so-called zones enumerated above is of equal geological importance. The zones of *Tetragraptus* (2), *Didymograptus geminus* (4), *Cænograptus gracilis* (5), *Monograptus gregarius* (12), and *Monograptus Nilssoni* (20) are of such paramount consequence, whether we consider the thickness of their included strata in Britain, or the great variety and wide geographical range of their distinctive faunas, that they deserve rather the titles of sub-formations. On the other hand, two or three zones, notably those of *Diplograptus vesiculosus* (11) and *Cyrtograptus Linnarssoni* (18), must, in the present state of our knowledge, be regarded merely as provisional stages, distinguished locally by a few peculiar forms, as yet restricted in their horizontal distribution. Again, the species which gives its name to the zone has, in one or two instances, been detected in the overlying bands, as is the case with *Monograptus gregarius*, Lapw., and more doubtfully with *M. spinigerus*, Nich.; but in these exceptional cases the species, instead of being predominant in these overlying beds, is rare and inconspicuous. But, if we have correctly interpreted the materials in our hands, it is indubitable that each of these zones marks a special substage or horizon in the ascending series of the Lower Palæozoic rocks. The formation to which it most naturally belongs is determined by the special facies of its collective Graptolite fauna; and its vertical place within that formation is fixed by its peculiar and predominant species.

This list must be regarded merely as a first attempt to define and localize the minor Graptolite faunas of these ancient sediments, and to make them available for the proposes of the geologist and zoologist, as indices of the systematic place of their containing beds, or as evidences of the mode and direction of the development of life. It may confidently be expected that future research will soon fix more definitely the composition and limits of the characteristic faunas of the zones already recognized, extending the range of some of their forms into neighbouring stages, detecting fresh criteria in their separation, and adding largely to the number of the zones themselves.

The acceptance of our conclusion that the Graptolites are as restricted in their vertical range as other and more perfectly and generally studied groups of fossils, is merely a

question of time; and in these zones the geologist is presented with a new and invaluable key to the elucidation of the details of the succession among the Lower Palæozoic rocks—a key of far wider application than any formerly at his command. The fossil Crustacea and Brachiopoda, on which he has hitherto been content to rely, are, as a general rule, confined to sediments containing a large proportion of carbonate of lime. The limestones and calcareous sandstones in which they occur most abundantly are usually so diversified in their petrographical characters that the working geologist is often wholly able to dispense with the aid of the palæontologist in determining the limits and inter-relationships of their containing strata. But these highly calcareous deposits constitute merely an insignificant fraction of our Lower Palæozoic sediments. The vast majority are grits, flagstones, and shales, containing a most minute proportion of calcareous matter, and from which, as a consequence, the lime-loving forms are wanting. These enormous accumulations of strata, composed of endless repetitions of similar rocks, incapable of subdivision by petrographical characters, and destitute of the special fossils upon which the palæontologist relies for guidance, the geologist has hitherto been compelled to leave undivided. The unbroken sheets of the flag-like Silurian rocks of Hereford, Merioneth, and Denbigh, which are shown upon the Survey maps in two doubtful divisions only, as contrasted with their minutely subdivided prototypes of Siluria, afford us a case in point. Other examples are seen in the wide-spreading sheets of Ordovician and Silurian strata which, unbroken by a divisional line, cover many thousands of square miles in Middle and North Wales, South Scotland, and Ireland. Now in these monotonous strata, so barren of organic remains of the higher groups, the lowly Graptolite is a frequent and characteristic fossil; and by its aid the geologist of the future will be able to read off the natural succession among these undivided sediments with ease and certainty.

(ix.) The several zones common to two or more regions occupy invariably the same relative position with respect to each other, and the same vertical place in the ascending series of formations. Hence we have no choice but to regard them as homotaxially or synchronologically identical. It will be seen from Table XII. that, as a general rule, the zones are not recognizable scattered irregularly over the globe, but that they occur more or less in groups, being restricted in their range to neighbouring geographical regions. Hence it is highly probable that we see in many of these zones the relics of what were originally special subformations or stages, once

geographically continuous, but now more or less broken up into isolated fragments. That the zones missing from the Lower Palæozoic series as developed in any single region owe their apparent absence generally to the fact that the strata have as yet been imperfectly studied, will be evident on a comparison of the Scanian column with the succession of zones as developed in Britain. The zeal and acumen of the Swedish geologists in the study of the Scanian rocks have resulted not only in the detection of all the Graptolite zones already recognized amongst us in that region, but in the discovery of several others, of the existence of which we were previously unaware. That the half-dozen zones recognizable upon the opposite side of the Atlantic were originally continuous with their British prototypes is not at all probable; but, judging from their correspondent position in the succession of formations, it may be asserted with confidence that, from a geological point of view, they answer to their representatives on this side of the Atlantic, not only in fossils but in the special epoch during which they were deposited.

(x.) In the face of these results the host of proofs formerly supposed to be afforded by the abnormalities of the vertical distribution of the Graptolithina, in favour of the doctrines of migration and colonies, vanish into thin air. These apparent evidences are now seen to have been fallacious appearances, due simply to defective knowledge. In every case where the subject is capable of proof, we have shown that the facies of the Graptolite fauna in every subformation was identical all over the Lower-Palæozoic world. We have at present no evidence whatever to show that any single Graptolite group, or even a single species or variety, made its appearance at an earlier date in one region than in another; and, as a consequence, the place of its origin and the direction of its extension in space are at present equally incapable of recognition.

The consideration of the bearing of these results upon the study of the morphological development of the Graptolites themselves demands some notice; but the subject is to a certain extent foreign to the main object of the present paper. It is enough to have demonstrated that the Graptolite appears to be as restricted in its vertical range, and as widely extended in its horizontal distribution, as any known form of life hitherto recognized as existent in Palæozoic times. Of all fossils it is the most frequent and the most widely disseminated in the rocks of that age. It is found certainly in the greatest abundance in the more carbonaceous deposits in the deeper water beds, but it is present more or less in all sediments. This is probably owing to the fact that at one stage or other of its

existence it was a free floating organism, drifting at the mercy of the winds and currents. All these circumstances conspire to render the Graptolite one of the most suitable of fossils for the purposes of the working geologist and systematist; its short vertical range affording elements for the subdivision of the accepted Lower Palæozoic formations into their component zones; its wide horizontal distribution allowing of the exact parallelism of synchronous deposits in areas now geographically separated; and its universal dissemination rendering it easy of collection and study.

CORRECTIONS.

- Vol. iii. page 253. The reference in the third note (†) should be transferred from *Retiolites* to *Didymograptus*.
Vol. iii. page 455, Table I. For (a) Lower Ludlow read (a) Upper Ludlow. The "Calciferos Group" should be united with the "Potsdam Group" in the Cambrian.
Vol. v. page 278, line 14 from the bottom of page, for *Tetragraptus* read *Trigonograptus*.
Vol. vi. page 19, line 12 from the bottom of page. *D. vacillans*, Tullb., is a Lower-Arenig species.
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XXVI.—*On Misdirected Efforts to Conjugation in Spirogyra.*
By H. J. CARTER, F.R.S. &c.

[Plate XIV. A. figs. 1-3.]

TURNING over the leaves of a MS. microscopical journal which I have kept since 1854, I observed figures of *Spirogyra* endeavouring to conjugate with *Cladophora*; and not being aware that any such fact has ever been published or even alluded to, it seems to me desirable that it should be publicly recorded. The material in which it occurred was obtained from a freshwater pool in the marshes of the island of Bombay, in the month of March 1854; and all that I can state respecting the species of the filamentous Algæ concerned is, that the *Spirogyra* was "double-banded," and the *Cladophora* the species usually found in the neighbourhood? *tranquebariensis*, Kg. Accompanying the figures, however, is the following note, viz. :—

"Figs. 5, 6, 10, 11, and 12. *Spirogyra* trying to conjugate with *Cladophora*, in which the contents of the cell of the former are passing off into long root-like processes of cell-membrane applied to a filament of the latter. This was a frequent occurrence in a large basin of water wherein the *Spirogyra* and *Cladophora*, among other things, happened

to be mixed together as they were collected" (Pl. XIV. A. figs. 1-3).

The conjugation of *Spirogyra* &c. affords an instance in which the "primordial cell," after having become incarcerated within the apparently lifeless sheath of the filament, can soften the latter at a particular point so as to enable itself to escape from its prison and mingle its green or gonimic contents with those of another cell of a like kind similarly circumstanced, to form the "resting spore." It is one of the innumerable examples of the instinct of two portions of the living protoplasm, when apparently shut off from all communication with the exterior, and in themselves but an inconceivably delicate aqueous film, being able, as in pairing for conjugation, to recognize the presence and proximity of each other, preparatory to synchronously softening the necessary points of their cell-walls, and by mutual tubulation to produce a continuous channel of communication between the two cavities, through which the contents of one cell are able to be mixed with those of the other for the purpose mentioned.

I have stated "apparently lifeless sheath," because, although the filaments of *Spirogyra* present in their sheath a substance which may be compared to horn in the animal kingdom, yet, if thrown confusedly into a basin of water at night, they will, by the next morning, have arranged themselves as parallelly as well-combed hair, while all this is effected by what has been termed "blind instinct," whose manifestations are familiar to us as being as common in the animal as in the vegetable kingdom, in the lowest state of living organic matter with which we are cognizant as in the highest development, in the act of the cuckoo which goes across the "seas" to the land of its parents a month after they have left our shores, as in the apparently chaotic mucus of the rose-shoot, which in a short time comes forth in the shape of a definite bunch of flowers. Yet who can tell what this "blind instinct" is?

Let us go further, and take the human germ, which at first is but an extremely minute cell containing a particle of this protoplasm, out of which all the organs of the full-grown being are developed, and then how punily does our "mental power" compare with this "blind instinct," which has not only developed the organ, viz. the brain, by which our mental power is manifested, but has *limited* that power to its own requirements—thus not only enabling us to see that our comprehension is finite, but that there is still something beyond which we cannot comprehend, *i. e.* the infinite. Nor can we help inferring, if the development of the human germ

accords with the evolution of the animal kingdom in its different stages, that there must be a period in both instances where the phenomena of *life* are independent of any brain or nervous system such as we understand it.

Again, there is a *variety or individuality* in this "blind instinct" which must exist *before* the chemical and physical influences are brought to bear upon the original "particle of protoplasm," whose particular development is by this particular instinct insured; for no two individuals are exactly alike, to say nothing of specific differences; while the subsequent existence of this "particular instinct," after the development has fulfilled all that is required of it, may be inferred, just as the leaves in autumn, after having fallen from a deciduous tree, to return to the dust from which they originally came, are succeeded by a similar development the following year under a similar instinct—or as the butterfly, perishing after the act for which all its elaborate metamorphoses have been passed through has been completed, appears again another year under similar circumstances.

EXPLANATION OF PLATE XIV. A.

- Fig. 1.* *Spirogyra* endeavouring to conjugate with *Cladophora*. *aa*, two cells of *Spirogyra* connected; *bb*, remains of spiral bands or gonimic contents; *c*, septum; *dd*, two bunches of root-like processes, respectively applied to *e*, filament of *Cladophora*.
- Fig. 2.* The same. *a*, single cell of *Spirogyra*; *bb*, remains of spiral bands or gonimic contents; *c*, bunch of root-like processes applied to *d*, filament of *Cladophora*.
- Fig. 3.* The same. *aa*, two cells of *Spirogyra* disconnected; *bbb*, remains of spiral bands or gonimic contents; *cc*, bunches of root-like processes applied to *dd*, two connected cells of *Cladophora*; *ee*, gonimic contents; *f*, septum.

XXVII.—*On Fossil Sponge-spicules from the Carboniferous Strata of Ben Bulbin, near Sligo.* By H. J. CARTER, F.R.S. &c.

[Plate XIV. B. figs. 1-17.]

IN the last contribution that Mr. James Thomson made to our knowledge of fossil sponges which existed during the Carboniferous epoch in the neighbourhood of Glasgow ('*Annals*,' 1879, vol. iii. p. 141, pl. xxi.), I described and illustrated *Holasterella conferta*, a genus of sponges, as the name indicates, exclusively composed of stelliform spicules, whose typical figure, from the same locality, had been found and illustrated a year previously. At the same time I added

(*ibid.* p. 145) some observations on specimens of limestone belonging to the Carboniferous series which Mr. Thomson had gathered from the western side of Black Head, county Clare, at the southern extremity of the entrance to Galway Bay, in which the siliceous element (often present in great quantity) seemed to indicate that it had been derived from some organisms more or less composed of silica, especially as in other parts, where the limestone is pure, the remains of sponge-spicules in a calcified state are abundantly recognizable, although in none of the specimens sent to me could I find a *definite* form.

Here the matter rested, so far as I myself was concerned; but Mr. Joseph Wright, F.G.S., who resides at Belfast, having subsequently visited the mountain near Sligo called "Ben Bulben," actually ascertained the presence of several forms of sponge-spicules in the limestone of the Carboniferous system there, and kindly forwarded specimens of them to me, together with fragments of the strata in which they are found, for description and illustration. But before I proceed to this, it is desirable that the following extracts from Mr. Wright's letter, dated Jan. 1, 1880, which accompanied them, should be given, viz. :—

"Last summer my friend Mr. S. A. Stewart spent a few days botanizing on Ben Bulben, and, whilst there, observed soft clay bands in the limestone, of which he brought me three different 'gatherings' to examine for Foraminifera, viz. :—1, containing no organisms; 2, a few Foraminifera and spicules; and 3, rich in sponge-spicules.

"The last material proved so interesting that we afterwards visited the place in company and brought away a quantity of the clay. It is of a pale yellowish colour, and occurs interstratified with bands of chert, especially at the summit of the mountain, where it is very soft, owing, apparently, to exposure to the weather; on the other hand, lower down, the same yellow material occurs, but much harder, although lighter, from its open pumice-like structure. At both places we found a great number of fossils belonging to the limestone of the Carboniferous system, viz.

"I sent some of the clay to a friend in Cork for analysis; and he has informed me that it contains 98 per cent. of silica."

After this follow sketches of all the forms of fossil sponge-spicules that Mr. Wright by dexterous manipulation was enabled to extricate from the clay—to which, after carefully looking over all that he found, which were subsequently forwarded to me, I can add no more specifically,

although I have been able to find a few with slightly different forms, which have assisted me in the following descriptions. Of course, as drift-spicules, which these must have been when originally deposited, to say nothing of the subsequent effects of fossilization &c., they are nearly all fragmentary; but sufficient of them remains for easy recognition and for restoration, as will be seen by the illustrations.

First and foremost is a sexradiate stellate (Pl. XIV. B. fig. 2), which in number of rays varies from 6, 12, 18 to 24 (figs. 4-7), according to the amount of division of the extremities of six arms. The stellates vary in size from 1-75th to 5-24ths of an inch (fig. 1) in diameter; and the smallest are not only the most numerous and have the greatest number of rays, but, as the latter often arise from a division of the arm close to the centre, they acquire the appearance of globular little stars; while, where the arms are a little more extended, they often present the appearance of a "Maltese cross." But the most striking feature of this spicule is that, from the smallest to the largest, each ray is spiriform; that is, its surface presents a spiral inflation in which the coils are more or less numerous, extending from the base to the apex of the ray (figs. 2 and 3); where they are most numerous they, of course, are more transverse, and then appear like separate annulations; while the most remarkable difference in them is confined to the rays of the largest stellates, where, towards the base, the spiral line of inflation becomes broken up into short portions (fig. 3, *b*), which look very much, from their alternate arrangement in adjoining coils, as if this had been produced by another spiral groove pursuing an opposite direction (that is, across the original inflation).

This fossil spicule is incomparably more numerous than the other spicular forms accompanying it; so that, together with its peculiarities *being confined to a stellate form*, I am compelled to think that it must have belonged to a species of *Holasterella* which, if found *in situ* hereafter (that is, forming the entire sponge), will be like *H. conferta*; hence I have much pleasure in naming it *Holasterella Wrightii*, after its discoverer.

The next spicule in frequency appears to have been a hexactinellid, with the sixth or external arm not produced as in the large surface-spicules of the Sarcohexactinellida, in which four arms are extended over the surface laterally, while the fifth, like the shaft of a nail, goes vertically inwards (fig. 8). With this, and also equally plentiful, are the free ends of "anchoring-spicules" terminated by four much-recurved

spines or flukes situated opposite each other, and still attached to a small fragment of the shaft (fig. 9), longer and larger portions of which may be observed in the "chert," both longitudinally and in transverse sections under fracture, indicating that with the anchoring ends they are the fragmentary remains of what originally were anchoring- or cord-spicules of a *Hyalonema* or Sarcohexactinellid sponge.

Tolerably numerous also are Lithistid spicules, especially one like a tripod, in which the centre is convex and smooth, while the three legs, bending outwards and downwards, end respectively in expanded concave feet, which seem to show that they were once applied to similar surfaces on adjoining spicules (figs. 10 and 11). This in all probability was a surface-spicule like those of *Corallistes aculeata* ('Annals,' 1880, vol. vi. pl. vii. fig. 45). Fragments of other Lithistid spicules are also present, such as the dendritically branched surface-spicule (fig. 12), and the shafted one of the fully developed or internal structure (fig. 13).

To these may be added a sausage-shaped spicule like that of some of the *Reniera* of the present day, also tolerably plentiful (fig. 14); and other fusiform acerate ones (figs. 15 and 16), which being common to many kinds of sponges, cannot in their isolated state be identified with any in particular.

Two fragments represent the arms of a quadriradiate spicule (fig. 17); but whether these were equal in length, or one was prolonged into a shaft, there is no evidence to show: if the former, it probably belonged to one of the *Pachastrellina*; if the latter, to a zone-spicule of one of the *Pachytragida*.

The most interesting part of this discovery, however, is that the "clay" of Ben Bulben, in which Mr. Wright found these remains, is apparently identical in every respect with that sent me by Mr. James Thomson, in which he found *Holasterella conferta*, near Glasgow. In both instances isolated sponge-spicules of different kinds are disseminated through it, which can be obtained by edulcoration with water, and are composed of silica in an opaque or chalcedonic state, rendered more or less irregular by the presence of rhomboidal excavations on the surface.

Here I might observe that, not only are the sponge-spicules, and the minute fossils of the Carboniferous Limestone which accompany them, silicified and pitted on the surface with the same kind of rhomboidal excavations, but the "chert" to which Mr. Wright has alluded appears to be a solid pseudomorph of the limestone; for its pumice-like worm-eaten cha-

racter occurring here and there, from partial absorption or decomposition of the material, presents a skeletal rhomboidal structure; while the same kind of rhomboidal excavations characterize the surface of the weather-worn *calcareous* fossils in the *pure Devonian Limestone* of this neighbourhood; by which I am led to infer that, in the first place, the sponge-spicules become partially or wholly calcified among *calcareous* material, else why should they now present rhomboidal excavations on their surface? that subsequently the siliceous element, being liberated, replaced the calcareous material so as to form the "chert;" and, thirdly, that the rhomboidal excavations on the surface of the spicules and the partial absorption of the spicules themselves, leaving nothing but their moulds, arises from the changes which the siliceous element itself is now undergoing—that is, becoming decomposed and removed, or passing from an amorphous state into clear quartz prisms. The latter, although but slightly the case, comparatively, in the specimens from Ben Bulben, is characteristically so in the specimens to which I have alluded from Black Head, co. Clare, wherein not only geodic cavities lined with quartz prisms, but perfect prisms themselves are present, imbedded in the amorphous siliceous material composing the rock, while all satisfactory traces of sponge-spicule form in these parts is entirely absent, so far as the specimens sent to me indicated.

Lastly, I am inclined to think that the "clay" of Ben Bulben is the "chert" decomposed, and that the innumerable fragments of sponge-spicules which are present in the latter (for in some parts the chert appears to be almost entirely composed of them), rendered still more fragmentary by partial removal so as to leave nothing but their moulds, as before stated, are those which at last come out entire, so far as they go, in the washing of the "clay."

It is remarkable, too, that by far the most plentiful among Mr. Thomson's collection of spicules from the clay near Glasgow is that of *Holasterella conferta*, as it is that of *H. Wrightii* at Ben Bulben; the "sausage-shaped" spicule (fig. 14) is also analogous to that of the supposed Renierid sponge ('Annals,' 1879, vol. iii. pl. xxi. fig. 11), and about the same in frequency. In Mr. Thomson's collection were also fragments of Lithistid spicules; and last summer he sent me a section of an entire sponge in Carboniferous Limestone, all calcified, with weathered-out spicules on the surface, but none of it sufficiently defined for useful delineation. The collection also contained some zone-spicules of the Pachytragida; so that, altogether, the Spongida appear to have been

as plentiful and as varied in the Carboniferous age as at any other time.

It would be worth while, when the opportunity offers, for some one to look over the weathered surface of the strata in the mountain of Ben Bulbin, where fragments, if not entire specimens, of sponges from which the spicules come might be found, after the manner that they have been discovered in the Carboniferous system in the south-west of Scotland.

EXPLANATION OF PLATE XIV. B.

- Fig. 1.* *Holasterella Wrightii*, spicule of, nat. size. The largest met with (diagram).
Fig. 2. The same, restored, to show the perfect form with spiral inflation on the arms. Magnified 7 diameters.
Fig. 3. The same. Furcate arm, much more magnified, to show—*a*, the simple spiral inflation, and *b*, the same when “broken up.” Scale 1-48th to 1-1800th inch.
Figs. 4, 5, 6, and 7. The same, to show the simple sexradiate and multifold divisions of the arms respectively (diagrams).
Fig. 8. Sarcohexactinellid. Fragment of large surface-spicule of unknown species.
Fig. 9. The same. Free end of anchoring-spicule.
Fig. 10. Lithistid. ? Tripod-like surface-spicule of unknown species.
Fig. 11. The same. Lateral view.
Fig. 12. The same. Dendritically branched surface-spicule of unknown species.
Fig. 13. The same. Form of body-spicule of unknown species.
Fig. 14. *Reniera*?. Sausage-shaped spicule of unknown species.
Fig. 15. Acerate spicule of unknown sponge.
Fig. 16. The same.
Fig. 17. Quadriradiate fragment of spicule of unknown sponge.
 N.B. Figs. 3 and 8-17 inclusively are all drawn to the scale of 1-48th to 1-1800th inch.

XXVIII.—*Descriptions of new Species of Asiatic Lepidoptera Heterocera.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

[Continued from p. 129.]

38. *Thalassodes opalina*, sp. n.

Wings semitransparent, emerald-green, striated all over with white and with opaline reflections: primaries crossed in the middle by a straight transverse slender white line; a shorter and less-defined line towards the apex; costal margin yellow, fringe tipped with yellow: secondaries angulated, a slender angulated white line beyond the middle, sinuated below the angulation; basal half of subcostal vein yellow, fringe tipped with yellow: antennæ white at base, golden

beyond the base; body sap-green, white at the sides and below. Wings below paler than above and immaculate, primaries with cream-coloured costa. Expanse of wings 1 inch 8 lines.

Darjiling (*Lidderdale*). Type B. M.

Nearly allied to *T. depulsata*, from the Celebes, but confounded by Walker with his *Geometra dissita* from Canara.

39. *Thalassodes glaucaria*, Walker.

♀. Pale smoky grey; wings mottled all over with minute opaline white striations, the discocellulars slightly darker than the ground-colour; an angulated darker stripe, bordered externally with snow-white, and slightly undulated at external third: body slightly brownish, vertex of head and antennæ snow-white. Wings below pearly white, without markings; costa of primaries and body below cream-coloured. Expanse of wings 1 inch 6 lines.

Darjiling (*Lidderdale*). Type B. M.

Nearest to *T. bifasciata*, but very distinct. Walker describes the male only as a *Thalera*.

The three following species would unquestionably have been referred to *Comibæna* by Walker; but only the first of them has the long palpi of that genus. Some of the species placed in *Comibæna* by Walker, and also by others who have followed him, are referable to *Chlorodes*, the palpi being short and the anal angle of the secondaries distinctly lobate; others are nearer to *Agathia*, and others, again, to *Thalera* or *Thalassodes*.

40. *Comibæna pictipennis*, sp. n.

Wings above sap-green, indistinctly striated with pearly white: primaries with the basal five eighths of the costa yellowish, the remainder snow-white; an oblique white line across the basal fourth; a small black dot at the end of the cell; an oblique, internally sinuated, externally diffused, tapering, discal, snow-white belt, terminating at the first median branch; a slightly undulated submarginal white line; a slender white marginal line interrupted by black dots between the veins; fringe tipped with white; a plum-coloured spot with ferruginous inner margin near the external angle: secondaries with the costal area pearly white; a large quadrate subapical patch, the veins at apex, the anal angle, and anal three fifths of abdominal fringe plum-colour; a small annular marking of the same colour at the end of the cell; a large dull golden arched band resting on the outer margin, and extending up into the lower radial and interno-median inter-

spaces; outer margin towards apex plum-coloured, spotted with blackish; a very slender silvery-white marginal line; apical fringe plum-coloured, intersected with white; centre of fringe somewhat golden; anal fringe plum-coloured: front of head laky brown; palpi and back of head greyish; antennæ white; collar bright green in front, yellow behind; tegulæ yellow in front, green behind; thorax white in front, yellow in the middle, green behind; abdomen green towards the base, with white dorsal line, white behind. Under surface opaline greenish white, with faint indications of the margins of the plum-coloured spots; black discocellular and marginal dots: primaries with bright green costal border: secondaries with rosy fringe. Expanse of wings 1 inch 5 lines.

Darjiling (*Lidderdale*). Type B. M.

41. *Chlorodes pastor*, sp. n.

Emerald-green: wings with stramineous external border, bounded internally by a rosy submarginal stripe; a ferruginous marginal stripe; fringe traversed by an indistinct interrupted ferruginous line; submarginal stripe bounded within upon the primaries by a white stripe, and on the secondaries by a stramineous stripe, both with zigzag inner edge; a very irregular angulated white discal stripe, edged with sap-green, on the primaries uniting with the outer stripe between the median branches: primaries with a large oblong white patch varied with rose-coloured and yellow streaks near the external angle; costal border white, spotted with green at the base; a white-bordered subbasal orange band: secondaries with the abdominal margin white, spotted with dull red; fringe white, becoming yellowish towards the anal angle: vertex of head, antennæ, and probably the abdomen white. Under surface sericeous white: wings tinted with the green of the upper surface; costa of primaries and fringes slightly yellowish, a marginal series of small dark brown spots: secondaries with several subapical and subanal brown spots parallel to the outer margin. Expanse of wings 1 inch 10 lines.

Darjiling (*Lidderdale*). Type B. M.

Allied to *Comibæna sanguineata* of Moore.

42. *Agathia scutuligera*, sp. n.

Wings above emerald-green, fringe pale stramineous, streaked with rose-red at the extremity of the veins; a marginal series of diamond-shaped red-edged white spots, bounded internally by a pale stramineous stripe; costal borders white; a few red dots in an interrupted series across the

basal third: primaries with two dots at the end of the cell, the lower one black; external angle broadly pale stramineous, traversed by a sinuous purplish abbreviated band, and mottled with lake-red: secondaries crossed at external third by a series of red dots; apex purplish: head in front yellowish, varied with red; back of head and antennæ white; thorax and base of abdomen green; rest of abdomen yellowish, sprinkled with red and with large red-edged lateral white spots, anal segments white at the sides. Under surface white; wings showing a slight greenish tint; fringe as above; a lake-red marginal line: primaries with pale yellowish costa; a purplish abbreviated band near the external angle, as above; legs cream-coloured, anterior femora and tibiæ streaked with rose-red. Expanse of wings 1 inch 3 lines.

Darjiling (*Lidderdale*). Type B. M.

A. scutuligera is very like the *Comibæna devevata* of Walker, to which it seems to be allied.

43. *Agathia gigantea*, sp. n.

Brilliant emerald-green: wings sparsely mottled with mustard-yellow, crossed beyond the middle by an extremely irregular olivaceous stripe, followed by a partly black-edged greyish-white line, and limiting the external area; on the second median interspace in all the wings this stripe is abruptly bent outwards so as to form three sides of a quadrangle; external area (occupying two fifths of the primaries and half the secondaries) sandy yellowish, mottled with black and grey, and spotted and blotched with brilliant green mottled with mustard-yellow, the green spots and blotches being arranged in an imperfect discal series and a nearly perfect and partly confluent submarginal series; fringe testaceous at its base, grey outwardly: primaries with the costal border pale flesh-colour, with two oblique blackish streaks near the base; a nearly central zigzag sandy-yellowish stripe, and a large roundish patch of nearly the same colour at the base of internal area: secondaries with white basicostal area; an olivaceous dot at the end of the cell; a subcuneiform sandy yellowish patch before the middle of abdominal area; base of the same colour: abdominal fringe white towards the base; palpi and face white; antennæ and proboscis fulvous; top of head greyish brown; collar and shoulders brilliant green; thorax sandy yellowish, with two green spots on the metathorax; tegulæ greenish; abdomen testaceous, ornamented on each segment by a large central bilunate spot. Under surface sericeous white; wings crossed by a blackish discal stripe, angulated on the primaries, followed at a short distance by an

ill-defined grey stripe, the area between these two stripes being striated with grey: primaries with a costal apical blackish spot and a second near the centre of the outer margin; a brownish dot at the end of the cell: secondaries with the outer border, excepting at apex, blackish; a minute blackish dot at the end of the cell. Expanse of wings 2 inches 3 lines.

Java (*Horsfield*). Type B. M.

44. *Agathia visenda*, sp. n.

Allied to *A. carissima**, but larger, with longer primaries and distinctly caudate secondaries; the external area with much more angular inner edge; the subapical green patch of primaries with distinctly zigzag inner edge, and the two spots below it larger and consequently more distinct, the external angle decidedly redder up to the second median branch; the costal border greyish brown, the curved stripe just before the middle of the wing darker and beginning in an irregularly cuneiform subcostal spot: secondaries with the external area wider and greyer at abdominal margin; the small green spot enlarged and placed further from the anal angle; the apical-marginal green spot almost separated into two very unequal semicircular spots. Wings below with the external area purplish, showing the green spots of the upper surface. Expanse of wings 1 inch 8 lines.

Darjiling (*Lidderdale*). Type B. M.

45. *Agathia beata*, sp. n.

Brilliant emerald-green: wings with the external area (occupying about a fourth of the primaries, and a third of the secondaries) dull black, limited internally by an undulated black-edged grey line; a large apical green patch almost obliterating the whole of the apical portion of the black external area of primaries; fringe whitish internally, black externally: primaries with pinky whitish costal border; a zigzag pale brownish stripe before the middle, commencing in a black subcostal spot; a large black spot at base: secondaries with the green apical patch terminating behind in an abbreviated white submarginal streak or line; a large subanal green patch composed of four unequal elongated lunate spots just beyond the undulated grey line; abdominal margin and fringe white towards the base; a small black basal spot: head brown in front; thorax blackish, the collar, shoulders, and a spot on the metathorax green; basal segment of abdomen black with

* Butler, Ill. Typ. Lep. Het. ii. pl. xxxvi. fig. 7.

a central green spot, three following segments green with pale brown borders and blackish dorsal tufts, remaining segments sordid white. Under surface creamy whitish; wings slightly tinted with green; external area grey, paler at the margins, and with the apical patches of the upper surface greenish white: primaries with an indistinct rosy zigzag stripe before the middle. Expanse of wings 1 inch 7 lines.

Darjiling (*Lidderdale*). Type B. M.

Nearest to *A. hemithearia* of Guénée.

46. *Thalera textilis*, sp. n.

Bright emerald-green, mottled, particularly on the veins, with pearly white; a submarginal chain-like belt of the same colour enclosing a series of green lunules; a marginal series of white and sulphur-yellow diamond-shaped spots, which extend into the fringe; fringe tipped with grey: primaries with grey-mottled chalky-white costal border; a white-edged green lunule at the end of the cell: secondaries with the basal half of abdominal fringe white: body mottled with white, abdomen with a dorsal series of white spots. Under surface white: wings glassy, opaline, veins dead white; fringe greenish spotted with testaceous, tipped with grey: primaries with blackish-speckled white costal border. Expanse of wings 1 inch 4 lines.

Darjiling (*Lidderdale*). Type B. M.

A beautifully delicate species, with strongly denticulated margin to the secondaries; it seems more nearly to approach "*Comibana*" *albiceps* of Felder in pattern than any other known form.

Palyadæ.

DISSOPHTHALMUS, gen. nov.

Ophthalmophoræ affine, corpore robustiore, abdomine brevi, palpis tenuioribus, alis brevioribus, cellulis² discoidalibus (præsertim cellula alarum anticarum) longioribus, ramis subcostalibus anticarum valde approximatis. Gen. typ. *D. iridis*.

47. *Dissophthalmus iridis*, sp. n.

Wings above with the basal three fourths lilacine, minutely irrorated with opaline scales; a dusky streak beyond the middle; external fourth pale greyish brown, crossed by a submarginal lilacine belt spangled with metallic blue and green, the spots in primaries decreasing in size from the costa downwards; the centre of the belt in the secondaries occupied by a large golden-green spot enclosing a blind black oval

ocellus with buff iris, bordered in front with blackish; fringe tipped with opal: body greyish brown. Wings below pearly bluish, crossed just beyond the middle by a purplish streak; a broad purple submarginal belt; body creamy white, palpi orange, tarsi testaceous, femora and tibiæ slightly brownish above. Expanse of wings 1 inch 2 lines.

Borneo. Type B. M.

Ephyridæ.

48. *Anisodes punctifera*, sp. n.

Near to *A. pardaria* from Borneo; ochreous, mottled all over with blood-red: primaries with a black subcostal dot near the base, a faintly indicated, oblique, zigzag, testaceous line, marked with two black dots at basal fourth; an oblique testaceous dash enclosing a black dot at the end of the cell; an oblique testaceous belt beyond the middle, margined externally by black dots, and emitting one internal and two external forks above the middle; a transverse testaceous dash near the external angle; a marginal series of black dots: secondaries pale at the base, crossed near the base by a testaceous abbreviated stripe; an interrupted, testaceous, mottled, undulated belt just before the middle, margined externally by a series of black dots, and limited internally by the black discocellular dot; a testaceous discal stripe forking towards the costa; a marginal series of black dots: antennæ with grey pectinations. Under surface cream-coloured, crossed by undulated grey lines corresponding with the bands of the upper surface; a black dot at the end of each cell. Expanse of wings 1 inch 10 lines.

Darjiling (*Lidderdale*). Type B. M.

49. *Anisodes Lidderdalii*, sp. n.

Ochreous, mottled all over with burnt-sienna red: wings with a black dot at the end of the cell of each wing, a marginal series of black dots, a dark greyish-brown oblique dash at apex, a second near the middle of external border, and two or three spots on the inner margins: primaries crossed beyond the middle by an angulated dark greyish-brown belt, which widens abruptly above the angulation at second median branch, and is excavated at its costal termination so as to give it almost a forked appearance: secondaries crossed close to the base by a dark brown stripe; a bisinuated, ill-defined, red line just before the middle, dotted at its extremities with blackish; two parallel, abbreviated, *N*-shaped, grey costal lines near the apex; a subquadrate discal dark brown patch

across the second median and discoidal interspaces : antennæ whitish, with grey pectinations ; a red posterior border on each side of the collar ; base of abdomen dark brown. Under surface stramineous, with all the markings of the upper surface, including the mottling, reproduced in grey. Expanse of wings 1 inch 3 lines.

Darjiling (*Lidderdale*). Type B. M.

In general pattern most like dark varieties of the species of the allied genus *Synegia* of Guénéé. The following described forms should be referred to the latter genus :—*Anisodes hadassa*, from Japan ; *A. imitaria* and its variety "*A. ? obri-maria*," from Ceylon ; *A. pustularia* and *A. eumeleata*, from Borneo. *Anisodes? platycerata* of Walker is a *Drapetodes*.

Erosiidæ.

The larva of this group, as Mr. Moore has shown me, proves it to be Pseudodeltoid ; for convenience' sake, however, I introduce the following new species here, since this is where it would naturally be looked for by Lepidopterists working with M. Guénéé's classification.

50. *Erosia himala*, sp. n.

Snow-white : primaries above with the basal half crossed by two widely separated, oblique, parallel, black stripes ; a slightly oblique smoky-brown stripe from the costa to the external angle ; an abbreviated submarginal black line ; costal margin dotted with black ; fringe brownish at the base : secondaries traversed by an elbowed black line parallel to the abdominal margin ; a large, oblique, pyramidal discal patch from just above the first subcostal branch to near the outer margin, ochreous with smoky brown extremities, its base excavated ; subapical area striated with brown ; a marginal, black, sinuated line connecting the caudal denticles ; a large, marginal, black spot at the extremity of the second median branch ; fringe traversed by a blackish line : anterior legs blackish internally. Wings below sordid towards the base : primaries with the black lines on basal half ill-defined ; external third brownish, flecked with darker striations : secondaries with creamy external area ; fringe traversed here and there by a blackish line ; a small black spot near the extremity of the second median interspace. Body below sordid white. Expanse of wings 1 inch 4 lines.

Darjiling (*Lidderdale*). Type B. M.

One of the largest and prettiest species in the genus.

Caberidæ.51. *Corycia vestigiata*, sp. n.

Snow-white, sericeous: wings crossed beyond the middle by an angulated series of internally brown-edged semicircular or lunate testaceous spots, followed immediately by a series of indistinct lunate brownish markings; a second similar but reversed submarginal series of lunate markings; a marginal series of minute black dots: frons reddish brown; antennæ testaceous. Under surface creamy white, immaculate. Expanse of wings 10 lines.

Darjiling (*Lidderdale*). Type B. M.

Macariidæ.52. *Evarzia indica*, sp. n.

Testaceous: wings black-speckled, crossed on the basal half by two subparallel blackish-mottled yellow lines, the outer one irregularly undulated: primaries with the external two sevenths darker, crossed obliquely from apex to inner margin by a broad dark brown stripe, which also crosses the secondaries just beyond the middle, its centre occupied by a sandy-yellow line; external area beyond the stripe greyish brown, marked at external angle with a black spot on a pale testaceous diffused patch striated with black; margin black; apical half of fringe blackish, inferior half testaceous; a sub-apical costal red-brown marking formed of two parallel oblique and slightly curved dashes corresponding in character with the commencements of the two subbasal lines; two black costal spots beyond the subapical dashes: secondaries with a diamond-shaped red-brown spot on second median interspace, and two or three ill-defined dots on the subcostal interspaces; a black marginal line: abdomen with two dorsal series of black dots. Under surface sandy yellow: wings speckled with black, crossed before the middle by a brown irregular line varied with ferruginous; a black dot at the end of each discoidal cell: primaries with a broad brown-edged rust-red band traversed by an indistinct lunulated brown line, and immediately followed by the smoky-brown external area; an oval sandy-yellow apical costal spot; fringe as above: secondaries crossed by a broad oblique discal belt, smoky brown internally, rust-red bordered with smoky brown externally; a black marginal line. Expanse of wings 1 inch 8 lines.

Darjiling (*Lidderdale*). Type B. M.

Near to *E. ozararia*, but with more defined markings, the broad discal stripe of the upper surface placed much further

from the outer margin ; the disk of secondaries spotted, the markings of the under surface darker, the apical spot oval and not bifid, and the broad belt of the secondaries of equal width throughout and placed further from the outer margin.

The males of *Evarzia* have a singular hyaline bladder-like spot near the base of the internal border of the primaries, somewhat as in the genus *Corymica*.

Fidoniidæ.

53. *Plutodes discigera*, sp. n.

Wings above citron-yellow ; primaries with a semicircular basi-internal patch of coffee-red bordered with plumbaginous and continuous with a broad triangular patch which occupies the basi-abdominal two fifths of the secondaries ; all the wings with a large oval discal patch of coffee-red, crossed by a zig-zag darker red line and bordered with plumbaginous ; body red-brown ; back of head, collar, and anal tuft pale yellow. Under surface pale creamy yellow, all the wings with a large chocolate-brown oval patch occupying nearly the whole of the disk ; secondaries with pale reddish-brown basi-abdominal area. Expanse of wings 1 inch 3 lines.

India. Type B. M.

This species was placed by Walker with *P. cyclaria*.

54. *Plutodes flavescens*, sp. n.

Nearly allied to the preceding, but the wings of a lemon-yellow colour, the discal patches comparatively smaller, more rounded in form, the line across them considerably more zig-zag, forming in the primaries ten, instead of three, angles ; body redder. Expanse of wings 1 inch 4 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

Owing to the increase of half a line in each of the front wings, the yellow area between the basal area and the oval discal patch is distinctly wider than in *P. discigera*.

55. *Plutodes exquisita*, sp. n.

Primaries above sulphur-yellow, with sericeous costal border ; outer margin and fringe citron-yellow ; an irregularly quadrate basi-internal rust-red spot with blackish margin ; disk almost wholly occupied by a broad rust-red belt, washed with pinky reddish internally and ochraceous externally, and traversed by a darker zigzag line, not reaching the costal margin, but edged at its upper extremity with plumbaginous, bordered internally by two black lines and externally by a single black

line flecked with plumbaginous: secondaries with the basi-internal and discal areas rusty red, edged externally with black flecked with plumbaginous; the disk also traversed by a darker zigzag line and bounded internally by two black lines, which terminate near the anal angle in a black spot, partly bordered internally with yellow and externally with plumbaginous; central area occupied by a triangular lemon-yellow belt; margin and fringe citron-yellow: body reddish; collar pale yellow; antennæ cream-coloured. Under surface pale creamy yellowish; the disks of the wings golden brown or pale clay-reddish, margined and banded with grey; fringes citron-yellow; abdominal border of secondaries slightly golden; body cream-coloured. Expanse of wings 1 inch 4 lines.

Darjiling (*Lidderdale*). Type B. M.

56. *Plutodes subcaudata*, sp. n.

Wings above pale sulphur-yellow, semitransparent, the costal border and fringes rather darker; primaries with a basi-internal triangular coffee-brown patch bordered with plumbaginous and black; disk almost wholly occupied by a broad coffee-brown belt, which, however, is abruptly narrowed to about one third of the width below the second median branch; this belt is traversed by an irregularly zigzag ferruginous line and bordered by a black-edged silvery line: secondaries with a basi-abdominal belt edged externally with plumbaginous and black, and a broad irregularly angulated belt, occupying nearly the whole disk, coffee-brown; the discal belt also bounded on both sides by a black-edged silver line, and traversed by a zigzag ferruginous line; external margin strongly angulated, with a large black spot extending into the fringe at the angle, so as to give it an almost caudate appearance; the outer half of the same fringe ochraceous: body brown; back of head and collar pale yellow; antennæ cream-coloured. Under surface creamy whitish, with yellow borders to the wings; discal belts formed nearly as above, but greyish brown with faint cupreous reflections. Expanse of wings 1 inch 5 lines.

Darjiling (*Lidderdale*). Type B. M.

Although similar in coloration, this species differs from the other members of the genus in the form of its wings, which somewhat approaches that of *Macaria*.

57. *Pagrasa rufescens*, sp. n.

Pale pinky brown: wings sericeous, inclining to flesh-colour: primaries with two large widely separated black costal spots; costal area minutely black-speckled; external border

greyish; fringe ferruginous; two widely divergent oblique orange stripes, the first slender, from median vein to inner margin, the second crossing the disk from the inner margin to just above the upper radial vein: secondaries with rosy outer border; an abbreviated submarginal stripe from the anal angle: antennæ silvery grey. Primaries below pale golden brown, subcostal and external areas dull blood-red; external border lilacine towards apex; a blackish costal spot at apical third: secondaries rosy brownish; an angulated discal ferruginous line: body below rosy brownish, tibiæ and tarsi greyish. Expanse of wings 1 inch 5 lines.

Darjiling (*Lidderdale*). Type B. M.

58. *Noreia sericea*, sp. n.

Sericeous pinky brown, the abdomen and basal areas slightly greyish: wings crossed just beyond the middle of primaries and before the middle of secondaries by an oblique dark ferruginous line; a slender irregularly undulated submarginal line of the same colour; a slender black marginal line; fringe rosy, pale at base: primaries with three semi-circular ferruginous lines across the cell and two parallel sub-basal sigmoidal lines below it. Under surface creamy whitish, sericeous; the wings sordid, crossed by two dark greyish-brown discal lines, the inner one straight, the outer one undulated; a slender marginal line; fringe rosy greyish towards the tips. Expanse of wings 1 inch 3 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

Zerenidæ.

59. *Abraxas pusilla*, sp. n.

Allied to *A. leopardinata*, but only of about two thirds the size; primaries with the central interrupted band expanded into a broad grey nebula occupying about a third of the wing; discal series of spots double, more or less confluent and forking towards the costa; marginal spots regular and generally confluent: secondaries with both the discal and marginal series of spots small and regular. Expanse of wings 1 inch 6 lines.

Darjiling (*Lidderdale*), Nepal. Type B. M.

There is no doubt in my mind of the distinctness of this little species. *A. leopardinata*, according to Walker, was a confused assemblage of three or four quite distinct species.

60. *Abraxas conspersa*, sp. n.

♂. Wings sericeous white: primaries above spotted and speckled with dark olive-green, the spots forming five bands—

the first basal, indistinct; the second subbasal, formed of three rounded spots, immediately followed by two larger, almost lunate spots and a rounded one on inner margin; third and fourth each of two closely approximated series, which combine into one band towards the inner margin; fifth formed of three series, the first of oval submarginal spots, the second of confluent lunate marginal spots, the third of semicircular spots on the fringe: secondaries with a discocellular spot, one or two dots towards base of abdominal margin, a discal interrupted series of two or three small subcostal, and one or two large abdominal spots; a submarginal series, a marginal series of elongate spots, and a series alternating with the latter upon the fringe, all blackish: body ochreous, spotted with black. Primaries below with all the markings sericeous grey. Expanse of wings 2 inches 4 lines.

Darjiling (*Lidderdale*). Type B. M.

Allied to *A. lapsariata*, but smaller, the white intervals between the bands of primaries mottled all over with olive dots and the central bands of large spots rather more sinuous.

61. *Abraxas consocia*, sp. n.

Near to the preceding, but considerably larger; the veins and borders of primaries pale olivaceous, the spots of the bands blackish, many of them confluent, and the secondaries dotted all with dark grey; the ordinary spots larger, those of the border confused by the numerous mottlings between them. Expanse of wings 3 inches 3 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

CALLABRAXAS, gen. nov.

Abraxati affine, differt autem cellulis brevioribus, vena costali alarum posticarum multo brevior, vena subcostali pone cellulam furcata. Gen. typ. *C. amanda**.

62. *Callabraxas amanda*, sp. n.

Wings above snow-white, sericeous: primaries with the basal half cupreous brown, crossed towards the base by three grey lines dotted with white on the veins, the third line undulated in the middle; a grey-and-white V-shaped marking immediately beyond the cell; costa towards apex black; two subapical spots, one below the other, close to the costa, three similar submarginal spots and an apical nebula grey; a marginal series of black spots; one or two minute grey dots near the external angle: secondaries with the external border

* *Abraxas Whitelyi* of Japan may also be referred to this genus.

golden ochreous, tapering towards the apex; a submarginal series of six oval black spots, the first two subconfluent, and eight marginal spots, of which all excepting the first and last are bifid; anal half of abdominal margin banded with black: body sordid cream-colour, spotted with black. Under surface of wings sericeous white: primaries with a dusky streak through the cell, otherwise the basal markings only visible from the transparency of the wing; a decreasing discal series of eight grey spots and a marginal series of bifid black spots: secondaries as above, excepting that the submarginal series of spots is continued to the costa, two spots being added at the upper extremity of the series: body sordid cream-colour, spotted and dotted with black. Expanse of wings 2 inches 2 lines.

Darjiling (*Lidderdale*). Type B. M.

This beautiful species, in the pattern of its primaries, somewhat resembles the genus *Melanippe*.

63. *Panæthia iridicolor*, sp. n.

♂ ♀. Wings above pale emerald-green, crossed in the middle by a broad angulated and widely sinuated chrome-yellow belt; a widely undulated discal stripe, white internally and yellow externally; external border washed with yellow, the veins and a series of internervular longitudinal rays beyond the discal stripe blue-black: primaries with a large and nearly complete annulus at the base, its inner edge yellow and its outer edge white; a small spot at the base of the costal border and a curved transverse line on the discocellulars blue-black: secondaries with the upper half of the discocellulars slightly blackish: body bright yellow; frons greenish, bright green just in front of the antennæ, the latter testaceous with the scape white; posterior margins of abdominal segments silvery white. Under surface pure white; primaries with a dark green line on the discocellulars. Expanse of wings 2 inches 4 lines.

Darjiling (*Lidderdale*). Type B. M.

This beautiful and delicate species is nearer to *P. hemionata* of Guénéé from North China than to any other known species; it is, however, utterly dissimilar in colour to any moth yet described.

Larentiidæ.

64. *Sauris ignobilis*, sp. n.

♂. Pale sandy brown: primaries crossed by numerous angulated wavy blackish lines; the basal area, a central angulated

belt (most distinct towards the costa above the angulation), a broad subquadrate apical patch, only separated by a slender black line from the external border, which is of the same colour, creamy whitish. Under surface sericeous, sordid whitish. Expanse of wings 1 inch 3 lines.

Darjiling (*Lidderdale*). Type B. M.

65. *Lygranoa cinerea*, sp. n.

Primaries above sericeous grey, crossed in the middle by two parallel subangulated yellow stripes, the inner one spotted with black on the costa, and the outer one enclosing a black line at costa and a black dot just above the angulation; costal margin minutely black-speckled: secondaries sandy whitish: thorax grey, abdomen sandy whitish. Primaries below greyish, with the apical area and costal border golden; secondaries sandy whitish, minutely speckled with grey, costal border slightly golden: body below whitish, palpi golden. Expanse of wings $9\frac{1}{2}$ to $10\frac{1}{2}$ lines.

Darjiling (*Lidderdale*). Type B. M.

66. *Cidaria fisisignis*, sp. n.

Nearest to *C. mactata* of Felder; primaries above pale sericeous pinky brown, adorned with large white-bordered black-brown patches and spots in six series as follows:—two spots at the base, two partly divided and larger near the base, a 7-shaped series just before the middle; the fourth series consists of a large quadrate costal patch, behind and below which run four small spots in a curved oblique line, and below that again a large cloven patch from above the median vein to near the inner margin; the fifth (or discal) series begins upon the costa in a large spot, and is continued, by small spots at intervals upon a sinuated brown line, to the inner margin; the last series represents a moderately wide external border, interrupted in three places and divided by pale veins into more or less quadrate spots: secondaries sericeous white, slightly tinted with brown towards the abdominal and external borders, the disk crossed from the abdominal margin to the middle by two irregular dusky lines; external border dusky; a marginal series of black geminated dots; fringe pale stramineous intersected by a dusky line: thorax dark brown, longitudinally striped with grey on each side; abdomen grey. Under surface sericeous pale greyish brown; wings with blackish discocellular *litræ*; a pale-edged dentate and crinkled blackish line just beyond the middle. Expanse of wings 1 inch 8 lines.

Darjiling (*Lidderdale*). Type B. M.

67. *Cidaria delecta*, sp. n.

Intermediate in character between *C. interplagata* and *mactata*: primaries above black-brown, basal fourth limited by a pale yellowish-white line, which emits a fork obliquely backwards towards the inner margin, and two nearly longitudinal streaks forwards to join a double stripe of the same colour, which runs obliquely through the centre of the wing; the inner line of the central stripe curves forwards and upwards from the first median branch so as to enclose a large partly cleft patch of the ground-colour, which crosses the end of the cell from the costal margin; the latter is also crossed by two indistinct whitish lines, and is partially enclosed by a pale brassy-yellow line close to the whitish one, and running across the disk; a slender dentate-sinuate whitish discal line followed below the third median branch by a gravel-brown stripe; a widely bisinuated submarginal whitish stripe; a nearly marginal slender whitish line; veins externally whitish or yellow; a slender indistinct whitish annular line near the middle of the inner border; fringe with a testaceous basal line: secondaries nearly as in the allied species: body whitish, tegulæ and sides of abdomen brown. Primaries below altogether greyer than above, brassy towards the apex, the markings less prominent: secondaries pale brassy yellow, minutely black-speckled; discocellular spot black and prominent; two central curved dusky lines and an indistinct discal streak dotted with brown: body below yellowish. Expanse of wings 1 inch 6 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

68. *Cidaria relata*, sp. n.

Allied to *C. silaceata*, *melancholica*, and *substituta*: primaries dark brown, crossed by four pale stripes, the first three pinky whitish and enclosing brown lines, the first subbasal arched, the second and third crossing one another so as to form a large ∞ -shaped figure, which covers more than a third of wing, the fourth biangulated, white, submarginal; several pale annular markings in the centres of the patches enclosed by the pale stripes: secondaries sericeous greyish white; anal half of abdominal border banded alternately with blackish and white; outer margin brownish: body pale bronzy brown, indistinctly banded with white. Primaries below greyish, with faint indications of the markings of the upper surface: secondaries whitish; a discocellular spot, an N-shaped marking on abdominal border, and a dentate-sinuate submarginal line dusky: body below whitish, legs testaceous; anterior tibiæ

indistinctly banded with brown. Expanse of wings 1 inch 4 lines.

N.E. Himalayas (*Lidderdale*). Type B. M.

69. *Cidaria aurigena*, sp. n.

Allied to *C. inextricata* and *aerosa**: the primaries much more golden than either, the dark brown markings, being confined to the base, costal border, the large patch which crosses the end of the cell and which is acutely angulated, and to the apex; all the other spots which are brown in *C. inextricata*, and partly so in *C. aerosa*, are of a brassy-golden colour in this species: secondaries with scarcely a trace of the white discal stripes: body pale brassy yellowish; thorax greenish in the centre, with a brown longitudinal dorsal stripe. Under surface brassy yellow, with greyish lines, as in *C. inextricata*. Expanse of wings 1 inch 1 line.

N.E. Himalayas (*Lidderdale*). Type B. M.

Apart from differences of pattern and coloration, this species measures about half an inch less in expanse of wings than *C. inextricata*; the latter differs from *C. aerosa* in having ten instead of eight yellow lines and stripes across the costal half of the primaries, and in the dark brown spots on the border near the external angle.

70. *Cidaria aliena*, sp. n.

Nearly allied to *C. aurata* of the *C. corylata* group: primaries black-brown, crossed at basal third and again on the disk near the outer margin by two widely diverging ochreous bands, touched here and there with ferruginous, and bordered by tolerably regularly dentate-sinuate white lines; a cuneiform costal apical spot and a small spot near the centre of external border of the same ochreous colour, but not white-bordered; outer border towards the external angle almost wholly ferruginous; a marginal series of slender white lunules; fringe ochreous, spotted with blackish: secondaries white, tinted, especially towards the outer margin, with golden yellow, fringe ochreous: body white, spotted with yellow and dark brown alternately. Primaries below altogether paler than above: secondaries white, speckled with dark brown, and crossed in the middle by two parallel irregularly arched dark brown lines; a blackish discocellular spot; indications of a dark brown submarginal line; veins almost wholly yellow; legs brownish. Expanse of wings 1 inch 3 lines.

Bhotan (*Lidderdale*). Type B. M.

* Ill. Typ. Lep. Het. iii. pl. lv. fig. 7.

XXIX.—Description of two remarkable new Species of Kingfishers. By R. BOWDLER SHARPE, F.L.S., F.Z.S., &c., Department of Zoology, British Museum.

MR. CHARLES HUNTEIN, who is collecting in South-eastern New Guinea, has forwarded to the British Museum a series of birds obtained by him on the East Cape, in Milne Bay, and neighbouring localities. Amongst many interesting birds there are two which are undoubtedly new to science, both of them being members of the family Alcedinidæ.

Genus TANYSIPTERA.

Tanysiptera Danae, sp. n.

T. affinis T. nymphae, Gray, sed pileo dorsoque brunneis, supercilio et facie laterali tota rufo-brunneis facile distinguenda. Long. tot. 10·5, culm. 1·25, alæ 3·45, caudæ 6·4, tarsi 0·6.

Lest any idea should occur that this species could be a stage of plumage of *T. nympha*, which it agrees with in the crimson under surface and lower back, it is well to state that the collection contained numerous examples of *T. Danae*, young birds as well as adult.

With the exception of *Tanysiptera obiensis* of Salvadori, from the Obi group of islands, and *T. Emilie*, Sharpe, from Raow, the British Museum contains examples of every species of the genus; and I may notice here that, having now seen several specimens of *T. salvadoriana*, Ramsay, from Port Moresby, I am convinced that it is distinct from *T. sylvia*, Gould, of Cape York. The discovery of the new species described in this paper will bring the number of *Tanysipterae* known to inhabit the island of New Guinea up to five, no other island in the Papuan archipelago as yet possessing more than one.

CLYTOCEYX, gen. nov.

Genus novum Daceloninarum, rostro quam cauda brevior, culmine lævi rotundato, rectricibus 12, commissura integra, naribus linearibus, tarso longiore quam halluce cum ungue mensurato, rostro magno obtuso, altitudine ad nares mensurata ejus latitudinem æquante insignissimum.

Typus est

Clytoceyx rex, sp. n.

♂. Capite brunneo; plumis oculum circumcingentibus et facie laterali brunneis; regione parotica nigra usque ad collum posticum nigrum producta et torquem latam formante; fascia supra-parotica, genis imis et fascia lata cervicali ochrascenti-fulvis; interseapulio nigro; seapularibus et tectricibus alarum brunneis,

his ochrascenti marginatis, minimis externis virescenti-cyaneo lavatis; tectricibus primariorum remigibusque saturate brunneis, extus sordide viridi lavatis; dorso postico et uropygio argenteo-cyaneis; supracaudalibus et reetricibus saturate brunneis viridi lavatis; gula alba; corpore reliquo subtus cum subalaribus ochrascenti-fulvis; remigibus infra fuscis, intus pallide ochraceo marginatis. Long. tot. 12, culm. 1.95, alæ 6.35, caudæ 4.7, tarsi 0.9.

A second example has the tail reddish, with remains of dusky margins to the feathers of the under surface and the collar on the hind neck: these markings are a sign of immaturity in the Dacelonine group of Kingfishers. The difference in the red and dusky green tails exhibited in *Clytoceyx* sufficiently demonstrates the affinity of the new genus to the genus *Dacelo*, and more especially to *Dacelo Gaudichaudi*.

XXX.—*On Cynanthus bolivianus, Gould.*

By D. G. ELLIOT, F.R.S.E. &c.

IN the Ann. & Mag. Nat. Hist. for June, p. 488, Mr. Gould has described a species of *Cynanthus*, brought by Mr. Buckley from Bolivia, as distinct from *C. mocoa*, under the name of *C. bolivianus*, basing his specific characters on its "smaller size," its "brighter metallic green," and its tail "more of a brilliant steel-blue than a vivid green." Being somewhat surprised that I and other ornithologists had overlooked a new species in our collections of so exceptionally conspicuous a form, I re-examined my series of *C. mocoa*, in order to endeavour to distinguish this new species from amongst my specimens, with the following results. Ten specimens of *C. mocoa* were available for the investigation, among which were those brought by Buckley from Bolivia and Ecuador, others from Peru procured by Jelski, and one specimen from Mr. Gould's collection, the locality doubtful. Those from Bolivia are from the same lot from which Mr. Gould obtained his *C. bolivianus*, and came from the Chairó road, between La Paz and Yungas. There are several of these in my collection; ample to show any specific difference, did it exist, from Ecuadorian specimens. In the general size of the birds from all the localities there is no appreciable difference. Mr. Gould gives the total length of the Bolivian bird as 6.3 inches, culmen 8.7, wing 2.6, tail 4.1, tarsus 0.2; and the Ecuadorian as 8 inches, wing 3, tail 5.5. My specimens (from Baños, Ecuador, *Buckley*) measure as follows:—

		Total length. inches.	Wing. inches.	Tail. inches.	Culmen. inch.
1. ♂	.....	$7\frac{1}{4}$	$2\frac{3}{4}$	5	$\frac{1}{2}$
2. ♂	.....	$6\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{7}{8}$	$\frac{9}{16}$

From Bolivia (*Buckley*) :—

3. ♂	.....	7	$2\frac{1}{8}$	$4\frac{3}{4}$	$\frac{5}{8}$
4. ♂	.....	$6\frac{3}{4}$	$2\frac{1}{2}$	$4\frac{3}{4}$	$\frac{5}{8}$
5. ♂	$6\frac{1}{2}$	$2\frac{1}{2}$	$4\frac{1}{2}$	$\frac{3}{4}$
6. ♂, Peru	$6\frac{1}{2}$	$2\frac{1}{2}$	$4\frac{1}{4}$	$\frac{1}{2}$

Mr. Gould's specimen (locality, Ecuador?) :—

7. ♂	$6\frac{7}{8}$	$2\frac{1}{2}$	$4\frac{5}{8}$	$\frac{1}{2}$
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Another specimen from Baños, Ecuador (*Buckley*), has not the tail fully developed; so I do not give the measurements; and two others are females. All the above are adult males in perfect plumage. It will be noticed that none of them has a total length of 8 inches, given by Mr. Gould as the measurement of *C. mocoa*, the largest being $7\frac{1}{4}$ inches; and this example, I consider, has an unusually long tail. The make-up of a skin causes a total length to vary sometimes very considerably; and it should always be mistrusted as indicating a specific character in birds like those of the family Trochilidæ. The length of wing, as will be seen, is about the same; while of the tail, the shortest is found in a specimen from Ecuador, as is also the longest. From the foregoing, as well as from my experience in these birds, I do not think that a slight difference in the measurement of any of their parts has any specific value whatever; and no specimen should be separated from its fellows as distinct with only a slight difference in size to substantiate its claim. Finding measurements unprofitable, I turned to colour. The "brighter metallic green" being only a comparative distinction from a "bright metallic green" proved to be a very difficult character to seize upon, as the colour of the birds varied in hue and intensity as the rays of light fell upon them; but it was easy to see that all possessed the same colouring, be the metallic hues bright, brighter, or brightest. The single remaining point was that the tail of the Bolivian bird should be more of a brilliant "steel-blue" than "vivid green." If this last should prove to be a stable character, there might be something in it; but what did the examination show? That no. 4, from Bolivia, possessed the most brilliant metallic green tail of all the specimens!!; and next to it was no. 5, also from Bolivia; while no. 2, from Ecuador, and no. 1, from Ecuador, exhibited rectrices of the same hues slightly tinged with steel-

blue, while the Peruvian bird, no. 6, showed but a trace of steel-blue in the vivid green. Mr. Gould's specimen from Ecuador (?) had a little blue above the black on the outer rectrices. It would therefore seem to be quite evident that both discrepancy in size and variation in hues are individual characteristics among specimens of *C. mocoa*, as is observed among examples of *C. forficatus*, and not of any specific value, and that the *C. bolivianus*, Gould, should be relegated to the synonyms of *C. mocoa*, as an untenable species.

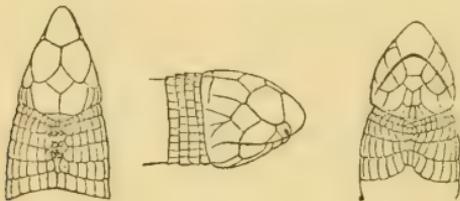
XXXI.—Description of new Species of Reptiles from Eastern Africa. By Dr. A. GÜNTHER, F.R.S., Keeper of the Zoological Department, British Museum.

THE British Museum has recently received some small consignments of reptiles from various parts of Eastern Africa, chiefly through the kindness of Dr. Kirk and Mr. Bewsher. The following very interesting species were recognized as undescribed.

GEOCALAMUS, g. n. Amphisbæn.

Allied to *Baikia*. Head very short, with compressed conical snout. Rostral large; two large frontalia form a suture together behind the rostral; vertical small, square, sometimes confluent with the frontals; two occipitals with small accessory scutes on the sides and behind. Nasal very small, above the first labial; ocular above the second and third labials. Three upper labials. Mentale square, of moderate size; three lower labials; gular scutes small, rather numerous. Sternal scutes similar to those of the body, oblong, quadrangular, small. Præanal shields two, triangular; præanal pores four. Lateral line distinct.

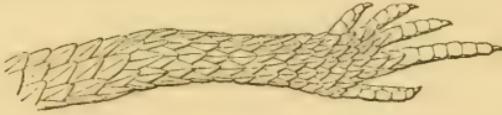
Geocalamus modestus.



One verticellus consists of 38 scutes, of which 17 are above, and 21 below the lateral lines. Upper parts greyish, lower white.

Three specimens were obtained by a missionary stationed at Mpwapwa, which is about 200 miles inland of the coast opposite Zanzibar. The longest is $9\frac{1}{2}$ inches long.

Chamaesaura miodactyla.



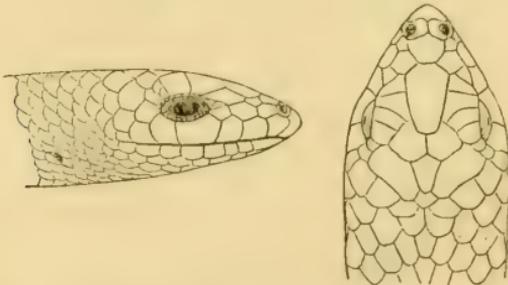
Fore limb with distinct upper and lower arm, and two or three claws, nearly reaching to the ear-opening when laid forwards; hind limb (see fig.) rudimentary, but well formed, with five clawed toes unequal in length, and with three large femoral pores. Scales round the body in 28 longitudinal series. Coloration as in *C. anguina* and *C. macrolepis*.

An adult specimen, discovered in the Peri-Bush by H. Trevelyan, Esq.

SEPACONTIAS, g. n.

This new genus cannot be referred either to the Scincidae or Sepidae, if these families be maintained with the definitions given by Gray. It has also affinity to *Acontias*, the large rostral shield of this genus being assumed here to be divided into three pieces. The rostral shield is rather large, depressed, and bordered behind by two shields (nasals), which form a suture together behind the rostral, and each of which is pierced by a large round open nostril directed upwards, and with a short slit to the hind margin of the nasal. In other respects the scutellation of the head and the formation of the body is that of a *Gongylus*. Scales smooth; ear-opening very narrow; eyelids scaly; limbs feeble.

Sepacontias modestus.



The nasals separate the rostral shield from the frontal, which is broader than long; vertical large, bell-shaped, angular

behind, and not in contact with the central occipital; two pairs of occipitals, of which the posterior is the larger; four superciliaries; postnasal and loreal nearly of the same size; six upper labials, of which the fourth is the largest, situated below the eye. Front lower labial rather narrow, followed by a single mentale, which is broader than long; six lower labials.

Body surrounded by 26 longitudinal series of scales; there are 73 transverse series of scales between the mentale and the vent; the body, therefore, is rather slender. Four preanal scales, of nearly the same size.

Fore limbs very small, reaching the ear-opening when laid forward; toes very short, the third a little longer than the fourth. The hind limb and toes very short, the second and fifth toes equal in length, the fourth a quarter longer than the third. Upper parts uniform dark olive, lower whitish; sides and the lower part of the tail punctulated with brown.

	millim.
Distance of the snout from the eye	4½
" " ear-opening	11
" " fore limb.....	20
" " vent.....	83
Length of fore limb	9½
" third front toe	2½
" hind limb	16
" fourth hind toe.....	5

In one specimen, in which the tail is preserved, this member is about as long as the rest of the body.

Three specimens were obtained at Mpwapwa.

Gongylus Johannaë.

Rostral shield with a straight upper margin; supranasals in contact with each other; frontal broad, single, with a straight posterior margin; vertical large, bell-shaped, narrower in front than behind, with a shallow notch in the middle of its hind margin, the small central occipital fitting into the notch; one pair of occipitals. Nostrils in a notch of the rostral shield; postnasal only one fifth the size of loreal. Six upper labials, the fourth not being larger than the third, and situated below the eye. Anterior lower labial rather narrow, followed by a single mentale, which is rather broader than long; seven lower labials.

Eyelids scaly; ear-opening small, round.

Body surrounded by 33 longitudinal series of scales. There are from 97 to 101 transverse series of scales between the mentale and the vent; the body, therefore, is very slender.

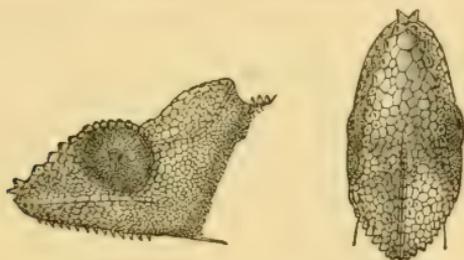
Four preanal scales, the two central ones being the largest.

Fore limbs very small, reaching to the ear-opening when laid forward. Toes very short, the third and fourth equal in length. The hind limb and toes very short, the second and fifth toes equal in length, the fourth one fifth longer than the third. Upper parts brownish, finely mottled with darker; lower parts whitish.

	millim.	millim.
Distance of the snout from the eye	5	4
" " ear-opening..	14	10
" " fore limb....	26	19
" " vent.....	118	70
Length of the tail	(broken).	107
" fore limb	11	8½
" third front toe	2½	1½
" hind limb.....	21	13
" fourth hind toe	5½	4

The British Museum has received three specimens of this species from the Comoro Islands—a smaller one through Dr. Kirk, and two larger ones through Mr. Bewsher, who states that they were obtained on the Paddy sugar estate in Johanna, under stones, at an altitude of 1000 feet above the sea.

Chamaeleon cephalolepis.

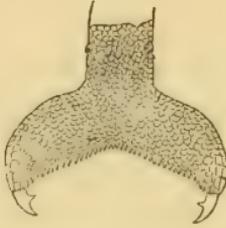


This species is allied to *C. tigris* from the Seychelles; but the scales on the head, which in the latter species are minute, are much larger and scute-like in the present new species. The snout is not produced, but terminates in two pairs of pointed tubercles, which are the continuation of the series of tubercles with which the canthus rostralis is furnished. The canthus rostralis passes uninterruptedly into the superciliary ridge, which is joined by a horizontal forward prolongation of the occipital ridge. A rather prominent crest runs along the middle of the occipital region. Occiput narrow, but rounded behind, without spine and without lateral flap. Scales of the body smooth, small, granular, equal. Dorsal crest very low, showing some short isolated spines anteriorly only. The gular and ventral crest is rather more distinct, but likewise very low. Coloration without distinct markings.

A single adult male from the Comoro Islands, $6\frac{1}{2}$ inches long, of which the tail takes $3\frac{1}{2}$ inches.

Rhampholeon Kerstenii.

Chamaeleo Kerstenii, Peters in Von der Decken's Reisen, iii. p. 12, Taf. 1. fig. 1.



This is a second species of the genus *Rhampholeon*, each claw being provided with the characteristic accessory sharp denticle; but the spine which vertically projects from the flexor side of the toes in *R. spectrum* is absent in the present species.

One specimen from Mpwapwa is $3\frac{1}{2}$ inches long, the tail measuring $1\frac{1}{3}$ inch.

Dipsas betsileana.

Scales in 23 series, those of the vertebral series scarcely enlarged. Head very short and broad; eye very large. The loreal enters the orbit below the single præorbital; two postorbitals; seven upper labials. Black, with about thirty-four narrow yellow cross bands on the trunk; tail similarly coloured. Snout with an irregular yellow band across the frontals.

One specimen, $15\frac{1}{2}$ inches long, from S.E. Betsileo, Madagascar.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

May 12, 1880.—Robert Etheridge, Esq., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "On the Structure and Affinities of the Genus *Protospongia*, Salter." By W. J. Sollas, Esq., M.A., F.G.S.

In this paper the author described the character of the Cambrian genus *Protospongia* from the original and other specimens. In Dr. Hicks's specimen the spicules of the sponge show their original

form, when it is clear that they are not fused together into a continuous network; they form a network only by the interlacing of their extremities. The spicules are quadriradiate, with the centre raised, so that each spicule indicates the outlines of a low four-sided pyramid, the centre being at the apex, and the four rays representing the four edges of the pyramid. The rays do not diverge at right angles; and thus the base of the pyramid is oblong, though this may be due to distortion. From some indications the author is inclined to believe that a fifth ray may have sprung from the centre of the spicule downwards. The rays of the spicules appear to be cylindrical. The spicules are generally of several sizes, the larger ones forming a framework which is filled in by the smaller forms, the latter being regularly arranged; so that the smaller ones fill up the square spaces left between the rays of the larger, and thus build up a network of square meshes gradually diminishing in size. The sponge-wall seems to have consisted of more than one layer of spicules. The spicules were probably originally siliceous; but now they consist of iron pyrites.

With regard to the systematic position of *Protospongia*, the oldest known sponge, the author remarks that similar spicules similarly arranged are to be met with in the Hexactinellidæ, the absence of one or two rays being not unusual in part of the spicules of true Hexactinellids. As the spicules are free, he would refer the sponge to Zittel's *Lyssakina*, which are nearly equivalent to Carter's *Sarcohexactinellida*.

2. "Note on *Psephophorus polygonus*, von Meyer, a new Type of Chelonian Reptile allied to the Leathery Turtles." By Prof. H. G. Seeley, F.R.S., F.G.S.

The specimen described is a portion of the shield from the anterior dorsal region, and was obtained from the later Tertiary deposits of the borders of Croatia. It was originally regarded by Von Meyer as the armour of an Edentate mammal; but it was afterwards suggested by him and Prof. Fuchs that *Sphargis* presented a nearer affinity. A keel runs along the middle of the specimen, and is regarded by the author as one of the outer folds of the shield. The dermal skeleton is made up of irregularly polygonal plates of various sizes, closely resembling those of *Sphargis*, except that each plate is almost twice as large as those of that form. The plates usually show a radiate ornament on the surface. On the underside of the slab are the remains of several vertebræ, apparently from the base of the neck; and these differ from the vertebræ of all known Chelonians in having strong transverse processes for the attachment of ribs. The neural arch, like the processes, is ankylosed to the centrum. The author considers that the dermal skeleton is not represented in the carapace of ordinary Chelonia, but is represented by the granulations on the surface of the carapace of the Trionychidæ. He is hence led to indicate three primary divisions of the Chelonian order, viz.:—1. *Aspidoche-*

lyidæ, in which the bony carapace is covered with symmetrical horny scutes, including Turtles, Emydians and Tortoises; 2. *Peltochelyidæ*, in which the bony carapace has a granular surface-structure and is covered with an undivided dermis without scutes, including only the Trionychidæ; and 3. the *Dermatochelyidæ*, in which the carapace is not developed, but is functionally represented by a bony skeleton within the skin, as in *Sphargis* and *Psephophorus*.

3. "On the Occurrence of the Glutton (*Gulo luscus*, Linn.) in the Forest-bed of Norfolk." By E. T. Newton, Esq., F.G.S.

Remains of the Glutton have hitherto been obtained only from cave-deposits. The author has lately received from Mr. R. Fitch, of Norwich, a portion of the lower jaw of this animal obtained from the Forest-bed of Mundesley, Norfolk. The specimen consists of about 2 inches of the left ramus, bearing the first true molar and the hinder half of the fourth premolar in place. The jaw is smaller than in average specimens of the recent Glutton, but presents all the characters of the species, as described in detail by the author.

4. "A Review of the Family Diastoporidæ, for the purpose of Classification." By George Robert Vine, Esq. Communicated by Prof. Duncan, F.R.S., F.G.S.

This family of the Cyclostomatous Polyzoa, never very prolific, has representatives from the Lower-Silurian era to the present time, and is now northern and of deep-sea habit. The author discusses the limits of the family, and gives a list of the recent and fossil genera and species included in it. He points out that there are important differences in the Palæozoic forms, several of which, though he leaves them provisionally among the Diastoporidæ, he considers, on fuller examination, will have to be removed. The author describes the characteristics of some Palæozoic genera of true Diastoporidæ.

5. "On Annelid Jaws from the Wenlock and Ludlow Formations of the West of England." By G. J. Hinde, Esq., F.G.S.

Referring to his paper on Annelid-jaws from the Palæozoic rocks of Canada and Scotland (Quart. Journ. Geol. Soc. vol. xxxv. p. 370), the author in this paper announced the discovery of similar objects in the Silurian deposits of Dudley, Much Wenlock, Iron Bridge, Stoke Edith, and near Ludlow. He noticed from these Silurian rocks seven species of *Eumicites*, two of which, *E. curtus* and *E. unguiculus* from the Wenlock, are new; nine species of *Ænonites*, of which six, namely *Æ. regularis*, *naviformis*, *præacutus*, and *tubulatus* from the Wenlock, *Æ. insignificans* from the Upper Ludlow, and *Æ. aspersans* from the Wenlock and Upper Ludlow, are described as new; seven species of *Arabellites*, four of which are new, namely *A. extensus*, *spicatus*, and *obtusus* from the Wenlock, and *A. anglicus* from the Wenlock and Upper Ludlow; further, *Lumbriconereites*

basalis, *Staurocephalites semula*, sp. n., and *Nereidavus antiquus*, sp. n., from the Wenlock group. Including varieties, 27 forms are noticed by the author, of which 21 are peculiar to the Wenlock group and 2 to the Ludlow, while 4 are common to the two groups. In the Wenlock there are 8 forms already described from American rocks, 3 occurring in the Cincinnati group, 3 in the Clinton, and 2 in both groups of rocks. Of the Ludlow forms, 2 occur in the Cincinnati group, and 1 of these also in the Clinton.

June 23, 1880.—Robert Etheridge, Esq., F.R.S.,
President, in the Chair.

The following communications were read :—

1. “On the Skull of an *Ichthyosaurus* from the Lias of Whitby, apparently indicating a new species (*I. Zetlandicus*, Seeley), preserved in the Woodwardian Museum of the University of Cambridge.” By Prof. H. G. Seeley, F.R.S., F.G.S.

In this paper a very fine skull of *Ichthyosaurus* was described in detail. From the broad triangular form of the skull and the great distance between the orbits, the author is led to regard it as belonging to a species distinct from any that have hitherto been described. As it was presented to the Woodwardian Museum by the Earl of Zetland, he proposed to name it *Ichthyosaurus Zetlandicus*.

2. “Note on the Cranial Characters of a large Teleosaur from the Whitby Lias, preserved in the Woodwardian Museum of the University of Cambridge.” By Prof. H. G. Seeley, F.R.S., F.G.S.

The author described a somewhat fragmentary cranium from the Whitby Lias, which has been sawn through along the median line so as to expose the brain-cavity. From the characters thus revealed he is led to infer that the resemblance of the Teleosaurs to the existing Crocodilia has been somewhat too strongly insisted upon. From the peculiarities of the prootic bone, and of the tympanic region, and the general shape of the brain-case, the author is led to regard the fragment as indicating a new species, for which he proposes the name of *Teleosaurus eucephalus*.

3. “On new Erian (Devonian) Plants.” By J. W. Dawson, LL.D., F.R.S., F.G.S.

The paper first referred to recent publications bearing on the Erian (Devonian) flora of N.E. America, and then proceeded to describe new species from New York and New Brunswick, and to notice others from Queensland, Australia, and Scotland.

The first and most interesting is a small Tree Fern, *Astropteris noveboracensis*, characterized by an axial cylinder composed of radiating vertical plates of scalariform tissue imbedded in parenchyma, surrounded by an outer cylinder penetrated with leaf-bundles with

dumbbell-shaped vascular centres. The specimen was collected by Mr. B. Wright, in the Upper Devonian of New York.

Another new fern from New York is a species of *Equisetides* (*E. Wrightianum*), showing a hairy or bristly surface, and sheaths of about twelve, short, acuminate leaves.

A new and peculiar form of wood, obtained by Prof. Clarke, of Amherst College, Massachusetts, from the Devonian of New York, was described under the name *Celluloxylon primævum*. It presents some analogies with *Prototaxites* and with *Aphyllum paradoxum* of Unger.

Several new ferns were described from the well-known Middle Devonian plant-beds of St. John's, New Brunswick; and new facts were mentioned as confirmatory of the age assigned to these beds, as showing the harmony of their flora with that of the Erian of New York, and as illustrating the fact that the flora of the Middle and Upper Devonian was eminently distinguished by the number and variety of its species of ferns, both herbaceous and arborescent. It will probably be found eventually that in ferns, equisetaceous plants, and conifers the Devonian was relatively richer than the Carboniferous.

