Nummulite, 2 lines in diameter. The section, fig. *g*, shows three whorls and a large central chamber; eighteen chambers in the outer whorl. The chambers, as to their relative size and setting-on, are like those of *N. Mamilla*.

By MM. d'Archiac and Haime *N. lenticularis*, var. *a*, is recognized as a species, and renamed *N. Tchihatcheffi*, Monogr. p. 98, pl. 1. fig. 9.

Var. β, pl. 7. figs. *a*, *b*. A small lenticular Nummulite, 2 lines in diameter, covered with closely-set granules; on the figure about thirteen granules lie in a row along the diameter of the shell.

According to MM. d'Archiac and Haime, this is *N. Lucasana*, Defr., var. *a*, Monogr. p. 125, pl. 7. fig. 7.

Var. γ, pl. 7. figs. *c*–*f*. A small, smooth, lenticular Nummulite ($3\frac{1}{2}$ lines in diameter), more convex on one face than on the other. In the section, fig. *e*, $6\frac{1}{2}$ whorls are seen, with the central cell large, and thirty-six chambers in the outer whorl (thirty-two on the fifth, and about the same number in the third whorl); chambers very like those of *N. Mamilla* and *N. lenticularis*, var. *a*, but more numerous.

MM. d'Archiac and Haime refer this to *N. Molli*, d'Arch., Monogr. p. 102, pl. 4. fig. 13.

Var. δ, pl. 7. fig. *g*. A small lenticular Nummulite, $3\frac{1}{2}$ lines in diameter, marked with twenty-four more or less curved or sinuous striæ, radiating from the periphery towards the centre of the face, but leaving a small clear umbonal area.

M. D'Orbigny collates this variety as identical with his *N. radiata*, For. Foss. Vien. p. 115; but we cannot coincide in this determination, though these varieties may belong to one species. According to MM. d'Archiac and Haime, this is *N. Biaritzensis*, d'Archiac, Monogr. p. 131, pl. 8. figs. 4–6.

Var. ϵ, pl. 7. fig. *h*. A small lenticular Nummulite, $3\frac{1}{2}$ lines in diameter, resembling var. δ, excepting that the interspaces between the radial lines are occupied with granules, mostly in single rows of from 4 to 7, but sometimes in double series towards the periphery.

This is *N. perforata* (Montf.), D'Orb., and accepted under that name by MM. d'Archiac and Haime, Monogr. p. 115, pl. 6. figs. 1–12.

These figures of five varieties of Nummulites, though boldly drawn and apparently with care, give us but little exact evidence of the real relationships of the originals. We have quoted the determinations arrived at by MM. d'Archiac and Haime, after considerable research; but, even with the aid of their painstaking and minute descriptions and their numerous and faithful drawings, we cannot readily follow them to their conclusions.

Nummulinæ, like other *Foraminifera*, take such licence in their mode of growth, in the relative size and setting-on of the segments and their alar lobes, and in the exaggeration of the exposed septal lines and pillars by the, as it were, capricious growth of shell-matter, that it is difficult, even with the best-grown of these giants of the family, to determine where anything like specific limits can be marked out.

It appears to us that, in its style of growth, *Nummulina* is related to *Operculina*,—so closely, indeed, that, like *Assilina*, the latter sinks to the low grade of a subvarietal condition, there being no strict boundary between it and *Nummulina*, as we find abundantly proved by both recent and fossil specimens. Just so *Nonionina* loses itself in *Polystomella*.

The hundreds of indifferently described Nummulitic forms to be found in geological works were in 1853 reduced to order by the combined labours of M. le Vicomte d'Archiac and M. Jules Haime, and arranged as fifty-two species, grouped in six sections, —namely, 1. Nummulinæ læves aut sublæves; 2. Reticulatæ; 3. Subreticulatæ; 4. Punctulatæ; 5. Plicatæ vel striatæ; 6. Explanatæ (septa et spira plus minusve prominentes),—Nos. 1–5 forming the division characterized by "cloisons embrassantes, plus ou moins inclinées et arquées," No. 6 being a division by itself, with "cloisons non embrassantes et presque droites."

The group No. 1, "læves," have the alar or umbilical lobes attenuate (corresponding to the smallness of the segments) and extremely sinuous,—"filets cloisonaires simples, très-sinueux." This is the chief characteristic of the large, flat, smooth Nummulites forming the group, of which *N. complanata*, Lamarck, is the type. We should have preferred the term "sinuatæ" or "complanatæ" for the group. Groups No. 2 and No. 3, "reticulatæ" and "subreticulatæ," are characterized by the inosculation of the "filets cloisonaires" or alar lobes of sarcode proceeding laterally from the segments; they are so closely related, that we may regard them as one group, characterized by the net-like arrangement of the inosculating lobes, "réseau cloisonaire," and typified by *N. lævigata*, Lam. The "punctulatæ" of group No. 4 are, we believe, artificially brought together: they belong part to group 1 and part to group 5, and in some cases have very close relations with groups 2 and 3. The feature referred to as characteristic in group No. 4 is the granulation of the surface; and, owing apparently to the strange mistake of the authors (formerly made also by Dr. Carpenter in his Memoir on Nummulites in the Quart. Journ. Geol. Soc. vol. vi.*) in regarding the subcrystalline columns seen in sections of Nummulites (that is, the septal walls and pillars) as calcareous

* Corrected by him in Phil. Trans. vol. cxlvi. p. 558, *note*.

infillings of funnel-shaped holes or pores, the nature of these granulations was misunderstood by MM. d'Archiac and Haime. In a Nummulite of any of the groups the septal lines exposed on the surfaces may be thickened, built up, or exaggerated by ridges or granules of hyaline shell-substance permeated with tortuous passages—part of the so-called "vascular system" of the shell; and these exogenous granules need not be confined to the septal lines, but may be planted in the interspaces, as in *Amphisteginæ* and other cognate forms, and will thus stand as lines and pillars of division to the alar lobes as the new segments are successively added. This is markedly the case in *N. scabra*, Lam., the granulated variety of *N. lævigata*, and indeed in numerous instances among *Nummulinæ* and their allies. In many Nummulites the granulate surface may be found at one period of growth, and the smooth at another; for, if a new segment or segments have been lately added, the surface will be far smoother than in the stage when the external increase of the septal lines and pillars only is going on.

