NOTES ON THE RADULA OF THE NERITIDAE.

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Introduction

This study began with an attempt to ascertain the systematic position of two species of Neritidae, *Nerita tessellata* and *Neritina virginea reclivata,* collected by the University of Michigan-Williamson Expedition in Venezuela (1920). Besides these two species, about fifty others were examined from "dried-in" and preserved animals in The Academy of Natural Sciences of Philadelphia, which were generously put at my disposal by Dr. Henry A. Pilsbry, to whom I am also very much indebted for assistance and criticism. My thanks are also due to Mr. E. G. Vanatta, and Dr. C. M. Cook, for constant advice and help. The preparation of the radulae and their study was carried on at the Zoölogical Laboratory of the University of Pennsylvania.

A. The Rhipidoglossate Radula.

I. General discussion.

The radula of the ideal progenitor of the Rhipidoglossa would appear to be a type in which each of the transverse rows consisted of quite similar, ligulate teeth, standing almost vertically on the basement membrane, and with reflected and well-cusped, distal ends. Such a radula is approximated, to a certain degree, by that of *Zyzyphinus canaliculatus* Troschel (1866–1882, xxiv–17).

However, very early, the central teeth must have tended to become somewhat differentiated from the remainder, either by enlargement (compare *Cyclostrema trochoides* Troschel; xxi–4), or by changes in form (compare *Phasianella kochii* Troschel; xviii–11.) The number of teeth in this central field varies slightly in the different groups, but 11 is the most common number, and is that characteristic of the generalized members of the Helicinidae and the Neritidae.

But, the greatest point of adaptive stress in the radula of the Rhipidoglossa appears to be near the outside edges of this central field, rather than at the very center. Thus, coincident with the

general modification of the middle teeth, comes a marked tendency for the ones nearest the marginals to become variously enlarged and specialized. The beginning of this tendency is well illustrated by *Delphinula atrata* Troschel (xxi–8). Although the numbers of these "laterals" is also variable, the presence of two on each side (the 4th and 5th from the center) appears to be very common, and is the primitive arrangement in the Gymnopoda. We now get a radula with a central group of 7 teeth, and, on each side, a lateral group of two teeth and a marginal group of primitive uncini.

The commonest trend of modification beyond this point, at least in the Gymnopoda, seems to be the increase of specialization in the lateral groups, and the reduction of the central field, while the marginal fields are comparatively slow to change. Thus, in the Helicinidæ and the Neritidæ, at least two of the central teeth are comparatively small, while, in the Neritopsidæ and the Neritilinæ, the rhachidian central has disappeared. In most of the families of Gymnopoda, the lateral or capituliform complexes are very large, closely knit together, and highly specialized.

It may not be out of place to include here a brief discussion of the terminology of the molluscan radula. Custom has sanctioned the general terms,—centrals, laterals and marginals; but practically nothing is known of the actual homologies of the teeth in different groups. For example, an attempt to homologize any group of teeth in the Rhipidoglossa with those of the Pulmonata would be at present extremely futile. As a result, this paper will use these terms simply to indicate relative position in the radula and not the hypothetical origin of the teeth.

In the Helicinidæ (1922), I used the terms: unpaired central for the rhachidian tooth; A, B and C centrals for the 1st, 2nd and 3rd teeth on each side; comb-lateral or T-lateral for the 4th tooth; accessory plate for the 5th; and then numbered the marginals in order from the inside out. In the Neritidae, it is the 5th and not the 4th tooth that develops the T-shape, so, in the present paper, I will continue the letters (D, E) to the 5th tooth. The following table shows some of the terms applied to these teeth:

R-central	= rhachidian central; unpaired central (Fischer 1885); middle-plate (Troschel, 1866–1882); central.
A-plate	= A-central; 1st paired central; 2nd central (Fischer); 1st "between"-plate (Troschel); "wing"-plate (von Martens, 1879); 1st lateral.

A-, B-, C-plates	= A-, B-, C-centrals; paired centrals (Fischer); "between"-plates (Troschel); laterals.
D-plate	= D-lateral; comb-lateral or T-lateral (Helicinidae).
E-plate	= E-lateral; accessory plate (Helicinidae).
D-, E-, plates	= capituliform tooth (Fischer), or complex; lateral (Fischer), or laterals; inner lateral, "hat-edge," or "mushroom"-plate (Troschel); "umbrella"-plate (von Martens).
Uncini	= marginals; lateral lamellae or lamellae of the outer lateral (Troschel); border-teeth (von Martens).

II. THE NERITID RADULA.

The radula of *Neritina virginea reclivata* (Say) (Plate IX, figs. 1, 2, 3) is a good example of the most primitive type in the family Neritidae. It consists of about 150 transverse rows, of which only about 90 are definitely formed. From the very large number of partially formed, nascent rows, the teeth of the Neritidae would appear to go through a very long hardening and "enameling" process, after they are first laid down. The E-laterals and A-centrals of adjacent rows appear to be actually fused together by this process.

Each transverse row (Plate IX, fig. 1) is made up of an unpaired R-central; and, on each side: a broad A-central, vestigial or reduced B and C centrals, a capituliform complex in which the D and E laterals are very closely associated or fused, and a large number of ligulate uncini. The rows are roughly the shape of a letter W (inverted), with the A-centrals forming the inner arms; the B and C centrals, the anterior points; and the laterals and uncini,—the outer arms.

The R-central (fig. 2) is roughly quadrate in outline, although rounded at the posterior end.[1] Its base (A) has the shape of an hour-glass, except that the anterior end is much broader than the posterior. On either side of this central base are thinner wings (B), which are inclined upward and outward, so as to rest on the inner ends of the A-centrals. The anterior end of the tooth (C) slopes obliquely upward and anteriad toward the broad, anterior edge; this overhanging portion gives the effect of a transparent half-

[1] All directions and dimensions of the teeth are given in terms of the entire radula, in position in the animal.

ellipse, just inside of the anterior border. The highest portion of the plate (the upper area of other groups) is in the form of a heavy rim or cusp (D), across the anterior side and a short distance down along the lateral edges. The top of this rim lies in a plane almost parallel to that of the basal portion.

The A-central may be regarded as an acute-angled triangle with the acute angle at the inner end, the two long sides forming the anterior and posterior edges, and the base toward the outside. The inner end has a lobe (Plate IX, fig. 2 E), on which rests the R-central. Externad to this is a thickened line (F), that marks the inner end of the body of the A-plate. The anterior edge is considerably thickened and bears a cusp (G) along practically its entire length; the outer end of this cusp is reflected posteriad, but the inner portion is almost vertical, as usually seen. The body (H) of the plate is thinner, but is thickened at both the inner and outer edges, for articulation with the R-central and B-central, respectively. The edges of its basal portion, which is somewhat smaller than the body, can be seen through the upper portion; they are shown by dotted lines in most of the figures. At the outer end of the tooth, is a rounded notch (J) under the cusp; the anterior edge of this notch is continued by a thickened line (K) on the under side of the plate. Into the notch and the roughly triangular cavity under the cusp, fits the inner end of the B-plate. Below the notch, the A-central bears a lobate projection (L), which fits over the basal portion of the B-central. The posterior edge of the A-central is shorter than the anterior one; at the inner end, it forms a thin shelf (M), which extends downward. The posterior lobe and point (N) extends up over the next plate posteriad (compare Plate IX, fig. 1.)

The B and C centrals are greatly reduced and appear to function mainly as two links of a chain, connecting the A-central with the D-lateral. The B-plate has a very thin, ovoid base (O), which fits under the outer edge of the A-plate, and a thickened, irregularly hooked process (P), which fits into the corresponding notch (J) and the triangular cavity on the under side of the A-central. This thickening also bears a notch (Q) at its anterior edge, into which fits the inner cusp of the C-plate, and several indistinct points or cusplets along its posterior border. The outer edge of the basal plate of the B-central fits over the inner portion of the base of the C-central.

The C-central is slightly larger than the B-central. It also has a thin, ovoid base (R), and an irregular, hooked thickening (S). The base fits under both the B-central and the D-lateral, while the inner point of the thickening fits into the corresponding notch, already mentioned (Q). In addition, the latter bears two other strong, irregularly triangular points or cusps.

The D-lateral and the E-lateral are so very closely connected that they are very seldom separated without breaking them. However, in *Neritina virginea reclivata,* they do break apart along certain lines, although in the more specialized forms they are so closely fused as to become practically one piece, which may break apart almost anywhere. As a result, the figure, showing the two separate, represents a more or less hypothetical condition, and it is often difficult to be sure how much is D-lateral and what part is E-lateral. Nevertheless, these studies have convinced me that they are separate entities, and that their general homologies are as indicated in the following pages. Although I have no definite proof to offer, I suspect that they are originally laid down as separate teeth, but are cemented together by the long hardening and "enameling" process, that they certainly undergo before they become functional.

The shape of the D-lateral (Plate IX, fig. 2D) may be roughly compared to a triangle with the apex directed posteriad and forming the base (T). The anterior margin has a marked concavity. On its lower surface, the D-plate shows a very distinct, Y-shaped, thickening (U), which runs across the base and up the inner side. The inner arm of the Y continues up along the inner side of the plate to its inner end, while the outer arm (X) extends diagonally across to the anterior, outer angle of the plate. Near the end, the inner arm bears a prominent process (V) on its outer side, while its inner end is somewhat the shape of a shoe turned upside down (W). Along its inner edge, the D-lateral bears two triangular wings. The smaller of these (Y) is near the posterior end and is directed slightly upward and inward so as to fit against the curve of the lateral complex next posteriad (compare Plate IX, fig. 1). The larger wing (Z) extends slightly downward as well as inward, and appears to help anchor the plate. The base of each D-lateral fits under the E-plate next posteriad (Plate. IX, fig. 1). The D-plate bears no cusps unless the extreme tip (W), which extends beyond the overlapping E-lateral, may be regarded as such.

The E-plate (Plate IX, fig. 2E) is roughly trapezoidal in shape. The basal portion (A) is quite thin, especially where it lies under the D-plate (about the inner third of its breadth). The inner margin of the E-lateral is just short of the inner margin of the D-plate, except near the anterior end, where the former slightly overlaps the latter (Plate IX, fig. 2D, E, B). Just outside of the position of the inner edge of the overlying D-plate, the E-lateral is strongly thickened (C) on the upper side. The posterior point of this thickening overlaps slightly the base of the D-lateral, while the broader anterior end is continued at right angles by a heavier portion parallel to the anterior margin, so that it strengthens the reflected portion (Plate IX, fig. 2E, D). The inner three-quarters of the anterior border of the E-lateral is thickened and reflected (D), so that it turns up over the anterior end of the D-plate and lies on the extremities of the Y-thickening (Plate IX, fig. 2D–W, V, X). This reflected portion bears a heavy, triangular major cusp (E) at its inner end, and a number of smaller cusps on the remainder of its free edge.

The bases of the first uncini are between the outer ends of the E-plates (Plate IX, fig. 1). These inner uncini (Plate IX, fig 2, nos. 1 and 8) are shorter and heavier than those farther out in the series (Plate, IX, fig. 3– 30th), and, as in the Helicinidae, they increase in length and become more slender until beyond the middle of each half-row. Toward the outside, they are of about equal length, but decrease the diameter of the distal portion. The very outermost (Plate IX, fig. 3–63rd) have wide, little reflected distal ends, as in the Helicinidae.

All of the uncini appear to be lighter than those of the Helicinidae. The base of each tooth is comparatively thin and lacks a very definite callus; the inner corner is prolonged into a quite acute point. The body of the tooth is quite regularly ligulate, and extends up almost vertically from the basal membrane. The reflected distal ends or blades are spatulate in shape. The innermost uncini are serrated along the inside of the cutting edge, at the tip and a little down the outside of the blade, so as to form about 14, thin cusplets. These are well defined and sharp, but are not definite, thickened, aculeate cusps, like those of the Helicinidae. On the marginals toward the outside of the radula, the cusplets become much longer, until the outer functional teeth are deeply lacerated on both the outer and inner edges (Plate IX, fig. 3, no. 20 and 30). In the outermost, broad, scale-like uncini (Plate IX, fig. 3, no. 63),

the distal ends are reflected but little, although they bear extremely fine cusplets, at least in all species examined under the oil-immersion objective.

The radula of *Vitta*, just described, may be considered as near the probable ancestral type of those of the living members of the subfamily Neritinae. From it lead three lines of radular development, besides the two isolated genera, *Pseudonerita* and *Neritodryas*. Two of these appear quite closely related and are treated as the genus *Neritina* (Septariae); the third leads into *Theodoxus* (Neritae). Both lines in *Neritina* lead to shell-forms with reduced spire and enlarged aperture.

Neritina (*Neripteron*) is the least changed. The R-central develops a rectangular cusp-like upper area, with an almost transverse, posterior cutting edge. The A-central retains much of its primitive form but is transversely more elongate, and relatively very large. The E-lateral is not greatly changed. The radulae, as well as the shells of the recognized sections, form an almost continuous series.

Vittina has much the same shell-form as *Vitta* but has considerably changed the radula. The R-central has a well marked upper area, while the A-central appears more rectangular and the posterior lobe is more sharply separated from the inner portion of the body. The depression for the reception of the posterior point of the tooth next anteriad is better developed. The inner uncini have longer blades and the cusps are reduced toward the tips.

Neritina s.s. appears to bear about the same relation to *Vittina*, that *Neripteron* does to *Vitta*. The A-central is transversely elongate and comparatively large. The E-lateral is very extensively reflected and the cusps are numerous, but practically vestigial. The blades of the inner uncini are still more elongate and are smooth at the tip. Besides the progressive changes in shell-form, the peg of the operculum is reduced in the section *Neritina* s.s., and is practically absent in *Neritona*.

Septaria carries the changes in the shell and operculum still farther; the latter has lost both rib and peg and is practically vestigial. I suspect that this genus is a continuation of the line of *Neritina* s.s., but have seen no radulae.

The inner marginals of both *Pseudonerita* and *Neritodryas* have rather long blades, which are smooth except for 2 to 4 cusps at the outer base. The E-lateral of *Pseudonerita* has large, conoid cusps

with a gradual change in size in the series instead of a marked major cusp at the inner end. In addition, the uncini are very heavy. *Neritodryas* must be the end-product of a long, divergent evolution. It has a very broad, rectangular R-central, massive A-central and E-lateral, and stout, aculeate, accessory cusps under the blades of the uncini. Both of these genera are very isolated, and do not connect up with any of the lines in *Neritina*.

The third line (Neritae) begins with *Theodoxus* (*Clithon*.) This line greatly increases the relative size of the posterior lobe, as compared to the inner portion of the A-central. The outer slope of the lobe is convexly rounded and the posterior point is usually quite blunt. In addition, the reflection of the E-lateral is heavier, apparently harder, and tends to develop the inner point, so as to make the structure broadly lanceolate in outline as viewed from the anterior end. *Clithon* s.s. is also characterized by the development of a shelly callus between the rib and peg of the operculum.

The only *Alina*-like member of *Clithon* (*Alinoclithon*) occurs in the Hawaiian Islands. It has a heavy black shell with spiral lines and is quite closely related to the peculiar *Neritoclithon*, also from Hawaii. This last section combines the central field of *Clithon* with the marginals of *Theodoxus* s.s., and has many of the shell-characters of *Nerita* (*Heminerita*.)

Theodoxus s.s. reduces the serrations on the inner uncini, also the cusps on the E-lateral and finally the peg of the operculum. *Nerita* terminates the series with practically cuspless E-laterals and long, smooth blades on the inner uncini. Typically it also changes the operculum, and develops striking, although very variable, shell-sculpture. This last characteristic and the deciduous epidermis (chalky shells) can be correlated directly with the habitat.

The subfamily Neritilinae presents the greatest reduction of the central field in the Neritidae. *Neritilia*, the only genus, has lost the R-central, and much reduced what is probably the D-lateral. The A-centrals mask the central field and are very oblique; the uncini balance this almost complete loss of function in the central field by increases in both size and number of the teeth. As Pilsbry (1923) has pointed out, *Lepyrium* Dall (1896) does not belong to the Neritidae or even in the Rhipidoglossa.

The subfamily Smaragdinae is perhaps the most peculiar of any of the groups, although the lateral complex is less changed than in *Neritilia*. Noteworthy are the quadrate A-centrals and the

enormous 1st marginals. Functionally, the radula of *Smaragdia* is 7-toothed; the R-central, the A-centrals, the lateral complexes and the 1st marginals are comparatively well developed, while the other teeth are hidden or practically vestigial. While certainly Neritid in character, it illustrates beautifully how a Taenioglossate type of radula may have developed.

Neritilia has practically lost the apophyses of the operculum, but *Smaragdia* retains the primitive *Vitta*-like type. Thus, changes in the operculum of the Neritidae are usually accompanied by changes in the radula, but the converse of this statement is not true. In other words, changes in the operculum are usually indicative of considerable racial differentiation, but resemblances do not necessarily indicate relationship. The same statement is true of many simple characters of the radula, but the Rhipidoglossate type is complex enough to permit the separation of the divergent lines.

III. COMPARISON WITH THE HELICINID RADULA.

As has already been intimated, the radula of the hypothetical common ancestor of the Neritidae and the Helicinidae may be considered as a type similar to that of *Delphinula atrata* Troschel (xxi–8). It would consist of a more or less quadrate R-central, A-, B- and C-centrals with some resemblance to the primitive uncini, but with most modification toward the center of the series, and large, overlapping D- and E-laterals. The uncini would probably resemble the outer ones of the Neritidae. The accompanying table (Table I) gives a comparison of the radula of two of the more primitive forms,—*Neritina virginea* from the Neritidae and *Hendersonia occulta* from the Helicinidae. From this it will be seen that the two families have considerably diverged, even as regard their more primitive, living members. Especially noteworthy is the dominance of the D-plate in the Helicinidae and the dominance of the E-plate in the Neritidae.

TABLE I. COMPARISON OF HELICINID AND NERITID RADULAE.

Tooth.	*Neritina virginea* (Linn.).	*Hendersonia occulta* (Say).
R-central.	Roughly quadrate; with anterior, upper rim.	Roughly quadrate, slightly but broadly reflected upward.
A-central.	Large, very broad, roughly triangular; entire reflection of anterior side.	Comparatively small; longer than broad; ovoid base and heavy, well-cusped reflection.