Reference was also made to a seed of the genus *Ætheotesta* of Charles Brongniart, found by the Rev. T. Broun in the Old Red Sandstone of Perthshire, Scotland, and to a species of the genus *Dicranophyllum* of Grand'Eury, discovered by Mr. R. L. Jack, F.G.S., in the Devonian of Queensland.

In all, this paper added six or seven new types to the flora of the Erian period. Several of them belong to generic forms not previously traced further back than the Carboniferous.

The author uses the term "Erian" for that great system of formations intervening in America between the Upper Silurian and the Lower Carboniferous, and which, in the present uncertainty as to formations of this age in Great Britain, should be regarded as the type of the formations of the period. It is the "Erie Division" of the original Survey of New York, and is spread around the shores of Lake Erie, and to a great distance to the southward.

4. "On the Terminations of some Ammonites from the Inferior Oolite of Dorset and Somerset." By James Buckman, Esq., F.G.S., F.L.S.

The author referred to the figures given by D'Orbigny of Jurassic Ammonites having the mouth-termination perfect, and proceeded to describe the characters presented by complete specimens obtained by him from the Inferior Oolite of Dorsetshire and Somersetshire. He enumerated 14 species, which he classified as follows, in accordance with the nature of the terminations:—1. Termination lanceolate, *i. e.* with a lance-shaped process on each side of the mouth (*A. concavus*, *subradiatus*, *Eduardianus*); 2. Ovato-lanceolate or spatulate, *i. e.* with a spatulate process on each side of the mouth (*A. Braikenridgii*, *linguiferus*, *Sauzii*, *Martinsii*, *subcostatus*); 3. Delphinulate

“side view like that of the classic dolphin” (*A. Gervillii*); 4. Semi-circular (*A. Brongniarti*, *Manselii*, *Humphresianus*); 5. Waved (*A. Moorei*, *boscensis*).

5. “On some new Cretaceous *Comatulæ*.” By P. Herbert Carpenter, Esq., M.A. Communicated by Prof. P. Martin Duncan, M.B., F.R.S., F.G.S.

In this paper the author described five new species of *Antedon* from British Cretaceous deposits, two of them in the possession of the Rev. P. B. Brodie, the rest in the collection of the British Museum. The species are:—*Antedon perforata* and *A. Lundgreni*, from the Upper Chalk, Margate; *A. striata*, from the Upper Chalk, Dover; *A. laticirra*, from the Chalk of Wylve, Wiltshire; and *A. incurva*, from the Upper Greensand, Blackdown. The author further gave a tabular key to the known English Cretaceous species of *Antedon*, and in conclusion referred to certain peculiarities in the structure of these fossils, apparently subservient to the circulation of water in their interior.

6. “A Review of the Family *Vincularidæ*, recent and fossil, for the purpose of Classification.” By G. R. Vine, Esq. Communicated by Prof. P. M. Duncan, M.B., F.R.S., F.G.S.

The author examined in detail the insufficient description of the genus *Vincularia* by its founder DeFrance, and the manner in which it has been employed by subsequent authors. He concluded that the different forms, ranging from the Carboniferous to the present day, which have been included in the genus, present no such features in common as would justify the retention of the generic or family name.

7. “On the Zones of Marine Fossils in the Calciferous Sandstone Series of Fife.” By James W. Kirkby, Esq. Communicated by Prof. T. Rupert Jones, F.R.S., F.G.S.

In this paper the author described the marine beds that he has met with in the Calciferous Sandstones of the east of Fife, and traced the sequence of over 4000 feet of beds, probably all belonging to the “Cement-stone group.” In the section from the west of Pittenweem to Anstruther he recognized eighteen zones, which he characterized by their contained fossils; in the section at Randerstone he distinguished eleven limestone beds; and he compared and, as far as possible, correlated the two series of deposits. Full lists of fossils were given; and the author further specially discussed the characters and distribution of the more important species.

MISCELLANEOUS.

Tabulæ in the Stellate Venations of Stromatopora.

By H. J. CARTER, F.R.S. &c.

To the Editors of the Annals and Magazine of Natural History.

GENTLEMEN,—On the 26th ult., under the kind guidance of my friend Mr. Champernowne, F.G.S., of Dartington Hall, near Totnes, I again went to “Pit-Park Quarry,” which is in the “Devonian Limestone” close by, where we found a block of that species of *Stromatopora*, which, from its large venation, appears to me to have been undescribed; and on clearing it a piece split off, which exposed a plane covered with its stellate venations, in which all the calcite usually filling them in the fossilized condition had been removed, so that they, in fact, presented the cœnenchyma just minus the soft parts or cœnosarc which originally filled them.

On examining these more closely after my return to this place, I found that the larger portions of the branches of the stellate venations were traversed by *tabulæ*.

Thus at once it was proved that the *Stromatoporeæ* could not have been sponges, and that they were *Tabulate corals*, like those in this respect in the same bed, in which the latter, in great abundance, are overgrown and enclosed by *Stromatoporeæ* throughout, so as once to have formed one great reef-mass now decomposing into its original elements.

In a future communication I hope to describe and illustrate this fact in connexion with the species of *Stromatopora* wherein it was discovered.

I am yours faithfully,

HENRY J. CARTER.

Budleigh-Salterton,
Aug. 7, 1880.

On the Oviposition of Pleurodeles Waltlii.

By M. L. VAILLANT.

We have lately obtained in the menagerie of the Museum the reproduction of a well-known Urodelous Batrachian, *Pleurodeles Waltlii*, Michaelis, which, although belonging to the European fauna, had not previously been investigated in this particular.

In the month of May 1879 M. Desguez and I observed an alteration in the form of the tail in the males of these animals; the membranous crests, both superior and inferior, were visibly more developed. A little later we witnessed the actions preparatory to copulation. These are of the most singular kind, and, while reminding us of what is known of different Batrachians of the same group, present peculiarities which it is important to indicate.

The male places himself beneath the female, in such a way that the upper part of his head answers to the gular region of the latter. He then clasps the anterior limbs of his consort by raising his own; his foot passes successively behind, outside, and in front of the arm of the other individual; and finally the digits are inserted into the

axilla and complete the circuit. The pair are thus firmly united; and the dark colour common to the two sexes aiding the confusion, it is even necessary to look very closely at them in order to recognize the real position of the parts, and distinguish what belongs to each of the animals. The male swims to and fro carrying the female with him, the latter appearing inert and making no movement; from time to time he sinks to the bottom, detaches one of his feet, the right one in the tolerably numerous observations that we have made, and turns round upon the left limb, which he continues to hold grasped by his own. In this manœuvre he stretches himself out at first in front of the female, with the extremities of the two muzzles nearly against one another; then he continues his evolutions so as to place himself parallel to her left side. His tail, at this time, performs rapid undulations, a sort of shivering which resembles the analogous movements described by Rusconi in *Triton cristatus*. From time to time he endeavours to turn himself over beneath the female in order to bring his cloacal aperture near to hers. In all probability it is thus that the actual copulation is effected; but hitherto we have not been able to ascertain this positively. At the end of a variable time the male resumes his first situation beneath the female and begins to swim again; and it is not until after having several times repeated this process that the animals finally separate.

At the period when these facts were observed for the first time they were not followed by any result; but this year, towards the middle of February, the *Pleurodelæ* copulated again; and on the 25th of that month oviposition commenced, and continued during at least two months and a half. It was, however, particularly abundant at first, when the ova could be collected by hundreds.

These ova, which are not unlike those of the Axolotls, are attached to submerged bodies, especially to stones, and isolated from each other (that is to say, without any actual connexion) when, as is frequently the case, they are close together. The transparent albuminous sphere measures from 7 to 10 millims. in diameter, the egg, properly so called, being not more than 2 millims. The latter at first is black in its upper hemisphere, except a central polar point, of which the colour is yellowish, like that of the inferior hemisphere; at the end of three or four days it becomes entirely of a yellow colour, and one can distinguish the mark produced by the evolution of the primitive streak.

It seems useless to dwell upon the evolution, which presents nothing peculiar. The eggs being placed in the best condition of heat and light, the young issued from them from the 16th to the 20th day after deposition. The adherent hooks disappeared on the thirteenth day after exclusion, at which period the young tadpoles possess a tridactyle arm; eleven days later the posterior limbs are already somewhat developed. Finally, the animals at about two months and a half measure 0·07–0·08 metre, the branchiæ are atrophied, and, except in size, they have acquired the characters of the adult.

It may be noted, as the fact is not general among the Urodela, that the *Pleurodeles Waltlii* observed in the menagerie of the Museum accomplished all their transformations without quitting the water, and the most developed still remain there habitually.—*Comptes Rendus*, July 12, 1880, p. 127.

On the Tertiary Echinida of Belgium. By M. G. COTTEAU.

We have just investigated and described the Echinida of the Tertiary deposits of Belgium. The species, belonging to seventeen genera, are thirty-one in number. This little fauna, notwithstanding its comparative poverty, is none the less very interesting, whether we study it from a stratigraphical point of view, or compare it with the fauna which was developed in other countries at corresponding epochs, or examine the species from a purely zoological point of view.

Of the thirty-one species, twenty-three belong to the Lower Tertiary or Eocene group. Four of these occur in the Landenian system—*Holaster Dewalquei*, *Hemiaster nuw* and *Vincenti*, and *Schizaster Corneti*. Three of these are new and hitherto peculiar to Belgium; only one, *Hemiaster nuw*, was previously known and described from a higher level, in France in the beds with *Serpula spiræa* at Biarritz, in Italy in the Eocene of Vicenza and Verona, and in Swizerland in the Nummulitic deposits of Yberg.

The Laekenian is the system richest in Echinida, including sixteen species, some of which are very abundant, namely *Cyphosoma tertiarium* and *Vincenti*, *Caratomus Lehoni*, *Nucleolites approximatus*, *Echinolampas affinis* and *Duponti*, *Pygorkynchus Gregoirei*, *Echinocyamus propinquus* and *gracilis*, *Lenita patellaris*, *Scutellina lenticularis* and *rotunda*, *Brissopsis bruxellensis*, *Schizaster acuminatus*, *Spatangus pes equuli*, and *Martia grignonensis*. Five of the most abundant and best characterized of these species, *Pygorkynchus Gregoirei*, *Lenita scutellaris*, *Scutellina lenticularis* and *rotunda*, and *Martia grignonensis*, have been collected in the Calcaire grossier of the neighbourhood of Paris, and establish the concordance of those deposits with the Laekenian system of Belgium. One species, *Echinolampas affinis*, is wanting in the environs of Paris, but occurs in France at Cassel (Nord) and at Blaye (Gironde) in the Eocene, and in Switzerland in the Nummulitic deposits of Yberg. There remain ten species at present peculiar to Belgium.

Eight species belong to the Pliocene group, the Diestian and Scaldisian systems, namely *Cidaris belgica*, *Echinus Nysti* and *Colbeaui*, *Psammechinus sphaeroideus*, *Dewalquei*, and *Cogelsi*, *Echinocyamus Forbesi*, and *Schizaster Scilla*. The last two only have been indicated outside of Belgium, namely *Echinocyamus Forbesi*, common in the Red Crag of Suffolk, and erroneously confounded by Forbes with the *E. pusillus* of the European seas, and *Schizaster Scilla*, which, in the south of France and Northern Italy, characterizes the Pliocene marls of Perpignan, Nice, and Asti.

Several of these species, both Eocene and Pliocene, deserve particular notice from a zoological point of view. We may cite in the

first rank *Holaster Dewalquei* of the Landenian system. This is the first time that the genus *Holaster*, so abundantly represented in the different stages of the Cretaceous formation, has been met with in the Tertiary. This species, although the last of the series, presents perfectly all the characters of the type; it is remarkable for its large size, its regularly cordiform aspect, its inflated and subgibbous upper surface, and its angular and very deep anterior groove. M. Manzoni has already noticed in the Tertiary of the environs of Bologna a species nearly allied to *Holaster Dewalquei*, but distinct, namely *Hemipneustes italicus*. We may also cite *Caratomus Leboni* from the Laekenian of St. Gilles, a very curious species, differing from the true *Caratomi* by the structure of the anterior ambulacral areas and the form of the peristome. And we may mention *Echinus Colbeari*, which we only know in the state of an interior cast, but which is distinguished from its congeners by its large size, its sub-conical form, its lower surface pulvinate and rounded at the margins, and by its peristome opening in a well-marked depression of the lower surface. Nor must we forget *Spatangus pes equuli*, peculiar to the Eocene of Belgium, and which will always be recognized with facility by its elevated hemispherical form, its flat lower surface with trenchant edges, and its very deep anterior groove with keeled margins.—*Comptes Rendus*, July 19, 1880, p. 182.

On the Antiquity of certain Subordinate Types of Freshwater and Land Mollusca. By C. A. WHITE, Palæontologist to the U.S. National Museum.

Among existing freshwater and land Mollusca there are certain comprehensive genera which may be divided into a greater or less number of more or less distinctly definable groups that are respectively recognizable by certain common characteristics, less conspicuous than those which separate the larger genera from each other. These minor groups have been treated as genera, subgenera, or as still less important sections by the various authors who have discussed them, according to the individual estimate that has been placed upon the relative value of the characters by which they are recognized. It is my present purpose, not to discuss the value of these distinctions as means of zoological classification, but to show that a considerable number, not only of the larger genera of living North-American freshwater and land Mollusca, but also a large proportion of the minor or subordinate types which those genera respectively embrace, had their origin as such at least as early as the closing epochs of the Cretaceous or the immediately following epochs of the Eocene Tertiary period.

The fossil collections upon which these observations are based, and which alone are referred to in the following remarks, are those which have been obtained by the different U.S. Government Surveys in the western portion of our national domain. The strata which have furnished these fossils are, in the ascending order, those of the Fox Hills, Laramie, Wahsatch, Green River, and Bridger groups. The first-named of these groups is unquestionably Cretaceous; and

the last three are as unquestionably Eocene Tertiary. The second I regard as representing a transitional epoch; but some geologists assign it to the Cretaceous period, because of the presence of dinosaurian remains in its strata. Others refer it to the Tertiary, because of the characteristics of its floral remains. It is sufficient for my present purpose to say that the molluscan types here discussed are found in strata which range from the Cretaceous to the close of the Eocene inclusive.

The comprehensive genera that embrace the minor types which are here more especially discussed or referred to are *Limnæa*, *Planorbis*, *Physa*, *Helix*, *Pupa*, *Succinea*, and *Unio*. The minor types that may be mentioned as having representatives among the fossil collections already referred to are especially noticeable among the pulmonate Gasteropoda and the Unionidæ. The principal examples of the former are indicated by the following list of the names by which the types are known, and which have been applied to them by different authors in either a generic or subgeneric sense. These examples by no means represent, even approximately, the full molluscan faunas of which they form a part; but they are selected for the special purpose already indicated.

LIMNÆINÆ.

1. *Acella*, *Haldeman*.
2. *Leptolimnæa*, *Swainson*.
3. *Limnophysa*, *Fitzinger*.

PLANORBINÆ.

4. *Planorbis* (typical), *Guettard*.
5. *Bathyomphalus*, *Agassiz*.
6. *Gyraulus*, *Agassiz*.

PHYSINÆ.

7. *Physa* (typical), *Draparnaud*.
8. *Bulinus*, *Adanson*.

HELICINÆ.

9. *Aglaia*, *Albers*.
10. *Arianta*, *Leach*.
11. *Patula*, *Haldeman*.
12. *Strobila*, *Morse*.
13. *Triodopsis*, *Rafinesque*.

PUPINÆ.

14. *Leucocheila*, *Alb. & Mart*.
15. *Pupilla*, *Leach*.
16. *Holospira*?, *Albers**

SUCCININÆ.

17. *Brachyspira*, *Pfeiffer*.

It should be mentioned that these subordinate types were originally recognized among, and their names applied wholly to, living forms. The discovery of fossil forms of those types is a gratifying confirmation of their genuineness (time being the crucial test of permanency), and proof of the sagacity of their authors.

Acella is represented by *A. Haldemani*, White †, from the Laramie strata of Bear-River valley, Wyoming. With the probable exception of an undescribed form in the Green-River strata of Wyoming, no other fossil species of that type is yet known; but the *Limnæa* (*Pleurolimnæa*) *tenuicostata* of Meek and Hayden, from the Laramie strata of Montana, is a closely allied form. *Limnæa* (*Leptolimnæa*?) *minuscula*, White, from the Green-River strata of Wyoming, appears

* *Holospira* is placed here under the *Pupinæ* only conventionally.

† The species herein mentioned are described and in part figured in the following publications:—Annual Reports U.S. Geol. Surv. Terr.; vol. ix. (4to ser.) of the same; Bulletin of the same; Powell's Rep. Geol. Uinta Mts.; U.S. Expl. and Surv. west of the 100th Merid., vol. iv.; U.S. Geol. Surv. 40th Parallel, vol. iv.; Simpson's Rep. Great Basin, Utah; and Proc. U.S. National Museum, vol. iii. (The latter now in press.)

to possess the characteristics of *Leptolimnæa*, Swainson. The earliest known species of *Limnophysa* is *L. nitidula*, Meek, which is associated with *Acella Haldemani*, just mentioned. Two other species from the Green-River group of Wyoming are referred to that type, namely *L. vetusta* and *L. similis*, Meek.

Planorbis proper is represented by *P. equalis*, White, in the Green-River strata of Wyoming. *Bathynomphalus* has two representatives, namely *P. (B.) kanabensis*, White, and *P. (B.) planoconvexus*, Meek and Hayden; both in the Laramie group. The former comes from Southern Utah, and the latter from Montana. *Gyraulus* appears to have several representatives in both the Laramie and Green-River strata: but *G. militaris*, White, from strata probably of the Laramie period, is the only one yet published.

A considerable number of species of the Physinæ are known in the Laramie, Wahsatch, and Green-River groups; and the subfamily was well established before the first-named period. It is an interesting fact, in confirmation of the latter statement, that a typical species of *Physa*, *P. Carletoni*, Meek, has been found at Coalville, Utah, in estuary strata which rest upon marine Cretaceous strata, and have more than 1000 feet of similar marine Cretaceous strata resting upon them. This is the earliest *Physa* known in American strata. *Physa pleromatis*, White, is a widely distributed species in the Wahsatch group of Wyoming, Colorado, and Utah; but true *Physa* is not common in the Laramie group, although that genus prevailed both before and after. In the last-named group *Bulinus* is somewhat common—*B. atavus*, White, and *B. subelongatus*, Meek and Hayden, being published examples.

The Helicinæ appear to have been almost as diversely differentiated during the Laramie, Wahsatch, and Green-River epochs as they are at the present day, no less than five of the subordinate types embraced in that subfamily having been more or less satisfactorily recognized among the molluscan faunas of these epochs. *Aglæa* is represented by *Helix peripheria*, White, in the Green-River group of Utah; and *Arianta* by *H. riparia*, White, in the same group of Southern Wyoming. *Helix kanabensis*, White, seems to possess the distinguishing characteristics of *Strobila*. It occurs in the upper part of the Laramie group of Southern Utah. *Patula* is represented by *Helix sepulta*, White, in the coal-bearing strata of Evanston, Wyoming, which belong either to the upper part of the Laramie group or the base of the Wahsatch, probably the former; and apparently also by an undescribed species in the Green-River group of Wyoming. *Triodopsis* is represented by *Helix evanstonensis*, White, which is associated with *H. sepulta*, just mentioned.

The Pupinæ have been recognized only in the Green-River and Bridger groups, four species only having yet been discovered. The true character of the aperture has been ascertained only in one of these; and they are therefore assigned with some doubt to the types mentioned. Their diverse forms, however, indicate that a wide differentiation had taken place in the Pupinæ at that early time. *Pupa arenula* and *P. atavuncula*, White, discovered in the Green-River strata of Wyoming, are referred provisionally to *Pupilla*, and

an associated species, *Pupa incolata*, White, to *Leucocheila*. Mr. Meek referred his *Pupa Leidyi* doubtfully to *Holospira*. It is from the Bridger strata of Wyoming.

Only one species of the Succininae has yet been discovered in any of the strata here considered, namely *Succinea papillispira* of the Green-River strata of Wyoming. This is plainly referable to *Brachyspira*.

The Unionidæ of the fossil molluscan fauna, herein discussed, are found to have become differentiated to a remarkable extent, especially during the Laramie epoch. An exceedingly interesting and suggestive fact in connexion with this differentiation is that the subordinate types are largely identical in character with some of those which are now living in the waters of the Mississippi river-system, and which are recognized by malacologists as distinctively North-American types. Illustrative of this relation of the fossil to the recent forms, the following parallel lists are presented, those of the left-hand column being a part of the fossil species now known in the Laramie strata of Wyoming and Utah, and those of the right-hand column being the living species of the Mississippi river-system which are selected as their respective type congeners.

<i>Unio propheticus</i> , <i>White</i> .	<i>Unio clavus</i> , <i>Lamarck</i> .
— <i>proavitus</i> , <i>W</i> .	— <i>ridibundus</i> , <i>Say</i> .
— <i>gónionotus</i> , <i>W</i> .	— <i>multiplicatus</i> , <i>Lea</i> .
— <i>holmesianus</i> , <i>W</i> .	— <i>apiculatus</i> , <i>Say</i> .
— <i>Couesi</i> , <i>W</i> .	— <i>complanatus</i> , <i>Solander</i> .
— <i>Endlichi</i> , <i>W</i> .	— <i>gibbus</i> , <i>Barnes</i> .
— <i>brachyopisthus</i> , <i>W</i> .	— <i>circulus</i> , <i>Lea</i> .

Still other examples might be given of close resemblances between fossil and recent forms of *Unio*; but these suffice to suggest in a very forcible manner that the Unionine fauna of the Mississippi river-system is genetically related to that of the Laramie period. It is true that in the Laramie fauna there are certain minor types of *Unio* which are not so closely like any living forms as those are which have been cited, and that close congeners of certain living types have not been discovered among the fossil forms; but these facts do not necessarily affect the legitimacy of the conclusion that the living has genetically descended from the fossil fauna. A like conclusion is also reached with reference to the pulmonate gastropods, which have already been discussed; but in view of the magnitude of the physical changes which have taken place since the close of even the latest epoch here considered, the survival of the types of the branchiferous Mollusca, and their transference from lacustrine to fluviatile waters, is a most remarkable circumstance.

Reviewing the collections which represent the fossil faunas herein discussed, so many familiar forms are seen that it is difficult to realize the fact that a large proportion of them, including those especially which have been mentioned by name in this article, were living contemporaneously with the last of the Dinosaurs. Yet such is the fact, and the shells of the former are often found commingled with the bones of the latter. What were the successive steps in the history of the transmission of these types from that remote time to the present we are unfortunately without the means of knowing with certainty, because of the remarkable paucity of molluscan remains in all the deposits of the great interior region

later than the Eocene. All the molluscan remains which have been found in these later deposits belong to familiar living types, although of extinct species.

That the palustral and land pulmonates might have been, and perhaps were, preserved under immediate conditions differing from those which ensured the survival of the Unionidæ is evident; but certain facts point to the conclusion that the peculiar "North-American" types of *Uniones* which prevailed in the Laramie epoch were not transmitted through the Eocene, Miocene, and Pliocene epochs as denizens of the freshwater lakes which succeeded the brackish water of the Laramie sea, and each other, in their occupancy of a great part of the interior region of North America, up to at least near the close of the Pliocene epoch. The Eocene freshwater deposits contain a considerable number of species of *Unio*, it is true; but they are all, so far as known, of a smooth surface and oval form, and constitute a type which, although common among living *Uniones*, is exceedingly rare, if not entirely wanting, in the Laramie group. The conclusion therefore seems necessary that those peculiar and varied forms of *Unio* which have been mentioned in the preceding list, with their faunal molluscan associates, escaped from the Laramie lacustrine waters before the close of that epoch, into those fluviatile waters which form the outlet to the lacustrine, and which became a part of the Mississippi drainage-system as the elevation of the continent progressed*.

The magnitude of the physical changes which have taken place upon the North-American continent since the epochs in which the Mollusca lived, which are discussed in this article, has already been referred to. These changes were no less than the gradual desiccation of the region formerly occupied by great inland lakes, which for magnitude have now no equals upon the earth, the elevation of the whole Rocky-Mountain system, and the establishment of the present great interior river-systems. Through all these changes these molluscan types have come down to us in unbroken lines, some of which, to speak figuratively, were of remarkable tenuity. It is true there has been a dropping out of some of the earlier associated types and an introduction of new ones as the epochs passed; but the lines of descent of the numerous types which have reached us unbroken seem to be almost parallel, so little have they changed with the lapse of time. So slightly divergent are these lines, considered as lines of differentiation, that, if we bound them all by two imaginary straight lines, we shall have an evolutionary parallax that would carry back the origin of these types to a period inconceivably remote. We must therefore conclude that their origin was, at least in some degree, saltatory; but the real conditions under which they originated must probably always remain obscure. I have, however, elsewhere† suggested that the differentiation of the Unionidæ took place under the influence of salt in the water in which they lived; but it is plain that this explanation will not apply to the case of the palustral and land Mollusca.—*Amer. Journ. Sci.*, July 1880, pp. 44-49.

* This subject is discussed at some length in Bull. U.S. Geol. Surv. Terr. vol. iii. p. 615.

† Bull. U. S. Geol. Surv. Terr. vol. iii. p. 623.

Note to Dr. C. A. White's Paper. By R. ELLSWORTH CALL.

In Dr. C. A. White's interesting communication "On the Antiquity of certain Subordinate Types of Freshwater and Land Mollusca," occur two slight errors which may be misleading to future students pursuing the same line of research. On p. 250 he lists seven species of fossil Unionidæ from the Laramie strata of Wyoming and Utah, together with a second series of seven recent *Uniones* "as their respective congeners." Congeneric with the *U. Couesi*, White, is written *Unio complanatus*, Solander. Since the Doctor gives a list of Unionidæ inhabiting the "waters of the Mississippi basin" as congeneric with the fossil forms, *U. complanatus*, Sol., is out of place in such a list, being an inhabitant solely of the Atlantic slope, together with the numerous other species of which it is a type. This species is not found west of the Alleghanies. This fact is important in the matter of the geographical distribution of the recent Unionidæ. A slight error in the determination, or the nomenclature, of the species placed as congeneric with *U. Endlichi*, White, occurs. Dr. White evidently means *Unio gibbosus*, Barnes. *Unio gibbus* was described by Spengler in 'Skriver af Naturhistorisk Selskabet,' vol. iii. (1792); and the habitat given is Tranquebar.—*Amer. Journ. Sci.* August 1880, p. 158.

Dexter, Iowa, July 6, 1880.

On the Metamorphosis of *Prosopistoma*. By M. A. VAYSSIÈRE.

In August 1878 I had the honour of presenting to the Academy, in conjunction with Dr. E. Joly, a note on the organization of *Prosopistoma punctifrons*. We had at our disposal for the investigation, of which we published a summary, a considerable number of living specimens; and nevertheless we were unable to observe any transformation in these curious insects. We were thus led to adopt the opinion of Mr. M'Lachlan, and to assume with him that *Prosopistoma* is only an Ephemerine adapted to a permanent aquatic existence. Our anatomical observations, and more especially those relating to the considerable concentration of the nervous system, seemed to confirm this hypothesis.

It must, however, be decidedly rejected, as on the 3rd of June I was able to witness the metamorphosis of two *Prosopistomas* captured in the Rhone near Avignon in April last.

The following are the principal phases of this metamorphosis. Towards the end of last month (May) the amber-yellow colour of some of the insects which I kept in captivity became darkened; I could then soon perceive through the skin the first lineaments of the new individual; and two or three days afterwards the animal cast off its nymphal envelope. To free itself from this the insect employs the same processes as the other Ephemerine types.

In the perfect state *Prosopistoma* very exactly resembles *Cœnis*, and consequently belongs definitely and indisputably to the family Ephemerinæ; its last segment is furnished with three rudimentary setæ, representing the natatory setæ which it possesses in its aquatic states. The anatomical modifications superinduced by this metamorphosis will be studied hereafter in a complete monograph of this genus.—*Comptes Rendus*, June 7, 1880, p. 1370.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 34. OCTOBER 1880.

XXXII.—*The Zoology of Barents Sea.* By W. S. M. D'URBAN, F.L.S., Curator of the Devon and Exeter Albert Memorial Museum.

THROUGH the spirited exertions of the Dutch geographers a small vessel of 79 tons, named the 'Willem Barents,' was fitted out at Amsterdam by subscription, and made two voyages to Barents Sea, between Spitzbergen and Novaya Zemlya, in the summers of 1878 and 1879*. The objects of these expeditions were to examine the state and position of the ice in Barents Sea and, if possible, in the Kara Sea, also to take deep-sea soundings with serial temperatures, and thus supply important contributions to our knowledge of that interesting region. Magnetic and meteorological observations were also to be taken, and natural-history collections to be diligently made at every opportunity. Mr. W. J. A. Grant, a gentleman well known for his skill as a photographer, accompanied both these expeditions, and each time brought back with him some bottles filled with animals dredged in Barents Sea, and preserved in spirits. These he very generously presented to the Museum under my charge. The bottles were carefully labelled with the dates, latitudes, longitudes, and depths at which the specimens were obtained; and

* Accounts of these voyages will be found in the 'Proceedings of the Royal Geographical Society' for January and November 1879. See also the 'Illustrated London News' for January 25, 1879, and January 31, 1880.

as the collections appeared to include many very interesting species, I was anxious to submit them to the best authorities in the various departments. I was so fortunate as to find several eminent scientific gentlemen who were willing to examine the specimens for me. I sent the Crustacea collected in 1878 to the Rev. A. M. Norman, and those obtained in 1879 to Prof. J. O. Westwood; the Mollusca were determined by Dr. Gwyn Jeffreys; the Echinodermata of 1878 were examined by the Rev. A. M. Norman, and those of 1879 by Mr. W. Percy Sladen; Dr. McIntosh named the Annelids; and the Rev. Thomas Hincks has made a laborious examination of the Hydrozoa and Polyzoa. The few Spongia and Actinozoa were examined by Mr. H. J. Carter. I take this opportunity of offering these gentlemen my sincere thanks for their kindness, which has enabled me to draw up a reliable list of the animals brought home by Mr. Grant. As yet nothing seems to have been published by the Dutch naturalists who accompanied the two expeditions, with the exception of a slight sketch of the zoology of the second voyage by Dr. F. H. van Lidth de Jeude, in a pamphlet published at Amsterdam, entitled "De Verslagen omtrent den tocht met de Willem Barents naar en in de Ijszee, in den zomer van 1879 (Uitgegeven vanwege het Aardrijkskundig Genootschap, Bijblad no. 6);" and, as nearly two years have now elapsed since the return of the first expedition, it seems desirable that the information obtained by the study of Mr. Grant's collections should be made available to the scientific public without further delay. Barents Sea was visited by the Austro-Hungarian North-Pole Expedition under Weyprecht and Payer in 1872-1874; and dredgings were made, but mostly to the north and east of the ground examined by the 'Willem Barents' expeditions. A portion of the Invertebrates obtained were catalogued and described by Dr. Emil von Marenzeller in a pamphlet published at Vienna in 1877*. Many of the species he mentions were obtained by the Dutch expedition, and, in addition, many that were not met with by the Austrians.

It is evident that Barents Sea abounds with animal life in a very marked degree. In fact all the explorers of these northern regions seem to have been deeply impressed with the extraordinary richness of the marine fauna of the Arctic seas to the north of Lapland, Russia, and Siberia. Austrians, Dutch, and Swedes alike dwell on the amazing number of

* 'Die Coelenteraten, Echinodermen und Würmen der k.-k. österreichisch-ungarischen Nordpol-Expedition bearbeitet von Dr. Emil v. Marenzeller.'

animals, both species and individuals, which the dredge brought to the surface.

Certain spots yielded a great variety of animal life, as the following examples will testify:—

On July 18, 1878, in lat. $73^{\circ} 41' 12''$ N., long. $22^{\circ} 58' 30''$ E., at a depth of 210 fathoms, occurred *Halichondria Hyndmani*, *Ctenodiscus crispatus*, *Archaster tenuispinus* and *A. bifrons*, *Ophiopholis bellis*, *Ophiacantha spinulosa*, *Nymphon hirtipes*, *Membranipora arctica* and *M. monostachys*, *Porella struma*, *Terebratula caput-serpentis*, var. *septentrionalis*, *Pecten grælandicus* and *P. Hoskynsi*, *Modiolaria discors*, *Nucula tenuis*, *Leda pernula* and *L. intermedia*, *Arca pectunculoides*, *Astarte crenata*, and *Siphodentalium vitreum*.

On July 30, 1878, in lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., at a depth of 160 fathoms, occurred *Calycella fastigiata*, *Thuiaria articulata*, *Sertularia cypressina*, *Lafoëa grandis*, *Selaginopsis decemserialis*, *Ammothea glomerata*, *Ctenodiscus crispatus*, *Ophiocten sericeum*, *Astrophyton Lamarckii*, *Ennoa nodosa*, *Nephtys ciliata*, *Cystenides hyperborea*, *Terebellides Stræmii*, *Phascolosoma Strombi*, *Munnopsis typica*, *Acanthostepheia Malmgreni*, *Tritropis Helleri*, *Unciola leucopes*, *Acanthonotosoma inflatum*, *Idotea Sabinii*, *Nymphon hirtipes*, *Flustra membranaceo-truncata*, *Mucronella scutulata* and *M. simplex*, *Crisia eburneo-denticulata*, *Diastopora obelia*, *Hornera* sp., *Aleyonidium excavatum*, *Barentsia bulbosa*, *Phylactella grandis*, *Myrionozoum subgracile*, *Flustra solida* (= *Eschara palmata*), *Scalardia grælandica*, and *Bulla propinqua*.

On August 1, 1878, in lat. $76^{\circ} 58'$ N., long. $45^{\circ} 40'$ E., in 110 fathoms, at the edge of the pack-ice, individuals of the following species were extremely numerous:—Five species of fishes: *Centridermichthys uncinatus*, *Icelus hamatus*, *Agonus decagonus*, *Liparis vulgaris*?, and *Hippoglossoides limandoides*; but the specimens were all of small size. Four crustaceans: *Crangon boreas*, *Sabinea septemcarinata*, *Pandalus annulicornis*, and *Idotea Sabinii*. *Nymphon Stromii* and *N. robustum*. The Echinoderms were *Strongylocentrotus dröbachiensis*, *Crossaster papposus*, var. *affinis*, *Ctenodiscus crispatus*, *Asterias stellionura*, *Ophiopleura arctica*, and *Astrophyton Lamarckii*. No Mollusca were brought to me from this dredging by Mr. Grant; but not far off from this spot on the previous day, in 130 fathoms, in sand and mud, *Lima subovata* was very numerous, with several other shells.

Another rich neighbourhood appears to be off Mesjdujarskii Island, on the south-west of Novaya Zemlya, in from 62 to 67 fathoms, where three species of fish, fourteen species of Mollusca, seven species of Crustacea (including *Alauna*

Goodsiri), nine species of Echinodermata (including *Antedon Eschrichtii*), ten species of Annelids, four species of Polyzoa, six Hydroids (including *Myriothela phrygia*, Fab., and a very large species of *Lucernaria*), and several sponges were obtained on July 31 and August 1, 1879.

When it is considered that Mr. Grant only took such things as were not required by the Dutch naturalists, the above lists will convey some idea of the profusion of animal life in Barents Sea.

Certain animals seem almost universally distributed in this region, such as the interesting tube-worm *Cystenides hyperborea*, which came up in almost every dredging and in great numbers. The Ophiurids *Ophiocten sericeum*, *Ophiopholis bellis*, and *Ophiacantha spinulosa* also occurred almost everywhere, and sometimes choked the dredge with their masses. *Ctenodiscus crispatus* was also very generally distributed at all depths from 62 to 210 fathoms.

Off the north coast of Norway, just outside Barents Sea, the Ophiurids were scarce, and, on the contrary, Brachiopoda, which were rarely met with in Barents Sea, abounded, at least in individuals.

The annexed list of species (p. 258) is tabulated in a similar manner to that given by Dr. Marenzeller; and the two can therefore be readily compared with each other.

SPONGIA.

Mr. Henry J. Carter, F.R.S., has kindly furnished the following descriptions of the two new Sponges:—

Suberites montalbidus.

Form monticular. Colour grey-white. Surface corrugated. Vents, one large on the summit, naked, the rest small, on the sides. Texture soft, matted. Spicules of two kinds, viz.:—1, skeleton, large, subpinlike, head variable in shape; 2, flesh-spicule, minute, shaft cylindrical, straight or curved, pointed at each end and inflated in the centre. Size of specimen 11-12ths inch in diameter at the base, 8-12ths inch high.

Suberites montiniger.

Form monticular. Colour grey-black. Surface even. Vents, one large at the summit, fringed, the rest small, on the sides. Texture soft, matted. Spicules of one kind only, viz. skeleton, large, subpinlike, head oval, elongated. Size of specimen 13-12ths inch in diameter at the base, 8-12ths inch high.

Hab. Marine, on hard objects.

Loc. Barents Sea, near S.W. end of Novaya Zemlya, in lat. $71^{\circ} 6'$ N., long. 50° E. 31st July, 1879. Depth 62 fathoms.

Obs. Both these sponges are monticular in form, but specifically different, as will be seen in comparing the above descriptions. *Suberites montalbidus*, however, is, with the exception of form and slight differences in the spiculation, the same as *Suberites domuncula*, Sdt., = *Halichondria suberea*, Johnston, common on the British shores. The differences in spiculation chiefly consist in the pinlike spicules of the former not having such a globular or defined head, and the flesh-spicule for the most part being pointed at each end instead of obtuse. Marenzeller mentions the following species collected by the Austro-Hungarian expedition:—

Cacospongia Schmidtii, Mar.; *Chalinula cavernosa*, Mar.; *Isodictya tenera*, Mar.; *Stylocordyla longissima*, G. O. Sars; *Thecophora semisuberites*, Schm., and *T. elongata*, Mar.; *Rinalda uberrima*, Schm.; *Halicnemis hemisphærica*, M. Sars; *Microciona ambigua*, Bowbk.; *Cladorhiza abyssicola*, M. Sars; *Ascetta coriacea*, Mont.; *Sycaltis glacialis*, Häck.; and *Sycandra utriculus*, Schm.

HYDROZOA.

The Rev. Thomas Hincks, B.A., F.R.S., has drawn up the following list of the Hydrozoa:—

Order HYDROIDA.

Suborder Athecata.

Genus MYRIOTHELA, Sars.

? *Myriothela phrygia*, Fabricius.

[Not *M. phrygia* of Allman and Hincks.]

This is distinct from the British species, and probably identical with *Lucernaria phrygia* of Fabricius.

Lat. $71^{\circ} 6'$ N., long. 50° E. Near S.W. end of Novaya Zemlya, 62 fms. [Greenland (*Fabr.*), Norway (*Sars*); off Halifax, N. S., in 52 fms. (*Verrill*).]

Genus EUDENDRIUM, Ehrenberg.

Eudendrium ? sp.

A fragment only occurs, which does not enable me to determine the species. The stem is compound below, but simple

List of Animals collected in Parents Sea by W. J. A. Grant, Esq., in 1878 and 1879.

Name.	Date.	North latitude.	East longitude.	Depth in fathoms.	Remarks.
PROTOZOA.					
<i>Triloculina tricarinata</i> , D'Orb.	17, 7, 78	74° 5' 0"	23° 0' 0"	220	Very large.
COELENTERATA.					
SPONGIA.					
<i>Halichondria Hymnami</i> , Bk.	18, 7, 78	73° 41' 12"	22° 58' 30"	210	See description.
<i>Suberites montalbidus</i> , H. J. Carter, n. sp.	31, 7, 79	71° 6' 0"	50° 0' 0"	62	" "
— <i>montiniger</i> , H. J. Carter, n. sp.	31, 7, 79	71° 6' 0"	50° 0' 0"	62	Attached to a coral.
<i>Isodictya</i> (species undetermined)	31, 7, 79	71° 6' 0"	50° 0' 0"	62	
HYDROZOA.					
<i>Hydroïda.</i>					
<i>Myriothela phlygia</i> , Pab.	31, 7, 79	71° 6' 0"	50° 0' 0"	62	See note.
<i>Eudendrium</i> species	15, 7, 79	72° 32' 3"	36° 29' 5"	128	A fragment only, probably <i>E. ramosum</i> .
<i>Calycella fastigiata</i> , Alder	30, 7, 78	75° 16' 6"	45° 19' 36"	160	On <i>Acyonidium</i> .
"	15, 7, 79	72° 32' 3"	36° 29' 5"	128	On <i>Genellaria</i> .
"	1, 8, 79	71° 23' 0"	49° 38' 0"	67	"
<i>Lafocia grandis</i> , Hanks	30, 7, 78	75° 16' 6"	45° 19' 36"	160	On <i>Myricosum</i> .
<i>Lafocina tenuis</i> , M. Sars	31, 7, 79	71° 6' 0"	50° 0' 0"	62	Off Novaya Zemlya.
"	1, 8, 79	71° 23' 0"	49° 38' 0"	67	On <i>Cellularia Peachi</i> .
<i>Filicium serpens</i> , Hassall	14, 7, 78	74° 6' 0"	18° 5' 0"	25	Off Bear Island; very fine, on <i>Balanus</i> .
"	17, 7, 78	74° 5' 0"	23° 0' 0"	220	On <i>Sertularella</i> .
"	14, 7, 78	74° 6' 0"	18° 5' 0"	25	Amongst <i>Genellaria</i> .

<i>Sertularia tricuspidata</i> , <i>Aller</i>	14, 7, 78	74	6	0	18	5	0	25	Very abundant.
"	17, 7, 78	74	5	0	23	0	0	220	
<i>Sertularia quadricornuta</i> , <i>Hicks</i> , n. sp.	14, 7, 78	74	6	0	18	5	0	25	Off Bear Island.
<i>Thuiaria articulata</i> , <i>Pallas</i>	30, 7, 78	75	16	6	45	19	36	160	
<i>Selaginopsis decemserialis</i> , <i>Mereschkowsky</i>	14, 7, 78	74	6	0	18	5	0	25	Off Bear Island.
"	17, 7, 78	74	5	0	23	0	0	220	
<i>Sertularia cupressina</i> , <i>L.</i>	30, 7, 78	75	16	6	45	19	36	160	One specimen.
<i>Calycosoa:</i>									
<i>Lucernaria campanulata</i> ?, <i>M.-Edl.</i>	1, 8, 79	71	23	0	49	38	0	67	Very large.
ACTINOZOA.									
<i>Annothea glomerata</i> , <i>Carter</i> , n. sp.	29, 7, 78	74	6	42	45	1	42	160	See description.
"	30, 7, 78	75	16	6	45	19	36	160	On <i>Tabularia</i> .
"	1, 8, 78	76	58	0	45	40	0	110	
"	31, 7, 79	71	6	0	50	0	0	62	Attached to shells.
<i>Gersemia florida</i> , <i>Rathke</i>	1, 8, 79	71	28	0	49	38	0	67	
"	15, 7, 79	72	32	3	36	29	5	128	
ECHINODERMATA.									
HOLOTHUROIDEA.									
<i>Eurygus scaber</i> , <i>Lütken</i>	31, 7, 79	71	6	0	50	0	0	62	Off S. W. coast of Novaya Zemlya.
ECHINOIDEA.									
<i>Strongylocentrotus dröbachiensis</i> (<i>O. F. Müller</i>) ..	1, 8, 78	76	58	0	45	40	0	110	
" ..	19, 7, 79	75	23	5	38	39	5	88	
" ..	31, 7, 79	71	6	0	50	0	0	62	Off S. W. coast of Novaya Zemlya.
ASTEROIDEA.									
<i>Asteracanthion grenlandicus</i> , <i>Sép.</i>	31, 7, 79	71	6	0	50	0	0	62	Off S. W. coast of Novaya Zemlya.
<i>Crossaster papposus</i> (<i>Lütk.</i>), var. <i>affinis</i> , <i>Brandt.</i> ..	1, 8, 78	76	58	0	45	40	0	110	8 rays.
<i>Ctenodiscus crispatus</i> , <i>Retz.</i> , = <i>corniculata</i> (<i>Lütk.</i>) ..	18, 7, 78	73	41	12	22	58	30	210	
" ..	24, 7, 78	72	5	6	37	57	18	140	
" ..	30, 7, 78	75	16	6	45	19	36	160	
" ..	1, 8, 78	76	58	0	45	40	0	110	

List (continued).

Name.	Date.	North latitude.	East longitude.	Depth in fathoms.	Remarks.
<i>Ctenodiscus crispatus</i> , Retz., = <i>corniculata</i> (Linné)	15, 7, 79	72 32	9 36 39	128	
"	31, 7, 79	71 6	0 50 0	62	
<i>Archaster tenuispinus</i> , Düb. & Kor.	18, 7, 78	73 41	22 58 30	210	
"	29, 7, 78	74 6 42	45 1 42	160	
<i>Archaster bifrons</i> , Wg. Thomson	18, 7, 78	73 41	22 58 30	210	Young.
<i>Asterias stelleriana</i> , Ferrier	1, 8, 78	76 58	0 45 40	110	One specimen.
OPHIUROIDEA.					
<i>Ophioglypha Sarsii</i> , Lütken	31, 7, 79	71 6	0 50 0	62	
<i>— robusta</i> (Ayres)	31, 7, 79	71 6	0 50 0	62	
<i>Ophiocten sericeum</i> (Forbes)	14, 7, 78	74 6	0 18 5	25	
"	29, 7, 78	74 6 42	45 1 42	160	
"	30, 7, 78	75 16	6 45 19 36	160	Very abundant.
"	31, 7, 78	76 31	18 45 36 30	130	
"	15, 7, 79	75 23	5 38 39	5	128
"	31, 7, 79	71 6	0 50 0	62	
<i>Ophiopholis bellis</i> (Linné)	18, 7, 78	73 41	22 58 30	210	
"	29, 7, 78	74 6 42	45 1 42	160	
"	31, 7, 78	76 31	18 45 36 30	130	
"	15, 7, 79	72 32	3 36 39	5	128
"	1, 8, 79	71 23	0 49 38	0	67
<i>Ophiopleura arctica</i> , Duncan	1, 8, 78	76 58	0 45 40	0	110
<i>Ophiacantha spinulosa</i> , Müll. & T.	18, 7, 78	73 41	22 58 30	210	
"	29, 7, 78	74 6 42	45 1 42	160	
"	31, 7, 78	76 31	18 45 36 30	130	Very abundant.
"	15, 7, 79	72 32	3 36 39	5	128
"	31, 7, 79	71 6	0 50 0	62	"
<i>Astrophyton Lamarckii</i> , Müll. & T.	30, 7, 78	75 16	6 45 19 36	160	Very young specimen.
"	1, 8, 78	76 58	0 45 40	110	Young (see note).

CRINOIDEA.

Antedon Eschrichtii (Müll.)

VERMES.

ANNELIDA.

Evarne impar (Johnst.)
 Antinocé Sarsi, Aaby.
 Lagisca varispina, Sars
 Ennoa nodosa, Sars
 Northia hyperborea, Hansen

Nyctia cirrosa, Pallas
 Nereis zonata, Mgn.
 Nephthys ciliata, O. F. Müller
 " "
 " "

Ephesia gracilis, H. Rathke
 Trophonia Whiteavesii, Müll. & T., variety
 Brada arenosa, McIntosh (= granosa, Stp.)
 Terebellides Stremii, Sars
 Cystenides hyperborea, Mgn.

" "
 " "
 " "
 " "
 Sabella spitsbergensis, Mgn.
 Dasychnone species.....

GEPHYREA.

Phascalosoma Strombi, Mont.....
 " "
 " "

Off S.W. coast of Novaya Zemlya.

67

0

49

38

0

1, 8, 79

71

23

0

0

0

Off S.W. coast of Novaya Zemlya.

62

0

50

0

0

31, 7, 79

71

6

0

0

0

In shelly tubes; off S.W. coast of
 Novaya Zemlya.
 In shells of Trochus.

62

0

50

0

0

31, 7, 79

71

6

0

0

0

62

0

50

0

0

31, 7, 79

71

6

0

0

0

62

0

50

0

0

31, 7, 79

71

6

0

0

0

62

0

50

0

0

31, 7, 79

71

6

0

0

0

160

6

45

19

36

30, 7, 78

75

16

0

0

0

128

3

36

29

5

15, 7, 79

72

32

3

36

29

128

3

36

29

5

15, 7, 79

72

32

3

36

29

160

6

45

19

36

30, 7, 78

75

16

0

0

0

140

6

37

57

18

24, 7, 78

72

5

6

37

57

160

6

42

45

1

29, 7, 78

74

6

42

45

1

160

6

45

19

36

30, 7, 78

75

16

0

0

0

130

5

38

39

5

19, 7, 79

75

23

5

38

39

88

0

50

0

0

31, 7, 79

71

6

0

50

0

62

0

50

0

0

31, 7, 79

71

6

0

50

0

62

0

50

0

0

31, 7, 79

71

6

0

50

0

In broken tubes of Cystenides.

160

2

45

14

0

29, 7, 78

74

6

42

45

14

160

36

45

19

36

30, 7, 78

75

16

6

45

19

88

5

38

39

5

19, 7, 79

75

23

5

38

39

List (continued).

Name.	Date.	North latitude.	East longitude.	Depth in fathoms.	Remarks.
ARTHROPODA.					
CRUSTACEA.					
<i>Cirripedia.</i>					
<i>Balanus balanoides</i> , L.	14, 7, 78	74 6 0	0 18 5 0	25	Very abundant off Bear Island.
— porcatus, Du Costa.	23, 8, 78	73 30 0	54 30 0		On dead <i>Fucus</i> -shell on shore, Matotschkin Shar.
<i>Edriophthalma.</i>					
<i>Anonyx nugax</i> (Phipps)	31, 7, 79	71 6 0	50 0 0	62	
<i>Acanthonotosoma inflatum</i> (Krøyer)	30, 7, 78	75 16 6	45 19 36	160	
<i>Gammaracanthus loricaeus</i> (Sabine)	31, 7, 79	71 6 0	50 0 0	62	
<i>Amphithoe læviuscula</i> , Bell?	15, 7, 79	72 32 3	36 39 5	128	
<i>Acanthostephia Malmgreni</i> (Goës)	30, 7, 78	75 16 6	45 19 36	160	
<i>Tritopsis Helleri</i> , Boeck	14, 7, 78	74 6 0	18 5 0	25	Off Bear Island.
"	30, 7, 78	75 16 6	45 19 36	160	
<i>Munnopsis typica</i> , Sars	30, 7, 78	75 16 6	45 19 36	160	
<i>Unciola leucopes</i> (Krøyer)	30, 7, 78	75 16 6	45 19 36	160	
<i>Hyperia cyaneæ</i> (Sab.)	15, 7, 79	72 23 3	36 39 5	128	Immature.
<i>Idotea Sabinii</i> , Krøyer	30, 7, 78	75 16 6	45 19 36	160	Small specimens.
"	31, 7, 78	76 31 18	45 36 30	130	On sand and mud.
"	1, 8, 78	76 58 0	45 40 0	110	Large and numerous.
<i>Podophthalma.</i>					
<i>Alauna Goodsiiri</i> , Bell	31, 7, 79	71 6 0	50 0 0	62	
<i>Hippolyte macilentata</i> , Krøyer	24, 7, 78	72 5 6	37 57 18	140	
— Belcheri, Bell	31, 7, 79	71 6 0	50 0 0	62	
<i>Pandalus annulicornis</i> , Leach	1, 8, 78	76 58 0	45 40 0	110	

Crangon boreas, Phipps	1, 8, 78	76	58	0	45	50	0	110	Very numerous.
Sabinea septemcarinata, Sabine	1, 8, 78	76	58	0	45	40	0	110	Very fine and numerous; ♀ loaded with eggs.
"	15, 7, 79	72	32	3	36	39	5	128	Small specimens.
"	31, 7, 79	71	6	0	50	0	0	62	Off Bear Island.
"	1, 8, 79	71	23	0	49	38	0	67	Off Novaya Zemlya, in shells of <i>Natica</i> , <i>Buccinum</i> , &c.
Eupagurus pubescens, Krøyer	14, 7, 78	74	6	0	18	5	0	25	
"	31, 7, 79	71	6	0	50	0	0	62	
"	1, 8, 79	71	23	0	49	38	0	67	
Nymphon hirtipes, Bell	18, 7, 78	73	41	12	22	58	30	210	Very plentiful.
"	30, 7, 78	75	16	6	45	19	36	160	"
"	1, 8, 79	71	23	0	49	38	0	67	"
Nymphon Strömii, Krøyer	1, 8, 78	76	58	0	45	40	0	110	"
— robustum, Bell	1, 8, 78	76	58	0	45	40	0	110	"
— gracile, Leach	31, 7, 79	71	6	0	50	0	0	62	"
— grossipes, L.	1, 8, 79	71	23	0	49	38	0	67	"
MOLLUSCA.									
MOLLUSCOIDEA.									
<i>Polyzoa.</i>									
Gemellaria loricata, Busk	14, 7, 78	74	6	0	18	5	0	25	Very fine and abundant off Bear Island.
"	15, 7, 79	72	32	3	36	29	5	128	Dark-coloured variety.
Cellularia Peachii, Busk	31, 7, 79	71	23	0	49	38	0	67	Off Novaya Zemlya.
Menipea ternata, Ellis & Sol.	14, 7, 78	74	6	0	18	5	0	25	Off Bear Island.
"	31, 7, 79	71	6	0	50	0	0	62	Off Novaya Zemlya.
"	1, 8, 79	71	23	0	49	38	0	67	Abundant.
Menipea ternata, Ellis & Sol., forma gracilis, Smitt.	15, 7, 79	72	32	3	36	29	5	128	
Bugula Murrayana, Johnston	15, 7, 79	72	32	3	36	29	5	128	
Flustra membranaceo-truncata, Smitt	30, 7, 78	75	16	6	45	19	36	160	
Membranipora monostachys, Busk	18, 7, 78	73	41	12	22	58	30	210	On stones, &c.
— lineata, L.	18, 7, 78	73	41	12	25	58	30	210	"
— craticula, Alder	14, 7, 78	74	6	0	18	5	0	25	"

List (continued).

Name.	Date.	North latitude.	East longitude.	Depth in fathoms.	Remarks.
Membranipora sophiae, <i>Busk</i>	14, 7, 78	0° 6' 0"	18 5 0	25	On stones &c.
— arctica, <i>Smitt</i>	14, 7, 78	74 6 0	18 5 0	25	Very common on stones, shells, &c.
"	18, 7, 78	73 41 12	22 58 30	210	and also free and erect.
Microporella ciliata, <i>Pallas</i>	14, 7, 78	74 6 0	18 5 0	25	On stones.
Porina tubulosa, <i>Norman</i>	14, 7, 78	74 6 0	18 5 0	25	On stones.
Myriozoum subgracile, <i>D'Orb.</i>	30, 7, 78	75 16 6	45 19 36	160	
Schizoporella sinuosa, <i>Busk</i>	24, 7, 78	72 55 0	37 57 18	150	On stones.
— hyalina, <i>L.</i>	14, 7, 78	74 6 0	18 5 0	25	On stones.
— plana, <i>Dawson</i>	14, 7, 78	74 6 0	18 5 0	25	On stones.
(Myriozoum crustaceum, <i>Smitt</i>)					
Porella struma, <i>Norman</i>	18, 7, 78	73 41 12	22 58 30	210	
Phylactella? grandis, <i>Hincks</i> , n. sp.	30, 7, 78	75 16 6	45 19 36	160	
Macronella scutulata, <i>Busk</i>	30, 7, 78	75 16 6	45 19 36	160	On stones.
— simplex, <i>Hincks</i> , n. sp.	30, 7, 78	75 16 6	45 19 36	160	
Eschारा (Flustra) solida, <i>Stimpson</i> (= Eschारा palmata, <i>Sars</i> , and Escharella palmata, <i>Smitt</i>)	30, 7, 78	75 16 6	45 19 36	160	Abundant.
Eschara glabra, <i>Hincks</i> , n. sp.	30, 7, 78	75 16 6	45 19 36	160	
Cellepora, ? n. sp.	15, 7, 79	72 32 3	36 29 5	128	On <i>Eudendrium</i> .
Crisia eburneo-denticulata, <i>Smitt</i>	30, 7, 78	75 16 6	45 19 36	160	
Diastopora obelia, <i>Johust.</i>	30, 7, 78	75 16 6	45 19 36	160	On <i>Flustra solida</i> , <i>Stp.</i>
Hornera, ? sp.	30, 7, 78	75 16 6	45 19 36	160	
Lichenopora verrucaria, <i>Fab.</i>	14, 7, 78	74 6 0	18 5 0	25	On <i>Balanus</i> .
Aleyonidium excavatum, <i>Hincks</i> , n. sp.	30, 7, 78	75 16 6	45 19 36	160	Abundant, attached to tubes of <i>Annelids</i> .
Arachnidium simplex, <i>Hincks</i> , n. sp.	31, 7, 79	71 6 0	50 0 0	62	
Buskia nitens, <i>Alder</i>	15, 7, 79	72 32 3	36 29 5	128	On <i>Eudendrium</i> .
Barentsia bulbosa, <i>Hincks</i> , n. sp.	30, 7, 78	75 16 6	45 19 36	160	
Loxosoma singulare, <i>Kerferstein</i>	31, 7, 79	71 6 0	50 0 0	62	On <i>Menipea</i> .

List (continued).

Name.	Date.	North latitude.	East longitude.	Depth in fathoms.	Remarks.
<i>Arca glacialis</i> , Gray	31, 7, 78	76 31 18	0 45 36 30	130	
"	19, 7, 79	75 23 5	38 39 5	88	
<i>Arca pectunculoides</i> , Scacchi	18, 7, 78	73 41 12	22 58 30	210	Large specimens.
<i>Cardium islandicum</i> , L.	19, 7, 79	75 23 5	38 39 5	88	Young.
"	31, 7, 79	71 6 0	50 0 0	62	"
<i>Astarte crenata</i> , Gray	18, 7, 78	73 41 12	22 58 30	210	
"	24, 7, 78	72 5 30	37 57 18	145	
"	19, 7, 79	75 23 5	38 39 5	88	
<i>Astarte fabula</i> , Keeve	19, 7, 79	75 23 5	38 39 5	88	
"	31, 7, 79	71 6 0	50 0 0	62	
"	31, 7, 79	71 6 0	50 0 0	62	
<i>Astarte borealis</i> , Chemnitz	24, 7, 78	72 5 30	37 57 18	145	
<i>Tellina calcarea</i> , Chenu.	19, 7, 79	72 23 5	38 39 5	88	
"	31, 7, 79	71 6 0	50 0 0	62	
"	14, 7, 78	78 6 0	18 5 0	25	
<i>Saxicava rugosa</i> , L., var. <i>precisa</i>	24, 7, 78	72 5 30	37 57 18	145	
"	31, 7, 78	76 31 18	45 36 3	130	Very large.
"	19, 7, 79	75 23 5	38 39 5	88	
"	17, 7, 78	74 5 0	23 0 0	220	
<i>Siphodontalium vitreum</i> , M. Sars	18, 7, 78	73 41 12	22 58 30	210	
"	29, 7, 78	74 6 42	45 1 42	160	
"					
<i>Solenocoenchia</i> .					
<i>Lepeta caeca</i> , Müll.	24, 7, 78	72 5 6	37 57 18	140	
"	24, 7, 78	72 5 30	37 57 18	145	
"	15, 7, 79	72 32 3	36 39 5	128	
<i>Gastropoda</i> .					

<i>Trochus groenlandicus, Chemn.</i>	14, 7, 78	78	6	0	18	5	0	25	
<i>Trochus varicosus, Mighels</i>	29, 7, 78	74	6	42	45	1	42	160	
"	19, 7, 79	75	23	5	38	39	5	88	
"	31, 7, 79	71	6	0	50	0	0	62	
"	31, 7, 79	71	6	0	50	0	3	62	
<i>Trochus cinereus, Couthouy, var. arctica</i>	30, 7, 78	75	16	6	45	19	36	160	
<i>Scalaria groenlandica, Chemn.</i>	14, 7, 78	78	6	0	18	5	0	25	
<i>Natica affinis, Gmelin</i>	29, 7, 78	74	6	42	45	14	2	160	
"	29, 7, 78	74	6	42	45	14	2	160	
<i>Natica groenlandica, Beck</i>	15, 7, 79	72	32	3	36	39	5	128	
"	31, 7, 79	71	6	0	50	0	0	62	Young.
"	15, 7, 79	72	32	3	36	39	5	128	Young.
<i>Cancellaria viridula, Fabricius, var.</i>	14, 7, 78	74	6	0	18	5	0	25	Egg-capsule and spawn.
<i>Buccinum undatum, L.</i>	31, 7, 78	76	31	18	45	36	30	130	Young.
"	31, 7, 79	71	6	0	50	0	0	62	"
<i>Buccinum glaciale, L.</i>	31, 7, 79	71	6	0	50	0	0	62	"
— ciliatum, Fabr., var.	19, 7, 79	75	23	5	38	39	5	88	"
<i>Fusus tortuosus, Revere</i>	31, 7, 79	71	6	0	50	0	0	62	"
"	23, 8, 78	73	30	0	54	30	0	..	[Shar.
<i>Fusus despectus, L., var.</i>	29, 7, 78	74	6	42	45	1	42	160	Dead shell, on shore, Matotschkin
<i>Pleurotonia bicarinata, Couth.</i>	17, 7, 78	74	5	0	23	0	0	220	
— turricula, Mont., var. nobilis	31, 7, 79	71	6	0	50	0	0	62	
— pyramidalis, Ström	29, 7, 78	74	6	42	45	1	42	160	
<i>Bulla propinqua, M. Sars</i>	30, 7, 78	75	16	6	45	19	36	160	
"	19, 7, 79	75	23	5	38	39	5	88	
<i>Bulla striata, Broen</i>									
VERTEBRATA.									
PISCES.									
<i>Centridermichthys uncinatus, Reinb.</i>	1, 8, 78	76	58	0	45	40	0	110	At edge of pack-ice.
<i>Icelus hamatus, Krøyer</i>	1, 8, 78	76	58	0	45	40	0	110	"
<i>Agonus decagonus, Bl. Schn.</i>	1, 8, 78	76	58	0	45	40	0	110	"
"	31, 7, 79	71	6	0	50	0	0	62	Young.
<i>Aspidophoroides monopterygius (Bloch)</i>	31, 7, 79	71	6	0	50	0	0	62	One specimen in a bad state.
<i>Liparis vulgaris¹, Flem.</i>	1, 8, 78	76	58	0	45	40	0	110	
<i>Blennius species</i>	31, 7, 79	71	6	0	50	0	0	62	
<i>Hippoglossoides limandoides (Bl.)</i>	1, 8, 78	76	58	0	45	40	0	110	At edge of pack-ice.

towards the extremity, and of a rather dark horn-colour. Branches are given off irregularly, which are ringed at the base and at intervals above it; they bear alternate polypiferous ramules, similarly annulated. The form is nearly allied to *E. ramosum*, if not identical with it.

Lat. $72^{\circ} 32' 3''$ N., long. $36^{\circ} 29' 5''$ E., 128 fms.

Suborder Thecaphora.

Genus CALYCELLA, Hincks.

Calycella fastigiata, Alder.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms., on *Alcyonidium*; lat. $72^{\circ} 32' 3''$ E., long. $36^{\circ} 29' 5''$ E., 128 fms., on *Gemellaria*, &c.; lat. $71^{\circ} 23'$ N., long. $49^{\circ} 38'$ E., 67 fms.

In the Barents-Sea specimens the pedicels are long and distinctly annulated; in the British examples which I have seen they are smooth.

Genus LAFOËA, Lamouroux.

Laföëa grandis, Hincks.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., on *Myriozoum*, 160 fms. [Davis Straits, 100 fms. (*Wallich*); Atlantic coasts of America (*Verrill*).]

Genus LAFOËINA, M. Sars.

Laföëina tenuis, Sars.

Lat. $71^{\circ} 23'$ N., long. $49^{\circ} 38'$ E., on *Cellularia Peachii*, in 67 fms., and lat. $71^{\circ} 6'$ N., long. 50° E., in 62 fms., off Novaya Zemlya.

Genus FILELLUM, Hincks.

Filellum serpens, Hassall.

Lat. 74° N., long. 23° E., in 220 fms., on *Sertularella tricuspidata*. Also very fine on *Balanus*, off Bear Island, in 25 fms.

Genus HALECIUM, Oken.

Halecium muricatum, Ellis and Solander.

Fragments with fine capsules amongst a mass of *Gemellaria loricata*, off Bear Island, in 25 fms.

Genus SERTULARELLA, Gray.

Sertularella tricuspidata, Alder.

Extremely abundant. Lat. 74° N., long. 23° E., in

220 fms.; and also off Bear Island, in 25 fms. As is usual in Arctic specimens, the capsules are present in profusion.

Sertularella quadricornuta, n. sp.

Bear Island, in 25 fms.

Genus THUIARIA, Fleming.

Thuiaria articulata, Pallas.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., in 160 fms. Obtained by Austro-Hungarian expedition in lat. $76^{\circ} 14' N.$, long. $58^{\circ} 54' E.$, 100 metres. [British Seas.]

Genus SELAGINOPSIS, Allman.

Selaginopsis decemserialis, Mereschkowsky.

Lat. $74^{\circ} N.$, long. $23^{\circ} E.$, in 220 fms., and also off Bear Island, in 25 fms. [Northern Pacific Ocean (*Mereschkowsky*).]

Genus SERTULARIA, Linn.

Sertularia cupressina, L.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E. A single specimen from 160 fms. [British Seas; Labrador (*Packard*); Massachusetts Bay (*Agassiz*).]

Marenzeller mentions the following species which were not in Mr. Grant's collection:—*Corymorpha glacialis*, M. Sars; *Salacia abietina*, M. Sars; *Laföëa dumosa*, Flem.; and *L. fruticosa*, M. Sars.

ACTINOZOA.

Mr. H. J. Carter considers the *Ammothea* which occurred abundantly in Barents Sea, and of which Mr. Grant brought me many specimens, distinct from *A. Luetheni* of Marenzeller. He has drawn up the following description:—

Ammothea glomerata.

Cauliflower-like, consisting of more or less verruciform polyps aggregated into tuberoso, globular masses, arising from a longitudinally corrugated stem. Colour, in spirits, white. Texture cartilaginous. Surface irregular, on account of the variety in size and variable amount of projection of the polyps. Composed of subcartilaginous material charged with calcareous spicules. Polyps octotentacular, the largest about 1-24th inch in diameter; tentacles tubular, coated both inside

and out with spicules; spicules comparatively long, slightly curved, slightly clavate, more or less covered irregularly with small tubercles, 1-100th by 1-750th inch in their greatest dimensions.

Hab. Marine, growing on the stems of *Tubularia* and attached to shells, 62 to 160 fms., Barents Sea.

Obs. This differs from *Ammothea Luetkeni*, Marenzeller (Coelent., Echinod. u. Würmer der k.-k. österreichisch-ungarischen Nordpol-Exp. p. 16, Taf. iii. fig. 1: Wien, 1877, 4to), in the more or less agglomerated condition of the polyps, which in *A. Luetkeni* are separate like bunches of grapes. The latter has been found on the west coast of Greenland, and by Capt. Feilden in Smith Sound. With reference to the disputed point about the "retractile" nature of the polyps in *Ammothea*, there can be no doubt that they are verruciform and composed of tubular tentacles coated all over, both inside (that is, towards the internal cavity of the polyps) and outside, with spicules, as above stated; while in *Lobularia* they are attached to a retractile tube *within* the radiated aperture of the surface. Hence, as stated by Kölliker (*apud* Marenzeller), they are *not retractile*. In *Ammothea* the only tentacles are those seen on the outside of the cell, which is not imbedded in the matrix.

Marenzeller mentions the following Actinozoa as having been met with by the Austro-Hungarian expedition:—*Ammothea Luetkeni*, Mar.; *Gersemia florida*, Rathke, and *G. loricata*, Mar.; *Umbellula encrinus*, L.; *Paragoria arborea*, L.; *Urticina felina*, L.; *Phellia*, sp. ?; and *Zoanthus arcticus*, M. Sars.

Dr. van Lidth de Jeude mentions a species of *Actinia* as having been found in three dredgings. On one occasion two specimens were obtained attached to a large whelk(?) shell. One or two corals brought home by Mr. Grant have not yet been determined.

ECHINODERMATA.

Crossaster papposus (Linck), var. *affinis* (Brandt).

The only specimen brought me by Mr. Grant had but eight rays.

Ophiopleura arctica, Duncan, in Ann. & Mag. Nat. Hist.
August and September 1878.

Only two specimens of this rare Ophiurid were brought me by Mr. Grant.

Astrophyton Lamarckii, Müll. et Tr.

Respecting the young specimen of this species taken in lat. $76^{\circ} 58' N.$, long. $45^{\circ} 40' E.$, in 110 fms., the Rev. A. M. Norman remarks as follows:—"The tubercles on the ribs of the disk make this, at first sight, to look like *A. Agassizii*; but the arms are not granular as in that species, and I therefore conclude that with advancing growth the tubercles on the ribs would disappear, instead of being developed into the irregular spines of *Agassizii*. I therefore suppose this specimen to be the young of *A. Lamarckii*."

Marenzeller mentions the following species, of which there were no examples in Mr. Grant's collections:—*Haplodactyla arctica*, Marenzeller; *Psolus Fabricii*, D. & K.; *Pteraster militaris*, O. F. Müller; *Stichaster albulus*, Stp.; *Corethaster hispidus*, Wy. Thom.; *Amphiura Sundevalli*, M. & T.; *Astrophyton eucnemis*, M. & T.; *Antedon celtica*, Barrett; and *A. Sarsii*, D. & K.

Dr. van Lidth de Jeude alludes to the following:—*Molpadia*, sp., *Psolus*, sp., in great numbers on 15th July, 1879, in 138 fms.; *Cribella sanguinolenta*, on 17th July, in 127 fms.; *Ophiocoma nigra*, *Asteronyx Loveni*?, and a *Comatula* on 5th and 17th July, in 100 and 127 fms.

VERMES.

Dr. van Lidth de Jeude mentions the following species of worms, of which there are no representatives in Mr. Grant's collections:—*Ampharete arctica*, *Sciöne lobata*, *Onuphis Eschrichtii*, *Chlymene lumbricalis*, *Brada villosa* and *B. granulata*, and *Phyllodoce grænlandica*.

Dr. Marenzeller enumerates the following species which were apparently not obtained by the Dutch expeditions:—*Cerebratulus angulatus*, O. F. Müller; *Scalibregma inflatum*, Rathke; *Cistenides granulata*, L.; *Ampharete Goesi*, Mgrn.; *Amphicteis Gunneri*, M. Sars; *Melinna cristata*, M. Sars; *Amphitrite cirrata*, O. F. Müller; *Thelepus circinatus*, F.; *Euchone tuberculosa*, Kröyer; *Chone infundibuliformis*, Kröyer; and *C. Duneri*, Mgrn.; *Spirorbis lucidus*, Mont. (this is probably the species which occurs on some of the Polyzoa brought home by Mr. Grant); *Hyalopotamus Claparedii*, Mar.; *Eucrante villosa*, Mgrn.; *Nephtys longosetosa*, Örst.; *Phyllodoce Luetkeni*, Mgrn.; *Syllis fasciata*, Mgrn.; *Nereis pelagica*, L.; *Northia conchylega*, M. Sars; *Glycera capitata*, Örst.; *Phascolosoma Örstedii*, Kef.; and *Echiurus forcipatus*, Rein.

The Gephyrean *Phascolosoma Strombi*, Mont., was found inhabiting repaired tubes of *Cystenides hyperborea*.

CRUSTACEA.

Dr. van Lidth de Jeude mentions *Hippolyte polaris* and *H. Sowerbyi* as having been dredged (the latter in great numbers) on 17th July, 1879. He also mentions *Pagurus Bernhardus* as being frequent at Matotschkin Shar, and a species of *Hyas*.

POLYZOA.

The Rev. Thomas Hincks has furnished the following list the species collected by Mr. Grant:—

Subclass HOLOBRANCHIA.

Group a. ECTOPROCTA.

Order GYMNOLÆMATA.

Suborder Cheilostomata.

Genus GEMELLARIA, Savigny.

Gemellaria loricata, L.

Very abundant off Bear Island, in 25 fms. A dark-coloured variety occurs, with much elongated internodes, in lat. $72^{\circ} 32' 3''$ N., long. $36^{\circ} 29' 5''$ E. [St. Lawrence, Dawson.]

Genus CELLULARIA, Pallas.

Cellularia Peachii, Busk.

Lat. $71^{\circ} 23'$ N., long. $49^{\circ} 38'$ E., 67 fms., off S.W. end of Novaya Zemlya. [St. Lawrence, Dawson.]

Genus MENIPEA, Lamouroux.

Menipea ternata, Ellis & Solander (normal form).

Extremely abundant, as in all northern dredgings.

Menipea ternata (forma *gracilis*, Smitt) = *M. gracilis*, Busk.

Lat. $72^{\circ} 32' 3''$ N., long. $36^{\circ} 29' 5''$ E., 128 fms. [F.-Pierce Bay, lat. $79^{\circ} 29'$ N., last British Arctic expedition.]

Genus BUGULA, Oken.

Bugula Murrayana, Johnston.

On *Gemellaria loricata*, lat. $72^{\circ} 32'$ N., long. $36^{\circ} 29' 5''$ E., 128 fms. [St. Lawrence, Dawson; lat. $79^{\circ} 29'$ N., last Brit. Arctic exped.]

Genus FLUSTRA, Linnæus.

Flustra membranaceo-truncata, Smitt.

An essentially Arctic form. In this species membranous processes are given off from the back of the cells, terminating in branched fibrils, by which the zoarium is attached. This structure, which is not shared by other members of the genus, points to some peculiarity in the conditions of life.

Genus MEMBRANIPORA, Blainville.

Membranipora monostachys, Busk.

On stones &c., lat. 74° N., long. 24° E., 220 fms.

Membranipora lineata, L.

On stones off Bear Island, 25 fms.

Membranipora craticula, Alder.

On stones off Bear Island, 25 fms. [St. Lawrence, Dawson.]

Membranipora Sophieæ, Busk.

On stones off Bear Island, in 25 fms.

Membranipora arctica, Smitt.

Extremely common. This is the most abundant species amongst the dredgings from Barents Sea. It occurs creeping over stones, shells, &c., and also erect and free, forming expansions composed of a single lamina or of two (*Hemeschara* or *Eschara* auctt.). In the Hemescharine state the dorsal surface of the zoecia is seen to be thickly covered with minute white disks. Lat. 74° N., long. 23° E., 220 fms.; and off Bear Island, 25 fms.

Genus MICROPORELLA, Hincks.

Microporella ciliata, Pallas.

On stones off Bear Island. The zoecia are much calcified and often coarsely grooved, the furrows extending from the margin to the umbo, which overhangs the pore. The latter is suborbicular and strongly dentate, and is placed in a hollow between the umbo and the lower lip. The avicularium is very generally wanting.

Genus PORINA, D'Orbigny.

Porina tubulosa, Norman.

On stones off Bear Island, 25 fms. [St. Lawrence, Dawson.]

Genus MYRIOZOOM.

Myriozoom subgracile, D'Orb.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms. Lat. $75^{\circ} 36' 3''$ N., long. $57^{\circ} 6' 7''$ E. (*Marenzeller*).

Genus SCHIZOPORELLA, Hincks.

Schizoporella sinuosa, Busk.

On stones, lat. $72^{\circ} 55'$ N., long. $37^{\circ} 57' 18''$ E., in 150 fms. [St. Lawrence, Dawson.]

Schizoporella plana, Dawson (= *Myriozoom crustaceum*, Smitt).

Off Bear Island. [St. Lawrence, Dawson.]

Schizoporella hyalina, L.

On stones off Bear Island, 25 fms.

Genus PORELLA, Gray.

Porella struma, Norman.

Lat. $73^{\circ} 41' 6''$ N., long. $22^{\circ} 58' 30''$ E., in 220 fms.

The habit of growth in the only Barents-Sea specimen is Hemescharine; and the dorsal surface of the zoecia is furnished with one or more spinous projections, often of some length.

[North of the Shetland group; Bergen (*Norman*).]

Genus PHYLACTELLA, Hincks.

Phylactella? grandis, n. sp.

Lat. $75^{\circ} 16' 6''$ N., long. $48^{\circ} 19' 26''$ E., 160 fms.

Genus MUCRONELLA, Hincks.

Mucronella scutulata, Busk.

On stones, lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms.

Mucronella simplex, n. sp.

On stones, lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms.

Genus ESCHARA, auctt.

Eschara (Flustra) solida, Stimpson (= *Eschara palmata*, Sars, and *Escharella palmata*, Smitt).

Abundant in lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms. Lat. $79^{\circ} 13' 1''$ N., long. $63^{\circ} 21' 7''$ E. (*Marenzeller*). [Greenland; St. Lawrence.]

Eschara glabra, n. sp.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms.‡

Genus CELLEPORA, Fabricius.

Cellepora, ?n. sp.

On *Eudendrium*, lat. $72^{\circ} 32' 3''$ N., long. $36^{\circ} 29' 5''$ E., 128 fms.

Suborder Cyclostomata.

Genus CRISIA, Lamouroux.

Crisia eburneo-denticulata, Smitt.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms.

Genus DIASTOPORA, Lamouroux.

Diastopora obelia, Johnston.

On *Eschara palmata (Flustra solida)*, Stp., lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms. [St. Lawrence, *Dawson*.]

Genus HORNERA, Lamouroux.

Hornera, ?sp.

Lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 36''$ E., 160 fms.

Genus LICHENOPORA, Defrance.

Lichenopora verrucaria, Fabricius.

On *Balanus*, off Bear Island, 25 fms.

Suborder Ctenostomata.

Genus ALCYONIDIUM, Lamouroux.

Alcyonidium excavatum, n. sp.

Attached to tubes of Annelids, lat. $75^{\circ} 16' 6''$ N., long. $45^{\circ} 19' 5''$ E.

Genus ARACHNIDIUM, Hincks.

Arachnidium simplex, n. sp.

On other Polyzoa, lat. $71^{\circ} 6' N.$, long. $50^{\circ} E.$, 62 fms., off Novaya Zemlya.

Genus BUSKIA, Alder.

Buskia nitens, Alder.

On *Eudendrium*, lat. $72^{\circ} 32' 3'' N.$, long. $36^{\circ} 29' 5'' E.$

Group b. ENTOPROCTA.

Order PEDICELLINEA.

BARENTSIA, nov. gen.

Barentsia bulbosa, n. sp.

Lat. $75^{\circ} 16' 6'' N.$, long. $45^{\circ} 19' 36'' E.$, 160 fms.

Genus LOXOSOMA, Keferstein.

Loxosoma singulare, Keferstein.

On *Menipea*, lat. $71^{\circ} 6' N.$, long. $50^{\circ} E.$, off S.W. end of Novaya Zemlya, in 62 fms.

The foregoing list of Barents-Sea Polyzoa embraces thirty-two species, of which six appear to be new. It compares very favourably with the results in this department of the Arctic expedition under Sir G. Nares, by which only seventeen species were obtained.

Marenzeller mentions, in addition to the species in Mr. Grant's collection, the following seven species:—*Hornera lichenoides*, L.; *Aleyonidium gelatinosum*, L.; *Scrupocellaria inermis*, Norm.; *Membranipora Flemingii*, Busk; *Eschara cervicornis*, Pallas (probably = *Porella compressa*, Hincks); *Discopora coccinea*, Abildg., form *ventricosa*, Hass. (= *Mucronella ventricosa*, Hassall); *Cellepora ramulosa*, form *avicularis* (= *Cellepora avicularis*, Hincks).

BRACHIOPODA.

Brachiopoda were rarely met with in Barents Sea. Dr. van Lidth de Jeude mentions *Terebratulina cranium* as having occurred off the north coast of Norway.

PTEROPODA.

Dr. van Lidth de Jeude records *Clio borealis* and *Limacina arctica*.

GASTROPODA.

The following species are mentioned by Dr. van Lidth de Jeude which were not found in Mr. Grant's collection:—*Siphonentalis affinis* and *Hero formosa*, Lovén, the latter in the Matotschkin Shar, where also other species of Nudibranchiata occurred.

CONCHIFERA.