The group No. 5, "plicatæ vel striatæ," contains a great many varieties characterized by a simple radiate arrangement of the alar lobes, which are usually elongate triangular, straight or slightly curved, either falciform or sigmoid. These Nummulites are usually small, and are well typified by *Num. planulata*, Lamk. We should have preferred the term "radiatæ" for this group.

No. 6 is the Assiline group ("explanatæ"), in which the whole of the spire is apparent from the want of the alar lobes. *Assilina*, however, like *Operculina*, passes by insensible gradations into *Nummulina*, by the varying development of the lateral lobes or flaps.

There are individual specimens that tend to show a linking together of the "sinuate," "reticulate," and "radiate" groups; but for the present we propose to regard these as three *specific* groups, headed respectively by *Nummulina complanata*, *N. lævigata*, and *N. planulata*. The Assiline forms are probably related as varieties to the "radiate" and "sinuate" groups.

Having said thus much respecting the Nummulites generally, we return to Fichtel and Moll's illustrations, with the following remarks:—

N. Mamilla and *N. lenticularis*, var. α, do not present any indication of the superficial lobes; but, from the style of their chambers, they probably belong to the "radiate" group, and, for what we can see, are of the same species, the relative amount of convexity not being essentially distinctive.

N. lenticularis, var. β, may be the *N. Lucasana* (of the "radiate" group), as stated by MM. d'Archiac and Haime, but is

quite as like some of the granulate varieties of the "sinuate" group.

N. lenticularis, var. γ, is referred by MM. d'Archiac and Haime to the "reticulate" group, probably with justice, and to a new species. Nevertheless it much resembles their figures of *N. Tchihatcheffi* in every respect.

N. lenticularis, var. δ, is decidedly a "radiate" form, resembling *N. Ramondi*, *N. Guettardi*, *N. striata*, and others, even more than *N. Biaritzensis*, to which MM. d'Archiac and Haime refer it. The differences, however, are merely varietal.

N. lenticularis, var. ε, is far more like *N. Rouaulti* and *N. Lucasana* (of the "radiate" group) than *N. perforata* (of the "sinuate" group).

N. radiata, *N. venosa*, and their allies above described, are simple forms of the "radiate" group.

Nummulina, essentially symmetrical in all its varieties, is connected with the truly unsymmetrical species of Nautiloid Foraminifers by the unequal-sided *Amphistegina*, small varieties of which have a striking isomorphism with the Asterigerine varieties of *Rotalia Beccarii*—for instance, the *Asterigerina lobata* and *A. carinata* of D'Orbigny; but the Rotalian forms seldom hide their primordial cell in their successive folds, whilst this habit is constant in *Amphistegina*, however distorted it may become: thus this species never exposes its spire on both sides, like *Operculina*, nor on one side, as in *Polystomella macella* and the *Rotaliæ*. *Heterostegina* (a flattish Nummulitoid species with subdivided chambers) is in external form rather more like some *Operculinæ*, with the earlier portion lenticular, and with thin marginal chambers*, than an *Amphistegina*; and it bears the same relation to *Operculina* that *Orbiculina* does to *Peneroplis*; whilst *Cycloclypeus*, a species next beyond *Heterostegina* in development, is in this respect analogous to *Orbitolites*. See also Dr. Carpenter, Phil. Trans. 1856, vol. cxlvi. p. 565.

16. Nautilus Calcar. Page 69. Twelve varieties. Five varieties (*a*–ε): "Recent: Rimini shore, Adriatic. Fossil: Coroncina, near Sienna."

Var. *a*. Pl. 11. figs. *a*–*c*. Keeled, rowelled, ribbed, and um-

* The form here referred to, with its gently biconvex centre and thin edge, is the *Amphistegina Cumingii* of Dr. Carpenter, so fully described and illustrated in his last Monograph (read before the Royal Society, June 17, 1858, and published in the Phil. Trans. for 1859). We cannot agree with this talented author in placing this somewhat feebly developed Nummuline form in the genus *Amphistegina*. For our own part, we cannot, on any good physiological grounds, separate it from *Operculina complanata*, on the one hand, or *Nummulina planulata*, on the other, which latter we regard as the parental form of both.

bonate. A thick, well-developed *Cristellaria Calcar*: typical. See Annals N. H. 2 ser. vol. xix. p. 290; and ibid. 3 ser. vol. iii. p. 476.

Var. β. Pl. 11. figs. *d–f*. ("Plancus, Conch. p. 85, pl. 1. fig. 12, STV, and fig. 13 *z*, Z; Soldani, Sagg. Orit. pl. 1. fig. *g*,*G*, Testaceogr. vol. i. pl. 33. fig. B.") Keeled, ribbed, and umbonate. *Cristellaria cultrata* of authors: a common well-developed variety.

Var. γ. Pl. 11. figs. *g–h*. Keeled, rowelled, bead-ribbed, and umbonate.

Var. δ. Pl. 11. figs. *i–k*. Keeled, rowelled, and bead-ribbed. γ and δ are varieties of *C. Calcar* ornamented with granulated septal lines.

Var. ϵ. Pl. 12. figs. *a–c*. ("Soldani, Sagg. oritt. p. 98, pl. 1. fig. 6 J; Testaceogr. vol. i. pl. 59. figs. *q q*, *r r*.") Keeled, rowelled, with irregular spikes, ribbed, umbonate; surface granulate and chambers narrow. A fine variety of *C. Calcar*, with narrow falciform chambers.