B-central.	Much reduced, but roughly like A-plate of *Hendersonia.*	Much like A-plate.
C-central.	Much reduced like B-plate; it interlocks with latter to form a connection between A and D plates.	Lanceolate, that is, retaining more the character of the primitive uncini.
D-lateral.	Heavy base; inner arm short and with only the extreme tip beyond the reflected portion of the E-plate.	(Comb-lateral). Heavy base with inner arm long, supported by a trapezoidal base, and bearing a series of large, heavy cusps.
E-lateral.	Roughly trapezoidal; thickened, reflected anterior margin, with numerous, well-marked cusps. The inner end fits under most of the D-plate.	(Accessory plate). Roughly trapezoidal; light, but considerably reflected, anterior margin, not cusped. The inner end fits under only the outer, triangular prolongation of D-plate.
Innermost uncini.	Weakly developed bases with a long inner point; distal ends or blades serrated at margins so as to form numerous, poorly differentiated cusplets.	Strongly reinforced, U-shaped bases; distal ends slightly reflected and bearing a few, well developed, heavy, aculeate cusps.

This difference in position of greatest adaptive stress becomes more and more pronounced as we go from the more primitive to the more highly specialized groups of the two families. Thus, the radula of the most highly specialized Helicinidae (Vianinae) may superficially resemble that of *Nerita* in the Neritidae, but the study of the continuous series shows a very great divergence. The most striking feature of both radulae is the large T-plate, or mushroom-shaped lateral, but in the Vianinae this is the D-plate, while in *Nerita* it consists mainly of the E-plate.

IV. METHODS AND VARIATION.

The methods employed in the study of Neritid radulae are very similar to those already described for the Helicinidae (1922). However, the radula of *Neritina*, especially of the typical subgenus, is comparatively thin, and horny in character. For this reason, great care must be taken not to leave the radula, especially those from dried-in animals that have been decaying for a number of years, in the alkali for too long a period, as the teeth are apt to become flaccid and collapse.

In addition, even more care must be taken to compare teeth in the same comparative position; although the student of neritid radulae must become familiar with the apparent changes in form which accompany change in position of the teeth and resultant

divergence in the point of view. Portions of the radulae should be mounted upside down, and even teased to pieces. Clay models of the teeth bring out many features; these can be made with the aid of the camera lucida and the micrometer scale of the fine adjustment. Alcoholic specimens, or freshly dried-in material, are much preferable to old dried animals, and, in fact, some of my own material is far from satisfactory.

Although more variable than that of the Helicinidae, the radula of the Neritidae is still surprisingly stable. The most variable character appears to be the number of cusps on the E-lateral, although even these differences appear to indicate a certain amount of racial differentiation or can be correlated with age (compare *Neritina virginea*). In this connection it must be remembered that the crenulations in *Nerita*, for example, are very weak and slight; they are practically invisible (dissolved away?) in new, unhardened teeth, and are very early worn away in the functional rows. Although fluctuating variations appear more common in the Neritidae, I have observed none of the big changes noted in certain specimens of the Helicinidae.

Several factors must be remembered in order to appreciate Troschel's inability to discover good characters in the radula of the Neritidae. In the first place, the microscopes with which he worked were far inferior to modern instruments. A good substage condenser, as well as a brilliant source of illumination, is absolutely necessary for the proper examination of the radulae, and an oil-immersion objective must be used to ascertain some points. In the second place, he did not successfully differentiate between actual differences in shape, and apparent changes in form due to variance in the viewpoint. In addition, he apparently did not take into account changes due to wear. Finally, his identifications are not always trustworthy; von Martens (1879, 1887) corrected these in many cases, after a re-examination of the specimens from which the radulae were obtained, and his re-indentifications are accepted throughout the present paper.

B. Ecology and Distribution.

The central motif of the family Neritidae is adaptability. No other family of molluscs, except perhaps the Auriculidae, approach it in this feature. The habitats of the Neritidae range from marine to practically terrestrial; single species live with apparently

equal facility in both fresh and salt water. *Nerita* itself occupies a habitat with perhaps as great extremes as any; in a single day its environment varies from salt water to the extreme dessication of the upper tidal flats of the tropics. One of the most primitive families in the Gastropoda, the very survival of the Neritidae is probably dependent on their ability to live where few other forms compete with them. Except on isolated islands, they rarely occur outside of these extremely unfavorable and fluctuating habitats; *Theodoxus* s.s. is perhaps the most notable exception to this general rule. In this connection, it should be noted that the occurrence of widely separated, but apparently closely related species (often insular), as is the case in so many groups of the Neritidae, indicate an ancient and disappearing group.

At first glance, the distribution of the Neritidae presents a confusion of paradoxes. Nevertheless, if care is taken to study each group from the standpoint of its habitat (too often imperfectly known), some of this confusion disappears. *Nerita* and *Smaragdia* are purely marine genera, and, as might be expected, even the sections have usually a world-wide distribution in the tropics. The groups that are mainly estuarine are almost as wide-spread. *Vittoclithon* is practically throughout the tropics; *Vitta* is American and West African; while the Malgachian species appears to partially bridge the gap between it and the Indo-Pacific forms (*Vittina*, *Provittoida*, and *Vittoida*.) Hawaii has two peculiar and quite closely related sections, *Alinoclithon* and *Neritoclithon*, which certainly indicate remarkable isolation.

The more completely fluviatile groups are usually somewhat more limited in distribution. *Clithon*, *Neripteron*, *Dostia* (estuarine), *Neritina* s.s., and *Neritona* are Indo-Pacific, while *Alina* is West American and West African, and *Nereina* is apparently only American. The subgenus *Theodoxus* s.s. is characteristic of the European region and its appendages. *Neritilia*, however, is very widely distributed, but extremely local. *Neritodryas*, the only genus which is practically terrestrial, is apparently limited to the East Indies and the adjacent Pacific Islands.

Peculiarly enough, the American species from the west coast appear most closely related to the West African ones, while the West Indian species seem to find their closest relatives in the Indo-Pacific. The first is true of *Alina* and of *T. afer* and *T. luteofasciatus*, while the latter is illustrated by *Nereina* in *Neritina* s.s.

and *T. meleagris* and *T. oualaniensis*, the other two species of *Vittoclithon*. However, *Viita* is an exception to the above, as it is West African and West Indian.

C. Analytical Key to the Groups of Neritidae.

KEY TO SUBFAMILIES.

A. Eyes peduncled; first uncinus not markedly different in size from the others.

B. R-central present; A-plates opposite and not inclined more than 45 degrees; B- and C-plates vestigial; D-plate with well-marked Y-thickening; uncini with elongate blades; opercula various. I. Subfamily Neritinae.

BB. R-central absent; A-plates with long axes almost parallel to that of the radula, inner ends alternating on opposite sides; C-plate rather elongate; D-plate vestigial; E-plate very oblique, with crescentic disc and well-marked cusps; uncini with large crescentic, cusp-bearing discs, and with prominent notch on the inner side near the distal end of the body; operculum without peg but sometimes with marginal projections at the usual position of the rib; shell globose; animal fluviatile. II. Subfamily Neritilinae.

AA. Eyes sessile; R-central reduced and much longer than broad; A-plate quadrate and bearing triangular cusp near the middle of length; B- and C-plates vestigial; capituliform complex transversely elongate; 1st marginal 3 times as wide as second; other marginals few and like the outermost ones of the other groups; operculum primitive; shell usually greenish, smooth and shining, ovoid with large, obliquely ovate aperture and very flat columellar area; animal marine. III. Subfamily Smaragdinae.

I. Subfamily Neritinae.

A. A-central more than twice as broad as long, triangular in shape or subrectangular with usually very oblique, almost straight outer slope to the posterior point and comparatively small posterior lobe; cusp and thickening at inner end extensive. Reflection of E-lateral either poorly developed and well cusped, or thin and elliptical, with poorly-developed major and minor cusps. a. Septariae.

AA. A-central less than twice as broad as long; posterior lobe large, usually rounded, with convex outer slope; cusp and thickening at inner end relatively shorter. Reflection of E-lateral well developed, heavy, and with a tendency to increase the inner point so as to be broadly lanceolate in shape. b. Neritae.

a. SEPTARIAE.

A. Inner marginals always well serrate out to or near tips, comparatively thin and horny, never with accessory cusp below the blade. E-lateral with the inner cusp usually much larger than the remainder.

B. Operculum large enough to close aperture completely, with well-developed apophyses, usually both rib and peg; fluviatile or estuarine. 1. Genus *Neritina* Lam.

BB. Operculum reduced so as not to completely close the aperture; without rib or peg; shell crepiduliform; fresh water; Indo-Pacific (radula apparently close to that of *Neritina* s.s.). 2. Genus *Septaria* Fér.

AA. Inner marginals with only a few (2–4) serrations at the base of inner side of blade.

C. R-central small, roughly triangular; A-plate with reflected cusp slightly posterior to anterior border; reflection of E-plate heavy, with heavy, conoid cusps which decrease gradually in size in the series from inside towards the outer end; uncini exceptionally heavy, with only two large cusps at the base of each of the inner blades; shell heavy, with prominent spire, and marked by fine spiral striations; estuarine (?); Indo-Pacific. 3. Genus *Pseudonerita* new.

CC. R-central very large, broader than long; A-plate massive with heavy, transverse shelf near anterior border; lateral complex heavy and well-fused together; reflection of the E-plate small but heavy, with short major cusp and numerous, vestigial minor ones; uncini with thin blades, the inner ones with 4 serrations near the outer base, and with a heavy, aculeate, accessory cusp just underneath; rib of operculum deeply excavated beneath and with finger-like lobes at free end; shell globose, brilliantly colored; animal terrestrial; Indo-Pacific. 4. Genus *Neritodryas* von Mart.

1. Genus *Neritina* Lamarck.

A. A-central roughly triangular, with well-marked indentation at outer edge for articulation with B-central, with outer slope of posterior point forming about 45 degree angle with long axis of tooth; D-lateral well developed; E-lateral with shallow reflections and well marked major and minor cusps; all uncini with prominent serrations on outer side and at the tip; operculum primitive.

B. R-central with a thickened rim; A-central not especially large or broad; cusps of E-lateral heavy; shell with prominent spire; estuarine to fluviatile; Afro-American. Subgenus *Vitta* Moerch.

BB. R-central with a rectangular, plane, upper surface or area; A-central transversely elongate so as to be as large or larger than lateral complex; cusps on E-lateral not so well developed; shell with reduced spire; aperture enlarged. Subgenus *Neripteron* Lesson.

C. R-central with rectangular upper area poorly developed, broader than long; shell with large aperture but with the upper expansion more extensive than the lower; mainly fluviatile; Afro-American. Section *Alina* Récluz.

CC. R-central with upper area heavier and better marked posteriad; shell with upper and lower expansions of aperture about equal in size.

D. A-central larger than E-lateral; columellar edge of aperture attached to last whorl; shell rather thin; mainly fluviatile; Indo-Pacific. Section *Neripteron* Lesson.

DD. A-central about as large as E-lateral; columellar edge of aperture free; shell solid; mainly estuarine; southern Asia. Section *Dostia* Gray.

AA. R-central with well-developed rectangular upper area; A-central roughly rectangular; indentation for articulation of B-central poorly developed or absent; with outer slope of posterior lobe very oblique to long axis of tooth, so that the point itself tends to approach the middle of the breadth, and with abrupt inner slope. Inner uncini with smooth or weakly serrate tips.

E. A-central about twice as long as broad, with posterior point near middle of breadth; tips of inner uncini usually with small, reduced cusps; shells and opercula primitive; estuarine and fluviatile; Indo-Pacific. Subgenus *Vittina* new.

F. R-central with upper area broader than long; posterior lobe small on A-central; E-lateral with slight reflection and large, well-marked, major and minor cusps. Section *Vittina* s.s.

FF. R-central with area longer than broad; posterior lobe of A-central more extensive; uncini more elongate, with minute cusps at tip.

G. E-lateral with reflection somewhat more extensive than in *Vittina*, but with well-marked cusps. Section *Provittoida* new.

GG. E-lateral extensive, thin reflection like *Neritina* s.s.; cusps reduced but numerous. Section *Vittoida* new.

EE. Upper area of R-central broader than long; posterior lobe of A-central about ½ the breadth of entire tooth; E-lateral with enormous thin, elliptical reflection, and numerous vestigial cusplets; inner uncini smooth at tips of elongate blades; shell with enlarged aperture; mainly fluviatile.

H. Upper area of R-central about twice as broad as long; inner marginals elongate, 3rd with 10 to 11 cusps; operculum with both rib and peg well developed and standing out at angle; columellar edge denticulate, at least at center. Subgenus *Neritina* s.s.

I. Inner end of A-central about as long as breadth of lobe; shell with upper edge of aperture not forming a spiral ear over spire; rib of operculum heavy, not very distant from peg; American. Section *Nereina* C. and J.

II. Inner end of A-central longer than breadth of lobe; shell with spiral ear over the spire; rib of operculum lighter, grooved below, distant from peg; Africa to Melanesia. Section *Neritina* s.s.

HH. Upper area of R-central almost 3 times as broad as long; inner uncini very elongate, 3rd with 16 to 22 cusps; operculum with peg vestigial or represented by finger-like processes; columellar edge smooth; East Indian, Melanesian, Hawaiian. Subgenus *Neritona* von Martens.

2. Genus *Septaria* Ferussac.

A. Apex median, projecting beyond posterior edge. Section *Septaria* s.s.

AA. Apex median, posterior, submarginal; shell generally narrow. Section *Navicella* Lam.

AAA. Apex above posterior edge, and laterally recurved. Section *Sandalium* Schumacher.

(3, 4. The genera *Pseudonerita* and *Neritodryas* are undivided).

b. NERITAE.

A. Blades of inner marginals with serrations on outer side; shells usually with persistent epidermis; estuarine to fluviatile. 5. Genus *Theodoxus* Montfort.

AA. Blade of inner (10) marginals very long and smooth; shells usually with deciduous epidermis, therefor chalky; marine. 6. Genus *Nerita* Linn.

5. Genus *Theodoxus* Montfort.

A. A-central with pointed posterior lobe or with a noticeable rectangular portion of the body inside of the lobe; uncini usually with quite well-developed cusps almost to tip; peg of operculum well developed in the neritiform species. Subgenus *Clithon* Montfort.

B. R-central with anterior edge broader than the quadrate upper area, which presents a free, very distinct posterior edge; A-central with rounded posterior lobe little more than half the breadth of the tooth; rib and peg of the operculum connected by a marked shelly deposit; epidermis of shell roughened by spines, warts, or axial wrinkles; mainly fluviatile; Indo-Pacific. Section *Clithon* s.s.

BB. Upper area of R-central with less distinct posterior edge; A-central with more pointed posterior lobe; shelly deposit of operculum indistinct or lacking; epidermis of shell smooth or with spiral striations.

C. Upper area of R-central with very poorly-marked posterior edge; epidermis smooth; mainly estuarine; tropics of world. Section *Vittoclithon* new.

CC. Upper area of R-central with anterior border not reaching anterior end of tooth and with posterior edge better marked; blackish shells with spiral striations or low, rounded ribs. Hawaiian Islands.

D. Inner uncini quite well cusped to near tip; shell shaped much like that of *Alina;* fluviatile. Section *Alinoclithon* new.

DD. Inner uncini with serrations near tip very indistinct; shell resembling that of *Nerita* (*Heminerita*); exterior of operculum quite distinctly granulate; estuarine. Section *Neritoclithon* new.

AA. A-central with rounded posterior lobe which is almost as broad as entire tooth; inner uncini with very weak serrations, especially toward tip of blades; peg of operculum slender or definitely reduced; mainly fluviatile; European region. Subgenus *Theodoxus* s.s.

E. Peg of operculum slender, but evident; Asia Minor and North Africa. Section *Neritaea* Roth.

EE. Peg of operculum markedly reduced; European region. Section *Theodoxus* s.s.

6. Genus *Nerita* Linn.

A. R-central apparently without basal lappets; operculum quite primitive; shell smooth or with poorly-developed sculpture; columellar edge finely denticulate. Subgenus *Puperita* Gray.

B. R-central with upper area considerably longer than broad; posterior lobe of A-central with long, oblique outer slope; E-lateral quite like that of *Theodoxus* (*Vittoclithon*); shell smooth, chalky; operculum primitive; West Indies.
Section *Puperita* s.s.

BB. R-central with quadrate upper area divided into a horizontal and an anteriad-sloping portion; posterior lobe of A-central large, with convex outer slope; E-lateral with aculeate major, and numerous, vestigial minor cusplets (?); shell usually with traces of spiral sculpture; operculum with peg somewhat flattened, typically granulate on exterior surface; Pacific Islands.
Section *Heminerita* von Mart.

AA. R-central with a thickening, on underside of base, which connects anteriad and laterad with basal lappets, which extend under the inner ends of the A-central; A-centrals subrectangular, with angulate outer slope to posterior lobe; shell usually with well-developed spiral sculpture; columellar edge usually well toothed; operculum with peg and rib flattened down; tropical seas; marine littoral.
Subgenus *Nerita* s.s.

C. Shell smooth or with poorly-developed ribs; parietal wall of aperture scarcely denticulate; columellar area almost smooth. Section *Amphinerita* von M.

CC. Shell usually with well-developed spiral ribs; parietal wall of aperture usually well toothed or plicate.

D. Columellar area tuberculate, or granulate.
Section *Theliostyla* Moerch.

DD. Columellar area rugose to smooth.

E. Columellar area rugose.
Section *Pila* Moerch.

EE. Columellar area quite smooth.
Section *Nerita* s. s.

II. Subfamily NERITILINAE.

7. Genus *Neritilia*, without subdivisions.

III. Subfamily SMARAGDINAE.

8. Genus *Smaragdia* Issel.

A. E-plate with several (6), heavy, conical cusps; Indo-Pacific.
Subgenus *Smaragdella* new.

AA. E-plate with a large cusp and an adjacent smaller one; West Indies; Mediterranean; Indo-Pacific?
Subgenus *Smaragdia* s.s.

D. Systematic Discussion.

In the following discussion of the radulae of the various species examined, one of each group, usually the type, is taken as a characteristic example; its dentition is described in some detail; and all of the other species of the group are compared to it. The probable distribution of each group is given and the synonymy is included in so far as changes of name are concerned. The localities given after the types are those of the authors of the species, unless definitely stated otherwise. In this connection, I wish to state that all new names, actually used for groups smaller than genera in this paper, are subgenera in the sense used by the International Code.

After the chosen name of each American species, is included its distribution and a brief review of the synonymy. Nude and manuscript names and those occurring only in synonymies are classed together, and no authority is given, as they can never be separated from the first name. After the name of foreign species, only those synonyms are included which have been commonly accepted as the correct name, or named as the types of groups. In case no synonymy is included, the type locality follows the name, while the actual distribution is included in parentheses. Following the synonymy, the reference to the figure in this paper is given first, then the lot numbers and localities of the specimens examined. In addition, references are given to figures in Troschel (1866–1882), or, in some cases, to those in other papers. In order to shorten the descriptions of the radulae as much as possible, all numerical data are concentrated in Tables II, III and IV, for *Neritina*, *Theodoxus* and *Nerita*, respectively.

I. Subfamily Neritinae.

Littoral marine; estuarine; fluviatile; terrestrial; tropics of world; also Europe.

a. Septariae.