Dr. van Lidth de Jeude mentions *Pecten islandicus*, *P. septemradiatus* and *P. abyssorum?*, *Cardium ciliatum*, and *Panopea norvegica* as occurring in Barents Sea.

On examining the list of animals collected by Mr. Grant it will be found that there are enumerated 153 species, namely—Protozoa 1, Spongia 4, Hydrozoa 13, Actinozoa 2, Echinodermata 16, Annelida 15, Gephyrea 1, Crustacea 24, Polyzoa 32, Brachiopoda 2, Mollusca 36, Pisces 7.

Considering the limited means at Mr. Grant's disposal, and the confined space on board the little vessel, in which fourteen persons were cooped up, it will probably be acknowledged that he has achieved satisfactory results by his efforts to secure specimens for the Exeter Museum.

XXXIII.—On new *Hydroida* and *Polyzoa* from Barents Sea.

By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Plate XV.]

A FULL list of the Hydroida and Polyzoa obtained by Mr. W. J. A. Grant in the Arctic seas, during the expedition of the Dutch exploring-vessel the 'Willem Barents,' is included in Mr. D'Urban's report, published in the present Number of the 'Annals.' This paper will contain a detailed description of the new forms which occur in the collection.

Subkingdom CELENTERATA.

Class HYDROZOA.

Order HYDROIDA.

Suborder THECAPHORA, Hincks.

SERTULARELLA, Gray.

Sertularella quadricornuta, n. sp. (Pl. XV. figs. 1, 1a.)

Stem almost straight or very slightly sinuated, irregularly

branched. *Hydrotheca* very large, separated by a joint, tall, erect, very slightly expanded below and towards the orifice (of very much the same width throughout), distinctly ribbed transversely; orifice quadrate, with four denticles and an operculum, the stem below the calyces more or less annulated or marked with transverse rugæ. *Gonotheca* produced at the base of the calyces, ovate, subpedicellate, covered with prominent transverse ribs, with a neck-like termination above, and on the summit four large and conspicuous spines.

Grows in somewhat straggling bushy tufts, which attain a height of about 2 inches.

This species bears a general resemblance to the *S. gigantea* of Mereschkowsky, which occurs in the White Sea* ; but the latter has an angularly bent stem, and is also described as having the margins of the cells "always furnished with several ledges (sometimes 8 or even 10) and an equal number of small opercula, one above the other." This is made a distinctive character, and is said to be always present in adult cells.

In these particulars *S. gigantea* differs from *S. quadricornuta*; and though it may be doubtful whether the ledges below the margin should be accounted a character of much significance, I hesitate to unite the two forms without further evidence of their identity. Unfortunately M. Mereschkowsky did not observe the capsule of his species. That of *S. quadricornuta* exhibits very marked peculiarities, and separates it from any form with which I am acquainted. In its ribbed character it agrees with that of *S. tricuspidata*, but it is distinguished from it by its coronal of spines.

The ramification of the present species is irregular; the shoots bifurcate near the base, and the secondary shoots divide and subdivide freely. M. Mereschkowsky identifies his *S. gigantea* with the *S. polyzonias*, var. *gigantea*, mihi †, and is surprised that I should not have recognized in the latter a distinct species. I have not access, at present, to my specimens of the Greenland variety; but if my figures of it (drawn with the camera) are to be trusted, it is certainly different from the *S. gigantea*, Mereschkowsky; and while the latter is undoubtedly entitled to specific rank, I am still unable to find any character to separate the former from *polyzonias* but its size. Sars appears to have taken the same view.

I venture, then, to think, with great respect for M. Mereschkowsky's opinion, that his *S. gigantea* and my *S. polyzonias*,

* "Studies on the Hydroïda," Ann. & Mag. Nat. Hist. for March and April 1878.

† "On Deep-water Hydroïda from Greenland" ("Iceland" wrongly in the text), 'Annals,' ser. 4, xiii. p. 151, pl. vii. figs. 11, 12.

var. *gigantea*, are two different things; and whilst I quite agree with him that the former is a species, I still hold that the latter is properly accounted a variety.

Suborder ATHECATA, Hincks.

Note on *Myriothela phrygia*, *Fabricius*.

A *Myriothela* occurs amongst the dredgings from Barents Sea which is undoubtedly distinct from the species described under the above name in my 'History of the British Hydroid Zoophytes' and in Allman's paper in the 'Philosophical Transactions'*. Prof. G. O. Sars has already pointed out that the *Lucernaria phrygia* of Fabricius is not identical with the British form; and he reports the occurrence of both species on the Norwegian coasts. He does not give any detailed account of the differences between the two; but he mentions that their mode of attachment is dissimilar.

In a notice of the third part of the 'Fauna Littoralis Norvegiæ' in the 'American Journal of Science' (vol. xvii. March 1879), Prof. Verrill describes a *Myriothela* which had been dredged off the coast of Nova Scotia, and which he believes to be the genuine *M. phrygia* of Fabricius. His account of it leaves no doubt that it is identical with the Barents-Sea species.

In this form the tentacles, which are furnished with very large capitula, are thickly distributed over more than half the body; they seem to want (so far as we can judge from a specimen preserved in spirit) the purplish spot on the summit, which is found in the British species. Beneath the tentaculiferous region the body is somewhat constricted, whilst the terminal portion is much swollen (having quite a bulbous appearance), and is densely covered with the reproductive zooids. The latter are, I think, larger than I have seen them in the British species; and each of them bears a considerable cluster of gonophores. They extend to the very base of the body, which terminates in an obtuse extremity and is totally destitute of any chitinous investment. The naked tract which, in our British form, succeeds the reproductive zone, and the bent or decumbent extremity clothed with polypary, have no representatives here. The base gives off a number of slender, filiform processes, which take their origin amongst the reproductive zooids; and these expand at the extremity into adhesive disks, by which the animal is attached.

* "On the Structure and Development of *Myriothela*," Phil. Trans. vol. 165, pt. 2, p. 549.

It seems probable that this is the second species referred to by G. O. Sars, and that Prof. Verrill is right in regarding it as the genuine *Lucernaria phrygia* of Fabricius. Provisionally, at least, it may bear his specific name.

Subkingdom MOLLUSCA.

Class POLYZOA.

Group a. ENTOPROCTA.

Order GYMNOLÆMATA.

Suborder CHEILOSTOMATA.

PHYLACTELLA, Hincks.

Phylactella (?) *grandis*, n. sp. (Pl. XV. figs. 4, 5.)

Zoarium incrusting; *zoecia* very large, suberect towards the oral extremity, below depressed, usually much expanded below, above narrowed off into a neck; walls thick, surface minutely and densely granular, a row of pores round the margin and across the front of the cells, a little above the base; orifice (adult) much contracted, elongated transversely, very narrow between the upper and lower margins (transversely semielliptical), primary orifice semicircular; oral spines four. *Oæcium* elongated, narrowed towards the opening, much thrown back, a spine visible on each side in front of it.

This fine species is referred provisionally to the genus *Phylactella*. The peristome is much raised round the sides and front, forming a very narrow secondary orifice; the upper margin is not elevated. The cells are highly calcified, and the walls remarkably thick and solid.

MUCRONELLA, Hincks.

Mucronella simplex, n. sp. (Pl. XV. fig. 7.)

Zoarium incrusting; *zoecia* quincuncially arranged, large, ovate, distinct; surface moderately convex, slightly roughened, covered with small punctures; orifice ample, quadrato-orbicular; peristome raised all round, slightly bent outwards in front, the lower margin rising in the centre into a prominent point or knob. *Oæcium* large, rounded, somewhat roughened, and punctate, the peristome carried up on it at each side.

A pretty species, in which the generic character is represented in its simplest form; the oral denticle is wanting.

ESCHARA, auctt.

Eschara (auctt.) *glabra*, n. sp. (Pl. XV. fig. 6.)

Zoarium erect, having the zoecia in two layers, placed back to back, dichotomously branched, the branches compressed and slightly contorted. *Zoecia* arranged quincuncially with great regularity, ovate, surface smooth; orifice depressed, rounded above, lower margin straight, peristome not raised; the whole of the front of the zoecium (in the adult state) covered by an avicularian cell, which is so closely united to it, down the sides, as to appear, at first sight, an integral portion of it; mandible terminal, prominent, overhanging the orifice, much thickened, semicircular. *Oaecium* globose, somewhat depressed; surface smooth and shining.

To understand the structure of this curious species, it is necessary to study the zoecium in the earlier stages of its development. When adult, and overlain by the avicularian cell, it appears subcylindrical, well arched in front, with a smooth, dense surface; but in its earlier stages the avicularian cell is quite undeveloped, and its surface is somewhat flattish; a little later on the walls of the former may be traced, rising on the front wall of the zoecium, which is ultimately completely covered in and concealed.

Every zoecium may be regarded as composed of two chambers, one superimposed upon the other and closely united to it. The true avicularium occupies the upper extremity of the avicularian cell, is circular in form, and very conspicuous.

In the lower portions of the stem, calcification is carried to a great extent, the orifices are deeply sunk, and much changed in character; in the basal region they are obliterated, and the outlines only of the cells are faintly traceable on the surface.

Eschara perpusilla, a form described by Busk in his account of the Polyzoa obtained on the last Arctic Expedition under Sir G. Nares*, is evidently an allied species; but in this case the avicularian cell is only about half the length of the zoecium.

It may be necessary to constitute a new genus for the reception of this species; but further study of kindred forms is necessary before it can be done satisfactorily, and meanwhile

* Narrative of a Voyage to the Polar Sea during 1875-76 in H.M. Ships 'Alert' and 'Discovery.' By Capt. Sir G. Nares. Vol. ii. Appendix, pp. 283-289.

it may bear the generic name to which it would be entitled under the older systems, and which merely indicates its erect and ramose habit.

Family Celleporidæ.

CELLEPORA, Fabricus.

Cellepora —, ? n. sp.

Zoecia suberect, urceolate, often obscurely furrowed or striated radiately in front, ventricose below; orifice orbicular, with a slight sinus in the inferior margin (produced below); peristome somewhat raised, and in front (in adult cells) carried up into a very prominent mucro, bearing on the summit a small subcircular avicularium.

Colony consisting of a small cluster of cells.

Probably this form should rank as a distinct species, though in some respects it bears a resemblance to *C. armata*, mihi. From the latter it is distinguished by the striated surface, the round avicularium, and the total absence, in the specimens which I have examined, of the spatulate avicularia, which constitute so conspicuous a feature of *C. armata*. The latter character, I am well aware, does not count for much; there is, however, a certain dissimilarity in general appearance between the two forms, which leads me to suspect that they may prove to be distinct*. If so, the Barents-Sea species may be distinguished as *C. striatula*.

Note on Flustra solida, Stimpson (Flustramorpha, Gray, Verrill).

(Pl. XV. figs. 2, 3.)

This species is better known as the *Eschara palmata*, Sars, which, according to Verrill†, is identical with the *Flustra solida* of Stimpson. A difficult question arises as to its systematic position, and Stimpson's generic name is only retained provisionally.

A striking character is the presence of numerous tubular fibres, which pass downward from various points on both the surfaces of the zoarium, uniting below to form a kind of stem, and finally giving off a multitude of fibrils, which serve as a

* I have only examined one or two small specimens of the present form.

† "Notice of recent Additions to the Marine Invertebrata of the North-eastern Coast of America," &c., Proc. of United-States National Museum, Nov. 5, 1879, fig. 165.

means of attachment. The fibres originate in certain cells whose surface is completely invested by a membranous envelope, and are a direct extension of this epidermal covering. They pass downwards along the surface, and as they advance become closely appressed one to the other, so as to constitute at last a cable-like stem, composed of many strands. The extremities bifurcate and run out into long slender fibres, which form a considerable mass at the base. A similar peculiarity is exhibited by *Eschara flabellaris*, Busk*, and *Flustra marginata*, Krauss†; but in these cases the fibres, though traversing the zoarium in various directions (at least in the latter of the two species), are principally aggregated along the margin, where they form a thickened rib. Both these forms are South-African.

Gray has instituted a genus (*Flustramorpha*) for these forms, and has taken *F. marginata* as the type. It is really based on a single character (the presence of the tubular fibres), which is the only distinctive element in his diagnosis. His account of the orifice of the zoecium is quite unintelligible; and the other points noted are all common to *Flustramorpha* and a large section of the old Escharine group.

The presence of the tubular fibres, however, cannot, in my judgment, be accounted a generic distinction: these structures are essentially identical with the (so-called) radical fibres, which occur on so many of the Polyzoa, and to which no special significance attaches. This view is confirmed by an examination of the zoecia of such a form as *Eschara flabellaris*. Though the mode of growth is Escharine, the cells are those of a *Microporella*, mihi, and, I believe, are specifically identical with those of the common *M. ciliata*, Pallas. I have already described a variety of the latter, which assumes an erect foliaceous habit, and has the cells in two layers, placed back to back‡; and it is a question whether *Eschara flabellaris* should be accounted any thing more than another variety or form of this protean species.

In *Flustra solida*, Stimpson, we have a totally different type of cell (Pl. XV. fig. 3); and it would be quite impossible in any natural system to rank it with *Eschara flabellaris* on the strength of the supporting fibres, which are common to them both.

Gray's genus, then, is quite untenable; and the species composing it must be ranked according to the character of their

* British-Museum Cat. part 2, p. 91, pl. cvii. figs. 7-10.

† Corall. und Zooph. der Südsee, p. 35, pl. 1. fig. 3, a-d.

‡ History of the Brit. Marine Polyzoa, vol. i. p. 210.

zoëcia. The exact position of *Flustra solida* is somewhat difficult to determine. Smitt has placed it in his *Escharella*, which is essentially equivalent to the genus *Smittia*, mihi; but from this group it differs in several important points. For the present it must hold a provisional place.

Suborder CTENOSTOMATA.

ALCYONIDIUM, Lamouroux.

Alcyonidium excavatum, n. sp. (Pl. XV. figs. 8, 9.)

Zoarium minute (about $\frac{1}{2}$ inch in height), erect, somewhat clavate. *Zoëcia* on one surface only, which is convex, the other concave, hollowed out in the centre; the cells irregular in shape, the outlines indistinctly visible on the surface; no papillæ.

This interesting form is characterized by its minuteness, by the disposition of the zoëcia on one side only of the claviform zoarium, and by the channelled condition of the opposite side. I have only seen two specimens, which occur on the tube of an Annelid: they are both of about the same size, and exhibit the same characters; and I see no reason to doubt that they are adult organisms. The centre of the non-celliferous surface is hollowed out from the top to within a short distance of the base of the zoarium; and the excavated portion is surrounded by a narrow border.

ARACHNIDIUM, Hincks.

Arachnidium simplex, n. sp. (Pl. XV. figs. 10, 11.)

Zoëcia disposed in linear series, elongate, expanded above, and slightly attenuated downwards, prolonged below into a delicate adherent fibre, by which they are linked together; the oral extremity turned obliquely upwards and free.

Hab. On the stems and branches of *Menipea*.

Though I have referred this form to *Arachnidium*, it differs in one respect from the other known members of this genus; indeed the generic character must be modified to admit of its reception. In the present species, so far as I have seen, the zoëcia are always arranged in simple unbranched linear series. In the typical *Arachnidia*, on the contrary, branch lines are given off from each side of the zoëcia, and the zoarium is more or less regularly reticulate.

The present form has the closest affinity in general structure with *Arachnidium*; and at present I do not see any sufficient ground for detaching it from this group.

Group b. *ECTOPROCTA*.Order **PEDICELLINEA**.Family **Pedicellinidæ**.**BARENTSIA**, nov. gen.

Generic character. Polypides with a cup-shaped body supported on a long peduncle, having a muscular enlargement at the base, the upper part fleshy and naked, the rest chitinous; peduncles borne on an erect chitinous stem, bulbous at the base; the stems united by a creeping stolon, with a chitinous investment.

The polypides of this very interesting form closely resemble those of *Pedicellina*; but it is separated from the latter genus by the singular structure of its zoarium. From the creeping stolon (which is more or less chitinous, and not, as in *Pedicellina*, a mere soft fleshy thread) rise at intervals tall chitinous stems terminating below in a somewhat bulbous enlargement. Along one side of the stems are placed at short distances from one another small bracket-like projections; and each of these supports a long peduncle with a polypide at its upper extremity. Immediately above the point of origin the peduncle is enlarged for a short distance, as in *Pedicellina gracilis*; and this portion is probably muscular in structure. Above the enlargement the peduncle is slender, and for a large proportion of its length composed of chitine; the terminal portion, however, immediately supporting the polypide is fleshy as in *Pedicellina*. Sometimes the main stem terminates above in two polypides (Pl. XV. fig. 12). One of the most striking differences between *Barentsia* and *Pedicellina* is the extent to which chitine enters into the structure of the former. In *Pedicellina* the whole colony is usually fleshy; the only exception is found in *P. gracilis*, which has the upper portion of the peduncle composed of a rigid (and probably chitinous) material.

Barentsia bulbosa, n. sp. (Pl. XV. figs. 12-14.)

Stolon a delicate chitinous fibre; erect stems usually tall, with numerous bracket-like projections arranged unilaterally, base enlarged. *Peduncles* long and slender, the soft portion supporting the polypide short. *Polypide* of a regular cup-shape, not distorted; tentacles (?).

The enlarged base of the peduncle seems to correspond with the similar structure in *Pedicellina gracilis*. The body of the polypide is as regular in form as that of *P. nutans*, Dalyell,

and exhibits none of the distortion which is so conspicuous in *P. cernua*. Within the stem a very delicate ringed or spiral structure is visible.

EXPLANATION OF PLATE XV.

- Fig. 1. *Sertularella quadricornuta*, n. sp. 1a. Gonothecæ.
 Fig. 2. *Flustra solida*, Stimpson, nat. size.
 Fig. 3. *Flustra solida*, zoecia, magnified.
 Figs. 4, 5. *Phylactella* (?) *grandis*, n. sp. 5a. Oœcium.
 Fig. 6. *Eschara* (auctt.) *glabra*, n. sp.
 Fig. 7. *Mucronella simplex*, n. sp.
 Fig. 8. *Aleyonidium excavatum*, n. sp.
 Fig. 9. *Aleyonidium excavatum*, showing the concave side.
 Figs. 10, 11. *Arachnidium simplex*, n. sp.
 Figs. 12, 13. *Barentsia bulbosa*, n. sp. Two of the erect stems, highly magnified.
 Fig. 14. *Barentsia bulbosa*: a single peduncle and polypide.

XXXIV.—*Descriptions of six new Species of Shells from Vancouver Island.* By EDGAR A. SMITH.

THE forms here described form part of a collection recently obtained by the British Museum.

Pleurotoma vancouverensis.

Shell fusiform, white. Whorls about eight in number, a trifle concave at the upper part, bulging beneath, cancellated with longitudinal fine costæ and spiral ridges, the points of intersection being somewhat nodulous. Spiral ridges or liræ about six or seven on a whorl, whereof the three uppermost are finest. Beneath these comes one rather stouter, which is again succeeded by two still coarser at the bulging part of the volutions; and another finer one is visible on some of the lower whorls adjacent to the suture. The costæ are flexuous, first bearing to the right and then to the left, and are thicker at the lower part or upon the stout transverse liræ, the nodules here being also coarser than those above. Last whorl contracted below the middle and shortly caudate, encircled with spiral ridges to the extremity, which are scarcely affected by the longitudinal ribs beyond the middle. Aperture less than half the entire length. Labrum thin, broadly notched beneath the suture, arcuate and prominent below the incision. Columella a little oblique, smooth, scarcely tortuous. Canal narrowish, moderately short. Length $11\frac{1}{2}$ millims., diam. 4.

The absence of colour and the peculiarity of its sculpture will distinguish this pretty form.

Sipho angustus.

Shell fusiform, eroded at the apex, whitish, with a broad obscure brownish band round the middle of the whorls, clothed with a greenish-yellow epidermis. Whorls probably about ten, slightly convex, slowly enlarging, longitudinally plicated, and everywhere finely spirally striated and marked with flexuous lines of growth. Plicæ a trifle oblique and arcuate, not particularly raised, broader than the interstices, about eighteen on the penultimate whorl. Last volution rounded at the middle, then contracted and produced into a slender recurved beak; the plicæ upon it become more or less obsolete below the middle. Aperture, together with the canal, occupying rather less than half the entire length of the shell, light brown within. Outer lip (viewed laterally) broadly sinuated above, and prominently arcuate at the middle. Columella scarcely arched at the centre, and turned obliquely to the left towards the extremity. Length 25 millims., diam. $6\frac{1}{2}$; aperture with canal $11\frac{1}{2}$ long, $3\frac{1}{3}$ wide.

This species is remarkable for its slender form, the close spiral striation, and the arcuate plicæ or ribs, a feature which is not characteristic of the genus.

Columbella (Nitidella?) Dalli.

Shell fusiformly ovate, yellowish white, reticulated with pale brown, the interstices being of irregular shapes and sizes; or, in other words, it is pale brown, closely spotted irregularly with yellowish white. Epidermis very thin. Apex eroded. Remaining whorls six, flattish or scarcely convex, smooth, separated by a deep suture, giving the spire a slightly turreted aspect. Last whorl feebly angular at the middle, contracted inferiorly, and striated around the extremity. Aperture pale lilac within, occupying about three sevenths of the entire length. Outer lip arcuate, thickened, especially at the upper part, thin at the margin, and armed within the mouth with about seven elongate tubercles. Columella arched above, oblique at the base, with indications of one or two tubercles below the middle, covered with a thin whitish callosity. Basal canal a little recurved. Length 14 millims., diam. $5\frac{1}{3}$; aperture 6 long, $2\frac{1}{2}$ broad.

This species is broader than *C. cribraria*, has a less acuminate and more turreted spire, and the colour is much paler. The outer lip, too, does not exhibit nearly so distinct a superior sinus; and the last whorl is more contracted at the base, forming more of a distinct basal canal with the lower extremity of the labrum.

Chemnitzia Lordii.

Shell subulate, whitish, banded at the sutures with light brown, with a narrow line of the same colour round the middle of the whorls. The latter 12–13, slightly convex, about twice as broad as high, longitudinally ribbed and spirally striated in the interstices. Costæ only slightly oblique, scarcely arcuate, rather broader than the interstices, about 18–20 on each volution, those upon the last terminating abruptly at the periphery. Suture hardly oblique, feebly undulating. Last whorl finely concentrically striated below the middle. Base pale brown, with a single white zone. Aperture a little longer than broad and a trifle effuse at the base. Columella simple, white, nearly erect. Length 13 millims., diam. $3\frac{3}{4}$.

The colour of this interesting species at a short distance from the eye appears to be a uniform pale brown, but on close inspection proves to consist of light zones with intermediate brownish ones. The apex of the single specimen at hand is worn; hence I cannot offer a description of the nuclear whorls. The transverse striæ are described as being in the interstices between the costæ; but in reality they are more or less feebly continuous upon them.

The name imposed upon this shell will awake pleasant recollections, in the minds of those who knew him, of one who passed away some years since. J. Keast Lord, a most liberal donor to the museum, did much to extend our knowledge of the natural history of Vancouver Island.

Trochus (Margarita) vancouverensis.

Shell conical, moderately umbilicated, greyish white. Whorls five, slightly convex, with oblique, flexuous ribs extending from suture to suture, also obscurely spirally striated. Last whorl obtusely angulated at the middle, rather flattened beneath, with four or five concentric sulci at the angle, of which the three uppermost are broader than those below; and the interstices or liræ between them are also stouter. The rest of the flattened base is arcuately plicated, or, in other words, exhibits the continuation of the costæ upon the upper half of the volution, which are interrupted by the sulci at the periphery. Umbilicus smallish, surrounded by a subtuberculous double ridge. Aperture subrotund, flattened at the base, iridescent within. Columella a trifle arcuate, somewhat expanded above, and at the lower extremity forming an angle with the base. Length $6\frac{1}{2}$ millims., diam. $6\frac{1}{2}$; aperture nearly 3 long and wide.

In some places, probably where the superficial calcareous layer is thin, the pearly iridescence beneath it is observable. The oblique flexuous costæ are about nineteen in number on the penultimate, and a trifle more numerous upon the last whorl.

Yoldia vancouverensis.

Shell almost equilateral, transversely elongate-oval, acuminate posteriorly, slightly gaping at both ends, clothed with a greenish olivaceous epidermis, which is darker towards the ventral margin and varied at intervals with dark zones. Surface not very glossy, marked with concentric lines of growth and close microscopic striation and granulation. Anterior side a trifle the longer, regularly rounded at the margin, posterior more acute. Hinder dorsal slope nearly rectilinear, scarcely arcuate. Area distinct. Length 12 millims., width $22\frac{1}{2}$, diam. 6.

This species is narrower posteriorly than *Y. arctica*, Gray, which it somewhat resembles, less glossy, and is very minutely granular upon the surface, this sculpturing being only discernible under a powerful lens.

XXXV.—Notes on the *Gasteropoda* contained in the Gilbertson Collection, British Museum, and figured in Phillips's 'Geology of Yorkshire.' By R. ETHERIDGE, Jun., F.R.Ph.S.Ed.

[Continued from vol. v. p. 485.]

THE SPECIES FIGURED ON PLATE XIV.

Patella scutiformis, Phillips (p. 223, t. 14. fig. 1).

The figure is drawn from a somewhat crumpled and fragmentary specimen, which bears a considerable resemblance to the subject of the next figure, *P. sinuosa*. From this imperfection the species will not be easy of recognition in collections, as it is impossible to say what the exact outline was, whether the margin was entire or sinuous. It certainly appears to be rounder than *P. sinuosa*, more depressed and to have a smaller apex; it is, however, a question, I think, whether these forms can be retained as more than varieties of one another. Professor M'Coy appears to consider *P. scutiformis* a good species, from its depressed form and marginal apex. I would, however, observe that in the absence of the broken end

it is difficult to say what relation the apex bears to the margin in position. It is the

Patella scutiformis, Phillips, loc. cit.; M'Coy, Synop. Carb. Foss. Ireland, 1844, p. 46; Morris, Cat. Brit. Foss. 2nd ed. 1854, p. 266.

Patella sinuosa, Phillips (p. 223, t. 14. fig. 2).

This figure is an accurate representation of the fossil it represents. Phillips describes the surface as smooth; this, however, it can hardly be said to be; for there are decided irregularities, caused by the obtusely rounded concentric undulations of growth. The apex appears to have been broken, but was probably acute. It is the

Patella sinuosa, Phillips, loc. cit.; ?De Koninck, Animaux Foss. p. 326, t. 23. fig. 4, *a, b*; Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 266.

Patella mucronata, Phillips (p. 223, t. 14. fig. 3).

The collection contains two specimens of this species; but as both are imbedded in matrix, it is difficult to conceive how either can be the original of the figure in question. Under these circumstances I think it not improbable that the latter is meant for a restoration. Notwithstanding this, it appears to be a good species, which may be distinguished by the depressed form, orbicular outline, central acute apex, and almost plain surface as compared with the other species of the genus. It is the

Patella mucronata, Phill. loc. cit.; M'Coy, Synop. Carb. Foss. Ireland, 1844, p. 46; Morris, Cat. Brit. Foss. 2nd ed. 1854, p. 266.

Patella curvata, Phillips (p. 223, t. 14. fig. 4).

The figure of this species would, to all intents and purposes, pass for that of an *Astarte* badly drawn. No Gasteropod in the whole of the Gilbertson collection bears the slightest resemblance to this figure; but, on the contrary, two specimens labelled as *P. sinuosa* are beautifully preserved examples, conical, with a nearly central apex, a plain non-sinuuous basal edge, and ornamented with fine, concentric, thread-like lines of growth.

Baron de Ryckholt has figured* a shell, under the name of *Emarginula carbonifera*, which, omitting the ventral depression in the side, has the exact appearance of the specimens labelled *P. sinuosa*; only the latter are much larger. It is the

Patella curvata, Phillips, loc. cit.; Morris, Cat. Brit. Foss. 2nd ed. 1854, p. 266.

* Mém. Couronnés Acad. R. Belg. 1852, xxiv. p. 43, t. 1. figs. 19, 20.

Patella retrorsa, Phillips (p. 223, t. 14. fig. 5).

The type of this species is retained in limestone, and is in an unsatisfactory state of preservation. The undulating border, corresponding concentric striae, segmented sides, and depressed form appear to be characteristic points of the species, although the grooves running up the flanks of the shell are rendered too definite in the figure. It is the

Patella retrorsa, Phillips, loc. cit.; Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 266.

Patella lateralis, Phillips (p. 223, t. 14. fig. 6).

Although this is stated to be in the Gilbertson collection, I have not met with the specimen.

On the Shells called Patella by Phillips.—No conclusive evidence, so far as I am aware, has been adduced to show in what relation these old Patelloid shells stand to the genus *Patella* as now understood. Of the muscular impressions we know little or nothing; and it appears to me, in consequence, that it would be better to refer them to some other genus, pending further details of their structure, rather than to definitely place them in a genus now existing, and to which they may perhaps bear no other affinity than that of outward resemblance.

Prof. James Hall has proposed* for American Lower-Silurian shells of somewhat similar aspect the name *Palæacmæa*, but which he defines as possessing an entire and non-sinuate peristome. With the exception of this one character his definition would quite accord with the shells referred by Phillips to *Patella*; and it becomes a question whether it would not be better to enlarge Hall's diagnosis, so as to include shells with both a plain and sinuated border or peristome. In this case the above species would become *Palæacmæa sinuosa*, Phill. sp., *Palæacmæa curvata*, Phill. sp., and so on.

Hall's definition is as follows:—"Conical univalve shells, having a circular, ovate, or elliptical outline, with a more or less elevated subcentral apex, either erect or slightly curving towards one extremity; peristome entire, not sinuate. Surface marked by concentric ridges of growth. Internal muscular markings unknown."

On the other hand, if this alteration of Hall's diagnosis is not permissible, these shells must remain as simple *Patellæ*

* Twenty-third Ann. Report New-York State Cab. Nat. Hist. 1873, p. 242.

until such time as their internal structure can be studied in conjunction with that of *Patella* itself.

Metoptoma pileus, Phillips (p. 224, t. 14. fig. 7).

This, the type of the genus *Metoptoma*, is a well-marked form and an almost perfect specimen. The truncated margin is concave, the apex being placed almost vertically above it. The lines of growth are close and thread-like, with stronger undulations here and there. It is the

Metoptoma pileus, Phillips, loc. cit.

Patella pileus, De Koninck, Animaux Foss. p. 328, t. 23. fig. 7, a, b.

Metoptoma pileus, Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 258.

Metoptoma imbricata, Phillips (p. 224, t. 14. fig. 8).

The form of this species closely approaches that of the last; but it may be at once distinguished by the step-like, more or less imbricating, strongly marked concentric ridges. Phillips describes it as conical; this term, however, can hardly be applied in this case, as the anterior and posterior sides are of different lengths and angles of inclination. It is the

Metoptoma imbricata, Phillips, loc. cit.

Patella imbricata, De Koninck, Animaux Foss. p. 329, t. 23 bis, fig. 4.

Metoptoma imbricata, Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 258.

Metoptoma elliptica, Phillips (p. 224, t. 14. fig. 9).

A very elegantly proportioned shell, and of which Prof. M'Coy has given a full and good description. It may be at once distinguished from both the preceding species by the proximity of the apex to the truncated posterior margin, and, in consequence, the total absence of the almost vertical posterior end. The apex is, as M'Coy states, just within the margin, scarcely terminal (as described by Phillips), and certainly not overhanging (as mentioned by De Koninck). It is the

Metoptoma elliptica, Phillips, loc. cit.

Patella elliptica, De Koninck, Animaux Fossiles, p. 330, t. 23 bis, fig. 3.

Metoptoma elliptica, Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 258.

Metoptoma oblonga, Phillips (p. 224, t. 14. fig. 10).

This species is founded on a single specimen, an internal cast, showing the muscular scars. It is quite clear the shell possessed strong concentric ridges, like *M. imbricata* and *M. sulcata*; but if the elongated form and slightly concave anterior lateral margins are constant, these will suffice to separate

it; however, I think it is desirable a series of specimens should be examined before any conclusive result can be arrived at as to the value of this species. It is the

Metoptoma oblonga, Phillips, loc. cit.

? *Patella oblonga*, De Koninck, Animaux Fossiles, p. 329, t. 23. fig. 6, a, b.

Metoptoma oblonga, Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 258.

Metoptoma sulcata, Phillips (p. 224, t. 14. fig. 11).

A small and imperfect shell. The ornament is exactly similar to that of *M. imbricata*; and, with the present material before me, I should not be inclined to do more than recognize it as a variety of the latter. It is the

Metoptoma sulcata, Phillips, loc. cit.; Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 258.

On the Genus Metoptoma, Phillips.—This genus was described in 1836 by the late Prof. Phillips for patelliform Carboniferous shells having the posterior end (or that under the apex) truncated. It was not adopted by Prof. de Koninck in the body of his work on the Belgian fossils, but was afterwards admitted, to some extent, in the supplement to that work, in consequence of the discovery of the muscular scars on the interior surface of the shells of *M. pileus*, Phill., and *M. solaris*, De Kon.; good examples of these are now in the British-Museum collection. In the two species just mentioned Prof. de Koninck describes the scars as horseshoe-shaped, placed on the posterior side of the shell, with their dilated pyriform ends directed towards the front.

Neither De Koninck nor M'Coy mention the fact that Phillips had already figured the muscular impressions in *M. oblonga*, although he failed to make any note of their significance; not so, however, those discriminating palæontologists Messrs. Meek and Worthen*, who draw special attention to this figure in the 'Geology of Yorkshire.'

Baron de Ryckholt † refers *Metoptoma* to the genus *Helcion*, De Montfort. This, however, simply arises from a misapprehension of the characters of the former, because the forms from the Carboniferous rocks of Belgium ascribed by De Ryckholt to *Helcion* bear no resemblance to those upon which Phillips established his *Metoptoma*, beyond all being more or less conical patelloid shells.

Prof. Hall has suggested ‡ that the *Metoptomæ* of Phillips

* Proc. Acad. Nat. Sci. Philadel. 1866, p. 266.

† Mém. Couronnés Acad. R. Belg. 1852, xxiv. p. 56.

‡ Twenty-third Ann. Report State Mus. N. York, p. 242.

are only *Chiton*-plates; but any attention to the muscular scars as figured by Phillips, or described by De Koninck, would have at once dispelled this idea.

In *Metoptoma oblonga* the muscular scars possess identically the same character as those of *M. pileus*, Phill., or *M. solaris*, De Kon., and, like them, are striated lengthways.

Now, if we compare these scars in either of the three species just mentioned with those of a recent *Patella*, we find the resemblance complete, the impressions in the latter being to all intents and purposes horseshoe-shaped, with the free ends directed towards the anterior or narrowed portion of the shell. Under these circumstances *Metoptoma* cannot be said to differ from *Patella* in more than its truncated posterior end and some other minor particulars.

The form of the muscular impressions and the utter absence of any facet-surface for rolling up, as in *Chiton*, the truncated posterior side of *Metoptoma* being in no way analogous to this, at once separate the latter from the former. In the *Chitones* the facet or overlapping surface of the valves is differently ornamented from their exposed surfaces, whilst in *Metoptoma* the posterior truncated side is ornamented in a similar manner to the rest of the surface. On the whole, *Metoptoma* may be conveniently retained for shells of the Palæozoic rocks having the general appearance of *Patella* but with the posterior end truncate.

Pileopsis? trilobus, Phillips (p. 224, t. 14.
figs. 12 & 13).

Not in the Gilbertson collection.

Pileopsis tubifer, Sowerby (Phillips, p. 224,
t. 14. fig. 14).

This, in many respects a remarkable specimen, has not been done justice to in Phillips's figure. The example preserved in the Gilbertson collection, and used by Prof. Phillips, also forms the actual type of the species, having been borrowed and figured by Mr. J. de C. Sowerby. The shell is more or less imbedded in limestone; and there are visible two rows of spine-bases, one on each side, with distinct traces of a central third one. From the margin of the shell, in a line with each of these rows, a coarse irregularly formed spine projects, enclosed to a great extent in matrix. The apex is not exposed; M'Coy says, however, it is arched, but not incurved, and that the general form of the shell is here more lengthened and narrower than in any species of this genus.

P. tubifer, which is apparently any thing but common, has

the general outline of *P. vetustus*, Sow., and well exemplifies the length to which variation proceeds in this very variable genus. It forms the British type of a condition much more common in the Palæozoic rocks of North America than in those of this country, and is allied to *Capulus dumosus*, Conrad, and *C. multispinosus*, Meek, both highly spinose species. It is the

Pileopsis tubifer, J. de C. Sow. Min. Conch. 1829, vi. p. 224, t. 607. fig. 4.

Pileopsis tubifer, Phillips, loc. cit.

Acroculia tubifer, M'Coy, Synop. Carb. Foss. Ireland, 1844, p. 45.

? *Capulus tubifer*, De Ryckholt, Mém. Couronnés Acad. Belg. 1852, xxiv. p. 34, t. 1. figs. 7, 8.

Capulus tubifer, Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 239.

Pileopsis striatus, Phillips (p. 224, t. 14. fig. 15).

The figure of this specimen is tolerably good; only the striæ are not close enough. They are also in parts alternately larger and smaller, and, from being here and there broken and disconnected, give to the ornament of the shell a somewhat granular appearance. The smaller striæ are interpolated from the margin upwards; and faint indications of concentric lines are to be found on some parts of the surface, especially on the apical region. If the surface of *P. striatus* was, when perfect, more or less cancellated, it will be the type of a group not hitherto recognized in our rocks, viz. the genus *Igoceras*, Hall. It is the

Pileopsis striatus, Phillips, loc. cit.

Capulus striatus, Morris, Cat. Brit. Foss. 2nd ed. 1854, p. 239.

Pileopsis neritoides, Phillips (p. 224, t. 14. figs. 16-18).

Figures 16 and 17 are two views of one specimen, and figs. 18 two views of another example. Fig. 17 is somewhat improved in the region of the inrolled apex. The strong lines of growth are wavy and interspersed with fine striæ. Prof. M'Coy appears to have been the only one to draw attention to the similarity existing between *P. neritoides*, Phill., and the *Conchyliolithus (Helicites) auricularis*, Martin. So far as an opinion can be formed only from a figure, I must express my entire concurrence in the reference advocated by him. Some forms of this genus, more particularly those described by American authors, show a distinct transition in form towards *Naticopsis*, M'Coy: with these may be placed *P. neritoides*, Phill.; for if we compare fig. 16 with that of *Naticopsis elliptica*, on the same plate, we see the general community of

type which exists between the two, so far as outward form is concerned. It is the

Conch. (Helicites) auricularis, Martin, Petr. Derb. 1809, t. 40. figs. 3, 4.

Pileopsis neritoides, Phillips, loc. cit.

Capulus neritoides, De Koninck, Animaux Fossiles, p. 334; Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 239.

Pileopsis vetusta, Sow. (Phillips, p. 224, t. 14. fig. 19).

This specimen is in a bad state of preservation, but it has an obliquely placed and spirally inrolled apex after the *P. neritoides* type. Prof. de Koninck has united it with the latter, and Prof. M'Coy with Martin's *P. auricularis* along with others. These authors are doubtless correct in this; it is not the true *P. vetusta*, Sowerby.

Pileopsis angustus, Phillips (p. 224, t. 14. fig. 20).

A small, almost entirely decorticated shell with an oblique spiral apex after the type of *P. neritoides*, with which it has been united by Prof. M'Coy as a synonym of *P. auricularis*, Martin. I quite fail to see how it can be separated, except as a variety with a less sinuated and more regular shape. It is the

Pileopsis angustus, Phillips, loc. cit.

Acroculia angustus, M'Coy, Synop. Carb. Foss. Ireland, 1844, p. 44.

Capulus auricularis, M'Coy, Brit. Pal. Foss. 1853, fasc. iii. p. 523.

Capulus angustus, Morris, Cat. Brit. Foss. 1854, 2nd ed. p. 239.

On the Shells called Pileopsis by Phillips.—Under what name should these shells be known? The generic names *Capulus*, Montfort, *Platyceras*, Conrad, *Acroculia*, Phillips, and *Pileopsis*, Lamarck, have been used for them; and the question to which of these should they be referred turns more or less upon that of their internal structure, more particularly of the muscular system. There appears to be little question of the identity of *Capulus* and *Pileopsis* on the one hand, and of *Platyceras* and *Acroculia* on the other; whilst *Capulus* is as much anterior in date to *Pileopsis* as *Platyceras* is to *Acroculia*; we have therefore a choice between *Capulus* and *Platyceras*.

In *Capulus* the muscular impression is horseshoe-shaped, discontinued or open towards the anterior or front of the shell. This may be satisfactorily seen in *C. hungaricus* or any of the larger recent species. So far as I am aware, the form of the scar in *Platyceras*, Conrad (= *Acroculia*, Phillips), was little known until figured by Messrs. Meek and Worthen, who have shown that the scars in *P. infundibulum*, M. & W., are horseshoe-shaped, with lateral dilatations, and situated on the pos-

terior side of the shell. There does not, therefore, appear to be any thing in the structure of *Platyceras*, Conrad, which definitely separates it from *Capulus*, Montfort.

The examination of numerous specimens has convinced me that the reduction in the number of species of the British Carboniferous *Capuli* made by Profs. de Koninck* and M'Coy† is a step in the right direction.

The latter writer has asked "whether Mr. Sowerby has confounded two species of *Pileopsis*, and which of them has the best right to the specific name *vetusta*?" After a careful examination of Sowerby's specimens, the conviction is forced upon me that two distinct forms have not been described under one name, but that the specimens in the "Min. Conch. Collection" fairly represent the old and young conditions of a single species, *Capulus vetustus*. It also appears to me that Prof. de Koninck‡ has followed the right and proper course in separating the specimen called *Pileopsis vetustus* by Phillips from that of Sowerby, and uniting with the last-named the *Pileopsis trilobatus*, Phillips.

Prof. M'Coy has united with the *Conch. (Helicites) auricularis* of Martin three forms described by Phillips; and in this, so far as one can judge from Martin's figures, I agree with him.

It results from the foregoing remarks that we have in the "Gilbertson collection" four species only of *Capulus*, viz. *C. vetustus*, Sow. (= *C. trilobatus*, Phill.); *C. tubifer*, Sow. (= *C. tubifer*, Phill.); *C. striatus*, Phillips; *C. auricularis*, Martin (= *C. vetustus*, Phill. non Sow., *C. neritoides*, Phill., and *C. angustus*, Phill.).

Prof. James Hall has proposed the subdivision of the genus *Platyceras*, Conrad (= *Capulus*, Montf.), into three sections; and a fourth has been added by Messrs. Meek and Worthen. However, as the latter authors have remarked, too much reliance should not be placed on these groups, from the tendency possessed by the component forms to run into one another; nevertheless they may be found of service in a broad sense. They are:—

1. PLATYCERAS, Conrad.—Typical forms with an incurved or spiral apex; surface concentrically striated, and sometimes radiately plicate, rarely spiniferous. Type *P. tubifera*, Sow.

The British species of this section are *Capulus vetustus*,

* Animaux Foss. p. 332.

† Brit. Pal. Foss. 1853, fasc. iii. p. 523.

‡ Loc. cit.

Sow., *C. tubifer*, Sow., *C. auricularis*, Martin (= *C. neritoides*, Phill.), &c.

2. ORTHONYCHIA, Hall.—Shell arched or straight, forming an elongated cone. Type *P. subrectum*, Hall.

A single specimen occurs in the "Gilbertson collection," which is probably an example of this section.

3. IGOCERAS, Hall.—Surface cancellated. Type *P. plicatum*, Hall.

In all probability, *Capulus striatus*, Phillips, when perfect will assume this condition of ornamentation, and be the British representative of the section.

4. EXOGYROCERAS, Meek and Worthen.—Forms with a sinistral spire and an obscure columella. Type *P. reversum*, Hall.

Unknown to me as British.

Natica ampliata, Phillips (p. 224, t. 14.
figs. 21 & 24).

The collection contains the originals of both the foregoing figures. The expanded outer lip, flattened inner lip, depressed and even concave spire render this a peculiar species amongst the other Carboniferous Naticiform shells. The ornamentation is equally characteristic, consisting of regular, even, flattened, filiform lines, or, as Prof. M'Coy has well described them, minute ribs, following the marginal outline of the shell. The figure of the larger example is fairly good; but a concavity which exists around the suture is hardly represented. The spiral fine striæ (mentioned by M'Coy) crossing the ribs I have not seen; but I find that, under a strong lens, the ribs themselves are traversed by fine parallel striæ.

In *N. ampliata* the apex is depressed and even somewhat concave, the inner lip broad, flat, sloping inwards, plain, and without any tubercle or callosity.

Under the name of *Nerita spirata*, Mr. J. de C. Sowerby figured two species. The larger of his two figures is the present species, *N. ampliata*, and possesses all the characters of it. The second figure given in the 'Min. Conch.' is a small individual of the variety of *Natica elliptica*, Phill., with the slightly elevated spire. The description given by Sowerby—viz., "Spire small, partly immersed, the upper part of which is flat, when old concave; aperture transversely oval"—is almost sufficient to show the identity of the two forms. Sowerby's collection contains a second specimen larger than that figured by Phillips.

Under these circumstances the name *Natica ampliata*, Phill.,

will have to be abandoned, and the shell must in future be known as *Naticopsis spirata*, Sow., sp. It is the

Nerita spirata, J. de C. Sow. Min. Conch. 1824, v. p. 93, t. 463. fig. 1 (excl. fig. 2).

Natica ampliata, Phillips, as above.

Nerita spirata, Portlock, Geol. Report, 1843, p. 420, t. 31. fig. 8.

Nerita ampliata, De Koninck, Animaux Foss. p. 485, t. 42. fig. 2, a-c.

Pileopsis ampliata, Goldfuss, Petref. Germ. iii. p. 11, t. 168. fig. 4, a, b.

Naticopsis ampliata, M'Coy, Brit. Pal. Foss. 1853, fasc. iii. p. 543.

Natica ampliata, Morris, Cat. Brit. Foss. 1854, p. 262.

Natica lirata, Phillips (p. 224, t. 14. figs. 22 & 31).

There are three specimens of this species in the Gilbertson collection, one of which certainly represents fig. 31; but whether we have the original of fig. 22 is questionable. This, which is a decided *Naticopsis* in form, will probably require separation, from the nature of the surface-ornamentation and the presence of an umbilicus; at least, one is said to exist by De Koninck, and one of our specimens decidedly appears to bear this out. It is the

Natica lirata, Phillips, as above.

Narica lirata, De Koninck, Animaux Foss. p. 476, t. 42. fig. 5, a-c.

Natica lirata, Morris, Cat. Brit. Foss. 1854, p. 263.

(Compare *Narica spinescens*, De Ryckholt, Mém. Couronnés Acad. R. Belgique, 1852, xxiv. p. 71, t. 3. figs. 1-3.)

Natica elliptica, Phillips (p. 224, t. 14. fig. 23).

The larger figure in outline appears to have been restored from a badly preserved large individual in the collection. Of the smaller figure I can find no exact representative, although there are several which might pass for it. The oblique striae round the suture are fine, and do not much exceed in size the lines of growth over the general surface of the shell. The apex is flat or slightly projecting. The inner lip slopes inward and is flattened, with its outer edge more or less sharp; there is no trace of a tubercle or callosity. It is the

Nerita spirata, J. de C. Sow. Min. Conch. 1824, v. p. 93, t. 463. fig. 2 (excl. fig. 1).

Natica elliptica, Phillips, as above.

? *Nerita spirata*, De Koninck, Animaux Foss. p. 484, t. 42. fig. 3, d.

Natica ampliata, Morris, Cat. Brit. Foss. 1854, p. 263.

(Compare *Naticopsis Phillipsii*, M'Coy, Synop. Carb. Limest. Foss. Ireland, 1844, p. 33, t. 3. fig. 9, t. 6. fig. 4, a, b.)

Natica plicistria, Phillips (p. 225, t. 14. fig. 25).

The type of this species is a well-preserved shell. One of the most important features of this species is the flat or concave condition of the upper portions of the whorls next the suture, and which is constantly obliquely strongly striated,

the striæ dying out, immediately they pass on to the body of the shell, into mere fine striæ of growth. The inner lip is reflected and thickened, transversely obliquely ridged, and with a small callosity near the upper angle. Spire elongated. Prof. de Koninck appears to have been one of the few authors who have noticed the transverse oblique ridges on the inner lip of this species. It is the

Natica plicistria, Phillips, as above.

Natica plicistria, var. β , Portlock, Geol. Report, 1843, p. 420, t. 31. fig. 7.

Naticopsis plicistria, M'Coy, Synop. Carb. Limest. Foss. Ireland, 1844, p. 34.

Nerita plicistria (pars), De Koninck, Animaux Foss. p. 483, t. 42. fig. 3, a-c.

Naticopsis plicistria (pars), M'Coy, Brit. Pal. Foss. 1853, fasc. iii. p. 544.

Natica plicistria, Morris, Cat. Brit. Foss. 1854, p. 263.

Natica variata, Phillips (p. 224, t. 14. figs. 26 & 27).

There does not appear to be any definite type example of this species preserved in the collection. It is the

Natica variata, Phillips, as above.

? *Nerita variata*, De Koninck, Animaux Foss. p. 481, t. 32. fig. 8, a, b.

Naticopsis variata, M'Coy, Brit. Pal. Foss. 1853, fasc. iii. p. 544.

Natica elongata, Phillips (p. 225, t. 14. fig. 28).

The figure of this species is not a good one. By several authors *N. elongata* has been placed as a synonym of *N. plicistria*; but they are quite distinct: the structure of the inner lip is sufficient to prove this, irrespective of other characters. In the present species it is very much reflected and thickened, with a large, prominent, blunt tubercle or callosity placed high up; the surface of the lip is plain and without any transverse ridges. In addition to this the apex of the shell is mamillary, and the body-whorl more or less concave about the middle; the latter character varies to some extent. It is the

Natica elongata, Phillips, as above.

Natica plicistria, var. *a*, Portlock, Geol. Report, 1843, p. 420, t. 31. fig. 6.

Nerita plicistria (pars), De Koninck, Animaux Foss. p. 483, t. 42. fig. 3, a-c.

Naticopsis plicistria, M'Coy, Synop. Carb. Limest. Foss. Ireland, 1844, p. 34; (pars) M'Coy, Brit. Pal. Foss. 1853, fasc. iii. p. 543.

Natica plicistria, Morris, Cat. Brit. Foss. 1854, p. 263.

Natica tabulata, Phillips (p. 225, t. 14. fig. 29).

The only specimen in the collection is smaller than the figure given in the 'Geology of Yorkshire,' and has portions

of matrix adhering to it, which render identification difficult. Prof. de Koninck states that the surface is ornamented with fine and irregular striæ of growth, which on the keel of each whorl are bent backwards, indicating the presence of a sinus in the outer lip. The striæ are not preserved in our specimen; but the keel is well exposed, and forms quite a projecting rim along the periphery of each whorl. In all probability it is either a *Murchisonia* or *Pleurotomaria*, perhaps the former, as it cannot in any way be considered congeneric with such forms as *Natica elliptica*, *N. elongata*, &c. It is the

Natica tabulata, Phillips, as above.

Ampullacera tabulata, De Koninck, Animaux Foss. p. 488, t. 42. fig. 4, a, b.

XXXVI.—On the Antipatharia (*Milne Edwards*), with reference to *Hydradendrium spinosum*. By H. J. CARTER, F.R.S. &c.

IN a late communication from the Rev. A. M. Norman, a very significant and proper question is put to me, viz.:—"Your *Hydradendrium* (Ann. 1880, vol. v. p. 454, pl. xix. fig. 8 &c.)—have you compared this with *Antipathes*? it looks uncommonly like one." In reply, I could only state that I had not done so—and for the simple reason that, not having specially given my attention to the Anthozoa, I had always regarded *Antipathes* as allied to *Gorgonia*, and therefore in no way connected with the Hydrozoa, of which I conceived *Hydradendrium spinosum* to be one, and had named it accordingly.

But the significance and propriety of the question coming from such high authority was immediately realized when I referred to Ellis's illustrations of *Antipathes*, among which *A. ulex* appeared to me to be identical in form with *Hydradendrium spinosum*; so the idea as quickly flashed upon me that *Antipathes* itself, after all, might be a Hydroid Cœlenterate.

The next step was to compare, as Mr. Norman had suggested, the Manaar specimen with different species of *Antipathes*. But here my resources entirely failed; and I was thus thrown back upon the literature of the subject, viz. Pallas*, Ellis and Solander †, Lamouroux ‡, De Blainville §, and, lastly,

* Elenchus Zoophytorum, 8vo, 1766.

† Nat. Hist. of Zoophytes, 4to, 1786.

‡ Corallina or Flexible Corallines (Engl. transl.), 8vo, 1824

§ Manuel d'Actinologie, and Atlas, 8vo, 1834.

Milne-Edwards and Jules Haime*, by which I observed that, throughout, the words of the latter (who wrote after Dana) were verified, viz. :—"Jusqu'ici on n'a pas étudié l'anatomie de ces animaux, et on ignore la disposition des lamelles mésentéroïdes et des organes générateurs;" so that, as regards the nature of *Antipathes*, I am just as well off without the actual specimens, since in possessing Pallas's accurate descriptions and Ellis's reliable illustrations I have as much as the specimens themselves would present. In short, hardly any thing more than I have stated of *Hydradendrium spinosum* has, to the best of my knowledge, been published of *Antipathes* except Ellis's figures of the supposed polyp, which have more a Hydroid than an Actinozoid character.

All are agreed, from Pallas downwards, that the cortex "non calcareus est; sed gelatinosum tegumentum, in extremis ramis crassius, inque polypos efflorescens. Hoc quidem cortice, utpote putrescibili, in Museis adservata specimina fere semper orbata videntur" (*op. cit.* p. 206). Lamouroux observes that the gelatinous or exterior polypiferous portion almost wholly disappears on desiccation (*op. cit.* p. 189). Consequently the polyps have never been satisfactorily examined; and the only original† figures of them given by the authors above mentioned (which consists of nothing but the mouth and tentacles) are those of Ellis, to which I have alluded (*op. cit.* tab. 19. figs. 4, 5), which were obtained by "examining in the microscope some of the warts that covered a specimen of *Antipathes spiralis* lately brought from the East Indies, and soaked for some time in warm water" (p. 98); while a section of the horny axis, by the same author (p. 6), shows that it is composed of concentric layers which, when torn asunder, present the same kind of spiniferous surface as that of the last-formed or outside one of the stem itself; hence, in this respect, it resembles the layers of *Hydractinia levispina* (Ann. 1873, vol. xi. pl. i. fig. 2, c, d).

Now, although the concentric lamination of the kerataceous axis of *Antipathes* is like that of *Gorgonia*, this, together with its spiniferous surface covered with a gelatinous layer of extreme tenuity which almost wholly disappears on desiccation, is much more like a Hydroid Cœlenterate, ex. gr. *Hydractinia echinata*, and especially *Hydradendrium spinosum*, than *Gorgonia*, whose cortex and polyps, which are Actinozoid, are for the most part almost as persistent as the horny axis itself; so that if I am wrong in having broken the rules of

* Histoire des Zoophytes, Coralliaires, and Atlas, 8vo, 3 vols., 1857.

† Milne-Edwards's are copied from Dana. See at the end of the "Postscript."

precedence in nomenclature by applying a new term to an already named object, it is possible that I am not so in ascribing to it a Hydroid nature.

Hence comes the question, whether *Antipathes* ought not to be considered a genus of the Hydractiniidæ. Certainly Ellis's figure of the supposed polyp before mentioned is much more like that of a Hydrozoon than of an Actinozoon. But here again priority steps in, and Pallas can claim the right of having first used the term "*Antipathes*" for this Cœlenterate; so that, complying with this obligation, the whole family instead of being called "Hydractiniidæ," would have to be called "Antipathidæ," or some such word, thus sacrificing a name which carries with it the meaning of the objects it represents to one which has no significance at all, at least at the present day, when things, if possible, are named after their "nature" rather than their resemblances.

I do not know who first pointed out the likeness of some of the polyps to *Hydra* in contradistinction to those which are more allied in their structure to *Actinia*; but both Ehrenberg and De Blainville appear to have been conscious of the distinction; for the latter in 1834 stated that Ehrenberg's Bryozoa correspond "à peu de choses près à nos Polypiaires" (Actinologie, p. 682), and les Polypiaires (Polypiararia) are designated by De Blainville as "animaux hydriformes" (p. 399), of which the first family is "Millepora." But it is to Prof. Huxley that we are mainly indebted for the use of the term "Hydrozoa" (in 1859, Ray Soc. Publ.), afterwards clearly defined and illustrated by him, in contradistinction to the Actinozoa, in his 'Introduction to the Classification of Animals' (1869, pp. 21-24). Latterly the appropriate term "Hydrocorallinæ" has been proposed for the stony Hydrozoa by Mr. H. N. Moseley, F.R.S. (Phil. Trans. vol. clxvii. pt. 1, 1877, p. 132); and thus by degrees the Hydroid are being separated throughout from the Actinozoid forms of the Cœlenterata.

May we hope that there are some well-preserved specimens of *Antipathes* among the 'Challenger' collections? for it is only by such, or by examining them in their living state in their native element, that we shall ever know what the nature of the polyp is, viz. whether Hydroid or Actinozoid. This has been well exemplified in two specimens of *Hydractinia echinata* on whelks (*Buccinum undatum*) which were brought to me alive, one of which I dried, while the other, with its polyps fully expanded in its own element, was plunged in this state into spirit and water,—in which instances the former, from the extreme tenuity of the sarcode investment,

looks as if it never had any, and the latter is almost unaltered, in the form and position of its polyps, from what it was when living and fully expanded in the sea-water. Thus, as the theca or sarcodic covering of *Antipathes* appears to be of the same nature, it would seem to be useless to seek for the form and structure of the polyps after the sarcode has once been broken down by desiccation. That is therefore now the great desideratum*.

The thread-cells, as they are much tougher and therefore more durable, may generally be detected; at least they exist in the dried remains of the sarcode on *Hydradendrium spinosum*, where, with all appliances, I have not been able to get out the form of the polyp. It may be remembered that I also found them in a dried specimen of *Ceratella procumbens* (Hydractinian) ('Annals,' 1873, vol. xi. p. 11), although this specimen had probably been picked up on the beach at Port Natal, in which way, also probably, most of the specimens of *Antipathes* have come into the museums, when the delicate layer of sarcode which covered them would stand little chance of preservation, exposed to the scouring effect of the sand and waves together.

There is one point in *Antipathes*, as well as in the Hydractinian *Ceratella fusca*, that should be mentioned here: viz. Pallas states that, although the flesh may be absent, the spines remain to diagnose the species (p. 207); but Lamouroux observes that they are "rarely smooth"—that is, sometimes without spines (p. 189); and Milne Edwards confirms this (vol. i. p. 312); while I have already observed that *Ceratella fusca* &c. have none ('Annals,' 1873, vol. xi. p. 12), assuming that *Hydractinia* and *Antipathes* belong to the same family. If Pallas has erred in this matter, Milne-Edwards has done no less so in mixing up *Hyalonema Sieboldi* with *Zoanthus* at the end of his *Antipathes* (p. 324). But "to err is human," especially in a progressive subject like natural history.

POSTSCRIPT.

Since the above was written, Mr. Thomas H. Higgin, F.L.S., has kindly sent me several species of *Antipathes* for examination, with reference to *Hydradendrium spinosum* stating that, "if the latter belongs to the Hydractiniidæ, so do all our specimens of *Antipathes*, which at present we have near the Gorgoniidæ, in the Liverpool Free Museum; and if you are right, then will all require removing."

* [The author unfortunately does not seem to have consulted Lacaze-Duthier's classical memoirs "Sur les Antipathaires," in the 'Annales des Sciences Naturelles,' ser. 5, Tome ii. p. 169, and Tome iv. p. 1. Had he done so, his doubts as to the organization of the polyps might have been set at rest.—ED'S. A. M. N. H.]

All these specimens are more or less like *Hydradendrium spinosum*; but on one of them (no. 14. 6. 61. 2, without name), which appears to have undergone better preservation than the rest, there is a thick light-brown sarcodic theca, which is uniformly inflated at short intervals over the branches, so as to present a succession of fusiform swellings averaging about 1-415th inch in their shortest diameter. When a bit of the branch bearing one of these swellings, after having been softened by soaking in spirit and water for twenty-four hours, is placed under the microscope and examined with a 1-inch object-glass, it may be observed to consist of a transparent sarcodic base densely charged with opaque white granular matter arranged in reticulated lines, which, on being further magnified, viz. under $\frac{1}{4}$ -inch object-glass, presents a variety of cellular forms in great plurality and of different sizes, among which the most noticeable are:—1, a discoid body with crenulated margin and central circular area, about 5-6000ths inch in diameter; 2, a pyriform body about 6-6000ths inch long; and, 3, ovoid thread-cells about 3-6000ths inch in their greatest diameter, together with other minute forms which may or may not belong to a *Penicillium* with which the sarcode is permeated. But it is the fusiform inflations themselves on the branches which command our attention most; for they appear to have contained the full-grown polyp, of which, however, nothing now can be seen but a slight depression on the most prominent part here and there, bearing no resemblance whatever to the radiated actinozoic form of the polyp in the theca of a *Gorgonia*; nor, as above stated, are we likely to find any thing more, unless the specimen be seen in its active living state in its own element, or after having been properly preserved in spirit and water, in the manner of that of *Hydractinia echinata* above mentioned. Dana's figures *apud* Milne-Edwards (*op. cit.* Atlas, pl. C. 2. figs. 5, 6) show nothing more than Ellis's, viz. that the polyp's head has six tentacles.

XXXVII.—*The Chalk Bluffs of Trimmingham.*

By A. J. JUKES-BROWNE, B.A., F.G.S.

THE existence of certain isolated masses or bluffs of chalk on the shore near Trimmingham, in Norfolk, has long been known to geologists. They are partially buried under the deposits of the Lower Glacial series, which here form cliffs of considerable height, and founder down from time to time in great landslips, so that a clear section from top to bottom is rarely exhibited. Many writers have described these masses of

chalk and the appearances presented by them under the successive disclosures caused by the wasting of the cliffs; but notwithstanding the attention they have attracted, the question of how they came to occupy their present position has always remained a moot point.

It was also well known that the Trimmingham chalk contained peculiar nodules of flint; but these had never been carefully examined until the locality was visited by Mr. W. J. Sollas and myself in 1875, when, finding that the hollow flints disclosed very distinct traces of sponge-structure, my friend undertook the study and description of these remains. As the results of his examination are likely to excite further interest in the chalk which contains these curious nodules, I am led to offer a brief review of the known facts and opinions regarding the Trimmingham bluffs; and the present paper may form a kind of introduction to Mr. Sollas's descriptions, which will shortly appear in the pages of this magazine.

The earliest notice of the Trimmingham Chalk is from the pen of Mr. R. C. Taylor in 1823* ; and some passages of this are worth quoting. He says, "The most easterly point at which chalk has been traced is on the coast between Mundesley and Cromer, where we find two detached masses of soft chalk, with numerous layers of flint, forming insulated cliffs of chalk. Several circumstances lead me to consider these masses as the remnants of a stratum which once extended further to the north-east, in the space now occupied by the sea, constituting a higher part of the series than the chalk of Norwich These masses are continuous with a solid bed of chalk, discernible at low water, reaching nearly a mile in length from Trimmingham to Sidestrand, and forming a level platform extending into the sea. . . . That which particularly distinguishes this stratum is the vast abundance of a small curved oyster called *Ostrea canaliculata* †. Almost every part of the chalk is crowded with these shells; and many of the flints have from twenty to thirty of them adhering, which, in that case, being hardened by the siliceous matter, afford the best specimens."

It will be observed that Mr. Taylor notices only two chalk bluffs; and in Woodward's 'Geology of Norfolk' (1833) the chalk is mentioned as occurring in "two isolated disrupted masses." But in the section accompanying this book *three* separate masses are shown; and Sir Charles Lyell, whose first observations were apparently made in 1829 ‡, also mentions

* Trans. Geol. Soc. ser. 2, vol. i. p. 375.

† This is not the *O. canaliculata* of Sowerby. Dr. Barrois has lately identified it with the *O. lunata* of Goldfuss.

‡ 'Principles of Geology,' 4th edit. (1835), vol. iv. p. 90.

three protuberances of chalk on the coast. It would seem therefore that about this time a third mass made its appearance, brought into view probably by the gradual recession of the cliff-line. The site of this third bluff of chalk was a little distance to the south of the two now remaining; but as no traces of its existence are now to be found, I have endeavoured to collect the records of its brief history and gradual destruction.

A description of it is given in the first edition of the 'Principles of Geology' (1830, p. 180), with an illustration showing the side view of the promontory which it formed, and the relations of the chalk to the glacial beds above. This was repeated in several succeeding editions.

In 1840 Sir Charles Lyell contributed a paper to the 'Philosophical Magazine,' in which the three chalk masses are thus described * :—"The most southern of the three protuberances occurs near the Beacon Hill, about halfway between Trimmingham and Mundesley; the mass of chalk is about 20 feet high, its extent along the beach about 100 feet, and its thickness from the beach inland a few yards only. It stands up like a narrow wall, which will ultimately be destroyed; and then the whole face of the cliff will consist of clay, sand, and gravel. . . . When I visited this spot in 1839 I found the cliff nearly in the same state as it remained in 1829; and the description which I gave of it in the 'Principles of Geology' would still be appropriate."

Five years later Mr. Joshua Trimmer wrote a description of the Norfolk cliff, in which he thus refers to the Trimmingham chalk † :—"Of the protuberances of chalk near Trimmingham the northern and middle seem now little changed, but the southernmost has undergone some alteration. Its length is still the same as when visited by Mr. Lyell; but it is reduced to nearly half its height, and the waves have washed away a portion of the overlying gravel at one extremity. The next fall of the cliff will probably bury this end of the protuberance entirely."

Mr. Gunn mentions the existence of the three chalk masses in his 'Geology of Norfolk,' and observes that a question has arisen as to whether they are detached boulders or part of the solid bed below. He informs me that his remembrance of the third bluff is, that in height it was less than either of the others, that it gradually wasted away under the attacks of winter storms, and finally disappeared in the great storm of January 1863. It was therefore no longer in existence when

* Phil. Mag. vol. xvi. p. 356.

† Quart. Journ. Geol. Soc. vol. i. p. 218.

Mr. Searles Wood, Jun., examined the cliffs; and consequently it is not indicated in the coast-section which he published in 1865.

Of the two masses which still remain, the more southerly, or that which was the centremost, does not call for any lengthy description; it does not stand out so prominently from the cliff-line, and consequently there are not the same facilities for studying its mode of occurrence. Sir Charles Lyell thus describes it* :—“The second or middle protuberance is near that last described, its front along the shore, measured in 1839, 65 yards. Its height was between 15 and 20 feet.” Since that time its length and height have certainly diminished; but it does not seem to have undergone so much alteration as the other two.

Greater interest has always attached to the most northerly mass; and it has frequently been visited and described. Mr. Taylor’s description has already been quoted; and Sir Charles Lyell thus writes of it in 1840† :—“The third and most considerable mass extends along the beach for a distance of 106 yards; and its position deserves particular notice, for it forms, like the southernmost mass, a projecting promontory about 30 yards beyond the general line of cliff.” Views from the side and front accompany the further description of this mass.

The following notes were taken in September 1875; and the sketch was made on the spot at the same time.

The mass of chalk is about 35 yards long and about 30 feet high‡, ending on each side with a nearly perpendicular face; the talus of the foundering cliff above is partly banked against the sides; but there is no evidence of any faulting, and it is clear that much chalk has been carried away from both ends; the front face stands out 8 or 9 yards from the base of this talus.

Viewed from the southern side the upper surface of the mass is seen to slope slightly and irregularly inward towards the cliff; it is surmounted by a thin bed of sand, which is succeeded immediately by a brown sandy boulder-clay without the intervention of any beds resembling the laminated series.

The chalk contains bands of flints at distances of from 2 to 3 feet apart; some of these are hard, black, and compact; but

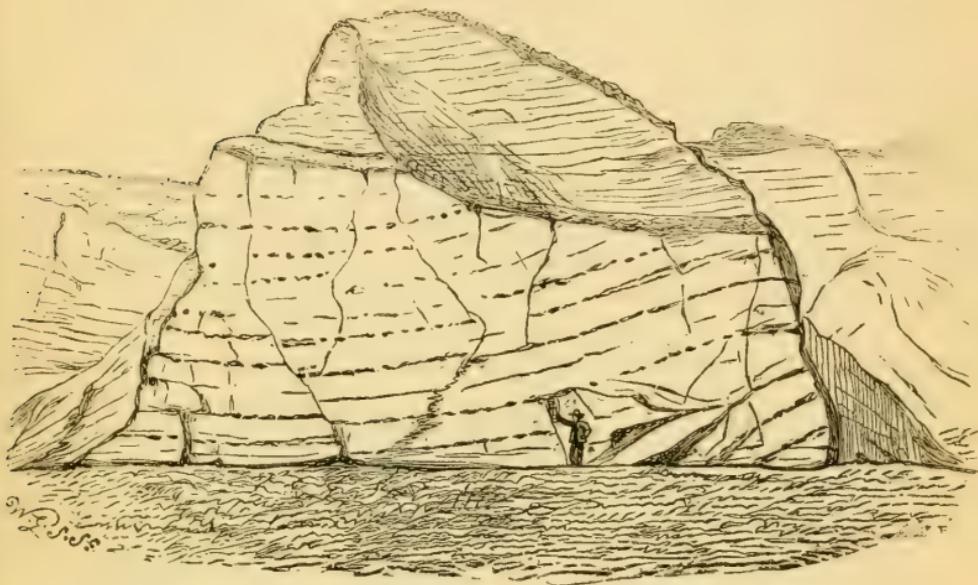
* Phil. Mag. vol. xvi. p. 356.

† Phil. Mag. vol. xvi. p. 356. See also Geol. Mag. vol. iii. p. 516, and vol. v. p. 544, and Lyell’s ‘Principles of Geology.’

‡ Mr. C. Reid, of the Geological Survey, has since informed me that his measurement gives 38 feet as its height from the present beach.

the majority are only half silicified, being hollow or partly filled with a grey chalky matter, which is gritty to the touch and is full of sponge-spicules and minute organisms. The flints are moreover surrounded with similar greyish chalk, which sometimes forms a band connecting two or more together;

Fig. 1.



Northern Bluff, Trimmingham, 1875.

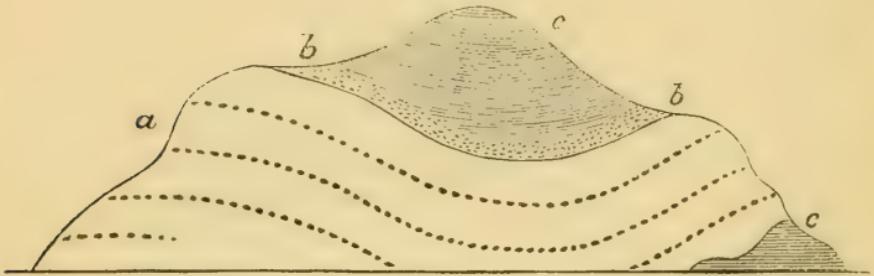
this greyish chalk also occurs in places without enclosing any flinty matter, and gives a mottled appearance to the mass. Between the layers of flint nodules the rock is full of a small curved species of oyster (since identified as *Ostrea lunata*, Nilss.); *Belemnitella mucronata* is also common; and there are many other fossils (see *postea*); but the best specimens are adherent to the flints.

If the measurements above given be compared with those of Sir Charles Lyell, and the mass in its present state (fig. 1) be compared with the figure in the early editions of the 'Principles of Geology' (reproduced in fig. 2), it will be seen that it has now only one third of the length it possessed in 1839. Originally the front face seems to have exhibited a complete synclinal curve, with more than half of the corresponding anticlinal at the southern end; but now only the centre of the synclinal is left, the beds rising very slightly to the southern, and more decidedly towards the northern end.

With regard to the dip of the beds as viewed from the sides some difference of opinion has existed. It is seldom, indeed, that a clear section is presented by the side face; for the chalk

breaks away along joint-planes, which are often discoloured, and still further obscured in summer time by the mud washed down from above. Sir Charles Lyell writes as follows* :—
 “A layer of chalk flints *in situ* shows that the stratification of the chalk is vertical, although the beds seen in a large cave

Fig. 2.

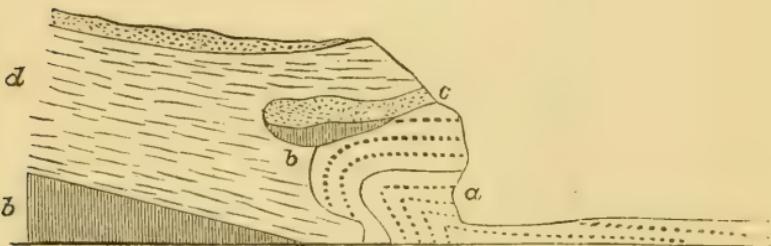


Northern Bluff, Trimmingham, 1839.
a. Chalk ; *b.* Sand ; *c.* Boulder-clay.

facing the sea show a slight curvature only.” Others have considered the beds to be nearly horizontal ; and certainly the flint layers in the upper portion of the mass appeared to be so in 1875.

Mr. Clement Reid, in his recent paper on the Glacial deposits of Cromer, has completely explained these conflicting appearances†. He had opportunities of visiting the spot after winter storms had cleared the section ; and he discovered that the beds are bent into a sharp curve or loop, and are so contorted as to be horizontal in one place and nearly vertical in another. The diagram (fig. 3) is an enlargement of part of the cross section given by Mr. Reid.

Fig. 3.



Northern Bluff, side view.
a. Chalk ; *b.* Boulder-clay ; *c.* Sand ; *d.* Contorted Drift.

* Phil. Mag. 1840, vol. xvi, p. 356.

† Geol. Mag. dec. 2, vol. vii, p. 55.

It will thus be seen that the disturbance of the chalk has resulted in the production of a double set of curves, the axes of which are at right angles to one another.

Several interesting questions are suggested by the position of these elevated outliers of chalk near Trimmingham.

(1) Are they connected with the chalk scar seen further out on the shore?

(2) How did they come to be left in their present isolated position?

(3) When was the chalk bent into the curves above described?

Although some have supposed that they were merely large fallen or detached masses, like those in the cliffs west of Cromer, yet the most competent observers are of a different opinion. Thus, in the description above quoted, Mr. R. C. Taylor distinctly states them to be continuous with the solid chalk below, as if he spoke from actual observation in the matter. Sir Charles Lyell inclined to the same opinion. Mr. Gunn also writes me word that he and Mr. Joshua Trimmer concurred in regarding the masses as fixtures and not boulders; and, finally, Mr. Fisher and Mr. Reid have observed that a particular layer of grey chalk is visible both in the cliff and on the foreshore opposite; so that little doubt can remain on this point.

With respect to the second question, several explanations have been put forward. Sir Charles Lyell seems to have regarded the masses of chalk as "protuberances" thrust upward into the overlying beds by the action of subterraneous forces; even in 1840 he speaks of being confirmed in his opinion, that both chalk and drift had been subjected to a common movement.

Mr. S. V. Wood, Jun., appears to have held a similar view, and even ventured to insert a fault at this point in his coast-section published in 1865. Whether he is still of the same opinion I am not aware; but it does not appear that he ever actually observed such a fault, and its existence can hardly now be maintained.

Mr. O. Fisher has suggested that the elevation and contortion of the chalk may have been due to a kind of "creep," like that in coal-mines, in consequence of the pressure exercised by the superimposed glacial beds*; but it seems unlikely that the weight of the overlying sands and clays could ever have been sufficient to affect the solid chalk to such an extent as this hypothesis demands. Moreover Mr. Fisher admits that there

* *Geol. Mag.* vol. v. p. 550.

are other features about the bluffs which are very puzzling. "One of these is the cavities they contain, filled with stratified alternations of calcareous sands and carbonaceous matter, evidently of ancient date. These cavities led me to suppose the masses might have formed needles or rocks in the glacial sea. But if so, it is difficult to conceive how the large flints, usually covering the chalk surface, could have been preserved upon their upper parts *in situ* as they are" (*loc. cit.* p. 551).

Mr. C. Reid has recently proposed another explanation*. He assumes the existence of a vast ice-sheet filling the North Sea in later glacial times, and supposes that the impact of this against the Norfolk shore was the cause of the contortions both in the Chalk and the Lower Glacial beds. This theory, however, seems open to the same kind of objection as that brought against Mr. Fisher's, viz. that physical considerations render it improbable: it is possible to conceive that the Lower Glacial beds may have been so doubled up; but it is very doubtful whether the solid scar of chalk could have been squeezed up and contorted in the manner suggested.

Both these theories involve highly theoretical questions of physics; and both assume that the contortions in the chalk were produced in Glacial times. It seems, indeed, more reasonable to suppose that this disturbance had a much more ancient origin, and that the beds of chalk were bent into the curves now visible before the commencement of the Glacial period. If this be assumed, there is then no necessity for calling in the aid of any special agencies, and the older and simpler view that the masses formed isolated stacks or pinnacles becomes the natural explanation; moreover the existence of the contortions would then be the very cause which conduced to the preservation of the bluffs, by enabling them to resist the agencies which broke up the surrounding portions of the chalk.

There is another fact, mentioned by Lyell, which tends to confirm this view, viz. that glacial beds have been seen underlying one end of the more northerly mass (see fig. 1); and in the 'Philosophical Magazine' (*loc. cit.* p. 358) he thus speaks of it:—"I have stated in the 'Principles' that this mass of chalk at its northern edge actually overlies some beds of blue clay or drift. Now this remarkable superposition was still evident in June 1839, notwithstanding the unusual height of the sea-beach, the clay containing broken chalk-flints being traceable for 7 feet under the chalk. It is known to have extended much further in a seaward direction." Elsewhere

* Geol. Mag. dec. 2, vol. vii. p. 61.

he suggests that the mass must have been “undermined when the crag was deposited, unless the boulder hypothesis is to be preferred”*.

Mr. Fisher has recently described in greater detail the cavities he discovered in the chalk †; but he still hesitates to draw the inference which their existence seems naturally to suggest. If they were sea-formed caves, as their position, shape, and contents appear to indicate, and if (as he believes) “they were formed and filled in the interval between the formation of the bluff and its envelopment in Boulder-clay,” surely this is almost sufficient to prove that the chalk mass existed as a cliff previous to the formation of the Lower Glacial series. I cannot think Mr. Reid is successful in explaining these caves away as expanded cracks ‡. The cavity specially described by Mr. Fisher has a much greater resemblance to the termination of a water-worn cave; and since the chalk bluff is known to have suffered so much in late years from the attacks of the waves, it is quite possible that Mr. Reid has never seen any such cavities as were visible up to 1868. Certainly none were observable in 1875.

Mr. Fisher finds a difficulty in the beds which rest on the top of the bluffs, and which he thinks “were evidently lifted up along with it;” but he assumes that they belong to the basement beds, or so-called *Laminated* series, whereas Mr. Reid considers that they are a portion of the sands which overlie the Till. And if he is correct, the difficulty vanishes; for they are nearly on a level with the normal horizon of these beds (as shown in Mr. Reid’s diagram, *loc. cit.* fig. 1).

The undermined edge described by Lyell and the existence of these ancient caves are, to my mind, strong arguments in favour of the view that the chalk bluffs were outlying rocks or needles, the remnants of a chalk zone which once formed a wide extent of land stretching far to the eastward, and that they owe their preservation to the local disturbance and arching of the strata, which gave them greater strength and enabled them to resist the action of the waves. Against their base were deposited the lowermost sands and clays of the fluvio-marine series; and as the area became gradually submerged their pinnacle tops were broken off and carried away; and upon the truncated surfaces thus left were laid down those later beds of clay and sand which are now seen in contact with the chalk.

It may also be pointed out that the Trimmingham bluffs

* Principles of Geology, ed. 5, vol. iv. p. 86.

† Geol. Mag. dec. 2, vol. vii. p. 149.