Var. ζ. Pl. 12. figs. *d–f*. "Fossil: Ripalta, near S. Quirico, in the Sienese." Keeled, ribbed, umbonate; last few chambers distorted. *C. cultrata*: a modified individual.

Three varieties (η–ι). "Recent: Adriatic and Mediterranean. Fossil: Coroncina." Var. η. Pl. 12. figs. *g*, *h*. ("Plancus, Conch. p. 12, pl. 1. fig. 3 H.") Keelless, ribbed, umbonate. The most common variety of *C. Calcar* in its less-developed state. The same as *C. rotulata*, *Robulina simplex*, &c.

Var. θ. Pl. 12. figs. *i*, *k*. Keelless, slightly rowelled, ribbed, and umbonate. Like the last, but rowelled.

Var. ι. Pl. 13. figs. *a*, *b*. Keeled, slightly rowelled, bead-ribbed, the granulate septal lines meeting at the umbo. An ornamented variety like vars. γ and δ, but smaller.

Var. κ. Pl. 13. figs. *c*, *d*. "Recent: Mediterranean." Keel slight, with some teeth; ribs faint; no umbo; chambers narrow. A variety of *C. Calcar*, faintly developed as to its several features.

Var. λ. Pl. 13. figs. *e–g*. "Fossil: Coroncina." Slightly keeled, faintly ribbed, umbonate; chambers large. A variety of *C. Calcar*, with large-sized chambers.

Var. μ. Pl. 13. figs. *h*, *i* (*k*, *l*, section). "Recent: Mediterranean. Fossil: Coroncina." Sharply rowelled, faintly ribbed, largely umbonate. The exogenous shell-substance in this variety of *C. Calcar* forms long sharp keel-teeth, and a large umbo.

Cristellaria Calcar, of a symmetrical but limited growth, occurs early in the Secondary deposits, and is often abundant in the clays of the Upper Trias, Lias, Oolites, Gault, and Chalk.

In the Tertiaries it is also abundant, and frequently attains a larger size, and puts on a bolder form of growth. In the recent state it is world-wide,—localities for large specimens being the Canaries, Mediterranean (especially the Adriatic), Norway coast, and the Abrolhos Bank. Bailey has figured it of a large size from the coasts of the United States.

17. Nautilus papillosus. Page 82, pl. 14. figs. *a–c.* "Recent: Adriatic." An elegant variety of *Cristellaria Calcar*, with a small keel and beaded septal lines. It is thick, and has many chambers.

18. Nautilus Vortex. Page 33, pl. 2. figs. *d–i.* "Soldani, Sagg. Oritt. p. 99, pl. 1. fig. 12; Testaceogr. vol. i. p. 66, pl. 59. fig. *t t.*" "Fossil: Coroncina." This is a keelless, thick variety of *Cristellaria Calcar*; it has very narrow and much-curved chambers, the septal lines taking a long, curved sweep to reach the margin. There are many gradual intermediate forms between this and the type. It is not unfrequent in clays of the Mediterranean, at about the depth of 90 fathoms; and it occurs fossil in the Tertiary clays of Tuscany, Vienna, and Malaga.

D'Orbigny has given two figures of this variety: that of his *Robulina orbicularis*, Annales Sc. Nat. vol. vii. p. 288, No. 2. pl. 6. figs. 8, 9; and that of his *R. Imperatoria*, For. Foss. Vien. p. 104, pl. 5. figs. 5, 6. The former differs from *Cristellaria Vortex* in having a slight keel, in not being quite so thick, and in being somewhat umbonate. *R. Imperatoria*, having the same amount of keel as *R. orbicularis*, is less gibbous, but more distinctly umbonate than the latter. These slight and almost insensible degrees of modification render the three shells here referred to notable examples of the gradual passage so often recognizable between varietal forms of species. The roundness and plumpness of *Cristellaria Vortex* is modified to the lenticular and comparatively lean *C. Imperatoria*, having markedly contracted chambers (the narrowest of any *Cristellaria*) and a pouting aperture, which is lost in the greater fulness of the chambers of *C. Vortex* and *C. orbicularis*. Full-sized and entire-keeled specimens of *C. Vortex*, supplying still further intermedia, are figured by Soldani.

19. Nautilus costatus. Page 47, pl. 4. figs. *g, h.* "Recent: Mediterranean, Coast of Africa." A *Cristellaria*, more or less keeled; the keel is somewhat toothed; the septal lines are raised or limbate,—a character which, however, is absent in D'Orbigny's figured specimen of a similar variety from the Tertiary beds of Vienna (*Robulina Ariminensis*, For. Foss. Vien. pl. 4. figs. 8, 9); the chamber-walls are regularly marked with numerous ribs at right angles to the septal lines. In this variety of *C. Calcar* (which is not of common occurrence, but sometimes met with in

deposits rich in *Cristellariæ*) we have the link with the Marginuline variety of *Nodosaria Raphanus*, especially in the Viennese specimen, which is narrow-chambered, pinched, and umbilicate, like the crozier-part of a *Marginulina*. This linking is not only shown by the form, the aperture, and the general structure of the shell, but markedly in the style of ornament. The ornamentation of ribs is highly characteristic of the Nodosarine group. In *Nodosariæ* the riblets are often fully and symmetrically developed; in some *Marginulinæ* the rib on the convex border surpasses its fellows; in *Cristellariæ* it is often the only remnant of these ribs; but in some varieties, as in *Robulina echinata*, D'Orb., *R. ornata*, D'Orb., and especially in *R. Ariminensis* and Fichtel's *Nautilus costatus*, the rib-ornament still bears evidence of the relationship mutually borne by these diversely modified forms. Hence one of the grounds for the foundation of the comprehensive genus *Nodosarina**, intended by us to embrace the *Nodosariæ*, *Cristellariæ*, and all the intermediate and associated varieties. Indeed, we see as yet no essential characters in this protean group whereby more than one real species can be established, although we have examined thousands of forms, not to say individuals, from the Permian, Triassic, Liassic, Oolitic, Cretaceous, and Tertiary deposits, as well as from deep and shallow seas of all parts of the world.