1. Genus **NERITINA** Lamarck.

Estuarine and fluviatile; tropics of world.

The genus *Neritina*, as constituted here, is practically equal to the *Neritaea* of Von Martens (1879), plus his *Neritona*, and minus his Viridae (=*Smaragdia*), his Venosae (= *Nerita*, *Puperita*, and *Pseudonerita*), typical *Neritaea* (in *Theodoxus*), and certain species here placed in *Theodoxus*.

TABLE II. NUMERICAL DATA FOR THE SPECIES OF *Neritina*.

Section	Species	Number of minor cusps on E-plate	Number of serrations on 3rd uncinus.	Number of uncini in a half-row.
Vitta	*glabrata*	7–9	10	50–53
	adansoniana	7	10	52
	zebra	7–8	9–10	68
	virginea virginea	13–19	12	71–74
	virginea zigzag	14–15; 23–25		
	virginea reclivata	22–29	12–15	64
Alina	*latissima*	30	10	?
	oweniana	18	10	74–77
Neripteron	*taitensis*	14	10	104
Dostia	*violacea*	18	10	81
Vittina	*gagates*	7–9	7–8	73–75
	roissyana	11–16	8–9	100?
Provittoida	*smithii*	28	15	93
	coromandeliana	21–24	15–16	94
Vittoida	*variegata*	about 40	10	98
	turtoni	about 35	10	?
	sandalina	about 55	14	?
Nereina	*punctulata*	about 45	11	?
Neritina	*pulligera*	40–45	10	99?
Neritona	*granosa*	55–75	16	108

Subgenus VITTA Moerch.

Estuarine to fresh-water; Eastern America; western Africa.

Vitta "Klein" Moerch (1852). Type *Nerita virginea* Linn. (1758). Mediterranean (sic).

Scapha "Klein" Moerch (1852), in synonomy; same type.

Neritina glabrata Sowerby (1849). Cazamanca, Liberia, West Africa.

Plate X, fig. 4. A. N. S. P., no. 113143, one specimen, labeled variety *senegalensis* Duclos (MSS?), collected near Congo River, West Africa, by H. H. Smith. The radula of this species differs from that of the type species, mainly in the pinched-in base of the R-central and the smaller number of heavier cusps on the E-lateral. Neither the radula nor the shell characters of this species resemble those of *Smaragdia*.

Neritina adansoniana (Récluz) (1841). Senegal River, West Africa.

A. N. S. P., no. 37584, one specimen from Cape Palmas, West Africa. The radula of this form is identical with that of the preceding.

Neritina zebra (Bruguière) (1792). Cayenne (Brazil to eastern Venezuela; Panama?).

???*Nerita paralella* "Bolten" Roeding. Possibly the second reference.

?*Neritina lineolata* Lamarck (1816). Probably a young specimen.

Nerita sobrina Récluz (1845).

Plate X, fig. 5. A. N. S. P., no. 105216, three specimens, Pedernales, Venezuela (Bond Expedition.) The radula of this

species agrees wth the two preceding in the small number of cusps on the E-lateral, but with the next in the shape of the R-central. Four, quite regular points occur on the C-central.

This species appears to be the rarest and least known of the American species of this group. There are sets in the A. N. S. P. from the mouth of the Amazon, from Cayenne (type locality), and from eastern Venezuela, that are undoubtedly this form. They are globose, dark olive-green shells with broad, slightly undulating, velvety black, longitudinal bands, and distinctly suggest *N. gagates* in form and general color. It is probably most closely related to *N. virginea zigzag.*

Neritina virginea virginea (Linn.). Mainly estuarine; south Florida and Mexico to northern South America.
Nerita virginea Linn. (1758). Mediterranean Sea.
Nerita serpentina "Bolten" Roeding.
???*Nerita cardinalis* "Bolten" Roeding. More probably *T. meleagnis.*
Neritina turriculata Menke (1828).
Nerita brasiliana Récluz (1841). Substitute.
Nerita phasiana Récluz (1842). Santo Domingo.
Vitta trabalis "Link" Moerch (1852).
Vitta matoni "Récluz" Moerch (1852).
Neritina virginea oblonga von Martens (1865).
Neritina virginea elongata von Martens (1865).
Neritina flavopicta, vinosa, varians, mutubilis, tigris, fasciola; in synonymy.
Form *listeri* Pfeiffer (1840). Cuba.
???*Nerita latilinea* "Bolten" Roeding. More probably *meleagris.*

Plate X, figs. 6, 7. A. N. S. P., 87919, four specimens, mud-flats, gorge of Yumuri River, Matanzas, Cuba (H. A. Pilsbry, 1904); A. N. S. P., 121476, one specimen, St. Croix, West Indes (Wheatley collection); 87970, four specimens from Lagunilla, 6 miles from Cienfuegos, Cuba (H. A. Pilsbry, 1904); 121467, three specimens, St. Cruz Islands. Total twelve specimens. Troschel: xvi–19.

Neritina virginea is a mass of confusion and misunderstanding, as the name has been used for almost every American species of *Neritina,* or *Theodoxus,* at some time or other. For that reason, I will perhaps be excused for the inclusion here of a review of typical *N. virginea,* as I understand it.

In the first place, it appears to be quite generally accepted that *N. virginea* is an American species. From the original description of Linnaeus, from his first reference, and from Hanley's (1855) review of typical specimens, it appears that we have to deal with a quite high-spired shell; both of Hanley's references show such a figure, and Linnaeus himself confused it with *N. turrita* (Gmelin). In addition, the columellar area must be convex, even gibbous

(i.e. with a heavy callus), and the columellar edge denticulate. It must be decorated with fine, wavy, hair lines (although Bonanni's figure, shows dots), interrupted by large, ovoid, lightish flecks, bordered with black. Such a shell is a quite common type in the West Indies, and is very similar to the *N. virginea turriculata* of von Martens (1879: x, 5–6; xiv, 4–9 or Tryon, 1888, xii–38.) I believe that, at present, *N. reclivata* and *N. zigzag* should be included with it, as subspecies.

N. virginea virginea is apparently quite variable in color pattern, but a great many of the forms, usually ascribed to it, belong to an entirely different species, which is called here *Theodoxus meleagris* (Lamarck). The latter is apparently the Atlantic analog of *T. oualaniensis* (Lesson). Although *N. virginea* and *T. meleagris* overlap each other in color pattern, and, in fact, appear to go through a remarkably similar series of color forms, they differ markedly in radula, and also in several important, although not strikingly noticeable, shell characters.

The peg of the operculum in *meleagris* is slender, cylindrical and slightly curved, while that of *virginea* is much stouter and truncated subtrigonal in shape. The peg and rib are much closer together in *meleagris* and a slight development of the shelly callus is often present; they are completely distinct and more widely separated in *virginea*. The edge of the operculum, between the peg and rib, is thickened in *virginea* (as in practically all species of *Neritina*), while it is thin in *meleagris* (as is quite characteristic of *Clithon*.)

The columellar area of *T. meleagris* is flat or even slightly concave, except in old specimens, where the callus is somewhat better developed. The columellar callus in *N. virginea* is always very heavy, with a markedly convex surface, even in young specimens. The edge of the columella in *meleagris* is broken by three or four, rather coarse, denticulations at the center, while that of *virginea* is usually quite evenly and finely denticulate.

T. meleagris is usually smaller and almost invariably has a shorter, more obtuse spire, and more rounded aperture. The aperture of *virginea* is almost always lanceolate in shape, with its longitudinal axis oblique to that of the shell. Both species have globose and conical forms, probably to be correlated, in part, with sex differences, as in the Helicinidae.

The typical color pattern of *T. meleagris*, a sickly, yellowish-green general coloration, and a pattern resembling imbricatnig

scales, does not appear to occur in *virginea*, which usually shows a predominance of the *reclivata* type of hair lines. In addition, *virginea* is never very brilliantly colored, although it may show obscure spiral bands of pinkish or violet under the hair-line pattern. *T. meleagris* is very much more variable in color than is *N. virginea virginea*.

Finally, the two species either occur in colonies or differ slightly in habitat. Those lots which are certainly from a single locality, do not show a mixture of the two species, even after an examination of the radula. The above differences will separate practically all specimens of the two species, but the radula appears to be the only infallible character yet described.

While there is marked racial differentiation inside of the species *Neritina virginea* as here constituted, sets in The Academy of Natural Sciences of Philadelphia appear to show intergradation, in shell characters, between all of the subspecies. *N. virginea virginea* is the characteristic form of the West Indes, although it occurs also on the mainland. It is the most distinct of the subspecies, but at least one set (A. N. S. P., 107522 from Cavech River, Guatemala; A. A. Hinkley, 1914) shows perfect intergradation, in color-pattern, between *virginea virginea* and *virginea zigzag*. Although Pfeiffer's description of *listeri* is inadequate, and Lister's figures look more like *T. meleagris*, I am inclined to believe that this form (compare von Martens, 1879, xiv–1, 2, 3, or Tryon, 1888, xii–37) is also on the border-line between these two subspecies.

There is considerable local variation in the radula. Typical *N. virginea* from Matanzas, Cuba, has 13–15 cusps on the E-lateral; those from Cienfuegos, Cuba, 15–19. Typical *N. virginea reclivata* from Florida shows 22 to 27, but a young specimen from Mississippi has only 14. The R-centrals of the specimens of *N. virginea virginea*, and those of *N. virginea reclivata* from Florida, show an outline that is longer than broad, while those from Venezuela with as high as 29 cusps on the E-lateral of the older specimens, show an outline that is broader than long. In all specimens the shape of the rim is quite constant, when viewed so that it is horizontal. The first lot of *zigzag* shows 14–15 cusps on the E-marginals, the second 23–25. Nevertheless, the specimens of the same age from a single lot are quite constant. It seems very probable that a careful study of the entire area will show *N. virginea* actually does consist of a number of species, each with its definite range, but, at present, no sharp distinctions seem possible.

Neritina virginea zigzag Lamarck (1822). Rivers of Antilles? (Guatemala to Panama, Trinidad, Jamaica, Haiti.)

Neritina reticulata Cristofori and Jan (1832).
???*Neritina striolata* Récluz (1841). Antilles? Philippine Islands (1850).

A. N. S. P., no. 107525, three specimens from shaded swamps, Livingston, Guatemala (A. A. Hinkley, 1913); 20322, two specimens, San Juan, Nicaragua (Swift Collection.) *N. virginea zigzag* is the form characteristic of eastern Central America, although it also occurs in the West Indes. It is the largest and is usually more globose in shape than are any of the other subspecies. The usual color pattern consists of zigzag lines, which interlace so as to give the appearance of a network. It intergrades with both *N. virginea virginea* and *N. virginea reclivata.*

Neritina virginea reclivata (Say). (Mississippi to Florida; Northern Mexico; Maracaibo, Venezuela; Havana, Cuba.)

???*Nerita usnea* "Bolten" Roeding. Unrecognizable; may be *virginea.*
Neritina lineolata Lamarck (1822) not Lamarck (1816). Habitat?
Theodoxus reclivatus Say (1822). St. John River, Florida.
Neritina gravis Morelet (1849). Swamps near Belize, Honduras.
Neritina floridana "Shuttleworth" Reeve (1855). Florida.
Neritina clandestina and *olivacea;* in synonymies.

Plate IX, figs. 1, 2, 3. My field number M269, three specimens (in alcohol) from a lagoon near Maracaibo, Venezuela, collected by E. B. Williamson (University of Michigan-Williamson Expedition). A. N. S. P., no. 91187; two specimens from Crystal River, Palm County, Florida (Clarence B. Moore); 48428, one specimen from Pass Christian, Mississippi (Bryant Walker.) Total six specimens. Troschel: xvi–10.

The first term that might be applied to this subspecies is *Nerita usnea* Roeding, in the "Museum Boltenianum" (1798.) I do not use it for two reasons. In the first place, Lister's figure is extremely poor and but doubtfully recognizable as this shell. In the second place, personally, I do not believe that inclusion in the "Museum Boltenianum" is sufficient authority for a scientific name. Bolten, the student and collector, may have been a consistent binomialist and an excellent systematist, but Roeding, the constructor of the sales catalog, and the only authority that might be quoted, was certainly neither.

The first name, *Neritina lineolata* Lamarck (1822), is preoccupied. *N. lineolata* Lamarck (Encycl. Méthod., 1816) is certainly not this form, but is probably a young shell of *N. zebra.* In the "Anim. sans. Vert.," Lamarck apparently changed the application of the name, as his description reads like *reclivata,* and the types are that form ac-

cording to A. Brot (von Martens, 1879.) Thus Say's name, with the first truly recognizable description, is the only one that can properly be applied to this subspecies.

Neritina virginea microstoma d'Orbigny (1845). Cuba.
Neritina reclivata conoidalis von Martens (1865).

N. virginea microstoma is the dwarfed, globosely conical form from Cuba (Manzanillo). It occurs in both *reclivata* and *zigzag* color patterns and is the least distinct of the four subspecies recognized.

Subgenus NERIPTERON Lesson.

Mainly fluviatile; practically the tropics of the world.

Section ALINA Récluz.

Estuarine and fluviatile; west coast of Central America; West Africa.

Alina Récluz (1842). Type *Neritina latissima* Broderip (1833). Real Llejos, (Nicaragua).
Alima auct., not Leach (1818).

Neritina oweniana (Wood) (1828). Africa (Estuarine and fluviatile; islands and mainland of Gulf of Guinea, west Africa.)

Plate X, fig. 8. Three specimens from the mouth of the Congo River. The upper area of the R-central is broader than long and is thin and light at the center, but thicker toward the edge. It is thus more or less intermediate between that of *Vitta* and that of *Neripteron* s.s. The A-central is shaped like that of *Vitta*, but the inner portion is much more extensive, so that the plate is very broad. It is considerably larger than the E-lateral. The B- and C- centrals are like those of *Vitta*. The capituliform complex is also very similar, but exceptionally small; the reflection is deeper but is not broad. The blades of the inner marginals are somewhat more elongate than in *Vitta*, and the cusps are exceptionally distinct and attenuate.

Neritina latissima latissima Broderip (1833) (Fluviatile; Panama to Nicaragua; west coast).
Neritina globosa Broderip (1833). Chiriquis, Panama.
Neritina intermedia Sowerby (1833). Isle of Lions, Panama.
Neritina latissima pilsbryi Tryon (1888). Color form of *intermedia*.

A. N. S. P., 20567, one specimen from Real Llejos, Nicaragua (T. B. Wilson); 120200, one specimen from Rio Tula, Nicaragua (McNiel Expedition). My radulae are so poor that I am unable to present a figure of this type species. It seems very similar to that of the preceding species. The distal end of the R-central is

even broader, so that it is considerably wider than the wings or the posterior end. The major cusp is distinct on the E-lateral, and the minor points are blunt-aculeate in shape. Neither of my bits of radula shows all of the marginals; the cusps on the inner ones are as in *oweniana*.

Neritina latissima fontaineana d'Orbigny (1837). (Estuarine; Guayaquil, Ecuador).
Neritina guayaquilensis Sowerby (1849).

Section NERIPTERON S.S.

Mainly fresh water; Malgachian Islands to Hawaii; Japan to Australia.

Neripteron Lesson (1830). Type *Neritina taitensis* Lesson (1830). Tahiti.
Neritopteron Fischer (1885). Substitutional emendation; same type.

Neritina taitensis Lesson (1830). Venus, Matavai Bay, Tahiti. (East Indes; Melanesia; Polynesia).
Neritina tahitensis auct.

Plate X, fig. 9. A. N. S. P., no. 121668, two specimens from Tahiti. The upper area of the R-central is well marked and is longer than broad; the cutting edge is quite evident. The remainder of the radula is quite similar to that of the preceding group. The blades of the inner uncini are rather elongate, and the serrations are quite coarse, even at the tip.

Neritina vespertina "Nuttall" Sowerby (1849). Hawaiian Islands.

Troschel's figure (xvii–1) of the radula of this species shows a specimen that is apparently peculiarly tilted and badly worn. Nevertheless, it is clearly a member of this group. *Theodoxus* (*Alinoclithon*) *cariosus* (Wood), also from the Hawaiian Islands, has somewhat similar shell form, but belongs to a totally different group.

Section DOSTIA Gray.

Mainly estuarine; Persian Gulf to Southern Japan.

Dostia Gray (1840). Type *Neritina crepidularia* Lamarck (1822). Brackish water; Indian Ocean.
Mitrula "Menke" Récluz (1850), not Gray (1821). Type *Neritina crepidularia*.

Neritina violacea (Gmelin) (1791). Habitat? (Distribution as section).
?Nerita patella "Bolten" Roeding.
Neritina crepidularia Lamarck (1822). Brackish water; Indian Ocean.

Plate XI, fig. 10; A. N. S. P., no. 20560, one specimen, Singapore (D. S. Archer); 37748, one specimen, Bombay, southern India; 121559, one specimen, labeled *depressa* Benson, Calcutta, India. Troschel: xvi–23. The radula of this species is very similar to

that of *N. taitensis*. The cusp of the R-central is a little broader, and the anterior end is strikingly thin, so that the anterior half-ellipse is more transparent than usual. The reflection of the E-lateral is somewhat more extensive than in *Neripteron* s.s., and the cusps are not so large or as well differentiated. Unfortunately, I am only able to present a figure of one that is tilted down considerably at the outer end; none of my radulae presents a good lateral complex in the more horizontal position. As the outer edges are curled under, I am not able to give the complete number of uncini. The gap between *Alina* and *Neripteron* seems considerably greater than that between the latter and *Dostia*.

Subgenus VITTINA new.

Estuarine and fresh-water; Indo-Pacific.

Section VITTINA s.s.

Vittina new. Type *Nerita roissyana* Récluz, from Samoa (my locality).
Paranerita Bourne (1908), pars; not Hampson (1901).

Neritina gagates Lamarck (1822). Habitat? (Mascarene Islands).

Plate XI, fig. 11. A. N. S. P., no. 29537, two specimens labeled *zigzag*, Mauritius, (V. Robillard). These specimens show the zig-zag striping much more prominently than indicated by the usual descriptions of *gagates*. They are of about the same size and rather globose form. The radula resembles superficially that of *Vitta*, but the cusp on the R-central is much better marked. The A-central is more elongated transversely, and shows the rectangular form and the comparatively slight, abrupt posterior lobe of that of *Vittina*. The serrations reach to the tips of the inner marginals.

Neritina roissyana (Récluz) (1841). New Guinea (East Indes, Micronesia, Melanesia.)