‡ *Loc. cit.* vol. vii. p. 238.

are by no means the only instances of contortions in the Norfolk chalk. Remarkable cases have been described by Mr. J. E. Taylor at Whitlingham* and at Swainsthorpe†. In the former case it is especially noted that the sands and gravels above do not participate in the disturbance of the beds on which they rest; hence, as Mr. Taylor says, it is evident that this disturbance took place before either the formation of the Norwich Crag or of the Drift deposits. If the section were equally clear at Trimmingham, I believe every one would be forced to accept the same conclusion regarding the chalk of that locality; but the foundering of the cliffs and the presence of the shingle beach combine to conceal the true relations of the beds, and allow scope for the free use of the scientific imagination. In this, however, as in most other cases, the simplest explanation is the most likely to prove correct.

This notice of the Trimmingham Chalk would not be complete without some reference to the interesting series of fossils it contains. The sponges will be described by Mr. Sollas; but the following list contains the names of the other fossils collected by ourselves and by Dr. Barrois‡, who visited the locality in the same year:—

Belemnitella mucronata, Schlot.

Ostrea vesicularis, Sby., var.

— *lunata*, Nilss.

Pecten quinquecostatus, Sby.

— sp.

Terebratula carnea, Sby.

Terebratulina striata, Wahl.

— *rigida*, Sby., var.

Magas pumilus, Sby.

Crania parisiensis, Defr.

Rhynchonella plicatilis, Sby.

— *limbata*, Dav.

Ananchytes ovatus, Lam.

Echinoconus Rœmeri?, D'Orb.

(or *Galerites abbreviatus*, Lam.).

Cyphosoma elongatum, Cott.

Cidaris serrata, Desor (spines).

Trochosmia cornucopiæ, Dun.

Serpula lumbricus, Defr.

— *heptagona*?, Von Hag.

To these may be added *Baculites magnus*, Sby., observed on Trimmingham beach by Samuel Woodward§.

Ostrea lunata is the species called *O. canaliculata* by Woodward and Rose. It is a Maestricht form, and was recognized by Dr. Barrois, who says (*op. cit.* p. 165), "I cannot distinguish my specimens from Trimmingham from the *O. lunata* (identical with the type figured by Goldfuss) which I have collected in the Upper Chalk of Ciplý."

The variety of *Ostrea vesicularis* is very large and globose; it only occurs in the uppermost beds of the chalk, and ought to be distinguished from the smaller shells passing under the same name.

* *Geol. Mag.* vol. ii. p. 324.

† *Op. cit.* vol. iii. p. 44.

‡ *Recherches sur les terr. Crét. Supérieurs* (Lille, 1876), p. 165.

§ *Geology of Norfolk*, p. 49.

XXXVIII.—*The Deep-sea Mollusca of the Bay of Biscay.*

By J. GWYN JEFFREYS, LL.D., F.R.S.

DURING the French deep-sea exploration last July, in the Bay of Biscay, in which expedition I was privileged to take part, on the obliging invitation of the Minister of Public Instruction, I was intrusted with the Mollusca. Perhaps the accompanying *catalogue raisonné* may interest conchologists.

A List of the Mollusca procured during the Cruise of the 'Travailleur' in the Bay of Biscay, 1880.

BRACHIOPODA.

1. *Terebratula caput-serpentis*, Linné. See as to this and other 'Porcupine' Mollusca the 'Proceedings of the Zoological Society of London' for 1878 and 1879.
2. *T. cranium*, Müller. A fragment.
3. *Platydia anomioïdes*, Scacchi & Philippi.
4. *Megerlia truncata*, L.
5. *Crania anomala*, Müll.

CONCHIFERA.

6. *Anomia ephippium*, L.
7. *Spondylus Gussoni*, O. G. Costa.
8. *Pecten pes-lutræ*, L. *P. septemradiatus*, Müll.
9. *P. groenlandicus*, G. B. Sowerby.
10. *P. fragilis*, Jeffreys.
11. *P. obliquatus*, J. (MS.).
12. *P. vitreus*, Chemnitz; and variety *abyssorum*.
13. *Amussium fenestratum*, Forbes; a monstrous variety.
14. *A. lucidum*, J.
15. *Lima elliptica*, J.
16. *L. subauriculata*, Montagu.
17. *L. Jeffreysi*, Fischer (MS.).
18. *Mytilus luteus*, J. (MS.). Allied to *Modiola incurvata*, Philippi, = *M. Martorelli*, Hidalgo; but it differs in shape, sculpture, epidermis, and colour.
19. *Modiolaria subclavata*, Libassi.
20. *M. cuneata*, J. (MS.).
21. *Dacrydium vitreum* (Holböll), Möller.
22. *Arca pectunculoïdes*, Sc., var. *septentrionalis*.
23. *Leda messanensis*, Seguenza. *L. acuminata*, J. (not Von Buch).
24. *L. pustulosa*, J.
25. *L. striolata*, Brugnone.

26. *L. lucida*, *Lovén*; and a variety.
27. *L. pusio*, *Ph.*; and variety *latior*.
28. *L. sericea*, *J.*
29. *L. Jeffreysi*, *Hid.* *L. lata*, *J.* (not Hinds).
30. *L. expansa*, *J.*
31. *Nucula ægeensis*, *Forb.*
32. *N. corbuloïdes*, *Seg.*
33. *N. tumidula*, *Malm.*
34. *N. sulcata*, *Bronn.*
35. *Limopsis cristata*, *J.*
36. *L. minuta*, *Ph.*
37. *Malletia obtusa*, *M. Sars.*
38. *M. cuneata*, *J.*
39. *Montacuta ferruginosa*, *Mont.*
40. *M. tumidula*, *J.*
41. *Lasæa pumila*, *S. V. Wood.* A Coralline-Crag fossil.
42. *Loripes lacteus*, *L.*
43. *Axinus flexuosus*, *Mont.*
44. *A. croulinensis*, *J.*
45. *A. eumyarius*, *M. Sars.*
46. *A. ferruginosus*, *Forb.*
47. *A. subovatus*, *J.*
48. *A. granulosus*, *J.*
49. *A. tortuosus*, *J.* (MS.).
50. *Mytilimeria? Fischeri*, *J.* (MS.).
51. *Cardita corbis*, *Ph.*
52. *Cardium minimum*, *Ph.*
53. *Isocardia cor*, *L.*; and the fry, which has many synonyms.
54. *Scrobicularia alba*, *W. Wood.*
55. *S. longicallus*, *Sc.*
56. *S. nitida*, *Müll.*
57. *Lyonsia formosa*, *J.* (MS.).
58. *Verticordia insculpta*, *J.* (MS.).
59. *Thracia convexa*, *W. Wood.* Young.
60. *T. tenera*, *J.* (MS.).
61. *Neæra abbreviata*, *Forb.*
62. *N. rostrata*, *Spengler.*
63. *N. cuspidata*, *Olivi*, var.
64. *N. bicarinata*, *J.* (MS.). A fragment.
65. *N. sulcifera*, *J.* (MS.).
66. *N. truncata*, *J.* (MS.).
67. *N. lamellosa*, *M. Sars.*
68. *N. striata*, *J.*
69. *N. imbricata*, *J.* (MS.).
70. *Saxicava rugosa*, *L.*

SOLENOCONCHIA.

71. *Dentalium striolatum*, *Stimpson*. *D. abyssorum*, *M. Sars*.
72. *D. gracile*, *J.* Not *D. filum*, *G. B. Sowerby*, *Jun.*
73. *Siphodentalium lofotense*, *M. Sars*.
74. *S. Olivi*, *Sc.*
75. *S. tetragonum*, *Brocchi*. *Dentalium quinquangulare*, *Forb.*, = *S. pentagonum*, *M. Sars*.
76. *Cadulus semistriatus*, *J.* (MS.).
77. *C. tumidosus*, *J.*
78. *C. artatus*, *J.* (MS.).

GASTROPODA.

- 79.**Chiton alveolus*, *G. O. Sars*.
80. *Rimula asturiana*, *J.* (MS.).
81. *Cylostrema sphaeroideum*, *S. V. Wood*. A Coralline-Crag fossil.
82. *Trochus gemmulatus*, *Ph.* A Sicilian fossil.
83. *Turbo filusus*, *Ph.* A Calabrian and Sicilian fossil, = *Trochus glabratus*, *Ph.*
84. *Hela tenella*, *J.*
85. *Rissoa cimicoïdes*, *Forb.*
86. *R. abyssicola*, *Forb.*
87. *R. deliciosa*, *J.* (MS.).
88. *R. tenuisculpta*, *J.* (MS.).
89. *Scalaria Trevelyana*, *Leach*.
90. *S. clathratula*, *Adams*.
91. *S. Cantrainci*, *Weinkauff*.
92. *Aclis Walleri*, *J.*
93. *Odostomia conoïdea*, *Brc.*
94. *O. Lukisi*, *J.*
95. *O. praelonga*, *J.* (MS.).
96. *O. acicula*, *Ph.*, var. *obeliscus*. From *M. de Folin's* gleanings.
97. *O. lineata*, *J.* (MS.).
98. *O. paucistriata*, *J.* (MS.).
- 99.†*O. fasciata*, *Forb.*
100. *O. Scillæ*, *Sc.*
101. *O. plicatula*, *Brc.* *Turbonilla speciosa*, *H. Adams*.
102. *Ianthina exigua*, *Bruguère*. Brought by Gulf-stream.
103. *Eulima stenostoma*, *J.*
104. *E. pyriformis*, *Brugn.* *M. de Folin*.
105. *E. subangulata*, *J.* (MS.).
106. *E. solidula*, *J.* (MS.); and a fragment of perhaps a new species.
107. *Natica sordida*, *Ph.* *N. fusca*, *De Blainville*, may be either this species or a variety of *N. millepunctata*.
108. *N. subplicata*, *J.* (MS.).

109. *Solarium pseudo-perspectivum*, *Brc. S. discus*, Ph.
 110. *Seguenzia elegans*, *J.*
 111. *Lamellaria perspicua*, *L.?* or perhaps a distinct species.
 Adriatic (*Stossich*).
 112. *Aporrhais Serresianus*, *Michaud*.
 113. *Cerithium metula*, *Lov.*
 114. *Buccinum Humphreysianum*, *Bennett*.
 115. *Ranella gigantea*, *Lamarck*.
 116. *Trophon muricatus*, *Mont.*
 117. *T. rugosus*, *J.* (MS.); and a fragment of perhaps another species.
 118. *Fusus gracilis*, *Da Costa*.
 119.**F. turgidulus*, *J.* (MS.). Fragments.
 120. *F. berniciensis*, *King*.
 121. *Cassidaria tyrrhena*, *Ch.* Perhaps a variety of *C. echinophora*, *L.*
 122. *Nassa semistriata*, *Brc.*
 123. *N. incrassata*, *Ström.*
 124. *N. limata*, *Ch.*, var.
 125. *Columbella haliæti*, *J.*
 126. *Taranis cirrhatus*, *Bru gn.* *Trophon Mörchii*, *Malm.*
 127. *Defrancia crispata*, *De Cristofori & Jan.*
 128. *D. parvula*, *J.* (MS.).
 129. *D. formosa*, *J.* (MS.).
 130.**Pleurotoma nivalis*, *Lov.*
 131. *P. pinguis*, *J.* (MS.).
 132. *P. modiolus*, *De Cr. & Jan.* *P. carinata*, Ph.
 133. *Ringicula leptochila*, *Bru gn.*
 134. *Cylichna umbilicata*, *Mont.*
 135. *C. ovata*, *J.* (MS.).
 136. *Utriculus expansus*, *J.*
 137. *Actæon exilis*, *J.*
 138. *A. ovatus*, *J.* (MS.).
 139. *Bullina elongata*, *J.* (MS.).
 140. *Bulla pinguicula*, *J.* (MS.).
 141. *Scaphander punctostriatus*, *Mighels & Adams.* *S. librarius*, *Lov.*
 142. *Philine scabra*, *Müll.*
 143. *P. striatula*, *J.* (MS.). Young.
 144. *P. quadrata*, *S. V. Wood.*
 145. *Melampus myosotis*, *Draparnaud.* Drifted from the shore.
 146. *Carinaria mediterranea*, *Péron & Lesueur.*

PTEROPODA.

147. *Limacina helicoïdes*, *J.*
 148. *Cavolina trispinosa*, *Pér. & Les.*

149. *C. labiata*, *D'Orbigny*. *Hyalæa inflexa*, Pér. & Les.
 150. *Clio pyramidata*, *Browne*.
 151. *C. lanceolata*, *De Bl.*
 152. *C. cuspidata*, *Lam.*

The species first named in italics appear to be new to science; those to which an asterisk is prefixed I consider peculiarly northern; and that to which a dagger is prefixed I consider peculiarly southern or Mediterranean. All the other species had been dredged by me in the 'Porcupine' cruise of 1870 off the western coasts of Spain and Portugal. The result shows that out of the 152 species in the above list, 11 are new, 3 northern, 1 southern, and 137 'Porcupine.' When M. de Folin has completed his examination of the sifted material, other species will in all probability have to be added to the list.

XXXIX.—*Descriptions of five new Species of Shells from Uruguay.* By EDGAR A. SMITH.

THE shells about to be described were collected by Dr. Copping, of H.M.S. 'Alert,' at present stationed in the Straits of Magellan for the purpose of surveying and exploration. The specimens from that region will shortly be treated upon elsewhere; and as those now characterized have a distinct geographical distribution, it is deemed advisable to publish their descriptions separately.

Nassa (Cæsia) simplex.

Shell rather thin, dirty whitish or pinkish white, with some small indistinct red spots or stains beneath the suture between the ribs. Whorls six and a half. Two apical ones smooth, the rest convex, separated by a deep suture, longitudinally plicated and transversely ridged and sulcated. Plicæ not very prominent, about seventeen in number on the penultimate whorl; spiral sulci shallow, cutting through the folds, rather narrower than the interstices, about seven on the upper whorls, two or three of them at the upper part being closer together than the rest. Last whorl sulcated throughout, with the plicæ attenuated beneath, yet extending to the base. Aperture small, somewhat irregularly circular, dirty brownish within; outer lip thin at the edge, with an exterior varix, very feebly lirate within. Columella arcuate at the middle, covered with a small callosity bearing an elongate transverse inconspicuous tubercle at the upper part, and some smaller and less distinct ones beneath. Length 12 millims., diam. 7; aperture $4\frac{1}{2}$ long, $3\frac{1}{3}$ wide.

Hab. 36° 47' S. lat., 55° 17' W. long., 28 fms. Off the mouth of the Rio de la Plata.

This is a dull unornamental species, and chiefly characterized by the convexity of the whorls, the depth of the suture, and the feebleness of the sculpture.

Trochus (Ziziphinus) Coppingeri.

Shell thin, shortly conical, rather shining, and somewhat iridescent, owing to the thinness of the calcareous layer above the pearl, very pale olive on the body-whorl, becoming darker on the upper volutions and reddish at the apex, ornamented with a series of minute red dots at the upper part of the whorls, just beneath the suture, and a second series on an angle at the middle of them, with a third series around the periphery of the last volution, and some rather larger spots around the umbilical region. Whorls seven; the first three or four somewhat convex, with three coarse spiral liræ. Antepenultimate whorl flat, sloping above, with an acute angle a little above the base, spirally lirated; liræ little raised, with the exception of that at the angle and one immediately beneath the suture, which is very prettily beaded. Penultimate like the preceding, but with the sculpture less pronounced and the angle nearer the middle. Last whorl still more feebly sculptured, the beading having become obsolete. It is biangulated at the middle, and the space between the two angles is flat, giving the shell a very angular aspect. Base a little convex, concentrically striated, white at the middle, with a conspicuous depression at the umbilical region, which is surrounded by three or four strong liræ. Lines of growth fine. Aperture oblique, irregularly pentagonal, smooth, and beautifully pearly. Columella arcuate above, obliquely straightish inferiorly. Height 13 millims., diam. max. 14, min. 12.

Hab. 36° 47' S. lat., 55° 17' W. long., 28 fms. Off the mouth of the Rio de la Plata.

This beautiful shell is very distinct in form and character from any other in the genus.

Nucula uruguayensis.

Shell ovate, somewhat ventricose, moderately thick, olive, smooth, with fine concentric lines of growth, bluish white within, not very iridescent except upon the muscular scars, very inequilateral. Anterior end rounded, posterior obtusely angulated. Front dorsal margin curved, not oblique near the umbo; posterior a little oblique, subperpendicular or almost at right angles to the anterior slope; lower or ventral edge regularly arcuate, forming an obtuse angle at its junction with the hinder dorsal margin, smooth within. Umbones rather prominent and acute. Teeth long, acute, about twenty behind the ligamental pit, and nine in front. Pit itself small, narrow,

nearly in a line with the front dorsal slope. Length 9 millims., diam. 12, thickness 7.

Hab. 36° 47' S. lat., 55° 17' W. long., 28 fms. Off the estuary of the Rio de la Plata, Uruguay.

This species is not unlike *N. obliqua*, Lamarek, as figured in Hanley's monograph in Sowerby's 'Thesaurus Conch.' fig. 150. It is, however, much more ventricose, has more of an angle at the anterior end, and the inner margin is not minutely crenulated. The teeth are remarkable on account of their length and sharpness. There are three specimens of different sizes from the above locality. The largest is of a brownish-olive colour, the intermediate one greenish olive, and the smallest of a still lighter tint.

Corbula Tryoni.

Shell a little inequilateral, small, very inequivalve, dirty white, sharply rounded behind, scarcely beaked, and rather squarely truncated anteriorly. Upper or smaller valve smooth near the beaks, then exhibiting three or four strong concentric ridges or stages of growth, which do not continue beyond a slight angle running from the apex to the anterior ventral extremity, the shell thus far, with the exception of that portion close to the apex, being very finely radiately striated and destitute of epidermis. Beyond this point the rest of the surface (about half the diameter of the valve) is clothed with a finely wrinkled epidermis. Lower valve also smooth in the umbonal region, then closely and strongly ribbed, the ribs becoming very fine, or almost disappearing, on a somewhat raised rounded arcuate ridge from the apex to the anterior ventral end. This prominence or ridge has a faint depression on each side. Teeth one in each valve, that of the lower the larger. Diam. 6½ millims., length 5, thickness 4.

Hab. 32° 45' S. lat., 50° 39' W. long., 48 fms. East of Uruguay.

This, so far as I can ascertain, is the first record of a *Corbula* from the eastern side of South America. I have much pleasure in naming this interesting species after Mr. Tryon, who has given, in the 'American Journal of Conchology,' a valuable catalogue of this genus.

Crassatella uruguayensis.

Shell compressed, subquadrate; anterior side broad, squarish, margin but very little curved; posterior end narrowing and rounded. Dorsal lines on each side of the umbones forming an angle of about fifty degrees. Hinder slope rather sudden, a trifle concave, anterior rather longer and a little curved outwardly. Ventral margin arcuate, but only slightly so. Sculpture consisting of concentric furrows and intermediate ridges, coarsest at the centre of the valves and towards the apex, and stopping short at the lunule and anterior dorsal area, both of

which are narrow, especially the latter, and defined by distinct margins. Colour light brown, covered with a very thin epidermis. Interior whitish, inclining to a pinkish tint towards the umbones; and the extreme outer edge is pinkish red and smooth. Hinge composed of a single tooth in the right valve, and two diverging ones in the left. Lateral teeth in right valve consisting of a thin marginal raised acute ridge extending nearly as far as the anterior dorsal slope. A similar ridge is met with in the left valve, only on the posterior dorsal margin. In each valve on the opposite side to the ridge is a narrow groove for the reception of the ridge in the opposing valve. Muscular scars small, posterior one the narrower. Diam. 15 millims., length $12\frac{1}{2}$, thickness 6.

Hab. $32^{\circ} 45'$ S. lat., $50^{\circ} 39'$ W. long., 48 fms. East of Uruguay.

This species is remarkable on account of the squareness of its form, especially at the anterior extremity.

XL.—Description of a new Species of Arvicola from Northern India. By OLDFIELD THOMAS, F.Z.S., British Museum.

AMONG the collections received by the British Museum from the India Museum at South Kensington was a specimen labelled and entered in the catalogue as *Cricetus songarus* (Pall.) *. When the skull was extracted, however, it proved to be, not a *Cricetus*, but an *Arvicola*, quite distinct from any species yet described. It was collected in Kumaon by Capt. (now Lieut.-Gen.) R. Strachey, after whom I propose to name the species

Arvicola Stracheyi, sp. n.

General colour of the fur above pale brownish grey, the hairs being of a slaty blue colour for three fourths of their length and their ends being brownish yellow tipped with black. On the belly the light tips are replaced by pure white. Ears rather short, scarcely showing beyond the fur, and thickly clothed with hair coloured like that on the back. Feet and tail pure white, the latter with a terminal pencil of hairs nearly half an inch long. Thumbs quite rudimentary.

The dentition of this species is very interesting, as the third upper molar is of a most remarkable type, and one apparently peculiar to the *Arvicolas* of this region, the only other species at all resembling *A. Stracheyi* in this respect being *A. Stoliczkana*, Blanf. †, from Yarkand and Ladak; but even in that the peculiarity is not so strongly marked.

* Horsfield, Cat. Mamm. Mus. E.L. Comp. p. 145 (1851).

† W. Blanford, J. A. S. B. 1875, pt. ii. p. 147; Mamm. Yark. Exped. p. 43, pl. viii. fig. 1 (animal), pl. x. B. fig. 2 (skull and teeth).

The molar pattern is as follows:—

Upper	I.	5 spaces,	3 external and	3 internal angles.		
"	II.	4 "	3 "	2 "	"	"
"	III.	3 "	4 "	2 "	"	"
Lower	I.	7 "	4 "	4 "	"	"
"	II.	5 "	3 "	3 "	"	"
"	III.	4 "	3 "	3 "	"	"

The first two spaces of the first and the two middle ones of the last lower molars are not distinctly separated.

The third upper molar has two strong salient angles on the front part of the inner side; and then follows the straight inner edge of the long posterior lobe. On the outer side there are anteriorly two very small angles, succeeded by a deep emargination, corresponding to the second of the inner angles; and then follow the two rounded outer corners of the posterior lobe, thus forming the third and fourth outer angles. The spaces enclosed are:—first, an irregularly triangular one between the two small external and one large interior angles; secondly, a small nearly circular one, contained in the second large internal angle; and, lastly, a long rectangular one, situated in the posterior lobe.

Arvicola Stracheyi has thus this tooth similarly formed to that of *A. Stoliczkana*; but the terminal lobe is much longer, being quite half the length of the whole tooth, and the two small anterior outer angles are just equal to one another, while in that species the first projects considerably beyond the second. The coloration and proportions of these two species are, moreover, very different.

The following are the measurements of the type, which is a skin in rather bad condition, so that they must be regarded as only approximate:—

	inches.
Length of head and body	3·7
Length of tail-vertebræ	0·7
Length of hind foot, without claws	0·65
Skull:	
From end of nasals to anterior angle of interparietal	0·84
Extreme breadth	0·59
Breadth between orbits	0·15
Breadth of brain-case	0·50
Length of nasals	0·32
Length of upper molar series	0·25
From upper molar series to incisors	0·30

Mr. Blanford has given me to understand that he intends shortly to publish descriptions, with figures of the teeth, of all the known North-Indian Voles; and so I have not thought it necessary to have a drawing made of the teeth of this species, as they will be figured in his paper.

MISCELLANEOUS.

On the Affinities of the Genus Polygordius with the Annelids of the Family Opheliidæ. By M. A. GIARD.

THE Polygordian which I have particularly studied occurs at the point of Beg-Mell, near Concarneau, where I discovered it during the spring-tides of April. It lives in a coarse shell-sand, like that which covers the tubes of *Terebella conchilega*. By sifting this sand through the fingers one may collect a great number of the *Polygordii* in a few minutes. The species, which I believe to be new, belongs to the same group as *Polygordius lacteus*, Schneider, and *P. Villoti*, Perrier—a group characterized by diœciousness, the length of the body, the circle of anal glands, &c.

Several months before Perrier, M'Intosh had described, under the name of *Limnotrypane apogon*, an Annelid which he has since thought he could identify with *P. Villoti*. It is quite certain that *Limnotrypane* is a Polygordian; and as it seems to me necessary to divide up the genus *Polygordius*, I propose, in order to avoid complicating the nomenclature, to apply the name *Limnotrypane* to the diœcious Polygordians, retaining the name of *Polygordius* for the hermaphrodite species of small size and of more archaic characters.

The genus *Polygordius* thus restricted includes the species *P. purpureus*, Schneider (Heligoland and Sebastopol), and *P. flavo-capitatus*, Uljanin (Sebastopol).

The genus *Limnotrypane* includes *L. lactea*, Schneider (Heligoland), *L. apogon*, M'Intosh (Shetland), *L. Villoti*, Perrier (Roscoff), and *L. erythrophthalma*, sp. n. (Concarneau). *L. erythrophthalma* is the Polygordian that I have investigated. It may attain a length of more than 0·1 metre. It is of a very bright rose-colour with iridescent reflections. It much resembles *L. Villoti* and *L. apogon*, but is distinguished at once from both these species by its red ocular points. *L. Villoti* is blind; and *L. apogon* has the eyes pigmented with black. Further the blood of our species is green, which is not the case in any other known Polygordian.

At the anterior part of the body the metameres are separated by a very fine black streak; at the posterior part they are indistinct externally, and marked only by the dissepiments and the enlargements of the digestive tube when the animal is examined by transmitted light.

The cuticle is very thick; and there are no annular muscular fibres beneath the matrix layer. Nor have I found any annular muscles in the interior of the longitudinal layer. Like Rajevsky I regard the inner lining of this layer as a tissue of connective nature, containing on each side of the general cavity numerous endothelial cells and forming a mesentery above and below the intestine. The vascular apparatus consists of a dorsal and a ventral vessel, united in each metamere by lateral loops, upon which the generative products are developed. The nervous system is formed of two supracæophageal plates, of a collar, and of a ventral chain placed immediately beneath the epidermis and very easily studied in transverse sections. The segmental organs are straight and ciliated throughout. *L. erythrophthalma* contains mature ova and perfectly active spermatozoids as early as the end of April.

I shall describe in more detail the anatomy of this interesting type; but I wish to dwell at present upon the affinities which it presents to an important family of the Chaetopoda, the Opheliidae, affinities already foreseen by M'Intosh, and which appear to me to be at least as great as those of the Polygordians with *Saccocirrus*, put forward by Uljanin.

The type *Polygordius* is not, as has been said, an intermediate type of worm; it is an archaic and aberrant type of Annelid.

Polygordius is not a type intermediate between the Annelids and the Nematodes. The resemblance to the Nematodes consists solely in the general arrangement of the musculature, and especially in the excessive development of the longitudinal muscular lamellæ, from which result a very peculiar habit and a characteristic mode of progression. But the same arrangement exists in certain Annelids (*Polyophthalmus*), the movements of which are modified in a similar way; it is a character due to a convergence easily explained by adaptation to special surroundings.

Nor is *Polygordius* an intermediate type between the Annelids and the Nemertians, the relationship of which to the Gymnotoeca appears to me exceedingly problematical. The vibratile cephalic pits of the Polygordians are by no means comparable to those of the Nemertians. Similar vibratile organs, fixed or exsertile, exist in Annelids belonging to the most various families, such as *Staurocephalus Chiajii*, Clap., *Podophylax veruger*, Clap., *Syllis similima*, Clap., *Aricia Erstedtii*, Clap., *Utenodrilus pardalis*, Clap., *Ammotrypane aulogaster*, Rathke, *Ophelia*, &c.

The absence of external vibratile cilia in the Polygordians, of which the digestive tube is ciliated internally throughout its whole length, is explained by the thickening of the cuticle and the great development of the musculature. The cuticle of *L. erythrophthalma* bears from place to place traces of ciliary tufts analogous to those of *Polyophthalmus*; and I should not be at all surprised if we were to find among the Polygordians types strongly ciliated externally. The Staurocephalidae, the embryonal form of which is not without analogy with the Polygordians, present a complete ciliary covering in certain species (*Prionognathus ciliatus*, Keferstein).

The absence of setæ in a Chaetopod need not surprise us more than the absence of articulated limbs in certain Arthropods (*Sacculina*, *Cryptoniscus*, &c.). We may trace the gradual disappearance of these organs in the series of the Opheliidae, from *Ophelia* to *Polyophthalmus* and *Ammotrypane*, certain species of which, described by M'Intosh, are almost certainly destitute of setæ.

The organization of the *Polyophthalmi* scarcely differs from that of *Limnotrypane*. At Concarneau I studied a large *Polyophthalmus* (0·3 metre and more) common among the Corallines and *Melobesia*, which I identify provisionally with *P. pictus*, Dujardin. The form of the mouth, the vibratile apparatus, the appendage of the pharynx, the anal papillæ, the ventral furrow, and the general arrangement of the musculature perfectly remind one of what exists in *Limnotrypane*. The resemblance is still greater if we compare two transverse sections suitably chosen.

In *Saccocirrus* the arrangement of the muscles and especially that

of the nervous system are far from presenting the same analogy. We find in it, in fact, two lateral nervous trunks such as exist in many groups of Tubicolar Annelids, and not a median chain like that of the Polygordians. The segmental organs also present considerable differences.

It would be very desirable to determine by an embryogenic investigation the exact degree of relationship of the Polygordians and Opheliidæ, which comparative anatomy leads us to suppose is very close. The embryo of *Polygordius* is an embryo of a primitive Annelid, a typical *Trochosphæra*. We have no information as to the embryogeny of *Polyopthalmus*. The supposed embryos of *Ophelia*, described and figured in a recent memoir, are unfortunately only embryos of *Arenicola piscatorum*.—*Comptes Rendus*, August 9, 1880, p. 341.

The Starfishes of the deeper Parts of the Gulf of Mexico.

By M. E. PERRIER.

For two consecutive years Mr. Alexander Agassiz, on board the 'Blake,' has performed a series of dredgings in the deep parts of the Gulf of Mexico. He has obtained the most brilliant results, and has done me the honour to confide to me the task of studying and describing the numerous starfishes that he has collected, forming a collection of more than 300 specimens. I beg leave to submit to the Academy, in a few words, a summary of my researches.

Luidie, *Archasteres*, and *Goniasteridæ* form the basis of this important fauna; but we also find in it *Linckie*, *Echinasteres*, *Solasteres*, and several *Pterasteres*; and the great division of the *Asteriadæ* is represented by some exceedingly remarkable forms, to which I shall devote this first notice. In 1874 Wyville Thomson described, under the name of *Zoroaster fulgens*, a starfish of the section *Asteriadæ*, which was met with only once in the Atlantic by the 'Challenger,' at a depth of 767 fathoms. The genus *Zoroaster*, which is distinguished in the family to which it belongs by the thickness and regularity of the skeleton of the starfishes included in it, is represented in the collection of Mr. Alexander Agassiz by two new species, to which I propose to give the names of *Zoroaster Sigsbeeii* and *Z. Ackleyi*, in honour of the captain of the ship and his lieutenant. *Z. Sigsbeeii* is at once distinguished by the considerable projection made by the enormous ossicles of its disk, which is thus rendered clearly distinct from the arms and comparatively voluminous. The arms, which are nearly rigid, are conical; and their skeleton consists of nine regular series of square ossicles. In *Z. Ackleyi* the ossicles of the disk are not salient, the disk is continuous with the arms, which are about twelve times as long as its radius, so that the animal has the physiognomy of a *Chætaster*. These arms are much more mobile than those of the other species, and are formed of seventeen rows of rather small ossicles. In the two species which I have before me the plates of the ventral region of the arms are covered with small flattened spines placed close together and intermixed with larger spines, so as to recall to mind the covering of the ventral surface of the *Luidie*; the adambulacral plates even bear, as in the latter, a comb of compressed spines, the direction of which is perpendicular to that of the ambulacral groove, and the innermost of which is

recurved like a sabre, as in the *Astropectinidæ*. The ambulacral tentacles are quadriserial at the base of the arms, but biserial at the extremity—which is an additional proof how artificial is the old division of the *Asteriæ* adopted by Müller and Troschel. These tentacles are terminated by a very small sucking-disk, which still further approximates *Zoroaster* to *Luidia*; they are intermixed with small straight pedicellariæ (*pédicellaires droites*): we may give the same name to some of these organs disseminated between the dorsal plates. The *Zoroasteres* were brought up by the dredge in sight of St. Kitts, from depths varying between 120 and 321 fathoms.

The starfish for which I propose the name of *Hymenodiscus Agassizii* is still more remarkable. I have examined two specimens which together complete the characters: one is a perfect disk, but destitute of arms; in the other the arms are well preserved, but the disk is perforated in the centre. They were collected in sight of Dominica, at depths of 321 and 450 fathoms. These are very delicate starfishes, which constitute an intermediate type very differently marked from the celebrated *Brisingæ* of Asbjörnsen. The *Hymenodisci*, in fact, resemble the *Ophiuri* in their rounded disk, clearly distinct from the arms, which are slender, elongated, mobile, and provided with a lateral row of spines like those of these animals, and likewise seem to serve only as organs of locomotion. But these arms are twelve in number, while there are never more than seven in the *Ophiuri*, and very generally only five. The disk is flattened, very thin, and destitute of a skeleton; so that it is represented only by a transparent membranous circle stretched upon the circle formed by the whole of the first ossicles of the arms, and almost in contact with the buccal membrane. The stomach has hardly more space for its lodgment than the thickness of a sheet of paper; and one is puzzled to know what can be the usual food of an animal so constructed. Spicules in the form of fenestrated calcareous plates, each bearing a small spine, are disseminated in the substance of the dorsal membrane. Through its walls one can clearly perceive the circular canal which surrounds the mouth, and the ambulacral vessels which start from it and penetrate into the arms, terminating at their extremity, and giving origin in their course to only a double row of ambulacral tubes. I have found no trace of the long cæcal processes which the stomach sends forth into the arms in all the *Stellerida*; and, unfortunately, I have been unable to observe the genital glands in the individuals that I possess; but from this we must not conclude that these glands are developed in the disk in *Hymenodiscus* as in the *Ophiuri*.

The skeleton of the arms is very simple and of a very peculiar structure. It is formed of four series of pieces. The two median series form the dorsal ridge; they are produced laterally into a sort of shield which partially covers the pieces of the two lateral series. The latter alternate with the preceding, and form the border of the ambulacral furrow; each of them bears in its middle a long lateral spine, covered by a soft sheath, inflated into a club, and having at its apex a tuft of pedicellariæ. These are crossed pedicellariæ (*pédicellaires croisées*), characteristic, as I have shown in previous memoirs, of the great division of the *Asteriadae*.

These four series of pieces form a groove in which the ambulacral

vessel rests, exactly as the ambulacral vessel of the *Comatulæ* rests in the furrow of the arm-skeleton. *The ambulacral pieces hitherto absolutely characteristic of the class Stellerida are deficient in the Hymenodisci.* A few irregular calcareous trabeculæ uniting the lateral pieces of the arm-skeleton are their sole representatives in the neighbourhood of the mouth. It is to be noted that the characters furnished by the pedicellariæ have survived the characters furnished by the constitution of the ambulacral groove, which has hitherto been regarded as typical; and this is a confirmation of the value which I thought ought to be attached to the pedicellariæ in the classification of the starfishes when I proposed to substitute the indications furnished by them for those derived from the number of rows of ambulacral tubes, which had been depended on by Müller and Troschel. The absence of ambulacral pieces, and of calcareous pieces covering the groove on the oral surface of the arms, does not allow us to compare the organization of the arms of *Hymenodiscus* except to that of the arms of the *Comatula*. The contrast between the arms and the disk, and the probable absence of genital glands and digestive cæca from the arms, on the other hand, approximate the *Hymenodisci* to the Ophiuri; by the absence of ambulacral pieces, and consequently of buccal pieces, they depart from all known Stellerida; their pedicellariæ, however, indicate that they constitute an aberrant form of the division of the Astერიadæ, in which they take their place, but as a distinct family, by the side of *Labidiaster*, *Pedicellaster*, and *Brisingæ*, which, like them, possess only two rows of ambulacral tubes. *Labidiaster* has a much greater number of arms; *Pedicellaster* has only five; the *Brisingæ* from eleven to twelve, but quite differently constructed. These latter animals, in fact, enter without any difficulty into the ordinary type of starfishes, of which the *Hymenodisci* constitute a form quite different from any thing hitherto known to us, and presenting the most exceptional characters.—*Comptes Rendus*, Aug. 30, 1880, p. 436.

On Gastrosaccus spinifer. By THOMAS R. R. STEBBING.

During the present month of August I have been successful in finding *Gastrosaccus spinifer* of both sexes at Whitby, in the sand at low water. I have also had the opportunity of seeing specimens and mountings of the species in Mr. Norman's very extensive collection of Crustacea. Mr. Norman has called my attention to the erroneous formation of the specific name *spiniferus*, which must of course be written *spinifer*. There can, I think, be no doubt whatever that the name *G. sanctus* must be confined to the species described by Sars under that title, as quite distinct from the present *G. spinifer* of Goës. At the same time, one of Mr. Norman's dissections, which agrees exactly with a subsequent one of my own, seems to show decidedly that the marsupial pouch is attached to the first pleopods, contrary to the criticism of Prof. G. O. Sars, who denies the attachment of the marsupium to the first pleon-segment. It may be further remarked that the number of spines on the telson and uropods appears to be subject to slight variations in different specimens.

Tunbridge Wells, Aug. 31, 1880.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 35. NOVEMBER 1880.

XLI.—*On the Minute Structure of the Recent Heteropora neozelanica, Busk, and on the Relations of the Genus Heteropora to Monticulipora.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E.

PART I.

THE genus *Heteropora*, De Blainville †, has long been known to palæontologists as comprising a number of Jurassic, Cretaceous, and Tertiary fossils which have been generally, and are now universally, referred to the Polyzoa. Though the fossil species are abundant in certain deposits and are widely distributed, it is only quite lately that we have become acquainted with any recent forms of the genus. The first account of these was given by Mr. A. W. Waters (Journ. Roy. Micr. Soc. vol. ii. p. 390, pl. xv. 1879), who describes and figures a Japanese species under the name of *H. pelliculata*, sp. nov., and an Australian species under the name of *H. cervicornis*, d'Orb., sp. Very shortly after the publication of the paper just alluded to, Professor Busk described (from specimens which I had previously forwarded to him) another recent type of *Heteropora* from the seas round New Zealand, giving to it the name of *H. neozelanica* † (Journ. Linn. Soc. vol. xiv. p. 724, pl. xv. 1879). We have therefore now a

* Man. d'Act. p. 417 (1834).

† Mr. Waters informs me, in a letter, that, having examined specimens which I had sent him, he is of opinion that *H. neozelanica*, Busk, is identical with his *H. pelliculata*, the latter having the priority.

knowledge of the skeleton of excellently preserved recent and fossil species of *Heteropora*, though we are still unfortunately in total ignorance of the structure of the soft parts.

My own object in writing the present paper is quite a special one, and arises from the fact that the genus *Heteropora*, apart from its own intrinsic interest, has a peculiar importance in the eyes of palæontologists, owing to the well-recognized and remarkable external resemblance which it exhibits to the Palæozoic genus *Monticulipora*, d'Orb. So striking is this resemblance that very high authorities have employed it as one of their principal arguments for the removal of *Monticulipora* and its allies bodily to the Polyzoa, a transference which has been actually carried out in some works of great weight (as, for example, in Prof. Zittel's admirable 'Handbuch der Palæontologie,' vol. ii. Lief. iv.). Not being myself, at present, prepared to acquiesce in the removal of *Monticulipora* to the Polyzoa, and being in possession of sufficient specimens of the recent *Heteropora neozelanica*, Busk, I determined to investigate for myself how far the resemblance between the two genera might extend as regards the details of their *internal structure*. With this view I prepared a series of thin sections of *H. neozelanica*, and have carefully studied these and compared them with precisely corresponding sections of various species of *Monticulipora*. In the present paper, then, I propose to give an account of the minute structure of the above-mentioned species of *Heteropora* and of two different types of *Monticulipora* (selected for different reasons), comparing these with one another, with the view of ascertaining how far they may agree with, or differ from, one another in fundamental characters. Before proceeding to this, however, it may be advisable to make a few very brief and general remarks on the genus *Heteropora*, and also to give a short account of the external characters of *H. neozelanica*, Busk.

The genus *Heteropora* is thus defined by Prof. Busk in his classical 'Monograph on the Fossil Polyzoa of the Crag' (1859):—

"Polyzoarium erect, cylindrical, undivided, or branched; surface even, furnished with openings of two kinds; the larger representing the *orifices* of the cells, and the smaller the *ostioles* of the interstitial canals or tubes."

The essential character of the genus is thus the possession of a skeleton made up of *two* kinds of tubes, larger and smaller, the latter being the most numerous. The former have always been regarded as the proper *zooecia*; but the relations of the interstitial tubes or "*cancelli*" to the rest of the organism

have not been as yet satisfactorily established, though they have been usually regarded as serving in some way to place the cavities of the polypides in direct communication*. With regard to the internal structure of the genus, the existence of cross partitions or "tabulæ" in the tubes was long ago pointed out by Jules Haime, as regards his *H. conifera* and *H. pustulosa* (Mém. de la Soc. Géol. de France, vol. v. p. 208, 1854). Mr. Busk ('Crag Polyzoa,' p. 122) pointed out that the cancelli enter not at all or rarely into the central axis of the branches of the skeleton, this being made up of the thin-walled and polygonal proper zoëcia. The same observer also pointed out that the "ostioles," or apertures of the cancelli, are often "completely closed by a calcareous depressed lid, which in the majority of cases, however, is perforated in the middle;" and he expressed the belief that "the remains of these hymen-like lids," left behind at successive stages of growth, might probably account for the existence in the interstitial tubes of some species of "partial transverse, nearly equidistant septa," giving to the tubes in question a "peculiar moniliform aspect." Mr. Busk further indicated that in one species of the genus (viz. *H. clavata* of the Crag) "the interstitial orifices, or many of them, exhibit a stellate appearance, owing to the projection into their interior of numerous minute rays; affording thus another curious, false resemblance to a true coral." With this exception, nothing which could be compared with the "septa" † of the Cœlenterata has

* As the difference between the cancelli and the proper zoëcia is one of size and shape merely, and as both sets of tubes are precisely alike in their internal structure, it may be regarded as tolerably certain that the former were occupied by a set of zoöids essentially similar to those inhabiting the zoëcia, but modified or specialized in some way. On this view, the colony would be a truly dimorphic one. As for the perforated calcareous or chitinous opercula covering the mouths of the cancelli in parts of the skeleton (as described by Waters), we may suppose that these do not exist to begin with, but that they are developed in the last stages of the life of the zoöid, and that they are produced successively from below upwards as the area of active vitality is successively carried further from the fixed base of the organism (as we see to be the case in the coralla of various species of *Favosites*).

† Professor Busk, in his descriptions of the species of *Heteropora*, frequently employs the term "septa" to indicate the *transverse* plates which intersect the tubes of certain forms of the genus. Mr. Waters has followed Prof. Busk in this, or has sometimes employed the term "dissepiments" for the same structures. It need hardly be pointed out that these terms have such a totally different significance among the Cœlenterata, that their use in this connexion is undesirable, and is apt to lead to confusion. The term "*septa*," in fact, should be in all cases confined to the *radiating* and *vertical* elements of a calcareous skeleton; and the plates so named in *Heteropora* are the analogues of the "*tabulæ*" of the Cœlenterates.

hitherto (so far as I am aware) been noticed as occurring in *Heteropora*.

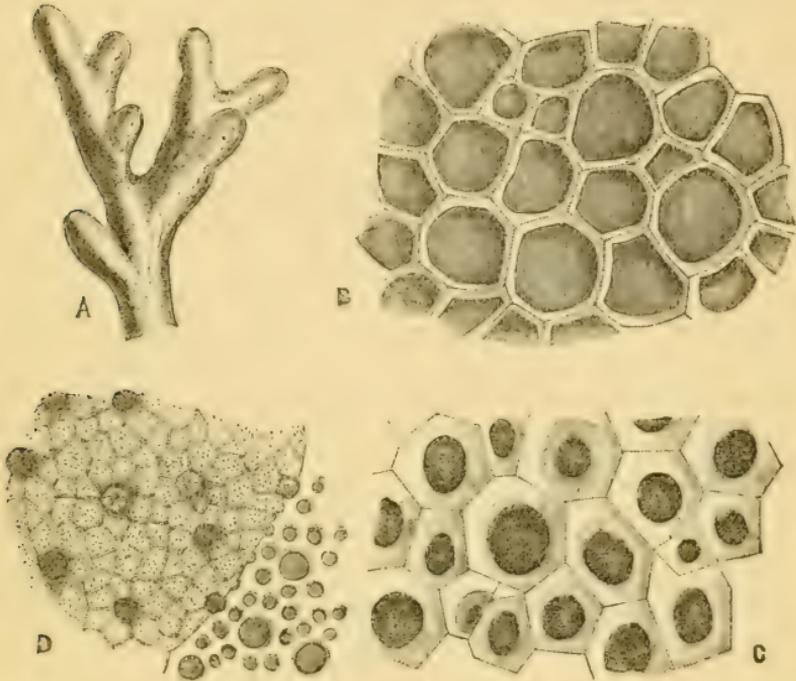
The above are the most important structural features which had been brought to light by the study of the fossil species of *Heteropora*; but our knowledge of the anatomy of the genus has been greatly extended by the investigation of recent species by Mr. Waters and Prof. Busk, as already referred to. The leading additional character which has been thus brought to light is that the walls of the zoecia and cancelli (in the outer portion of their course) are perforated by numerous canals, which open into the cavities of the tubes by well-defined circular openings, thus placing contiguous tubes in direct communication.

Having now shortly passed in review some of the more important characters of *Heteropora*, so far as our present inquiry is concerned, I may next give a short account of the general features of *H. neozelanica*, Busk, before describing in greater detail its minute internal structure. The zoarium of this species (fig. 1, A) is "erect, composed of short divergent branches springing from a short thick stem, and soon dividing once or twice dichotomously, and terminating in blunt rounded extremities. The diameter of the primary branches is $\cdot 2$ inch, and of the terminal ones about $\cdot 1$ to $\cdot 15$ inch. The surface presents orifices" (see fig. 1, B and C) "of two kinds, though scarcely distinguishable in size. The larger ones, in the older parts of growth, have a slightly raised peristome and are quite circular; the others (*cancelli*), disposed more or less regularly round these, generally to the number of seven or eight, are more or less angular, and the border of the opening is never raised" (Busk, *loc. cit.*).

Mr. Busk considers his *H. neozelanica* to be probably distinct from *H. pelliculata*, Waters, on the ground (1) of certain differences in the general form of the polyzoary, and (2) of the absence in the former of any external calcareous pellicle covering the surface, though there exists, in perfectly preserved parts of the specimen described, a thin chitinous covering closing the mouths of the tubes. Mr. Waters, as before remarked, is inclined to believe that the two forms are identical, in which case the name *H. neozelanica* will have to be abandoned. In fig. 1, B and C, I have figured the two states of the surface which my specimen of *H. neozelanica* exhibits, one of these being a reproduction of the excellent figure given by Prof. Busk (*loc. cit.*). I have also reproduced the figure given by Mr. Waters of the surface of *H. pelliculata*, as it shows characters which merit a moment's attention in this connexion. The left-hand portion, namely, of this

figure (fig. 1, D) shows the mouths of the interstitial tubes or cancelli, as well as some of those belonging to the proper zoecia, to be closed by a thin calcareous pellicle, which is left after incineration, and which exhibits the peculiarity that it is perforated with numerous minute apertures opposite to the mouth of each of the interstitial tubes. The

Fig. 1.



A. A fragment of the polyzoary of *Heteropora neozelanica*, Busk, of the natural size (original). B. A portion of the surface of the same, apparently somewhat altered by maceration in sea-water, greatly magnified (original). C. A portion of the surface of the same (copied from Busk), apparently in a more nearly natural state, greatly magnified. Both B and C show the apertures of the zoecia and cancelli. D. Portion of the surface of *H. pelliculata*, Waters (copied from Waters), enlarged 25 times, and showing the zoecia and cancelli. In the upper part of the figure the cancelli (and the zoecia partially) are closed by a calcareous pellicle, which is wanting on the right-hand side of the figure.

right-hand portion of the same figure shows the character of the surface, where the pellicle just alluded to has been removed. There can be no question that the existence of such a calcareous (or more usually chitinous) surface-pellicle, closing the cell-mouths, is a feature which speaks strongly for Polyzoan affinities; but it should not be entirely lost sight of that very similar structures occur in certain extinct types

which would almost universally be referred to the corals, and which, at any rate, are very unlike the ordinary forms of Polyzoa. Thus it is well known that various species of *Favosites* (such as *F. Forbesi*, Ed. and H., var. *tuberosa*, Rominger, *F. turbinata*, Billings, and *F. clausa*, Rominger) are liable to have the mouths of the corallites closed by a calcareous pellicle, which may cover a large part of the surface of the colony.

It only remains to add, with regard to the general external characters of *H. neozelanica*, that the mouths of the tubes, even when fully exposed by maceration in sea-water (as in fig. 1, B), do not appear to show any signs of radiating spines ("septa"), though, as will be subsequently seen, such really exist in the interior of the cells. It may also be noted, as compared with any ordinary Monticuliporid, that though the skeleton is clearly dimorphic, in the sense that it is made up of two sets of tubes, the difference between the large tubes (zoecia) and the small ones (cancelli) is small and sometimes hardly recognizable. The cancelli, in fact, are often nearly or quite as large as the proper zoecia (see fig. 1, B and C); and the chief distinction between them rests upon the generally more clearly angular shape of the former, and upon their mouths not being at all raised above the general surface.

*The minute Structure of the Skeleton of Heteropora
neozelanica, Busk.*

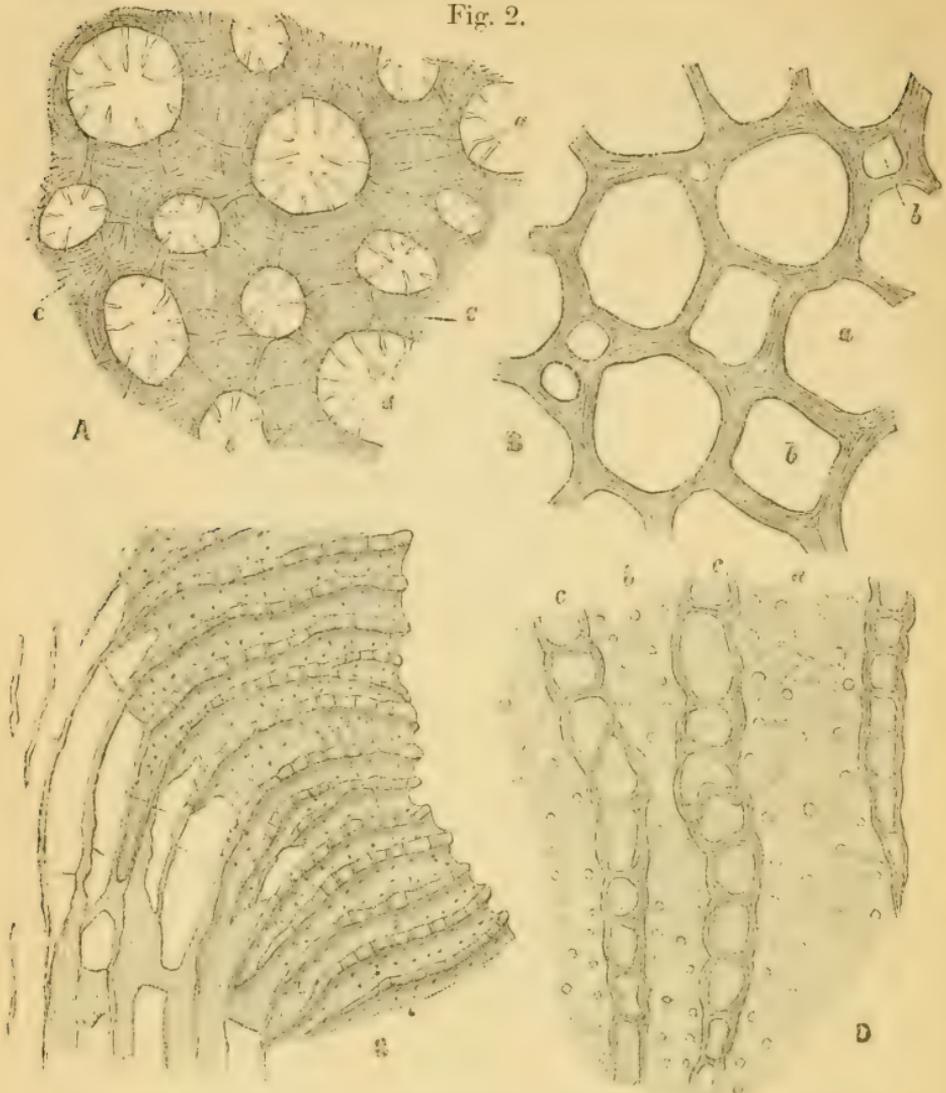
The skeleton of *H. neozelanica*, as of the species of *Heteropora* generally, is ramose or dendroid; and the branches resemble those of many similarly shaped corals in being composed of fasciculate tubes which are nearly vertical in the axis of the branch, but ultimately bend outwards to reach the surface. We can thus divide each branch into an *axial* and a *peripheral* or *cortical* portion; and not only do the tubes in these two portions of their course differ in *direction*, but they are markedly different (as we shall see) in their actual *structure*. That is to say, the structure of any particular tube is exceedingly different, according as we examine it in the axial or in the cortical part of its course. However, it is in the cortical portion of the skeleton alone, or almost alone, that the interstitial tubes are developed, the axis consisting wholly, or almost wholly, of the proper zoecia. We cannot, therefore, arrive at a proper understanding of the true structure of *Heteropora* (or of any similarly constructed skeleton) without making *three* distinct sections, viz. :—one parallel to the surface *and just below it*, which we may call *tangential*, and which is the most important of all, as giving us the cross

section of the tubes in their final and most fully developed condition; secondly, one at right angles to the branch (a *transverse* section); and, thirdly, a *longitudinal* section, dividing the branch vertically through its median plane. The following are the principal points brought to light by an examination of these three sets of sections in *H. neozelanica*:—

(a) *Tangential sections*.—As just remarked, there are no sections which yield more interesting and valuable results than those which intersect the skeleton tangentially, just below the surface upon which the tubes open. When we examine such a section (fig. 2, A) we observe that it is generally quite possible to distinguish the proper zoecia from the interstitial tubes by their size, but that these two sets of tubes are in no way distinguished from one another in point of structure, while their dimensions are often very nearly the same. The tubes are all rounded; and their walls are very thick, and are composed of delicate calcareous laminae arranged concentrically around the cavity, and not showing any line of demarcation between each other. In this respect the walls have the structure of such species of *Monticulipora* as *M. ramosa*, *M. Jamesi*, &c., and differ altogether from such other species as *M. pulchella*. The most remarkable feature, however, in the structure of the wall consists in the presence of numerous canaliculi, which pass transversely across the thickened wall (fig. 2, A) and open at both ends by wide funnel-shaped apertures into the cavities of the tubes. In this way the zoecia and interstitial tubes are placed in direct and free communication with one another throughout the entire colony. Sections of this nature also prove with absolute certainty that these canaliculi are strictly confined to the *walls* of the tubes—a point upon which, as will be seen, longitudinal sections might leave us in some doubt.

Another very interesting and important point brought out by tangential sections is that both the zoecia and cancelli are provided in this part of their course with numerous delicate radiating spines, which spring from the wall (fig. 2, A) and are directed inwards for a longer or shorter distance, usually falling short of the centre. I am not aware that the presence of these radiating spinules has hitherto been recognized as occurring in the recent *Heteropora*, or in the extinct forms, except in *H. clavata*, Goldf. (according to Busk), and then only at the mouths of the interstitial tubes. In *H. neozelanica* they are very slender and delicate, and often break up in thin sections, so that they may appear to be wanting in a greater or less number of the tubes; but I have never failed to recognize their existence in some part or another of tangential

Fig. 2.



Thin sections of *Heteropora neozelanica*, Busk (recent). A. Part of a *tangential* section taken just below the actual surface, enlarged fifty times. The zoecia are cut across in their outer thickened portion; and the canaliculi traversing their thick walls and communicating with the smaller interstitial tubes are well shown, as are the delicate radiating spines projecting into the cavities of both the sets of tubes. B. Part of a *transverse* section of a branch, showing the thin-walled angular condition of the zoecia in the *axis* of the stems, the comparative paucity of interstitial tubes, and the total or almost total absence of connecting canaliculi in this region (enlarged 50 times). C. Part of the median *longitudinal* section of a branch (enlarged 18 times), showing principally the outer thickened portions of the zoecia. The section shows distinct cross-partitions (or "tabulae") crossing the cavities of the tubes towards the deeper parts of the branch, as also the canaliculi crossing the walls, and the pores representing the openings of these on the backs of the tubes. D. Part of a *transverse* section in its outer portion, where the zoecia are laid open *longitudinally* (enlarged 50 times). The section shows the peculiar structure of the thickened walls and the canaliculi crossing these. A few of the delicate radiating spines are also seen. *aa*, the proper zoecia; *bb*, the interstitial tubes; *cc*, the walls, with the connecting canaliculi.

sections, and have no doubt that they are in this species really present throughout the whole of the peripheral part of the skeleton. Their special interest arises from their being in appearance precisely similar to the "septal spines" of so many species of *Favosites* (using the term "septal" in its proper signification).

(b) *Transverse sections*.—The appearances presented by transverse sections vary according to the part of the section which may be looked at. The central portion of such a section exhibits the tubes in the axial portion of the branch divided at right angles. In the circumference of the section, on the other hand, the tubes are divided more or less nearly longitudinally, owing to their curvature on nearing the surface, while this part also shows them in the thickened condition which they possess in the cortical portion of the branch. The appearances presented by the periphery of transverse sections are therefore the same as those shown in the corresponding region in *longitudinal* sections, and need not be considered till we come to speak of the latter. In the central region of a transverse section (fig. 2, B) we can study the condition of the tubes in the axis of the branches before they bend outwards to the surface; and we find that their structure is very different from that which they possess in the cortical region (as seen in tangential sections). Instead of being rounded and thick-walled, and provided with a largely developed canal-system, they are now thin-walled, and angular or polygonal in shape, and the canaliculi of the wall seem to have totally (or almost totally) disappeared. There is also an apparent total absence of the radiating spines which are developed in the cortical part of the tubes. Lastly, the tubes in this region appear to be almost entirely, or entirely, referable to the proper zoecia, the interstitial tubes or cancelli existing only, or mainly, in the cortical region.

(c) *Longitudinal sections*.—These show precisely the same differences, as regards their central and peripheral portions, as have been already noted in transverse sections; but it is now necessary to briefly direct attention to both parts of the section (fig. 2, C and D). In the central portion of the section (supposing the slice to be taken in the median plane) the tubes are seen in the *axial* portion of their course, where they are nearly vertical, and where they exhibit the features which I have pointed out as characterizing them in the central region of transverse sections. That is to say, they are here provided with thin and delicate walls, in which the canal-system of the cortical region seems to be very slightly developed or wanting. The chief point to notice about the tubes

in this part of their course (and it is one that I have never failed to recognize) is that their cavities are here crossed by transverse calcareous plates or "tabulæ" (the "septa" of Prof. Busk and Mr. Waters), which, though few in number, are "complete" and in every way well developed* (fig. 2, C).

On the other hand, in the peripheral portion of their course (where the appearances are precisely the same as in the corresponding region of a transverse section) the tubes have very much thickened walls, and the walls are crossed at right angles by numerous canaliculi, which open at both ends into the cavities of the tubes by trumpet-shaped apertures. In all parts of the section, also, where the inner surfaces of the tubes are brought into view, these exhibit numerous rounded apertures or pores, which represent the mouths of the said canaliculi, and which have been well described and figured by Prof. Busk and Mr. Waters (*loc. cit.*). It is very difficult in the outer part of these longitudinal sections to distinguish between the proper zoëcia and the interstitial tubes or cancelli, their size being very much the same, and their internal structure being exactly alike; and this leads me to make a few remarks upon another point. When, namely, such a section as I now speak of is examined with the $\frac{1}{4}$ -inch objective, it is seen that the wall separating contiguous tubes exhibits a central light space, limited on both sides by dark and definite boundaries, and crossed by the transverse canaliculi which have been already described (fig. 2, D). There is thus created an appearance of a central tube in the interior of the wall; or, rather, what I have here described as the *wall* might possibly be taken to be really *one of the smaller interstitial tubes divided longitudinally*. Apart, however, from the difficulty of conceiving how the canaliculi could be continued across and through the *cavity* of an interstitial tube, we have in tangential sections, as previously remarked, the conclusive proof that this is not the case, but that we really have to deal with the wall of the tubes. These sections, in fact

* Transverse partitions or "tabulæ" are well developed in various other Polyzoa (e. g. *Entalophora*, *Ceramopora*, and *Heterodictya*), but, of course, cannot be homologous with the "tabulæ" of the Coelenterates. In a recent number of the 'Annals' (ser. 5, vol. vi. p. 244) Mr. Carter announces the discovery of transverse partitions or "tabulæ" in the well-known "stellate canals" of a *Stromatopora*, and adds that it is at once thus "proved that the *Stromatopora* could not have been sponges and that they were *Tabulate Corals*." This conclusion could only have been penned by Mr. Carter by inadvertence, since "tabulæ" occur not only in many corals, but also in various Hydroids, and, as just remarked, in several unquestionable Polyzoa, to which last group some good observers have referred the *Stromatoporoids*.

(fig. 2, A), prove, beyond a doubt, that the canaliculi are entirely confined to the *walls* separating contiguous tubes, whether these be the proper zoëcia or the cancelli.

So far as I have seen, no "tabulæ," or but an occasional one, seem to be developed in the outer thickened portion of the tubes; but it is often possible to recognize the delicate radiating spines or "septa," which are so well displayed in tangential sections. Lastly, owing to the unequal thickening of the walls of the tubes, it is not uncommon for the longitudinal section of their cavities to assume a beaded appearance, though this is not constant, and, when present, varies much in amount.

[To be continued.]

XLII.—On *Stromatopora dartingtoniensis*, *n. sp.* with *Tabulation in the Larger Branches of the Astrorhiza*.
By H. J. CARTER, F.R.S. &c.

[Plate XVIII.]

IN 1878 I made the following statement, viz. :—" Thus in all essential points the structure of *Caunopora placenta* was the same as that of *Millepora alcicornis*," &c. ('Annals,' vol. ii. p. 313). I also stated that, in *Millepora alcicornis*, "the axial [structure], which in the transverse fracture only appears to be a cribriform surface, is now [in the opposite direction] found to be composed of longitudinal tubes in juxtaposition, more or less interrupted by tabulæ, and more or less pierced with holes by which they communicate with each other" *ibid.* p. 308). In 1879 I found that neither of these statements was tenable, but that the tubes of *Caunopora placenta* belonged to a separate organism, and that the "axial structure" was *Favosites Forbesii* (not *gothlandicus*, as first stated), over which the *Caunopora* had grown.

This year (1880) an article by Dr. F. Roemer has appeared in the 'Geological Magazine' for the month of August, in which the author states (p. 345) that "*Caunopora* of Phillips is not a good genus, but is founded on masses of *Stromatopora* which are perforated by vertical tubes not essentially belonging to *Stromatopora*," which tubes Dr. Roemer considers a form of *Aulopora repens*, having previously noticed what he published in 1844, viz. "that *Caunopora placenta* of Phillips was nothing else than *Stromatopora concentrica*" (p. 344); now, however, he adds, "My own observations confirm entirely the statement that the

tubes have not the internal structure of *Syringopora*, but are hollow, and therefore cannot belong to that genus" (*l. c.*).

His original statement, however, best accords with the observations I made last year (before I knew what Dr. Roemer had published in 1844, 'Das Rheinische Uebergangsgebirge,' p. 57), viz. that Mr. Champernowne had shown me specimens of the so-called cyathophylloid coral (*Battersbya*) and *Syringopora*, respectively enveloped in *Stromatopora*, like the tubes of the so-called *Caunopora* ('Annals,' vol. iv. p. 102).

Again, these "tubes," although often apparently "hollow" (from the *homogeneous* crystalline character of the calcspar filling them), as stated by Dr. Roemer, yet sometimes, as my specimens show, present not only infundibuliform tabulæ, like those of *Syringopora*, but horizontal ones like those in *Millepora alcicornis*, as figured in 1877 ('Annals,' vol. xix. pl. viii. figs. 21-23)—a combination in *Syringolites huro-nensis*, Hinde, to which Dr. G. Steinmann has lately called attention as "scarcely" differing from *Syringopora infundibulifera*, Goldf. (Neues Jahrbuch f. Mineral. Geol. u. Paläont. Jahrgang 1880, Band i. p. 435, with illustration); hence Roemer's original statement might not have been altogether wrong. Still I have one specimen from "Pit-Park Quarry" in which the *Stromatopora* surrounding a Cyathophylloid coral is so densely charged with *Aulopora repens*, var. *minutula*, Goldf., that it appears unmistakably, weathered out on the surface, in its genuine double branching form.

Caunopora, therefore, having been found to be no genus, but a compound of *Stromatopora* and *Aulopora repens*, renders (as I have before stated) a description of *Stromatopora* much more simple, which is thus reduced to the basal structure and the stellate venations, in the larger branches of which I have lately found the tabulæ which it is my object now to describe. But before doing so it is also desirable that we should first direct our attention to the nature of "tabulæ" generally, and then as they appear in the tubular spaces of that living organism which is the nearest yet found to *Stromatopora*, viz. *Millepora alcicornis*.

The term "tabulæ" has been given to those portions of the cœnenchyma which traverse the tubular structure of the so-called "Tabulate Corals" (ex. gr. *Favosites*). They are formed *pari passu* with the growth of the tubes that in juxtaposition follow a concentric laminated development of the coral, which is thus made up of them, so that in a vertical section the tabulæ appear to correspond with the laminæ of

the coral: but it is not so really; for on closer examination they will not only be found to be more or less *inequidistant*, but often more or less oblique, showing that the growing surface of the coral must have always been so far irregular or pitted; hence the tabulæ in the tube of *Favosites* &c., although generally, are not always equidistant, and are often more or less oblique. This irregularity is well illustrated in Mr. Berjeau's faithful drawings at the end of Nicholson's valuable work on the Tabulate Corals of the Palæozoic Period (Blackwood and Sons, Edinb. 1879); while sometimes they are scarcely, if at all, distinguishable from the rest of the homogeneous transparent calcspar which fills the tube. It is necessary to remember all this; for it will tend to explain what may hereafter be stated of the tabulation in the "stellate venation," or *astrorhiza*, of *Stromatopora*, viz. the irregular disposition of the tabulæ as regards distance, direction, and definition, they being sometimes, although present, undistinguishable from the rest of the calcspar filling the tubes.

Astrorhiza.—In my paper "on the Structure of *Stromatopora*" ('Annals,' 1879, vol. iv. p. 258) I have described the stelliform parts of the cœnosarcal cavities under the head of "stellate venation;" but this term is not sufficiently expressive for the defined and characteristic feature which this part of the cœnosarcal structure *generally* presents; hence I shall hereafter substitute for it "*astrorhiza*," as fulfilling the purpose better, at the same time that it is more in accordance with the term "*hydrorhiza*," already applied to the root-like or originating portion of Hydroid Zoophytes; for the *astrorhiza*, according to my view, is homologous with the "stolon-like tubulation," which is put forth from the embryo of *Hydractinia echinata* for the development of the individual, whose horny structure or cœnenchyma is formed upon a filament of the same kind of cœnosarc as that which *pari passu* covers its exterior and produces the polypites ('Annals,' 1877, vol. xix. p. 46, pl. viii. fig. 3c, &c.), whereby the *astrorhiza* becomes in plurality (Pl. XVIII. fig. 2, *aaa*) the origin of each lamina of the *Stromatopora*, through which the whole mass is finally produced.

Those who have read Mr. H. N. Moseley's admirable paper "On the Structure of *Millepora*" &c. (Phil. Trans. 1877, vol. clxvii. pt. 1, p. 117) must have observed (at p. 125) that he uses the term "*hydrophyton*" for the *whole* of the cœnosarc in *Millepora* as "*homologous with the hydrorhiza of other hydroids*;" but inasmuch as Mr. Moseley finds it necessary afterwards to make a distinction between the "main canals" and the smaller ramifying ones which con-

tain the basal or vermicular cœnosarc of *Millepora*, so in *Stromatopora* it becomes necessary to make a similar distinction; but the "main canals" here assuming for the most part a stellate form, in which the branches radiate from fixed points in the laminae successively, instead of meandering about irregularly as in *Millepora*, I propose henceforth to designate each group by the name of "astrorhiza," as above mentioned (Pl. XVIII. fig. 1, *ccc*). At the same time it should be remembered that, although the astrorhiza is so strongly developed in *Stromatopora dartingtoniensis*, there are other species in which it is so little differentiated from the general cœnosarcal structure that none but an experienced eye can detect its presence.

What, then, is the condition of the tabulæ in *Millepora alcicornis* (which so far may be considered the nearest living representative of *Stromatopora*)? Here they present themselves in the way above mentioned, in the tubular spaces extending from the axial structure of the branch through its cœnenchymal tissue to the circumference. I have said "spaces;" for the cœnosarc; from its extreme tenuity, almost wholly disappears on desiccation, when the tube itself is left as a mere excavation without wall in the midst of the cœnenchymal tissue; hence the cœnosarc of the latter is continuous with that which originally filled these tubular spaces, and but for the presence of the tabulæ, which act like so many diaphragms in dividing the space into separate compartments, the cœnosarc in them would be directly continuous throughout. In structure, composition, and size the tabulæ (often, however, provided with a stelli-form prolongation outwardly, as in *Tubipora musica*) are thin imperforate plates of calcspar, about 1-1800th inch thick, and, on an average, about 1-120th inch apart. Here, again, it is necessary to remember that the cœnosarcal cavities, which are vermiculate, open into the "tubular space" throughout, and therefore that the cœnosarc which originally filled the tubular spaces was continuous with the cœnosarc which filled the cœnosarcal cavities or vermicular channels of the cœnenchyma.

Thus we are prepared to follow out my description of the tabulation in the larger branches of the astrorhiza in *Stromatopora*, which I have no doubt will be received with much hesitation; but if I can show that, under certain circumstances, these tabulæ are left in the branches of the astrorhiza as they appear in the tubular spaces of *Millepora*, while all the rest of the calcspar has been removed, and that they are also to be seen in the midst of the calcspar filling the branches

of the astrorhiza in the more consolidated fossil, I do not see how we can come to any other conclusion than that, although the tabulation is not so evident or striking as that of *Favosites* &c., it nevertheless, under certain conditions, makes its appearance here and there in the large branches of the astrorhiza,—which is quite sufficient for our considering *Stromatopora* to have been a “tabulate coral.”

As announced in the last number of the ‘Annals,’ I, on the 26th July last, under the kind guidance of my friend, Mr. Champernowne, F.G.S., again visited “Pit-Park Quarry” (which is in the Devonian Limestone near his residence at Dartington Hall, Totnes), in quest of the species of *Stromatopora* to which I have before alluded as possessing the largest development of the astrorhiza (“stellate venation”) that has been published. This in due time we came upon; and splitting off some portions from the block, a fracture passed horizontally through the plane of lamination so as to divide a set of astrorhizæ also horizontally, and almost equally, so that they were visible on each surface of the fracture. It was observed, too, that they were more marked than usual, owing to a partial decomposition and removal of their contents, which rendered the branches more or less empty and of a light brown colour; but having no time then to examine them more particularly, the specimens were put aside until I came home (Pl. XVIII. fig. 2, *aaa*).

Returning, then, to the examination of this specimen at the beginning of August, I observed that not only had the contents of the branches of the astrorhiza been partially removed by decomposition, but in the greater number of the larger branches thin diaphragms of calcspar had been left, which, although a little more irregular in disposition and direction, presented the same appearance as the tabulæ in *Millepora alcicornis*, and about the same thickness, viz. 1-1800th inch (Pl. XVIII. fig. 3). Impressed, therefore, with this fact, yet not observing the plates in the calcspar filling the branches of the astrorhizæ in other parts where it had not been removed by decomposition, I sought for it in more consolidated specimens of other *Stromatopora*, wherein I felt convinced that I had seen something of the kind. So I repaired to Mr. Vicary’s large collection of polished slices at Exeter, to which I have before alluded; and showing him a fragment of the specimen from “Pit-Park Quarry” which presented the tabulated appearance above mentioned, he immediately and of his own accord picked out three different species in which it was unquestionably illustrated, observing that “when one knows what to look for, it is not difficult to find it.” This comparatively

independent evidence was of course more acceptable than if I had selected the specimens myself. I afterwards found, on polishing another specimen of a species of *Stromatopora* with curvilinear structure, that I had brought away from "Pit-Park Quarry" a much better illustration of it than in any other of a like kind.

Here it is necessary to state that, in all probability, the finding of a specimen of *Stromatopora* in which the calcspar usually filling the branches of the astrorhiza has been removed by decomposition, and the tabulæ left, is *very rare*, and that, even when it is found, the branches for the most part, not running along on the same plane, may only be partially exposed here and there in the horizontal section, so as to present but a few of the tabulæ with which they may be more or less traversed throughout. Then the irregular disposition of tabulæ, both as to distance and direction, is rather the rule than the exception, as may be seen by the illustrations of the "Tabulate Corals" at the end of Prof. Nicholson's magnificent book, to which I have before alluded; while the impossibility of distinguishing the tabulæ from the general mass of transparent calcspar with which the branches of the astrorhiza are usually filled, is illustrated by a similar occurrence sometimes even in *Favosites*, where they are generally so well marked.

When, however, we recur to the slices of more consolidated *Stromatopora* which are polished over the lamination, this tabulated structure in the branches of the astrorhiza is *not* so uncommon, if we know what to look for; but as, in *Millepora*, the astrorhizal venation of *Stromatopora* is, as it were, excavated in the cœnenchymal structure without wall, and the vermiculate channels of the cœnosarc freely open into the cavity of the branch, so in the horizontal section, which barely touches the branch, a number of holes may be observed along its course; but the fibre separating these must not be confounded with the tabulæ, nor must the extension of the cœnenchymal structure or filament across the branch be confounded with them; but we must look for a specimen in which the plane of the section has fairly taken off the whole of the surface of the branch, and then seek for white lines which traverse it *directly* (that is, without curvature) and *not* in continuation with the fibre of the cœnenchyma, when there will be little left for us to conclude than that such a structure must be owing to tabulation.

Although the fact may not bear directly upon the argument in favour of tabulation in *Stromatopora*, yet it may be observed that all the corals in the "quarry," which are more or

less enveloped in the *Stromatopora*, possess the tabulated character, so that if *Stromatopora* did not do so it would be an exception. Nor must it be fancied that the tabulae in *Stromatopora* and *Millepora* are totally different from what occurs generally in that family of the Hydroids to which I have likened the former. On the contrary they do occur, although in a modified form, in the Hydractiniidæ and in the annular constrictions of the flexible Hydroids, as I have already shown (*Ann. & Mag. Nat. Hist.* 1877, vol. xix. pl. viii. fig. 4, *g g*, and figs. 9 and 12).

Having thus described the tabulation in *Stromatopora*, let us now direct our attention to that species in which it first presented itself to my notice, since the astrorhiza here, in some instances, far exceeds in size the largest given by Baron Rosen, viz. that in *Stromatopora astroites* ('*Natur der Stromatoporen*,' Taf. ii. fig. 6; and '*Annals*,' 1879, vol. iv. pl. xv. fig. 1); so it is just possible that the Dartington species may not have been publicly noticed, and hence it is desirable to give its principal features, so far as they are at our command; but before doing so it will be as well to recall to mind what I stated and illustrated respecting the division of the cœnenchymal structure of the *Stromatopora* into "rectilinear and curvilinear," viz. that of course this was "subject to modifications which more particularly belong to the description of the *species* respectively" ('*Annals*,' 1879, vol. iv. p. 254). These "modifications" consist of the passage of one kind of structure into the other, so that the species in this respect may be more allied to the former than to the latter, and *vice versâ*. There is also a difficulty in getting the real or original *surface* of the species, chiefly on account of weathering and decomposition, whereby a most important distinction may be lost; while the general form may be influenced by that of the organism over which the *Stromatopora* may have grown (*ex. gr.* a branched coral)—just as at the present day a number of specimens of calcareous Polyzoa dredged in Bass's Strait for the Liverpool Free Museum, by Capt. Cawne Warren, have been found to derive their varied form from that of different kinds of sponges which they have overgrown. Hence it again becomes difficult to determine what the original form of a *Stromatopora* was, further than that, when not influenced in the way mentioned, it assumes a massive state of concentric lamination like that of any other coral of a like growth, exceeding sometimes two or three feet in diameter. Following is a description of what we know of the Dartington species:—

Stromatopora dartingtoniensis, n. sp.

(Pl. XVIII. figs. 1-5.)

Coral massive (Pl. XVIII. fig. 2) or spreading over foreign objects (fig. 1); the latter form presenting a reticulated surface which is more or less grooved throughout by branches of the astrorhiza, that radiate respectively from more or less convex elevations, whose summits, from weathering, may present one or more apertures (fig. 1, *c c c*); *mutatis mutandis*, like the growing surfaces of *Millepora alcicornis* and *Hydractinia arborescens*, &c. Showing in the *vertical* section (fig. 4) that the basal structure or cœnenchyma is composed of rectilinear latticework, arranged in concentric, more or less undulating laminae, traversed by the branches of the astrorhiza (fig. 4, *d, e e*); and in the *horizontal* section (fig. 5) a union of the ends of the perpendicular rods by intervening fibre, which presents a curvilinear or *quasi-vermicular* form, still traversed by the branches of the astrorhiza, but now seen from a horizontal point of view instead of laterally, whereby the branch is more or less observed to ramify among the cœnenchyma (fig. 5, *e*), until, by subdivision, it finally becomes confluent with the vermiculated cœnosarcular canaliculi, with which, too, it is also in communication laterally throughout its whole course. Astrorhiza consisting of a group of radiating branches, which dip downwards from a vertical axis to ramify on all sides among the laminated cœnenchyma until they are lost by subdivision in the canaliculi of the cœnosarc, as just stated (fig. 1, *c c c* and *b, e, g g*, also fig. 4, *d*, and fig. 5, *e*, &c.); parting from the axis successively (fig. 1, *e, f*) stolon-like, without any distinctly continuous vertical canal or stem; the larger branches traversed here and there by tabulae, inequidistant, direct or oblique (fig. 3, *a*). Centres of the astrorhizæ at different distances from each other, varying from $\frac{1}{2}$ -1 inch in the massive form (fig. 2, *a a a*), but much wider apart in the incrusting one (fig. 1, *c c c*), where the branches are sometimes 2 inches long and 1-24th inch wide near the centre. Size variable.

Hab. Marine.

Loc. Devonian Limestone. Pit-Park Quarry, Dartington, near Totnes.

Obs. It is not improbable that fig. 1 represents the *true* surface of the incrusting form, but so altered by weathering and decomposition that it presents nothing satisfactory beyond the large size of the astrorhizæ; while in fig. 2 the branches of the astrorhizæ are necessarily represented as truncate, from their ultimate ramifications being below the plane of fracture. In the vertical section of the cœnenchyma (fig. 4) the lines of

fibre are all inflated at their point of contact, as shown at fig. 4, *b*; and on account of the undulating development of the laminae the horizontal section (fig. 5), although generally presenting the curvilinear structure (fig. 5, *a*), sometimes presents a punctate one (fig. 5, *b*), or a retiform one, as at fig. 5, *c*, or a more compact curvilinear one, as at fig. 5, *d*, &c. &c., owing to the section passing through the undulations at slightly variable depths.

Of course the above description of *S. dartingtoniensis*, having been taken from only a few specimens of the species found in "Pit-Park Quarry," must be considered approximate, since it probably not only exists throughout the Devonian Limestone of the neighbourhood, but may be found to present itself under many more forms, both generally and structurally, than those above mentioned.

EXPLANATION OF PLATE XVIII.

Fig. 1. *Stromatopora dartingtoniensis*, n. sp. Natural size. Incrusting form, showing:—*a*, natural surface; *b*, broken surface; *c c c*, astrorhizæ; *d*, union of ultimate branches of the astrorhizæ; *e*, vertical section of the astrorhiza as it is developed upwards through the structure of the *Stromatopora*; *f*, ends of the branches obliquely cut by the section; *g g*, truncated ends of branches of the astrorhizæ as they appear in a vertical section of *Stromatopora*.