20. Nautilus acut-auricularis. Page 102, pl. 18. figs. *g–i*. "Recent: zoophytic concretions, Mediterranean." A subglobose or ovoid *Cristellaria*, with numerous smooth, narrow, flush chambers, slightly keeled. This is a variety intermediate between *C. Calcar* and Defrance's *Saracenaria Italica*. It is also nearly related to *C. arcuata*, D'Orb. (For. Foss. Vien. pl. 3. figs. 34–36). This appears to be a rather rare and small form. Fichtel and Moll's reference to Soldani, Testaceogr. vol. i. p. 61, pl. 49. fig. *x*, for this form, is correct.

21. Nautilus Crepidula. Page 107, pl. 19. figs. *g–i*. "Recent: Leghorn coast." A delicate, elongate, Marginuline, flattened *Cristellaria*. This variety, which by innumerable linkings passes into *C. Calcar*, is so readily modified by external conditions as perhaps not to be represented by any two perfectly similar individuals. D'Orbigny's *C. cymboides* (For. Foss. Vien. pl. 3. figs. 30, 31) is almost an exact counterpart of Fichtel's figure; but in the former the coil is more open. *C. compressa*, D'Orb. (*loc. cit.* figs. 32, 33), and *C. lanceolata*, D'Orb. (*l. c.* figs. 41, 42), as well as Montfort's "Astacole crepidule," which is Blainville's and Defrance's "Crepiduline astacole" (Dict. Sc. nat. pl. 19. fig. 8), are similar attenuate, but keeled, varieties of *Cristellaria Calcar*.

* Annals, 1859, iii. p. 477.

Cristellaria Crepidula runs insensibly into *C. Cassis* on one hand, and on the other into the Planularian section of the *Vaginulinæ*. It is common wherever *Cristellariæ* are abundant, whether in the fossil or recent state. The specimen figured by Soldani (Testaceogr. vol. i. p. 64, pl. 58. fig. *b b*) is very similar to *N. Crepidula*, as Fichtel and Moll supposed.

22. Nautilus Cassis. Page 95. Five varieties. "Fossil: Coroncina."

a. Pl. 17. figs. *a–d*. Plancus, Conch. p. 120, pl. 1. fig. 11 Q R.
β. Pl. 17. figs. *e–g*. Soldani, Oritt. p. 97, pl. 1. fig. 1 A B C.
γ. Pl. 17. figs. *h, i*.
δ. Pl. 17. figs. *k, l*. Soldani, Testaceogr. vol. i. p. 63, pl. 55. fig. A.
ε. Pl. 18. figs. *a–c*.

We have here some modifications of a varietal form of *Cristellaria*, discoidal and foliaceous, apt to be ornamented by clear granules at the centre and along the septal lines, and to expand itself into a broad and serrate keel.

Individuals of this variety are often pre-eminent among *Cristellariæ* for their size and elegance. Their sinuous and, as it were, loosely-set chambers, their flatness, and the irregular position of the aperture, remove them but a little way from the typical *C. Calcar*. In the var. *ε* the aperture is so nearly central that the chambers grow saddle-shaped, and present us with the essential characteristic of *Flabellina*. Hence the removal of another supposed "generic" limit,—nay, of a "specific" boundary.

Cristellariæ of this shape and size occur in the Italian Subapennine Tertiaries, and also at Malaga in Spain. Individuals of smaller growth abound in some Secondary and Tertiary deposits, and also in recent seas. In the muds dredged off the Abrolhos Bank, in about 30 fathoms water*, we have similar *Cristellariæ*, almost rivalling the Subapennine specimens.

Besides the references to Soldani and Plancus above noted, Fichtel and Moll refer with justice to Soldani (Testaceogr. vol. i. p. 63, pl. 55. figs. A–G, and pl. 56. figs. H–N) for figures of various forms of *Cristellaria Cassis*.

23. Nautilus Galea. Page 100, pl. 18. figs. *d–f*. "Fossil: Coroncina." This is a fine, outspread, extremely flattened, smooth, and broad-keeled *Cristellaria Cassis*, with very widely transverse chambers, the inner extremities of which stretch beyond the spire. In this feature we have an interesting isomorphism, if we may so term it, with other and not related generic forms. This individual, with its attempt at cycloid growth, reminds us of the *Peneroplis planatus*, in its broadest forms, out-

* By Capt. Richards, H.M.S. 'Plumper.'

grown from their short, thick, Dendritine type; and also of that peculiar variety of *Vertebralina striata* in which the later chambers curve round and embrace the earlier spiral portion (*Renulites opercularis*); nor is the mode of growth essentially different in *Orbiculina*, which shows this tendency in *O. adunca* and its varieties, and becomes perfectly cyclical in some individuals,—a feature which is the typical character in *Orbitolites*.

[To be continued.]

XI.—*Note on the Comparative Size of Marine Mollusca in various Latitudes of the European Seas.* By R. M'Andrew, F.R.S.