Plate XI, fig. 12. A. N. S. P., no. 77295, three specimens, Savaii, Samoa (C. N. E. Eliot). The A-central is broader than long and presents an extensive upper area, with a rather distinct posterior cutting edge. The figure represents the A-central as usually seen, with the inner portion of the cusp almost vertical. The depression, for the reception of the posterior lobe of the tooth next anteriad, is more prominent than in *Vitta*, while the notch, at the outer end of the body, is less distinct. The posterior point is near the middle of the tooth, and the inner end of the lobe is abruptly truncate. The B-and C-centrals are very much as in the preceding groups. The D-lateral is not as distinct as in *Vitta*. The large, inner cusp

of the E-lateral is especially well developed and the remainder of the free edge appears as if carried out along its inner border. The smaller number of minor cusps is present in the youngest specimen. The inner uncini have much the general form of those of *Vitta*, but the blade is longer and the serrations just reach the tip. The first uncinus is somewhat broader than the next and the blades increase in length out to the 6th. I am unable to count the marginals as the outer edges are turned under and the teeth themselves are warped, as is often the case in radulae from long-dried specimens. However, by counting the bases as far as possible, I estimate that there about 100 in each half-row.

Neritina turrita turrita (Gmelin) (1791). Islands of Antilles (sic) (East Indies.)
Neritina strigilata Lam. (1822) River Antilles (sic) (Micronesia.)

One of Troschel's figures (xvi–12, *cumingiana*) appears to indicate a member of this group. His other (xvi–14) certainly does not closely resemble the first. Von Martens (1879) was apparently doubtful as to the species actually represented by the second, as he does not include this figure in his synonymy. It looks to me like a worn radula of *N. coromandeliana*.

Neritina turrita semiconica Lamarck (1822). America? (Bengal to Sumatra.)

Troschel's figure (xvi–13) is very similar to that of his *cumingiana*.

Neritina waigiensis Lesson (1830). Waigiu, Moluccas (East Indes and Melanesia.)
???*Neritina lugubris* Lamarck (1822). Habitat?
Nerita communis Quoy and Gaimard (1834). Vanikoro, Santa Cruz Islands.

Troschel's figure (xvi–11) appears to indicate this section.

Section PROVITTOIDA new.

Estuarine and fresh-water; India to Tahiti.

Provittoida new. Type *Nerita smithii* Wood from Calcutta (my locality.)

Neritina smithii (Wood) (1828). Africa (sic.) (Bengal, India).

Plate XI, fig. 13. A. N. S. P., no. 121658, one specimen from Calcutta (Wheatley Collection). The upper area or cusp of the R-central is considerably longer than broad. The A-central is about twice as broad as long. The inner slope of the obtuse, posterior point is very oblique. The cusp is well developed and has a definite depression along the anterior border near the outer end; into this fits the posterior point of the tooth next anteriad. The reflection of the E-lateral is considerably more extensive than

in *Vittina*, but less so than in *Vittoida*. The major cusp is large and heavy, but not long. The minor cusps are rather weak and small. The inner marginals are similar to those of *Vittina;* they have rather elongate blades with much weaker serrations near the tip than down the outside. The base of the D-lateral is broader and thinner than in *Vittina*.

The radula of this group, and the next, approaches uncomfortably close to that of *Clithon* s.s. However, the A-central is more elongate transversely, and its inner edge is almost straight and oblique. The teeth are apparently all more horny in texture, and the reflection of the E-lateral is thinner and not as lanceolate in outline.

Neritina coromandeliana Sowerby (1841).[2] Coromandel Coast, India (1841); Tahiti (1849).

Neritina zigzag, zigzac, ziczac auct., not *zigzag* Lamarck (1822).

A. N. S. P., no. 20364, two specimens labeled *turrita*, from Tahiti. As represented by my specimens, the radula of this species appears to be very similar to that of the type. The reflection of the E-plate is somewhat more extensive, and the inner cusp is not as prominently separated from the remainder of the free edge. Twelve coarse serrations are present on the outer edge of the blade of the 3rd uncinus, in addition to 3 or 4 finer ones at the tip.

Section VITTOIDA new.

East Indies to Southern Polynesia.

Vittoida new. Type *Neritina variegata* Lesson from Gulf Davao, Mindanao, Philippines (my locality).

Neritina variegata Lesson (1830). New Ireland (Nicobars to Tahiti.)

Neritina pulchra Sowerby (1841). Panama (sic).

Plate XI, fig. 14. A. N. S. P., no. 98297, one specimen collected at Gulf Davao, Mindanao, Philippines, by Alvin Seale (1908). The R-central is longer than broad and shows a quite well-developed, almost quadrate, upper area. The A-central is almost rectangular, except for the short, posterior point, which is very near the middle of the breadth of the tooth. The truncation at the inner end of the lower surface, under the cusp, is more nearly vertical than in the preceding group. The figure shows the A-central tilted as in that of *N. smithii*. The B-central is very much like that of *Vittina*, but the C-central, shown tilted inward in my

[2] The date is that on the title page of the copy of the "Conchological Illustrations" in the A. N. S. P. The *Neritina* plates must actually antedate 1838, as they are quoted in Deshayes' "Animaux sans Vertèbres."

figure, is rather featureless, as the cusps are not well marked. The lateral complex shows greater development along the lines initiated in *Provittoida,* and has almost reached the stage shown by *Nereina.* The base of the D-lateral is quite broad and thin. The reflection of the E-plate is enormous, but is thin and often collapses in mounted teeth. No decided thickening is present along the outer edge of the reflection and into the reduced major cusp; this is a marked feature in *Provittoida.* Like the remainder of the radula, the uncini appear quite horny in texture, and collapse quite easily after preparation. The elongate, thin blade of the third uncinus bears 10 coarse serrations along the outer edge, but the tips appear quite smooth and rounded in my specimens.

Neritina turtoni (Récluz) (1843). New Ireland (Melanesia.)

Plate XI, fig. 15. A. N. S. P., no. 121483, three specimens from Navigator Islands (Samoa) (Wheatley Collection.) The radula of this species is very close to that of the preceding. The reflection of the E-lateral (figured) is perhaps a trifle more extensive, and the posterior point of the A-central is even closer to the middle of the breadth of the tooth.

Neritina sandalina (Récluz) (1842). Sandal-Bay, Viti; Tahiti.

A. N. S. P., no. 64306, one specimen (G. W. Carpenter, 1903). Although my radula is poor, it seems also to belong to this group, as indicated by Tryon (1888). The serrations on the elongate blades of the inner marginals are pointed and conspicuous.

Subgenus NERITINA s.s.

Mainly fluviatile; Indo-Pacific and American Tropics.

Section NEREINA C. and J.

Mainly fluviatile; West Indies; Mexico to Brazil.

Nereina Cristofori and Jan (1832). Type *Nereina lacustris* C. and J. (1832). Brazil.

Neritina punctulata punctulata Lamarck (1816). Guadeloupe (Distribution as section).

Nereina lacustris Cristofori and Jan (1832). Brazil.
Neritina turbida Mo r lt (849). River Machaquila, Guatemala.
Neritina bahiensis Récluz (1850). Bahia, Brazil.
Neritina sargi Crosse and Fischer (1892). Guatemala.
Neritina fuscilabris, aperta; in synonymy.

Plate XII, fig. 16. A. N. S. P., no. 20491, two specimens without locality (T. B. Wilson); no. 20494; three specimens from Cumberland River, St. Vincent (Sharp Collection). The upper area or

cusp of the R-central is considerably broader than long. The A-central is shaped somewhat like that of *Vittina*, but the portion inside of the posterior point is more slender and extensive. The inner thickening is very marked, as is also the depression for the reception of the posterior lobe of the tooth next anteriad. The B- and C-centrals are much as in the next group. The D-lateral is thin, broad, and poorly defined. The basal portion of the E-lateral is proportionately well developed, and is considerably thickened under the thinnest portion of the D-plate. This gives the impression, at first glance, that the D-lateral is absent, or reduced to this area. The reflection of the E-plate is enormous, but thin and easily crushed. The major point is not noticeable, except on the newly-formed teeth, and the 45 minor cusps are truly vestigial. The peculiarly curved thickening of the outer end appears quite characteristic. The inner uncini are much as in *N. pulligera*. They are smooth at the tip, and have 11 quite long, very sharp-pointed cusplets on the outer side. My specimens do nót admit a full count of any half-row.

Neritina punctulata cassicula Sowerby (1841). Habitat? (Mazatlan to Nicaragua.)

This form, mainly if not entirely from the west coast, appears to be subspecifically distinct.

Section NERITINA s.s.

Fluviatile; East Africa; Malgachian Islands; East Indies; Micronesia; Melanesia.

Neritine Férussac (1807); Lamarck [1809]. Only the former defines; neither author latinizes this term.
Laphrostoma Rafinesque (1815). Nude name.
Neritina "Lamarck" Rafinesque (1815). Nude term; used in synonymy of preceding.
Neritina Lamarck (1816). Type (chosen by Children, 1823) *Nerita pulligera* Linn. (1766). Rivers of India.
Neretina auct. Misspelling.
Neritella "Humphrey" Gray (1848). Substitute; type *N. pulligera*.
Chernites Gistel (1848). Substitute; type *N. pulligera*.
Clypeolum Récluz (1850). Type *N. pulligera*.
Lamphrostoma "Rafinesque" Herrmannsen (1852) =*Neritella;* type *N. pulligera*.
Lamprostoma "Rafinesque" H. and A. Adams (1858); not Swainson (1840). Type *N. pulligera*.
Labialia, Onychina "Megerle" Scudder (1882) =*Neritina;* type *N. pulligera*.[3]
Laphrostoma "Rafinesque" Pilsbry (1917). "Substitute for *Neritina*." Type *N. pulligera*.[4]

[3] This is not the use of these terms in the A. N. S. P. copy of Megerle's manuscript. *Elea* was published in 1833 as a synonym of *Theodoxus*, which see.

[4] And not *N. meleagris* Lamarck (1822), which is the type of *Neritina* s.s. Swainson (1840).

Laphrostoma Rafinesque (1815) is a purely nude name; it apparently could not have been used as a substitute for *Neritina* Lamarck (1816). *Neritina* "Lamarck" Rafinesque (1815) is also nude, and can have no significance in nomenclature. Lamarck had not published any description of *Neritina* or Neritine, previous to that date.

The original genus *Neritina* Lamarck (1816) contains 6 species: *N. pulligera* Linn., *N. punctulata* Lam., *N. zebra* Bruguiere, *N. lineolata* Lamarck (=*zebra*?), *N. fasciata* Lamarck (=*dubia*), and *N. auriculata* Lamarck. Children (1823) chooses the first of these as the type. However, Lamarck's figure does not appear to represent *N. pulligera* s.s., but is undoubtedly some member of the group, probably that later separated as *N. squamapicta* "Récluz" Sowerby (1849).

Neritina pulligera (Linn.) (1766). Rivers India (East Indes; Melanesia.)

Plate XII, fig. 17. A. N. S. P., no. 20482, one specimen from New Ireland (T. B. Wilson); no. 20477, one specimen from Philippines. Troschel: xvi–8. The radula is quite similar to that of *N. punctulata*. However, the A-central is much broader, so that the posterior point is little more than $\frac{1}{3}$ the breadth from the outer end. The B-central is quite as in the other groups of the genus. The C-central shows considerable reduction of the cusp-like points. The lateral complex, shown much tilted inwards in my figure, is still more modified along the lines noted in *Nereina*. Forty to 45 vestigial, minor cusps are present on the very large, thin reflection (DE), which extends even behind the body of the tooth. The inner uncini have elongate, thin blades with smooth tips, and quite long, attenuate cusps. My radulae are fragmentary, and I am not sure of the accuracy of the number of uncini given.

Subgenus NERITONA von Martens.

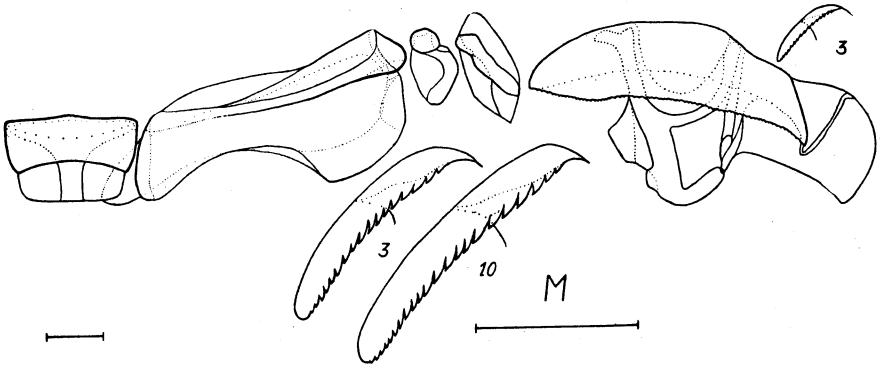
Fluviatile; East Indies (Northern Celebes to Philippines); Melanesia; Hawaii.

Neritona von Martens (1879). Type *Neritina labiosa* Sowerby (1841).

Neritina labiosa Sowerby (1841). (Northern Celebes to Philippines).

The operculum of the type species is clearly figured by von Martens (1879). The reduction of the peg, evident in *Neritina* s.s., appears to be practically complete, as it certainly is in *N. granosa* Sowerby. Troschel and von Martens describe briefly the radula of the type species. It appears to be very similar to that of the

next; they both state that the E-lateral is smooth, but that is true of the anterior (worn) teeth in all species with vestigial cusps. The large number of cusps on the inner margins seems to indicate very elongate blades, as in *N. granosa*.



Neritina (*Neritona*) *granosa*. (×1¼.) Centrals, lateral complex and tip of 3rd uncinus. The tips of the 3rd and 10th marginals also shown (M) under greater magnification. (×3½.) This radula is from a small specimen (greatest diameter 20 mm.); the larger ones examined (30 mm.) have less pronounced but more numerous cusps on the E-lateral.

Neritina granosa Sowerby (1825). Hawaiian Islands.

Text-figure. Three radulae examined from fresh specimens, Wailuku River, Hilo, Hawaii (D. Thaanum, 1921).[5] The sharply limited upper area of the R-central is more transverse than in any other species of *Neritina* examined. The A-central has much the shape of that of *N. pulligera*, but the inner thickening is heavier and more extensive, and the anterior border is peculiarly arched. The B-centrals and C-centrals are quite similar to those of the latter species. The lateral complex is also very similar. The inner uncini have enormously elongate blades with very numerous, long, attenuate cusps along their outer margins; the tip itself is smooth. The third marginal has 16 cusps, while the 10th (longest blade) has 22. The blades from about the 10th to the 20th are almost equal in length, and as many as 27 cusps were counted.

2. Genus **SEPTARIA** Férussac.

Fresh-water; Malgachian Islands; British India; East Indies; Micronesia; Melanesia; Polynesia.

[5] Mr. D. Thaanum kindly sent me a series of 16 specimens.

I have been unable to obtain the radula of any species of this genus, so will confine myself to the presentation of the synonymy of the three more important groups. Troschel shows several figures of the radula of this genus. Although considerable variation appears in his illustrations, it seems that the radula is quite similar to *Neritina* s.s. The great elongation (transverse) of the A-centrals is especially noticeable in most of his figures. The striking divergence in the operculum is excuse enough for its separation from *Neritina;* anyway, it is the second generic name in the family.

Section SEPTARIA s.s.

Same distribution as the genus.

Septaria Férussac (1807). Type *Patella borbonica* St. Vincent (1803) Isle Bourbon.
Nacelle Lamarck (1809). Nude, vernacular term.
Cimber Montfort (1810). Type *Cimber tabernaculatus* Montfort (1810).
Nacella "Lamarck" Rafinesque (1815). Nude name.
Septarius Gray (1821). Emendational substitute; type *P. borbonica.*
Catillus "Humphrey" Swainson (1840). Type *P. borbonica.*
Cibota "Brown" H. and A. Adams (1858); in synonymy; type *P. borbonica.* Not *Cibota* "Browne" Herrmannsen (1852).
Laodia Gray (1867). Type *Navicella cumingiana* Récluz (1842). Philippines.[5]
Paria Gray (1867). Type *Navicella freycineti* Récluz. (1841). Celebes.[5]

Septaria borbonica (St. Vincent) (1803). Reunion Island (Mascarene Islands.)

Cimber tabernaculatus Montfort (1810). Substitute.
Navicella elliptica Lamarck (1816). Ile de France and Moluccas.

The radula is figured by Troschel (xvi–3, 4).

Septaria janellii (Récluz) (1841). Philippines and Mariannes. Troschel: xv–8.

Section NAVICELLA Lamarck.

Bengal and Ceylon to Viti.

Navicella Lamarck (1816). Type (chosen by Children, 1823). *Navicella tessellata* Lamarck (1816).
Navicellus Gray (1821). Emendational substitute; same type.
Scapha "Klein" Récluz (1841); in synonymy; same type.
Stenopoma Gray (1867). Type *Navicella lineata* Lamarck (1816). Rivers India.

Septaria lineata lineata (Lamarck) (1816). Troschel: xvi–6.

Septaria lineata tessellata (Lamarck) (1816). Made synonym by Gray (1867). Troschel: xvi–1, 2.

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[5]These two groups are regarded by some authors as separate sections. *Orthopoma* Gray (1867) is founded on a loose operculum, contains no species, and may refer to anything but this group.

Section SANDALIUM Schumacher.

Fresh-water; East Indies; Melanesia; Micronesia.

Sandalium Schumacher (1817). Type *Sandalium pictum* Schumacher (1817).
Sandalinum "Schumacher" Récluz (1841). Misspelling.
Elara H. and A. Adams (1858). Type *Navicella suborbicularis* Sowerby (1825).
Elana Gray (1867). Type *N. suborbicularis*.

Septaria porcellana (Linn.) (1758). (Distribution as section).

Patella porcellana Linn. (1758). Oceans of India.
Sandalium pictum Schumacher (1817).
Navicella suborbicularis Sowerby (1825).

This seems the most probable application of the Linnean name, although Hanley (1855) prefered the type species of the genus. In any case, Sowerby's name cannot stand.

3. Genus **PSEUDONERITA** new.

Estuarine (?); Viti Islands to India.

Pseudonerita new genus. Type *Neritina holoserica* Garret (1872). Vanna Levu, Viti.

Pseudonerita holoserica (Garret) (1872). (Viti Islands).

Plate XII, fig. 18. A. N. S. P., no. 37599, bits from one specimen from mud flats of Matawa Bay, Vanna Levu, Viti (type lot); no. 121755, bits from one specimen from Viti Islands (Wheatley collection). No complete radula of this species was obtained, but samples of all of the kinds of teeth were studied.

The R-central is slightly longer than broad and the base is quite markedly constricted. The A-central is transversely elongate. Its cusp is slightly posteriad to the anterior border. It support for the R-central is markedly thickened at the extreme inner end, in addition to the usual inner truncation. Its posterior point is almost at the middle of its breadth. The B– and C–centrals are present, but their detailed structure was not made out.