Fig. 2. The same. Natural size. Massive form. Tracing of the plane of fracture *a a a a*, showing the form, size, and arrangement of the astrorhizæ, whose branches are partially empty, all the calc-spar but the tabulae having been removed by ? decomposition.

N.B. As the branches of the astrorhizæ are not on the same plane, but generally dip downwards (fig. 1, *f*), their smaller branches disappear in the horizontal section, and thus the larger ones look in the delineation as if abruptly terminated.

Fig. 3. The same. Astrorhiza of fig. 2, magnified about four diameters, to show *a*, the tabulae. Diagram.

Fig. 4. The same. Vertical section, to show the structure of the cœnenchyma, relatively magnified about four diameters. *a*, appearance of the vertical rods and horizontal lines of the laminae as they cross each other at nearly right angles, modified by slight undulations; *b*, portion showing their inflation at the point of intersection; *c*, portion in which the vertical rods are omitted and the lines of the laminae only inserted; *d*, large branch of an astrorhiza; *e e*, truncated branches of astrorhizæ as they appear in the vertical section. Diagram.

Fig. 5. The same. Horizontal section, to show the structure of the cœnenchyma, relatively magnified about four diameters. *a*, curvilinear appearance of the lines of the laminae when viewed horizontally—sometimes, owing to the undulation of the lamina, presenting a punctate appearance (*b*), or a reticulated one (*c*), or a more compact curvilinear structure (*d*); *e*, branch of astrorhiza. Diagram.

XLIII.—*On Palæontological and Embryological Development.*
By Prof. ALEXANDER AGASSIZ*.

SINCE the publication of the 'Poissons Fossiles' by Agassiz, and of the 'Embryologie des Salmonidées' by Vogt, the similarity, traced by the former, between certain stages in the growth of young fishes and the fossil representatives of extinct members of the group has also been observed in nearly every class of the animal kingdom, and the fact has become a most convenient axiom in the study of palæontological and embryological development. This parallelism, which has been on the one side a strong argument in favour of design in the plan of creation, is now, with slight emendations, doing duty on the other as a newly discovered article of faith in the new biology.

But while, in a general way, we accept the truth of the proposition that there is a remarkable parallelism between the embryonic development of a group and its palæontological history, yet no one has attempted to demonstrate this, or, rather, to show how far the parallelism extends. We have, up to the present time, been satisfied with tracing the general coincidence or with striking individual cases.

The resemblance between the pupa stage of some Insects and of adult Crustacea, the earlier existence of the latter, and the subsequent appearance of the former, in palæontological history, furnished one of the first and most natural illustrations of this parallelism; while theoretically the necessary development of the higher tracheate insects from their early branchiate aquatic ancestors seemed to form an additional link in the chain, and point to the Worms, the representatives of the larval condition of Insects, as a still earlier embryonic stage of the Articulatés.

Indeed, there is not a single group of the animal kingdom in which embryology has not played a most important part in demonstrating affinities little suspected before. The development of our frogs, our salamanders, has given us the key to much that was unexplained in the history of Reptiles and Batrachians. The little that has been done in the embryology of Birds has revolutionized our ideas of a class which at the beginning of the century seemed to be the most naturally circumscribed of all. Embryology and palæontology combined have led to the recognition of a natural classification

* From 'Science' for September 18, being a verbatim report of the address delivered at the Meeting of the American Association for the Advancement of Science at Boston, August 1880.

uniting Birds and Reptiles on the one side and Batrachians and Fishes on the other. It is to embryology that we owe the explanation of the affinities of the old Fishes in which Agassiz first recognized the similarity to the embryo of Fishes now living, and by its aid we may hope to understand the relationship of the oldest representatives of the class. It has given us the only explanation of the early appearance of the Cartilaginous Fishes, and of the probable formation of the earliest vertebrate limb from the lateral embryonic fold, still to be traced in the young of the Osseous Fishes of to-day.

Embryology has helped us to understand the changes aquatic animals must gradually undergo in order to become capable of living upon dry land. It has given us pictures of swimming-bladders existing as rudimentary lungs in Fishes with a branchial system; in Batrachians it has shown us the persistence of a branchial system side by side with a veritable lung. We find among the earliest terrestrial Vertebrates types having manifest affinities with the Fishes on one side and Batrachians on the other, and we call these types Reptiles; but we should nevertheless do so with a reservation, looking to embryology for the true meaning of these half-fledged Reptiles, which lived at the period of transition between an aquatic and terrestrial life, and must therefore always retain an unusual importance in the study of the development of animal life.

When we come to the embryology of the marine Invertebrates, the history of the development of the barnacles is too familiar to be dwelt upon; and I need only allude to the well-known transformations of the Echinoderms, of the Acalephs, Polyps, in fact of every single class of Invertebrates, and perhaps in none more than in the Brachiopods, to show how far-reaching has been the influence of embryology in guiding us to a correct reading of the relations between the fossils of successive formations. There is scarcely an embryological monograph now published dealing with any of the later stages of growth which does not speak of their resemblance to some type of the group long ago extinct. It has therefore been most natural to combine with the attempts constantly made to establish the genetic sequence between the genera of successive formations an effort to establish also a correspondence between their palæontological sequence and that of the embryonic stages of development of the same, thus extending the mere similarity first observed between certain stages to a far broader generalization.

It would carry me too far to sketch out, except in a most

general way, even for a single class, the agreement known to exist in certain groups between their embryonic development and their palaeontological history. It is hinted at in the succession of animal life of any period we may take up, and perhaps cannot be better expressed than by comparing the fauna of any period as a whole with that of following epochs—a zoological system of the Jura, for instance, compared with one made up for the Cretaceous; next, one for the Tertiary compared with the fauna of the present day. In no case could we find any class of the animal kingdom bearing the same definitions or characterized in the same manner. But apply to this comparison the data obtained from the embryological development of our present fauna, and what a flood of light is thrown upon the meaning of the succession of these apparently disconnected animal kingdoms, belonging to different geological periods, especially in connexion with the study of the few ancient types which have survived to the present day from the earliest times in the history of our earth!

Although there is hardly a class of the animal kingdom in which some most interesting parallelism could not be drawn, and while the material for an examination of this parallelism is partially available for the Fishes, Mollusks, Crustacea, Corals, and Crinoids, yet for the illustration and critical examination of this parallelism I have been led to choose to-day a very limited group, that of Sea-urchins, both on account of the nature of the material, and of my own familiarity with their development and with the living and extinct species of Echini. The number of living species is not very great (less than three hundred), and the number of fossil species thus far known is not, according to Zittel, more than about two thousand. It is therefore possible for a specialist to know of his own knowledge the greater part of the species of the group. It has been my good fortune to examine all but a few of the species now known to exist, and the collections to which I have had access contain representatives of the majority of the fossil species. Sea-urchins are found in the oldest fossiliferous rocks; they have continued to exist without interruption in all the strata up to the present time. While it is true that our knowledge of the Sea-urchins occurring before the Jurassic period is not very satisfactory, it is yet complete enough for the purposes of the present essay, as it will enable me, starting from the Jurassic period, to call your attention to the palaeontological history of the group, and to compare the succession of its members with the embryological development of the types now living in our

seas. Ample material for making this comparison is fortunately at hand; it is material of a peculiar kind, not easily obtained, and which thus far has not greatly attracted the attention of zoologists.

Interesting and important as are the earliest stages of embryonic development in the different classes of the animal kingdom, as bearing upon the history of the first appearance of any organ and its subsequent modifications, they throw but little light on the subject before us. What we need for our comparisons are the various stages of growth through which the young Sea-urchins of different families pass, from the time they have practically become Sea-urchins until they have attained the stage which we now dignify with the name of species. Few embryologists have carried their investigations into the more extended field of the changes the embryo undergoes when it begins to be recognized as belonging to a special class, and when the knowledge of the specialist is absolutely needed to trace the bearing of the changes undergone and to understand their full meaning. Fortunately the growth of the young Echini has been traced in a sufficient number of families to enable me to draw the parallelism between these various stages of growth and the palæontological stages in a very different manner from what is possible in other groups of the animal kingdom, where we are overwhelmed with the number of species, as in the Insects or Mollusks, or where the palæontological or the embryological terms of comparison are wanting or very imperfect.

Beginning with the palæontological history of the regular Sea-urchins of the time of the Trias, when they constituted an unimportant group as compared with the Crinoids, we find the Echini of that time limited to representatives of two families. One of these, the genus *Cidaris*, has continued to exist, with slight modifications, up to the present time, and not less than one tenth of all the known species of fossil Echini belong to this important genus, which in our tropical seas is still a prominent one. It is interesting here to note that in the *Cidaridæ* the modifications of the test are not striking, and the fossil genera appearing in the successive formations are distinguished by characters which often leave us in doubt as to the genus to which many species should be referred. In the genus *Rhabdocidaris*, which appears in the lower Jura, and which is mainly characterized by the extraordinary development of the radioles, we find the extreme of the variations of the spines in this family. From that time to the present day the most striking

differences have existed in the shape of the spines, not only of closely allied genera, but even in specimens of the same species—differences which in some of the species of to-day are as great as in older geological periods. The oldest *Cidaridæ* are remarkable for their narrow poriferous zones. It is only in the Jura that they widen somewhat; subsequently the pores become conjugated, and only later, during the Cretaceous period, do we find the first traces of any ornamentation of the test (*Temnocidaris*) so marked at the present day in the genus *Gonicidaris*. So far, then, as the *Cidaridæ* are concerned, the modifications which take place from their earliest appearance are restricted to slight changes in the poriferous zone and in the ornamentation of the test, accompanied with great variability in the shape of the primary radioles. We must except from this statement the genera *Diplocidaris* and *Tetracidaris*, to which I shall refer again. The representatives of the other Triassic family become extinct in the lower Tertiaries. The oldest genus (*Hemicidaris*) undoubtedly represents the earliest deviations from the true *Cidaris* type—modifications which affect not only the poriferous zone, but the test, the actinal and the abactinal systems, while, from the extent of these minor changes, we can trace out the gradual development of some of the characteristics in families of the regular *Echini* now living. The genus *Hemicidaris* may be considered a *Cidaris* in which the poriferous zone is narrow and undulating, in which the granules of the ambulacral system have become minute tubercles in the upper portion of the zone and small primary tubercles in its actinal region, in which many of the interambulacral granules become small secondaries, in which the plates of the actinal system have become reduced in number and the apical system has become a narrow ring, and finally in which the primary radioles no longer assume the fantastic shapes so common among the *Cidaridæ*.

We can trace in this genus the origin of the modifications of the poriferous zone, leading us, on the one side, through genera with merely undulating lines of pores to more or less distinct confluent arcs of pores formed round the primary ambulacral tubercles, and, on the other, to the formation of open arcs of three or more pairs of pores. The first type culminates at the present day with the *Arbaciadæ*, the other with the *Diadematidæ*, *Triplechinidæ*, and *Echinometradæ*. This specialization very early takes place, for already in the lower Jura *Stomechinus* has assumed the principal characteristics of the *Triplechinidæ* of to-day.

Although in *Hemicidaris* the number of the coronal plates has increased as compared with the *Cidaridæ*, and while we find that in many genera, even of those of the present day, the number of the coronal plates is still comparatively small, yet, as a general rule, the more recent formations contain genera in which the increase in number of the interambulacral plates is accompanied by a corresponding decrease in the number of plates of the interambulacral area, so characteristic thus far of the *Cidaridæ* and *Hemicidaridæ*, a change also affecting the size of the primary ambulacral tubercles. This increase in the number of the coronal plates is likewise accompanied by the development of irregular secondary and miliary tubercles, and the disappearance in this group of the granular tuberculation, so important a character in the *Cidaridæ*. With the increase in the number of the interambulacral coronal plates, the *Pseudodiadematidæ* still retain prominent primary tubercles, recalling the earlier *Hemicidaridæ* and *Cidaridæ*, and, as in the *Cidaridæ* proper, the test is frequently ornamented by deep pits or by ridges formed by the junction of adjoining tubercles. The genital ring becomes narrower, and the tendency to the specialization of one of its plates, the madreporite, more and more marked.

With the appearance of *Stomechinus*, the *Echinidæ* proper already assume in the Jura the open arcs of pores, the large number of coronal interambulacral plates, the specialization of the secondary tubercles, and the large number of primary tubercles in each plate. With the appearance of *Sphærechinus* in the early Tertiary come in all the elements for the greater multiplication of the pairs of pores in the arcs of the poriferous zones, while the gigantic primary spines of some of the genera (*Heterocentrotus*) and the small number of primary tubercles are structural features which had completely disappeared in the group preceding the *Echinometradæ*, to which they appear most closely allied.

Going back again to the *Hemicidaridæ*, it requires but slight changes to pass from them to *Acrosalenia* and to the *Salenie* proper; the latter have continued to the present day, and have, like the *Cidaridæ*, retained almost unchanged the characters of the genera which preceded them, combined, however, with a few *Cidaridian* and *Echinid* features which date back to the Triassic period. We can thus trace the modifications which have taken place in the poriferous zone, the apical and actinal systems, the coronal plates, the ambulacral and interambulacral tubercles, as well as in the radioles, and, in the most direct manner possible, indicate the origin of the peculiar combination of structural features which we find

at any geological horizon. On taking in succession the modifications undergone by the different parts of the test, we can trace each one singly, without the endless complication of combinations which any attempt to trace the whole of any special generic combination would imply.

Leaving out of the question for the moment the Palæchinidæ, we find no difficulty in tracing the history of the characters of the genera of the regular Echini which have existed from the time of the Trias and are now living, provided we take up each character independently. Nothing can be more direct than the gradual modification of the simple, barely undulating poriferous zone, made up of numerous ambulacral plates covered by granules, such as we find it among the Cidaridæ of the Trias, first into the slightly undulating poriferous zone of the Hemicidaridæ, next into the indistinct arcs of pores of the Pseudodiadematidæ, then into the arcs with a limited number of pores of the Triplechinidæ, and finally to the polyporous arcs of the Echinometradæ. What can be more direct than the gradual modification to be traced in the development of the primary ambulacral tubercles, such as are characteristic of the Echinidæ of the present day, from their first appearance at the oral extremity of the ambulacral system of the Hemicidaridæ, and the increase in the number of primary interambulacral tubercles, accompanied by the growth of secondaries and miliaries, which we can trace in *Hemicidaris*, *Acrosalenia*, and *Stomechinus*, the increase in number of primary and secondary tubercles being accompanied by a reduction in the size of the radioles and a greater uniformity in their size and shape?

But while these modifications take place, the original structural feature may be retained in an allied group. Thus the Cidaridæ retain unchanged from the earliest time to the present day the few primary tubercles, the secondary granules, the simple poriferous zone, the imbricating actinal system, and the few coronal plates, with the large apical system and many-shaped radioles; while in the Salenidæ the primary interambulacral tubercles, the secondary granules, the radioles, the genital ring are recognized features of the Cidaridæ, associated, however, with an Echinid actinal and anal system, Hemicidarid primary ambulacral tubercles, and an Echinid poriferous zone. In the same way, in the Diadematidæ, the large primary interambulacral tubercles are Cidaridian features, while the structure of the ambulacral tubercles is Hemicidaridian. The existence of two kinds of spines is another Cidaridian feature, while the apical and actinal systems have become modified in the same direction as that

of the Echinidæ. The more recent the genus, the greater is the difficulty of tracing in a direct manner the origin of any one structural feature, owing to the difficulty of disassociating structural elements characteristic of genera which may be derived from totally different sources. This is particularly the case with genera having a great geological age. Many of them, especially among the Spatangoids, show affinities with genera following them in time, to be explained at present only on the supposition that, when a structural feature has once made its appearance, it may reappear subsequently, apparently as a new creation, while, in reality, it is only its peculiar combination with structural features with which it had not before been associated (a new genus) which conceals in that instance the fact of its previous existence. A careful analysis, not only of the genera of the order, but sometimes of other orders which have preceded this combination in time, may often reveal the elements from which have been produced apparently unintelligible modifications.

There is, however, not one of the simple structural features in the few types of the Triassic and Liassic Echini from which we can so easily trace the origin of the structural features of all the subsequent Echinid genera, which is not also itself continued to the present day in some generic type of the present epoch, fully as well characterized as it was at the beginning. In fact, the very existence to-day of these early structural features seems to be as positive a proof of the unbroken systematic affinity between the Echini of our seas and those of the Trias, as the uninterrupted existence of the genus *Pygaster* or *Cidaris* from the Trias down to the present epoch, or as the connexion of many of the genera of the Chalk with those of our epoch (*Salenia*, *Cyphosoma*, *Psammechinus*, &c.).

Passing to the Clypeastridæ, we find there, as among the Desmosticha, that the earliest type, *Pygaster*, has existed from the Trias to the present time, and that while we can readily reconstruct, on embryological grounds, the modifications the earliest Desmosticha-like Echini should undergo in order to assume the structural features of *Pygaster*, yet the early periods in which the precursors of the Echinoconidæ and Clypeastridæ are found have thus far not produced the genera in which these modifications actually take place. But, starting from *Pygaster*, we naturally pass to *Holectypus*, to *Discoidea*, to *Conoclypus*, on the one side; while, on the other, from *Holectypus* to *Echinocyamus*, *Sismondia*, *Fibularia*, and *Mortonia* we have the natural sequence of the characters of the existing Echinanthidæ, Lagamidæ, and Scutellidæ, the

greater number of which are characteristic of the present epoch. If we were to take in turn the changes undergone in the arrangement of the plates of the test, as we pass from *Pygaster* to *Holectypus*, to *Echinocyamus*, and Echinanthidæ, we should have in the genera which follow each other in the palæontological record an unbroken series showing exactly what these modifications have been. In the same way the modifications of the abactinal and anal systems, and those of the poriferous zone, can equally well be followed to *Echinocyamus*, and thence to the Clypeastridæ; while a similar sequence in the modifications of these structural features can be followed from *Mortonia* to the Scutellidæ of the present period.

Passing finally to the Petalosticha we find no difficulty in tracing theoretically the modifications which our early Echinonidæ of the Lias should primarily undergo previous to the appearance of *Galeropygus*. The similarity of the early Cassiduloid and Echinoneoid types points to the same systematic affinity, and perhaps even to a direct and not very distant relationship with the Palæchinidæ. For if we analyze the *Echinothuria* of the present day we find in genera like *Phormosoma* many structural features, such as the shape of the test, the character of the spines, the structure of the apical system, that of the poriferous zone, indicative of possible modifications in the direction of *Pygaster* or of *Galeropygus*, which have as yet not been taken into account.

Adopting for the Petalosticha the same method of tracing the modifications of single structural features in their palæontological succession, we trace the comparatively little modified palæontological history of the Echinoneidæ of the present day from the *Fyrina* of the lower Jura. This, in its turn, has been preceded by *Hyboclypus* and *Galeropygus*, while the Echinolampadæ of the present day date back, with but trifling modifications, to the *Echinobrissus* of the Lias, itself preceded by *Clypeus*; and they have been subject only to slight generic changes since that time, *Echinobrissus* being still extant, while such closely allied genera as *Catopygus* and *Cassidulus* of the earlier Cretaceous are still represented at the present day—the modifications taking place in the actinal system, in the ambulacral zones of the Echinonidæ and of the Echinolampadæ showing the closest possible systematic affinity in these families. Starting again from *Hyboclypus*, with its elongate apical system, we naturally pass to *Collyrites* and the strange Dysasteridæ, forms which, in their turn, are closely allied to the Holasteridæ. From *Holaster* on the one side, and from *Toxaster* on the other, we find an unbroken

sequence of structural characters uniting the successive genera of Holasteridæ, such as *Cardiaster*, *Offaster*, *Stenonia*, *Ananchytes*, and *Asterostoma*, with *Palæopneustes*, *Homolampas*, and the *Pourtalesia* of the present day, while from the genera of the Toxasteridæ we naturally pass to the Cretaceous *Hemiaster*; in this genus and the subsequent *Micraster* we find all the elements necessary for the modifications which appear in the Spatanginæ from the time of the Chalk to the present day. These modifications result in genera in which we trace the development of the fascioles, of the actinal, anal, and abactinal plastrons, of the beak, the formation of the petaloid ambulacra, first flush with the test, and little by little changed into marsupial pouches, the growth of the anterior groove and the manifold modifications of the ambulacral system in *Spatangus*, *Agassizia*, and *Echinocardium*, often recalling in some of its features structural characters of families which have preceded this in time.

Apparently in striking contrast with the Echini of the Secondary period and those which have succeeded them stand the Palæozoic Echini; but when we have examined the embryology of Echini, we shall be better prepared to understand the structure and the affinities of the Palæchinidæ with the Echini of the present day and their immediate predecessors.

Taking up now the embryological development of the several families which will form the basis of our comparisons, beginning with the Cidaridæ, we find that in the earliest stages they very soon assume the characters of the adult, the changes being limited to the development of the abactinal system, the increase in number of the coronal plates, and the modifications of the proportionally gigantic primary radioles.

In the Diadematiidæ the changes undergone by the young are limited to the gradual transformation of the embryonic spines into those which characterize the family, to the changes of the vertical row of pores in the ambulacral area into arcs of three or four pairs of pores, and to the specialization of the actinal and abactinal systems.

In the Arbaciadæ the young stages are remarkable for the prominent sculpture of the test, for the flattened spines, for their simple poriferous zone, for their actinal system, and for their genital ring. The anal plates appear before the genital ring.

In the Echinometradæ the young thus far observed are characterized by the small number of their primary tubercles, the large size of the spines, the simple vertical row of pores, the closing of the anal ring by a single plate, and the turban-

shaped outline of the test. Little by little the test loses with increasing age this *Cidaris*-like character; it reminds us, from the increase in the number of its plates, more of *Hemicidaris*, then, with their still greater increase, of the *Pseudodiadematidæ*, and, finally, of the *Echinometradæ* proper. The spines, following *pari passu* the changes of the test, lose little by little their fantastic embryonic or, rather, *Cidaris*-like appearance, and become more solid and shorter, till they finally assume the delicately fluted structure characteristic of the *Echinometradæ*. The vertical poriferous zone is first changed into a series of connected vertical arcs, which become disjointed, and form, with increasing age, the independent arcs of pores, composed of three or more pair of pores, of the *Echinometradæ*.

In the *Echinidæ* proper we find in the young stages the same unbroken vertical line of pores, which gradually becomes changed to the characteristic generic types. We find, as in the *Echinometradæ*, an anal system closed with a single plate, and an abactinal system separating in somewhat more advanced stages from the coronal plates of the test. This is as yet made up of a comparatively small number of plates, carrying but few large primary tubercles, with fantastically shaped spines entirely out of proportion to the test, but which, little by little, with the increase of the number of coronal plates, the addition of primary tubercles, and their proportional decrease in size, assume more and more the structure of the genus to which the young belongs. The original anal plate is gradually lost sight of from the increase in number of the plates covering the anal system, and it is only among the *Temnopleuridæ* that this anal plate remains more or less prominent in the adult. In the *Salenidæ*, of which we know as yet nothing of the development, this embryonic plate remains permanently a prominent structural feature of the apical system*.

Among the *Clypeastroids* the changes of form they undergo during growth are most instructive. We have in the young *Fibularinæ* an ovoid test, a small number of coronal plates surmounted by few and large primary tubercles, supporting proportionally equally large primary radioles, simple rectilinear poriferous zones, no petaloid ambulacra—in fact scarcely one of the features we are accustomed to associate with the

* The young of the following genera have served as a basis for the preceding analysis of the embryonic stages of the *Desmosticha*:—*Cidaris*, *Dorocidaris*, *Goniocidaris*, *Arbacia*, *Porocidaris*, *Strongylocentrotus*, *Echinometra*, *Echinus*, *Toxopneustes*, *Hipponoë*, *Temnopleurus*, *Temnechinus*, and *Trigonocidaris*.

Clypeastroids is as yet prominently developed. But rapidly, with increasing size, the number of primary tubercles increases, the spines lose their disproportionate size, the pores of the abactinal region become crowded and elongate, and a rudimentary petal is formed. The test becomes more flattened, the coronal plates increase in number, and it would be impossible to recognize in the young *Echinocyamus*, for instance, the adult of the *Cidaris*-like or *Echinometra*-like stages of the Sea-urchin, had we not traced them step by step. Most interesting also is it to follow the migrations of the anal system, which, to a certain extent, may be said to retain the embryonic features of the earlier stages of all Echinoderm embryos, in being placed in more or less close proximity to the actinostome. What has taken place in the growth of the young *Echinocyamus* is practically repeated for all the families of Clypeastroids: a young *Echinarachnius*, or *Mellita*, or *Encope*, or a *Clypeaster* proper resembles at first more an *Echinometra* than a Clypeastroid; they all have simple poriferous zones and spines and tubercles out of all proportion to the size of the test*.

When we come to the development of the Spatangoids we find their younger stages also differing greatly from the adult. Among the Nucleolidæ, for instance, the young stages have as yet no petals, but only simple rectilinear poriferous zones. They are elliptical with a high test, with a single large primary tubercle for each plate, and a simple elliptical actinostome, without any trace of the typical bourrelets and phylloides so characteristic of this family. Very early, however, this condition of things is changed, the test soon becomes more flattened, the petals begin to form as they do in the Clypeastroids, and we can soon trace the rudiments of the peculiar bourrelets characteristic of the family, accompanied by a rapid increase in the number of tubercles and in that of the coronal plates.

Among the Spatangidæ some are remarkable in their adult condition for their labiate actinostome, for the great development of the petals, for the presence of fascioles surrounding certain definite areas, for the small size of the tubercles, the general uniformity in the spines of the test, and the specialization of their anterior and posterior regions. On examining the young stages of this group of Spatangoids, not one of these structural features is as yet developed. The actinostome is simple, the poriferous zone has the same simple

* Among the Clypeastroids I have examined the young of *Echinocyamus*, *Fibularia*, *Mellita*, *Laganum*, *Echinarachnius*, *Encope*, *Clypeaster*, and *Echinanthus*.

structure from the actinostome to the apex, the primary tubercles are large, few in number, surrounded by spines which would more readily pass as the spines of *Cidaridæ* than of *Spatangoids*. The fascioles are either very indistinctly indicated, or else the special lines have not as yet made their appearance; the ambulacral suckers of the anterior zone are as large and prominent as those of the young stages of any of the regular *Echini*. It is only little by little, with advancing age, that we begin to see signs of the specialization of the anterior and posterior parts of the test, that we find the characteristic anal or lateral fascioles making their appearance; only with increasing size that the spines lose their *Cidaris*-like appearance, that the petals begin to be formed, and that the simple actinostome develops a prominent posterior lip. In the genus *Hemiaster* the young stages are especially interesting, as long before the appearance of the petals, while the poriferous zone is still simple, the total separation of the bivium and of the trivium of the ambulacral system, so characteristic of the earliest *Spatangoids* (the *Dysasteridæ*), is very apparent*.

From this rapid sketch of the changes of growth in the principal families of the recent *Echini* we can now indicate the transformations of a more general character through which the groups as a whole pass.

In the first place, while still in the *Pluteus* stage all the young *Echini* are remarkable for the small number of coronal plates, and for the absence of any separation between the actinal and abactinal systems and the test proper. They all further agree in the large size of the primary spines of the test, whether it be the young of a *Cidaris*, an *Arbacia*, an *Echinus*, a *Clypeaster*, or a *Spatangoid*. They all in their youngest stages have simple vertical ambulacral zones; beyond this we find, as changes characteristic of some of the *Desmosticha*, the specialization of the actinal system from the coronal plates, the formation of an anal system, the rapid increase in the number of coronal plates, with a corresponding increase in the number of the spines and a proportional reduction of their size, the formation of an abactinal ring, and the change of the simple vertical poriferous zone into one composed of independent arcs.

In the *Spatangoids* and *Clypeastroids* we find common to both groups the shifting of the anal system to its definite place, the modifications of the abactinal part of the simple

* For this sketch of the embryology of the *Petalosticha* I have examined the young of *Echinolampas*, *Echinoneus*, *Echinocardium*, *Brissopsis*, *Agassizia*, *Spatangus*, *Brissus*, and *Hemiaster*.

ambulacral system in order to become petaloid, and the gradual change of the elliptical ovoid test of the young to the characteristic generic test, accompanied by the rapid increase in the number of the primary tubercles and spines. Finally, limited to the Spatangoids are the changes they undergo in the transformation of the simple actinostome to a labiate one, the specialization of the anterior and posterior parts of the test, and the definite formation of the fascioles.

Comparing this embryonic development with the palæontological one, we find a remarkable similarity in both, and in a general way there seems to be a parallelism in the appearance of the fossil genera and the successive stages of the development of the Echini as we have traced it.

We find that the earlier regular Echini all have more or less a *Cidaris*-like look (that is, they are Echini with few coronal plates, large primary tubercles with radioles of a corresponding size), that it is only somewhat later that the Diademopsidæ make their appearance, which, in their turn, correspond within certain limits to the modifications we have traced in the growth of the young Diadematiidæ and Arbacidæ. The separation of the actinal system from the coronal plates has been effected. The poriferous zone has either become undulating or forms somewhat indefinite open arcs; we find in all the genera of this group a larger number of coronal plates, more numerous primaries, the granules of the *Cidaridæ* replaced by secondaries and miliaries, and traces of a *Hemicidaris*-like stage in the size of the actinal ambulacral tubercles.

Comparing in the same way the palæontological development of the Echinidæ proper, we find that, on the whole, they agree well with the changes of growth we can still follow to-day in their representatives, and that, as we approach nearer the present epoch, the fossil genera more and more assume the structural features which we find developed last among the Echinidæ of the present day. Very much in the same manner as a young *Echinus* develops, they lose, little by little, first their *Cidaridian* affinities, which become more and more indefinite; next their *Diadematiidian* affinities, if I may so call the young stages to which they are most closely allied; and finally, with the increase in the number of the coronal plates, the great numerical development of the primary tubercles and spines, and that of the secondaries and miliaries which we can trace in the fossil Echini of the Tertiaries, we pass insensibly into the generic types characteristic of the present day.

Although we know nothing of the embryology of the Salenidæ, yet, like the Cidaridæ, they have in a great measure remained a persistent type, the modifications of the group being all in the same direction as those noticed in the other Desmosticha—a greater number of coronal plates, the development of secondaries and miliaries, combined with a specialization of the actinal system not found in the Cidaridæ.

An examination of the succession of the Echinoconidæ shows but little modification from the earliest types; the changes, however, are similar to those undergone by the Clypeastroids and Petalosticha, though they do not extend to modifications of the poriferous zone, but are mainly changes in the actinostome and in the tuberculation. In fact, the group of Echinoconidæ seems to hold somewhat the same relation to the Clypeastroids which the Salenidæ hold to the Cidaridæ; and the earliest genus of the group (*Pygaster*) has remained, like *Cidaris*, a persistent type to the present day.

The earliest Clypeastroids are all forms which resemble the Fibularinæ and the genera following *Echinocyamus* and *Fibularia*; they are mainly characterized by the same changes which an *Echinarachnius* or a *Mellita*, for instance, undergoes as it passes from its *Echinocyamus* stage to the *Laganum* or *Encope* stage. The comparison is somewhat more complicated when we come to the Spatangoids. The comparison of the succession of genera in the different families, as traced in the Desmosticha and Clypeastroids, is made difficult from the persistency of the types preceding the Echinoneidæ and the Ananchytidæ, which have remained without important modifications from the time of the Lower Cretaceous; previous to that time the modifications of the Cassidulidæ are found to agree with the changes which have been observed in the growth of *Echinolampas*. The early genera, like *Pygurus*, have many of the characteristics of the test of the young *Echinolampas*. The development of prominent bourrelets and of the floscelle and petals goes on side by side with that of genera in which the modification of the actinostome, of the test, and of the petals is far less rapid, one group retaining the *Echinoneus* features, the other culminating in the *Echinolampas* of the present day, and having likewise a persistent type, *Echinobrissus*, which has remained with its main structural features unchanged from the Jura to the present day. That is, we find genera of the Cassidulidæ which recall the early *Echinoneus* stage of *Echinolampas*, next the *Caratomus* stage, after which the floscelle, bourrelets, and petals

of the group become more prominent features of the succeeding genera. Accompanying the persistent type *Echinobrissus*, genera appear in which either the bourrelets or petals have undergone modifications more extensive than those of the same parts in the genera of the *Echinoneus* or *Caratomus* type.

The earliest Spatangoids belong to the Dysasteridæ, apparently an aberrant group, but which, from the history of the young *Hemiaster*, we now know to be a strictly embryonic type, which, while it thus has affinities with the true Spatangoids, still retains features of the Cassidulidæ in the mode of development of the actinostome and of the petals, as well as of the anal system. The genera following this group, *Holaster* and *Toxaster*, can be well compared, the one to the young stages of *Spatangus* proper before the appearance of the petals, when the ambulacra are flush with the test, and when the test is more or less ovoid, the other to a somewhat more advanced stage, when the petals have made their appearance as semi-petals. In both cases the actinostome has the simple structure characteristic of all the young Spatangoids. The changes we notice in the genera which follow them lead in the one case through very slight modifications of the abactinal system, of the anterior and posterior extremities of the test, to the Ananchytid-like Spatangoids of the present day, the *Pourtalesice*, the genus *Holaster* itself persisting till well into the middle of the Tertiary period; while, on the other side, we readily recognize in the Spatanginæ which follow *Toxaster* (a persistent type which has continued as *Palæostoma* to the present day) the genera which correspond to the young stages of such Spatangoids as *Spatangus* and *Brissopsis* of the present day—genera which, on the one hand, lead from *Hemiaster* (itself still represented in the present epoch), through stages such as *Cyclaster*, *Peripneustes*, *Brissus*, and *Schizaster*, and, on the other, through *Micraster* and the like, to the Spatangoids, in which the development of the anal plastron and fasciole performs an important part, while in the former group the development of the peripetalous fasciole and of the lateral fasciole can be followed. None of the genera of *Petalosticha* belonging to the other groups develops any fasciole in the sense of circumscribing a limited area of the test.

The comparison of the genera of Echini which have appeared since the Lias with the young stages of growth of the principal families of Echini, shows a most striking coincidence, amounting almost to identity, between the successive fossil genera and the various stages of growth. This identity cannot, however, be traced exactly in the way in which it

has usually been understood, while there undoubtedly exists in the genera which have appeared one after the other a gradual increase in certain families in the number of forms, and a constant approach in each succeeding formation, in the structure of the genera, to those of the present day. It is only in the accordance between some special points of structure of these genera and the young stages of the Echini of the present day that we can trace an agreement, which becomes more and more limited as we go further back in time. We are either compelled to seek for the origin of many structural features in types of which we have no record, or else we must attempt to find them existing potentially in groups where we had as yet not succeeded in tracing them. The parallelism we have traced does not extend to the structure as a whole. What we find is the appearance among the fossil genera of certain structural features giving to the particular stages we are comparing their characteristic aspect. Thus, in the succession of the fossil genera, when a structural feature has once made its appearance, it may either remain as a persistent structure, or it may become gradually modified in the succeeding genera of the same family, or it may appear in another family associated with other more marked structural features which completely overshadow it. Take, for instance, among the Desmosticha, the modifications of the poriferous zone of the actinal and abactinal systems of the coronal plates, of the ambulacral and interambulacral systems, the changes in the relative proportion of the primary tubercles, and the development of the secondaries. These are all structural features which are modified independently one of the other; we may find simultaneous development of these features in parallel lines, but a very different degree of development of any special feature in separate families.

This is as plainly shown in the embryological as in the palæontological development. In the Cidaridæ there is the minimum of specialization in these structural features. In the Diademopsidæ there is a greater range in the diversity of the structure of the poriferous zone and of the coronal plates, as well as of the actinal system. There is a still greater range among the Echinidæ; while among the Salenidæ the modifications, as compared with those of the Echinidæ and Diademopsidæ, are somewhat limited again, being restricted as far as relates to the poriferous zone and coronal plates, but specialized as far as the actinal system is concerned, and specially important with reference to the structure of the apical system. The special lines in which these modifications take place produce, of course, all possible combinations; yet they give us the key

to the sudden appearance, as it were, of structural features of which the relationship must be sought in very distantly related groups. It is to this specialty in the palæontological development that we must trace, for instance, the Cidarid affinities of the *Saleniæ*, their papillæ, the existence of a few large primary interambulacral tubercles, the structure of their apical system, and their large genital plates; while it is to their affinities with the Hemicidaridæ that we must refer the presence of the few larger primary ambulacral tubercles at the base of the ambulacral area, and by their Diademopsid and Echinidian affinities that we explain the indented imbricated actinal system with the presence of a few genuine miliaries. But all the structural features which characterize the earliest types of the Desmosticha can in reality be traced, only in a somewhat rudimentary form, even in the Cidaridæ. The slight undulation of the closely packed, nearly vertical poriferous zone is the forerunner of the poriferous zone first separated into vertical arcs and then into independent arcs. The limitation in the number of the rows of granules in the ambulacral zone, and their increase in size, are the first traces of the appearance of the somewhat larger primary ambulacral tubercles of the Hemicidaridæ and *Saleniæ*. The existence of the smooth cylindrical spines of the abactinal region of the test naturally leads to similar spines covering the whole test in the other families of the Desmosticha. The difference existing in the plates covering the actinal system from those of the coronal plates leads to the great distinction between the structure of the actinal system and of the coronal plates in some of the Echinidæ.

Passing to the Clypeastridæ and Petalosticha, we trace a parallelism of the same kind, and readily in the successive genera of fossil Clypeastroids, but often in widely separated genera—the precise modifications which the poriferous zone has undergone as it first becomes known to us in *Echinocyamus* and *Fibularia*, and as we find it in the most complicated petaloid stage of the Clypeastroids of the present day. We readily trace the changes the test undergoes from its comparatively ovoid and swollen shape, to assume first that of the less gibbous forms, next that of the Laganidæ, and finally of the flat Scutellidæ; while we trace in the Echinanthidæ the persistent structural features of some of the earliest Clypeastroids, together with an excessive modification of the poriferous zone. Likewise for the Echinoconidæ we trace mainly the slight modifications of the poriferous zone and of the coronal plates; and, finally, when we come to the Spatangidæ we find no difficulty in tracing from the most Desmostichoid of the Spatangoid genera the modifications of a test

in which the ambulacral and interambulacral areas are made up of plates of nearly uniform size, in which the anterior and posterior extremities are barely specialized, to the most typical of the Ananchytidæ, in which the anterior and posterior extremities have developed the most opposite and extraordinary structural features. In a similar way we can trace among the fossil genera of different families the gradual development of the actinal plastron from its very earliest appearance as a modification of the posterior interambulacral area of the actinal side, or the growth of the posterior beak into an anal snout, the successive changes of the anal groove, the formation of the actinal labium, or the development of the bourrelets and phyllodes from a simple circular actinostome, the gradual deepening of the slight anterior groove of some early Spatangoid to form the deeply sunken actinal groove. Equally well we can trace the modifications of the ambulacral system as it passes from the simple poriferous zones of the earlier Spatangoids to genera in which the petaliferous portion makes its appearance, and finally becomes the specialized structure of our recent Spatangoid genera, such as *Schizaster*, *Moira*, and the like. Finally, we can trace, to a certain extent, the development of the fascioles, on one side, from genera like *Hemiaster*, in which the peripetalous fasciole is prominent, to genera like *Brissopsis*, *Brissus*, and the like, of the present day; on the other, perhaps, or in both combined, the formation of a lateral and anal fasciole from genera like *Micraster* in *Spatangus* and *Agassizia*. Thus we must, on the same theory of the independent modifications of special structural features, trace the many and complicated affinities which so constantly strike us in making comparative studies, and which render it impossible for us to express the manifold affinities we notice without taking up separately each special structure. Any attempt to take up a combination of characters, or a system of combinations, is sure to lead us to indefinite problems far beyond our power to grasp.

In the oldest fossil Clypeastroids and Petalosticha, as well as in the Desmosticha, we also find the potential expression of the greater number of the modifications subsequently carried out in genera of later date. The semipetaloid structure of some of the earlier genera of Spatangoids, the slight modifications of some of the plates of the actinal side near the actinostome, are the precursors, the one of the highly complicated petaloid ambulacra of the recent Spatangoids, the other of the actinal plastron, leading as it does also to the important differences subsequently developed in the anterior and posterior extremities of the test, as well as to the modifications which lead to the existence of a highly labiate actinostome.

The appearance of a few miliaries near the actinostome constitutes the first rudimentary bourrelets.

Going back now to the Palæchinidæ, the earliest representatives of the Echini in Palæozoic times, without any attempt to trace the descent of any special type from them, we may, perhaps, find some clue to the probable modifications of their principal structural features preparatory to their gradual disappearance. In the structure of the coronal plates, the specialization of the actinal and abactinal systems, the conditions of the ambulacral system, we must compare them to stages in the embryonic development of our recent Echini with which we find no analogues in the fossil Echini of the Lias and the subsequent formations. In order to make our parallelism we must go back to a stage in the embryonic history of the young Echini, in which the distinction to be made between the ambulacral and interambulacral systems is very indefinite, in which the apical system is, it is true, specialized, but in which the actinal system remains practically a part of the coronal system. But here the comparison ceases, and, although we can trace in the palæontological development of such types as *Archæocidaris* or *Bothriocidaris* modifications which would lead us, without great difficulty, on the one side to the Cidaridæ, and on the other to the *Echinothuricæ* and Diadematidæ of the present day, we cannot fail to see most definite indications in some of the structural features of the Palæchinidæ of characteristics which we have been accustomed to associate with higher groups. The minute tuberculation, for instance, of the Clypeastroids and Spatangoids, already existing in the Melonitidæ, the genital ring, and anal system, are quite as much Echinid as Cidarid. The polyporous genera of the group represent, to a certain extent, the Polypori of the regular Echini; and the lapping of the actinal plates of the Cidaridæ and of the coronal plates in some of the Diadematidæ, as well as the existence of such genera as *Tetracidaris*, of four interambulacral plates in *Astropyga*, and of a large number of ambulacral plates in some of the recent Echinometradæ—all these are Palæchinid characters which we can explain on the theory of the independent development of the structural features of which they are modifications. We should, however, remember that the existence of a large number of coronal plates, especially interambulacral plates, in the Palæchinidæ is a mere vegetative character which they hold in common with all the Crinoids, a character which is reduced to a minimum among the Holothurians, and still persists in full force among the *Pentacrini* of the present day, as well as the *Astrophytidæ* and *Echinidæ*.

It would lead me too far to institute the same comparison between the embryonic stages of the different orders of Echinoderms and their earliest fossil representatives. We may, however, in a very general way, state that we know the earliest embryonic stages of the orders of Echinoderms of today, which, with the exception of the Blastoidea and Cystideans, are identical with the fossil orders, and that, so far as we know, they all begin at a stage where it would be impossible to distinguish a Sea-urchin from a Starfish, or an Ophiuran, or a Crinoid, or an Holothurian—a stage in which the test, calyx, abactinal, and ambulacral systems are reduced to a minimum. From this identical origin there is developed at the present day, in a comparatively short period of time, either a Starfish, a Sea-urchin, or a Crinoid; and if we have been able successfully to compare, in the development of typical structures, the embryonic stages of the young Echini with their development in the fossil genera, we may fairly assume that the same process is applicable when instituting the comparison within the different limits of the orders, but with the same restrictions: that is, if we wish to form some idea of the probable course of transformations which the earliest Echinoderms have undergone to lead us to those of the present day, we are justified in seeking for our earliest representatives of the orders such Echinoderms as resemble the early stages of our embryos, and in following, for them as for the Echini, the modifications of typical structures. These we shall have every reason to expect to find repeated in the fossils of later periods; and going back a step further we may, perhaps, get an indefinite glimpse of that first Echinodermal stage which should combine the structural features common to all the earliest stages of Echinoderm embryos.

And yet, among the fossil Echinoderms of the oldest periods, we have not as yet discovered the earliest type from which we would derive either the Starfishes, Ophiurans, Sea-urchins, or Holothurians. With the exception of the latter, which we can leave out of the question at present, we find all the orders of Echinoderms appearing at the same time. But while this is the case, one of the groups attained in those earliest days a prominence which it gradually loses with the corresponding development of the Starfishes, Ophiurans, and Sea-urchins; it has steadily declined in importance: it is a type of Crinoids, the Cystideans, which culminated during Palæozoic times, and completely disappeared long before the present day. If we compare the early types of Cystideans with the typical embryonic Echinodermal type of the present day,

we find they have a general resemblance, and that the Cystideans and Blastoids represent among the fossil Echinoderms the nearest approach we have yet discovered to this imaginary prototype of Echinoderms.

This may not seem a very satisfactory result to have attained. It certainly has been shown to be an impossibility to trace in the palæontological succession of the Echini any thing like a sequence of genera; no direct filiation can be shown to exist; and yet the very existence of persistent types, not only among the Echinoderms but in every group of marine animals, genera which have continued to exist without interruption from the earliest epochs at which they occur to the present day, would prove conclusively that at any rate some groups among the marine animals of the present day are the direct descendants of those of the earliest geological periods. When we come to types which have not continued so long but yet have extended through two or three great periods, we must likewise accord to their latest representatives a direct descent from the older. The very fact that the ocean basins date back to the earliest geological periods, and have afforded to the marine animals the conditions most favourable to an unbroken continuity under slightly varying circumstances, probably accounts for the great range in time during which many genera of Echini have existed. If we examine the interlacing in the succession of the genera characteristic of later geological epochs, we find it an impossibility to deny their continuity from the time of the Lias to the present day. The *Cidaris* of the Lias and the *Rhabdocidaris* of the Jura are the ancestors of the *Cidaris* of today. The *Salenia* of the Lower Chalk are those of the *Salenia* of today. *Acrosalenia* extends from the Lias to the Lower Cretaceous, with a number of recent genera, which begin at the Eocene. The *Pygaster* of today dates back to the Lias; *Echinocyamus* and *Fibularia* commence with the Chalk. *Pyrina* extends from the Lower Jura through the Eocene. The *Echinobrissus* of today dates back to the Jura. *Holaster* lived from the Lower Chalk to the Miocene; and the *Hemiaster* of today cannot be distinguished from the *Hemiaster* of the Lower Cretaceous.

Such descent we can trace, and trace as confidently as we trace a part of the population of North America of today as the descendants of some portion of the population of the beginning of this century. But we can go no further with confidence, and bold indeed would he be who would attempt, even in a single State, to trace the genealogy of the inhabitants from those of ten years before. We had better acknow-

ledge our inability to go beyond a certain point ; any thing beyond the general parallelism I have attempted to trace, which in no way invalidates the other proposition, we must recognize as hopeless.

But in spite of the limits which have been assigned to this general parallelism, it still remains an all-essential factor in elucidating the history of palæontological development ; and its importance has but recently been fully appreciated. For, while the fossil remains may give us a strong presumptive evidence of the gradual passage of one type to another, we can only imagine this modification to take place by a process similar to that which brings about the modifications due to different stages of growth—the former taking place in what may practically be considered as infinite time when compared to the short life-history which has given us, as it were, a *résumé* of the palæontological development. We may well pause to reflect that in the two modes of development we find the same periods of rapid modifications occurring at certain stages of growth or of historic development, repeating in a different direction the same phases. Does it, then, pass the limits of analogy to assume that the changes we see taking place under our own eyes in a comparatively short space of time—changes which extend from stages representing, perhaps, the original type of the group to their most complicated structures—may, perhaps, in the larger field of palæontological development, not have required the infinite time we are in the habit of asking for them ?

Palæontologists have not been slow in following out the suggestive track ; and those who have been anatomists and embryologists besides have not only entered into most interesting speculations regarding the origin of certain groups, but they have carried on the process still further, and have given us genealogical trees where we may, in the twigs and branches and main limbs and trunk, trace the complete filiation of a group as we know it today, and as it must theoretically have existed at various times to its very beginning. While we cannot but admire the boldness and ingenuity of these speculations upon genetic connection so recklessly launched during the last fifteen years, we find that, with but few exceptions, there is little to recommend in reconstructions which shoot so wide of the facts as far as they are known, and seem so readily to ignore them. The moment we leave out of sight the actual succession of the fossils and the ascertainable facts of post-embryonic development, to reconstruct our genealogy, we are building in the air. Ordinarily the twigs of any genealogical tree have only a

semblance of truth; they lead us to branchlets having but a slight trace of probability, to branches where the imagination plays an important part, to main limbs where it is finally allowed full play, in order to solve with the trunk, to the satisfaction of the writer at least, the riddle of the origin of the group. It seems hardly credible that a school which boasts for its very creed a belief in nothing which is not warranted by common sense should descend to such trifling.

The time for genealogical trees is past; its futility can, perhaps, best be shown by a simple calculation which will point out at a glance what these scientific arboriculturists are attempting. Let us take, for instance, the ten most characteristic features of Echini. The number of possible combinations which can be produced from them is so great that it would take no less than twenty years, at the rate of one new combination a minute for ten hours a day, to pass them in review. Remembering now that each one of these points of structure is itself undergoing constant modifications, we may get some idea of the nature of the problem we are attempting to solve when seeking to trace the genealogy as understood by the makers of genealogical trees. On the other hand, in spite of the millions of possible combinations which these ten characters may assume when affecting not simply a single combination, but all the combinations which might arise from their extending over several hundred species, we yet find that the combinations which actually exist (those which leave their traces as fossils) fall immensely short of the possible number. We have, as I have stated, not more than twenty-three hundred species actually representing for the Echini the results of these endless combinations. Is it astonishing, therefore, that we should fail to discover the sequence of the genera, even if the genera, as is so often the case, represent, as it were, fixed embryonic stages of some Sea-urchin of the present day? In fact, does not the very history of the fossils themselves show that we cannot expect this? Each fossil species, during its development, must have passed through stages analogous to those gone through by the Echini of the present day. Each one of these stages at every moment represents one of the possible combinations; and those which are actually preserved correspond only to the particular period and the special combination which any Sea-urchin has reached. These stages are the true missing links, which we can no more expect to find preserved than we can expect to find a record of the actual embryonic development of the species of the present day without direct observation at the time. The actual number of species in

any one group must always fall far short of the possible number; and for this reason it is out of the question for us to attempt the solution of the problem of derivation, or to hope for any solution beyond one within the most indefinite limits of correctness. If, when we take one of the most limited of the groups of the animal kingdom, we find ourselves engaged in a hopeless task, what must be the prospect should we attack the problem of other classes or groups of the animal kingdom, where the species run into the thousands, while they number only tens in the case we have attempted to follow out? Shall we say "ignorabimus" or "impavidi progrediamus," and valiantly chase a phantom we can never hope to seize?

XLIV.—*On a new Species of Gyraacanthus, a Fossil Fish from the Coal-measures.* By JAMES W. DAVIS, F.G.S. &c.

Gyraacanthus denticulatus, Davis (sp. n.).

Spine: length 8·5 inches, greatest diameter (one third the length from the basal extremity) ·7 of an inch. The spine is slightly curved, rather more so on the posterior than the anterior surface. The basal portion contracts slightly and has a rounded termination. The exposed part tapers gradually to a fine point. The spine is much compressed laterally; the anterior portion is rounded; and a deep cavity extends posteriorly from the base more than one third its length, and is continued internally to within a short distance from the point. The line dividing the exposed part of the spine from that which was enclosed in the body of the fish is very oblique; beginning ·7 of an inch from the base in front, it extends across to the back, where it is 3 inches from the base. The basal portion has the usual fibrous character. The exposed surface is covered with the ridges and grooves characteristic of the genus *Gyraacanthus*; they extend very obliquely from the posterior to the anterior surface, where they meet with the ridges from the opposite side at a sharp angle; they are continuous; but the surface of the ridge is produced at short intervals, so as to present a beaded or tuberculate appearance, especially towards the anterior surface. Extending from the point along the posterior portion of each side is a space which is free from the gyrating ridges and grooves. It is about 2½ inches long and ·15 of an inch wide; with the exception of two or three minute ridges running parallel with

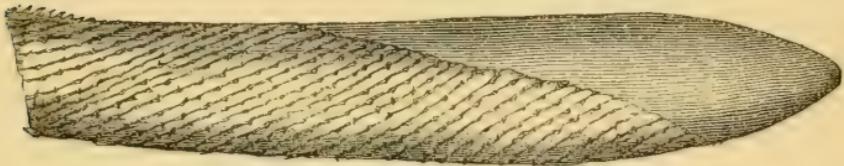
the posterior edge of the spine, this surface is smooth. At the angle formed by the junction of the posterior with each lateral surface there is a row of sharp recurved denticles; they are small and closely set, being not more than 1-20th of an inch apart, and projecting about an equal distance from the spine. The two rows of denticles extend from the point along at least half the length of the spine.

Spine of *Gyracanthus denticulatus*, $\frac{3}{4}$ nat. size.

1.



2.



1. Upper half of spine.

2. Basal extremity.

This spine presents features differing very materially from the species of *Gyracanthus* hitherto described. In general form and outline it is similar to *Gyracanthus formosus*, Ag.*, except that it is much compressed laterally and of a more delicate and elegant mould. It, however, differs materially from the types of Agassiz, as well as all others, in having a double row of denticles along the dorsal aspect. Prof. M'Coy† has described a species of *Gyracanthus* from the Yellow Sandstone at the base of the Carboniferous series near Draperstown, which has indications of a small number of denticles near the apex; it is named *obliquus*, and is rounder and more robust than the one here described; it has not the smooth space near the apex; and the denticles appear to be of quite a different form, besides being so limited in number and extent. I suggest the specific name *denticulatus*, as serving to distinguish the special features of the specimen now described.

Locality. Tingley, near Leeds. In an impure cannel coal of the Middle Coal-measures.

* Poissons Fossiles, vol. iii. p. 17, tab. v. figs. 4, 5, 6, 7, 8.

† Brit. Palæoz. Rocks and Foss. p. 629, pl. 3 K. figs. 13, 14.

XLV.—*Additional List of the Deep-sea Mollusca of the Bay of Biscay.* By J. GWYN JEFFREYS, LL.D., F.R.S.

AFTER giving, in the last number of the 'Annals,' a list of the species of Mollusca procured by the French Expedition, I said, "When M. de Folin has completed his examination of the sifted material, other species will in all probability have to be added to the list." This examination has now been completed by M. de Folin, with his usual industry and care; and I subjoin a supplemental list, distinguishing in the same way as before the new, northern, southern, and 'Porcupine' species. The present and former list give a total of 199 species, viz. 17 new, 9 northern, 2 southern, 169 'Porcupine,' and 2 (*Terebratula subquadrata* and *Odostomia nitidissima*) which are Atlantic and Mediterranean but not 'Porcupine.' It will be seen that several of the species in the present list are supposed to have been drifted from shallower water. This may have been owing to the proximity of the explored area to the shore, and to the consequent action of rivers and tidal currents.

BRACHIOPODA.

1. *Terebratula subquadrata*, *Jeffreys*. Young. Proc. Zool. Soc. 1878, p. 402, pl. xxii. fig. 4.

CONCHIFERA.

2. *Pecten similis*, *Laskey*. A single valve; probably drifted.
3. *Mytilus edulis*, *Linné*. A valve of a young specimen. Same remark.
4. *Modiolaria marmorata*, *Forbes*. Same remark.
5. *Arca lactea*, *L.* Same remark.
6. *Leda tenuis*, *Philippi*. *L. pygmea*, auct., not Von Münster.
7. *Nucula striatissima*, *Sequenza*.
8. *Montacuta ovata*, *J.* (MS.).
9. *Decipula ovata*, *J.*
10. *Kellia symmetros*, *J.* 'Valorous' expedition, 1750 fathoms; Norwegian Arctic expedition, 656 and 1200 fathoms.
11. *Lasæa rubra*, *Montagu*. A single valve; probably drifted.
12. *Woodia digitaria*, *L.* Same remark.
13. *Tellina gladiolus*, *J.* (MS.).

SOLENOCONCHIA.

14. *Dentalium capillosum*, *J.* Fragments.
15. *Cadulus ovulum*, *Ph.* A Calabrian and Sicilian fossil.
16. *C. gibbus*, *J.* (MS.).
- 17.**C. propinquus*, *G. O. Sars.*
- 18.**C. subfusiformis*, *M. Sars.*
- 19.**C. gracilis*, *J.*
20. *C. cylindratus*, *J.*

GASTROPODA.

21. *Cyclostrema trochoïdes*, *J.*
- 22.**Mölleria costulata*, *Möller.*
23. *Rissoa parva*, *Da Costa.* A dead specimen; probably drifted.
24. *R. subsoluta*, *Aradas.*
25. *R. semistriata*, *Mont.* Probably drifted.
26. *Hydrobia ulvæ*, *Pennant*, var. *Barleei.* Same remark.
27. *Odostomia blandula*, *J.* (MS.).
28. *O. nana*, *J.* (MS.).
29. *O. insculpta*, *Mont.* Probably drifted.
30. *O. interstincta*, *Mont.* Same remark.
31. *O. sceptrum*, *J.* (MS.).
32. *O. nitidissima*, *Mont.* Probably drifted.
33. *Eulima intermedia*, *Cantraine.*
34. *E. obtusa*, *J.* (MS.).
35. *E. distorta*, *Deshayes.*
36. *E. curva*, *J.* (MS.).
37. *Adeorbis umbilicatus*, *J.* (MS.).
- 38.†*Columbella scripta*, *L.* A fragment of a young specimen; probably drifted.
39. *Utriculus obesus*, *J.* (MS.).
40. *U. excavatus*, *J.* (MS.).
41. *U. pusillus*, *J.* (MS.).
- 42.**U. globosus*, *Lovén.* A young specimen.
43. *Bulla similevis*, *J.* (MS.).
44. *P. catena*, *Mont.* A single specimen; probably drifted.

PTEROPODA.

45. *Limacina carinata*, *J.* (MS.). Pelagic.
46. *Spirialis retroversus*, *Fleming.* Same remark.

CEPHALOPODA.

47. A sucker of a small octopod.

XLVI.—*Contributions towards a General History of the Marine Polyzoa.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

[Continued from p. 92.]

[Plates XVI. & XVII.]

II. FOREIGN MEMBRANIPORINA (*continued*).

Membranipora tenella, n. sp. (Pl. XVI. fig. 7.)

Zoecia elongate, tapering off gradually below; aperture oval, more or less elongated, occupying (usually) three fourths of the front of the cell, with a narrow and smooth margin, except at the bottom, where it is slightly expanded and punctate, covered in by a delicate, translucent and shining membrane; lower portion of the cell tapering slightly downwards, smooth and glossy, with a single nodule in the centre, or two, one on each side. *Avicularia* none. *Oœcia* (?).

This species presents no very striking features. The whole zoarium is of singularly delicate material, and very bright and hyaline. The *zoecia* vary somewhat in shape, having the aperture at times much elongated and narrowed; they are disposed rather irregularly in lines. Cells are of frequent occurrence which give origin at the upper extremity to two abnormally narrow ones, the result of a longitudinal division of the bud.

Loc. Florida, on weed (*Miss Jelly*).

Membranipora Flemingii, Busk, var.
(Pl. XVI. fig. 8.)

Zoecia turbinate; area enclosed by a raised margin, crenated on the inner surface, occupying three fourths of the front of the cell, with a calcareous lamina, minutely pitted, which fills in about two thirds of it; aperture moderate, markedly trifoliate; the lower portion of the cell (below the area) of variable size, tapering downwards to a point; an *avicularium* in the centre of the lower margin of the area, placed transversely, sloping obliquely upwards, with an acute mandible; avicularian chamber subturbinate. No spines. *Oœcia* (?).

Loc. Unknown. On a foreign species of *Retepora* (*Miss Jelly*).

This seems to be a spineless form of the well-known *M. Flemingii*. The zoarium, in the only specimen examined, is remarkably bright and silvery; the lower portion of the cell

is well developed, and the form distinctly turbinate. There is no trace of spines. The avicularium is not unfrequently single and central in this species.

The present form is worth noting for its beauty and the peculiarity of its appearance, but it has no claim to be accounted more than a variety.

Membranipora pedunculata, Manzoni.
(Pl. XVII. figs. 2, 2 a.)

M. pedunculata, Manz. Bryozoi foss. Ital. contr. 4 (1870), p. 7, pl. ii. fig. 7.

Zoæcia irregularly massed together, forming a thick white crust, or running out into linear series and disposed in single file, pyriform, oval above, and below narrowing off to a point, so as to appear somewhat stalked, suberect, the cell-wall strongly calcified, dense, smooth, porcellaneous, rising from the base to the bottom of the aperture, where it is highest; aperture sloping off to the top of the cell, occupying usually about half the front surface, wholly covered in with membrane, oval, with a smooth raised margin, expanded towards the bottom into a rather broad border. *Avicularia* none. *Oæcia* "globose, smooth, imperforate" (*Manzoni*).

Loc. Ceylon, on weed (*Miss Jelly*).

Range in time. Italian Pliocene deposits, Castell' Arquato (*Manzoni*).

The dense white walls are a conspicuous feature in this species. From the base of the aperture the cells taper off rapidly to a point, so as to appear almost pedunculate. In the mass they are suberect; and the aperture, which slopes upward, is subterminal. When running out in single series they present a very *Hippothoa*-like appearance; in this condition they are often very slightly united, and in some cases are wholly disjunct. Many small rudimentary zoæcia are scattered over the colony amongst the normal cells.

There would seem to be no material difference between the Ceylon form and the Tertiary species described by Manzoni under the name of *M. pedunculata*, which must therefore take its place in the recent fauna.

Membranipora polita, n. sp. (Pl. XVII. fig. 1.)

Zoæcia disposed in regular transverse rows, of a solid, white, smooth, ivory-like material, expanding above and tapering off downwards, separated by very distinct narrow sutures, very prominent in front, usually with a smooth umbonate swelling immediately below the aperture, often much grooved

transversely across the front wall; aperture subterminal, occupying about one third of the whole length, with a membranous covering, arched above, lower margin straight or slightly curved outwards; peristome thickened and often somewhat elevated at the sides. *Avicularia* none. *Oœcia* (?).

Loc. Glenelg, Australia, incrusting stems of weed (*own collection*).

Both this species and the preceding belong to the section of the genus of which *M. catenularia*, Jameson, is the best-known representative.

Membranipora corbula, n. sp. (Pl. XVII. fig. 6.)

Zoœcia short-oval, distinct, front wall wholly membranous; margins thin, bearing a number of somewhat compressed spines (usually four on each side and one at the bottom), which bend rather abruptly over the area, the extremities meeting and crossing in the centre, but not uniting; orifice semicircular, on each side of it two tall and stout spines, of which the foremost are usually curved and of gigantic size. *Oœcium* shallow, rounded, smooth, much thrown back, with a raised rib across the front, a little above the oral margin. *Avicularia* none.

Loc. Australia, on other Polyzoa (*own collection*).

A very pretty form, with bright glittering cells, which creeps over the stems of various Polyzoa. It has much the appearance of a *Membraniporella*; but the spines are never united so as to form a single piece; it is properly ranked amongst the spiniferous *Membraniporæ*. At the same time it must be admitted that through such a form as the present the two groups are brought very close together.

An attempt will be made hereafter to give at least a rough estimate of the number of described species (recent) which are referable to the present genus.

Family Microporidæ.

MICROPORA, Gray.

?*Micropora coriacea*, Esper, var. (Pl. XVI. fig. 6.)

Zoœcia irregularly lozenge-shaped, front surface very slightly convex, minutely granular, with numerous small punctures, often covered with a brown epidermis; margin thin, very slightly granular or beaded, not much elevated, of about equal size throughout (not enlarged at the base of the orifice); orifice semicircular. *Avicularia* none. *Oœcia* large, rounded, somewhat elongated, with a knob in front, from which two

ribs pass off to the margin, so as to enclose a triangular space.

Loc. Mediterranean or Red Sea (*R. S. Newall*).

This form seems to be a variety of *M. coriacea*, distinguished by the total absence of the nodulous enlargement of the margin on each side immediately below the orifice. This character can hardly be accounted of much importance, as it is one of those which are found to be liable to great variation. I have not noticed avicularia on the present form; but they are often wanting on the normal *M. coriacea*.

STEGANOPORELLA, Smitt.

Steganoporella Rozieri, Audouin.

This species was figured by Savigny in his work on Egypt; and subsequently by Busk in his 'Catalogue,' from specimens obtained by Mr. Darwin in South America. It occurs in various parts of the world, but with certain modifications, which are extremely interesting as illustrating the range of variation and indicating the elements of structure which are most liable to change.

In the normal *S. Rozieri* the raised margin terminates above on each side in "a small tuberosity," and the front of the cell is represented as decidedly elliptical; avicularia are altogether wanting; the œcium is large, globose, and somewhat bilobate.

In Mazatlan a form occurs (described by Busk as a species under the name *Membranipora gothica**) which seems to be distinguished from the foregoing chiefly by the non-development of œcia and the presence of large avicularia. The œcium (according to Busk) is "represented by one or two rounded eminences at the bottom of the cell in front." This variety is very abundant at Santa Monica, California, where it spreads profusely over weed; I have figured it from a specimen obtained in this locality (Pl. XVI. fig. 3).

Another form has been received from India (Pl. XVI. figs. 1, 1a). In this the marginal tuberosities, which are so conspicuous a character in the two preceding, are wanting; avicularia are present, which bear a general resemblance to those of *S. gothica*, Busk, though they are furnished, I believe, with a somewhat different mandible; and there is a large bilobate œcium, like that of the normal *S. Rozieri* (Pl. XVI. fig. 1a).

Yet another variety has occurred, from Australia, which

* Quart. Journ. Micr. Sc. 1856, pl. vii. figs. 5-7.

agrees in general character with all the foregoing, and in common with the normal form and *S. gothica* possesses the tuberosities. But the avicularium has undergone a very striking modification, and is furnished with an elongate, tapering, and somewhat falciform mandible (Pl. XVI. fig. 2). Oœcia have not been met with.

I confess I cannot regard the differences just noted as having any specific value in the face of the striking resemblance in general character and in the more permanent features amongst the various forms. No importance can attach to the presence or absence of the marginal tuberosities, whilst the avicularia are too uncertain in their occurrence and too variable in form to be relied upon *alone* as diagnostic characters. The apparent suppression of the oœcium in *S. gothica* has no greater claim, I believe, to be accounted a specific distinction. We know that in *Lepralia Pallusiana* this structure is generally undeveloped, and only occurs in rare instances.

The various forms just enumerated may be arranged as follows:—

Steganoporella Rozieri, Audouin.

1. Normal form. With marginal tuberosities and large bilobate oœcium; avicularia wanting.

2. Form *gothica*. With marginal tuberosities; destitute of oœcia; avicularia large, with triangular mandible.

Loc. Mazatlan (*Dr. Philip Carpenter*); California (*own collection*).

3. Form *indica*. Without tuberosities; avicularia large, with somewhat elongate, slender, pointed mandible; large bilobate oœcium.

Loc. India (*Miss Jelly*).

4. Form *falcifera*. With marginal tuberosities; avicularia large, with much elongated, tapering, falciform mandible; oœcium (?).

Loc. Australia (*Miss Jelly*).

Steganoporella elongata, n. sp. (Pl. XVI. fig. 4.)

Zoœcia very much elongated, narrow, subquadrangular, covered in by a coarse, granulated, and punctured lamina, which slopes steeply up from a little below the orifice to the lower lip; on each side of the sloping portion a small foramen, usually filled in by a granular covering; margin strongly beaded; orifice small, narrow between the lower and upper margins. *Avicularia* small, scattered over the zoarium in the line of the cells, occupying a distinct area marked off by a

granular border; the mandible triangular, directed obliquely upwards. *Oæcia* (?).

Loc. Africa (*Miss Jelly*).

Steganoporella Jervoisii, n. sp. (Pl. XVI. fig. 5.)

Zoæcia quadrangular, about twice as long as broad, closed in by a glossy, transparent lamina, which is thickly covered with minute white disks; margin much raised, thin, smooth; the lamina (which is often intersected and divided into segments by opaque-white lines) depressed below, elevated towards the orifice, where it is smooth, and having on each side of it a foramen; orifice arched above, the lower margin slightly curved outwards, taller than broad, with a raised thin margin; on each side of it a prominent nodule, glassy and transparent below, with a conspicuous opaque-white summit. *Aricularia* infrequent, placed in the line of the cells on a distinct area; mandible somewhat raised, pointed, directed straight upwards. *Oæcia* (?).

Loc. Adelaide, Australia, on weed (*Miss Gatty*).

This is a singularly beautiful species, distinguished by its glossy, transparent, speckled lamina and the prominent opaque-white nodules which flank the orifice on each side.

The following recent species are probably referable to the genus *Steganoporella*:—*Eschava impressa*, Moll. (= *Membranipora gracilis*, Reuss; *M. calpensis*, Busk; ? *M. andegavensis*, Busk; *M. bifoveolata*, Heller; *Micropora impressa*, Waters); *Flustra Rozieri*, Audouin; *Membranipora gothica*, Busk (= *S. Rozieri*, form *gothica*, mihi); *Membranipora magnilabris*, Busk; *S. Smittii*, Hincks.

III. FOREIGN CHEILOSTOMATA (Miscellaneous).

Family Microporellidæ.

MICROPORELLA, Hincks.

Microporella fissa, n. sp. (Pl. XVII. fig. 4.)

Zoæcia ovate, somewhat elongate, separated by distinct furrows, the front surface convex, minutely granulated, traversed by nodulous ridges which pass from the margin towards the centre, punctate or areolated round the edges; the centre of the cell occupied by an elliptical depression, within which is a narrow, longitudinal, slit-like pore; orifice semi-circular; peristome thin, much raised, especially above, where it bends in hood-like fashion over the mouth, the inner edge of the lower lip very minutely crenate; immediately below the

inferior margin an *avicularium*, placed transversely, with pointed mandible directed obliquely upwards; in some cells this *avicularium* is absent and is replaced by a very large *avicularium* placed at one side of the orifice, the beak much elongated and somewhat falciform, the mandible expanded at the base and tapering off to a point above, directed upwards. *Oæcia* (?). Frequently a pointed *avicularium* on the lower part of the cell.

Loc. Indian Ocean (*Miss Jelly*).

Flustra coronata, Audouin, *Lepralia marsupiata*, Busk, *Porellina stellata*, Verrill, as well as the present form, may be added to the list already given of species referable to this genus.

Family **Myrizoidæ** (part), Smitt.

SCHIZOPORELLA, Hincks.

? *Schizoporella sanguinea*, Norman, var.
(Pl. XVII. fig. 3.)

Zoæcia flattish, quadrangular, in linear series, separated by raised lines; surface punctured and roughened by ridges and nodules; orifice depressed, much broader than high, arched above, lower margin straight, with a central sinus, and on each side a small notch. In a line below the inferior margin three small circular *avicularia*—one central, and one on each side between the orifice and the side wall. *Oæcia* (?).

Loc. Red Sea or Mediterranean (*R. S. Newall*).

The only character by which this form can be distinguished from *S. sanguinea*, Norman, is the triplet of circular *avicularia* below the orifice. They appear to be generally present, and always occupy, so far as I have seen, the same positions. Taking into account, however, the inconstant character of the *avicularian* appendages in this group, it seems better to rank the present form as a variety.

Family **Escharidæ** (part), Smitt.

PORELLA, Gray.

Porella rostrata, n. sp. (Pl. XVII. fig. 5.)

Zoæcia enlarged above, narrowing off towards the base, rounded at the top, bounded by a slightly raised line; surface smooth and shining, bearing several bosses or umbos of various size; front wall rather abruptly raised towards the inferior margin, below depressed; orifice (primary) arched above, slightly narrowed towards the lower margin, which is straight; peristome (in the adult) raised, forming a secondary

orifice, arched above, the sides inclining slightly inwards, the lower margin (which is somewhat curved outwards) bearing a round *avicularium*; within it three denticles, the central one hammer-shaped, the two lateral acute; immediately below it a tall and very stout rostrum, with a smaller one on each side of it, the three stretching across the cell; at the top of the orifice usually two or three similar processes of smaller size, sometimes two spines on the upper margin. *Oœcia* (?).

Loc. Australia (*Miss Jelly*).

In this curious species the cells are often separated from one another, an open space or groove lying between the margins.

MUCRONELLA, Hincks.

Mucronella (?) *tubulosa*, n. sp. (Pl. XVII. fig. 7.)

Zoœcia large, irregularly arranged, suberect; surface white, smooth, and glossy, very convex and subcarinate in front; orifice suborbicular, depressed; peristome very much raised on the sides and in front, so as to form with the wall of the neighbouring cells a wide funnel-shaped shaft, in which the mouth is quite concealed; peristome carried up in front into a massive central mucro; at the base of it a large linguiform *avicularium*, much raised; mandible directed downwards. *Oœcium* rounded above, somewhat compressed and flattened towards the orifice, smooth or very minutely roughened, placed at some distance above the mouth, towards the upper part of the oral shaft.

Loc. Australia (*Miss Jelly*).

This is a remarkable form, distinguished especially by the position of the ovicell, and the ample funnel-shaped shaft in which the mouth is immersed. The arrangement of the zoœcia is also peculiar. I have only had the opportunity of examining a small fragment and can hardly determine with certainty its generic place. For the present it may be referred to *Mucronella*, with which it has apparent affinity.

EXPLANATION OF THE PLATES.

PLATE XVI.

- Fig. 1.* *Steganoporella Rozieri*, Audouin, form *indica*. 1 a. Oœcium.
Fig. 2. *Steganoporella Rozieri*, Audouin, form *falcifera*.
Fig. 3. *Steganoporella Rozieri*, Audouin, form *gothica*, Busk.
Fig. 4. *Steganoporella elongata*, n. sp.
Fig. 5. *Steganoporella Jervoisii*, n. sp. 5 a. Avicularium.
Fig. 6. *Micropora coriacea*, Esper, var.
Fig. 7. *Membranipora tenella*, n. sp.
Fig. 8. *Membranipora Flemingii*, Busk, unarmed variety.

PLATE XVII.

Fig. 1. *Membranipora polita*, n. sp.

Fig. 2. *Membranipora pedunculata*, Manzoni.

Fig. 3. *Schizoporella sanguinea*, Norman, var.

Fig. 4. *Microporella fissa*, n. sp.

Fig. 5. *Porella rostrata*, n. sp. 5 a. Young cells showing the tridentate lower margin of the orifice.

Fig. 6. *Membranipora corbula*, n. sp.

Fig. 7. *Mucronella tubulosa*, n. sp.

XLVII.—*On the Flint Nodules of the Trimmingham Chalk.*

By W. J. SOLLAS, M.A., F.R.S.E., F.G.S., Professor of Geology in University College, Bristol.

[Plates XIX. & XX.]

Personal.—In 1873 Mr. Jukes-Browne gave me some very interesting specimens of flint nodules which he had obtained from the chalk of Trimmingham, Norfolk. To the examination of these I devoted a great part of the summer of 1874, preparing some hundreds of drawings of the sponge-spicules which are associated with them. After a visit to the Trimmingham cliffs together, my friend Jukes-Browne and I arranged to write a joint paper on them, he undertaking their general geology and leaving the description of the flints to me. Jukes-Browne's paper was ready for publication a year or more ago; but mine seemed in danger of indefinite postponement, when I heard from Mr. G. Jennings Hinde, F.G.S., that he too was at work on the same or a very similar subject. This led me to embody my results in the following paper, which was read before section C of the British Association during its meeting at Swansea this summer. It will appear as an abstract in the Annual Report, and is given here in full as a sequel to Mr. Jukes-Browne's, which appeared in the 'Annals' of last month.

The Flint Nodules.—In form they vary greatly: some are flabellate, some irregularly conical; others consist of a somewhat ellipsoidal body seated on a short stalk, while many are irregular and amorphous. They consist of chalk and silex in various proportions; sometimes the chalk forms the greater part of a nodule, sometimes it is altogether absent. Between a nodule consisting of a solid mass of silex, black throughout, except on the surface, and one consisting chiefly of siliceous chalk there are any number of others forming a complete transitional series. Commonly the flint is traversed by a number of winding anastomosing passages, which are occu-

pied by chalk of a greyish-white colour, and often crammed with sponge-spicules, many of which are large enough to be visible to the naked eye. The trabeculæ of flint between the passages are white and porous exteriorly, where they lie in contact with the chalk; but on breaking them across they are found to consist within of ordinary black flint, with its characteristic greyish spots and patches.

In the more completely silicified nodules the middle consists of a core of solid flint, and chalk-filled passages exist only on the exterior. These finally disappear in the last stages of silicification; and the nodule then consists of compact flint throughout.

The exterior of most of the nodules is covered with a more or less extensive layer of flint, which may form a mere film enclosing the interlaced flint and chalk within, or may attain a thickness of an inch and become continuous with the trabeculæ of the interior; on the surface it is even, white, and porous, with no appearance of structure, indeed just like the surface of an ordinary chalk flint. In the completely silicified forms this layer is not present as a distinct structure, being represented merely by the exterior of the nodule.

To separate the chalk with its spicules from the flint, the nodules were placed in distilled water; the chalk becoming soft and semifluid, easily fell away from the flint, and with its contained spicules formed a thick sediment at the bottom of the water. To complete the separation, and to remove carbonate of lime, sufficient hydrochloric acid was next added: this dissolved the chalk; and an insoluble residue then remained behind, consisting of silicified coccoliths, Foraminifera, Entomostraca, Polyzoa, and echinoderm-spines, siliceous and glauconitic casts of Foraminifera, and sponge-spicules in great variety. This material was washed, dried, and mounted for microscopic investigation. As a medium for mounting, Canada balsam was, in most cases, found to be unsuited; it rendered the spicules too transparent for observation; and so glycerine jelly was substituted for it.

The flint, after it had shed its associated chalk, was also washed and dried. The parts from which the chalk had been removed showed a white porous surface, sometimes marked by a number of small circular pits, varying in size, many being between $\frac{1}{50}$ and $\frac{1}{100}$ inch in diameter, and recalling to mind the ostia of a sponge. No definite structure, however, could be detected in this layer.

Occasionally a broken fragment of a Lithistid or Dictyonine Hexactinellid sponge projects from it; and so one finds now and then a protruding fragment of a molluscan shell, or the

rostrum of a *Belemnitella*; but none of these included bodies have determined the general form of the nodule in which they occur. The surface of the passages in the flint bristles with large spicules having one end imbedded in the flint and the other projecting freely outwards; these spicules may serve to determine whether the chalk or the flint of the nodule occupies the place of the sponge which, we believe, determined by its existence the formation of the flint. If the chalk, then the points, if the flint the heads of the spicules should be seen projecting into the cavity. On examination one finds both heads and points projecting, but the heads least frequently, perhaps because they have been broken off. These observations go but a very little way towards proving any thing; by analogy with other flints, however, we should conclude that the chalk represents the original sponge; and so far as the position of the spicules in the nodules indicates any thing it is in this direction.

We now proceed to the determination of the spicules, commencing with those belonging to the Lithistidæ. It will be seen that the Lithistidæ are placed within the Tetractinellidæ as a suborder. This necessitates the formation of a new name for those Tetractinellidæ which are not Lithistids; and we propose to call them Choristidæ, since their spicules are separate and not locked together into a network. Thus, just as we have Dictyonine and Lyssakine Hexactinellidæ, so we can speak now of Lithistid and Choristid Tetractinellidæ.

TETRACTINELLIDÆ.

Lithistidæ.

TETRACLADINA.

Discodermites cretaceus. (Pl. XIX. fig. 1.)

Dactylocalycites polydiscus, Carter, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. p. 122, pl. vii. figs. 3-5.

This spicule, with its nearly circular disciform head and conical shaft, and those of fig. 2, with their smooth cylindrical arms and botryoidal apophyses, precisely resemble the dermal spicule and skeletal corpuscle, respectively, of *Discodermia polydiscus*, Bocage; they may therefore be regarded as having belonged to that or a very closely allied sponge. To identify them specifically with it, in the absence of fuller information, would perhaps be going too far; and hence it may be preferable to ascribe them to a distinct species provisionally. As the recent *D. polydiscus* possesses a long acerate spicule, we may associate with the two forms already

mentioned that of fig. 3, merely, however, as an indication that such spicules are not absent from the deposit, and by no means as implying a belief that this particular one actually formed a part of the skeleton of *Discodermites cretaceus*.

Rhagadinia Zitteli. (Pl. XIX. fig. 8.)