In the 'Natural History of the European Seas,' by the late Prof. Edward Forbes, edited and continued by Mr. Godwin-Austen, I meet with the following passage, treating of the shells of Piedmont:—"'It is remarkable,' says Mr. Jeffreys, 'that examples of the same species are smaller than those found in the British seas: *Tellina balaustina*, *Jeffreysia diaphana*, and *Rissoa pulcherrima* are instances of this.' The diminution in size which is to be observed with respect to many other species, such as *Corbula nucleus*, when traced from north to south, is the more remarkable because the converse does not take place as to southern forms in their range north. *Haliotis tuberculata*, which extends through the whole Lusitanian zone, is larger at Guernsey, which is the extreme northern limit, than elsewhere. *Ringicula auriculata* and *Mactra rugosa* are larger in Vigo Bay than in the Mediterranean, though at Vigo they are both outliers; and *Tellina balaustina*, which has its numerical maximum in the Mediterranean, is largest about the Hebrides."

I do not question the correctness of Mr. Jeffreys's remark applied to the shells collected by him on the coast of Piedmont; but to infer from it, and from the other instances cited by Mr. Austen, that Mollusca generally, or any large proportion of them, whether belonging to northern or southern latitudes, increase in size as they advance northward, and none in a southerly direction, is a grave error, which I feel called upon to dissipate, as far as this end can be accomplished, by a statement of the results of my own experience bearing upon the point; because, in order to advance our knowledge, I look upon it as more essential to get rid of existing fallacies than even to establish new facts.

Corbula nucleus diminishes in size when traced *northward* as well as southward from the British seas, and is as large at Lisbon, or even at Malaga, as upon the shores of North Drontheim.

The size attained by *Haliotis tuberculata* in Guernsey is certainly remarkable; but that it is not owing entirely, if at all, to northern position, may be inferred from the fact that it does not vary in dimensions progressively with the latitude. When inhabiting the coasts of the Bay of Biscay, it is no larger than in the neighbourhood of Gibraltar.

With respect to the *Ringicula* of Vigo, it is questionable whether it is the same species as *R. auriculata* of the Mediterranean, as, in addition to its extra size and solidity, it differs in being destitute of striæ, with which the other is furnished; and Mr. Woodward has suggested the possibility of its identity with a fossil species. If it *should* prove to be *R. auriculata,* the same observation will apply to it as to the *Haliotis,* that the increase in size is not progressive.

Touching *Mactra rugosa,* we require more information with regard to its distribution. In Vigo Bay, dead shells, certainly of large dimensions, are not unfrequent; but, after diligent search, I could never succeed in obtaining a recent specimen there. The other localities from which I have procured the species are Faro in Algarve and Cadiz; one or two stray valves in the Mediterranean, and the same at Mogador. In Faro, where the specimens found on the shore are much more recent than in Vigo, they are nearly, if not quite, as large; while at Cadiz, only thirty miles further south, they are smallest.

The Arctic species belonging to the genera *Trichotropis, Trophon, Margarita,* and *Admete,* with some others, when they extend into the Boreal and Celtic regions, are diminutive. *Pecten Icelandicus* attains its largest dimensions on the coast of Finmark, and is of very diminished size and solidity from Spitzbergen. *Margarita alabastrum* (Boreal) does not appear to vary in size from the North Cape to the seas of Zetland. *Arca raridentata* is generally distributed on the northern coasts of Norway, where it is very much larger than in the Hebrides; and a few specimens which I have obtained as far south as Gibraltar are still more minute. This species inhabits only deep water, which accounts for the extent of its range southward.

Trochus cinerarius and *T. tumidus* have their greatest development in number and size on the northern coasts of Norway, and are found progressively and uniformly smaller as we proceed southward. *Trochus lineatus,* which I have never encountered north of the British Isles, attains its largest dimensions in the neighbourhood of Vigo.

Astarte arctica is as large at Tromsoe, near the southern limit of its range, as in higher latitudes. *A. elliptica* diminishes when traced from Finmark to its southern termination in the British seas. *A. sulcata* attains its maximum on our own coasts, dimi-

nishing in size and frequency as we follow it along the coasts of Nordland and Finmark, as well as to Gibraltar, its most southern locality. The little *A. triangularis* I did not find in northern Scandinavia: it is extremely abundant in some parts of the Hebrides; but, though rare, is of larger size in Gibraltar Bay than I have met with it elsewhere. I take this opportunity of mentioning that I have recorded this species from the Canary Islands; but Mr. Searles Wood, to whom I showed them, believes the Canary specimens (smaller even than the British) to be a different species, and identical with a Crag fossil. *A. incrassata,* a more southern species, is rather larger in the Canaries than in the Mediterranean.

The genus *Crenella* is analogous to that of *Astarte. C. discors* and *C. decussata* attain larger growth and are more abundant in the Arctic and Boreal regions than in the Celtic. *C. marmorata,* which ranges from Finmark to the Canaries, is largest and most frequent on the Scottish coast; while the more southern form, *C. rhombea,* is rather larger in the Canaries and Mediterranean than at the northern limit of its range in the British Channel. So with the genera *Nucula* and *Cardium*; *N. lævis, C. suecicum,* and *C. fasciatum* become smaller as we follow them southward from their principal habitat in northern Scandinavia. *N. nucleus* is as large at Gibraltar as in Finmark, being eminently a Celtic species; while of *N. decussata* my largest specimens are from Malaga; and *C. rusticum* becomes larger as we proceed south from the British Channel, attains its maximum at Gibraltar, and is smallest in the Canaries. *C. papillosum* is also largest in the Mediterranean, though distributed both northward and southward in the Atlantic. *C. pygmæum* is smaller in the Mediterranean than in Britain, but I have obtained it largest in Vigo Bay.

Venus verrucosa, like *Cardium rusticum,* has its northern limit in Britain, increases in size southward to Gibraltar and the Mediterranean, and is again much smaller in the Canaries. *Mactra stultorum* grows to larger size in Minorca than in Britain. Of *Fusus antiquus,* ranging to within the Arctic Circle, the largest specimens have been obtained in Liverpool Bay. *Littorina rudis* attains as large growth upon the coast of the north of Spain as upon that of Finmark. *Scalaria Turtonis* is larger in Britain than in the Mediterranean or at Madeira. *S. communis,* on the contrary, is larger at Gibraltar than in England.