The D-lateral is heavy and quite well developed. The E-lateral is heavy but the portion outside of the D-lateral is comparatively small, as in *Neritodryas*. The reflection is heavy and quite pronounced. The six, heavy, conoid cusps gradually decrease in size in the series, from the innermost out; the first two are almost equal in size. This reflection and its cusps somewhat resemble that of *Smaragdia* (*Smaragdella*.)

The number of the uncini is not known, as no continuous series was obtained. Their bases are heavy and somewhat resemble those of the Helicinidae; the inner point is not as well developed

as is usual in the Neritidae. The blades of the inner marginals are comparatively small, but very heavy, and bear two well-marked cusps near the base of each.

This genus does not fit very well into either the Septariae or the Neritae. The shape of the A-plate is more like that of the Septariae, but is most like that of *Neritodryas*. The peculiar development of the cusps on the E-lateral, and the heavy, almost Helicinid uncini, separate this genus from all of the other groups.

The operculum is *Vitta*-like in appearance, but the peg is shorter and stouter, and more markedly hollowed beneath. The rib is very weak. The marginal process is distinct. The shell is heavy, with much the shape of that of *Theodoxus* s.s.; it is finely and spirally striate. The columellar margin is denticulate and the columellar area is wrinkled and weakly granulate. *Pseudonerita obtusa* ("Benson" Sowerby) (1849), from Calcutta, also shows these characters, and probably belongs to this group.

4. Genus **NERITODRYAS** von Martens.

Terrestrial; East Indes; Melanesia; Polynesia (Tahiti).

Neritodryas von Martens (1818). Type *Nerita cornea* Linn. (1758). Habitat? (New Ireland now chosen.)

Neritodryas cornea (Linn.) (1758). (East Indies; Melanesia to Viti).

Plate XII, figs. 19, 20. A. N. S. P., no. 12589, one specimen from New Ireland. Troschel: xvi–15. The base of the R-central is very large, but the wings are very small. The broad upper area is evident, but not very sharply marked off from the base. The A-central is massive with rounded edges, and is transversely elongate. It support for the R-central is narrow. The cusp consists of a transverse shelf, some distance posteriad from the anterior border of the tooth; it is only well developed near the outer end.

The B-central is trapezoidal and bears a crescent-shaped thickening along the anterior and outer borders. The inner point of this fits under the cusp of the A-central, as is usual, while the anterior, outer angle is hollowed-out below the surface, so as to leave a projecting shelf, under which fits the point of the C-central. The latter is almost circular and bears a transverse thickening, the inner end of which projects into the socket just described.

The lateral complex is very heavy and apparently the D and E components are very firmly fused together. The portion that

represents the D-lateral is comparatively thin and poorly developed. The reflection of the E-lateral is very heavy but quite shallow. The inner cusp is heavy and short. In the anterior rows of teeth (the functional ones), the remainder of the cutting edge is smooth. My radula lacks the youngest, posterior portion, but, in some of the younger teeth that do remain, numerous, minute points (45 counted) can be made out. These are very thin and weak, and appear to be worn away early, as in *Nerita*.

The uncini (138 counted) have rather heavy bases with the inner point characteristic of the family. The blade, of each of the well-developed inner teeth, is quite slender, sharply pointed, and bears 4 serrations or cusps near the outer base. Just under the blade is a stout, secondary cusp. This is heavy, almost as long as the blade itself, and is a development of the entire outer portion of the shaft, and not simply a lobe of the outer margin, as in *Neritilia*. Troschel's figure evidently shows only this secondary cusp on the marginals; it is heavier than the transparent blades, and, in certain lights, is more easily seen. The 1st uncinus is considerably broader than the others; it is long-ovate in shape and lacks the secondary cusp.

Although plainly Neritine in character, this radula is certainly the most isolated and divergent in the subfamily. The broad A-centrals and the comparatively slight reflection of the E-lateral seem to indicate a closer relationship with the Septariae than with the Neritae. Cited as a practically terrestrial form, a study of its adaptation for the protection of the aerating membranes, should prove very interesting.

Neritodryas dubia (Gmelin) (1791). (East Indies; Melanesia; Tahiti).

Troschel indicated that the radula of this species is similar to that of the preceding, but did not figure it.

b. NERITAE.

5. Genus **THEODOXUS** Montfort.

Mainly fluviatile; tropics of the world; and the European region.

TABLE III. NUMERICAL DATA FOR THE SPECIES OF THEODOXUS.

Section		Number of minor cusps on E-plate.	Number of serrations on 3rd uncinus.	Number of uncini in a half-row.
Clithon	*corona*	30–33	11–12	92
Vittoclithon	*luteofasciatus*	25–27	15–16	86
	afer	24	10	75

Vittoclithon	*oualaniensis*	16–19	7-9	62–69
	meleagris	22–26	8–9	81
Alinoclithon	*cariosus*	35	13–14	73
Neritoclithon	*neglectus*	25	10–11	83
Neritaea	*jordani*	25	8	87–89
Theodoxus	*fluviatilis*	25	7	65–69

Subgenus CLITHON Montfort.

Mainly fluviatile; tropics of world.

Section CLITHON s.s.

Clithon Montfort (1810). Type *Nerita corona* Linn. (1758). Rivers of Asia.
Cliton Lesson (1830). Substitute; same type.
Corona "Chemnitz" Recluz (1850); not Albers (1850). Substitute; same type.
Urceus "Klein" auct., in synonymy.

Theodoxus corona (Linn.) (1758). Rivers of Asia (Fluviatile; East Indies to Melanesia.)

???*Nerita spinula* "Bolten" Roeding.
Neritina brevispina Lamarck (1822). Timor.
Neritina domingensis Lamarck (1822). Rivers Santo Domingo (sic). Teste "A. Brot" von Martens (1879).

Plate XIII, fig. 21. A. N. S. P., no. 77293, two specimens, Savaii, Samoa (C. N. E. Eliot); no. 20520, one specimen, Pacific Islands (Wilkes Exploring Expedition); 121578, one specimen (Wheatley collection). Schepman (1908, viii–4) figures clearly and exactly the lateral complex as tilted inward. The lateral complex of Troschel's figure (xvii–2) does not resemble that of any known Neritid.

Although undoubtedly resembling that of *Vittoida* in some characteristics, this radula is quite distinctive. The R-central is expanded anteriad so that the anterior border is considerably broader than the quadrate upper area, which is sharply marked posteriad, so as to form a definite cusp-like edge. It is supported by an extra lamella from the center of the basal portion. The A-central is heavy. The cusp is well developed toward the outside but apparently does not reach the inner thickening. The anterior depression, for the reception of the posterior point of the tooth next anteriad, is extensive. The inner thickening is prominent and heavy. The outer edge is also strongly thickened, and the truncation under the cusp is concave. The inner lobe is well marked. The posterior lobe is large and broadly rounded posteriad and up the outer slope. The thickening of the B-central has an especially deep sinuation for the reception of the inner tip of the thickening

of the C-central. The latter is heavy and long, but bears no distinct cusps on the free edge, except the terminal one, which articulates with the B-central.

The D-lateral is very well fused with the E-lateral. The latter is large and heavy. The reflection is somewhat similar to that in *Provittoida*, but shows a more noticeable tendency to develop the inner point, and is much heavier, like that of *Vittoclithon*. The major cusp is large and stout; the minor cusps are small and plicate. The basal portion of the entire tooth extends anterior to the reflection, as is true of all of the Neritae.

The uncini are heavy, but rather small, in comparison with the other teeth. The inner ones bear elongate, heavy blades; the 3rd has 11 to 12 serrations along the outer side almost to the tip. The 9th is the longest, with 14 cusplets.

Theodoxus coronatus (Leach) (Fluviatile; Malgachian Islands).

Theodoxus coronus Montfort (1810). The figure.
Clithon coronata Leach (1815).
Nerita corona Lamarck (1822).
Nerita longispina Récluz (1841).

Montfort (1810) figured this species but he clearly designated *Nerita corona* Linn. (1758) as the type of *Clithon*. The Malgachian species did not receive a name until 5 years later, when Leach plainly figured it as *Clithon coronata*. Récluz, although he quoted Leach, unfortunately disregarded the prior name, and renamed it *N. longispina*, by which synonym it is best known.

Section VITTOCLITHON new.

Mainly estuarine; tropics of world.

Neritina s.s. Swainson (1840). Not Lamarck (1816). Type *N. meleagris*.
Vittoclithon new. Type *Neritina meleagris* Lamarck (1822). Rivers Santo Domingo.

Vittoclithon, as here constituted, could easily be made a subgenus with 3 sections. *T. afer* and *T. luteofasciatus* form a rather distinct group, which shows certain resemblances, in the shape of the A-central and the marginals, to *Clithon* s.s., and in the R-central to *Alinoclithon*. *T. oualeniensis* is closer to *T. meleagris* than to either of the preceding, but has quite different uncini. Those of the last species approach those of *Theodoxus* s.s. For convenience in description they are taken up in inverse order.

Theodoxus meleagris (Lamarck) (1822). (Mainly estuarine; South Carolina, Bermudas and Mexico to Brazil).

???*Nerita cardinalis* "Bolten" Roeding.
???*Nerita latilinea* "Bolten" Roeding.
Neritina meleagris Lamarck (1822). Rivers Santo Domingo.
Nerita pulchella Wood (1828). West Indies.
???*Neritina lurida* Cristofori and Jan (1832). American Antilles.
Neritina elegantissima Hartmann (1840–44).
Vitta chlorina "Link" Moerch (1852).
Neritina jamaicensis C. B. Adams (1852). Jamaica.

Plate XIII, fig. 23. A. N. S. P., no. 119002, three specimens from St. Thomas, West Indies (typical coloration); no. 110539, three specimens, Cavech River, Guatemala, by A. A. Hinkley (1914) (typical coloration); no. 20319; two specimens from Biscayne Bay, south Florida (Jos. Wilcox) (colored like *N. pupa*); no. 20326; one specimen from Cuba (colored something like *N. virginea*, but with bright red, spiral band). Total nine specimens.

The points of difference between the shells of *Neritina virginea* and *Theodoxus meleagris* have already been pointed out. Lamarck's description of the latter, and the figures cited by him, certainly point to a globose, obtuse-spired shell, with yellowish-green general coloration and a pattern suggesting imbricating scales. Such a form occurs in the Antilles and doubtless in Santo Domingo, the type locality. I believe that von Martens' (1879) figures 15 to 21, plate XIV, and Tryon's (1888) figures 31 to 35, 40 to 42, 44 and 45, plate XII, represent *T. meleagris*.

The two American species, *T. meleagris* and *T. luteofasciatus*, may be immediately separated by the golden-chestnut color of the callus in the latter. The color forms of *meleagris* are, in fact, closer to the series in *T. oualaniensis* than they are to those of *T. luteofasciatus*. The shelly deposit between the rib and peg of the operculum is best marked in *T. oualaniensis*, poorly marked in *T. luteofasciatus*, very slight or absent in *T. meleagris*, and completely lacking in all specimens I have seen, from *T. afer*. *T. modicellus* Deshayes (1863) from the Isle of Bourbon, and *T. nouletianus* Gassies (1863) from New Caledonia, probably also belong in this group.

The rather heavy R-central is longer than broad. The upper area is almost quadrate and the tooth is thicker in this portion than it is in *Neritina*, but the posterior edge appears obtuse and easily worn away, so that usually the level upper surface appears to shade gradually into the anterior downward slope. The A-central is not much broader than long. The posterior lobe is very large and

has a convexly rounded, outer slope. The cusp is heavy but the depression along its anterior border is very extensive. The inner margin of the tooth is heavily thickened and slightly concave. The B-central has a rather poorly-developed, cusp-like thickening, with one overhanging, rounded point. The cusp of the C-central is also reduced and the 2 proximal points are very indistinct.

The lateral complex is heavy and solid. The reflection (DE) is broadly lanceolate in outline, and bears a rather prominent major cusp, and plicate minor ones. The inner uncini have elongate blades, which are thicker (more lenticular in cross-section) than in any species of *Neritina* I have examined. The tip is smooth and the serrations appear to be mainly on the upper surface of the outer edge, so that they are rather obscure. The 9th marginal, with 9 cusps, has the longest blade. The uncini are quite close-ranked.

Theodoxus oualaniensis (Lesson) (1830). Oualan Island, Micronesia. (Southern India to Hawaii; southern China and Japan to northern Australia.)

Neritina ualanensis auct.

Plate XIII, fig. 22. A. N. S. P., no. 104319; two specimens from Manila market, Philippines (Alvin Seale, Aug., 1909). The radula of this species differs from that of the type species in the more elongate R-central, with its more distinctly separated upper area, and in the more prominent serrations of the inner uncini. The latter are about as well marked as in *Clithon* s.s.

Theodoxus afer (Sowerby) (1841). Fernando Po (Estuarine and fluviatile; west Africa.)

Plate XIV, fig. 26. A. N. S. P., no. 37685, two specimens from Fernando Po, ex auct. (T. B. Wilson); 121713, 1 specimen (*aequinoxialis*) from Prince Island (Wheatley collection). The upper area of the R-central is broader than long and is very poorly marked posteriad. The posterior lobe of the A-central is more broadly rounded and the inner portion is more extensive than in *T. meleagris;* it thus approaches that of *Clithon* s.s. The serrations of the inner uncini are rather distinct.

Theodoxus luteofasciatus (Miller) (1879). (Estuarine; Lower California to Ecuador).

Neritina picta Sowerby (1833), not Férussac (1825).
Neritina picta luteofasciata Miller (1879).
Neritina picta guttata Miller (1879), not *Nerita guttata* Récluz (1841).
Neritina picta albescens Miller (1879).
Neritina picta nigrofasciata Miller (1879).
Neritina usurpatrix Crosse and Fischer (1892).

A. N. S. P., no. 121466, four specimens from Mazatlan, Sinaloa, Mexico. Troschel: xvi–9. The radula of this species, quite well figured by Troschel, is very similar to that of the preceding species. The upper area of the R-central is broader than long and is somewhat better marked posteriad; the A-central is very similar to that of *T. afer*. The blades of the inner marginals are rather elongate and bear 15 to 16 very fine, but quite sharply-cut serrations.

Section ALINOCLITHON new.

Alinoclithon new. Type *Nerita cariosa* Wood (1828). Africa (*sic*).

This section and the next one are rather distinct from any of the other groups, and perhaps together should constitute a separate subgenus.

Theodoxus cariosus (Wood) (1828). (Fluviatile; Hawaiian Islands).

Plate XIII, fig. 24. A. N. S. P., no. 108818; two alcoholic specimens collected from Anahulu River, at Haleiwa Hotel, Oahu, by H. A. Pilsbry (1913). In shell form, this species bears considerable resemblance to *Alina*, but the heavy, black shell, with weak, spiral striations, shows its relationship to *Neritoclithon*. The peg of the operculum is somewhat reduced.

The upper area of the R-central is broader than long, and does not reach the anterior border of the tooth, as usually seen. The posterior edge is indistinct, as in *Vittoclithon*. The A-central is heavy like that of *Clithon* s.s., but the inner thickening is even more prominent but less extensive, while the posterior point is sharper. The B-and C-centrals are very similar to those of *Neritoclithon*. The lateral complex is heavy and has a very extensive and heavy reflection like that of *Vittoclithon;* it bears a heavy major cusp and plicate minor ones. The heavy blades of the inner uncini are elongate and bear 13 to 14 rather poorly-marked serrations. The blade of the 10th marginal is the longest and also bears 14 cusps.

Section NERITOCLITHON new.

Neritoclithon new. Type *Neritina neglecta* Pease (1860). Hawaiian Islands.

Theodoxus neglectus (Pease) (1860). Estuarine; Hawaiian Islands.

Plate XIII, fig. 25. A. N. S. P., no. 108826, two alcoholic specimens, collected at Kewalo Beach, Honolulu, by H. A. Pilsbry (1913). This species has shell and opercular characters quite similar to *Nerita* (*Heminerita*), and a radula that combines the central field of *Clithon*, with uncini similar to those of *Theodoxus* s.s.

The R-and A-centrals are similar to those of *Alinoclithon*, but the latter tooth is even less transversely elongate, and approaches that of *Vittoclithon*. The B-central is similar to that of *Clithon*, but has a better-marked wing over the anterior notch of the thickening. The C-central shows a slight point near the outer end of the thickening. The lateral complex is quite like that of *Alinoclithon*, but also shows certain resemblances to *Clithon* s.s. in the development of the major cusp and the shape of the outer portion of the tooth. The inner uncini have elongate, heavy blades; the serrations are so poorly developed, especially toward the tip, that they are difficult to distinguish. The 9th blade, with 11 serrations, is the longest.

Subgenus THEODOXUS s.s.

Mainly fluviatile; Europe to Northern Africa and southern Persia; British India?

Section NERITAEA Roth.

Mainly fluviatile; Asia Minor to Persia and the Falls of the Nile; British India?

Neritaea Roth (1855). Type *Neritina jordani* Sowerby (1841). River Jordan.
Neritoconus Kobelt (1871). Type *N. jordani*.

Theodoxus jordani (Sowerby) (1841). (River Jordan and lakes).

Plate XIV, fig. 27. A. N. S. P., no. 37652, two specimens from Judea. Troschel: xvi–22. The radula of this species is very similar to that of the next. The posterior edge of the quadrate upper area is more sharply marked and appears considerably thicker. The A-central is not quite as long. The E-lateral is especially heavy and has somewhat the appearance of that of *Nerita pupa*. The cusps are wide-spaced and easily worn away. The inner marginals appear slightly more elongate, and the serrations are perhaps a trifle better marked.

Section THEODOXUS s.s.

Mainly fluviatile; Europe to north-western Africa and southern Persia.

Theodoxus, Theodoxis Montfort (1810). Type *T. lutetianus* Montfort (1810).
Elea "Ziegler" Fitzinger (1833). Type *Elea serratilinea* "Ziegler" Fitzinger (1833).
Neritoglobus Kobelt (1871). Type *Nerita fluviatilis* Linn. (1758).
Theodoxia Bourguignat (1877). Substitute for *Theodoxis;* same type.

Theodoxus fluviatilis (Linn.) (1758). Europae cataractis.

Theodoxus lutetianus Montfort (1810).
???*Neritina jayana* Récluz (1850). North America (sic.)

Plate XIV, fig. 28. A. N. S. P., no. 20423, one specimen from Calvados, France (Swift collection); no. 20433, three specimens from Goetland, Sweden. Troschel: xvi–16, 17, 18: Loven (1848), etc. The upper area of the R-central is quadrate, and its posterior edge is sharply marked laterad but centrally there is a marked convexity that appears to pass gradually into the anterior slope. The R-central is somewhat like that of *T. meleagris* but has a more rounded posterior point. The B-central is not especially distinctive although somewhat more reduced than in *Vittoclithon*. The middle one of the cusp-like points of the C-central is broadly rounded. The E-lateral is heavy, clear and transparent. The extensive, broadly lanceolate reflection bears a heavy major cusp and about 25, very poorly developed, weak, widely-spaced minor ones. The inner uncini have heavy, glass-like blades with very indistinct serrations, especially obscure toward the tip. I count 7 on the 3rd and 8 to 9 on the 9th (with the longest blade).