Compare Zittel, *Caloptychium*, Taf. vii. figs. 25, 26, 27, 30.

This spicule is selected for representation as the largest and most regular of a large number of similar forms. Its conical stalk is expanded above into three broad flattened branching arms, which lie in the same plane and form together a much divided disk. It closely resembles the dermal spicule of *Rhagadinia rimosa*, Rœm., from which it is distinguished by the simple edges of its arms, which have not the secondary or minor lobations of *R. rimosa*, and consequently do not present the same ragged appearance. In this respect it much more resembles the dermal spicule of *Rhacodiscula*, Zitt.

Fig. 10 may possibly be the skeletal corpuscle of this species, and fig. 15 the small acerate corresponding to that figured by Zittel from *R. rimosa*.

Eurydiscites irregularis. (Pl. XIX. fig. 14.)

This is one of a number of similar dermal spicules, distinguished by their large size and the coalescence of the arms into an irregularly lobate disk, generally less lobate than in the example here figured, which is an exceptionally regular form. They remind one, but for the presence of a stalk, of the disks of *Plinthosella* represented in Zittel's monograph.

These disks alone are not sufficient to characterize a genus; but they must have a name, and so we designate them provisionally *Eurydiscites irregularis*. Probably they will speedily be identified with the outer coating of some already described fossil genus; and then the necessity for our name will cease. If the genus should be related to *Plinthosella*, we might regard fig. 17 as representing a part of one of its skeletal corpuscles.

Nanodiscites parvus. (Pl. XIX. fig. 13.)

This is a dermal spicule, somewhat resembling that of *Theonella Pratti*, Bow. Its simple, asymmetrical, short branches give it a curious stunted appearance, which suggests the name *Nanodiscites*, from *vávos*, a dwarf.

Compsapsis cretacea. (Pl. XIX. figs. 21 and 22.)

These skeletal corpuscles appear to approach more closely those of *Kaliapsis cidaris*, Bow., than any other form.

In the recent sponge the swollen part of the fourth arm is ornamented by fine longitudinal lobations, which are absent in the fossil fragments. The finely branched ends of the three other arms have disappeared in the fossil spicules as a consequence of fossilization. To indicate the alliance between the recent and the fossil forms, and, at the same time, to denote their difference, I have employed the word *κομψός* for *κάλλος* in the construction of the generic name.

No dermal spicules have been seen which could be considered strikingly similar to *K. cidaris*. Fig. 24 is a curious, finely tuberculated little disk; but it has no shaft, and cannot be referred here.

MEGAMORINA.

Podapsis cretacea and *parva*.

(Pl. XIX. figs. 18 and 23, 25 and 26.)

Carter, on Fossil Sponge-spicules, *loc. cit.* p. 118, pl. x. figs.; Wright, Irish Cret. Microzoa, Belfast Nat. Field-Club, ser. 2, vol. i. pl. iii. figs. 2 and 3.

Figs. 18 and 23, 25 and 26 represent the skeletal corpuscles of a Lithistid evidently allied to *Lyidium torquila*, Sdt. They appear to be much too small to be referred to any of Zittel's species of Megamorina from the chalk; and we provisionally give them a distinct name, the curious foot-like shape of the articular surface at the end of their simple unbranched rays suggesting the term *Podapsis*. They differ themselves widely in size; and the larger forms appear to be also simpler than the smaller; so that we may distinguish them as species, the larger as *P. cretacea*, the smaller as *P. parva*. In Zittel's *Doryderma* (*D. dichotoma*, Phil.) a bifurcated trifid spicule is present, somewhat similar to that of fig. 19, which we place here for comparison.

Carter, who was the first to identify Megamorine corpuscles in the fossil state, says of those he found in the Haldon Greensand:—"many . . . are almost facsimiles of Schmidt's figures of *Lyidium torquila*, obtained by M. de Pourtales in 270 fathoms off the island of Cuba (Atlant. Spong. Fauna, p. 84)."

RHIZOMORINA.

Corallistes cretaceus. (Pl. XIX. fig. 4.)

Carter, Fossil Sponge-spicules, *loc. cit.*; Zittel, *Cœloptychium*, Taf. vi.; Wright, Irish Cret. Microzoa, *loc. cit.*

This trifid spicule with bifid arms is a very common form; it is probably derived from the dermal skeleton of some

Lithistid, though *Thenia muricata* and *Stelletta discophora*, as well as other sponges, contain very similar forms. Amongst recent Lithistids we find it in *Corallistes microtuberculatus* and *C. Bowerbankii*, among fossil forms in *Callopegma* and *Turonina*, *Pachinion* and *Scytalia*. The dermal spicule of *Pachinion* and *Scytalia* differs, however, in possessing shorter and less slender arms; while the dermal spicules of the other two genera, though much more like our forms, are associated with Tetracladine skeletal corpuscles, and these are scarcely plentiful enough in our deposit to account for the large number of dermal spicules which occur in it. On the other hand, Rhizomorine corpuscles are more abundant, and, considering their resemblance to the corpuscles of *Corallistes*, may very well have been associated with dermal spicules similar to those which are known to exist in this genus. Thus one may group the dermal spicule Pl. XIX. fig. 4 with the skeletal corpuscles of figs. 5 and 12. The characters of such a group would approach those of *Scytalia*; and so we might venture to add to it the uniaxial forms Pl. XIX. figs. 7 and 9, which resemble those figured by Zittel as occurring in *Scytalia turbinata*, and which are common in the flint nodules.

Fig. 6 should probably not be included here, as it is much more likely to have belonged to some Echinonematous sponge. There are many spicules in the flints similar to fig. 6, but much more abruptly bent; and I fancy they must have belonged to a sponge like *Dictyocylindrus*.

Macandrewites Vicaryi. (Pl. XIX. fig. 20.)

Dactylocalycites Vicaryi, Carter, Fossil Sponge-spicules, *loc. cit.* pl. vii. figs. 1, 2, 6; Zittel, *Cæloptychium*, Taf. vii. fig. 31?

This form is remarkably similar to the dermal spicule of *Macandrewia clavatella*, O. S., a slight difference in size (this being the larger) chiefly distinguishing them. The skeletal corpuscle shown in fig. 16 is likewise similar to that of *Macandrewia*; and we place the two together under the name of *Macandrewites Vicaryi*.

CORALLISTITES? (Pl. XIX. fig. 27.)

This is a trifold spicule with branching arms, tuberculated on the upper surface and prolonged into a long shaft below. It differs apparently from the dermal spicule of *Corallistes nolitangere* in bearing tubercles on the upper surface of its rays; but in other respects it is very similar.

Choristidæ.

Pachastrellites fusifer. (Pl. XX. fig. 28.)

This fusiform acerate, with its ovate swelling in the middle, resembles the spicule figured by Schmidt (Taf. vi. fig. 5, Atlant. Spong.) from *Pachastrella connectens*.

A similar form occurs in *Papyrula candida*, O. S., and in some Hexactinellids. That it did not belong to a Hexactinellid appears to be shown by the fact that the canal, which frequently occurs in a much enlarged state, never presents a sexradiate cross within the central bulb. It is true that this test is not quite so decisive as one could wish, especially as the canal is altered by enlargement, expanding within the bulb concentric with its surface. On the whole, however, it appears probable that this spicule should be placed with the Pachastrellidæ; and we may provisionally associate with it the trifold spicule (fig. 29), and perhaps the bent acerate (fig. 38).

Pachastrellites globiger. (Pl. XX. fig. 39.)

Fig. 39 is a tubercular globate spicule very similar to that figured by Carter as occurring in his *P. geodoides* ('Annals,' ser. 4, vol. xviii. pl. xiv. fig. 23).

Fig. 40 is similar, but differs in the somewhat more regular size and disposition of its tubercles. They may have been associated with the form fig. 30, and perhaps with spicules like figs. 29 and 38 as well.

T. thylites cretaceus. (Pl. XX. figs. 31, 32.)

Wright, Irish Cret. Microzoa, *loc. cit.* sphaerostellate spicule.

These two spicules are undistinguishable from the stellates of *Tethya lyncurium*; and figs. 33 and 51 represent acute spicules like those of *T. lyncurium*. Zittel has already given the name *Tethyopsis* to a form which he considers related to *Tetilla*, Sdt. As it appears to me that *Donatia* cannot be allowed to replace *Tethya* in our nomenclature, I cannot call my form *Donatites*, and so form its generic name from *Tethya* with the termination "lites."

Triphyllactis elegans. (Pl. XX. fig. 42.)

This trifold spicule with broad trifurcate arms, inclined from the shaft as much upwards as outwards, vasiform, is unlike any known recent or fossil form. It varies from $\frac{1}{200}$ to $\frac{1}{140}$ inch in the length of its rays. Schmidt has lately figured (Spong. d. Meerbusen v. Mexico, 1880, Taf. ix. fig. 4) some spicules which agree in the essential character of having trifold arms;

but in general form these appear to be different. He gives them as coming from a *Pachastrella*-like sponge; ours probably are also derived from a *Pachastrellid* genus.

Dercitites haldonensis, Carter.

(Pl. XX. figs. 41 & 47.)

Carter, Fossil Spicules, *loc. cit.* pl. x. fig. 71.

These, as Carter has pointed out in speaking of the similar spicules from Haldon, are essentially similar to the quadri-radiate spicules in *Dercitus Bucklandi*, Bow. They cannot, however, with certainty be referred to this genus, since O. Schmidt has discovered similar spicules in a Lithistid sponge, *Collectella avita* (Mex. Spong. Taf. v. fig. 1, p. 86).

Geodites cretaceus. (Pl. XX. fig. 34.)

Geodites haldonensis (in part), Carter, Fossil Spicules, *loc. cit.* pl. x. figs. 59, 62, 69.

This is evidently the globate of a Geodine sponge. It has lost all trace of tubercles and internal structure, owing to changes produced by mineralization; but the hilum is still clearly shown.

Such globates are abundant in the deposit, varying in diameter from $\frac{1}{87}$ to $\frac{1}{350}$ inch; it is possible that they may belong to more than one species.

The largest forms are bigger than those of *G. Macandrewi*, in which they attain the largest size known amongst recent sponges. It is, however, with the globates of *G. Macandrewi* that these fossil forms best agree; and the trifid spicule with bifid rays of fig. 43, and the similar but also *Stelletta*-like form of fig. 55 are both so similar in character to the corresponding spicules of *G. Macandrewi*, that we may, with great plausibility, associate them with the globate, while the forms shown in figs. 35 and 43 are sufficiently similar to the anchors with projecting and recurved rays occurring in this sponge to go in the same grouping.

Thus figs. 34, 35, 36, 37, 43, and 45 may be regarded as having probably been derived from one species of sponge, to which we may give the name *Geodites cretaceus*.

The opportunity may be taken to add here a few words on fossil globate spicules in general. They were first discovered by Carter, and described in his paper on fossil sponge-spicules before quoted. Zittel* figured them in connexion with *Cæloptychium*; and his specimens are of great interest as presenting the various stages of dissolution which may be observed in

* Zittel, *Cæloptychium*.

the deciduous globates of recent *Geodia*, and in globates which have been treated with caustic potash*. Though Carter was the first to announce the discovery of fossil globates, they had been previously described by Blake†, who, however, regarded them as Foraminifera, owing to those he examined having undergone complete calcification. These interesting pseudomorphs, which occur in the Coralline Oolite, were named by Blake *Renulina Sorbyana*. Mr. Huddleston, who, with Blake, is our great English authority on the Coral-rag, was kind enough to place in my hands a thin slice of the North-Grimstone rag, and some siliceous matter which had been left behind on dissolving a fragment of that rock. In the latter, remains of trifid spicules and globates were readily seen; in the former, characteristic sections of *Renulina*, agreeing in form and size with the siliceous globates of the insoluble residue, were as clearly evident. A good illustration of these sections as seen in a slice of Grimston rag, magnified 100 diameters, is given by Sorby ‡. Most of the globates of *Renulina*, or, as we may now say, *Geodites Sorbyanus*, have been completely transformed into calcite; others have undergone secondary silicification. The amount of silica set free during their transformation into calcite must have been very great, as will appear from the following statement by Sorby §; he says:—"The Perna bed in Dorsetshire, and also certain beds in Yorkshire, are remarkably rich in the small reniform shells named by Mr. Blake *Renulina*, which constitute as large a part of the bulk of the rock as the Foraminifera do in all but a very few exceptional specimens of chalk."

Huddleston|| has since clearly recognized the nature of *Renulina*; but Blake¶ appears to dispute it.

Rhopalocoenus tuberculatus. (Pl. XX. fig. 46.)

This spicule has the form of a cone with rounded ends; its surface is covered all over by regularly disposed tent-like tubercles. It varies in length from $\frac{1}{100}$ to $\frac{1}{20}$ inch.

Pachæna Hindi. (Pl. XX. figs. 44, 52, 56, 64, and 69.)

* There is a similarity of facies about these large thick spicules which leads one to group them together; we have

* Sollas, "Action of Caustic Potash," *Annals*, ser. 4, vol. xx. pl. ix. figs. 8-11.

† Blake, 'Monthly Microscopical Journal,' 1876, vol. xv. p. 262.

‡ Presidential Address, London Geol. Soc. vol. xxxv. pl. vi. fig. 1, p. 70 (sep. copy).

§ *Loc. cit.* p. 51.

|| Proc. Geol. Assoc. vol. v. p. 443.

¶ *Ibid.* p. 266.

no reason for supposing that they belong to a *Geodia*, though they might very well be derived from some not distantly related sponge, in which case the large conical spicule which we have named *Rhopaloconus* may have filled the same place in it as the globates in *Geodia*. Perhaps fig. 54 should be associated with this group.

SCOLIORHAPHIS? (Pl. XX. fig. 66.)

This undulating uniaxial spicule may be derived from a *Scoliorhaphis*.

HEXACTINELLIDA.

DICTYONINA.

Separate octahedral knots, and fragments of Euretoid network, occur pretty frequently in the flints. Numerous sexradiate spicules are also found, and may very possibly have been derived from the dermis, roots, and other parts of the Dictyonine sponges, which are indicated by the fragments of network.

Fig. 69 is a form resembling one of the commonest spicules in *Euplectella*.

Figs. 58, 60, and 65 are evidently anchoring-spicules, the two latter terminating in a four-rayed, the first in a double-rayed, head. In fig. 60 the four rays are all on one side of the head. The shafts are smooth and not spined. Fig. 68 is also apparently an anchoring spicule.

Fig. 62 is possibly part of a spicule which when complete resembled those which Carter describes as forming a fringe to the edges of the tubes in *Myliusia Grayi*.

Fig. 63 is probably a dermal spicule.

Figs. 57 and 61 are small spicules of indefinite nature.

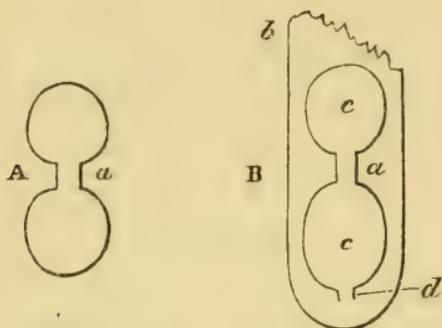
Figs. 67 and 67a, the end probably of one of the small rotulate spicules of a Hexactinellid.

[Casts of Foraminifera.

Zittel, *Cæloptychium*, Taf. v. figs. 11, 12, and 17.

Fig. 50 looks like a new form of spicule, for which one might find a name meaning "dumb-bell form;" as a sponge-spicule, indeed, we find it regarded in Zittel's monograph on *Cæloptychium*. The occurrence of similar forms, but possessing three globular swellings instead of only two (fig. 49), and these not always in a straight line (fig. 48), naturally suggests doubts as to its spicular character, and leads one rather to see a resemblance to Foraminifera, such as the *Nodosarina*. Nor can there be any doubt that they are simply

siliceous casts of Foraminifera, after the following observations by Carter. In a letter, dated June 16, 1875, he writes, “. . . the dumb-bell form you pointed out to me has almost close to it the original kind of test (silicified) from which it appears to have come, thus:—



“Correctly drawn to the same scale, viz. $\frac{1}{2}$ to $\frac{1}{1800}$ inch.

“A is the dumb-bell or cast of the chambers (*e*) of the organism; *a*, the cast of the tube which connected the chambers.

“B is the silicified foraminifer, *b* the test, *c c* the chambers. A little tube seems to have been prolonged from one chamber (*d*), and may have been connected with another chamber or cast. Thus the dumb-bell is a cast of a couple of chambers of a Foraminifer connected by the intervening tube.”]

In concluding this description of the various kinds of spicules I would add that in the majority of cases I regard the identifications and generic groupings proposed as provisional only. It is with many misgivings that I have made many of them; and nothing but the fact that I had undertaken the task of classification would have induced me to continue what I have felt at times to be a hopeless endeavour. Some kind of order, however, has been evolved out of chaos, though probably not that which would result if, by any process of magic, the spicules could be restored to their proper places in the structure of their original owners.

Many forms of spicules remain undescribed; those here represented have been derived from two or three small flints only. Of the rich sediments which remain from some twenty or thirty other specimens I have made no use in this paper; they remain for future observation, and are at the disposal of any one who would care to examine them.

Mineral Condition of the Spicules.—The spicules are white and opaque when viewed in air by reflected light; in water or other media they are highly transparent, but without the

smooth surface and glassy lustre of fresh spicules; the surface, indeed, differs very much as that of ground from polished glass. That they have exchanged the colloid for the crystalline state is clearly shown by the elevation which has taken place in their refractive index and by the colours which they give with polarized light. The effects of solution are visible in little hemispherical pits which have been eaten in over the surface (fig. 46), and by the irregular outline of some of the fusiform spicules, which appear in optical section as though irregularly scolloped. The canals of many are enlarged, but obliterated in the majority, probably as a result of secondary silicification. To secondary silicification we may also refer the tuberculation of some of the forms. Occasionally dendrites of iron pyrites are seen shooting through the substance of the spicules, the first stage of a replacement which is found completed in spicules from other deposits.

Probable depth of the Sea.—The sponges which furnished the spicules lived on a sea-floor probably somewhere between 100 and 400 fathoms deep. The Lithistidæ, which have furnished so large a proportion of the spicules, have been dredged from depths varying between 75 and 374 fathoms. *Lyidium torquilla*, which so closely resembles the fossil *Podopsis*, was obtained from a depth of 270 fathoms. Of other sponges the recent *Pachastrella geodoides*, which our *P. globiger* resembles, was dredged from 292 fathoms, and *Geodia Macandrewi*, which is represented by the fossil *G. cretaceus*, from 100 to 270 fathoms.

[To be continued.]

XLVIII.—*Additional Observations on the Antipatharia.*

By H. J. CARTER, F.R.S. &c.

BY reference to the footnote at page 304 of the last number of the 'Annals,' it will be seen that I had not then read Lacaze-Duthiers's memoirs "Sur les Antipathaires" (in the 'Annales des Sciences Naturelles, Zoologie,' tomes ii. and iv. pp. 169 and 1 of 1864 and 1865 respectively) at the time that I finished my short article on the Antipatharia, chiefly questioning the nature of the polyp (viz. whether Hydroid or Actinoid?), and stating, at page 302, that MM. Milne-Edwards and Jules Haime, in 1857, had summed up our knowledge on this point in the following way, viz. :—

"Jusqu'ici on n'a pas étudié l'anatomie de ces animaux, et on

ignore la disposition des lamelles mésentéroïdes et des organes générateurs."

Since then I have read Lacaze-Duthiers's memoirs; and although the *spineless* are separated from the *spiniferous* species of Antipatharia under the name of "*Gerardia*," whose polyps are evidently actinoid, nothing is so satisfactorily stated of the polyps of the *spiniferous* species, which in contradistinction are termed "Antipathaires vrais."

Thus, at p. 25 *et seq.* (tom. iv. *op. cit.*), we learn, respecting the "Organisation des Polypes," that in *A. subpinnata* (Ellis & Solander), the Mediterranean species which Lacaze-Duthiers had *alive* in an aquarium while on the coast of Africa, the oral aperture was linear elliptical, surrounded by a slight prominence, from which six lines radiate outwards hexagonally, between each two of which is a round tubercle indicative of its tentacular nature, also arranged elliptically; that the surface is covered with cilia, in the midst of which are groups of thread-cells; and that, when viewed laterally ("de profil"), under the microscope with a power of 60 diameters (p. 60), an œsophageal channel may be seen to pass downwards from the oral aperture or mouth, to be followed by what are conjectured to be two mesenteric laminae ("cordons pelotonnés") covered with thread-cells, the remains of six of which, but for an arrest of development, might have been the same as in the development of the young *Actinia* at this period. "Ne pourrait-on pas dire qu'un arrêt de développement a frappé quatre des cloisons primitives, et que deux se sont seulement développées?" (pp. 27, 28). Finally, at p. 52, it is stated respecting the reproductive process, "aussi n'ai-je rien à dire de cette fonction."

Hoping to find something more in the late lamented Count Pourtalès's Report on the specimens of *Antipathes* dredged in the Caribbean Sea by the 'Blake,' under the superintendence of Prof. A. Agassiz, in 1878-79, and published in February last*, I consulted a copy kindly lent me by Mr. Stuart O. Ridley, F.L.S., of the British Museum, for this purpose, from which the following is an extract of that lamented author's prefatory remarks:—

"With regard to the polyps, the drawings herewith presented have the disadvantage of having all been made from alcoholic specimens in various stages of contraction. Still there are differences from one species to another which cannot be ascribed to that cause. There appears to be a connexion

* Bulletin of the Museum of Comparative Zoology, Harvard College, Cambridge, Mass., vol. vi. no. 4, "Report on the Corals and Antipatharia," by L. F. Pourtalès.

between the shape of the polyps and the shape and disposition of the spines. Those species which have triangular spines have polyps with longer tentacles than those with cylindrical spines, with a greater tendency to become regular in shape, though there are some in which the polyp is very oblong in horizontal outline, as in *A. tetrasticha* (pl. iii. fig. 30). Very long tentacles are found in *A. spiralis* (figs. 25, 26). In very few instances the tentacles are found retracted, as figured by Lacaze-Duthiers; in most cases they are simply contracted; and in many species they are probably not retractile at all."

Out of the twelve species whose skeletons are then described three only have their polyps noticed and figured, viz. *Antipathes spiralis*, *A. picea*, n. sp., and *A. felix*, Pourt.

The plate contains twenty-five figures characterizing the spines and their disposition on twenty species, together with eight figures characterizing the appearance of the polyps on seven species.

Thus this Report, of February 1880, adds hardly any thing more to our knowledge of the polyp of *Antipathes* than MM. Milne-Edwards and Jules Haime had stated in 1857; nor are we likely to get more until some one with equal ability studies the living *Antipathes* after the manner of Mr. Moseley's investigations of *Millepora* &c., published in the 'Philosophical Transactions.'

XLIX.—Description of a new Species of Turbo, and a Note on the Occurrence of *Rossia Owenii* on the Coast of North Wales. By EDGAR A. SMITH.

Turbo cepoides.

Testa anguste sed profunde perforata, ovato-conica, pallide fusca, viridi strigata alboque variegata. Anfractus 7, valde convexi, superne leviter depressi vel subexcavati, incrementi lineis conspicuis, irregularibus, sublamellosis ornati, striis spiralibus inconspicuis et sulcis paucis superne sculpti. Apertura fere circularis, spira paulo brevior, intus dilute salmonea, margaritacea. Long. 80 millim., diam. max. 70; apertura 38 millim. longa.

Hab. —?

The colour of this shell calls to mind the greenish striping of an onion, from which circumstance I have imposed upon it the name *cepoides*. The ground-colour is a light yellowish brown; the lines of growth are of a peculiarly imbricating

character and of a pale green tint, at times edged with white. The base of the body-whorl exhibits indications of three or four concentric narrow bands of a green colour, more or less interrupted, and just beneath the suture there are some small, subequidistant, dark spots also noticeable upon the preceding volution. The upper whorls are strongly sulcated and ridged; but the sulci gradually disappear upon the lower half of the penultimate whorl, being replaced by faint spiral striæ.

The form of this species is very similar to that of *T. magnificus* of Jonas, figured in Philippi's 'Abbildungen,' vol. ii. pl. vi. (*Trochus*), and in his monograph of the genus *Turbo*, in the second edition of the 'Conchylien-Cabinet,' pl. xiv. figs. 1, 2.

T. cepoides is distinguished from that species by the presence of a deep perforation, difference of coloration, the peculiarity of the lines of growth, its less conspicuous spiral striæ, and the few narrow sulci revolving round the upper part of the whorls. The lower columellar portion of the peristome in *T. magnificus* is very much thickened by a stout callosity, resting upon the base of the whorl and thinly spreading over the surface to the upper extremity of the outer lip.

In the present species the portion of the peritreme first referred to stands out thin, not being reflexed upon the base, the edge of it extending upwards into the narrow umbilicus, and there is scarcely any callosity above the umbilicus. The upper end of the outer lip in *S. magnificus* is peculiarly prominent just beneath the suture, owing to the considerable arcuation of the lines of increment; and this is particularly observable when the shell is viewed laterally. On the contrary, in *T. cepoides* this prominence is absent, the lines of growth being scarcely curved at that particular part.

Both species have an opaque limbus to the aperture, and also a transverse callosity or ridge at the upper part of the columella, extending within the shell subparallel with the suture.

Rossia Owenii, Ball.

This appears to be a comparatively rare species; hence a record of its capture may be of interest. A mutilated specimen was picked up on the beach at Llandudno, North Wales, after a storm, by Mr. Thomas Williams, a resident of that town, who kindly sent it to the British Museum. This species, which, according to Steenstrup (*teste* Gwyn Jeffreys), is the male of the Mediterranean *R. macrosoma*, Delle Chiaje, was first discovered in Dublin Bay, but has since been recorded from the English Channel and the North Sea.

L.—*A new Cetonia from Madagascar.*

By CHARLES O. WATERHOUSE.

THE new species which I here describe was lately received in a small collection made at Antananarivo by the late Rev. R. Toy. I propose to call it

Pantolia brevicollis, n. sp.

Nigra, nitida, elytris fortiter punctato-sulcatis, apice crebre punctato, pygidio creberrime transversim ruguloso.

Long. 8 lin.

Very close to *P. striata*. It differs in having the thorax shorter and less narrowed anteriorly, the anterior angles not at all prominent. The head and clypeus are delicately punctured, the latter scarcely emarginate in front. The punctures on the thorax are not very close together, and are extremely fine and delicate; there are no stronger punctures at the sides. Scutellum smooth. The elytra are channelled and sculptured in the same way as in *P. striata*. The pygidium is covered with fine, closely placed, transverse rugæ; there is a slight longitudinal median impression. The posterior femora are sparingly and delicately punctured below, with a line of strong punctures along the anterior and posterior margins. The anterior tibiæ have three very acute teeth.

Hab. Madagascar.

LI.—*Description of a new Species of Arvicola from Gilgit.*

By JOHN SCULLY.

Arvicola Blanfordi, sp. nov.

♂. Head and body 4·55 inches, tail 2·05, hairs at end of tail 0·2, fore foot 0·4, hind foot 0·75, length of ear 0·7, breadth of ear 0·68. Lips, hands, and feet flesh-colour, the nose a little darker; irides blackish brown.

General colour of the fur above rather pale brown, with a slight rufous tinge, the hairs being of a deep slate-colour for the greater portion of their length and their ends pale brown with blackish tips. Under surface greyish white, the hairs deep slaty at base with white tips; along a line separating the colour of the upper and lower surfaces the tips of the hairs are isabelline. Feet white. Tail sullied white, with a dusky stripe along its upper surface, which is most conspicuous near the tip.

The above measurements and description were taken from a fresh specimen.

The molar pattern is as follows:—

Upper	I.	5 spaces,	3	external and	3	internal angles.
"	II.	4	"	3	"	"
"	III.	3	"	3	"	"
Lower	I.	7	"	4	"	"
"	II.	5	"	3	"	"
"	III.	3	"	3	"	"

Hab. Gilgit, Kashmir.

This vole, which I have named after Mr. W. T. Blanford, has the molar teeth somewhat like those of *Arvicola Roylei*; the differences in this respect could only be made intelligible with the aid of figures. The colour and proportions, however, of *A. Roylei* and *A. Blanfordi* are widely different. The Gilgit vole is quite distinct from the lately described *A. Stracheyi*.

BIBLIOGRAPHICAL NOTICE.

Memoirs of the Geological Survey of India.—Palæontologia Indica, &c. Tertiary and Upper Cretaceous Fauna of Western India. Ser. XIV. Vol. I. 1. *Sind fossil Corals and Aleyonaria.* By P. M. DUNCAN, M.B. (Lond.), F.R.S., V.P.G.S. 4to. Calcutta, Geological Survey Office; and London, Trübner: 1880.

THE authorities of the Geological Survey of India have worthily opened a new series of their valuable 'Palæontologia Indica' with an excellent description by Prof. Duncan of the remains of Corals and Aleyonarians from the Upper Cretaceous and Tertiary rocks of Sind. Altogether Dr. Duncan describes and figures 136 species of true corals, the majority of which are pedunculated forms with a well-developed epitheca, and by their characters and relationships indicate the existence of a shallow sea in which the deposits containing them were accumulated. This applies even to the corals from the Upper Cretaceous formation, in which no production of reefs or of coral limestone can be traced; and it is not until we come to the uppermost coralliferous series that we meet with massive corals forming reefs and producing a sort of saccharoid limestone.

Dr. Duncan's researches fully confirm the most recent stratigraphical results arrived at by the Indian Geological Surveyors. The olive shales immediately underlying the Deccan trap have been regarded as Cretaceous, although it must be confessed that the palæontological evidence available for the determination of their stratigraphical position is not the most satisfactory in the world. The principal fossil, *Cardita Beaumonti*, is indeed nearly allied to European Neocomian and Gault species; and one *Nautilus* is said to be

undistinguishable from the European *N. Bouhardianus*; but for the rest the species might almost as well be Tertiary as Cretaceous. The same statement will apply to the corals, nine species of which are described, Dr. Duncan stating that their facies is rather Eocene than Cretaceous. There are, however, three species of *Caryophyllia*, a genus which is numerous in the Lower Cretaceous beds of Southern India; but the species are all distinct. On the whole it would appear that these olive shales must be reckoned as belonging to the Cretaceous series by their stratigraphical position, whilst their fossils would indicate a state of transition towards the succeeding Tertiary conditions.

With the next series, the Ranikot group, there is no longer any doubt. Out of 50 species, many of them of great beauty, here described, 7 are identified with forms occurring in South-European Eocene deposits, whilst 5 others find near allies in the same beds; and the whole series is referred by the author to the Nummulitic formation. Of the 16 species obtained from the overlying Khirthar group, 3 are identical with, and 3 closely allied to, European Nummulitic forms; these are regarded by Dr. Duncan as Upper Nummulitic. The Oligocene is represented by the Nari beds, in which 5 out of 20 species are identical with European Nummulitic and Oligocene forms; whilst the Gáj series, with 41 species, forming the highest member of the Tertiary group, is regarded as Miocene, from the recent facies of the corals, and the absence from among them of any actually existing species. It is curious that among these many of the species represent West-Indian forms, and also that here alone, as already stated, modified reef conditions appear to have prevailed. It is also remarkable that these successive faunas are exceedingly distinct, scarcely any of the species extending through more than one series.

The Alcyonaria described, which are not numerous, are all from the Gáj, or highest group. Their remains consist exclusively of the calcareous joints of the polypidom of several species of the genus *Isis*, one of them a species apparently of gigantic size, which Dr. Duncan names in honour of Prof. Dana.

We have done little more than indicate the general nature of the contents of this excellent treatise, which we believe is the first of a series to be carried out (in part, at least) by the same hand. The great interest attaching to these Sind fossils arises from the circumstance that we have evidently in that country a series of rocks representing conditions more or less intermediate between those under which the deposits that we usually appeal to in our classifications were laid down, and therefore here, as in the Western Territories of North America, we may expect to find the materials for hitherto unwritten chapters in geological history. We can only wish that all the materials obtained may be as carefully and conscientiously worked out as these Sind corals have been by Prof. Duncan.

Before taking leave of the book, we may, however, say a few words about the plates, 28 in number, with which it is illustrated. These

have been executed, under the author's superintendence, by Mr. De Wilde and Mr. A. S. Foord; and those artists have worked with a zeal and care which really leave little to be desired. With scarcely an exception the figures are most satisfactory; and we are glad to see that Mr. Foord has succeeded in rivalling the veteran coralliographer with whose work his own is here brought into competition.

MISCELLANEOUS.

On some Facts in regard to the first Phenomena of the Development of the Osseous Fishes. By M. L. F. HENNEGUY.

THE formation of the blastodermic leaves in the osseous fishes is still but little known. In the trout, Cellacher makes the mesoderm and endoderm originate from the deeper layer of the germinal disk by simple differentiation of cells. According to Kupffer, Van Bambeke, His, and Klein the mesoderm alone results from the differentiation of the deeper layer of the germ, and the endoderm is formed by the cells which originate in the *subblastodermic layer* of Lereboullet, or the *parablast* of Klein. Lastly, Götte supposes that the blastoderm folds under at the margins to form a layer of cells, which afterwards subdivides into mesoderm and endoderm.

My own observations in part confirm those of Götte. Sections effected in germs of trout of from seven to ten days, hardened by osmic acid, have in fact shown me very distinctly the reflection of the blastoderm at its margins. The germ at this epoch is spread out upon the vitellus in the form of a lamina with thickened contours, the thinner centre of which conceals a cavity, the germinal cavity. The external surface of the germ is constituted by a layer formed by a single series of cylindrical cells. This layer appears very early, long before the germ begins to spread over the vitellus; Cellacher has given it the name of the *corneous lamina*. Beneath this lamina there is a pluricellular layer, presenting at first the same thickness throughout; this is the *sensorial layer*. This layer soon becomes inflected at the periphery of the disk, towards the vitellus, and penetrates into the germinal cavity; the corneous lamina takes no part in this inflexion, and stops suddenly at the surface of the vitellus. In sections made across a germ arrived at this stage of development, we see a linear fissure separate the sensorial layer from the reflected portion of the blastoderm and stop at a certain distance from the rounded margin of the germ.

In germs hardened by chromic acid the fissure is not visible; in its place one only observes a line separating the two layers of the blastoderm, but stopping at a certain distance from its free margin. This fact explains the opinion of Cellacher, who, having hardened all his trout-ova in chromic acid, assumes only a simple differentiation of cells for the mesoderm.

The parablast extends beneath the germ, and forms the floor of the germinal cavity: it is more abundant at the periphery than in the central region; so that it forms a sort of cupule in which the germ is enshrined. There is a canal with a triangular section surrounding the germ and included between the corneous lamina, the parablast, and the point of inflection of the sensorial layer.

When the embryonal shield begins to appear, the blastoderm is thicker at this level than in the rest of its extent, and the reflected portion advances further into the germinal cavity than that of the opposite side.

In the fresh state, in the ovum of the perch, thanks to its extreme transparency, I have been able to see the reflection of the margins of the blastoderm; and I was easily able to ascertain, by slightly compressing the ovum, the presence of the fissure which separates the sensorial lamina from its reflected part.

In trout-ova of which the blastoderm had covered rather more than half the vitelline globe, I have found, at the posterior part of the embryo, beneath the point at which the dorsal cord stops, a small vesicle lined with cylindrical cells. This vesicle, by its position, its form, and the constitution of its walls, appears to me to be identical with that described by Kupffer in the stickleback under the name of allantoid. In this last fish, in which I have been able to verify its existence, Kupffer's vesicle projects into the interior of the vitellus, and has the form of a hemispherical cap, the convexity of which is turned towards the vitellus, whilst its floor looks towards the ventral surface of the embryo. In the trout the vesicle does not project into the vitellus; and although it presents the same form, its convexity is fixed in the embryo, and it rests by its flat part upon the parablast.

Hitherto I have been unable to ascertain the presence of a canal placing the vesicle in communication with the exterior, either in transverse or in longitudinal sections. This vesicle has only a temporary existence; I have been unable to detect it in more advanced embryos.

By making sections of ova of which the blastoderm had just closed behind the posterior extremity of the embryo, I have been able to see at this point a canal placing the surface of the vitelline globe in communication with the dorsal surface of the embryo. This canal therefore traverses the posterior extremity of the embryo; for the blastodermic pad (*bourrelet*), as demonstrated by His, has just soldered itself to the embryo to become subsequently the extremity of the tail; it is completely independent of Kupffer's vesicle, which has long since disappeared.

In the perch, as Lereboullet was the first to observe, the embryo forms slowly; it does not appear until the blastoderm has almost entirely covered the vitelline globe. The blastodermic pad, corresponding to the reflected part of the margins of the germ, however, some time before the closure of the blastoderm, presents a widened part at the spot where the embryo will be formed. When the blastoderm closes, there remains for some time at the posterior part

of the embryo a funnel-shaped opening, circumscribed by the blastodermic pad and corresponding to the canal which is seen in the trout.

Kupffer's vesicle only appears in the perch after the disappearance of the closure-canal of the blastoderm. It has the same situation and the same form as in the stickleback. In a living embryo I have distinctly seen, at its posterior part, on its dorsal surface and above the vesicle, a small orifice with folded borders, which is very probably the aperture of invagination of the vesicle; but as yet I have unfortunately been unable to assure myself, by sections, of the continuity of this orifice with the vesicle, so as completely to confirm Kupffer's description.

Prof. Balbiani, who has verified my observations, agrees with Balfour and Rauber in regarding Kupffer's vesicle as the homologue of the primitive intestine of the Cyclostomi and Batrachians, its external orifice representing the anus of Rusconi. As to the canal originating from the closure of the blastoderm, it corresponds to the blastopore of English writers, or to the mouth of the gastrula of Hæckel. In the Batrachia the blastopore and the anus of Rusconi are confounded; in the fishes these two orifices are distinct.—*Bull. Soc. Philom. de Paris*, April 10, 1880.

Completion of the Biology of the Aphides of the Galls of the Poplar
(*Pemphigus bursarius*, Linn.). By M. J. LICHTENSTEIN.

In his former paper on this insect* the author was compelled to leave a gap in its history, namely the life of the insect from the time of its quitting the gall as an emigrant until its return to the trunk of the poplar as a pupiferous form.

After unsuccessful attempts with the roots of grasses and other plants, it occurred to him to try *Filago germanica*, he being led to select that plant because while he only knew the first two stages (founder and emigrant) of *Pemphigus bursarius*, he only knew the last two stages (gemma-parous and pupiferous) of *Pemphigus filaginis*, Boyer. With this purpose he covered a plant of *Filago* with a bell glass, and enclosed with it a poplar-gall filled with winged emigrants. The plant was soon covered with the woolly secretion of *Pemphigus filaginis*. At the same time (from 1st to 15th July) all the plants of *Filago* growing in the open round the bell glass were covered with the same secretion and with the green and velvety black Aphides constituting the gemma-parous phase † of that insect.

The development of the winged pupiferous form proceeds very rapidly; three weeks suffice for it. On taking into his study the bell glass and the plant of *Filago* covered by it, the author saw the

* See 'Annals,' May 1880, vol. v. p. 433.

† In this species the gemma-parous phase is simple, and not multiple as in *Phylloxera vastatrix*; and all the individuals proceeding from it are winged.

winged insects quit the capituli on which they had been developed and seek to escape from the bell glass. He then inserted a fragment of poplar-bark under the bell, when the Aphides at once collected upon it and began producing sexual individuals. The same thing was done by individuals which had been allowed to fly and had collected on the window-panes. The poplars in the garden were at the same time covered with these Aphides.

In conclusion M. Lichtenstein calls attention to a possible objection to his experiment, viz. that he did not grow the *Filago* from seed under cover—and promises to remedy this defect next year.—*Comptes Rendus*, August 9, 1880, p. 339.

On the Ciliated Embryo of Bilharzia. By M. J. CHATIN.

The regularly oval egg of *Bilharzia* (*B. hæmatobia*, Cobb., the African Trematode parasite in the blood of man) presents no traces of striæ or flutings; but at one of its poles it bears a conical prolongation*. The segmentation of the vitellus takes place rapidly, and we soon witness the formation of an embryo of very characteristic aspect.

Clothed with a cuticle, from which innumerable vibratile cilia emerge, the young larva appears like an infusory contained within the egg, and the interior mass of which does not yet present any indication of differentiation; externally the contours become more strongly marked, and a sort of mamilla (proboscis) begins to indicate the future cephalic region. This general state usually persists until the period of exclusion†; and the latter is announced by various precurrent acts, into the details of which I cannot enter, and then makes itself plain by important organic modifications: beneath the proboscidian zone there is sketched out a cæcum, which plunges vertically into the somatic mass, and soon attains considerable dimensions; on its lateral parts appear secondary diverticula, which together form a rather complex whole, whilst at different parts of the body, and especially in the tegumentary layer, elegant vasculiform streaks ramify.

During this time phenomena of a very different kind appear towards the posterior extremity of the body; peculiar formations, generally spheroidal, begin to show themselves there, and increase rapidly in number and volume. Are we to see in these only "sarcode globules"? Such a hypothesis disappears before the application of a method rendered classical by important researches (Ranvier, Certes, &c.); the mode of grouping of the nitrogenous,

* In all the eggs that I have been able to examine, this prolongation was distinctly axial; but it is well known that Bilharz has described a second kind of ovules with the point lateral, in which, indeed, Sonnino even appears to find an indication of an actual specific duality.

† Sometimes, however, one can distinguish the first lineaments of the cæca even in the embryo still contained within the egg.

glycogene, and fatty matters forbids our assimilating them to simple amœboid masses. It would seem that we may rather compare them to buds, which would thus originate in the interior of the embryo: their development even marks the term of its existence; for we soon see it become disaggregated to set free these bodies, which move, animated by rapid contractions, in the circumambient fluid.

It will be seen that such results compel us to modify profoundly the signification which helminthologists assign to the ciliated embryo of *Bilharzia* in the cycle of development of that species. Its formation in the ovule as a consequence of a sexual act can alone explain the name of proscoplex generally given to it: in reality its constitution evidences a superiority the reflection of which we should seek in vain among the different types of the class considered at this period. Far from being deficient, the internal parts are here represented by the cæca, in which we may see the first sketch of a digestive apparatus, and by that vascular ramification which drains the economy after the fashion of an excretory apparatus. By their mode of origin, as by their characters, the contractile corpuscles finally introduce an idea which is new and of high importance, since it enables us to bring together in the same stage the different evolutive states of the Trematode—a conclusion of which it is easy to foresee the importance in general morphology.—*Comptes Rendus*, September 27, 1880, p. 554.

Note on Argiope capsula.

By J. GWYN JEFFREYS, LL.D., F.R.S.

This tiny but remarkable Brachiopod has been lately found by my esteemed correspondent, Mr. Duprey, in Jersey, living at low water. It adheres by its comparatively short but stout byssus, in an upright position, to the underside of large stones which are sunk and partly buried in the sandy mud. Its companions are *Chiton scabridus*, *Rissoa striatula*, *Adeorbis subcarinatus*, and an apparently undescribed species of *Ascidia*. The fall of spring-tides in Jersey is equal to a depth of from 33 to 41 feet.

The specimens kindly sent me by Mr. Duprey are larger than any I had previously seen; and I was enabled to examine the inside of the shell by soaking them for some days in dilute potash water, together with specimens of *Argiope cistellula* of the same size. *A. capsula* has a thick hinge; and the smaller (though scarcely smaller) valve has a sharp-edged and wavy crest or ridge lying a little within the margin, which is heart-shaped and continuous in front. The shell is strong for its size, and is nearly spherical and equivalve, the beaks of both valves being excavated to contain the byssus. There is no trace of a septum in either valve. The cæcal tubercles are numerous, twice as many as in *A. cistellula* of the same size. The latter species is transversely oblong;

there is a distinct and prominent septum in each valve; and the laminar ridge in the smaller valve is much slighter, and is interrupted by the septum to which it is attached. Both species occur together on the English and Irish coasts, and at Etretat in Normandy; and *A. capsula* was recorded by the late Prof. Sars as fossil at Kirköen, near Christiania.

Notes on the Early Stages of some Polychæteous Annelides.

By E. B. WILSON.

In view of the morphological interest of the marine annelides as the most highly specialized forms among the "Vermes," and the scarcity of detailed accounts of their early stages of development, the following preliminary abstract of studies on the eggs of *Arenicola* and *Clymenella* seems of some interest. The eggs are small and very numerous, and are imbedded in transparent gelatinous masses issuing from the mouths of the tubes or burrows inhabited by the worms. The egg-masses of *Arenicola* are of great size, being sometimes 5 or 6 feet in length and from 2 to 4 inches in diameter; such a mass must contain several hundred thousand eggs. Those of *Clymenella* are usually about the size and shape of a pigeon's egg; the eggs are much fewer and considerably larger than those of *Arenicola*.

The whole course of development is essentially alike in the two forms. No polar globules of constant relation to the yolk were observed. The first cleavage divides the egg into two unequal spherules. The second, passing at right angles to the first, divides the smaller spherule into two equal parts, and the larger into two unequal parts. The third cleavage separates from these four blastomeres four much smaller ones at one pole of the egg. The latter (micromeres) soon become so displaced as to alternate with the former (macromeres). The micromeres now divide more rapidly than the macromeres, which they come ultimately to include by growing down over them. The ectoderm is formed by the derivatives of the micromeres, and in part, I believe, of the macromeres. The remaining portions of the macromeres form the entoderm. Two large spherules, which originally formed a part of the largest of the four primary blastomeres, are visible up to a late stage at the posterior extremity of the embryo. They are at first at the surface, but ultimately are grown over by the ectoderm and disappear. It is possible that they are concerned in the formation of the mesoderm and are to be regarded as primary mesoblasts. The mouth arises on the ventral side nearly opposite that pole of the egg where the first four micromeres were formed. The anus arises at the posterior end of the embryo. The egg-membrane is directly converted into the cuticle of the larva. The egg exhibits, during segmentation, alternate periods of activity and quiescence.

The embryo acquires two dorsal eye-specks, præoral and præ-

anal belts of cilia, and a broad ventral band, and becomes a "Telo-trochous" larva which passes directly into the adult. The setæ develop from before backwards; and those of the dorsal ramus appear before those of the ventral.

The segmentation is closely similar to that of some Oligochæta (*Euaxes*, *Tubifex*), and resembles also that of the leeches. The gastrula stage is not attained by a typical invagination, but by a downgrowth of the ectoderm over the entoderm.—*Amer. Journ. Sci.* Oct. 1880.

Beaufort, N. C., July 1880.

The Rhythmical Character of the Process of Segmentation.

By W. H. BROOKS.

A number of observers have called attention to the fact that in certain animals the segmenting eggs pass through alternating stages, in which the segmentation-products are first conspicuous and well defined and then flattened and fused together.

In a paper on the development of the freshwater pulmonates I have attempted to show that the alternation is due to the fact that periods of segmenting activity alternate with periods of rest, and that the tendency which the elasticity of the egg exerts to render its form spherical when no other force is acting upon it causes the partial obliteration of the outlines of the spherules during each resting stage.

The essential factor is therefore the alternation of rest with activity; and the change of shape during the resting periods is a secondary phenomenon, brought about incidentally by the physical properties of the yolk.

In most eggs the yolk is not sufficiently elastic to allow any great change of form; but careful time-records show that the process of segmentation is rhythmical, and that short periods of active change alternate with longer periods during which there is no external change.

During the past year various members of the Biological Department of the Johns Hopkins University have observed this alternation in various vertebrate and invertebrate eggs. Dr. Clarke has noticed it in an amphibian, *Amblystoma*, where the segmentation is total. I have observed it in the egg of an unknown fish, where segmentation is restricted to a blastoderm. Mr. Wilson has observed it in three annelides, where segmentation is total and irregular—*Arenicola*, *Clymenella*, and *Lumbricus*. It is very well marked in an arthropod, *Leucifer*, whose eggs undergo total regular segmentation.

Its occurrence in so many widely separated groups with such different methods of segmentation renders it probable that it will be found in nearly all eggs upon sufficiently careful examination.—*Amer. Journ. Sci.* Oct. 1880.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 36. DECEMBER 1880.

LII.—*On the Anatomy of a new Parasitic Worm found in the Intestine of a Bat* (*Megaderma frons*). By Dr. JOHN DENIS MACDONALD, F.R.S., Inspector-General R.N.

[Plate XXI.]

In no. 573, vol. xxii., of 'Nature' my friend and colleague Surgeon-Major G.E. Dobson, M.A., F.L.S., announced his discovery of a new and interesting parasitic worm, with all the *primâ facie* appearance of an Annelidan, in the intestine of the above-named Bat. The notice contains a good general account of the little worm, with an intimation that he had passed it over to me for further examination. He thus describes it in one paragraph:—"The specimen in question is about half an inch in length, without distinct segmentation, except what is indicated by the perfectly regular disposition of the cephalo-somatic appendages—seventy-three pairs, extending from the anterior almost to the posterior extremity of the body—whereof those occupying the anterior attenuated fourth of the body are fin-like lamellæ, apparently branchial, with a simple unarmed mouth not provided with a proboscis, with the intestine spirally coiled round the ovarian tube and terminating inferiorly at the posterior extremity of the body." This description, though short, has left me very little to say in relation to the leading features of the anatomy of the worm. I would offer, however, a few remarks as to its probable posi-

tion and zoological relationships, giving enlarged figures of the different regions of the body and some structural particulars of interest.

The general form of the body is terete, with a tendency to coil upon itself ventrally, gradually diminishing in size towards the head, which is very small, and preserving a degree of fulness towards the posterior extremity, which is rounded, but slightly truncated.

The mouth is simple and subterminal in front; and there is a little cervical constriction marking off the head.

The cephalo-somatic appendages spoken of by Dr. Dobson are lamellate at the fore part of the body (Pl. XXI. figs. 1, 5) and styliform (figs. 2, 3, 6, 7) in the rest of its extent.

The leaflets consist of a simple extension of the integument, broadly sickle-shaped, with the point directed backwards (fig. 5). They are supported by an internal fan-like disposition of chitinous fibres, dividing at the attached extremity into a dorsal and a ventral layer, so as to rest broadly upon the muscular sheath of the body, though having no distinct connexion with it. They gradually increase in size from the head backwards (fig. 1) to near the generative opening (fig. 2), where they begin to grow smaller, and become quite rudimentary, while the chitinous fibres approximate and coalesce into a pointed bundle with a bilobed base.

From this point backwards, the leaflets having been transformed into pointed styles, these organs grow larger, until they nearly equal the original length of the leaflets.

There is no external or internal indication of annulose segmentation of the body, if we except the disposition of the lateral appendages, which flank the ventral surface on either side at pretty equal distances.

The muscular sheath of the body is well defined, and chiefly made up of longitudinal fibres, circular ones, though undoubtedly present, not being very easily demonstrated.

From the mouth (fig. 1, *a*) the intestine passes backwards as a simple straight tube (*b*) for some distance (about one fourth from the head), where it forms a sigmoid ventral flexure, somewhat dilated, which is surrounded by the convolutions of the ovarian tube (fig. 3, *f*). It next again takes a comparatively straight course for a little way, and then winds spirally round the spiral rachis of the ovarium, and finally terminates in a subterminal and ventral anus within a kind of sheath (fig. 4, *d*).

The ovarium (figs. 3 & 4, *e*) consists of a spiral rachis, already mentioned, giving off large rounded sacculi or lobules; and from near the fore part of the organ a lengthy oviduct

(fig. 3, *f*) arises, and having formed numerous convolutions around the sigmoid stomachal dilatation above noticed, terminates in a kind of ventral fissure, near the point where the leaflets become rudimentary before their change of form is completed.

Now, as to the true nature and relationships of this little parasite much might be said. Though at first agreeing with Dr. Dobson that it represented a new order of Annelids, I am at present more disposed to look upon it as a new type of worm whose alliance is rather with the Nematoda.

Though minute scaly spines are often found equally distributed over the integument of the body in the Helminths, there is no case on record of a complete series of appendages running on each side through nearly the whole length of the body as in the form above described. In an *Echinorhynchus* which I found in the rectum of a *Bonito*, there were six pairs of simple stout spinous processes attached to the fore part of the body. Something similar may be said of *Strongylus horridus*, found by Rudolphi in the œsophagus of the water-hen. Other instances might be quoted; but such organs have always hitherto been found on limited portions of the body.

It should be remarked also that, just as in the case of the hooklets of the *Acanthocephali*, the leaflets and stylets of the present form are not supplied with special muscles, in which particular they differ from the sclerous organs of the true Annelida.

In the following paper Dr. G. E. Dobson has added some further notes on the systematic position of this worm and on the circumstances attending its discovery.

EXPLANATION OF PLATE XXI.

a, mouth; *b*, œsophagus; *c*, intestine; *d*, anus; *e*, ovarium; *f*, oviduct; *g*, vulva.—N.B. The same letters apply to all the figures.

Fig. 1. Head and fore part of the body of the worm described above, as seen with a $\frac{1}{4}$ -inch objective.

Fig. 2. Exhibits the transformation of the leaflets into the stylets which succeed them.

Fig. 3. Part of the body, showing the sigmoid stomachal dilatation of the alimentary canal, part of the ovarium, the convoluted oviduct, and the lateral appendages.

Fig. 4. Posterior extremity of the body, showing ovarian sacculi and the termination of the intestine in the anal opening.

Fig. 5. One of the leaflets, magnified 300 diameters—to show its peculiar form and the supporting chitinous fibres spread out between its dorsal and ventral layers.

Figs. 6, 7. Two stylets, showing the coalescence of the fibres seen in fig. 5, so as to form a pointed process with a bifid base.

Fig. 8. A single ovum, showing the coiled-up embryo within.

Fig. 9. Homogeneous placental matrix in which the ova are developed.

LIII.—*Note on Pterygodermatites Macdonaldii, the Type of a new Order of Vermes.* By G. E. DOBSON, M.A., M.B., &c.

IN the preceding paper Dr. Macdonald has very fully described the interesting parasitic worm discovered by me in the intestinal canal of *Megaderma frons*, and of which I have given a short account in 'Nature' (vol. xxii. no. 573). He has conclusively shown that this form, though Annelidan in external characters, is really to be classed rather with the Nematoid worms. In assigning it then a place in the zoological series we display another instance of what Dr. Macdonald calls "representative relationships"—not unexpectedly, however, as the following extract from one of his lately published papers* shows:—

"If we look upon the *Trematoda* as representing the *Hirudineï*, coupling also the *Oligochæta* with the *Polychæta*, and the *Rotifera* with the *Articulata*, Prof. Huxley's interesting classification, embodying a large proportion of the results just alluded to, would seem to sanction the idea. Thus the corresponding part of his Table may be arranged, without material change, in the following manner:—

1. ARCHÆOSTOMATA.

Trematoda
Oligochæta
Rotifera

2. DEUTEROSTOMATA.

Hirudineï
Polychæta
Arthropoda

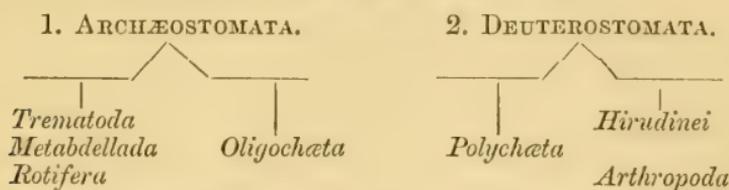
"There is surely something more than coincidence in this. There may be misgivings as to the position of the *Oligochæta*; but, perhaps, something will soon turn up to reconcile it."

This prophecy appears to be fulfilled by the discovery of the parasitic worm above described, which may be considered the type of a new order—Metabdellada—of Vermes †. If now we seek to assign this order a position in the above Table, it will be found to fall very naturally into the position previously doubtfully occupied by *Oligochæta*, while the latter

* "On a new Genus of *Trematoda*, and some new or little-known Parasitic *Hirudineï*," Trans. Linn. Soc., 2nd ser. Zoology, vol. i. p. 209.

† While these notes were passing through the press Prof. F. Jeffrey Bell called my attention to a paper by Dr. Wedl in Sitzungsber. Akad. Wissensch. Wien, vol. xlv. p. 464, Taf. ii. figs. 5–11, in which a worm (*Pterygodermatites plagiostoma*) (not noticed in the 'Compendium of Helminthology') from the intestine of *Erinaceus auritus*, evidently belonging to the same genus as this parasite of *Megaderma frons*, is described, but which may be at once distinguished from it specifically on comparison.

and the *Polychæta* may be arranged, as follows, in a manner more illustrative of their close affinities * :—



While on the subject it may be advisable to again refer to the circumstances under which this parasite was discovered.

I was engaged in examining the intestinal tract of a specimen of *Megaderma frons*, which had been sent to me from Cape-Coast Castle by Surgeon J. J. Lamprey, A.M.D., when, in the lower part of the ileum, lying spirally coiled up and adhering to (not covered by) the mucous membrane of the intestine, I found a small worm of a pale yellow colour about half an inch in length. Its very peculiar appearance when examined by the microscope showed me at once that it was probably not only new to science, but that it represented a new order if not a new subclass of Vermes.

Megaderma frons, the host of this remarkable worm, is a species of Bat of very peculiar aspect†, which is, apparently, widely distributed throughout, and restricted to, the tropical parts of the Ethiopian region. It belongs to a genus whereof one of the species at least is known to suck the blood of smaller Bats, which it captures on the wing (see my 'Monograph of the Asiatic Chiroptera,' p. 77); and as all the species closely resemble one another in structure, it is exceedingly probable that they have all much the same habits.

Although I found insect-remains in the intestinal canal of the specimen from which the above-noticed parasite was taken, yet there was also mixed up with them a large quantity of hair, not from its own body, but evidently (judging from the microscopic structure) that of some other Bat, on which very likely it had been feeding.

That this worm is really a parasite appears to be sufficiently well indicated by the circumstances under which it was found. It was spirally coiled up (a position which such an animal would evidently naturally assume on being immersed in strong alcohol, such as its host was preserved in); and, although long

* Prof. Huxley remarks ('Anatomy of the Invertebrata,' p. 226):—
"Except that the *Polychæta* are almost invariably dioecious and marine, while the *Oligochæta* are monoecious and inhabitants either of land or fresh water, it is hard to say what absolute characters separate these two groups."

† See pl. x. fig. 3, Cat. Chiropt. Brit. Mus. 1878.

soaked in glycerine and water since its removal from the intestine, it still assumes, when not prevented by pressure, the same position by the elasticity of its body. If swallowed alive it would most probably have died and have suffered partial digestion before it had reached the lower part of the ileum. Furthermore, the intestine of the worm is filled with a reddish substance like the remains of blood; and we know that the Bats of the genus to which its host belongs feed partially on the blood of smaller species of Bats; so that, even if the worm is not a true parasite, it is very probably a messmate.

I have much pleasure in connecting with the specific title of this very interesting form the name of Dr. Macdonald, whose valuable researches have so largely contributed to our knowledge of the zoology of the Invertebrata.

LIV.—*On the Minute Structure of the Recent Heteropora neozelanica, Busk, and on the Relations of the Genus Heteropora to Monticulipora.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E.

[Continued from p. 339.]

PART II.

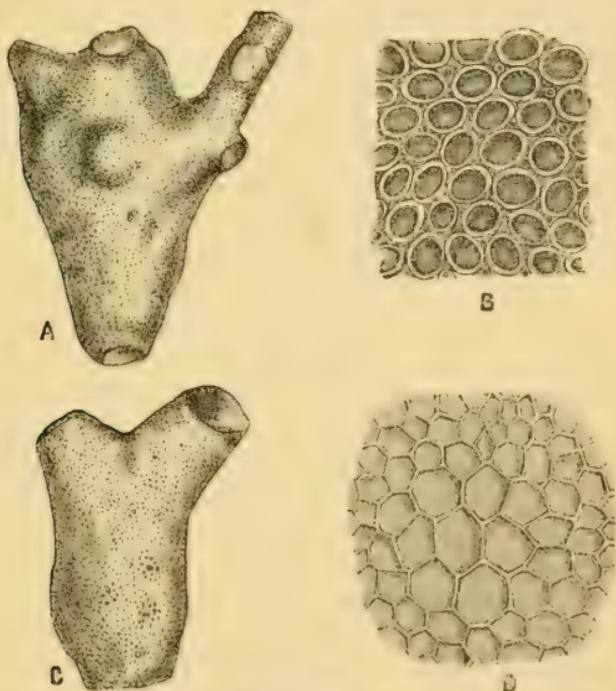
HAVING now considered the structure of the skeleton of a recent species of *Heteropora*, we may pass on next to consider the conformation of the corallum in *Monticulipora*, and may, finally, come to some conclusion as to the extent to which the two may be regarded as really similar to one another. That there exists a general resemblance between the ramose or dendroid forms of *Monticulipora* (using the term in its wide sense) and the species of *Heteropora* is undeniable and has long been known. Both consist, as regards their skeleton, of fasciculate tubes, which are nearly vertical in the centre of the branches, but which sooner or later bend outwards to reach the surface, becoming thickened, or otherwise structurally altered, in the latter part of their course. Nor is there any difference in size, either as regards the skeleton as a whole or the component tubes, which would prevent us comparing the two; while in both we have the remarkable feature that the skeleton is composed (except in a few *Monticuliporids*) of tubes which are not all alike, but which clearly differ, either in size or in some other character, from one another. It becomes therefore a matter of interest to discover how far this external resemblance is accompanied by an agreement in internal structure; and it is obvious that in investigating this point it is

desirable not only to select specimens which are externally similar in shape and figure, but also to compare a series of sections cut from precisely corresponding regions in both groups of examples. In order to fulfil these conditions I have chosen, in the first place, the Lower-Silurian *Monticulipora Jamesi*, Nich., which presents a close external resemblance to *Heteropora neozelanica*, Busk; and after briefly describing the external and internal features of this, I shall give a short account of the characters of *Monticulipora pulchella*, E. & H., in which we have a type of *Monticulipora* at least subgenerically distinct from *M. Jamesi*. I shall finally place together in a summary form the characters in which *Heteropora* and *Monticulipora* agree and those in which they differ.

Monticulipora Jamesi, Nich.

The corallum in this species of *Monticulipora* (fig. 3, A) is dendroid, the branches varying from about $\frac{1}{8}$ up to $\frac{1}{2}$ inch in

Fig. 3.



A. Part of the corallum of *Monticulipora Jamesi*, Nich., of the natural size. B. Part of the surface of the same, enlarged; from the Cincinnati group of Ohio. C. Part of a typical specimen of *Monticulipora pulchella*, Edw. & H., from the Wenlock Limestone of Dudley, of the natural size. D. Part of the surface of the same, embracing one of the clusters of large corallites, enlarged.

diameter, dividing dichotomously, terminating in rounded free ends, and sometimes becoming palmate by partial fusion.

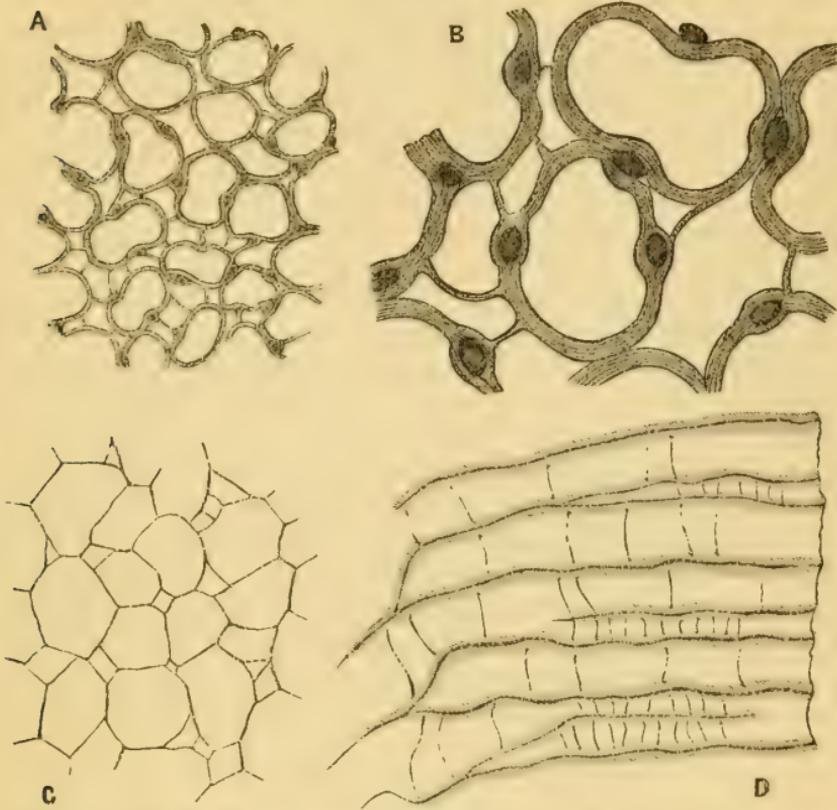
The surface in well-preserved specimens exhibits the apertures of the ordinary corallites, interspersed with numerous smaller openings, some of the latter being exceedingly minute; but in their more ordinary state of preservation the mouths of the smaller tubes can only be made out with difficulty or not at all. In any case, the larger corallites are rounded in form, and their mouths are encircled by thickened walls. The general appearance of the surface is thus very similar to that of *Heteropora neozelanica*, except that the small tubes are disproportionately minute as compared with the larger ones. We shall see also that the small tubes differ from the "interstitial tubes" of *Heteropora* in having a special internal structure unlike that of the ordinary corallites. With regard to the internal structure of *Monticulipora Jamesi*, we shall briefly examine the same three sets of sections as have been described in the case of *Heteropora*.

(a) *Tangential sections*.—These (fig. 4, A & B) exhibit the rounded or oval apertures of the larger corallites, which occupy the greater part of the section. Mixed up with these, at all their angles of junction, are numerous smaller corallites, which differ from the larger tubes both in size and in their very irregular though mostly angular shape. Lastly, placed at the angles of junction of the tubes previously mentioned, or intercalated in the wall between two contiguous corallites, we observe a great number of dark rounded bodies, which are the cross sections of a series of strong but really hollow tubes with thick walls and an exceedingly small central cavity. These "spineform corallites," as I have elsewhere termed them, may be with considerable probability regarded as representing a series of rudimentary or specially modified corallites; and they form a peculiar and characteristic feature in many *Monticulipora*; but I cannot discuss their nature in this place. The walls of the tubes, as seen in sections of this nature, are thickened; but the line of demarcation between the walls of contiguous corallites is always distinctly recognizable, except occasionally in the boundaries between some of the smaller tubes. Lastly, it is to be noted that there are absolutely no traces of any canal-system in the walls of the corallites, or of any pores which might place the visceral chambers in communication with one another; nor can we discover the slightest indication of any thing of the nature of radiating septal spines or lamellæ.

(b) *Transverse sections* show centrally (as already pointed out in the case of *Heteropora*) the transversely divided tubes of the *axis* of the branch, while marginally they exhibit the tubes of the exterior thickened zone cut nearly longitudinally,

thus resembling in this region the outer portion of longitudinal sections. The only point to notice about these sections is

Fig. 4.



Thin sections of *Monticulipora Jamesi*, Nich. A. Part of a *tangential* section, taken just below the surface, enlarged eighteen times, showing the large and small corallites and the interspersed spiniform corallites. B. Part of the same section, enlarged fifty times. C. Part of a *transverse* section of a branch, in the *acial* region, enlarged eighteen times, showing the thin-walled, polygonal, and unequal-sized corallites of this part of the corallum. D. Part of a *longitudinal* section in the median plane, showing the corallites in the *outer* portion of their course, where their walls are thickened. The section shows the larger and smaller corallites, the former with remote, and the latter with close-set, tabulae. From the Cincinnati group, Ohio.

that in their central portion we find the axial corallites to be polygonal in shape, and to be bounded by very thin and delicate walls (fig. 4, C), which, as before, are wholly imperforate. There is also now a total absence of the smaller interstitial corallites, these latter being confined to the exterior zone of the branches, and not extending into the deeper parts of the corallum.

(c) *Longitudinal* sections show different characters according to the precise point at which they are examined. In

their central portions we have the longitudinally divided corallites of the axis of the branch, which are here provided with very thin walls, and are nearly vertical in direction. Their cavities in this region are also intersected by but a very small number of "tabulæ," though these structures are present in small amount. In the outer part of longitudinal sections (as in the peripheral portions of transverse sections) we can study the characters of the tubes in their external thickened region, where they have become bent outwards on their way towards the surface (fig. 4, D). In this part of their course the walls of the corallites have become considerably thickened, though there is never any difficulty in recognizing the line of demarcation between the proper investment of any one tube and that of its neighbours. No indications are visible of any canals or pores placing the cavities of contiguous tubes in communication; but the visceral chambers are traversed by numerous complete and well-developed transverse partitions, or "tabulæ," which continue to be developed till close upon the actual mouths of the tubes. Between the larger corallites we can now also readily distinguish the smaller interstitial corallites, which can be at once distinguished, not only by their more diminutive size, but likewise by the distinct structural character that they are provided with more numerous and closely set "tabulæ" than is the case with the normal tubes.

*Monticulipora pulchella**, Edw. & Haime.

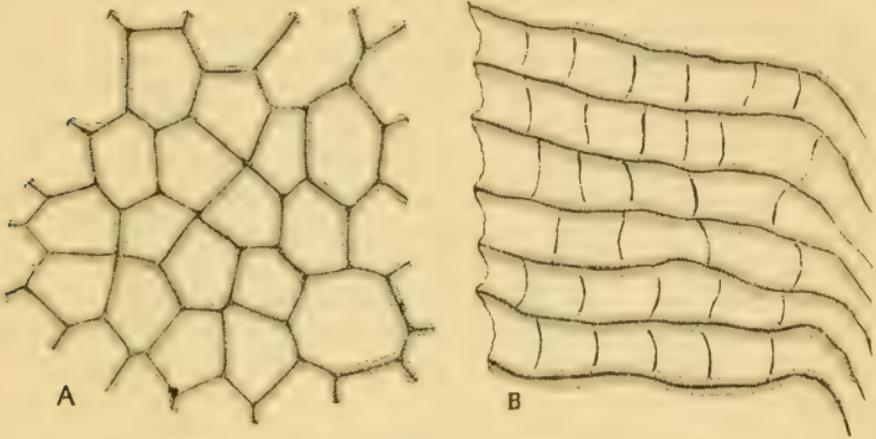
As there are considerable differences (differences of at least subgeneric, possibly of generic, value) between the various forms usually included by palæontologists under the common name of *Monticulipora*, I have thought it advisable to give here a short description of the structure of a type of the genus markedly distinct from *M. Jamesi*, Nich.; and for this purpose I have selected the well-known *M. pulchella*, E. & H., of the Upper Silurian deposits of Britain.

The typical *M. pulchella*, E. & H., as regards its shape and general appearance (fig. 3, C), is very similar to *Heteropora neozelanica*, Busk, except that the mouths of the tubes

* It may be noted here that the form which I have described from the Lower Silurian rocks of North America under the name of *Chaetetes pulchellus* (Pal. Ohio, vol. ii. p. 195, and Quart. Journ. Geol. Soc. vol. xxx. p. 503) is not, as I have now ascertained, the same as *Monticulipora pulchella*, E. & H. It very closely resembles the true *M. pulchella* in external characters, and especially in the possession of clusters of large tubes interspersed at intervals among the average corallites of the corallum; but I find its internal structure to be such as to entirely separate it from the British species.

are regularly polygonal and thin-walled. Moreover, in place of large tubes mixed up singly in great numbers with smaller

Fig. 5.



Thin sections of a typical example of *Monticulipora pulchella*, E. & H., from the Wenlock Limestone of Dudley. A. Part of a *tangential* section, enlarged eighteen times, not passing through one of the groups of larger corallites. B. Part of a *longitudinal* section, enlarged eighteen times. Both sections show that the *wall* of the tubes has the same structure as is characteristic of *Favosites*; and the latter exhibits the remote *tabulae* which intersect the cavities of the tubes.

tubes, we have *clusters* of large corallites (fig. 3, D) interspersed at short intervals in a general basis of smaller corallites. In the two points just alluded to, *M. pulchella* similarly differs from such a form of *Monticulipora* as *M. Jamesi*. In other respects, however, its general conformation and plan of structure are the same.

As regards the *internal structure* of *M. pulchella*, E. & H. (fig. 5), we find a much greater simplicity than exists in *M. Jamesi*. Thus in *tangential* sections (fig. 5, A) the corallites are seen to be regularly polygonal, with moderately but by no means excessively thickened walls, and showing no trace whatever of radiating spines or "septa." The structure of the wall, moreover, is entirely different from that of many *Monticuliporids*, and agrees precisely with what we find to exist in *Favosites*. That is to say, each tube is provided with its own calcareous investment, which remains permanently distinct. Hence the wall which separates any two contiguous tubes is always composed of two distinct calcareous laminae, separated by a dark and definite boundary-line which is thickened at the points where three or more tubes come into contact. There are no very minute tubes, nor any "spiniform corallites;" and the dimorphism of the corallum is shown only by the presence at intervals of groups or clusters of corallites

of a larger size than the average. These large tubes, however, possess no special peculiarities of structure to distinguish them.

In *longitudinal* sections of *M. pulchella* the corallites are seen to be thin-walled, gradually thickening as they approach the surface, the boundary-lines between contiguous tubes being, in the outer part of their course, quite clearly marked. The cavities of the tubes are crossed by remote and complete tabulæ, which continue to be developed till close upon the surface; and there is no difference observable in the tabulation of the clusters of large tubes as compared with that of the ordinary corallites. There are no traces, either in longitudinal or tangential sections, of any canals or pores traversing the walls of the tubes or placing the visceral chambers of contiguous corallites in direct communication.

GENERAL CONCLUSIONS.

Finally, in instituting a comparison between *Heteropora* and *Monticulipora*, we may briefly review the following points:—

(1) As to the general *form* of the corallum, the two genera are very similar, though this point is of itself wholly without significance, and the latter genus comprises types of very varied shape and mode of growth. If, however, we compare *Heteropora* with the ordinary dendroid types of *Monticulipora*, we have in both a corallum made up of slender fasciculate tubes, which are nearly vertical in the centre of the branches, and then curve outwards, gently or abruptly, to reach the surface. In both, therefore, there are established two distinct regions of the corallum, an axial and a peripheral region. In both, moreover, these two regions are very different in internal structure, the tubes in the axial region of their course being thin-walled and polygonal, while in the peripheral region their walls are thickened, and they often become more or less rounded in form. In both, further, it would appear that any special interstitial tubes that may be present are developed in the peripheral region only, and extend either not at all, or to a very limited extent, into the axial part of the corallum.

(2) As regards the *dimorphism* of the corallum, all the most characteristic and typical species of *Monticulipora* consist of at least two, and sometimes of three, distinct sets of tubes, which generally differ both in size and in internal structure, and which are differently arranged in different cases. In *Heteropora* the skeleton consists of a series of large tubes surrounded by smaller interstitial tubes; but it does not appear that there is any special difference in the *internal structure* of

these. In neither genus are we acquainted with the *soft parts*; and therefore we cannot assert positively that this dimorphism has precisely the same significance in the two genera, while there are grounds for thinking that the reverse is the case.

(3) As regards the structure of the *wall*, the visceral cavities of the tubes of *Monticulipora* appear to be always closed, no traces of any pores or canals in the wall having yet been clearly proved to exist. In the case of *Heteropora*, on the other hand, the thickened walls of the tubes, in the peripheral part of their course, are traversed by an exceedingly well-developed series of transverse *canaliculi*, which open into the cavities of the tubes by definite *pores*, and which thus place the body-chambers of contiguous zooids in direct communication. These "canaliculi" differ structurally from the "mural pores" of the Favositidæ chiefly in being tubes with definite walls and dilated extremities, instead of being mere circumscribed deficiencies in the wall.

(4) No radiating "septa," in the form either of spines or of lamellæ, are known to exist in any species of *Monticulipora*. In *Heteropora*, on the other hand, the tubes, in the peripheral part of their course, are intersected by numerous delicate spinules, which are arranged in a radiating manner, and reach a considerable distance into the body-chamber (sometimes nearly to its centre). The spinules in form and arrangement precisely resemble the "septal spines" of many species of *Favosites*; but, admitting the Polyzoan affinities of *Heteropora*, it is obvious that they cannot be compared homologically to the septa of any Cœlenterate.

(5) Transverse partitions, or "tabulæ," are universally developed in the corallites of *Monticulipora*; and it is very common for the different kinds of tubes which make up the corallum to show marked differences in the nature and degree of their tabulation. In *Heteropora neozelanica*, Busk, tabulæ are, so far as I have seen, always present, though their number is comparatively small. They are also undoubtedly present in other species, and in greater numbers (*e. g.* in *H. conifera*, Haime, and *H. pustulosa*, Haime). So far as *H. neozelanica* is concerned, the tabulæ seem to be confined to the axial region of the corallites, and not to be developed in the interstitial tubes at all, thus differing in both of these respects from the tabulæ of *Monticulipora*. As in the case of the radiating spines, however, just noticed, if we concede the Polyzoan affinities of *Heteropora*, then the transverse partitions which cross its tubes must have a different value and import from the "tabulæ" of *Favosites* and of the so-called "Tabulate Corals" in general.

(6) Lastly, as to the supposed relationship between *Monticulipora* and *Heteropora*, and as to the deduction which has been drawn from this as to the propriety of referring the former genus to the Polyzoa, it is clear that the points of likeness between the two are by no means so weighty as the points of difference. On the one hand, we have a strong external resemblance, a general similarity in the mode of construction of the skeleton, and an agreement in the fact that in both genera the colony consists of two sets of tubes, while both have their tubes crossed by transverse partitions. Such transverse partitions of the tubes (or, as we may loosely call them, "tabulæ") occur, however, in organisms of such exceedingly diverse affinities that we can, admittedly, attach no value to the last mentioned of the above resemblances. A mere similarity in general form, appearance, or mode of skeletal conformation is also of no classificatory weight, since we could find species of *Favosites* or *Pachypora* which in these respects are quite like either *Monticulipora* or *Heteropora*; so that, after all, the resemblances between the two genera under consideration dwindle down to a comparatively small quantity.

On the other hand, to set against the mostly superficial points of resemblance above noted, we have a number of fundamental structural differences. Thus, in *Monticulipora* the walls of the tubes are imperforate, there are no traces of radiating spines or "septa," and in the dimorphic or trimorphic species there are usually important structural differences as regards the different groups of corallites. In *Heteropora*, on the contrary, the walls of the tubes are traversed by a very remarkable and exceptionally developed canal-system, the tubes possess in their outer portions a well-developed series of radiating spines arranged in vertical rows (sometimes, at any rate, if not always*), and the interstitial tubes are in no way structurally different from the proper zoecia.

In the face of the above distinctions I feel compelled to believe, in the meanwhile, that there is no real relationship at all between *Heteropora* and *Monticulipora*. This belief would not, of course, constitute any valid ground for denying the possibility that *Monticulipora* may truly belong to the

* It is true that radiating spines have not generally been observed in *Heteropora*, and that even in *H. neozelanica*, where they are plentifully developed, they seem to have been overlooked by such excellent observers as Prof. Busk and Mr. Waters. I ascribe this, however, to their very fragile nature, and to the general neglect of *tangential* sections, in which alone they can be readily made out; and I entertain no doubt that they occur generally in the genus.

Polyzoa rather than to the Cœlenterata; and on this point I prefer at present to come to no absolutely final conclusion, though my opinions lean decidedly towards the latter as a proper resting-place for the genus. It must, however, be evident that in supporting (as many palæontologists now do) the Polyzoan affinities of *Monticulipora*, little or no weight can in future be attached to the likeness which the genus shows to *Heteropora*. It may be also pointed out that, in our present ignorance of the *animal* of *Heteropora*, it is, perhaps, not entirely without hazard that we should unhesitatingly assign it to a place among the Polyzoa. I do not at all overlook its resemblance to many undoubted Cyclostomatous Polyzoa, nor am I in any way prepared to deny its Polyzoan affinities; but I cannot entirely ignore the fact that the pore-canals, septal spines, and tabulæ, which are now known to exist in some species of the genus *Heteropora*, are, at any rate, as reconcilable with its reference to the Cœlenterata as to the Polyzoa.

LV.—*On the Northern Species of Buccinum.*

By J. GWYN JEFFREYS, LL.D., F.R.S.