Bulla hydatis is very diminutive in the Mediterranean compared with British specimens; but those from Vigo (situated south of the shores of Piedmont) are fully equal in size to the British or Irish.

Murex erinaceus grows larger upon the coasts of Spain, both north and south, than in Britain. *Cerithium reticulatum* and

C. perversum are likewise larger in the Mediterranean than in our seas. *Triton nodosum* attains greater size at Malaga than at Vigo or further north, but is smallest in the Azores. *Aclis supranitida* grows larger at Madeira than in Britain.

The southern forms of Mollusca appear to follow the same rule as the more northern. *Murex brandaris, Cypræa lurida,* and *C. spurca,* not recorded to have been found north of the Mediterranean, attain larger dimensions in the Canary Islands than in that sea.

There are a few species the larger growth of which appears to be influenced by western longitude or Atlantic exposure. It has been remarked that *Tellina balaustina* is found larger in the Hebrides and on the west of Ireland than in the Mediterranean, where it is much more frequent. I have obtained it at Gibraltar of intermediate size; and a valve dredged off Cape Finisterre in Spain was of the same size as the Scottish and Irish specimens. *Lucina spinifera* is found larger in the Hebrides and west of Ireland than elsewhere; upon the coast of North Drontheim it is quite as small as upon that of Spain. *Solen siliqua, Lutraria elliptica,* and some other species, are found of extraordinary dimensions in the outer Hebrides; several others attain larger growth in Bantry Bay than on any part of the English coast.

From the examples I have stated (and there would be no difficulty in adducing more of a similar character) I think we may fairly come to the conclusion, that, although there are exceptions in both directions, and although the size attained by Mollusca may be influenced by various conditions in different localities, as a general rule, each species attains its greatest size, as well as greatest number, in the latitude best suited to its general development; and that, whether a species be Arctic, Boreal, Celtic, or Lusitanian, it will grow largest in the region to which it belongs.

XII.—*On some new* Longicornia *from the Moluccas.*

By Francis P. Pascoe, F.L.S. &c.

In Mr. Wallace's last collection from Batchian, in the Moluccas, there are about one hundred and fifty Longicorns, mostly new to science, but referable (with two or three exceptions) to genera which appear to be more or less frequent in the Indian Islands. The new forms, one of which resembles the South American genus *Onychocerus* in habit, and of which a second species is found in New Guinea (Aru), are confined to Mr. Wallace's private collection, and therefore, unfortunately, cannot now be described; but amongst the others there are a few species which are interesting either as indicating a more extended range of the

genera (as in *Glaucytes, Agnia,* and *Cylindropomus*), or as additional members in very limited and remarkable groups, as *Eurycephalus* and *Trihammatus.*

Eurycephalus.

Laporte, An. Art. ii. p. 430.

Eurycephalus variabilis.

E. ater; elytris rugosis, basi plus minusve sanguineis.

Deep black, the upper surface covered with very short erect hairs; head rather broad, thickly punctured; ridge over the insertion of the antennæ, parts about the mouth, and mandibles, except at the apex, blood-red; prothorax coarsely and very thickly punctured, with a short central keel, and a strong tooth on each side, placed behind the middle; elytra irregular, as if roughly punctured, apparently caused by the inequality of the pubescence, the base or base and sides more or less of a blood-red colour; body beneath dull black. Length 10 lines.

Of fifteen specimens examined, no two were quite alike in colour; one was entirely black, and another had rather more than half the elytra red; these were the extremes of the set; and amongst the whole, three had the legs pale red.

Glaucytes.

Thomson, Archives Entomologiques, i. p. 423. *Leptocera,* Serville, *non* Schönherr.

Glaucytes scitulus.

G. niger; prothorace impunctato capiteque griseo-pubescentibus, sericeis; elytris chalybeatis, biapiculatis, maculis quatuor argenteo-albis; femoribus basi testaceis.

Black; head, prothorax, body beneath, and legs covered with a thin, silky, pale greyish pubescence; elytra biapiculate, irregularly punctured, smooth, each with four spots formed of short white hairs, the first before the middle, the second obliquely transverse behind it, then a small round spot, and lastly an oblong one at the apex; prothorax impunctate, rounded at the side; antennæ rather longer than the body, reddish brown; femora at the base testaceous. Length 5 lines.

Agnia.

Newman, Entomol. p. 291.

Agnia eximia.

A. nigra, nitida; capite elytrisque albo-maculatis; prothorace postice

albo-marginato: infra subnitida, marginibus segmentorum abdominis albis.

Deep glossy black; line below the eye, another behind, and one on the vertex, posterior border of the prothorax, scutellum, and several transverse spots on the elytra, pure white (formed by dense patches of short hairs); body beneath and legs black, less glossy than on the upper surface, sparingly covered with a delicate ashy pubescence; margins of the abdominal segments white. Length 10 lines.

This handsome insect is nearly allied to the Philippine *Agnia clara*. *Agnia* differs from *Cereopsius*, principally, in its unarmed prothorax.

TRIHAMMATUS.

Chevrolat, Rev. et Mag. de Zool. No. 2. 1857.

Trihammatus tristis.

T. niger, nitidus, subtiliter griseo-pubescens; prothoracis margine antico et vitta suboculari, lateribusque pectoris infra albis; elytris maculis quatuor atris.

Glossy black, covered with a short, dense, greyish pubescence, giving the upper surface a dull leaden hue; head sulcated in front, an oblique yellowish white band beneath the eye, which is continued along the sides of the thorax beneath; prothorax strongly spined on the side, the anterior margin narrowly bordered with yellowish white; scutellum triangular, truncated posteriorly; elytra thickly and irregularly punctured, with several small shining tubercles at the base, and two opake deep-black irregular spots on each (one before, the other behind the middle); antennæ (♂) twice as long as the body. Length 12 lines.