Theodoxus transversalis ("Ziegler" Pfeiffer) (1828). River Danube, etc.

A. N. S. P., no. 60221, one specimen from Alt Fluss, Transylvania (E. A. Bielz). Troschel: xvi–20, shows a very much tilted central field. My radula is very poor, but it appears to be similar in type to that of the preceding species. The cusps on the E-lateral are heavier and less numerous.

6. Genus **NERITA** Linn.

Marine; tropics of world.

As regards the radula, this is a quite homogenous genus. *Nerita* s.s. differs from *Puperita* in the special development of the lappets on the basal plate of the R-central, but I am not sure of the value of this rather obscure character, although its presence in *Nerita* s.s. appears quite constant. *Puperita* has a *Vitta*-like operculum, but the peg is somewhat flattened in *Heminerita*, while the rib is compressed, on the inner surface, in *N.* (*Amphinerita*) *morio*. The lack of shell and opercular sculpture in *N. pupa* is also quite distinctive, but *Heminerita* shows transitional stages. In addition to these differences, the history of *Puperita* is almost excuse enough for its retention as a subgenus; it has remained in *Neritina* for over a century.

TABLE IV. NUMERICAL DATA FOR THE SPECIES OF NERITA.

Section	Species	Number of minor cusps on E-plate.	Number of cuspless inner uncini.	Number of uncini in each half-row.
Puperita	*pupa*	25	14–15	99
Heminerita	*bensoni*	70?	16–17	86
	japonica	62?	19	81
Amphinerita	*melanotraga*	about 90	22	91
	morio	about 90	22	88
	picea	about 60	18	77–80
	polita	about 75	22	60?
Theliostyla	*albicilla*	about 65	12 (20)	78
	tessellata (young)	about 50	16	78
	t. fulgurans	about 100	22	79
	textilis	few, indistinct	20	75
Pila	*ornata*	about 70	20	68–71
	undata	present	18	61
	reticulata	present	19	63
	plicata	over 80	22	71
Nerita s.s.	*versicolor*	about 100	24	82
	peloronta		27	84

Subgenus PUPERITA Gray.

Marine; West Indies and Pacific Islands.

Section PUPERITA s.s.

Florida and Bahamas to Guadeloupe.

Puperita Gray (1857). Type *Nerita pupa* Linn. (1758). Jamaica.

Nerita pupa pupa Linn. (1758). (Distribution as section.)

Neritina venosa Menke (1828).
Neritina delineata "Boubée" Villa (1841).
Neritina liturata, in synonymy.

Plate XIV, fig. 29. A. N. S. P., no. 77209, three specimens, collected at Havana, Cuba by S. N. Rhoads. The R-central is very elongate, and bears an elongate, sharply marked, upper area, which is supported by a definite, medial thickening. The A-central is very similar in shape to that of *Theodoxus* s.s. but is still heavier and longer. The B– and C–central are still more reduced. The capuliform complex is very heavy and thoroughly fused together; the D-element is much reduced. The extensive, heavy reflection bears a prominent major cusp and about 25 vestigial points or plications, which can be seen only on the unworn teeth. The inner uncini are short and heavy, but bear long, cuspless blades. The cusps develop quite rapidly beyond the 15th marginal.

Nerita pupa tristis (d'Orbigny) (1845). Cuba.

Section HEMINERITA von Martens.

Pacific Islands.

Heminerita von Martens (1887). Type *Nerita pica* Gould (1859). Japan.

Nerita bensoni (Récluz) (1850). Lord Hood Island (Southern Polynesia.)

Neritina reticulata Sowerby (1833). Not *Neritina reticulata* Cristofori and Jan (1832), nor *Nerita reticulata* Karsten (1789). Lord Hood Island.
Neritina desmoulinsiana Récluz (1850). Nouka-Hiva.

Plate XV, fig. 32. A. N. S. P., no. 20398, one specimen from Paumotu Islands (W. H. Pease). The R-central has a quadrate upper area; but the horizontal portion is broader than long, and is separated quite distinctly from an anterior area, which slopes slightly downward. The posterior lobe of the A-central is more extensive than in *N. pupa*. The major cusp of the E-lateral is reduced to a small, thorn-like point. My radula lacks the unworn teeth, and no definitive minor cusps can be made out on those that remain. However, about 70 minute plications are present inside of the edge; these possibly represent the positions of the vestigial cusplets. The exterior of the operculum of this species is practically smooth, but those of the following ones show minute granulations. Récluz appears to have been aware that *N. reticulata* Sowerby was preoccupied, as he proposed *N. bensoni* as a substitute.

Nerita japonica Dunker (1859). Japan (Japan and Micronesia.)

Nerita pica Gould (1859), Japan. Not *Nerita pica* Gmelin (1791).
Neritina rudis Pease (1867). Caroline Islands. Not *Nerita rudis* Wood (1828).

Plate XIV, fig. 30. A. N. S. P., no. 37543, two specimens of *N. rudis*, ex auct. I have not seen the operculum of Japanese specimens, but *N. rudis* appears practically identical in shell characters. The radula examined is very similar to that of *N. bensoni*. The horizontal portion of the upper area of the R-central is broader and more distinctly marked. In my specimens, the minor cusps are worn away from the E-plate.

Nerita amoena (Gould) (1847). (Viti, Samoa, Phoenix Island).

Theodoxus godeffroyanus Mousson (1869). Phoenix Island.
???*Neritina tenebricosa* C. B. Adams (1852). Jamaica.

A. N. S. P., no. 121455, fragments of a radula from Viti. On preliminary examinations, this was seen to be very close to that of *N. japonica*, but it disintegrated after being mounted, so I cannot describe it accurately.

One author's specimen of *N. tenebricosa* (cotype?), without operculum, is in the A. N. S. P. It is very similar to *N. amoena*, although the spire is slightly more prominent. A number of complete specimens will be necessary to fix its status.

Subgenus NERITA s.s.

Marine littoral; tropics of world.

The radulae of this group show very little diversity. While certain of the presence of the basal lappets on the R-central of all species of *Nerita* as examined, I am not so sure of their absence in *Heminerita*. Traces of numerous, vestigial, minor cusplets are almost always present on the E-lateral; they appear to increase in number with the age of the animals, but to decrease in size and regularity.

Section AMPHINERITA von Martens.

Indo-Pacific; Red Sea to Peru.

Odontostoma "Klein" Moerch (1852). Not Turton (1829), nor d'Orbigny (1845). Type *Nerita polita* Linn. (1758). Oceans Asia.
Amphinerita von Martens (1887). Type *Nerita umlaasiana* Krauss (1848). Natal.
Melanerita von Martens (1889). Type *Nerita nigra* "Gray" von Martens (1887). South Australia, New Zealand.

Nerita melanotraga E. A. Smith (1884). South Australia, New Zealand.
Nerita nigra "Gray" von Martens (1887); not Dillwyn (1817).

Plate XIV, fig. 31. A. N. S. P., no. 94091, four specimens from Victoria, Australia (F. H. Baker). Below the portion that corresponds to the base of the R-central of the preceding groups, is a central T-shaped thickening. Each end of the anterior cross-bar of this T is continuous with the lower edge of a large basal lappet, which extends laterad from the margin of the anterior slope, below the inner end of the A-central. The body of the last is almost rectangular due to the striking convexity of the outer slope of the posterior lobe. The inner lobe, for articulation with the B-central, has a raised tooth above the inner margin of the body, and a larger wing below it. The lateral complex is heavy and bears an extensive, thickened reflection. The elongate D-lateral is quite prominent, but the E-lateral extends beyond it in all directions. The major cusp is represented simply by the smooth, terminal angulation of the reflection, while the minor ones are very weak and numerous; they are usually worn away in the anterior teeth, and often cannot be seen (dissolved away?) in the posterior (newer) ones. The inner marginals have long, heavy, close-ranked blades.

Nerita morio (Sowerby) (1833). Easter Island (to New Guinea.)

A. N. S. P., no. 37535, three specimens from New Guinea, ex auct. The radula of this species is practically identical with that of the preceding one; in fact, I am inclined to agree with Tryon's (1888) suggestion that these two forms are hardly separable species. Specimens from the eastern Pacific Islands are somewhat smaller and smoother than those from which my radulae were obtained, but the series of *melanotraga* from a single Australian locality shows more variation than that represented by these differences.

Nerita picea Recluz (1841). Hawaiian Islands.

A. N. S. P., no. 108828, two specimens (in alcohol), collected at Momoomi, Molokai, by H. A. Pilsbry (1913). Troschel: xvii–9. The upper area of the R-central is broader than in the preceding species, and the A-central is broader, and approaches that of *N. polita* in shape.

Nerita cerostoma Troschel (1852). Peru.

Radula: vii-7. I have seen no specimens.

Nerita polita Linn. (1758). (Entire Indo-Pacific and Australia).

Plate XV, fig. 33. A. N. S. P., no. 37519; two specimens from Philippines (T. B. Wilson). Troschel: xvii–3. The A-central is more strikingly rectangular than in *N. melanotraga*, and the inner thickening is continued down the posterior edge of the inner lobe. The inner 22 uncini lack conspicuous cusps, but, from about the 10th to the 15th, minute crenulations are visible, but may be due to warping. My radulae are rather poor, and I am uncertain as to the accuracy of the marginal count (Table 4). The specific distinction of *N. umlaasiana* is doubtful, and its sectional separation appears impossible. Troschel also figures (xvii–10) the radula of *N. yoldii* Recluz (1841).

Section THELIOSTYLA Moerch.

Tropics of world.

Theliostyla Moerch (1852). Type *Nerita albicilla* Linn. (1758). Habitat?
Natere Gray (1858). Type *Nerita albicilla.*
Ilynerita von Martens (1887). Type *Nerita planospira* Anton (1839).

Nerita planospira Anton (1839). (East Indes to Melanesia; Japan to Australia).

Troschel's figure (xvii–20) shows larger and fewer cusps on the E-lateral than is usual in *Nerita* s.s. The exterior of the operculum is practically smooth. I have not been able to obtain a radula.

Nerita albicilla Linn. (1758). Africa to Tahiti; China to Australia.

A. N. S. P., no. 30078, one specimen, Cape Good(sic). Troschel: xviii–7. The teeth of the central field of my radula are so badly warped that no accurate description can be given; they seem quite similar to those of *fulgurans*. The vestigial cusps of the E-lateral are more distinct and regular than in the adults of the other species of this group, but less so than in *N. melanotraga*. Although the blade of the 13th uncinus shows minute serrations, distinct cusps do not appear until the 20th.

Nerita tessellata tessellata Gmelin (1791). (Florida to Venezuela).

Nerita tessellata Gmelin (1791). Islands between Africa and Middle America.
Nerita antillarum Gmelin (1791). Antilles.
Nerita striata Chemnitz, auct.
Nerita angulata "Bolten" Roeding.
Nerita nigreola "Bolten" Reading.
Nerita exarata Pfeiffer (1840).
Nerita listeri Récluz (1841). Pacific Ocean.
Nerita tadin Récluz (1850).
Nerita varia "Meusch" Moerch (1852).
??*Nerita nivosa* Reeve (1855). Habitat?
??*Nerita commanotata* Reeve (1855). Habitat?
??*Nerita scalpta* Reeve (1855). Habitat?
Nerita tessellata recluziana von Martens (1887).

My field number M 260; breakwater, Puerto Cabello, Venezuela; one specimen in alcohol. Troschel: xvii–18, 19; xviii–5. My radula is from a small, probably young specimen, which accounts for the small number of cusps on the E-lateral. The other characters are practically identical with those of the next form.

Nerita tessellata fulgurans Gmelin (1791). (West Indies; Honduras to Brazil).

Nerita fulgurans Gmelin (1791). Islands of America.
Nerita praecognita C. B. Adams (1845). Jamaica. Light-colored variety.
??*Nerita genuana* Reeve (1855). Habitat?
??*Nerita albipunctata* Reeve (1855). Habitat?

Plate XV, fig. 34. A. N. S. P., no. 20128, three specimens (*praecognita*), St. Thomas, W. I. This radula is quite similar to that of *Nerita melanotraga*. The subbasal thickening appears double. The A-central is markedly rectangular, and the cusp is distinct only the outer end. The thickening of the B-central has an extensive wing, which overlies the inner point of the C-central. The anterior portion of the base of the C-plate is very heavy and fits under the larger, inner wing of the lateral complex. The minor cusps of the E-lateral are irregular in shape and size, but extend almost to the inner angulation (major cusp) of the reflection.

Nerita tessellata bernhardi Récluz (1850). (Gulf of California to Panama and Galapagos. Peru? Chile?).
Nerita funiculata Menke (1850).

Troschel: xvii–17.

Nerita textilis Gmelin (1791). (East Africa to British India).
Nerita plexa Chemnitz.

Plate XV, fig. 35. A. N. S. P., no. 37468, one specimen without locality (T. B. Wilson). Troschel: xvii–14, 15. This radula is very similar to that of *fulgurans*. The upper area of the R-central is heavier and more distinct, and, in fact, approaches that of the next group. Although my radula is complete, I am able to find only a few, exceedingly reduced cusps on the outer portion of the reflection of the E-lateral. Troschel also figures the radulae of *N. lineata* Gmelin (1791) (xvii–5, 6); *Nerita patula* Recluz (1841) (xviii–3); *Nerita chamaeleon* Linn. (1758) (xviii–2); and *Nerita exuvia* Linn. (1758) (xviii–16). The last species has often been considered the type of the genus *Nerita* (Children, 1823).

Section PILA Moerch.

Tropics of world.

Pila "Klein" Moerch (1852). Type *Nerita plicata* Linn. (1758). Indian Ocean.
Ritena Gray (1858). Type *Nerita plicata*.
Cymostyla von Martens (1887). Type *Nerita undata* Linn. (1758).

Nerita ornata Sowerby (1820–24). (Gulf of California to Panama and Galapagos).
Nerita scabricosta Lamarck (1822). Habitat?
Nerita fuscata Menke (1829).
Nerita deshayesii Recluz (1841). California.
Nerita multijugis Menke (1847).

Plate XV, fig. 36. A. N. S. P., no. 107102; three specimens, Panama (S. N. Rhoads). Troschel: xvii–7, 12. The radula of this species appears almost as close to that of *Amphinerita* as to that of the other species of *Pila*. The upper area of the R-central is heavier and more nearly quadrate than in *fulgurans*, and the upper, lateral wings are reduced in extent. The cusp of the somewhat broader and heavier A-central is reduced to a beak, at the outer end of the anterior edge of the tooth. The B- and C-centrals are much as in the preceding species. The vestigial cusps of the E-lateral are rather well marked. The elongate blades of the inner uncini are very closely ranked.

Nerita undata Linn. (1758). (East Indies to China and Melanesia).

A. N. S. P., no. 37509, one specimen (*leguillouana*), Hongkong, China (B. Schumacher). Troschel: xvii–8. My specimen is poor,

but the radula is evidently similar to that of *N. plicata*, rather than to that of *N. ornata*. The upper area of the R-central is almost quadrate.

Nerita reticulata Karsten (1789). (East Indies to Tahiti and Australia).

A. N. S. P., no. 37486; one specimen, Tahiti (W. H. Pease). Troschel: xviii–1. The radula of this species is similar to that of *undata* and *plicata*. Troschel says the E-plate is cusped; my radula does not show them distinctly.

Nerita plicata Linn. (1758). (Indian and Pacific Oceans).

Plate XV, fig. 37. A. N. S. P., no. 128616, three specimens (in alcohol), Oahu, Hawaii (W. H. Jones). Troschel: xvii–11. The upper area of the R-central is almost quadrate, and the entire anterior end is thick and almost opaque. Both the lower lappets and the upper wings are reduced in extent, and only overlap the inner, thinnest portion of the inner lobe of the A-central. The cusp of the A-plate, is still more reduced in size than in *N. ornata*, but the body is heavy and rectangular. The inner lobe is especially large and heavy. The B- and C-centrals are similar to those of *fulgurans*. The E-lateral has quite distinct, vestigial cusplets almost to the pointed, inner end of the reflection. The blades of the inner uncini are elongate and the inner 2 or 3 are pointed.

Section NERITA s.s.

Nerita Linn. (1758). Type (chosen by Montfort, 1810.) *Nerita peloronta* Linn. (1758).
Neritarius Dumeril (1806). Substitute for *Nerita;* same type.
Peloronta Oken (1815). Type *N. peloronta* Linn.
Tenare Gray (1858). Type *N. peloronta* Linn.

Two species have been commonly considered as the type of this genus, *Nerita polita* and *Nerita exuvia*. I do not know the reason for the use of the first; but the second is doubtless due to Lamarck's (1798, 1801) citation of that species as the example of the genus. However, Lamarck is not the author of the name nor of *Nerita* s.s., so I prefer the first definite mention of a type, that by Montfort.

Nerita versicolor Gmelin (1791). Antilles (Bermuda and Florida to Columbia and Cayenne.)

Nerita variegata Chemnitz.
Nerita tricolor Gmelin (1791). West shore of Africa.
Nerita pica Gmelin (1791). Indian Ocean.
Nerita flammea Gmelin (1791). Islands Middle America.
Nerita musica "Bolten" Roeding.
Nerita tessellata "Bolten" Roeding.
Nerita selot "Adanson" Reeve (1855).

Plate XV, fig. 38. A. N. S. P., no. 88025, five specimens, Hailer's Rock, off Bahia Honda Key, Florida (Fowler and Brown, 1904). Troschel: xviii–4. The radula of this species is somewhat like that of *N. plicata* but approaches most closely that of *N. peloronta*. The upper area of the R-central is about as long as broad. The A-central is very heavy; the inner lobe is somewhat reduced; and the posterior point is near the middle of the breadth. The reflection of the E-lateral has about 100, very indistinct points. The inner uncini approach those of *N. peloronta*.

Nerita peloronta Linn. (1758). O. Asiae ad Bandam (Bermudas and Florida Keys to Venezuela.)

Nerita papilio "Bolten" Roeding.
Nerita vrginea "Bolten" Roeding.
Nerita erythrodon Récluz (1850).

Plate XVI, fig. 39. A. N. S. P., no. 129161, three fresh specimens, Morro Castle, Havana, Cuba (C. B. Clark, May 18, 1921). Troschel: xvii–4. The R-central is noticeably elongate and the upper area is slightly longer than broad. The A-central is very heavy and is coarsely thickened at the inner and outer ends and under the cusp. The inner lobe is very small, but heavy. The B- and C-centrals do not differ markedly from those of *fulgurans*. The heavy, extensive reflection of the E-lateral is not distinctly angulate at the inner end, and the plications are scarcely visible, although present, especially toward the outer end of the margin. The blades of the inner uncini are quite markedly pointed, and are thickened by a ridge along the lower side, so as to be triangular in cross section. The first 27 are without serrations and definite cusps do not appear until beyond the 30th. The edges of all of my radulae curled under, due to a protracted stay in the alkali, but I am able to count the bases on one inverted specimen.