THE late Prof. Stimpson published, in the 'Canadian Naturalist' for October 1865, a "Review of the Northern Buccinums," and gave sixteen species with fifteen synonyms. Having had the privilege of examining his types, as well as those of Linné, Fabricius, Turton, Bennett, Broderip, Forbes, Möller, Hancock, Mörch, Reeve, G. O. Sars, Friele, Verkrüzen, and others, I thought a revised list of the species might be useful, and I now submit it. I recognize eight species only, with forty-six synonyms; and I believe even that number of species may be reduced when more intermediate forms are observed. Their fecundity and extensive distribution in the northern hemisphere, added to the difference in the conditions of habitat and temperature, would account for the great variability of the species. *Buccinopsis* connects *Buccinum* with *Fusus*. The generic name *Tritonium* is undoubtedly subsequent to *Buccinum*, and included *Fusus* and what I consider its subgenera, viz. *Sipho*, *Neptunea*, *Chrysodomus*, *Volutopsis*, and *Boreofusus*.

1. *Buccinum glaciale*, Linné.

B. carinatum, Phipps.

B. polaris, Gray.

Var. *B. angulosum*, Gray.

- Var. *B. Donovanii*, Gray.
- Var. *B. grænlandicum*, Hancock (not Chemnitz).
- Var. *B. tubulosum*, Reeve.
- Var. *B. undatum*, Dawson (not L.).
- Var. *B. Hancocki*, Mörch.
- Var. *B. turritum*, Verkrüzen.

2. *Buccinum undatum*, L.

- B. vulgare*, DaCosta.
- Var. *B. striatum*, Pennant.
- Var. *B. zetlandicum*, Forbes (a deep-water form).
- Var. *B. labradoreuse*, Reeve.
- Var. *B. Belcheri*, Reeve.
- Var. *B. fragile*, Verkr.
- Var. *B. conoideum*, G. O. Sars.
- Monstr. *B. carinatum*, Turton.
- Monstr. *B. acuminatum*, Broderip.
- Monstr. *B. imperiale*, Reeve.

3. *Buccinum grænlandicum*, Ch.

- B. cyaneum*, Bruguière.
- B. undatum*, Fabricius (not L.).
- B. tenebrosum*, Hanc.
- Var. *B. Donovanii*, Gould (not Gray).
- Var. *B. ciliatum*, Gould (not Fabr.).
- Var. *B. boreale* (Leach), Gray.
- Var. *B. undulatum*, Möller and Dawson.
- Var. *B. Humphreysianum*, Möll. (not Bennett).
- Var. *Tritonium ovum*, Middendorff (not *B. ovum*, Turt.).
- Var. *B. sericatum*, Hanc.
- Var. *B. fusiforme*, Kiener (not Broderip).
- Var. *B. perdix* (Beck), Mörch.
- Var. *B. finmarkianum*, Verkr. (a deep-water form).
- Var. *B. pulchellum*, G. O. Sars.
- Var. *B. parvulum*, Verkr.
- Var. *B. sulcatum*, Friele.

This species is closely allied to *B. undatum*; and both may be one and the same species. Herr Friele has shown that the cuspidation of the odontophore is not a reliable character for distinguishing the species of this genus.

4. *Buccinum hydrophanum*, Hanc.

- Var. *B. tumidulum*, G. O. Sars.
- Var. *B. Mörchi*, Friele.
- Var. *B. nivale*, Friele.

5. *Buccinum Humphreysianum*, Benn.

- B. anglicanum*, Fleming (not Lamarck).
- B. Puxleianum*, Leach.
- Var. *B. ventricosum*, Kiener.
- Var. *B. striatum*, Philippi (not Penn.).
- Var. *B. Kieneri*, Monterosato.
- Var. *B. inflatum*, Benoit (not Deshayes).

Not *B. Humphreysianum* of Möller, Lovén, Middendorff, M. Sars, Danielssen, or Malm.

6. *Buccinum Totteni*, (*Tottenii*) Stimpson.

B. terræ-novæ (Beck), Mörch.

B. undulatum, Hanc. (not Möll.).

Var. *B. plectrum*, St.

Var. *B. Packardi*, St.

Var. *Tr. simplex*, Midd.

Var. *B. Amaliæ*, Verkr.

Var. *B. elegans*, Verkr.

7. *Buccinum tenue*, Gray.

B. scalariforme (Beck), Möll.

Tr. ochotense, Midd.

B. tortuosum, Reeve.

8. *Buccinum ciliatum*, Fabr.

B. cyaneum, Hanc. (not Brug.).

Tr. tenebrosum (as of Hancock), var. *borealis*, Midd.

B. Molleri, Reeve.

LVI.—*Diagnoses of new Shells from Lake Tanganyika and East Africa.* By EDGAR A. SMITH*.

LIMNOTROCHUS, gen. nov.

Testa trochiformis, umbilicata, epidermide haud induta, spiraliter lirata. Anfractus ultimus in medio carinatus. Apertura intus non lirata, labro exteriore obliquo, margine basali late sinuato, columellari aliquanto reflexo, calloque labro superne juncto. Operculum corneum, paucispirale.

Limnotrochus Thomsoni.

Testa subsolida, anguste umbilicata, trochiformis, livide purpurea, fusco notata, ad basim et suturam albida. Anfractus 7, plani, declives, inferne late canaliculati, supra liris quatuor inæqualibus granulosis (suprema et infima quam cæteræ majoribus) cincti; anfr. ultimus in medio fortiter et subacute carinatus, infra medium leviter convexus, liris circiter 8 concentricis, plus minusve granulosis cinctus. Apertura subquadrangularis, intus supra carinam purpurascens, infra pallida. Labrum tenue, obliquum. Margo basalis late sinuatus; columella arcuata, superne leviter reflexa, labro callo juncta.

Long. 18 millim., diam. 11; aperturæ longit. 7½ millim., diam. 6.

Hab. Lake Tanganyika (*J. Thomson*).

* It is proposed to give elsewhere a full account of the collections of which the shells here described form part, with more detailed descriptions and coloured figures.

Limnotrochus Kirkii.

Testa trochiformis, anguste sed profunde umbilicata, lutescens. Anfractus circiter 7, leviter concavi, liris 6-7 granulosi (infima ad suturam maxima) ornati; anfr. ultimus medio valde angulatus, lirisque duabus fortibus granosis cinctus, inferne planiusculus, versus carinam concavus, liris numerosis inæqualibus, iis prope umbilicum quam cæteræ majoribus, cinctus. Apertura albida. Labrum obliquum, leviter incurvatum. Margo basalis late et profunde sinuatus; columellaris aliquanto incrassatus et reflexus, callo crassiusculo labro junctus.

Longit. 15 millim., diam. 17.

Hab. Lake Tanganyika (*E. Coode Hore*).

Lithoglyphus neritinoïdes.

Testa ovata, imperforata, tenuiuscula, lævis. Spira brevis, purpurascens, infra suturam albida. Anfractus 4, convexi; anfr. ult. magnus, elongatus, semipellucide albidus, epidermide tenuissima subolivacea indutus, lineis transversis filiformibus rufis ornatus. Apertura inverse pyriformis, longitudinis totius $\frac{5}{6}$ vix æquans. Labrum tenue. Columella callo maximo lato induta.

Longit. $6\frac{1}{2}$ millim., diam. 5; aperturae long. 5 millim., lat. 3.

Hab. Lake Tanganyika (*Thomson*).

Lithoglyphus rufiflorus.

Testa globosa, crassa, rimata, alba, lineis gracilibus rufis cincta, epidermide tenuissima induta. Anfractus $5\frac{1}{2}$, celeriter accrescentes, convexi, sutura simplici profundiuscula discreti, incrementi lineis striati; anfr. ult. magnus, globosus. Apertura magna, inverse subpyriformis, albida, longitudinis totius circiter $\frac{7}{8}$ æquans. Labrum tenue. Margo basalis incrassatus. Columella arcuata, valde callosa, reflexa, superne callo albo crasso labro juncta.

Longit. 13 millim., diam. $11\frac{1}{2}$; aperturae long. $10\frac{1}{2}$ millim., lat. 6.

Hab. Lake Tanganyika (*Thomson*).

SYRNOLOPSIS, gen. nov.

Testa subulata, lævis, imperforata. Apertura ad basim late sinuata. Labrum leviter incrassatum, in medio late sinuatum, inferne aliquanto productum, longe intus liris 1-2 prominulis munitum. Columella incrassata, plica valida superne instructa, labri extremitati callo tenui juncta.

Syrnolopsis lacustris.

Testa lævis, nitida, elongata, subulata, imperforata, luteo-cornea, infra suturam albo zonata. Anfr. 12, primi 2-3 convexi, cæteri fere plani, lente accrescentes, lineis incrementi valde flexuosis

tenuiter striati; sutura simplex, vix obliqua. Apertura parva, longitudinis totius $\frac{1}{4}$ fere æquans. Labrum et columella ut supra descripta.

Longit. $11\frac{1}{2}$ millim., diam. 3; aperturæ long. 3 millim., lat. 2.

Hab. Lake Tanganyika (*Thomson*).

Melania (Sermyla) admirabilis.

Testa solidiuscula, elongata, turrita, albida luto fuscescente decorata. Anfractus circiter 10, convexi, sutura obliqua profundissima sejuncti, longitudinaliter valide costati, sulcoque paululum infra suturam inæqualiter bipartiti; costæ valde arcuatæ, obliquæ, supra sulcum tuberculatæ; anfr. ultimus ad peripheriam rotundatus, infra eam liris validis 5-6 concentricis instructus, costis ad medium subito truncatis. Apertura subovata, longitudinis totius $\frac{1}{3}$ haud æquans, ad basin effusa. Columella obliqua, inferne arcuata, callosa, labro callo juncta.

Longit. 47 millim., diam. 14; aperturæ long. 14 millim., lat. 8.

Hab. Lake Tanganyika (*E. Coode Hore*).

Melania tanganyicensis.

Testa parva, turrita, solida, fere nigra, circa medium anfractuum zona lata dilute castanea cincta. Anfr. circiter 6, plani, superne rotunde humerosi, costis validis, latis, parum elevatis instructi; anfr. ult. magnus, basi sulcis paucis concentricis sculptus. Apertura dimidium testæ fere æquans. Columella arcuata, pallida, inferne incrassata.

Longit. $7\frac{1}{2}$ millim., diam. $2\frac{3}{4}$; aperturæ long. $3\frac{1}{2}$ millim.

Hab. Lake Tanganyika (*Thomson*).

Melania (—?) Horei.

Testa ovato-conica, lævis, fusca, infra suturam linea alba cincta. Anfr. $6\frac{1}{2}$, vix convexi, lineis incrementi levibus striati; anfr. ultimus prope aperturam paulo ascendens, inde subito ad marginem labri descendens, et ad basim aliquanto incrassatus. Apertura ovata, superne acuminata, purpureo-fusca, longitudinis totius $\frac{3}{7}$ adæquans. Labrum præcipue prope suturam incrassatum, versus basim leviter patulum. Columella albescens, mediocriter arcuata, superne callo tenui labro juncta.

Longit. 14 millim., diam. $6\frac{1}{2}$; aperturæ long. 6 millim., lat. 4.

Hab. Lake Tanganyika (*E. C. Hore*).

Bulimus notabilis.

Testa ovata, late umbilicata, pallide fusca. Anfractus 8, mediocriter convexi, liris confertis filiformibus, parum obliquis, vix arcuatis vel flexuosis ormati, sutura pæne horizontali discreti; anfr. ultimus ad peripheriam convexus, carina obsoleta, vix conspicua instructus, circa umbilicum carinatus. Apertura irregu-

lariter ovata, supra et infra aliquanto acuminata, ad basin canaliculata, intus carneo-fusca, longit. totius $\frac{2}{5}$ adæquans. Peristoma album, tenue, margine exterioro obliquo, haud dilatato, medio vix prominulo, columellari late expanso, arcuato, extremitatibus callo tenuissimo junctis.

Longit. 43 millim., diam. 20; aperturæ long. $17\frac{1}{2}$ millim., lat. 11.

Hab. Between Lake Nyassa and east coast (*Thomson*).

Achatina Thomsoni.

Testa solidiuscula, elongato-ovata, albida, nigro-fusco strigata, epidermide tenui, flavescente, decussata induta; spira aliquanto purpureo-rubida, plus minusve detrita. Anfr. 7, leviter convexi, incrementi lineis striati; anfr. ult. elongatus, angustus, sensim descendens. Apertura pyriformis, cæruleo-alba, longit. totius $\frac{1}{2}$ subæquans. Columella arcuata, incrassata, inferne haud abrupte truncata, labro callo tenui superne juncta.

Longit. 75 millim., diam. 32; aperturæ long. 38 millim., lat. 21.

Hab. Between Lake Nyassa and east coast (*Thomson*).

Achatina Kirkii.

Testa elongato-ovata, superne aliquanto acuminata, alba, strigis fuscis, suberectis, leviter undulatis ornata, epidermide flavescente induta. Anfr. 8-9, medioeriter convexi, lineis decussantibus subgranose sculpti; sutura inter anfr. superiores horizontalis, inter duos ultimos obliqua; anfr. ult. descendens, infra medium levior. Apertura subpyriformis, cæruleo-alba, longitudinis totius $\frac{1}{2}$ haud æquans. Columella parum arcuata, albida, subabrupte truncata, labro callo tenui juncta.

Long. 81 millim., diam. 37; aperturæ long. 39 millim., lat. 20.

Hab. Between Zanzibar and Lake Tanganyika (*Dr. J. Kirk*).

Subulina solidiuscula.

Testa elongata, subulata, solidiuscula, imperforata, alba, epidermide tenui olivacea obtecta, incrementi lineis striisque transversis haud profundis sculpta. Spira lateribus rectilinearibus, lente accrescens. Apex obtusus, truncatus. Anfractus reliqui 8, vix convexi, sutura subhorizontali simplici sejuncti. Apertura brevis; columella curvata.

Long. 52 millim., diam. 11; aperturæ long. 9 millim., lat. $5\frac{1}{3}$.

Hab. Near Lake Tanganyika (*Thomson*).

Subulina lenta.

Testa subulata, imperforata, epidermide pallide olivacea, strigis obliquis obscurioribus hic illic variegata, induta. Anfractus 11-12, parum convexi, lente accrescentes, incrementi lineis ob-

liquis leviter flexuosis sculpti. Sutura simplex, aliquanto obliqua, profundiuscula. Apertura parva, longitudinis totius $\frac{1}{5}$ haud æquans. Columella perarcuata, inferne abrupte truncata.

Hab. Near Lake Tanganyika (*Thomson*).

Streptaxis Craveni.

Testa anguste umbilicata, oblique distorta, lævis, nitida, sordide lactea. Anfr. 7, leviter convexi, infra suturam confertim costulatum striati; anfr. ult. antice subito descendens, inde supra anfr. penultimum aliquanto ascendens, peroblique excentricus. Apertura obliqua, haud denticulata. Labrum ad suturam sinuatum, in medio prominulum, arcuatum, inferne obliquum, leviter incrassatum et reflexum. Columella incrassata, anguste reflexa, parum arcuata.

Long. 29 millim., diam. 22; aperturæ long. 15 millim., lat. $12\frac{1}{2}$.

Hab. On hills between the mouth of the river Dana and Mombasa, E. Africa (*Dr. J. Kirk*).

Streptaxis gigas.

Testa maxima, alba, late umbilicata. Anfr. 6, regulariter accrescentes, convexiusculi, costulis perarcuatis, validis, confertis instructi; anfr. ult. infra peripheriam nitidus, lineis incrementi tenuibus sculptus. Apertura magna, sublunata. Labrum obliquum, superne arcuatum et productum, inferne late sinuatum, tenue. Columella aliquanto supra expansa.

Alt. 30 millim., diam. 33; aperturæ long. $17\frac{1}{2}$ millim., lat. 15.

Hab. Between Lake Nyassa and the east coast (*Thomson*).

Streptaxis mozambicensis.

Testa parva, rimata, albida, lævis, nitida. Anfr. 6, convexi, infra suturam profundam crenulati; anfr. ultimus obliquus, antice descendens, prope labrum breviter ascendens, supra aperturam paulo complanatus. Apertura circulariter lunata, parva, haud denticulata. Labrum leviter arcuatum, obliquum, anguste expansum. Margo columellaris latius expansus.

Alt. $7\frac{1}{2}$ millim., diam. anfr. ult. $4\frac{1}{2}$; aperturæ long. 3 millim., lat. $2\frac{1}{2}$.

Hab. Between Lake Nyassa and the east coast (*Thomson*).

Unio Horei.

Testa oblonga, subrhomboidalis, postice leviter latior, inæquilateralis, tenuiuscula, margaritacea, epidermide tenui flavo-olivacea induta, concentricè striata, supra umbones corrugata, utrinque prope marginem dorsalem radiatim plicata. Margo dorsalis rectiusculus; margo anterior late curvatus, posterior obliquus parum arcuatus, ventralis leviter curvatus. Facies interna alba, margaritacea. Dentes anteriores et posteriores lamellæformes. Cicatrices parum profundæ, anterior profundior, subquadrata.

Long. $16\frac{1}{2}$ millim., lat. 25; diam. $9\frac{1}{2}$ millim.

Hab. Lake Tanganyika (*Thomson*).

Unio Thomsoni.

Testa ovata, postice aliquanto acuminata, inæquilateralis, flavescens vel rosaceus, sordide rosaceo obscure radiata, epidermide tenui olivacea obtecta, concentrice striata, prope marginem dorsalem granose radiatim distincte utrinque corrugata. Margo dorsalis postice declivis, antice subsinuate descendens; margo ventralis valde arcuatus, postice vix sinuatus. Umbones parvi, acutiusculi, concinne corrugati, ad $\frac{2}{7}$ longitudinis siti. Dentes cardinales parvi, irregulariter bifidi vel tripartiti, rugosi, striati; posteriores graciles. Pagina interna cæruleo-alba, roseo radiata vel purpureo-fusca.

Long. 15 millim., lat. 21; diam. 10 millim.

Hab. Lake Tanganyika (*Thomson*).

LVII.—*Notes on the French exploring Voyage of 'Le Travailleur' in the Bay of Biscay.* By the Rev. A. M. NORMAN, M.A., F.L.S., &c.*

IN JUNE last a Commission was appointed by the French Government for the purpose of exploring the great depths which captains and Spanish fishermen affirmed existed in the Gulf of Gascony, off the coasts of Cantabria and the Asturias. The members of this Commission were Professor Milne-Edwards (President), Professor Alphonse Milne-Edwards, the Marquis de Folin, Professor Vaillant, Professor Marion, Professor L. Perier of Bordeaux, and Dr. Paul Fischer. M. Jules Ferry, the Minister of Public Instruction and Science, did my friend Dr. Gwyn Jeffreys and myself the honour of inviting us to act with this Commission as "collaborateurs étrangers," and to accept hospitality on board the Government steamer 'Le Travailleur,' which was placed at the disposal of the Commission for the last fortnight of July.

'Le Travailleur' is a paddle-steamer of about 1000 tons, with a complement of officers and men, which was increased to 145 for the expedition, additional hands being engaged, so that there might be no cessation night or day in the soundings and dredgings. She was carefully fitted up with every scientific appliance necessary for such an expedition, and was most admirably handled by Captain Richard, her commander, and his efficient staff of officers, all of whom threw themselves

* Paper read at Meeting of the British Association at Swansea, August 31, 1880.

with unflagging zeal and energy into the somewhat unusual duties which devolved upon them, taking most intelligent and lively interest in the various scientific work.

The fittings of the ship generally and the scientific apparatus employed were similar for the most part in character to those employed in the English expeditions; there were, however, two or three novel appliances, which may be mentioned.

The dredge, devised by Alexander Agassiz, which has a metal skeleton frame within the net, so that the extent of bearing on the bottom is not only the mouth but the entire side, appeared admirably designed for use on a very soft bottom, such as is usually met with in the great depths, it having less tendency to bury itself in the mud. Unfortunately, at the second haul, this dredge, coming up with an immense load, was lost by the breaking of the rope; but in the one successful haul the end desired appeared to have been satisfactorily obtained, and the mud consisted of that which belongs to the softest surface-stratum.

Another instrument which was found efficient may be called the "beam-sweep." It consisted of a long bar of wood, similar in size and structure to the "beam" of a large trawl. To this beam were attached at each end bundles of faggots, so as to raise it about a foot from the ground, while at the same time weights were, of course, added to keep it from floating. To this beam three small dredges, such as are ordinarily employed in shallow water, were fastened by ropes three or four fathoms long, so that they might be dragged behind it, one in the centre and one at each end, while the whole length of the beam itself was hung with "tangles." It will be understood that by the use of the "beam-sweep" a much greater breadth of the bottom was swept than is effected by the ordinary single large dredge and its attached "tangles." And it was found to be very effectual; for not only did it come up laden with Crustacea and Echinoderms, but even rare deep-water fish, referred by Prof. Vaillant to the genera *Stromias* and *Macrurus*, were caught in the tangles and secured in beautiful preservation.

Nor must I omit to refer to the most satisfactory results attained by the use of a form of the "hydra" sounding-lead combined with an apparatus in which steel pianoforte-wire, as recommended by Sir William Thomson, was employed as the sounding-line. The wire was coiled on a very narrow drum of considerable diameter, attached to the side of which was a clockwork dial on which each revolution was registered. The circumference of the wheel being known, the multiplica-

tion of the number of revolutions by the circumference at once gives the depth. The advantages of the use of the wire are evidenced, 1st, in the rapidity with which the sounding is effected, the lead descending at the rate of about 175 metres (say 94 fathoms) in a minute, whereas with the ordinary hemp line it would be about 60 metres in the minute, and being wound on the wheel again at the rate of about 85 metres in the minute; 2ndly, in that the friction of the water upon the fine wire is reduced to a minimum, and that consequently nearly absolute perpendicularity of the sounding is secured; 3rdly, the hand feels with much greater certainty than with a rope the moment when the lead reaches the bottom; lastly, the greatly reduced size, and consequent compactness, of the whole machine, which, instead of encumbering the deck, as is necessarily the case when a drum is used on which there are coiled some thousands of fathoms of rope, the drum on which the wire is coiled has only the breadth of an ordinary cart-wheel.

The directions given to the Commission having been to examine that portion of the Gulf lying off the northern coast of Spain, the soundings and dredgings were limited to a distance of about fifteen miles from land. In the fortnight's operations more than 100 soundings were taken, at depths ranging (roughly) from 150 to 2700 metres. The results of these soundings will, when published, be very interesting to the hydrographer and to all interested in Physical Geography. As a general observation, it may be stated that, off St. Sebastian and Santander, where the general range of the Pyrenean mountains and their outliers is at an angle with the coast, the sea-bottom is found to descend with great rapidity down to a thousand fathoms and more, while further west, where the Cantabrian mountains run parallel with the coast, the increase of depth is very gradual, so that from a little to the west of Santander, and thence reaching to Cape Penas, the sea-bottom of the district examined was a plateau with a nearly uniform depth of 60–80 fathoms.

A remarkable ravine in the sea, about twelve miles north of Bayonne, has long been known under the name of the *Fosse de Cap-Breton*. The ravine runs at right angles to the coast, cutting in two by its narrow channel a great shallow plateau, and extends from the shore seawards about three miles, with a depth of 100–200 fathoms. This ravine had been the scene for many years past of extensive dredging operations by the Marquis de Folin, who had there procured great numbers of Invertebrata of the highest interest; and it was the great success which had attended the investigations of the Marquis in this spot which in a great measure induced the French

Government to inaugurate the more extended examination of that portion of the Bay of Biscay which has now been made. The course of the Fosse de Cap-Breton more than about three miles from land was not known ; but a sounding on the chart further seaward indicating much shallower water, suggested the possibility that the Fosse might be a merely local depression. Cross sections of soundings by the 'Travailleur,' however, have now satisfactorily determined that the Fosse, at about three miles from land, suddenly turns southward, then westward, and then north-westward, until, gradually increasing in depth, it joins the great abyss. It was suggested that this Fosse de Cap-Breton indicated the outlet, under a former geological epoch, of the river Adour, which now empties itself into the sea at Bayonne. The intervening country between Bayonne and Cap-Breton is at the present time occupied by "Les Sables," a range of Tertiary sandhills.

It remains that I should now notice some of the zoological results of the expedition. Dr. Gwyn Jeffreys has already acquainted the Section with those results as relates to the Mollusca. It is with the other classes that I have to do ; and it is necessary that I should preface what I say by stating that the names I give must be received with caution, inasmuch as these notes merely give the impressions conveyed to me as the animals were dredged, being without books to refer to at the time. The specimens are in the hands of those able French naturalists who were members of the Commission, and with whom will rest the determination and description of the animals obtained ; and I have thus had no opportunity of examining and accurately naming them.

As might have been expected, many of the Crustacea obtained off the Portuguese coast by the 'Porcupine' occurred in the North-Spanish dredgings ; among these were *Dorhynchus Thomsoni*, Norman, *Amathia Carpenteri*, Norman, *Ebalia nux*, Norman, *Ethusa granulata*, Norman, *Pagurus tricarinatus*, Norman, *Munida tenuimana*, G. O. Sars, and *Apseudes spinosa*, Sars, and *grossimana*, Norman. The large Norwegian Brachyuran *Geryon tridens*, Kröyer, which was traced southward by the 'Porcupine' to the entrance of the Bay of Biscay, was found to be the most abundant species within the Bay, though in size greatly dwarfed as compared with Norwegian specimens. A *Thysanopoda*, probably *T. norvegica*, was taken several times abundantly, and was doubtless caught as the dredge approached the surface. The large, most remarkable, blood-red Schizopod *Gnathophausia zoëa*, Willemöes-Suhm, which was discovered in the 'Challenger' Expedition near the Azores and off the coast of Brazil,

delighted us with its beauty. Many undescribed species were met with. Preeminent among these were :—a new genus allied to *Dromia**; a very curious new genus of Galatheidæ, which is blind and has the eyestalks converted into spine-tipped processes; a new Palæmonid remarkable for having its carapace girt with a ring of spines; and a *Scalpellum* apparently new.

Among the Gephyrea were two species recently described by Danielssen and Koren from the Norwegian coast and not hitherto found further south—the grand *Sipunculus priapuloides*, which is the largest and most interesting species of the genus known to me, and the curious little *Ochnesoma Steenstrupii*. This latter species I dredged last year in great abundance at the mouth of the Hardanger fiord, Norway. A third Gephyrean obtained is also perhaps the *Phascolosoma squamatum* of the same authors.

In the Fosse de Cap-Breton the curious Annelid *Sternaspis thalassemoides*, Otto, which was formerly referred to the Gephyrea, was found abundantly.

Several examples of the much-disputed *Chætoderma nitidulum* were obtained. This is one of those animals which, exhibiting relationship to more than one class in almost equal ratio, becomes, by its somewhat intermediate characters, of special interest.

Only a single Polyzoön occurred. This was *Triticella Bæckii*, or an allied species. It was infesting the Crab *Geryon tridens*, on which same host the species just named was discovered by Professor G. O. Sars.

There was a remarkable absence of Hydrozoa.

In no class is the collection finer than among the Actinozoa. Of Actinians not secreting a corallum there were a new *Palythoa* (parasitic on the spines of *Cidaris papillata*), an *Actinia* (*Adamsia*?) parasitic on an *Isis*, and two or three other things which were not recognized by us. Of corals there were *Caryophyllia clavus*, a *Flabellum* belonging to the *Flabellum apertum* group (in which the corallum is little or not at all compressed), a *Deltocyathus*, and *Lophohelia prolifera*. Of Gorgonian allies there were *Gorgonia verrucosa* and at least two species of *Isis*, one of which was of considerable size, and when dredged at night was gorgeously phosphorescent, exhibiting a blaze of light. Of Virgularians there were many fine species, including two large forms of *Virgularia* (or a closely allied genus), what appeared to be a *Scytalium* of very elegant

* M. Alphonse Milne-Edwards had previously seen this among the Crustacea dredged by A. Agassiz in the 'Blake,' and proposes to name it *Dicranodromia ovata*.

form and bright-red widely separated fins, a genus which from the curved flaccid state of the polyparium appeared to be devoid of all calcareous axis, *Kophobelemnon stelliferum*, and an example of the genus *Umbellularia**. This genus, first discovered in the Arctic Seas in 1753, and admirably figured by old Ellis, was lost sight of for 120 years, when it was re-discovered by Lindahl in the Swedish Expedition between Greenland and Newfoundland. Subsequently the 'Challenger' dredged it in several spots, and as far south as midway between Cape St. Vincent and Madeira. But the finding of this most interesting animal within a few miles of the European coast by 'Le Travailleur' (July 30, in 1160 metres) leads us to hope that hereafter it may even be added to the British fauna.

Echinodermata, as is usual in deep-sea dredgings, were numerous. Of Holothuroidea there were a form entirely unknown to me (furnished with only two rows of suckers, remarkable for their great size, and ten tentacula), a *Molpadia* (which has generally been regarded as an Arctic genus), and *Echinocucumis typica* (an abundant Norwegian type, of which the presence in the Bay of Biscay was evidenced by a single specimen). A curious instance occurred of the meeting in the Bay of Biscay of species hitherto supposed to be confined to Scandinavia with others regarded as eminently Mediterranean. The trawl had been down in 360 metres; and when taken up, out of it rolled one or two hundred huge Holothurians, each about a foot long. It was at once evident that they belonged to two species; and further examination proved about two thirds of them to be the rosy-coloured *Holothuria tremula* of Norway: the remainder, known at a glance by their light-brown colour and flattened side, were *Stichopus regalis* of the Mediterranean. They had apparently met on this neutral ground, and were living together on the most amicable terms.

Sea-Urchins were represented by:—*Echinus microstoma*, Wyville Thomson; *Calveria hystrix* (or an allied species), of which several fine specimens occurred; *Pourtalesia Jeffreysii*; and a new Spatangoid, remarkable on account of its globular form, and referable perhaps to the genus *Ayassizia*.

Starfishes were not numerous in species, and gave us nothing new. *Archaster tenuispina* and *bifrons*, *Astropecten andromeda*, and *Brisinga coronata* were the rarer forms.

The Brittlestars were of much importance; for though the number of examples was not great, the number of species (and perhaps of new forms) was considerable. The Ophiuridans

* Probably *Umbellula Thomsonii*, Kölliker.

require attentive study, and cannot be determined at a glance. It will therefore suffice to say that there were many which were not familiar to me, belonging apparently to the genera *Asteronyx* (parasitic on *Isis*, rather small, and possibly distinct from *Loveni*), *Ophiomusium*, *Ophiacantha*, *Ophioscolex*, together with a remarkably large and fine form, which I was unable to refer to any genus known to me. An Ophiurid was also met with which I had discovered last year in Norway, and which I propose to name *Amphiura Danielsseni*.

Sponges, with respect to the number both of species and of specimens obtained, were scarce. *Thenea muricata* (Bowerbank) (= *Wyvillethomsonia Wallichii*, P. Wright), and *Holtenia Carpenteri*, Wyv. Thomson, only occurred in a young state; and a little bunch of the strong coarse spicula of the great *Askonema setubalense*, Kent, came up wrapped round the dredging-line; a single *Hyalonema lusitanicum*, Bocage, was dredged in about 600 fathoms; and a fine though dead specimen of *Farrea* or *Lefroyella* was procured, but, unfortunately, in fragments.

The Foraminifera of course could not, from their minute size, be examined as they were dredged; but among the larger forms noticed in the sieves were many very interesting and recently described types. Foremost among these were the largest and most perfect examples of the beautiful *Orbitolites tenuissimus*, Carpenter, I had ever seen (they equalled a sixpence in size, and were dredged in about 1200 fathoms, July 20), and the very remarkable thread-like *Bathysiphon filiformis*, G. O. Sars (which, as far as I am aware, had before been met with only in the Norwegian fiords). Arenaceous forms were abundant and fine, and included the following recently described species:—

- Rhabdammina abyssorum*, M. Sars.
- Hyperammina ramosa*, H. B. Brady.
- Saccammina spherica*, M. Sars.
- Psammosphæra fusca*, Schultze.
- Storthosphæra albida*, Schultze.
- Astrorhiza arenaria*, Norman.
- Lituola subglobosa*, M. Sars.
- Cyclammia cancellata*, H. B. Brady.

In concluding these rough notes I must express the deep sense I entertain of the kindness, courtesy, and attention which we received from the French naturalists who were members of the Commission, and also from Captain Richard and all the officers of 'Le Travailleur.'

LVIII.—*On the Flint Nodules of the Trimmingham Chalk.*

By W. J. SOLLAS, M.A., F.R.S.E., F.G.S., Professor of Geology in University College, Bristol.

[Continued from p. 395.]

The formation of the Flints.—If it were possible to give a satisfactory explanation of the formation of the flints, a difficult and interesting problem would have been solved; and though a complete solution has not yet been attained, it is nevertheless certain that the observations of the past ten years have brought us remarkably near to it.

In this part of the paper (which was not read at Swansea) I propose to offer a brief general discussion of the subject, arranging our inquiries under the four following heads:—(i) The source of the silica of which flints consist; (ii) its accumulation, chiefly as sponge-spicules, in the flint-bearing deposits; (iii) the solution of the accumulated silica; and (iv) its redeposition as flint and other forms of mineral silica.

(i) *The proximate source of the Silica.*—Two opposite opinions are held with regard to this:—one to the effect that the silica was introduced into the flint-bearing bed, subsequent to its formation, in solution from without; the other, that it was deposited contemporaneously, and subsequently dissolved *in situ*. According to the first view, which is advocated by Hull and Hardman in explanation of the Carboniferous chert of Ireland, and by Renard for the Carboniferous Phthanites of Belgium, a shallow sea became charged with an unusual amount of silica derived from the siliceous rocks of surrounding lands. The siliceous waters permeating the calcareous sediments below brought about a replacement by which they were converted into flint. The second was the opinion of Ehrenberg and Lyell, and is supported by W. Thomson, Wallich, and quite recently by Alexis A. Julien. According to it the silica has been derived from siliceous organisms, either collected into distinct layers or scattered through some other deposit like the siliceous remains now found dispersed in the Atlantic ooze.

For some years past I have regarded this latter proposition as an almost self-evident truth.

1. In a discussion on Dr. Wallich's paper on "the Physical History of the Cretaceous Flints," Dr. Sorby stated, in terms admirably terse, the general argument which has long been advanced in its favour. He says *, "Though deep-

* Quart. Journ. Geol. Soc. xxxvi. p. 91.

sea mud differs from chalk in many important particulars, yet still it is sufficiently related to warrant a comparison. Since the remains of siliceous organisms are absent from the chalk, but flints present, whilst in the deep-sea mud siliceous organisms are abundant and flints absent, probably the material of the flints had been to a greater or less extent derived from these organisms."

This argument depends on the analogy of some deep-sea mud with the chalk; and by this analogy the inference is drawn that siliceous organisms were at one time present in the chalk, just as they are now in the grey ooze. We shall now proceed to make this inference independent of analogy by showing that it is really nothing less than a statement of fact.

2. The deposits in which flints occur can be proved by direct observation to have originally contained abundant siliceous organisms, which have since, to a greater or less extent, disappeared from them.

The Trimmingham flints afford evidence straight to the point; for not only are sponge-spicules intimately associated with them and in great numbers, but these spicules afford us clear proof of the previous existence of a great mass of other spicules of which they are themselves but a miserable remnant. The small fragments of Hexactinellid and Lithistid network indicate the previous existence of whole skeletons of such network, and also of a great quantity of those minute spicules which in the living sponge are thickly strewn throughout its sarcode; of these flesh-spicules not a trace is now to be found. And finally, while a large part of the larger spicules and all the flesh-spicules of the sponges have entirely disappeared, those that remain present abundant signs of corrosion, and have evidently lost a considerable proportion of the silica they once contained.

We thus see, not only that certain spicules still exist in the flint-bearing chalk, but that, by the law of association, a vastly greater number of other spicules must have existed along with them. Somehow these other spicules cannot be found in the deposit now; somehow flint nodules, which are not associated with recent sponges, have made their appearance. And the inference is clear; as one says, the facts speak for themselves.

This argument holds not only in the case of the Trimmingham flints, but of nearly all flints which I have examined, and may be extended to many other kinds of siliceous deposits as well. In the Niagara chert-beds of the Silurian of North America remnants of sponge-skeletons abound. In the Car-

boniferous beds of Scotland we have the same association ; and in those of North Wales pseudomorphs of Radiolaria in calcite occur along with minute quartz crystals. The Lias of South Wales contains beds of chert literally crammed with sponge-spicules of large size ; and in some of the Lias limestones dispersed spicules are abundantly present along with minute quartz crystals and chalcedonized shells. In the Coraline Oolite of Yorkshire we find the calcitic pseudomorphs of *Geodites Sorbyanus*, to the abundance of which Sorby testifies ; and accompanying them are chalcedonized shells and numerous granules of silica with a radiate crystalline structure. The sponges of the Yorkshire oolite, often of large size, are known to have been siliceous solely by a study of their form and structure ; for they now consist of carbonate of lime, the silica which they once contained being, according to our view, chiefly collected in radiating crystalline patches or granules, which occur in association with them. In the freshwater Purbeck beds of Lulworth freshwater chert occurs, in which Mr. John S. Young, F.G.S.*, has found numerous spicules of *Spongilla* (*S. purbeckensis*, Young). In the Cambridge Greensand we have a remarkable instance of the association we are illustrating in the fossil Renierid sponge *Pharetrospongia Strahani*, the spicular fibres of which have exchanged a siliceous for a calcareous composition, while the chalk surrounding them in the interstices of the sponge has been converted into silex, with but slight alteration in morphological character.

I believe I may fairly claim to have substantiated the statement with which I set out, and will now only add the following passage, which I venture to extract from my paper on *Catagma*† ; it indicates the same line of reasoning, though it was used in a quite different connexion :—“ As regards siliceous sponges, many of these often exist now in a calcareous state ; but it may be as well to note that whenever a siliceous sponge becomes calcitized in fossilization the deposited silica is generally to be found somewhere not far off, either in patches in the sponge itself, or in granules or nodules such as flints in the surrounding matrix, or as chalcedony silicifying associated calcareous shells, *ex. gr.* in the Lias of the South-Welsh coast, or in minute dispersed crystals of quartz, *ex. gr.* in the Devonian and Carboniferous limestone. In compact strata, such as chalk or limestone, it may be taken as an almost invariable rule that the replacement of organic silica by calcite is always accompanied by a subsequent deposition

* Geol. Mag. new ser. dec. ii. vol. v. p. 220 (1878).

† Ann. & Mag. Nat. Hist. 1878, ser. 5, vol. ii. p. 361.

of the silica in some form or other; and thus, if one finds flints, chalcedonized shells, or minute quartz crystals in such strata, one will naturally look for the remains of the siliceous organisms which supplied them, and one's search will seldom be unsuccessful."

As an objection to what we may call the theory of the intrinsic source of the silex in flint we may quote the following passage by Prof. Renard* :—"The details of micro-structure which we have entered into prove also that it is impossible to admit, in order to explain the formation of Phthanites, as has been so often repeated in the case of flints, that these rocks are derived from an accumulation of organisms with siliceous envelopes. In the first place the examination of thin slices shows us but very seldom in these rocks sections of shells which one would refer to organisms with siliceous tests; and if in some cases we do meet with them, in flint for example, the siliceous envelopes are there so well preserved that, admitting the entire mass of the nodule to have been derived from the transformation of these remains of organisms into gelatinous silica, we cannot understand why some sections should have escaped this transformation and should have been preserved intact in the midst of the 'fusionment.'"

The Trimmingham flints appear to throw some light on this difficulty; for we find that as silicification proceeds and the nodule becomes more completely a flint, the sponge-spicules, which are abundant enough in the contiguous siliceous chalk, completely disappear in the flint itself; indeed one may even observe one half of a large spicule projecting out of a mass of silex, while the other half, which is certainly imbedded within it, is not to be distinguished from the surrounding flint. As regards the precision with which the form of some sponge-spicules is preserved in flint, my observations† show that this does not extend to their substance; for in such cases, though white, opaque, well defined, and apparently solid, they are really nothing more than empty hollow casts. When these casts become filled in with silica subsequently, as they sometimes do, they lose their solid appearance and become mere shadows of their former selves.

* "Recherches lithologiques sur les Phthanites du Calcaire carbonifère de Belgique," par A. Renard, S.J. Extrait des Bulletins de l'Académie royale de Belgique, 2^me sér. t. xlv. nos. 9, 10 (1878).

† Quart. Journ. Geol. Soc. xxxiii. p. 817 (1877):—"Indeed, I may go so far as to state that whenever one sees a very white and opaque solid-looking spicule imbedded in clear transparent flint, one may expect to find it just the very reverse as regards solidity of what it seems" ("On the Genus *Siphonia*").

After having explained a difficulty with regard to the intrinsic view, one may *en revanche* suggest one to the extrinsic view. This is to be found in the restriction of the flints to definite layers in the chalk, the chalk above and below being free both from them and from sponge-spicules. It is difficult to see, in the first place, how a shallow sea came to consist of a strong solution of silica, and still more so to understand how it came to vary in a rhythmical fashion, sometimes being concentrated enough to lead to the formation of flints, and again pure enough to leave the intervening chalk almost absolutely devoid of silica.

(ii) *The accumulation of the Sponge-spicules.*—Since we have shown that the silica of the flints has in all probability been derived in many cases from accumulations of sponge-spicules, we have next to show how these accumulations were produced. Two different explanations naturally suggest themselves: either the spicules have been derived from successive generations of sponges which grew upon the same spot, or they have been separated from a large quantity of chalk and washed together by current-action.

The Trimmingham flints contain each a diversified collection of spicules derived from several different genera of several different families of sponges; and the assemblage of forms obtained from one flint does not differ in any distinct way from the assemblage obtained from another. This possession by a number of separate flints of a group of diverse spicules in common might lead us at first to suppose that the spicules had been drifted together by currents, except that such a supposition would not account for the characteristic form presented by many of the flints. Of this curious association of well-preserved external form with a mixture of spicules the chalk affords numerous striking examples, of which, perhaps, the best-known is that of *Cæloptychium**, which yielded to Zittel quite as many extraneous spicules as are figured here from the Trimmingham nodules, and which, at the same time, presents us with a much more characteristic external form. Another, less known, is that of the so-called Neptune's cup of the chalk: this is incontestably the Cretaceous representative of the existing *Poterion patera*, Hardwicke; so that it may well be named *Poterion cretaceum*. It is a suberite sponge with characteristic outer form, and when alive contained only pin-headed spicules; in its silicified state, however, it is crowded with other forms, which have been introduced into it from without. *Poterion cretaceum* has certainly not been drifted, it has been silicified where it stands; and so, we

* Abhandl. der k. bayer. Akad. der W., h. Cl. xii. Bd. iii. 1876.

believe, have such of the Trimmingham flints as still retain a definite form. At the same time they have evidently received an addition to their proper spicular complement from sponges of other kinds; and we have still to consider whether these additional spicules were collected by current-action. That currents may have had some influence is clear enough. The flints were not formed at any abyssal depth; as we have seen, the associated spicules indicate limits of 100 to 400 fathoms; and Carter states that even at greater depths considerable drifting is produced by currents. Thus he says* :—“The dredgings of H.M.S. ‘Porcupine’ indicate, through the specimens now with me, that about 100 miles north of the Butt of Lewis, in 632 fathoms (station no. 57), there must be a bed of sponge-spicules of many kinds, portions of which are rounded by the currents into pebble-like forms, which may one day become the nuclei of flints.”

The observation of Sorby that some specimens of chalk seem to show signs of a gentle washing-action, and the occurrence of a few small grains of quartz-sand in the Trimmingham chalk, are both evidences favouring the idea of current-action. Still I do not think that drifting has occurred to any great extent. The spicules are not sorted out and collected into a purely siliceous layer; but such of them as remain are intimately mixed with granules, coccoliths, and Foraminifera, which do not differ from ordinary chalk material, except in being partly siliceous; in other words, the separation which drifting might be called in to accomplish has not taken place. In like manner the different spicules themselves are confusedly mixed together, large and small alike, with no tendency for the small to occur in one place and the large in another. The once existing flesh-spicules, it is true, are absent—not because they have been washed away, however, but dissolved; for they are invariably absent in fossil sponges and stratified deposits. Neither Zittel nor I have seen a trace of them; and my observations on the comparative readiness with which they undergo solution in caustic potash serve to explain their absence. If drifting has taken place, it must have been to a very slight extent, sufficient to help in mixing the different sponge-spicules together, but not to sort them out into any distinct layer.

Our belief is that the area over which the Trimmingham spicules are now found was once a sponge-bed, where numerous sponges flourished, generation after generation, in a luxuriant meadow-like growth; many of them led a parasitic

* Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. p. 40 (1875).

or epizoic life upon others; several grew crowded together on the same object of support, just as at the present day one may find no less than seven different species of sponge growing together on one small fragment of *Lophohelia* not an inch square*. With death and the dissolution of the organism the spicules were set free from the different adjacent sponges, and, falling into the same deposit, naturally mingled together; movements of the surrounding sea-water may very well have taken place, and would serve to render the mixture of the spicules more complete. In this way would be produced a layer of chalky ooze crammed with sponge-spicules of all sorts and sizes. Such sponges as possessed skeletons coherent enough to maintain their general form after death would be covered up and filled in with this mixture of ooze and spicules, and, undergoing silicification, would furnish us with instances of fossil sponges presenting a well-preserved form externally and a curious mixture of spicules within. For some suggestive observations on this subject Dr. Wallich's paper on "the Natural History of the Cretaceous Flints" may be consulted †.

Excepting that sponges do not periodically shed their spicules like leaves and spores, the explanation we have just suggested bears a striking resemblance to the "growth-in-place" theory of our coal beds. In the coal, as in the flints, the structure of the constituents has generally been almost entirely obliterated, yet some few of the leaves or spicules, as the case may be, are occasionally found in an admirable state of preservation; and just as a *Sigillaria* every now and again remains a solitary survivor of a whole forest, so now and then a whole sponge is to be found preserved out of a host of associates now vanished or turned to flint.

(iii) *The solution of the Spicules.*—From the preceding paragraphs it is clear that solution of sponge-spicules has been of very common occurrence. A summary of the evidence in proof of this, however, may not be out of place here. Thus:—1, fossil sponge-spicules are frequently eroded externally and their axial canals enlarged internally; 2, all flesh-spicules, necessarily once present, have entirely disappeared; 3, in many chalk-flints Ventriculite and Lithistid skeletons occur, perfectly preserved as to form, but not as solid network, merely as empty casts; 4, the skeletons of many fossil sponges have exchanged a siliceous for a calcareous composition.

As to the reality of the alleged solution there can be no

* Carter, Ann. & Mag. Nat. Hist. ser. 4, vol. xii. pl. i. figs. 1, 2.

† Quart. Journ. Geol. Soc. vol. xxxvi. p. 68.

doubt; but as to the means by which it has been effected we have still much to learn. Alexis A. Julien, in a paper of the highest importance on the geologic action of the humic acids, suggests* that albuminoid or glairy matters and acids akin to the azohumic of Thenard, produced during the submarine decomposition of organic matter, may have been the agents which accomplished the solution. This may very possibly have been the case, though possibly the water at the sea-bottom may, even without the assistance of these substances, have been a sufficiently powerful solvent; and this appears the more likely when we consider the considerable pressure under which such water exists, even at depths no greater than that under which the Trimmingham spicules were dissolved, the depth of water which we have indicated for them (100 to 400 fathoms) giving a pressure of from 20 to 80 atmospheres. An observation of Carter's tends to bear this opinion out; for some spicules which he examined, from depths not much greater than those under which ours were formed, were found to exhibit the usual signs of incipient solution, such as pitting of the surface and enlargement of the axial canals. Yet these spicules came from an area swept by a marine current, where organic matter was presumably not plentiful. The bottom-water of the sea is remarkably free from organic matter; and in this case we probably have to do with solution under pressure. Again, the rapid whitening of the black surfaces of freshly broken flints when exposed to the weather, as in the case of the flint walls in Cambridgeshire, seems to show that even pure rain-water is of itself capable, without any aid from pressure, of dissolving a form of silica much less soluble than that of sponge-spicules. It is true that the presence of a certain quantity of lime in the flints may have rendered them more liable to the action of slightly carbonated water such as rain-water, though, on the other hand, the exceedingly small proportion of lime present, as shown by analyses, may make us hesitate in attributing any great influence to it.

(iv) *The redeposition of Silica.*—After the silica of siliceous skeletons has passed into solution, it is again extricated in the solid state; and, since both the deposition and solution take place in the same deposit, a seeming difficulty presents itself, since one would have thought that the conditions which led to the one would have been incompatible with the occurrence of the other. An explanation is to be found in the fact that the one process is not merely a reversal of the other, and in the possibility that both did not take place at the same

* Proc. Am. Assoc. Adv. Science, xxviii. p. 396, Saratoga Meeting, 1879.

time. For instance, the silica of the skeletons occurs in conjunction or probably in combination with an organic basis known as *spiculin*; on solution it is liberated from the spiculin and exists in the colloid state, whence it readily passes into the pectous condition, and subsequently becomes crystalline; it is, moreover, probable that, under conditions not yet investigated, a solution of colloid silica may give rise directly to silica in a crystalline form. If it be objected that in this expanded explanation, fact and conjecture are mixed together, I to some extent admit it, but at the same time remark that there is no conjecture in the statement that the silica which passes into solution is a very different thing from the silica which has passed out of solution. The one may be conveniently called organic, and the other mineral silica; the properties of the two are strikingly different; and the process which has really happened has been a solution of organic silica and a deposition of mineral silica, not a solution and deposition of the same kind of silica. In the next place, solution and deposition need not have proceeded *pari passu*; if one succeeded the other only after a considerable interval, there would be time for the conditions to change: an elevation of the sea-floor and a consequent shallowing of the sea might, for instance, have intervened; and if we suppose the silica to be held in solution through the influence of hydrostatic pressure, the diminution of this pressure would lead to its deposition. There are difficulties, however, in the way of this supposition which lead me not to lay great stress upon it.

We shall now proceed to consider the different modes in which the deposition of silica has been effected. Of these there appear to be three, viz. the simple deposition of silica, its deposition as a pseudomorph after carbonate of lime, and in combination with bases forming silicates.

(1) *Simple deposition of the dissolved Silica.*—(a) The simplest case of this is presented by the minute crystals of quartz which frequently occur dispersed through the substance of limestone beds; a figure of these is given in my paper on *Catagma* (*loc. cit.* p. 361). They are mentioned by Zittel (*Lehrbuch der Petrologie*, 1866) and fully described by Mr. T. Wardle of Leek, in his presidential address to the North-Staffordshire Field-Club in 1873. As the 'Proceedings' of this society may not be generally accessible, I venture to quote Mr. Wardle's description in full. He says:—

“My friend Mr. Woodcroft, who has made a careful examination of the Mountain Limestone of Caldron Low, gives the following as the result of his analysis:—carbonate of

lime, alumina, silica, carbonaceous matter, and traces of iron. Out of 30 lbs. of limestone dissolved in hydrochloric acid, there was left a residue which, when well washed with distilled water and dried, was found to contain 680 grains of mud (consisting of alumina for the most part and carbonaceous matter), and 1260 grains (or nearly 3 ounces) of silica, which, when we put it under the microscope, we were delighted to find consisted entirely of microscopic crystals, of six-sided prisms terminated by six-sided pyramids, the usual form of rock crystal. It may be accepted as a fact that in the Mountain Limestone these beautiful crystals are prevalent. Mr. Woodcroft has dissolved many pieces, and always found them. In the Buxton Limestone they occur in larger crystals and a little worn or corroded; but in that of this locality (except in the hydraulic Mountain Limestone of Waterhouse near Leek, in which the silica occurs in an amorphous form) they are always perfect in form, transparent, and very interesting 'objects,' averaging in measurement about the 400th of an inch in length, by the 1000th of an inch in breadth. The smallest are less than 1000th of an inch long. They are beautiful polariscopic objects. The encrinital slabs, which seem wholly composed of fossils, also contain these crystals. They do not appear to be present in the Liassic, Oolitic, or Silurian Limestones."

Prof. A. Renard also mentions precisely similar forms as occurring in the Carboniferous Limestone (assise V. *f*) of Belgium (*loc. cit.* p. 15, footnote). I have myself seen them in the Silurian limestone of Hamilton, Ontario, in the Devonian limestone of Newton Abbot, the Carboniferous of North Wales, and the Lias of Sutton, South Wales; and in all but the Devonian limestone they were obviously associated with the remains of siliceous organisms.

In these crystals we have an instance, disentangled from all complication, of the simple crystallization of quartz from a siliceous solution; and the notion that deposition of silica from diffused solutions could not take place without the presence of an organic nidus is thus completely disposed of.

(*b*) A similar case to the preceding occurs in some flints, where quartz crystals, with their apices directed inwards, line a cavity in the interior; but these crystals are macroscopic.

(*c*) The siliceous casts in the interior of some Foraminiferal shells appear to offer a case of the simple deposition of silica.

(*d*) The last case is that presented by various forms of chalcedonic incrustation. The fossil Lithistids of Blackdown and Haldon afford a good illustration of this. The reticulate skeletons of these sponges are now reduced to the condition

of hollow casts, while the interstices of the network are filled up by a chalcedonic deposit surrounding the exterior of the casts. The chalcedony has a fibrous structure, the fibres radiating from the incrustated surface; where one group of fibres meets another a sharp line of demarcation is produced; and intersecting lines of demarcation make with one another an angle of 120° ("Structure of *Siphonia*," *loc. cit.* p. 816). The chalcedony so constantly appears as a growth upon the siliceous skeleton that it looks very much as if the latter had exerted some special attraction upon the silica in solution, leading to its deposition. The idea finds support in an observation of Carter's, who asserts that in the Haldon Greensand a chalcedonic deposit frequently occurs on the imbedded sponge-spicules, but never on the clastic grains of quartz. On the other hand the deposition of the chalcedony on a siliceous skeleton may be explained without invoking the aid of any specific attraction; for if a solution of silica were to exert a solvent action on the siliceous skeletons bathed by it, it is quite possible that deposition might by the very act of solution be brought about, a molecule of mineral silica being deposited for every molecule of organic silica removed; and the process of crystallization over any surface once set up, would continue in the same place in preference to beginning afresh on some new one.

(2) *Deposition of Silica as a Pseudomorph after Carbonate of Lime.*—It is a curious fact that the action of siliceous solutions on carbonate of lime is not to displace the carbonic anhydride from the latter, but to replace the molecule of carbonate of lime as a whole; it is a fact, however, that has long been well known, though it is only lately that it has been shown to have been concerned in the formation of chert and flints. The valuable observations of Prof. Rupert Jones, the investigation of Hull and Hardman, and the elaborately careful study of Prof. Renard prove conclusively that flint and chert are to a certain extent pseudomorphs after carbonate of lime; and of this the Trimmingham flints furnish us with a fresh demonstration. Thus some of the nodules consist within of ordinary flint, black, translucent, and compact, but exteriorly simply of ordinary chalk with a few siliceous remains scattered through it. Between these two we find every intermediate stage of silicification. Passing from the chalk to the flint, one finds first the coccoliths, Foraminifera, and other calcareous constituents of the chalk converted into silex, the siliceous pseudomorphs retaining all the details of their original form, down to the delicate striæ on some of the foraminiferal tests; from the mixture of chalk material and its siliceous

pseudomorphs we proceed nearer the flint and reach a porous superficial layer, formed by the cementation of the siliceous pseudomorphs together into a siliceous network; the side of this network next the flint enters half immersed into it as it were; a step further and we reach the flint itself, the siliceous pseudomorphs being now completely involved and no more distinguishable from one another in the common "fusionment" than the separate snow-crystals of a mass of snow which has been frozen by infiltrating water into ice.

Instances of the deposition of silica after carbonate of lime are so plentiful and well known that it would be superfluous to mention them here; chalcedonized corals and shells are common in British deposits, and usually, so far as I know, in connexion with the remains of siliceous organisms.

Finally, the power of a dilute solution of colloïd silica to replace carbonate of lime has been experimentally demonstrated by Prof. A. C. Church*, who has actually converted a coral into silica by its means.

(3) *The deposition of Silica in combination as a Silicate.*—Since studying the structure of glauconitic grains from the Cambridge Greensand, I have taken a deep interest in the problem of their formation, but have never yet met with a satisfactory solution of it. The occurrence of glauconitic casts in the siliceous chalk of the Trimmingham flints, in the interstitial siliceous chalk of *Pharetrospongia*, and along with siliceous spicules on existing sea-floors is a very suggestive fact; and one sees no difficulty in the supposition that the dissolved silica derived from siliceous organisms should combine with the impurities present in the surrounding sediment, and so give rise to glauconitic deposits; thus, with such matters as iron oxide, alumina, and potash the silica is supposed to combine, while carbonate of lime it merely replaces. The case of the green grains of the Cambridge bed requires a little fuller consideration. In that deposit we meet with the fossil sponge *Pharetrospongia*, in which the structure of a coarse-fibred Renierid is perfectly preserved to us; no doubt it owes its preservation to the thickness of its fibres, the spicular components of which, however, no longer consist of silica, but of carbonate of lime. But if one Renierid sponge existed during the deposition of the Greensand, can we suppose that no other species was associated with it? Is it not infinitely more likely that a great number of others lived at the same time and have since disappeared? In the coprolites of the Greensand we have indeed evidence of the existence of

* Chem. News, v. 95; Journ. Chem. Soc. xv. 107.

several other kinds of sponges, Lithistid, Choristid, and Hexactinellid, none of which now retains a siliceous composition; and considering that not a single instance is yet known to us of any tender small-spiculed sponge existing in the fossil state, although such must have been present in the ancient seas, it would appear certain that *Pharetrospongia* formed but an insignificant fragment of the sponge-fauna which existed both in the beds from which the Greensand was derived and in the Greensand proper itself. But if this sponge-fauna once existed and has disappeared, what has become of the silica which must have been produced by it? It certainly is not to be found as a deposit of free silica anywhere in the Greensand bed. On the other hand, what is the origin of the abundant glauconitic granules scattered through this bed? The answer that suggests itself is as follows:—The chalk marl which forms the greater part of the Cambridge Greensand still contains a good deal of argillaceous impurities, together with traces of ferruginous matter; and once it contained much more; the silica set free from decaying sponges combined with the alumina, iron, and alkalies present, to the entire exclusion of lime, and formed glauconite, which was deposited in green granules enclosing coccoliths and Foraminifera, some of which had probably been previously replaced by silica, since when examined in thin slices of the glauconite they are without a tinge of green and quite colourless. In the greensand of Devonshire a simple deposition of silica has followed the formation of the green grains, and cemented them and the other materials of certain beds into compact chert.

We appear to have travelled rather wide of the subject of the Trimmingham flints; but though we have not confined ourselves to this subject it has been steadily kept in view throughout, and we are now in a position to take up the scattered threads and to frame a consistent explanation of the flints, complete in all respects so far as it goes, save one, since it does not include an account of how they acquired their external form.

Briefly to sum up, a deposit of sponge-spicules accumulated in the chalk ooze, and in the presence of sea-water under pressure entered into solution. Replacement of the calcareous material of the ooze then ensued, small shells, and many large ones too, being converted into siliceous chalk, not flint, was the result. The chambers of the Foraminifera and the interstices of the chalk were now filled up by a simple deposition of silica, and the siliceous chalk became converted into black flint, an incompletely silicified layer of chalk remain-

ing as the white layer of its surface. Some of the silica combined with the iron, alumina, and alkalis present in the ooze, and so gave rise to the associated glauconitic grains.

The last question which remains for discussion is the origin of the various external forms assumed by flint.

A good deal of misconception appears to have arisen on this subject through a too exclusive attention to one particular form of flint arbitrarily selected as the type of all others. For this (generally the irregular nodular form) a theory is framed, which is then made to account for the rest. Thus, when Dr. Bowerbank attempted to show that flints are silicified horny sponges, he accounted for the flint-veins of the chalk by supposing them to be silicified horny sponges which had grown over the sides of an open fissure at the cretaceous sea-bottom; and Dr. Wallich, after giving an explanation of flint nodules and layers, speaks of the veins as formed by a "sluggish overflow" of silica-saturated protoplasm "into fissures in the chalk." There does not appear much to choose between these rival explanations of the veins: both are attempts to square a preconceived hypothesis with an obnoxious fact.

The forms of flint are chiefly four—those following the outline of some enclosed sponge-skeleton, irregular nodular masses, tabular sheets, and veins.

1. *The tabular sheets*, as offering the simplest case, may be taken first; they have in all probability been formed by the solution and redeposition *in situ* of an extensive bed of sponge-spicules. All the flint layers which I have examined exhibit abundant casts of various kinds of sponge-spicules confusedly mixed together. The chert beds of the Devonshire greensand, analogues of the chalk-flint layers, also contain numerous casts of spicules; and in the same formation deposits of loose spicules occur several feet in thickness.

2. *The Flint veins*.—Of these more than one explanation is possible; but we select the following as the most likely. We may fairly assume that the chalk traversed by the veins was permeated by a solution of silica derived from siliceous remains, and this at a time so far subsequent to its formation, that it had already become compact enough to be broken by fissures; whether organic matter, as Dr. Wallich understands it, would have endured so long as this, is uncertain but not probable. The solution of silica was bounded on one side by a free surface, that of the fissure; and free surfaces are eminently determinative of deposition, not only of silica but of calcite and many other minerals as well; we see this in geodes and in the mineral deposits formed within shells. It

is true that in most cases silica so deposited takes a crystalline form; but crystals of silica in the presence of chalk are of rare if not of unknown occurrence. We do certainly find them in the interior of some flints; but then they are seated on, and surrounded by, the silex, and are nowhere in actual contact with the chalk itself. It would indeed appear that the simple deposition of silex is impossible in the chalk; the first stage of deposition in this deposit is always that of replacement.

The deposition of the silica being determined as to place by the presence of the fissure, began, as we might expect, by a replacement of the chalk, silicifying the walls of the fissure; subsequently, as in the Trimmingham flints, a simple deposition of silica followed, cementing the siliceous chalk into compact structureless flint, and a flint vein was the result.

It will be seen that we merely make use of the fact that free surfaces are often surfaces of deposition, without explaining it; but to enter fully into this subject would be beyond the scope of the present paper.

3. *Flints formed about Sponges.*—The irregular nodules may be left to be dealt with after we have considered those forms in which the general outline of some known sponge, such as a *Ventriculite* or *Siphonia* is represented, or more generally those which have obviously been formed about some kind of sponge-skeleton. The characters of these are well known. One meets with, say, an egg-shaped mass of flint; and on breaking it open a conical *Ventriculite* is seen in the middle; sometimes the form of the *Ventriculite* is more closely represented, the vasiform skeleton being merely coated inside and out by a layer of flint, often about an inch thick; while occasionally a *Ventriculite* may be met with simply girdled by a ring of flint round the middle, the rest of the sponge remaining unenveloped. Sometimes the body of the sponge is enclosed, and not the roots, sometimes the roots and not the body. The sponges included are of various kinds—*Siphonia*, *Poterion*, and, in one instance known to me, a *Tethya*.

In attempting to find an explanation for the form of these flints we may consider the following suppositions:—(i) The form may have been determined by the presence of animal matter (protoplasm, *Wallich*), or (ii) of the products of its decomposition, or by the presence of the siliceous skeleton of the sponge, either (iii) through a special attraction exerted between it and silica in solution, or (iv) by its furnishing an extra supply of silica to the surrounding water, or (v) on account of its providing a free surface of deposition.

The first explanation may best be stated in Dr. Wallich's own words. Thus, speaking of the irregular nodules, he says:—
 “those characteristic amœbiform outlines which, according to my hypothesis, are dependent on the presence of, and the combination of the silica with, the accumulation of nearly pure protoplasm still sufficiently recent to have resisted admixture with calcareous or other matter” (*loc. cit.* p. 79).

As I have already shown in the earlier part of this paper that flints originate as silicified chalk, we need not spend time on a formal confutation of this hypothesis; but when Dr. Wallich remarks that “the various conditions that present themselves from the earliest elimination of the silica from the sea-water to the period when it becomes finally consolidated, have never, that I am aware, been consecutively followed out” (*loc. cit.* p. 89), I would take the liberty to refer him to a paper of my own, printed in abstract in the *Quart. Journ. Geol. Soc.* vol. xxix. p. 76 (1873), where the steps are perhaps almost as consecutively followed out as in Dr. Wallich's paper itself. As my paper has never been published in full, I shall make no apology for giving here a rather lengthy extract from it.

It is “necessary to inquire next how far there are any facts in chemistry or physics which throw any light on this singular and intimate connexion between animal matter and mineral substances. One fact noticed by Graham, and which any one may experimentally verify, is very noticeable, viz. that silicic acid has the property of actually combining with such substances as albumen and gelatin to form with them distinct chemical compounds, silicate of albumen and silicate of gelatin.

“If, then, such animals as sponges flourish in the bed of an ocean which contains a sensible amount of silicic acid, when these creatures die the consequence will be that the water, finding ready access to every corner of their organism, will yield its silicic acid to the greater attraction of the sponge-fibres, and will form with them a well-marked, definite chemical compound; and it is conceivable that in course of time this compound, like all other highly complex organic bodies, will decompose, its carbon, hydrogen, nitrogen, and oxygen will disappear, and the result will be a concentration of the silica in the form of flint, very much in the same way as carbon concentrates in coal.

“Other processes, of course, would proceed at the same time, aiding to the same end; any sodic silicate in the water would probably be decomposed by the carbonic anhydride escaping from the decomposing animal matter, and would form

sodic carbonate and silicic acid, which would combine at once with the organic matter of the sponge to form a silicate with it. Now sodic silicate is a crystalloid body, and would easily find its way into the interior of the fibres and sarcode of the sponge; but if decomposed there into silicic acid and sodic carbonate, the silicic acid would be entrapped in the organism, since it is colloidal and could not diffuse out. In the same way, when once a coating of colloidal silica had been formed round any body, while sodic silicate could easily pass through it, yet, when decomposed in the interior into silicic acid, as before it would be unable to return outwards, since the colloidal silica coating the organism would act as a dialyzer and would prevent it.

“Immediately the organism had grasped and extricated from the water a molecule of silicic acid, a difference of specific gravity would be set up between the spot where the silicic acid had disappeared from solution and the surrounding water. This difference would be rapidly equalized by diffusion, in which way the water which had yielded its silica to the sponge would be replaced by fresh supplies, the silica of which would again be removed and combined with the substance of the organism, throughout which this process would be actively going on, until in time it had combined with all the silicic acid which it had power to fix. In this way we produce that circulation of water which is absolutely necessary to any theory of fossilization, and explain how with merely molecular currents the sufficient supplies of silicic acid would be brought within reach of the organism undergoing fossilization. While the sponge was exposed to the direct action of the ocean-water, if it ever was so exposed, molecular currents might expedite the process; but when covered up by the fine sediment, in which it is afterwards found imbedded, it could only derive its mineralized water in this molecular way, by the well-known action of diffusion and without involving any of the transcendental mysteries of an undiscovered attraction. An observation of Petzholdt's shows that in certain cases the process of fossilization really has continued in an organism after it has been silted up. Petzholdt found that in dolomite occurring immediately around a flint, there existed but 2·31 per cent. of silica, while that a little further removed contained a little more than twice as much; the precise figures are 4·73 per cent. This may be explained on the hypothesis that animal matter entered into combination with the surrounding silicic acid and continued to do so after it had been overwhelmed in silt, and until its affinities were satisfied.

“ Bischoff says that in the Infusorial beds of Rolt and Geishingheim Ehrenberg found that no empty shells occur, since all the smaller species are filled with siliceous matter—a fact that meets with its explanation on this combination-and-concentration hypothesis. The same author mentions the occurrence of a Belemnite in which the calcareous rostrum was all replaced by barytic carbonate, whilst the more organic phragmocone was replaced by silica.

“ It is generally assumed that the casts of Echinoderms in flint required for their formation the intermediate agency of sponges which inhabited their interior. No doubt sufficient evidence has been adduced to prove that this has certainly been the case with some of these casts; but one may just point out that it need not have been so with all of them; for it is possible that in a good many instances the animal matter of the decomposing Echinoderm itself may have sufficed to separate the silica from the surrounding medium without requiring invariably the assistance of indwelling sponges. So, too, in regard to the teeth of *Mosasaurus* found by Mr. Charlesworth to be injected with silica, we are not reduced to supposing with Dr. Bowerbank that the presence of this silica required for its explanation the preexistence of a sponge extending throughout the tubules of the tooth. This need by no means have been so, since the animal matter which we know once was present there is of itself sufficient explanation of the presence of the silica. In all these and similar cases the silica concentrated by the dissipation of the animal matter, which served in the first place to imprison it from solution, might remain in the crystalloid or the colloid state; at this distance of time we cannot determine. The silica of flint is generally found in a cryptocrystalline condition: no tendency to a crystalline appearance is seen in the general mass of the nodule; but, at the same time, it acts feebly on polarized light. This, however, proves nothing concerning its original condition, whether it was colloidal or crystalline; for I have lately succeeded in determining as a fact what has long been held as a hypothesis, viz. that as glass, when kept at a moderately high temperature for a long while, becomes devitrified, *i. e.* crystalline, so flint, in the course of ages, may have lost its originally colloidal properties and settled down into the static state of crystalline silica. The way in which I have determined this leads me to the subject of the well-known silicified shells of Blackdown. No one who has seen the silica filling these shells could for a moment assent to Dr. Bowerbank's extraordinary hypothesis of its spongy origin; it is evidently derived from the separation of silica from the siliceous waters

furnished by the action of carbonic acid on the sand of the formation, and in the following way:—Water holding silicic acid in solution, both in the crystalline and colloid condition, filters downwards through the beds of the Blackdown sand, and in its way meets a shell turned like a basin to receive it. Now whether the silica shall pass through the shell or not depends on two things, the permeability of the shell and the state, colloidal or crystalline, of the silica. The shell is generally permeable, and from its lamellæ of membrane acts precisely as a dialyzer: colloidal silica in solution on reaching the shell is stopped; the water passes through, leaving the silica behind. This process goes on continuously till the silicic acid is so far concentrated that it sets and prevents any further action, or, as in some cases, actually overflows the shell. This concentration of silicic acid from weak solutions by the power of dialysis furnishes us with a very simple explanation of the condition of the Blackdown shells, without invoking the aid of hypothetical sponges. The *crystalline* silica, which the percolating water carries in solution, passes through the shell, and in some cases, under favourable conditions, crystallizes out in long fine prisms closely apposed to form a mamillary layer of chalcedonic appearance. Now let us see what happens to the calcic carbonate of the shell itself. The action here is one of loose chemical affinities. The water carries in solution as much silicic acid as it can hold. Calcic carbonate has a greater affinity for carbonated water than has silica; consequently the calcic carbonate unites itself with the carbonated water, displacing some quantity of silicic acid, which takes its place in the shell and eventually entirely replaces it. We have on these grounds every reason, *à priori*, to believe that the silicic acid now found caught inside the shell was once colloidal, and that the silicic acid which has passed through the shell was crystalline. What do we find on examining sections of the silica in these two positions? Not one colloidal and the other crystalline, as we should anticipate, but *both* crystalline. But there is this very important difference between them, viz. that in the one we should expect to be colloidal, crystallization has commenced from various centres in the mass, scattered mostly on both upper and lower surfaces, as if the whole had once been a jelly in which centres of crystallization were set up, from each of which crystallization radiated in all directions throughout the mass, till the crystals of different centres interfered with one another, encroached on one another, and the process was completed. But the one we might expect to be crystalline is in a very different condition: in this crystallization was evidently not an after-

thought, but at work from the very beginning; and the crystals commence all along the boundary of the shell, from which the silicated water oozed out. From this process of reasoning we conclude that colloidal silica has the power of changing, in course of time, into the static or crystalline condition. In the case of the Blackdown shells the colloidal silica probably remained for a long time in a jelly-like condition, which may, among other things, help to account for its perfect crystallization.

“Thus the crystalline state of flint nodules offers us no evidence for or against our theory of the formation of these fossils. This theory may be summed up under two heads:—(1) combination of silicic acid with animal matter of various kinds—a chemical *fact*; and (2) concentration of the silica from the silicate of animal matter thus formed, by the extrication of the organic part of the compound. This is a pure assumption, but one which agrees very well with other well-known facts in chemistry.”

That organic matter has in certain cases been replaced by silix may be considered certain, the numerous observations made from the time of Von Buch and Bischoff down to the present day seem to leave no doubt on this point; the occurrence of silicified wood is an instance; and still more striking instances are known, as that of the nuts so often mentioned, in which the soft kernels have been converted into silix, while the shell remains unchanged—or, better still, that of the marvellous silicified *Trigonia* from the Portland beds of Tisbury, Wilts, described and figured by Mr. Charlesworth as still showing the structure of the animal, even to the separate filaments of its branchiæ; and if, in these cases, silicification of organic matter has occurred, it certainly might in that of the chalk-flints; but whether, as a matter of fact, it has so assisted in the formation of these bodies, is quite a different question; and what little evidence we can find bearing directly on the point seems to show that it has not. Some little light is thrown on the subject by the condition of the sponge enclosed in the flint. Very frequently it consists of a network, the interstices of which are empty and not filled with flint, the solid flint forming a complete enclosure to the sponge, but stopping short internally at the borders of the skeletal network, just where animal matter might be expected to have been most abundantly present. If we try to elude this difficulty by supposing the sarcode to have been already shed over the subjacent ooze, then all connexion is lost between the form of the sponge and that of the enveloping flint; or, again, if we suppose the sponge to have been completely covered by the

ooze, so that it might lose its sarcode by diffusion all round before silicification took place, then we are involved in the admission that a considerable time had elapsed between the death of the sponge and its silicification, since chalk accumulates slowly; and during this lapse of time the sarcode would have become decomposed.

(ii) We dismiss, then, the notion that protoplasm itself can have had any direct influence in determining deposition; but perhaps the products of its decomposition may have been more effectual, and we might attempt to substitute for Dr. Wallich's hypothesis a supposition of Alexis A. Julien, who says:—"I would therefore modify Sollas's theory by suggesting that *during the decomposition* of the sarcode of both animal and vegetable organisms, after death, gelatinous or colloid substances are generated, resembling *glairine*, which are soluble in sea-water, which combine with silica, and may therefore convey and concentrate it, dissolving its particles disseminated through submarine sediments, and which may in certain forms, produced by gradual oxidation, act also as acid solvents of lime, oxides of iron and manganese, &c. To this idea, in part, an early opinion of Bischoff approaches: 'Silicifications are nothing else than the result of combinations between the crenic acids (Quellsäuren) formed through decomposition of organic matter (*e. g.* of mussels and oysters) and silica, which in aqueous solution, *e. g.* as in the water of springs, comes into contact therewith'" (p. 364).

Julien, however, does not attribute the form of flints to the organic matter furnished by them, but speaks of the dissolved silica being deposited ". . . around the undissolved siliceous organisms or particles as nuclei."

We reach now the explanations based on the supposition that the skeleton of the sponge has had the chief part in determining the deposition of the surrounding flint; and (iii) with regard to the first notion, that silica has been attracted by the sponge-skeleton and so deposited, one may point out that, if true, silicification should have commenced from the surface of the fibres of the skeleton and proceeded outwards, while observation shows that this has not been the case, the skeleton remaining an empty porous network after being completely enclosed in flint. (iv) With regard to the suggestion that silica has been contributed by the sponge-skeleton to the pervading solution of silica, and so rendered the latter concentrated enough to bring about a replacement in the surrounding chalk ooze, there seems much more in it. The chief part of the siliceous enclosing the skeleton has clearly been gathered from without; but some silica has disappeared from

within, and this may have been just sufficient to lead to the deposition of the siliceous round the sponge in preference to some other place. The frequent absence of flint within the skeleton may be owing to the absence of chalk-ooze, which in these cases had failed to penetrate into the interior of the sponge. The mere zonal enclosure of the sponge by a ring of flint may be accounted for by supposing that the sponge-spicules from which the flint was derived formed a bed surrounding it at the level of the ring, but were not present in sufficient quantity to produce silicification above or below that level.

The complete enclosure of a sponge in a more or less spherical mass of flint may be accounted for by supposing that silicification once started at any place would continue there in preference to recommencing at a fresh centre.

Amongst some notes I made in 1873 I find a drawing which somewhat strengthens the notion that silica proceeding from the sponge-skeleton may have led to deposition. It shows an *Ostrea* seated on a *Ventriculite*, which has been everywhere coated with silica, except where the *Ostrea* is attached, the oyster lying below the general surface of the flint, which bulges out all round it. I feel some hesitation in placing entire dependence on a note made so long ago, when I was only just beginning the study of flints: but I well remember making the observation; and if the fact be as represented it would certainly seem as though the surrounding flint had been deposited through the influence of something proceeding outwards from the sponge, either silica in solution or, less likely, organic matter, and that the obstruction furnished by the oyster had prevented the accumulation of the siliceous immediately over it.

(v) Finally there is the supposition that the sponge skeleton may have led to deposition by furnishing a free surface to the siliceous solution. This is likely enough, but it is difficult to prove or disprove. In the case of other organisms, such as Echinoids, the tests of which have determined the deposition of siliceous, supposition iv. is excluded on chemical grounds, and the last supposition appears to be the only probable one. The characters of the flint urchins agree very well with it: frequently the siliceous is found only within the test, the siliceous solution having filtered through the walls, filling up the ambulacral pores; occasionally the test is only half filled with siliceous, as though it had rested half immersed in a bed of sponge-spicules; sometimes it is quite filled; sometimes the siliceous protrudes from the mouth and anus; and, lastly, the test is sometimes not only filled with siliceous but completely enclosed in it.

4. Lastly we have to consider the irregular nodules of flint. These, by their fantastic flowing outlines, are responsible for much of the theorizing which can only regard flint as a silicification of organic matter. Thus Dr. Wallich repeatedly lays stress on "the unique amœbiform nodulation of the flints,"—though one may remark that one of the characteristic features of an amœbiform outline is that it seldom remains the same two minutes together; and this cannot be said of flints, although, as Dr. Wallich speaks in another place of the flints showing "signs of the specific contractility of colloid silica," one might infer that he does not regard this character as absent. A flint moving by means of its pseudopodia would indeed be an interesting object; but perhaps the distinguished writer merely alludes to the excessive shrinking which colloid silica undergoes in passing from the pectous to the solid state; and certainly to one who has experimented with colloid silica, the wonder on Dr. Wallich's hypothesis would be, not that the flints show signs of shrinkage, but that they do not present them more markedly. The time for conclusions based on superficial resemblance is now gone by; we no longer regard "dendrites" as fossils on account of their moss-like form, nor profess to be "able to tell an honest man by the smell."

The direct action of organic matter seems to be excluded by the great lapse of time which would be required for the solution of sponge-spicules, and during which the organic matter would decompose and wholly disappear.

Many concretions exhibit an irregular form besides flints (the cornstones of the Old Red Sandstone for instance); only the irregularity is carried further in the nodular flints than in most cases.

The form of the nodules simply indicates the irregular distribution of siliceous solutions about an irregular bed of sponge-spicules, at the time they replaced the surrounding chalk and deposited silica in its interstices.

This paper has much exceeded the length I proposed on commencing it; and I will only remark in conclusion that at length, out of much that is uncertain, some few fixed points in the history of flints begin to appear. That the silica composing them has been derived from sponge-spicules is no longer a mere assertion, but a well-ascertained fact; that it has been deposited in the first place as a pseudomorph after carbonate of lime is also clear, and no less so that subsequently a simple deposition of silica converted the siliceous chalk into flint. Various causes have determined the external forms of flint, chiefly the distribution of the spicules which have furnished it, but partly the existence of open fissures

and cavities. And above and beyond the particular question of the formation of flint is the general fact that of the vast multitude of spicules which must have existed in nearly all stratified formations, only an insignificant remainder is now to be found; and in those which have disappeared we have the key to the great variety of silicifications which characterize ancient sediments.

EXPLANATION OF THE PLATES.

PLATE XIX.