The females of this genus (which have not been hitherto described) differ essentially from the males in the *fourth* joint of the antennæ, only, being enlarged; and this enlargement assumes a cylindrical form, not rounded or pear-shaped, as in the other sex.

CYLINDROPOMUS.

Blanchard, Voyage au Pôle Sud, iv. p. 268.

Cylindropomus grammicus.

C. niger; prothorace utrinque vittis duabus albis; elytris fuscescentibus, lineis duabus longitudinalibus, antice posticeque conjunctis, albis.

Dull black; head broader than the prothorax, impunctate, minutely pubescent, a raised line on the vertex and an oblong

white spot behind the eye; prothorax slightly corrugated in the centre, a broad yellowish-white line on each side and a narrower one beneath; scutellum transverse, black; elytra acuminate, finely punctured, pale brown, with two longitudinal whitish lines on each, united at the shoulder and apex; antennæ and legs pitchy, the former nearly three times the length of the body, the femora reddish at the base; body beneath with a greyish pile. Length 7 lines.

Cylindropomus should, I think, be placed in the Lamiidæ, near *Olenocamptus*, from which, indeed, it scarcely differs. A series of this species shows a very considerable amount of variation in the width of the head: in some it is scarcely wider than the prothorax, and from these it runs up to nearly twice the width.

XIII.—*On the Markings of the Diatomaceæ in common use as Test-objects.* By G. C. Wallich, M.D.

The markings on the valves of certain species of Diatoms have long been prized as tests of the defining and amplifying powers of microscopic lenses. Up to a very recent period they answered every purpose; but the rapid advances achieved of late by our leading opticians in the construction of objectives furnish us with many instances in which the formerly received interpretation of minute organic structure has turned out to be fallacious. These tests have thus been somewhat unduly valued, and, as a natural consequence, many indifferent objectives have been thrust on the public, the efficiency of which depended, not on accuracy of construction, but on the variable nature of the tests they were subjected to.

Accuracy of measurement is of the first importance in all microscopic investigations, whether we desire to measure the striæ on a Diatom, the thickness of a cell-wall, a blood-disk, or any of the numberless objects the microscope reveals to us; and until this perfect accuracy is ensured, it is almost needless to say that a vast amount of time and patient labour will be expended in vain.

As an example in point, we need only take the value of *Pleurosigma fasciola*, a Diatom which was considered, until a very late date, as one of the severest tests for a first-rate $\frac{1}{8}$ or $\frac{1}{12}$ objective. It is true that *P. fasciola*, under certain restrictions, may be made an admirable test; but it is one adapted with equal propriety to test either a $\frac{1}{2}$ or a $\frac{1}{12}$ objective. This is due to the widely varying character of its lineation,—a fact of which the less scrupulous class of opticians were not slow to avail

themselves, in order to arrogate for their workmanship a degree of excellence it in nowise merited.

It should be borne in mind that the mere number of lines in any given fractional portion of an inch is not all that is required in a Diatom employed as a test. Much depends on the particular conformation of the Diatomaceous valve—on its thickness, flatness, the angularity of its markings, their direction, the kind of illumination, and so forth. But this only tends still further to diminish the value of such objects as tests, inasmuch as the same form, under different conditions, may or may not be suited to test a given combination.

It is not my province to discuss how much valuable time is often wasted in the endeavour to resolve markings on Diatoms or other minute objects, that might be applied to higher and far more useful purposes. It is well known that many ardent observers labour, for days and even weeks together, in order to conquer some difficulty of the kind,—their toil ending in failure simply because they are unaware that the same species of test-Diatom may present itself under such modifications as to baffle all attempts at resolution in one shape, whilst it may be made to yield readily in another. At present the capabilities of lenses have, too frequently, to be discovered after purchase. They may or they may not come up to the professed standard. The owner may apply an incorrect or an insufficient kind of test; and, under any circumstances, he is unable positively to assure himself of the real power of the apparatus he is using.

Certain Diatoms may still be advantageously employed as test-objects, but assuredly not in the manner hitherto in vogue. In order to ensure uniformity, or, what amounts to the same thing, in order to ensure the purchaser of a lens of a stated power actually obtaining what he desires, it becomes essential that each test-slide should itself be compared with some accredited and universal standard, before being applied to the decision of the capabilities of any optical combination.

I shall endeavour presently to show how likely we are to be misled in our estimate of lenses based upon the resolution of some of the ordinary tests, by giving a tabular statement of the range of lineation admitted to exist by those who have given the greatest amount of attention to the markings on the various test-Diatoms. In dwelling on this topic I have an important purpose in view, namely, the introduction of a definite and uniform standard test, for each grade of objective, in lieu of the indefinite and variable ones that have heretofore been in use.

M. Nobert's test-glasses at once suggest themselves to our notice as likely to afford the requisite standard. We have here a degree of minute workmanship destined for ever to defy the

unaided eye, and demanding the highest of our optical aids to render its nature manifest. These glasses have certainly met with little encouragement in this country; but this depends on no fundamental error either in M. Nobert's principle or his handiwork, but on a minor defect, which will, without doubt, be speedily overcome. I allude to the difficulty of engraving the different series of lines on slips of glass sufficiently thin to admit of their employment under the highest and most delicately adjusted combinations of the microscope. It is universally allowed that the accuracy of the lineation cannot be surpassed, the last and closest series of lines being as regular and distinctly ruled as the first or most distant. The difficulty can hardly be overcome, however, until a separate slip of glass is devoted to each two of the first five or six series, and each one of the remaining number. This would, of course, enhance the cost to a considerable extent; but a truly effective standard would be the result, and we should establish a check upon the fallacious test-objects hitherto resorted to. It must be evident that the more perfect our instruments become, the more urgent is the requirement for an undeviating standard of comparison. When this is known to exist, purchasers of lenses will be provided with a safeguard; and, as a necessary consequence, the efforts to produce improved apparatus will be redoubled.