II. Subfamily NERITILINAE.

Fresh-water; locally in tropics of America, Africa, and the Pacific Islands.

Neritilidae Shepman (1908).

7. Genus **NERITILIA** von Martens.

Distribution as the subfamily.

Neritilia von Martens (1879). Type *Neritina rubida* Pease (1867). Tahiti.

Neritilia rubida (Pease) (1867). Tahiti (also Melanesia.)

Plate XVI, fig. 42. A. N. S. P., no. 37675, from Tahiti, ex. auct. Schepman's (1908, viii–5) description of this radula is far better than his figure.

The R-central appears to be completely lacking. The A-central is very large, but extremely thin. The inner end is somewhat spoon shaped and laps over the one on the opposite side. The concave, anterior border is very oblique to the transverse axis of the radula, is somewhat thickened throughout its length, and is slightly reflected at the outer end, so as to form a weak, rounded cusp. The entire anterior portion of the A-plate is fundamentally similar to that of the A-central of the preceding groups, but the terminal thickenings are very weakly developed. The posterior portion of the body forms an enormous, spatulate lobe, which is very thin. This lobe overlaps the row next posteriad, always masks the cusp of the A-central of that row, usually covers the B- and C-centrals, and may overlie even the inner end of the lateral complex. Thus the entire central field must be quite unable to assist in the rasping of food-material.

The reduced cusp of the B-central fits under the cusp of the A-central, as is usual in the Neritidae. The most prominent feature of this tooth is a finger-shaped thickening along the anterior border; with the thin base itself, this forms a socket which receives the inner end of the C-central. The entire B-central is included as part of the A-central in the figures of previous writers. The C-central is almost rectangular in shape as shown in the upper figure, but appears lanceolate when tilted inward, as is often the case (lower figure). The distal thickening bears a stout, triangular cusp, which fits into the socket in the B-central, already described.

The lateral complex is very oblique to the transverse axis of the entire radula. The D-lateral is practically vestigial. The E-lateral bears 15 to 18, large, sharp cusps, which are smaller at both ends of the reflection. The absence of a large inner cusp may be correlated with the fact that this end is overlapped by the cusp of the C-central and often by the posterior lobe of A-central. The thin, outer lobe of the E-plate is omitted in previous figures.

The 184 uncini are exceptionally well developed. The inner ones are rather broad, and the bases show the elongate, inner point, which appears to be quite characteristic of the Neritidae. Each is thickened at the base and up the inner side. The distal end, in at least the innermost 50, bears six, heavy, aculeate cusps, arranged in a slightly oblique row across the broad tip. Just under this cusp-bearing portion, the inner margin is produced into a thin, triangular lobe or cusp, more like that of *Helicina* s.s., than of *Neritodryas*.

The outer uncini are similar to the type present in all Neritid and Helicinid groups.

For purpose of comparison, the radula of *Neritopsis radula* (Linn.) was also examined (A. N. S. P., no. 37287, one radula mounted in balsam by H. A. Pilsbry, and labeled Mauritius), and is figured here (Plate XVI, fig. 40). The R-central is absent, but there are three small, elongate, lanceolate teeth on each side of the central field (figured as tilted inward). The outermost of these is the smallest and is difficult to distinguish, on account of the refraction of light from the others and from the adjacent edge of the lateral. Each bears a reflected cusp at the anterior end. A single large, ladle-shaped tooth appears to represent the lateral complex. This tooth is thickened at the base, and up a portion of the inner edge, but I do not believe any separate piece can be recognized. As near as I could make out, the inner 136 uncini bear long, entire blades. Fischer's (1875) figure shows only the anterior edge of these teeth. Basally, the body of each of the innermost teeth is a very large plate with a long point, which is directed inward and posteriad. Distally the upright body becomes narrower and the cusp is borne almost parallel to the long axis of the base. In the outer teeth, the slender, distal portion is much longer. At about the 130th tooth, the blade appears to break up quite suddenly into fine aculeate cusps; this apparently sudden change possibly may be due to my inability to see the intermediate stages. The total number of marginals appears to be approximately 250, and the outer scale-like teeth of the Neritidae and the Helicinidae appear to be lacking. As I count 260 transverse rows, the total number of teeth must be around 132,000.

The radula of *Neritopsis radula* is certainly a very highly specialized type. The primitive, lanceolate shape of the paired centrals, the structure of the lateral, and the apparent absence of the characteristic scale-like or rectangular, outermost uncini, appear to indicate that the divergence of this family antedates the separation of the Neritidae and the Helicinidae. Generalizations, in regard to such a highly specialized and divergent radula, are rather dangerous; but, it is certainly safe to state that the radula gives no indication of even approximate relationship with the Neritilinae, or with any other Neritid or Helicinid group that I have studied.

Neritilia succinea succinea (Récluz) (1841). Guadeloupe.

Plate XVI, fig. 41. A. N. S. P., no. 20457, three specimens from Guadeloupe (Swift collection). The radula of this species is very similar to that of *N. rubida*. One hundred and seventeen transverse rows are present in one radula that appears quite complete, and there are 196 uncini in one of the half-rows counted, making a total of about 47,000 teeth. This is a very large number of marginals for such a small species. The increase in the number and the development of the uncini, in this genus and in *Neritopsis*, appears to balance the reduction of the central field.

The lobe of the A-central of this species seems a little narrower and heavier than that in *N. rubida*, and the cusp is also a little better marked.

Neritilia succinea guatemalensis Pilsbry (1919). Cavech River, Guatemala.

Pilsbry's figures of the radula of this subspecies represent very exactly the appearance of that of the typical form, as seen under any magnification less than that obtained by the use of an oil-immersion objective. The radula of *Neritilia* is exceedingly minute.

III. Subfamily SMARAGDINAE.

Marine; West Indies; Mediterranean Sea; Indo-Pacific Ocean.

8. Genus **SMARAGDIA** Issel.

Distribution as the subfamily.

Subgenus SMARAGDELLA new.

Indo-Pacific Ocean.

Smaragdella new. Type *Neritina* (*souverbiana*) *hellvillensis* Crosse (1881). Hellville, Nossi-Bé, Madagascar.

Smaragdia souverbiana souverbiana (Montrouzier) (1863). Jejen, New Caledonia. (Japan to Australia.)

Smaragdia souverbiana hellvillensis (Crosse) (1881). (Islands near Madagascar).

Plate XVI, fig. 43. A. N. S. P., no. 37681; two specimens, Mayotte Island (E. Marie). The R-central has a narrowly ovoid base, with a smaller thickening of the same shape over the center. The anterior end of this is thicker than the remainder, and the two portions are separated by a marked, vertical surface, which must act as a sort of cusp. The A-central is almost regularly hexagonal in shape, and bears transversely across its middle, a strongly raised cusp of much the same general structure as is general in the Neritidae. The posterior point extends up over the next A-plate posteriad; the entire posterior portion is thicker than usual, and must

act as a definite cusp. The B-plate has a large, thin base, but the cusp-like thickening is reduced to a small, kidney-shaped nodule, which fits over the outer end of the A-central, under the cusp, as in the typical subfamily. The C-plate is not especially peculiar, and bears three, irregular, cusp-like points. The lateral complex is very broad, and appears elongated transversely. The portion that corresponds to the D-plate is poorly developed, but similar to that in *Pseudonerita*. The portion of the E-plate outside of the D-lateral is almost as large as is the remainder of the tooth. The reflected, anterior portion is very heavy, and bears a large, conoid cusp at the inner end, and 5 smaller ones of similar shape on the remainder of its free edge. The first marginal overlies the outer portion of the E lateral and reaches almost to the D-lateral. It is very large and heavy, and bears a thick, but slight, distal thickening, which appears to be perfectly smooth. The remainder of the marginals (22 counted) are much smaller and resemble in shape the outer, rectangular uncini, characteristic of the other subfamilies of the Neritidae and all of the Helicinidae. The second marginal bears 19, very fine, aculeate cusps, which are arranged in a row along its slightly oblique, distal end. The rows of uncini are very oblique, and the rather heavy bases form an almost longitudinal row at the outer edge of the radula.

Subgenus SMARAGDIA s.s.

West Indies; Mediterranean; Indo-Pacific?

Smaragdia Issel (1869). Type *Nerita viridis* Linn. (1758). Minorca; Jamaica.
Gaillardotia Bourguignat (1877). Type *Nerita viridis*.

Smaragdia viridis (Linn.) (1758). (Bermudas; Florida and Mexico to Trinidad; Madeiras, Canaries, Mediterranean Sea).

A. N. S. P., no. 20458, bits of one specimen, Key West, Florida (H. Hemphill). Troschel: xvi–21. I was unable to obtain a complete specimen of the radula of this species, but succeeded in washing out samples of the various larger teeth. Although not sufficient for a detailed study, these show that the structure is very similar to that of *Smaragdella*.

Only the large, inner cusp and the nearest small cusps are present on the E-plate; both of these are thinner than in *Smaragdella*, and the latter is conspicuously reduced in size. The third, outer point of Troschel's figure is undoubtedly the corner of the first marginal, which fits over the E-plate to about the position of the point shown.

The first uncinus actually is very similar in shape and size to that of *Smaragdella*. The other marginals appear to be thinner, longer and more slender than in *hellvillensis;* they also bear numerous, very fine, needle-like cusps, which are so delicate that Troschel apparently was not able to detect them. Except for the points noted, his figure gives a very good idea of the general appearance of the radula.

IV. INCERTAE SEDIS.

Three groups of shells, two among the thalassoid species of Lake Tanganyika, have been refered to the Neritidae by various writers. Until their opercula and radulae are known, little can be said of their true affinities. I have only seen specimens of *Stanleya neritinoides*.

STANLEYA Bourguignat.

Stanleya Bourguignat (1885). Type (definitely stated) *Lithoglyphus neritoides* "Smith (1880, 1881)" Bourguignat (1885).
Rumella Bourguignat (1885). Type *Rumella giraudi* Bourguignat (1885).

Stanleya neritinoides (Smith) (1880, 1881).

Lithoglyphus neritinoides Smith (1880, 1881).
Stanleya neritoides Bourguignat (1885). Substitute or misspelling.
Rumella giraudi Bourguignat (1885) (Teste E. A. Smith, 1904). Not *Stanleya giraudi* Bourguignat (1885).

COULBOISIA Bourguignat.

Stanleya Bourguignat (1885). In part, but not the type.
Coulboisia Bourguignat (1888). Type *Stanleya giraudi* Bourguignat (1885).
Stanleya Bourguignat (1888). Type *Stanleya neritoides* Bourguignat (1888).

Coulboisia giraudi (Bourguignat) (1885).
Coulboisia smithiana (Bourguignat) (1885).
Coulboisia rotundata (Smith) (1904).

Stanleya neritoides Bourguignat (1888). Description and figure, teste Smith (1904), not *S. neritoides* Bourg. (1885), which is simply a misspelled citation.

MAGADIS Melvill and Standen.

Magadis Melville and Standen (1899) Monotype *M. eumerintha* M. and S. (1899) Channels between reefs, Mér, Torres Straits.

Description of Plates IX–XVI.

The figures are numbered consecutively under the left end of each. Under the number is given a hair line, which represents an actual size of 50 microns (.05 millimeters). All of the teeth in a single figure are under the same magnification, unless especially noted, either by an additional hair line or, in the case of uncini, by a dotted line, between the more highly magnified figure and one with the enlargement of the remainder of the teeth. The marginals are numbered from the inner end of the series out.

In the key to each figure is given the A. N. S. P. lot number of the specimens from which the radula figured was obtained. The second figure in parentheses gives the relative magnification. To assist in the comparison of the various figures, figure 1 is taken as unit magnification, and all of the other magnifications are expressed in terms of this unit. Figure 1 was originally drawn under an enlargement of about 300 diameters.

The teeth are represented, as nearly as possible, in their proper position in respect to the transverse and longitudinal axes of the entire radula, although not in respect to each other. The R–and A–centrals are usually shown in position, while the B–and C–centrals are separated, but retain their proper position in respect to the transverse row. The lateral complex is shown separated from the others, and usually also as if moved anteriad, so as to bring it in a line with the remainder.

Plate IX.—*Neritina* (*Vitta*) *virginea reclivata* (M269).

Fig. 1.—The transverse row. (×1). Central and lateral fields and left marginal field of one transverse row. Left central and lateral fields of the one next anteriad also included to show relationships. R-, A-, B- and C-centrals, also D-and E-laterals, indicated by their letters.

Fig. 2.—Individual teeth. (×1¾.)

R-central.
- A....base, seen through upper portions.
- B....wings; overlap E of A-central.
- C....overhanging anterior slope; seen as transparent half-ellipse.
- D....thickened upper rim, or cusp-edge.

A-central.
- E....inner lobe; lies under B of R-central.
- F....inner thickening of body.
- G....cusp.
- H....body or basal portion.
- J....inner notch, for articulation with P of B-central.
- K....thickened outer edge of lower surface; under cusp.
- L....inner lobe; overlaps base of B-central.
- M....posterior lobe of shelf; slopes downward.
- N....posterior lobe and point.

B-central.
- O....thin, basal plate.
- P....cusp-like thickening.
- Q....notch for articulation with S of C-central.

C-central.
- R....thin, basal plate.
- S....cusp-like thickening; projects into Q of B-central.

2DE=capituliform or lateral complex united.

2D=separate D-plate (separation largely theoretical.)
- T....base.
- U....Y-thickening on under-side.
- V....outer projection of inner arm of Y-thickening.
- W....tip of inner arm of Y-thickening.
- X....tip of outer arm of Y-thickening.

Y....posterior wing; directed upward to articulate with tooth posteriad.
Z....anterior wing; directed downward for support.
2E=separate E-plate, tilted backward (separation largely theoretical.)
A....body.
B....innermost end of base of body (see 2 DE).
C....thickening just outside of D-lateral.
D....anterior, thickened, cusp-bearing reflection.
E....major, inner cusp.
F....portion underlying D-lateral.
1....1st marginal.
8....8th marginal.

Fig. 3.—Marginals. (×4.) Blades of 3rd, 6th, 12th and 20th; outer view of 30th (approximately); inner view of 63rd.

PLATE X.—*Neritina* (*Vitta*) and *Neritina* (*Neripteron*).

FIG. 4.—*N.* (*Vitta*) *glabrata.* (113143.) (×3.) Centrals, lateral complex, and tips of 1st and 3rd marginals.

Fig. 5.—*N.* (*Vitta*) *zebra.* (105216.) (×2.) Lateral complex.

Fig. 6.—*N.* (*Vitta*) *virginea virginea.* (87919.) (×1¼.) Anterior view of reflection of E-lateral, to show shape and extent.

Fig. 7. *N.* (*Vitta*) *virginea virginea.* (87919.) (×2¼.) Centrals and lateral complex. Note: B- and C-centrals tilted inward.

Fig. 8. *N.* (*Alina*) *oweniana.* (×1¾.) R-and A-centrals, lateral complex, and blade of 3rd marginal.

Fig. 9.—*N.* (*Neripteron*) *taitensis.* (121668.) (×1¾.) R- and A-centrals, lateral complex and blade of 3rd marginal.

PLATE XI.—*Neritina* (*Neripteron*) and *Neritina* (*Vittina*).

Fig. 10.—*N.* (*Dostia*) *violacea.* (20560.) (×1¾.) R- and A-centrals; lateral complex.

Fig. 11.—*N.* (*Vittina*) *gagates.* (20537.) (×3.) Centrals, lateral complex, and blades of 1st and 3rd marginals.

Fig. 12.—*N.* (*Vittina*) *roissyana.* (77295.) (×1¼.) R- and A-centrals; lateral complex and tip of 5th marginal. Also outline of reflection of E-lateral (E) from a younger specimen, to show shape and extent.

Fig. 13.—*N.* (*Provittoida*) *smithii.* (121658.) (×1.) R- and A-centrals; lateral complex; and blade of 3rd marginal. A-central tilted backward; complex tilted up at inner end.

Fig. 14.—*N.* (*Vittoida*) *variegata.* (98297.) (×1.) Centrals; lateral complex; and tip of 3rd marginal. A-central tilted backward; complex tilted down at inner end.

Fig. 15.—*N.* (*Vittoida*) *turtoni.* (121483.) (×1.) Outline of reflection of E-lateral, viewed from anterior end, to show shape and extent.

PLATE XII.—*Neritina* sensu strictu; *Pseudonerita* and *Neritodryas.*

Fig. 16.—*N.* (*Nereina*) *punctulata.* (20491.) (×1.) R- and A-centrals, and lateral complex.

Fig. 17.—*N.* (*Neritina s.s.*) *pulligera.* (20482.) (×1¼.) Centrals and lateral complex; lateral complex viewed from posterior end, to show shape and extent of reflection (DE); blade of 3rd marginal (also shown more highly magnified); inner view of 3rd and 25th marginals (approximate number only). The C-central and the lateral complex are tilted down at their inner ends.

Fig. 18.—*Pseudonerita holoserica.* (37599.) (×2¼.) R- and A-central; lateral complex and tip of 1st uncinus; also tip of 1st and 4th marginals under greater magnification. (×3¾.)

Fig. 19.—*Neritodryas cornea.* (121589.) (×2¼.) Tips of 1st and 9th marginals as usually seen; tip of 11th marginal tilted backward to show underside of blade.

Fig. 20.—*Neritodryas cornea.* (121589.) (×1¼.) Centrals, lateral complex, and 1st and 3rd marginals.

PLATE XIII.—*Theodoxus (Clithon).*

Fig. 21.—*T. (Clithon) corona* (77293). (×1¼.) Centrals, lateral complex, and tips of 3rd and 9th marginals.

Fig. 22.—*T. (Vittoclithon) oualaniensis.* (104319.) (×2.) R- and A-central; lateral complex; and tip of 3rd marginal.

Fig. 23.—*T. (Vittoclithon) melcagris.* (119002.) (×1¼.) Centrals, lateral complex and tip of 3rd marginal; also the last under higher magnification; and the outline of the reflection of the E-lateral (DE) as viewed from the posterior end of the tooth.

Fig. 24.—*T. (Alinoclithon) cariosus.* (108818.) (×1¾.) R- and A-centrals; tip of 3rd marginal (also under greater magnification); and lateral complex.

Fig. 25. *T. (Neritoclithon) neglectus.* (108826.) (×1¼.) Centrals, lateral complex and tip of 3rd marginal.