- Figs. 1-3.* Spicules of *Discodermites cretaceus*, Soll.
Figs. 4, 5. *Corallistes cretaceus*, Soll.
Fig. 6. Curved acuate spicule, possibly from an Echinonematous sponge.
Fig. 7. Cylindrical spicule, possibly from *Corallistes cretaceus*.
Fig. 8. *Rhagadinia Zitteli*, Soll. : dermal spicule.
Fig. 9. Acuate of *C. cretaceus*?
Fig. 10. *Rhagadinia Zitteli*: body-spicule.
Fig. 11. Lithistid spicule.
Fig. 12. *C. cretaceus* (?): body-spicule.
Fig. 13. *Nanodiscites parvus*, Soll. : dermal spicule.
Fig. 14. *Eurydiscites irregularis*, Soll. : dermal spicule.
Fig. 15. Small acerate (*R. Zitteli*?).
Fig. 16. *Macandrewites Vicaryi*, Carter : body-spicule?
Fig. 17. Tuberculated skeleton-corpuscle.
Fig. 18. *Podapsis cretacea*, Soll. : body-spicule.
Fig. 19. Forked spicule (*P. cretacea*?).
Fig. 20. *Macandrewites Vicaryi*, Carter : dermal spicule.
Figs. 21, 22. *Compsapsis cretacea*, Soll. : body-spicule.
Fig. 23. *Podapsis cretacea*.
Fig. 24. Disciform spicule of unknown nature.
Figs. 25, 26. *Podapsis parva*, Soll. : body-spicules.
Fig. 27. Dermal spicule (*Corallistes*?).
 (All magnified 54 diameters.)

PLATE XX.

- Figs. 28, 29.* *Pachastrellites fusifer*, Soll.
Fig. 30. *Pachastrellites* (? *globiger*),
Figs. 31, 32. *Tethylites cretaceus*, Soll.
Fig. 33. Acuate spicule of *T. cretaceus* (?).
Figs. 34, 35. *Geodites cretaceus*, Soll.
Fig. 36. *Geodites*; small globate spicule.
Fig. 37. *G. cretaceus*.
Figs. 38, 39. *Pachastrellites globiger*, Soll.
Fig. 40. *P. globiger* (?).
Fig. 41. *Dercitites haldonensis*, Carter (?).
Fig. 42. *Triphyllactis elegans*, Soll.
Fig. 43. *Geodites cretaceus*.
Fig. 44. *Pachæna Hindi*, Soll.
Fig. 45. *Geodites cretaceus*.
Fig. 46. *Rhopaloconus tuberculatus*, Soll.
Fig. 47. *Dercitites haldonensis*?
Figs. 48, 49, 50. Casts of Foraminifera.
Fig. 51. Head of an acuate spicule (? *Tethylites*).
Fig. 52. *Pachæna Hindi*.

Fig. 53. Large sexradiate spicule.

Fig. 54. *Pachæna Hindi*.

Fig. 55. *Geodites cretaceus*.

Fig. 56. *Pachæna Hindi*.

Fig. 57. Small sexradiate spicule.

Fig. 58. Anchoring-spicule of a Hexactinellid.

Fig. 59. *Pachæna Hindi*.

Fig. 60. Anchoring-spicule of a Hexactinellid.

Figs. 61, 62, 63. Sexradiate spicules.

Fig. 64. *Pachæna Hindi*.

Fig. 65. Anchoring-spicule of a Hexactinellid.

Fig. 66. *Scoliorhaphis?*

Figs. 67, 67 a. Small sexradiate spicules.

Fig. 68. Anchoring-spicule.

Fig. 69. Spicule similar to a common form in *Euplectella*.

(All magnified 54 diameters, except figs. 67 and 67 a.)

LIX.—*Descriptions of two new Coleoptera from Madagascar.* By CHARLES O. WATERHOUSE.

AMONG some Coleoptera recently received from Madagascar, forwarded to the British Museum by Mrs. Toy, I find the two following species, which appear to be undescribed.

Cetoniidæ.

Coptomia celata, n. sp.

Flavo-viridis, nitida; elytris flavescentibus, ad apicem maculis duabus olivaceis; pygidio piceo, crebre transversim striolato. Long. 9 lin.

Somewhat resembles *C. quadrimaculata*, Waterh., in colour, but is more elliptical in form, with less-projecting shoulders to the elytra. It is closely allied to *C. prasina*, Burm.; but, besides the difference of coloration, it differs in having the pygidium more strongly striolated. The sternal process is similar in form; but the portion which is formed by the mesosternum is not much longer than its greatest width; whereas in *prasina* it is at least twice as long as wide; the apex is rounded, shining brown. The elytra are sordid yellow, with an olivaceous spot just before the apex; the six dorsal striæ are very deep, the second and fourth interstices being much broader than the third and fifth.

Hab. Antananarivo.

Lamiidæ.

Rhaphidopsis pulchra, n. sp.

Nigra, dense furfurosa; capite thoraceque læte fulvo-ochraceis, hoc tuberculo laterali punctisque duobus posticis nigris, elytris pallide flavo-albidis nigro maculatis. Long. 10 lin.

Build of *R. zonaria*, Buq., but rather broader. Head and thorax bright fulvous yellow; the latter with a lateral tubercle rather behind the middle, the sides in front of this oblique. Elytra pale greenish white, tinted with yellow on the sides; each with six black spots, viz. one next the scutellum, a large oblique one just before the middle at the suture, another behind the middle a little removed from the suture, and three smaller spots on the humeral margins. The underside of the insect is greenish yellow, with a black spot on the side of the metasternum, and with the abdominal segments narrowly edged with black.

Hab. Antananarivo.

LX.—*Description of Ophites japonicus, a new Snake from Japan.* By Dr. A. GÜNTHER, F.R.S. &c.

SCALES in seventeen rows, those in the middle of the back so feebly keeled as to appear almost smooth. Ventrals 205; anal divided; subcaudals 69. Form of the head resembling that of *Leptodeira annulata*. Eye rather small, with vertical pupil. Anterior frontals short, rather broader than long; vertical as long as broad. Nostril in a large deep hollow. Loreal narrow, more than twice as long as deep, narrower behind than in front. No præocular; two postoculars; eight upper labials, the third, fourth, and fifth entering the orbit; the portion of the third which enters the orbit is very narrow and pointed. Temporals 2+3. Purplish grey, with numerous black cross bands, which on the anterior part of the trunk are subquadrangular, much broader than the interspaces, and subrhombic, and about as broad as the interspaces on the rest of the body. Lower parts whitish, clouded with black or marbled towards the middle of the belly.

Two specimens were obtained, by Mr. C. Maries, near Nikko in Central Japan. The larger is 26 inches long, of which the tail takes 5 inches.

MISCELLANEOUS.

New Northern Gephyrea.

By MM. D. C. DANIELSSEN and J. KOREN.

MM. DANIELSSEN and Koren have described several new genera and species of Gephyrea obtained by the Norwegian North-sea expedition north of 63° N. lat. One species is described and illustrated in detail; it constitutes a new genus of the family Bonellidæ, named *Hamingia*, after the goddess of fortune in the northern mythology.

HAMINGIA, g. n.

Body cylindrical; mouth at the anterior extremity, towards the ventral surface. Anal orifice in the centre of the posterior extremity. A slightly projecting crescentiform fold surrounds the mouth (rudiment of the proboscis). In the anterior part of the ventral surface there are two long cylindrical papillæ, at the apex of which there is a round aperture for the efferent duct of the uterus. No setæ.

The intestinal canal forms loops, but no spiral, and terminates in a cloaca, from each side of which springs a ramified glandular apparatus. Central nervous cord smooth, without ganglia. One ovary, which lies along the nervous cord in the posterior half of the body-cavity. Two uteri, with their efferent ducts and funnels. Male unknown.

Hamingia arctica, sp. n.

Body cylindrical, smooth, 120 millims. long, 20 millims. broad, assuming various forms under contraction. Colour lighter or darker grass-green, with yellowish-white buccal disk. The crooked papillæ on the ventral surface greenish, with yellowish-white extremities.

A single example, taken at Station 290, in 72° 27' N. lat., 20° 51' E. long., on a bottom of sandy clay. It is nearly allied to *Bonellia viridis*.

A second new type of Bonellidæ is briefly described as follows:—

SACCOSOMA, g. n.

Body claviform. The anterior part cylindrical, opaque, with a round buccal aperture at the free extremity; the posterior part, containing the whole of the intestinal canal, is nearly spherical, transparent, terminating in an opaque cone, at the apex of which is the anus. Ovaries in the anterior part of the body-cavity. No hooks.

Saccosoma vitreum, sp. n.

The anterior, cylindrical, opaque part of the body 12 millims. long; the posterior, transparent, globular portion 18 millims. long, 12-14 millims. broad. Colour of the anterior part of the body and of the conical termination white with a slight reddish tinge; the globular, transparent portion is colourless.

A single example, at Station 40, in 63° 22'·5 N. lat., 5° 29' W. long., from sandy mud at 1215 fathoms.

Of the family Sipunculidæ the authors give short characters of the following new species:—

Phascolosoma Lilljeborgii, sp. n.

Cylindrical, transparent. Body furnished with scattered fine papillæ; its breadth in proportion to its length as 1:20. Proboscis as long as the body, beset with exceedingly small acute papillæ. Tentacles eight to ten. One retractor.

Many examples, taken at three stations, from 63° 5' to 71° 59' N. lat., and between 14° 32'·7 and 0° 52'·5 E. long., at depths of

536, 587, and 1110 fathoms, on bottoms of mud and *Biloculina*-ooze.

Aspidosiphon armatum, sp. n.

Body cylindrical, 8 millims. long, covered with larger and smaller chitinous plates; posterior extremity obliquely truncated. Proboscis twice as long as the body, set all over with hooks, and furnished with from ten to twelve short tentacles. Terminal shield round, nearly flat, composed of chitinous plates, which are tongue-shaped in the margin, round in the centre. Besides the shield there are six rings beset with plates. The anterior shield reversed heart-shaped.

A single example, at Station 87, in $64^{\circ} 2' N.$ lat., $5^{\circ} 35' E.$ long., at a depth of 498 fathoms, on a muddy bottom.

Onchnesoma glaciale, sp. n.

Body cylindrical, 35 millims. long, 2 millims. broad; its posterior extremity sparingly beset with extremely fine papillæ. Proboscis twice as long as the body; its anterior fourth furnished with numerous regular rows of hooks. Skin transparent.

Numerous examples, at five stations ranging from $65^{\circ} 53'$ to $73^{\circ} 47.5' N.$ lat., and from $7^{\circ} 18' W.$ long. to $14^{\circ} 21' E.$ long. Chiefly on *Biloculina*-ooze, at depths of from 767 to 1163 fathoms; one specimen on blue clay at 634 fathoms (lat. $68^{\circ} 65' N.$, $9^{\circ} 44' E.$ long.).

STEPHANOSTOMA, g. n.

Buccal disk very broad, with ten large groups of tentacles, between which are seated some isolated tentacles. Anal aperture immediately behind the base of the proboscis.

Stephanostoma Hansenii, sp. n.

Body cylindrical. Proboscis nearly as long as the body. Skin firm, coriaceous. Anal orifice in a prominent papilla. Tentacles placed in ten groups, sixteen in each group, and between each two groups a pair of tentacles, making in all 180; four retractors; intestine forming a spiral. Spindle muscles. Colour—body olive-green; proboscis lighter, with a rose-coloured neck; buccal disk nearly white, with ten red streaks; tentacles rose-coloured.

One whole example and many fragments obtained at Station 223, in $70^{\circ} 54' N.$ lat., and $8^{\circ} 24' W.$ long., at a depth of 70 fathoms, in black volcanic sand and mud; and a nearly perfect specimen at Station 267, in $71^{\circ} 42' N.$ lat., $37^{\circ} 1' E.$ long., at 148 fathoms, on a bottom of mud and stones.

The authors further propose a new family under the name of

EPITHETOSOMATIDÆ, Dan. & Koren.

Body furnished with a cylindrical hollow tube corresponding to the crop-cavity. Behind this, on each side of the anterior extremity of the body, is a fissure furnished with apertures at the bottom. No hook-bristles.

EPITHETOSOMA, g. n.

Body cylindrical, furnished at its anterior end with a long, non-retractile, tubular appendage (proboscis). Behind this, on the ventral surface, the round buccal aperture. On each side of the anterior extremity of the body a fissure, which is furnished with several apertures at the bottom; no anal appendages; anus at the posterior extremity of the body.

Epithetosoma norvegicum, sp. n.

Body cylindrical, 12 millims. long, 2 millims. broad. The tubular appendage two and a half times as long as the body; intestine the same, much folded. Colour of the body olive-green, of the proboscis pale greenish.

One example, taken at Station 190 in 69° 41' N. lat., 15° 50' 5 E. long., at a depth of 870 fathoms, on a bottom of sandy mud.—*Nyt Magazin for Naturvid.* 1880, pp. 44-66.

On the Existence of Polar Globules in the Ovum of the Crustacea.

By M. L. F. HENNEGUY.

Grobben is the only author who has hitherto noticed the presence of polar globules in the ovum of the Crustacea. He states that he saw, in the ovum of *Moina rectirostris*, a small clear spot situated at the superior pole, enclosed in the vitellus, which he regards as a polar globule flattened by the envelope of the ovum which is closely applied to the vitellus.

On examining recently laid ova of *Asellus aquaticus* I saw, in the tolerably wide space which separates the vitellus from the chorion, two small transparent globules, containing a few granules and presenting all the characters of the polar globules observed in the ova of other animals. I have even been fortunate enough twice to see one of these globules detach itself from the vitellus. In all the ova that I have examined, these little bodies were nearly of the same diameter. In some ova there were four of them, forming a little group; and they were then smaller than in the ova in which there were only two: it is probable that in this case the two globules had divided.

These globules persist for some time in the ovum, and only disappear when the vitellus is already divided into about ten segments. The first segmentative grooves forming simultaneously around nuclei which make their appearance at the surface of the vitellus, the polar globules do not here play any part in relation to the production of the first segmentative furrow, and cannot be regarded as directive corpuscles. Their formation is very probably connected with the disappearance of the germinal vesicle, as Fol and Hertwig have demonstrated in the case of the Echinoderms; but the opacity of the vitellus has not allowed me to see the germinal vesicle, or to witness its disappearance.—*Bull. Soc. Philom. Paris*, April 10, 1880.

On the Organization and Development of the Gordii.—Second Note*.
By M. A. VILLOT.

In the *Gordii* the adult state is characterized by the atrophy of the digestive apparatus, and the development of the generative organs, the integuments, the muscular apparatus, and the nervous system.

The integuments have not the complex structure that Dr. O. von Linstow has recently attributed to them. We can only distinguish in them two layers—a superficial structureless layer scarcely measuring 0.001 millim., and a deeper one, formed of intercrossed elastic fibres, more or less strongly coloured, and having an average thickness of 0.029 millim. These two layers correspond to the cuticle of the Nematoids, and do not differ from it in origin. The elastic fibres which constitute the deep layer are only differentiated towards the close of the second larval period.

The description that I have given of the nervous system is very naturally explained by organogeny, and is not without analogy to that which is accepted for other animals. The relations of continuity which exist between the cerebroid organ, the ventral cord, and the hypoderm are shown by longitudinal and transverse sections. These are facts which I have been the first to indicate, and which possess a certain value, independently of any physiological interpretation. In the larva of *Gordius* we find, in place of the cerebroid organ, an actual ring which gives passage to the œsophagus, and is the homologue of that which is observed in all Nematoids. The transformation of the œsophageal collar into a cephalic ganglion in the adult *Gordii* is the consequence of the disappearance of the œsophagus. The union of the medullary centres into a single cord situated in the ventral region is the result of the fact of the non-existence in the *Gordii* of lateral areas, submedian lines, or dorsal line. This important character fully justifies the creation of a special order for the genus *Gordius*; it approximates these animals to the *Sipunculi*, and in this way establishes a well-marked passage from the class of Helminthes to that of the Gephyrea. The network of fibres and cells which constitutes the hypoderm is placed beyond doubt by means of suitably directed sections and the employment of colouring-matter; and its ascription to the nervous system has nothing startling in it when we consider the transitory forms which this apparatus assumes among the superior types of the animal kingdom. The nervous system of the *Gordii* is arrested at that phase of development which represents the differentiation of the medullary centres by gemmation from the ectodermic lamella. Although still intimately united with the hypoderm, their ventral cord has already passed the muscular zone and penetrated into the middle region of the body. It is the same organogenic phase that we observe in the adult Nematoids; but here the differentiation of the nervous centres appears to be less advanced. It is still less so in the Polygordians. *Polygordius Villoti* has a ventral cord of very flattened form, situated beneath the muscular layer and in imme-

* See 'Annals,' August 1880, p. 169.

diate contact with the hypoderm. The nervous system of the *Gordii* is endowed with very remarkable absorbent properties, which may, under certain conditions, give it the appearance of a true vascular apparatus. Water penetrates into it with the greatest facility, and causes in it singular alterations as soon as the animal loses some of its vitality. The cells of the hypodermic network dilate and become pyriform; the epidermis of the papillæ also swells and becomes prolonged exteriorly in the form of tubes or long filaments. These alterations have been described by Möbius and Grenacher as normal and integral parts of the animal; by Von Siebold and myself as parasitic Algæ.

The muscular elements of the *Gordii* are derived from the embryonic cell by a series of very simple modifications. The myoblast, by elongation and lateral compression, passes from the spherical form to the ribbon-like state. The envelope of the cell constitutes the myolemma; and its contents (protoplasm and nucleus confounded together) become converted into contractile substance. The latter condenses against the cell-wall and divides into longitudinal fibrillæ parallel to the longer axis of the fibre. The thickness of the muscular layer thus increases in the direct ratio of the lateral flattening of the embryonic cells. This process of formation, which is common to the Nematoids, the Gordians, and the Polygordians, attains its maximum of development in the last-named.

The atrophy of the digestive apparatus consists principally in the disappearance of the mouth and œsophagus. The so-called "secretory organ," described by Meissner in the adult *Gordii*, is nothing but the intestine. Its true nature is attested by the fact that in the larvæ it is in relations of continuity with the mouth and œsophagus. In the adults we see that it opens posteriorly into the cloaca, and that in front it terminates below the cephalic ganglion in a very slender cæcum. The contraction of the anterior extremity of the intestine results both from the degenerescence of its tissues, and from a sort of constriction caused by the connective fibres of the parenchyma.

The divisions of the cloaca of the female, which Grenacher has designated by the names of *seminal receptacle*, *uterus*, and *cloaca proper*, do not correspond either to differences of structure or to differences of function.

As to the parenchyma it is constituted by very diverse anatomical elements. Some parts remain, even in the adults, in the state of embryonic tissue; others pass to the condition of connective or even of cartilaginous tissue. By making transverse sections upon the cloaca of the females, we can see how these different tissues are derived from each other; in fact we can distinguish in them four well-characterized zones; the most inferior is entirely composed of embryonic cells, not yet modified, but already in course of proliferation; the second zone is formed of cells having all the properties of the cartilaginous cell; the third zone shows the passage from the cartilaginous cell to the connective corpuscle; the fourth and last zone is represented by normal connective tissue, such as is observed in most of the inferior animals.—*Comptes Rendus*, Nov. 8, 1880, p. 774.

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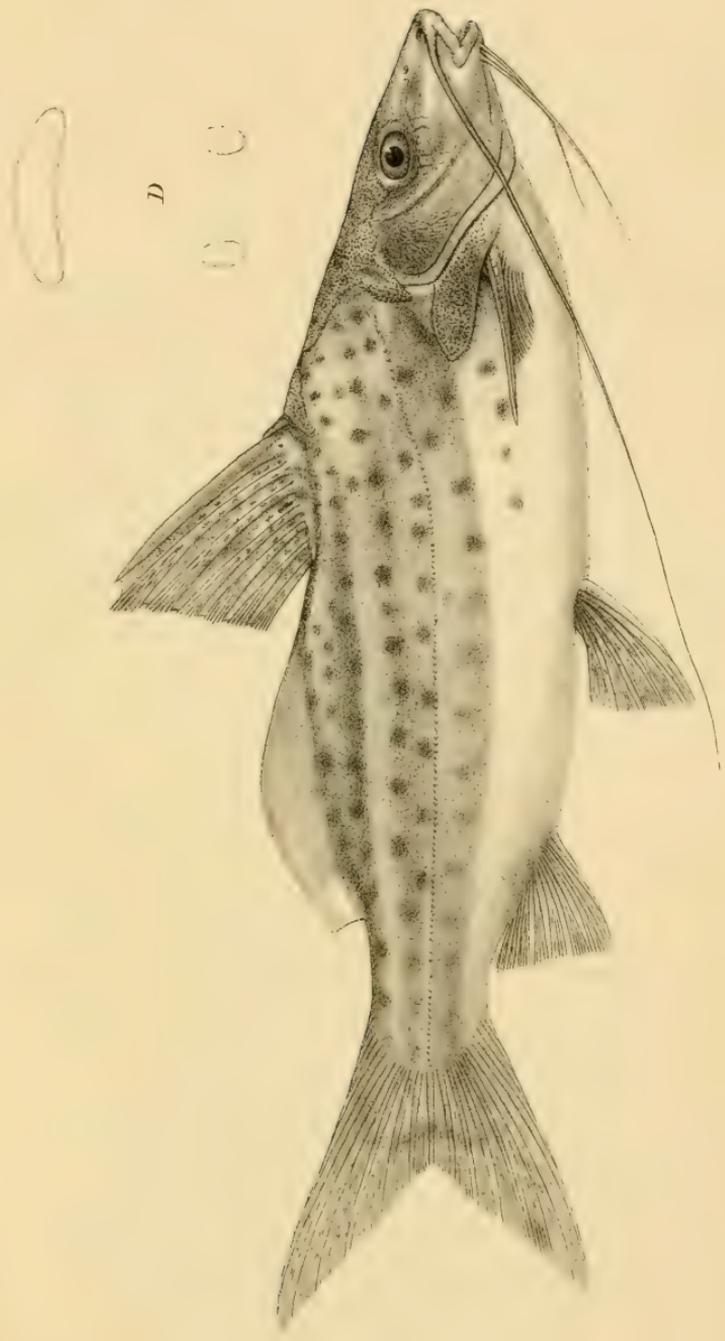
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END OF THE SIXTH VOLUME.





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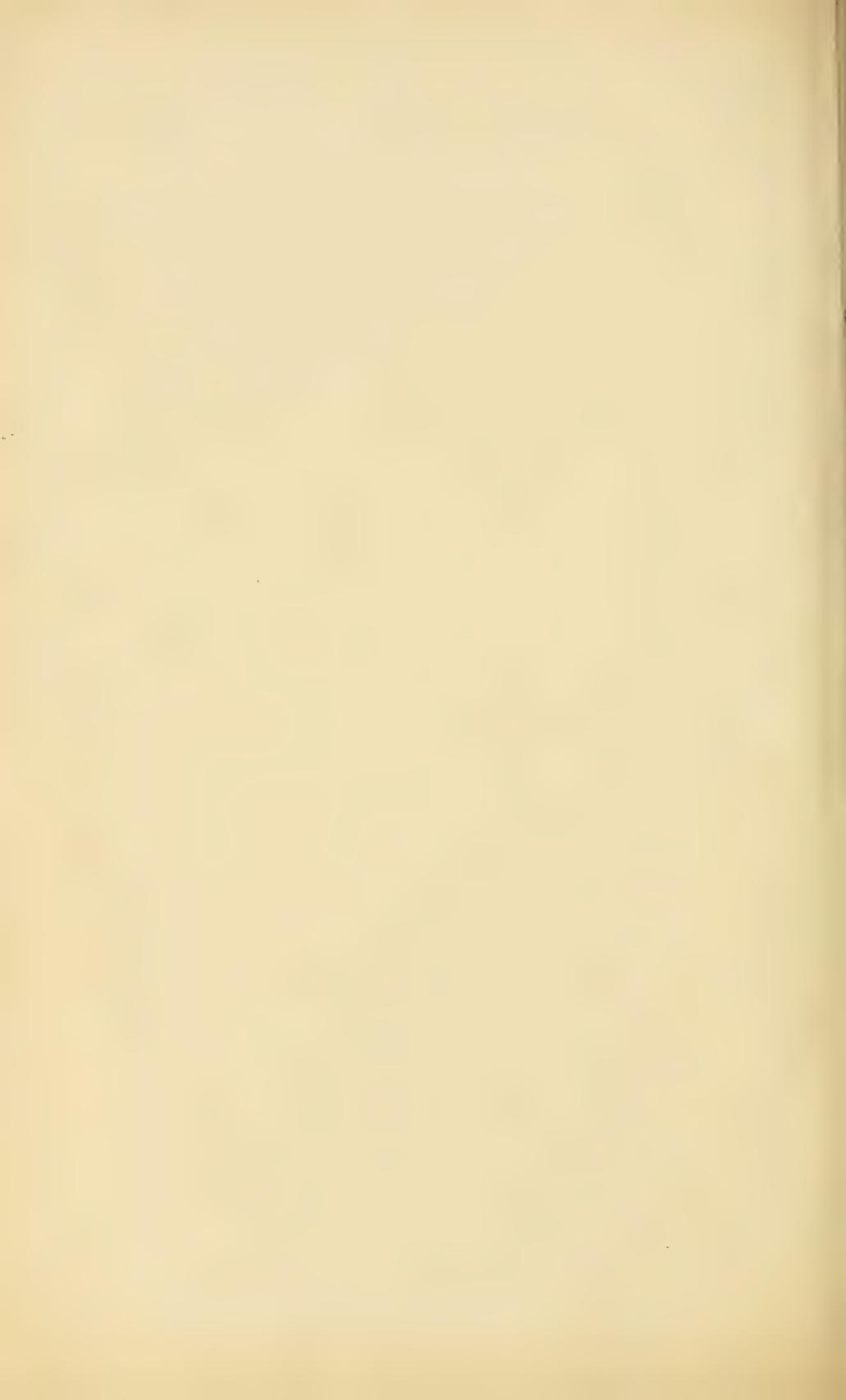


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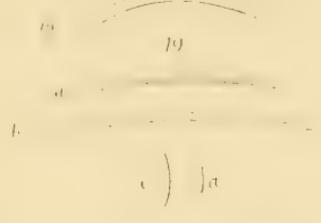




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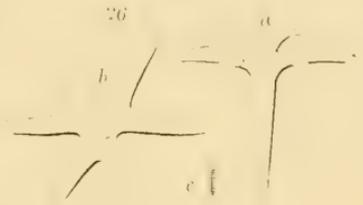
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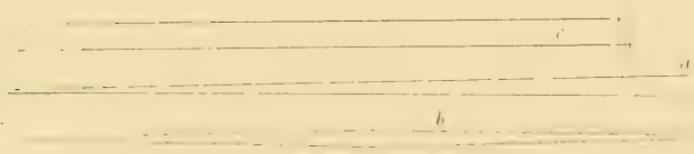
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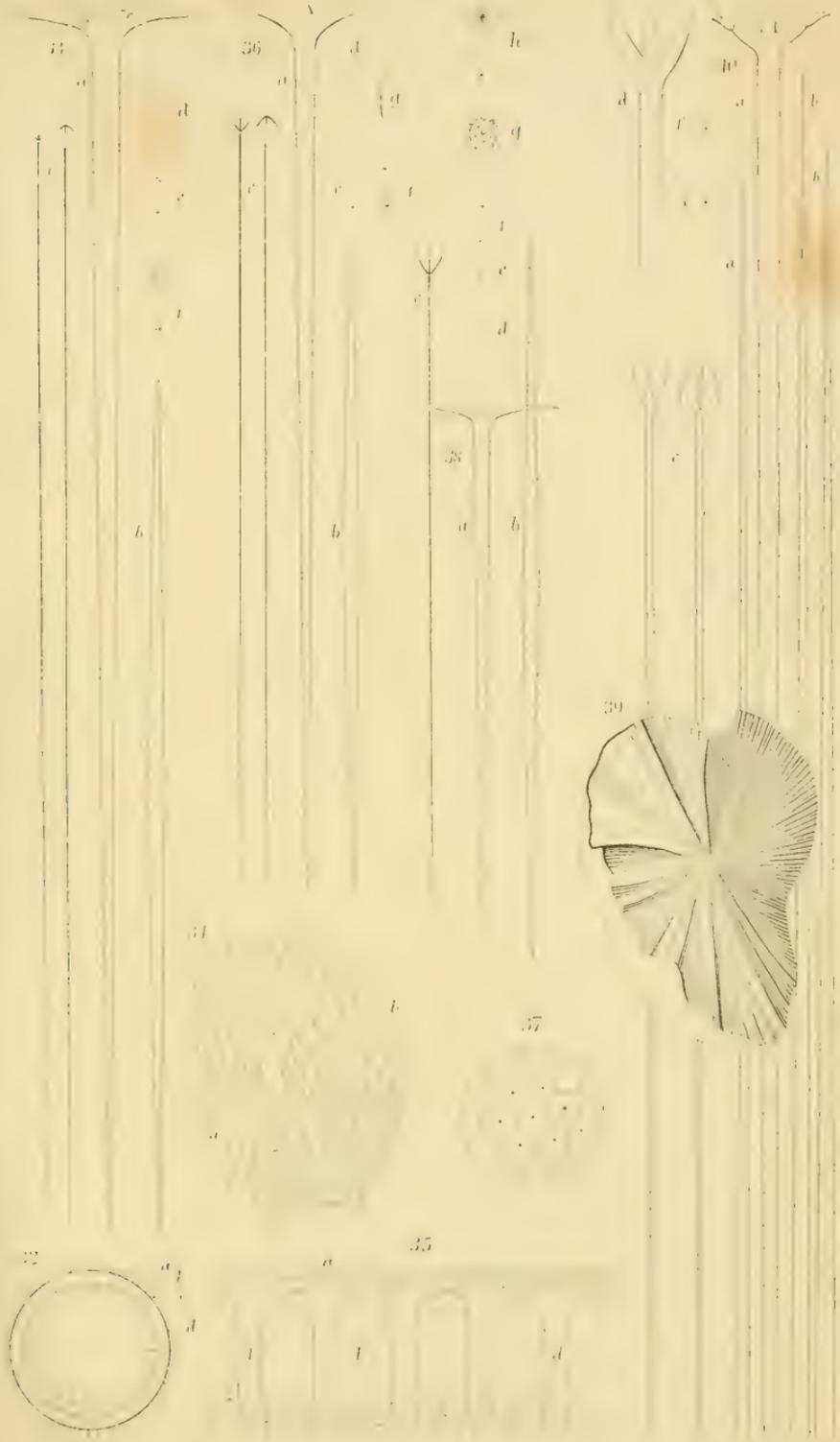
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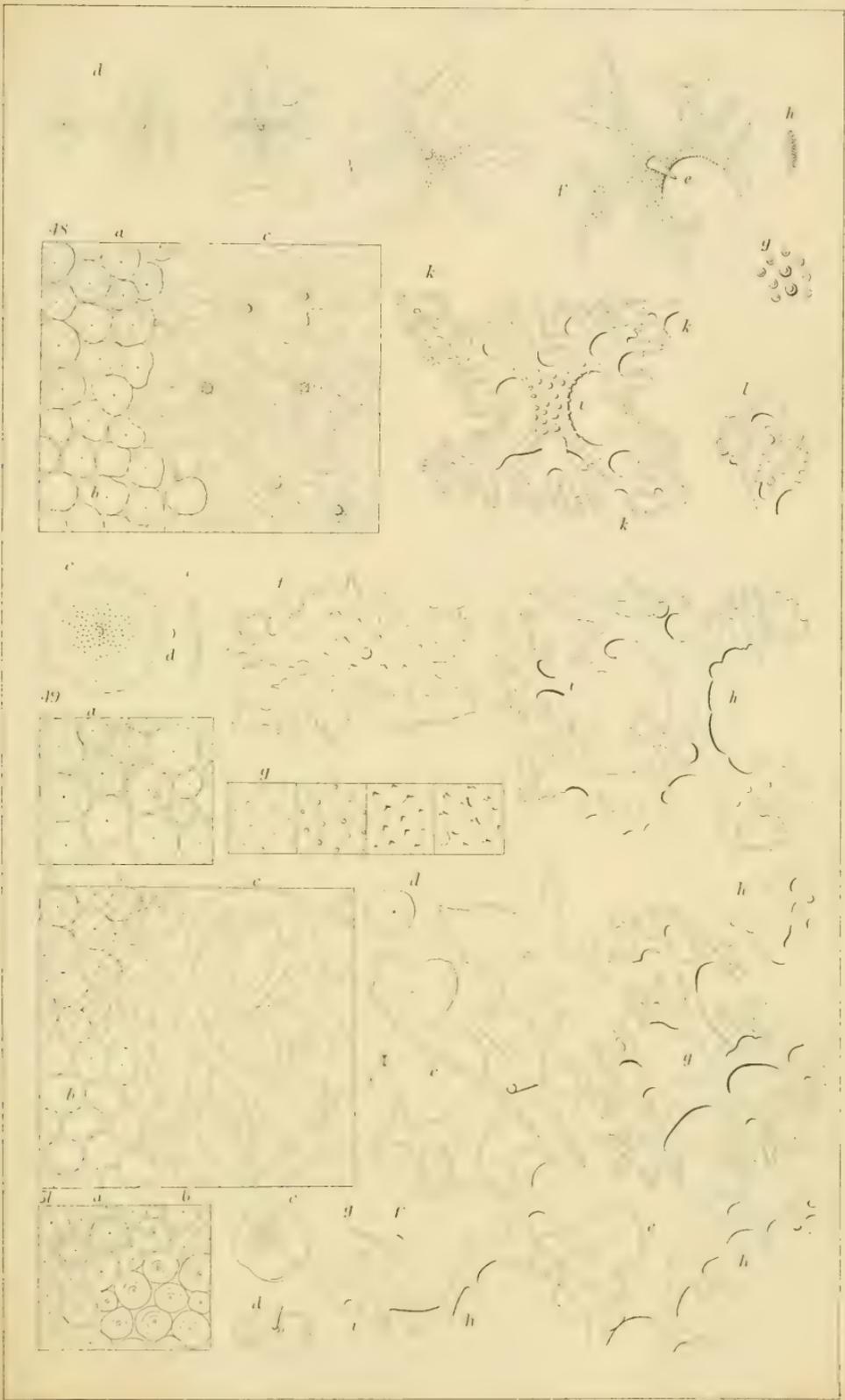


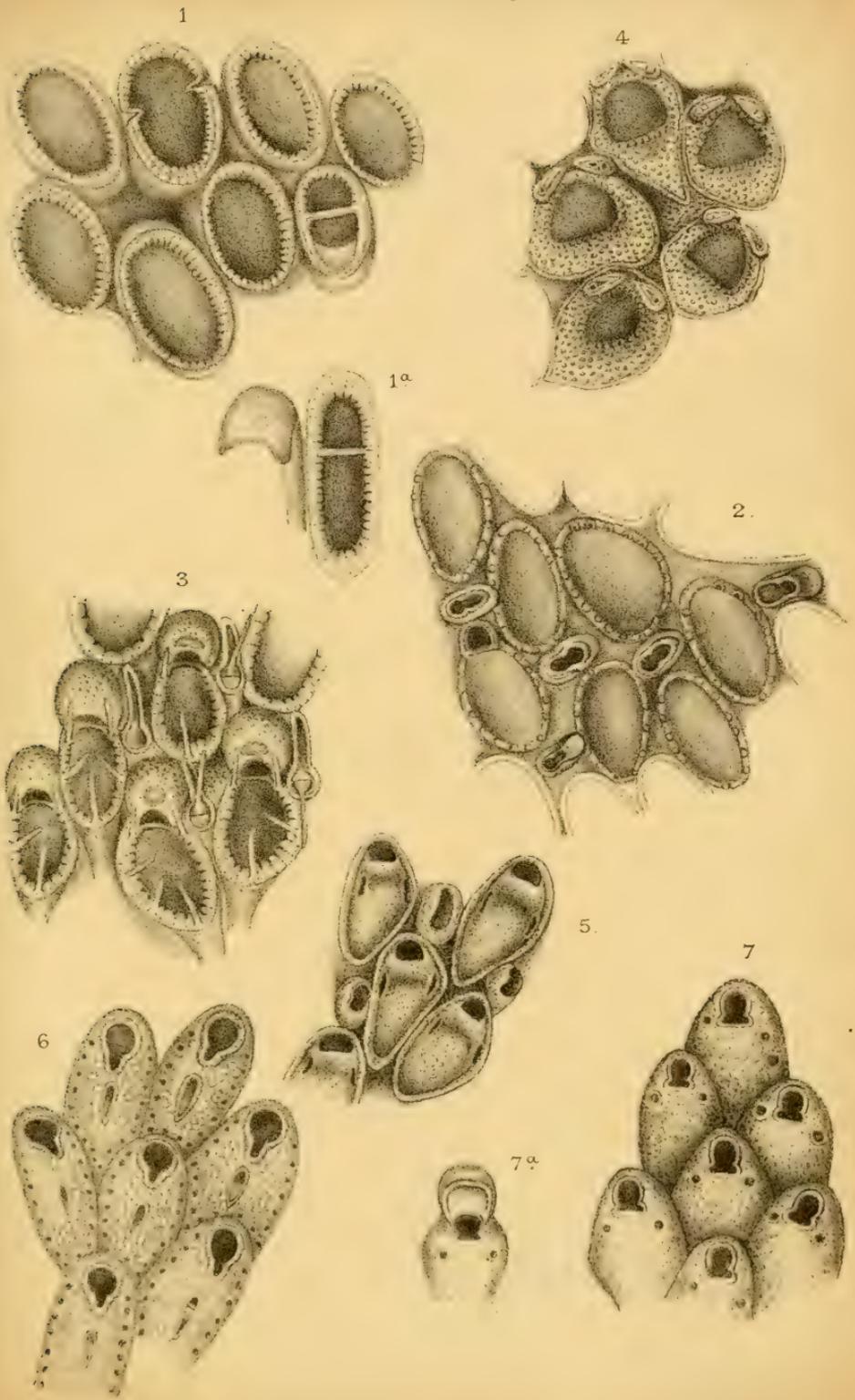
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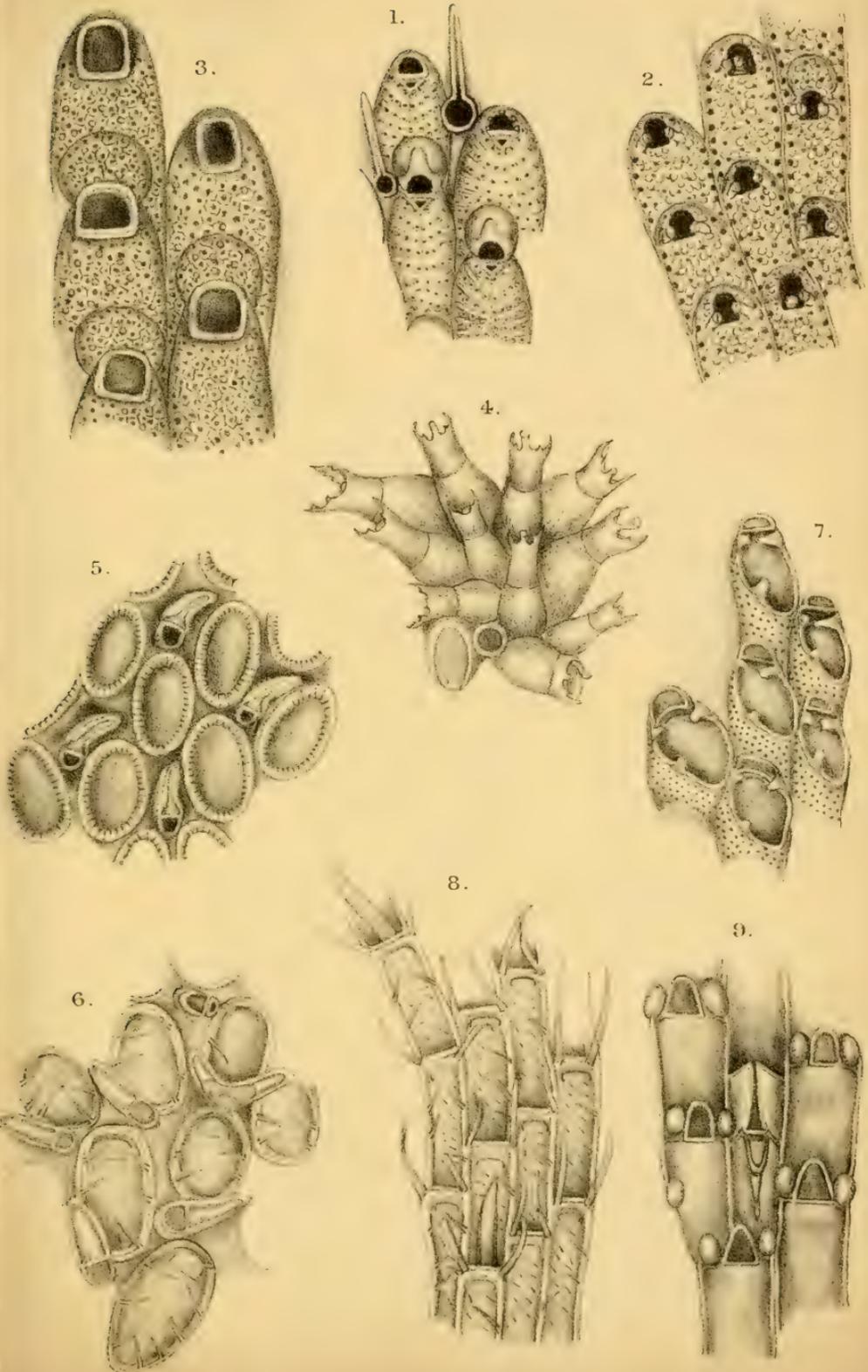




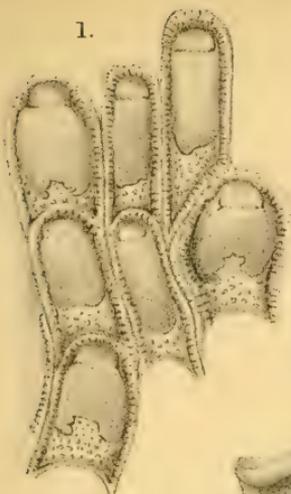




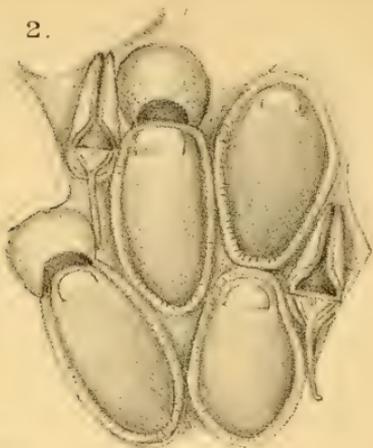




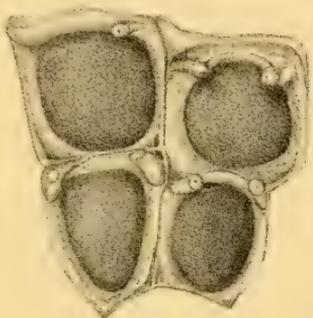
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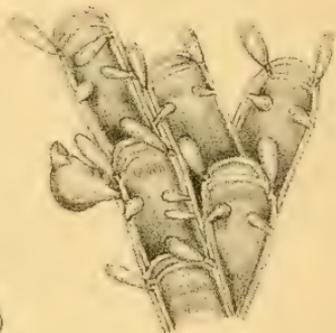
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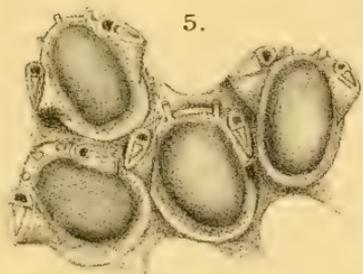
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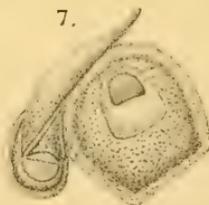
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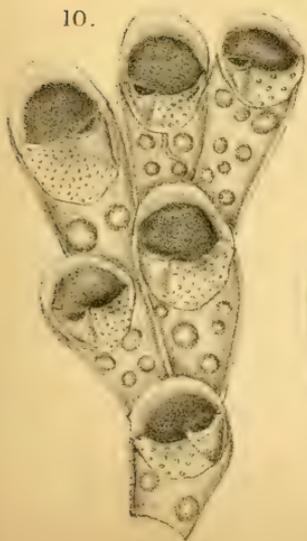
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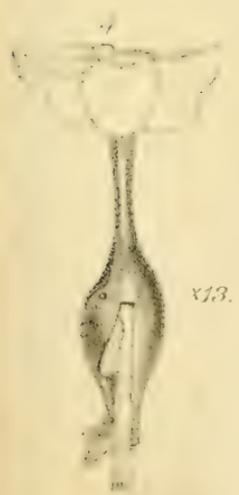
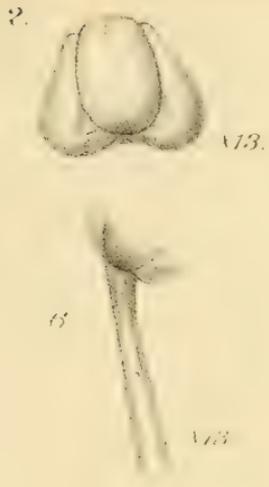


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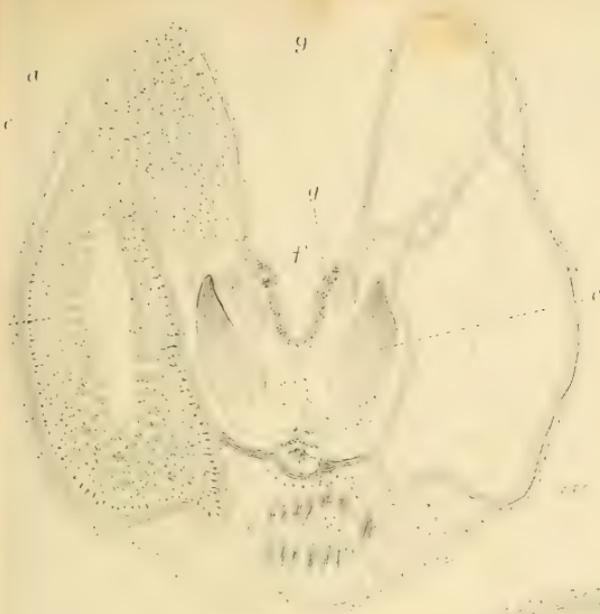


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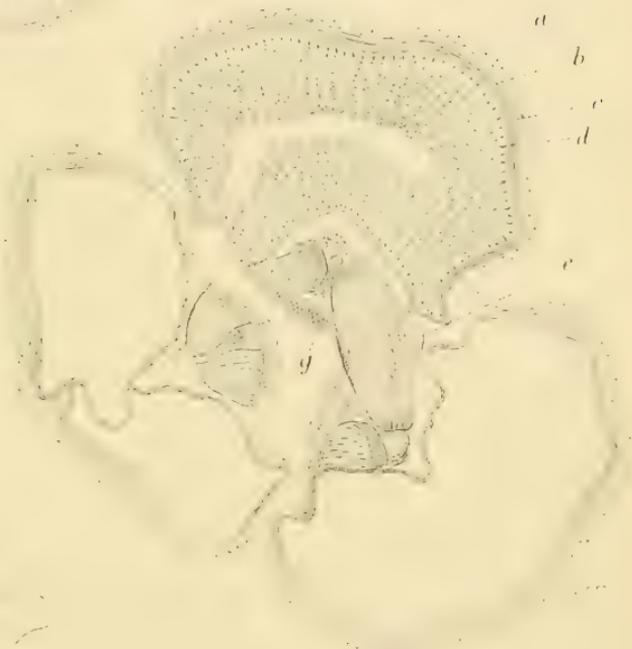




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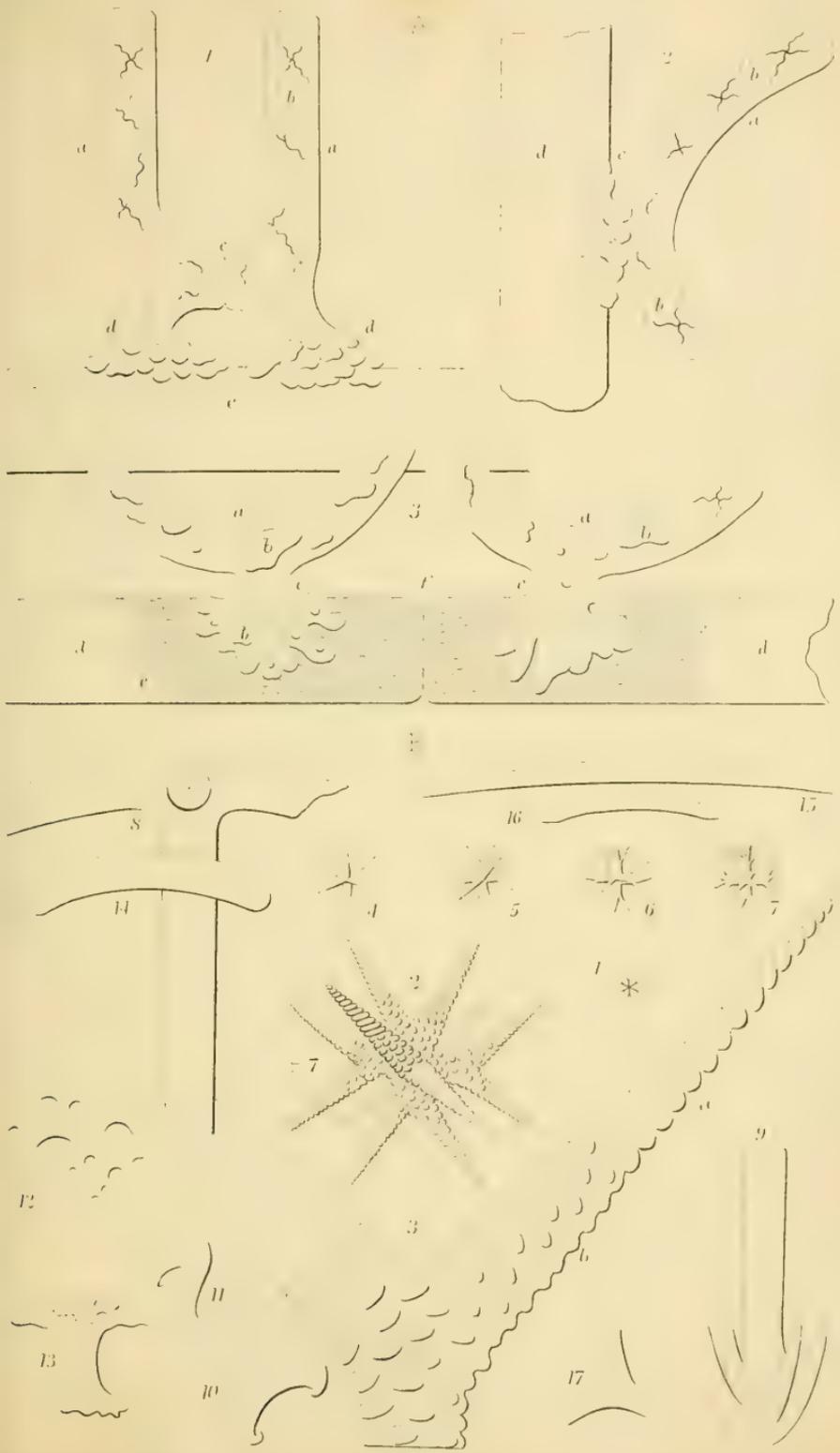


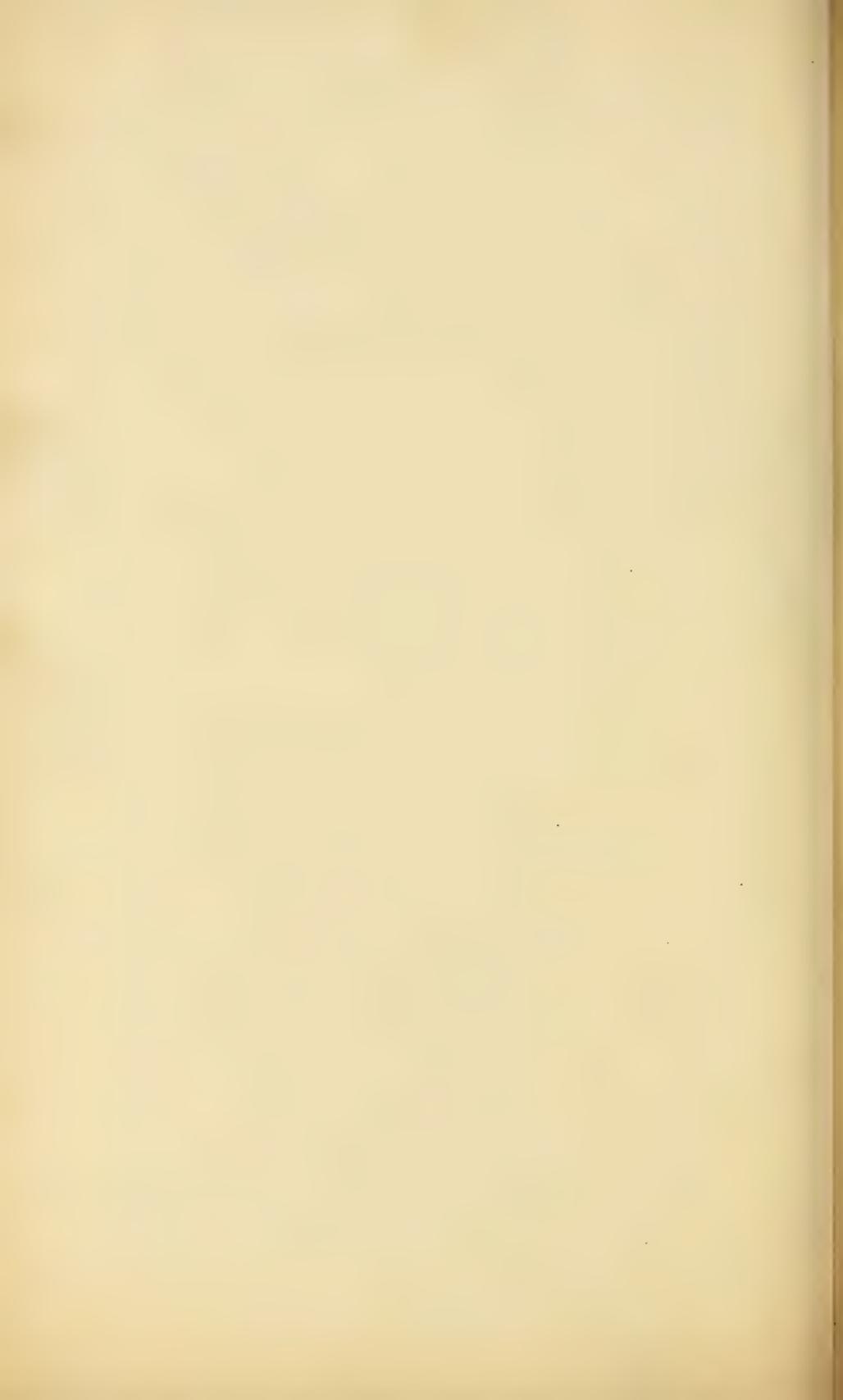
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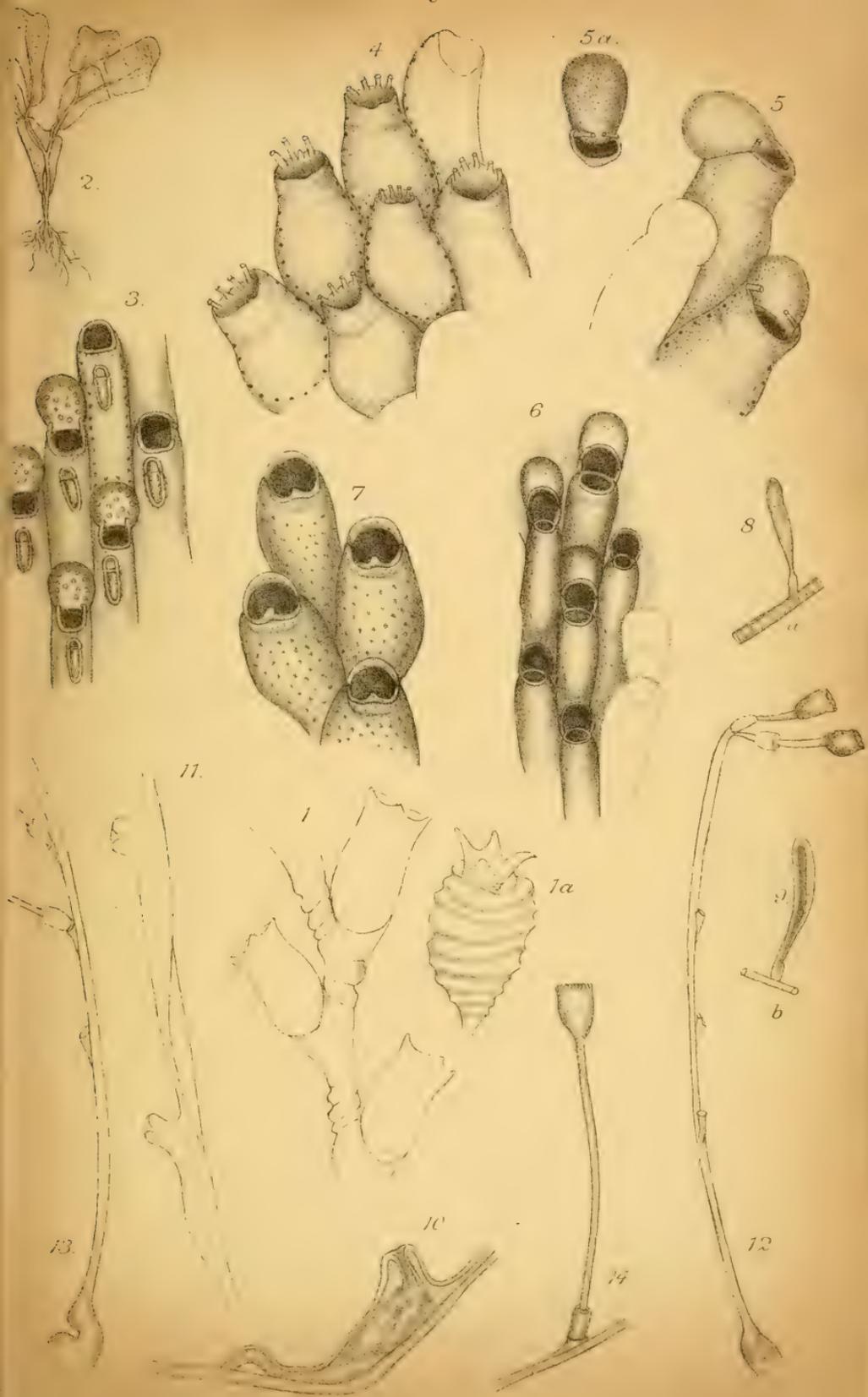


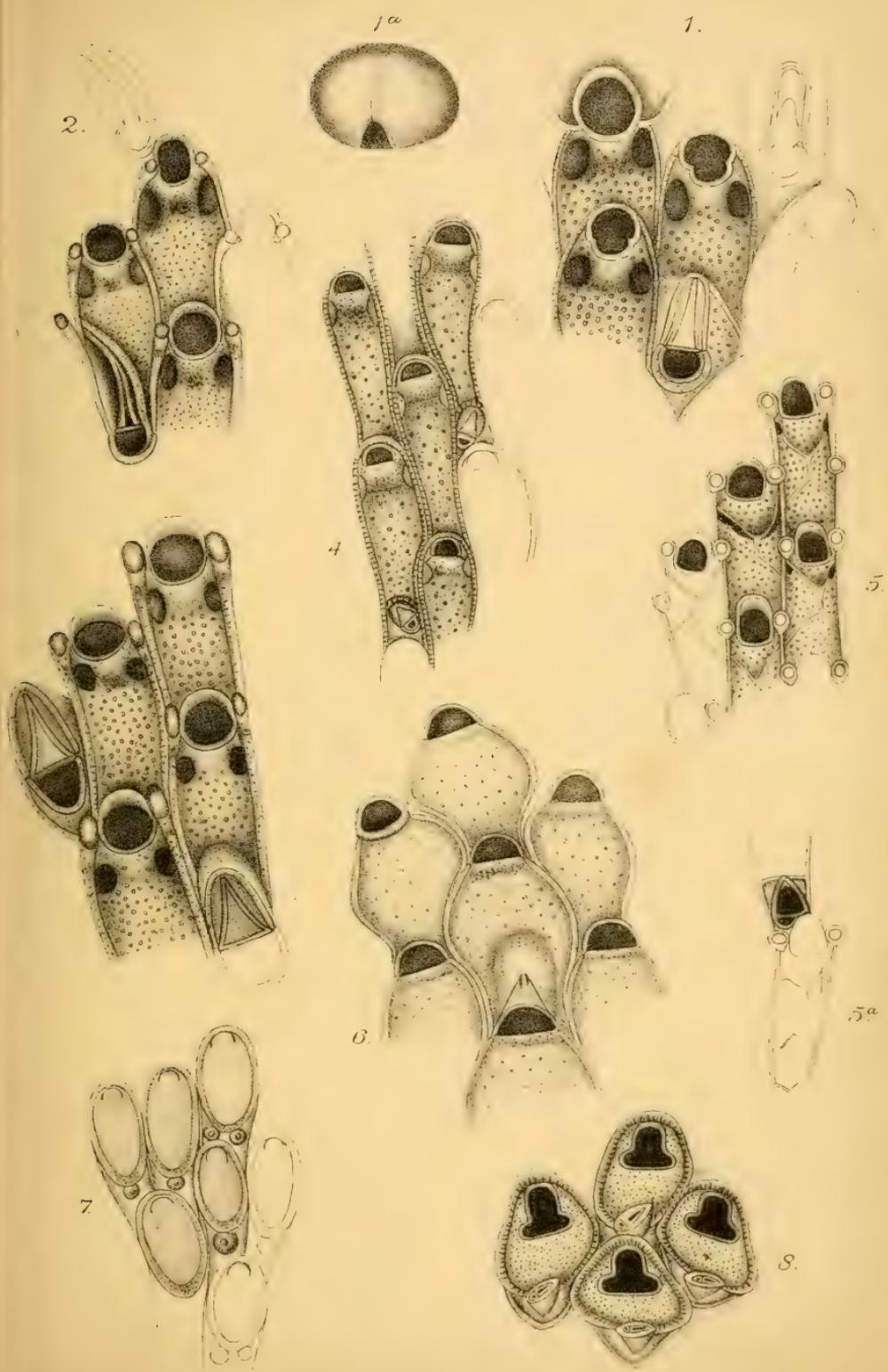
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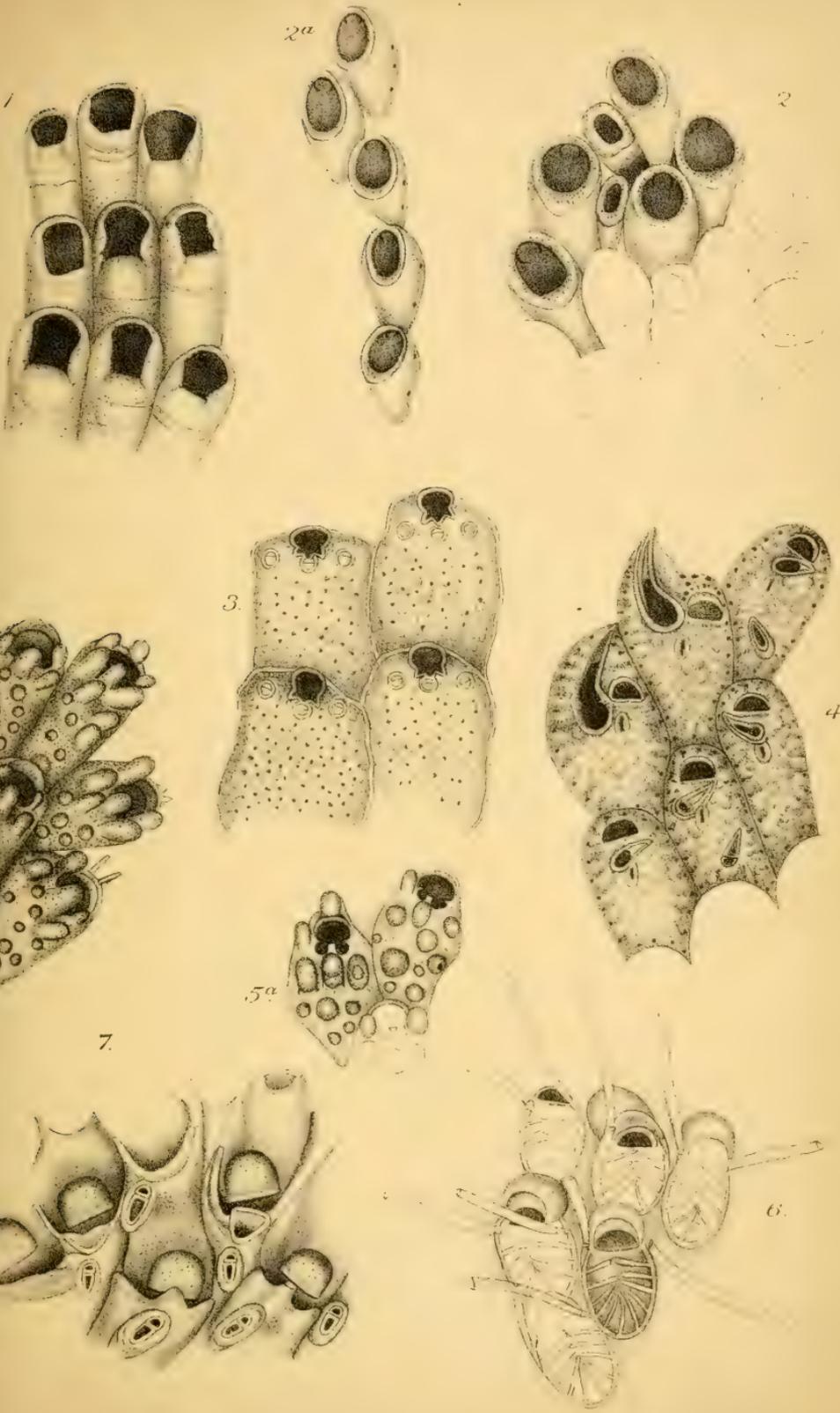


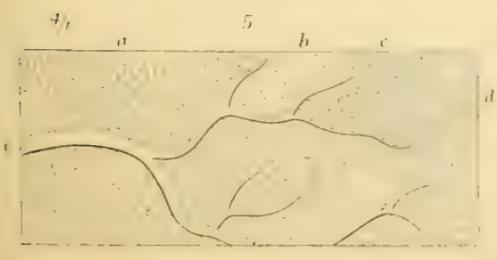
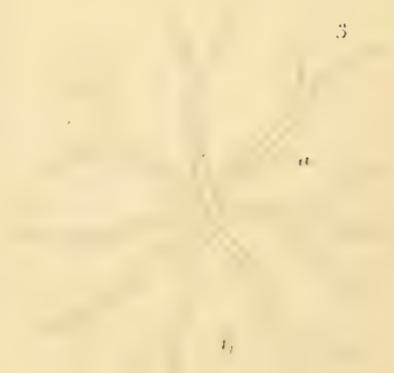
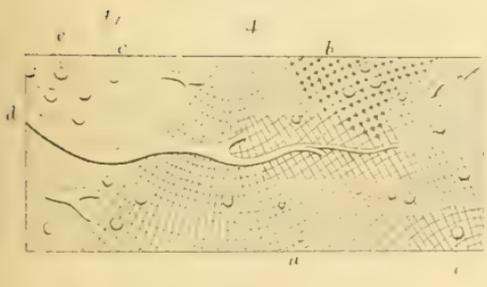
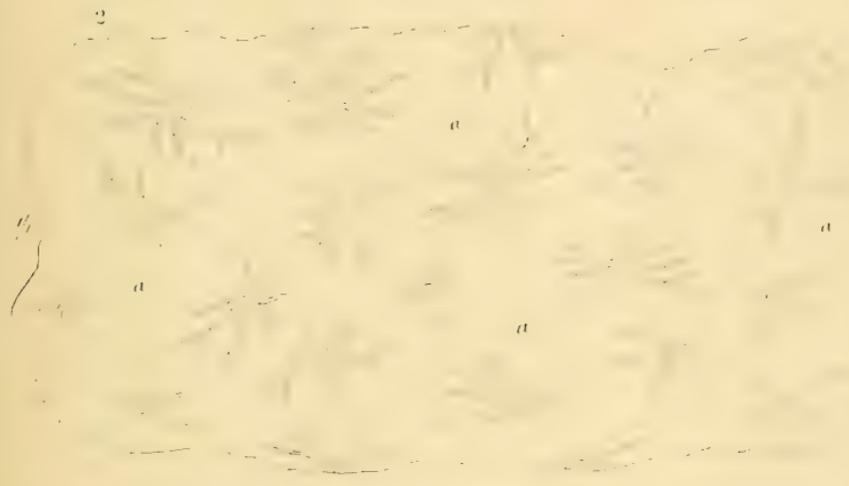


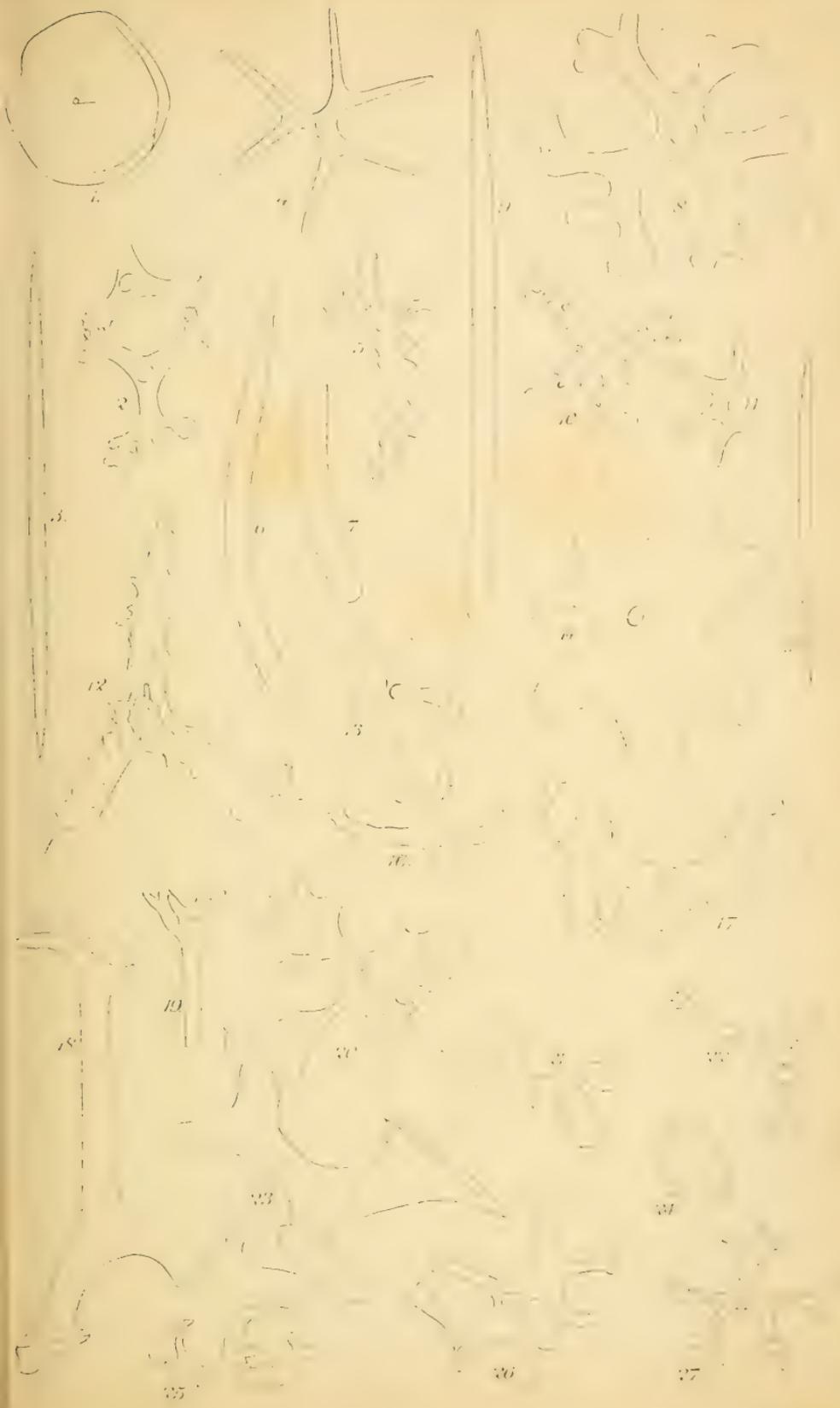


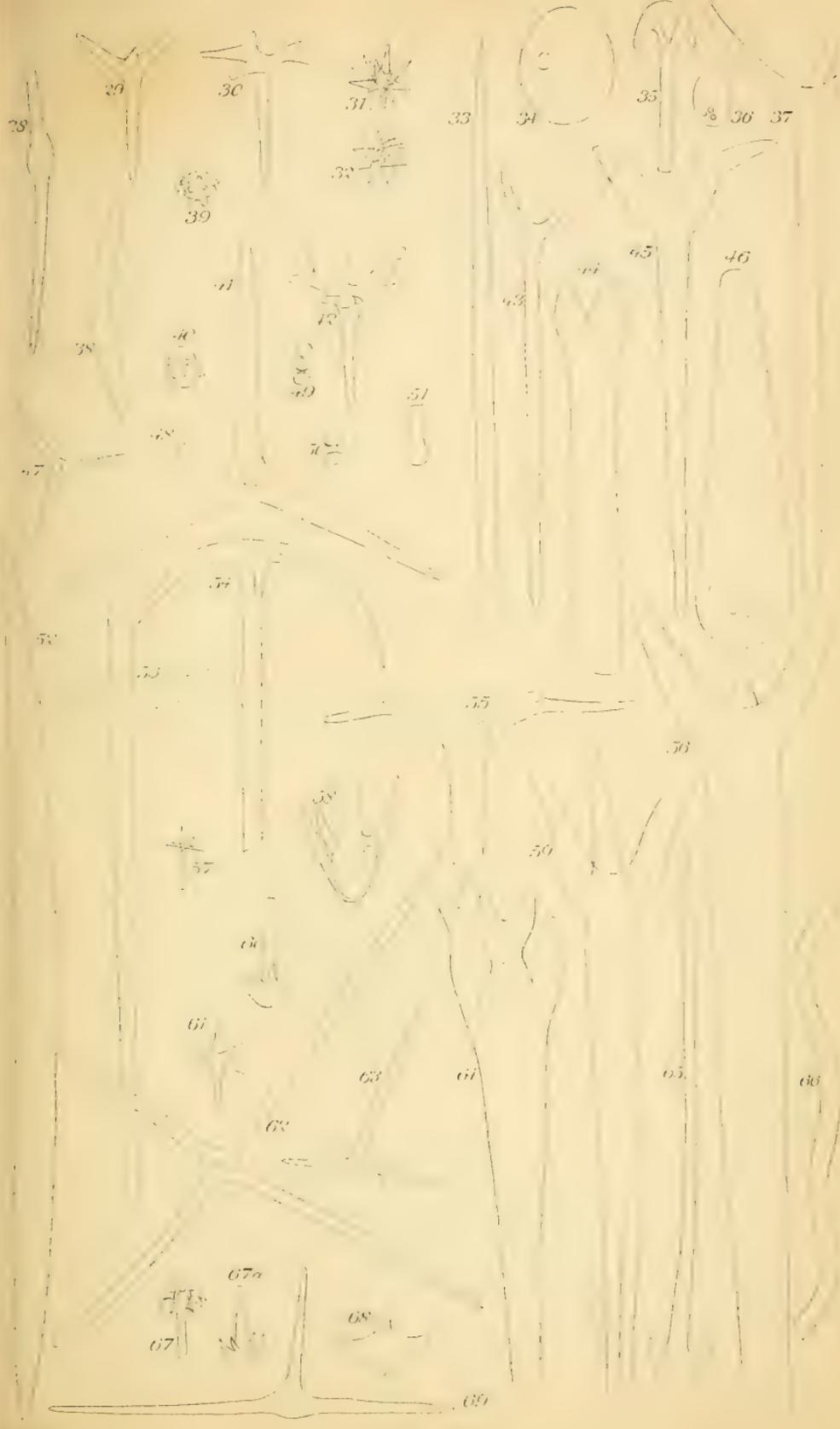


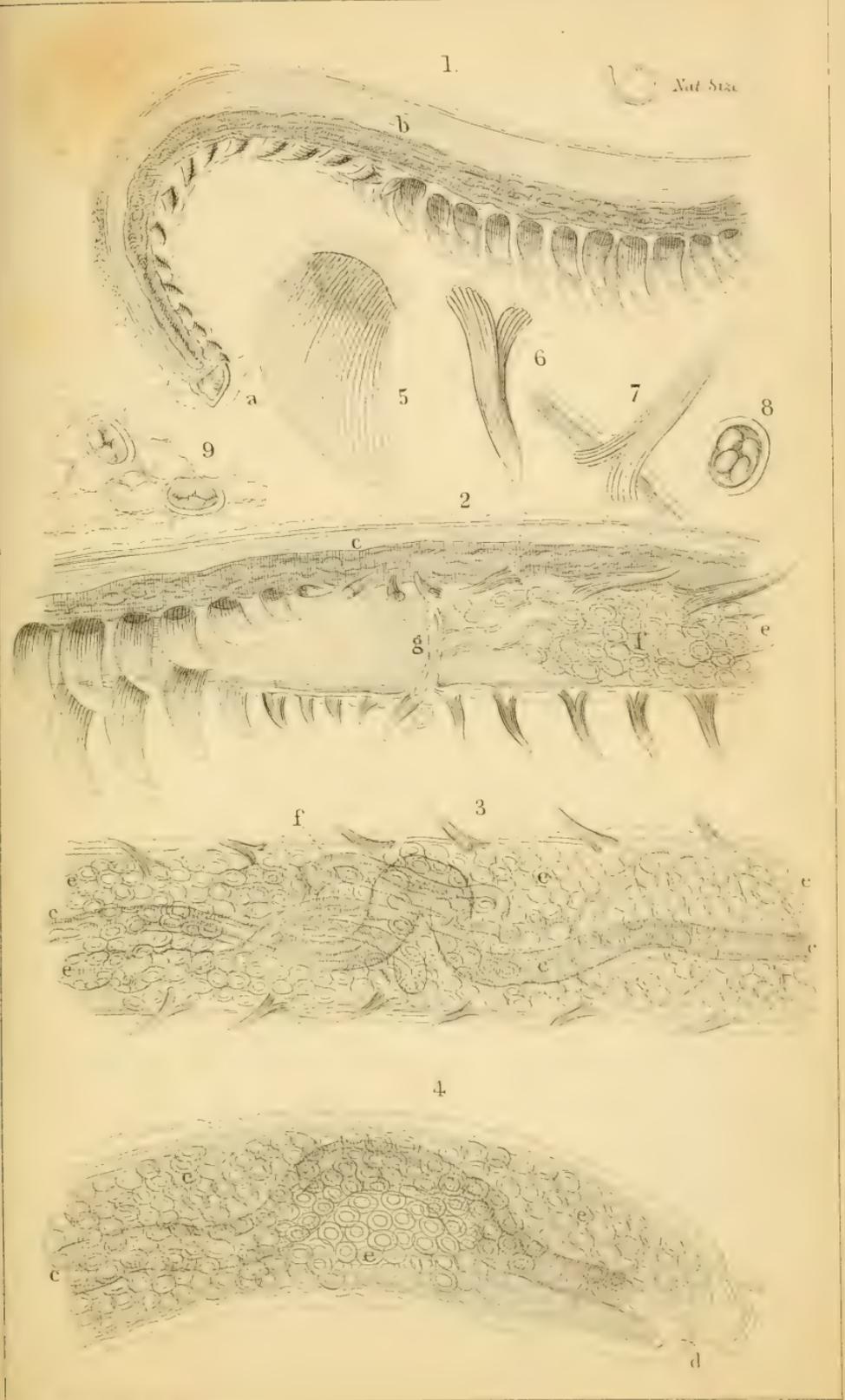












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