The subjoined Table gives the lineation of some of the commonly employed test-species, according to the authorities noted in the first column. M. Sollitt's measurements, it will be seen, embrace the extreme ranges. The accuracy of his figures is unquestioned, as regards all but the two last-named forms on the list; and in these it has met with scepticism solely from

Tabular Statement of Lineation in 1000*th of an inch.*

Authorities.	Pleurosigma angulatum.	Pleurosigma fasciola.	Pleurosigma quadratum.	Pleurosigma formosum.	Pleurosigma balticum.	Pleurosigma hippocampus.	Pleurosigma strigosum.	Navicula acus.	Navicula rhomboides.
The 'Synopsis of Brit. Diatomaceæ.'	52	64	45	36	38	Lo. 32 Tr. 40	44		
Carpenter*.....	52	64	...	...	...	Lo. 30 Tr. 40	44	...	85
Micrographic Dictionary.	52	64	45	36	38	Lo. 30 Tr. 40	45	125·130	85
Sollitt†	46·51	50·90	35·60	20·32	20·40	40·45	40·80	120·130	60·111

* 'The Microscope,' by Prof. Carpenter, p. 205.

† Quarterly Journal Microscop. Science, No. 29, p. 51.

the extreme difficulty of counting lines so delicate, even granting them to be visible under the lens. Accepting the measurements as approximately correct, it is apparent that a series of markings, the variation of which, in the several species, ranges from about 5 to 50 per cent., ought no longer to be received as affording standard tests or specific characters.

I have stated that the hitherto received interpretation of various structures, as seen under the microscope, has in many cases turned out to be inaccurate, owing to the improved means of observation at our command. I would draw attention more especially to one of the most valuable, inasmuch as it is the most constant in its lineation, of all our test-Diatoms, viz. *P. angulatum*. It is well known that, under the generally adopted view, the markings consist of hexagonal *depressions* on the surface of the valve. Not only has this interpretation been insisted on by all our chief authorities, but its accuracy has been made to appear unimpeachable on the evidence afforded by a photographic image. Facts are stubborn things to contend against; and in an endeavour to correct an impression based on such apparently incontrovertible testimony I am painfully aware that I have a hazardous task to perform.

Professor Carpenter ('The Microscope,' p. 304) writes as follows:—

"In the first place it may be remarked, that there is a much greater uniformity in the general character of these markings than was supposed when attention was first directed towards them; for what were at first supposed to be *lines* are now resolved by objectives of large angular aperture into *rows of dots*; and these dots, when sufficiently magnified, are found to bear a close resemblance to the coarser markings on the larger species. It is to the latter, therefore, that we should have recourse for the determination of the nature of these markings; and we cannot resort to better illustrations than those that are afforded by *Isthmia*, *Triceratium*, and *Biddulphia*, in all of which the structure of the valve can be distinctly seen under a low magnifying power, and with ordinary light." After proceeding to show that the markings, in each of these instances, consist of a number of areolar depressions, he continues: "Now, it would not be difficult to bring together a connected series of Diatomaceæ in which the markings, still exhibiting the same general aspect, become more and more minute, requiring for their resolution the use of oblique light, or stops with a central diaphragm, and of objectives of larger and larger angular aperture, until we come to those species which present the greatest difficulty, and the nature of whose markings seems to be most obscure. The more perfectly these markings are defined, however, in any

case, the more decidedly are they found to correspond with what has been already seen. Thus, if we examine *Pleurosigma angulatum* (one of the easier tests) with an objective of $\frac{1}{4}$ inch focus and 75° aperture, we shall see a double series of interrupted lines, crossing each other at an angle of 60°, so as to have between them imperfectly defined lozenge-shaped spaces. When, however, the valve is examined with an objective of $\frac{1}{12}$ inch focus, having an angular aperture of 130°, and is illuminated by oblique rays, the hexagonal areolation becomes very distinct; and if a photographic representation obtained by such a power be itself enlarged by photography, as has been accomplished by Mr. Wenham, the appearance represented (by the diagram, *loc. cit.*) is obtained, which is in all respects comparable with that presented under a low power by the valve of *Triceratium* or *Isthmia.*"

In the 'Micrographic Dictionary' we find observations nearly to the same effect. But a remarkable paragraph occurs at page 221 (new ed.), in the article "Diatomaceæ." After denoting the varying phases a Diatomaceous valve may be made to assume under different powers and modes of illumination, it thus concludes:—"If the condenser and stop be not exactly centrical, or the surface of the valve be not flat, the true form of the dots will be replaced by some other: thus hexagonal dots may be made to appear triangular, quadrangular, &c., and those dots which cannot be conceived to be really hexagonal may be made to appear so,"—*Pleurosigma balticum* being here referred to amongst the figures.

I duly appreciate the difficulty of having to deal with statements supported by such unquestionably high authority,—more particularly when they seem to carry with them the proof derived from the photographic art. But the latter testimony appears to me by far the most assailable, and I have adduced the paragraph just quoted in support of my assertion. For if, by modification in the focussing of a valve, hexagonal dots may be made to appear triangular or quadrangular, and those dots which cannot be conceived to be really hexagonal may be made to appear so, it follows that by similar modification under the photographic appendage to the microscope, these figures may be respectively reproduced according to the fancy of the operator.

Although the evidence derived from a photographic picture may safely be relied on under ordinary circumstances, it at once loses its value in the case before us, the image thrown on the prepared plate or paper being of necessity identical with that impressed upon the eye of the observer when adjusting the object to be depicted, and whatever he sees being, as a matter of course, reproduced in the photographic picture.