PLATE XIV.—*Theodoxus* and *Nerita.*

Fig. 26.—*T. (Vittoclithon) afer.* (37685.) (×2.) R-and A-centrals and tip of 3rd uncinus.

Fig. 27.—*T. (Neritaea) jordani.* (37652.) (×2.) R-and A-centrals and tip of 10th uncinus.

Fig. 28.—*T. (Theodoxus* s.s.) *fluviatilis.* (20423.) (×2.) Centrals, lateral complex and tip of 3rd marginal.

Fig. 29.—*N. (Puperita) pupa.* (77209.) (×1¾.) Centrals, lateral complex, and tip of 10th uncinus.

Fig. 30.—*N. (Heminerita) japonica.* (37543.) (×1¾.) R-and A-centrals. DE=lateral complex viewed from anterior end, to show shape of reflection. (×¾.)

Fig. 31.—*N. (Amphinerita) melanotraga.* (94091.) (×1.) Centrals, lateral complex, and tips of 10th, 27th and 44th uncini. Also the two latter under greater magnification, and a detail of the edge of the reflection of the E-lateral (E) very much magnified.

PLATE XV.—*Nerita.*

Fig. 32.—*N. (Heminerita) bensoni.* (20398.) (×1¾.) R-and A-centrals.

Fig. 33.—*N. (Amphinerita) polita.* (37519.) (×1¼.) R-and A-centrals.

Fig. 34. *N. (Theliostyla) tessellata fulgurans.* (20128.) (×¾.) Centrals, lateral complex (cusplets not shown), and tip of 10th uncinus.

Fig. 35.—*N. (Theliostyla) textilis.* (37468.) (×¾.) R-and A-centrals.

Fig. 36. *N. (Pita) ornata.* (107102.) (×1.) R-and A-centrals.

Fig. 37. *N. (Pila) plicata.)* (128616.) (×1¼.) R-and A-centrals.

Fig. 38.—*N. versicolor.* (88025.) (×¾.) R-and A-centrals.

PLATE XVI.—*Nerita, Neritopsis, Neritilia* and *Smaragdia.*

Fig. 39.—*Nerita peloronta.* (129161.) (×¾.) Centrals, lateral complex and tip of 10th marginal.

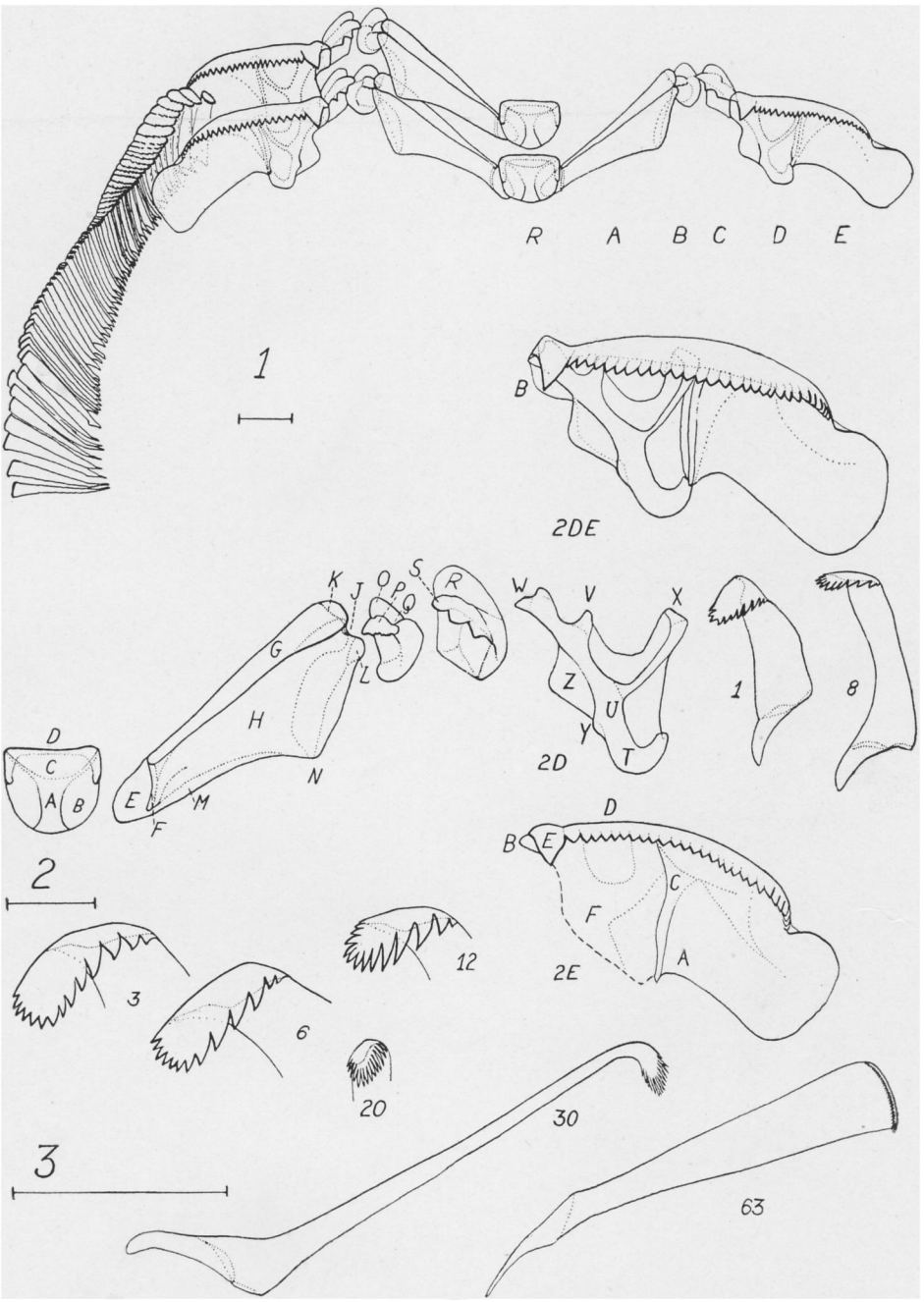
Fig. 40.—*Neritopsis radula.* (37287.) (×1¼.) Paired centrals and lateral; tip of 1st marginal; the 5th marginal somewhat foreshortened; the tips of the 55th and 137th marginals. The innermost paired central (×2½) and the tip of the 137th marginal (×4½) also shown under greater magnifications. The paired centrals are tilted inward they are shown in their proper relation to the horizontal axis of the lateral, but are separated from it and from each other. They actually lie in a close group under the inner end of the reflection of the lateral.

Fig. 41.—*Neritilia succinea.* (20457.) (×5¼.) A-central.

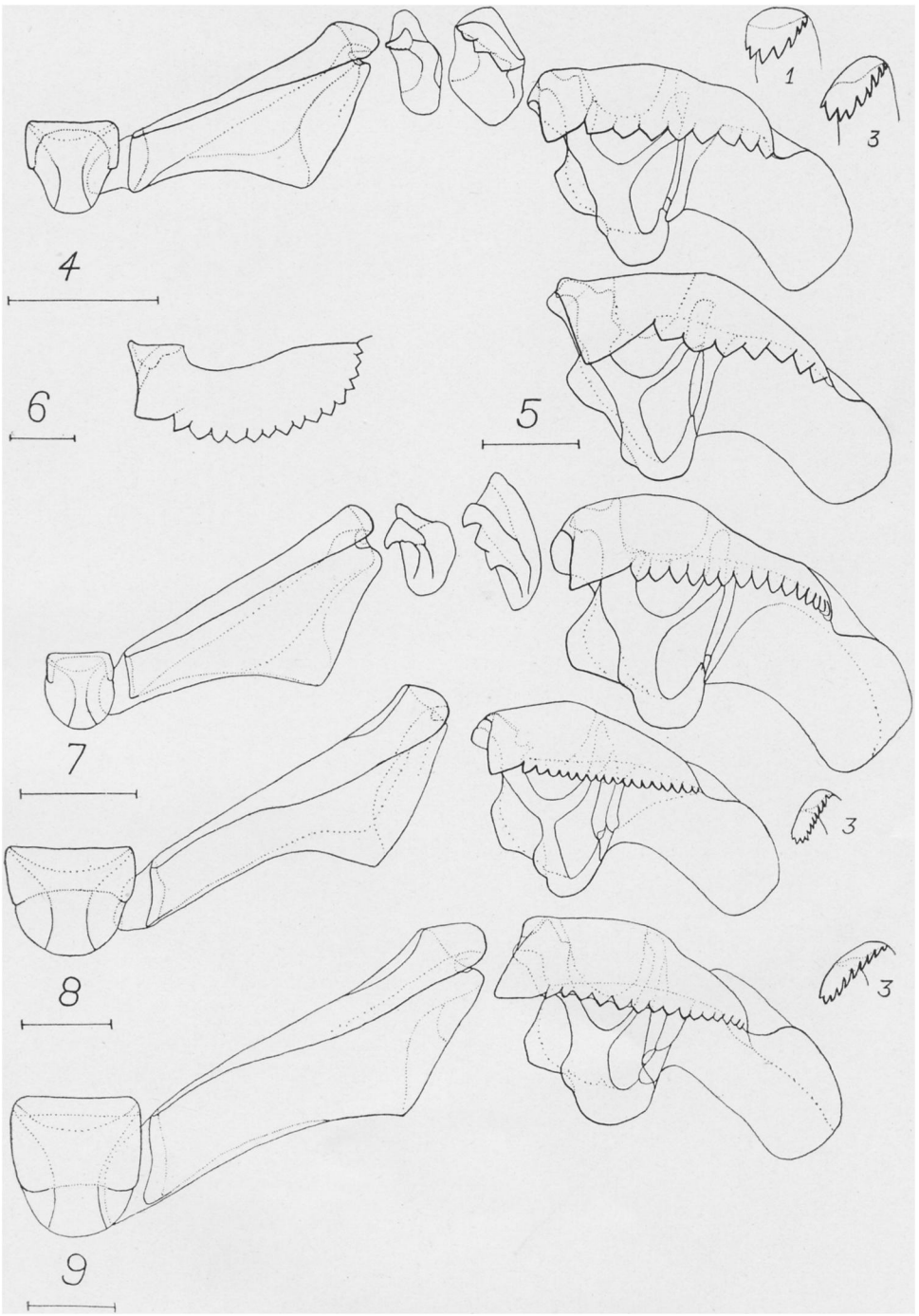
Fig. 42.—*Neritilia rubida.* (37675.) (×5¼.) The A-, B- and C-centrals; another outline of the C-central tilted inward (shown below); the lateral complex; the 1st marginal; the tip of the 1st marginal tilted slightly backward so as to better expose the notch; the tip of the 3rd marginal tilted

backward still more, so as to show underside of the terminal disc. The centrals and laterals are shown in about their proper positions in respect to the transverse axis of the radula, but are separated along it.

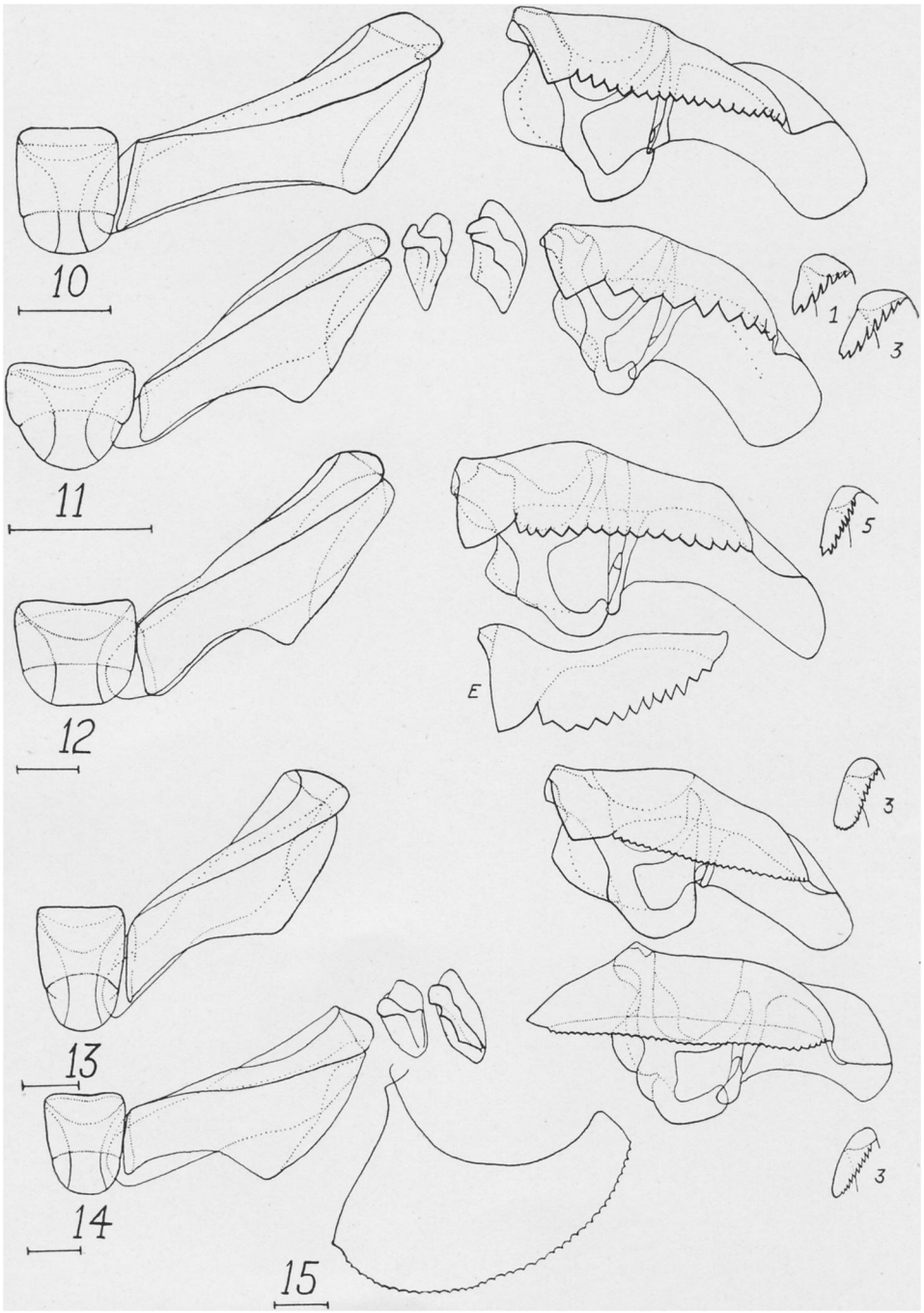
Fig. 43.—*Smaragdia* (*Smaragdella*) *souverbiana hellvillensis*. (37681.) (×2½.) Centrals, lateral complex and 1st and 2nd uncini; the tip of the 2nd also shown under great magnification. (×4¼). The centrals, lateral complex and 1st marginal are spread out along a transverse axis of the radula. The 2nd uncinus is moved directly anteriad; its tip actually lies under the reflection of the 1st.



BAKER: RADULA OF NERITIDAE



BAKER: RADULA OF NERITIDAE.



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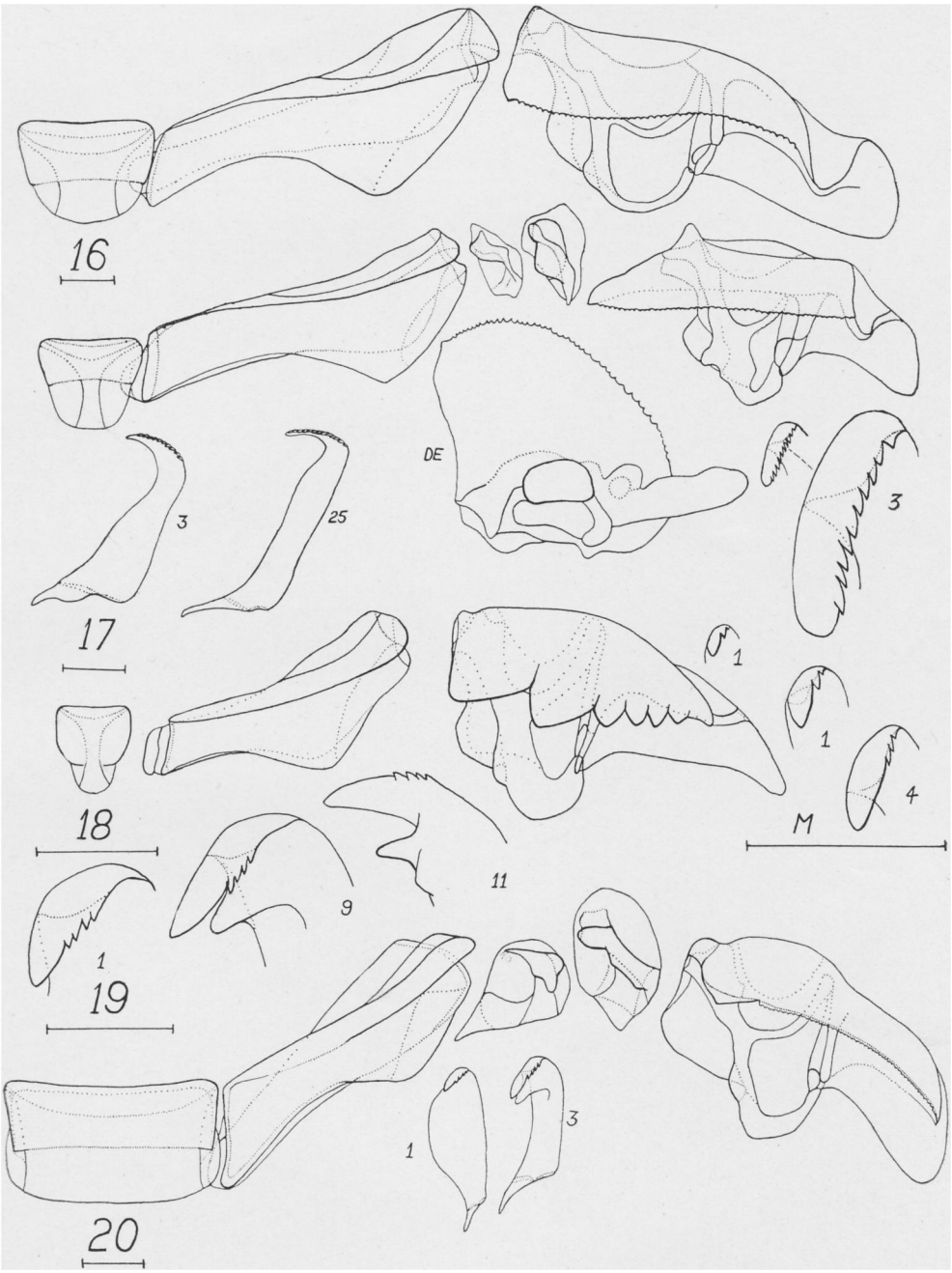
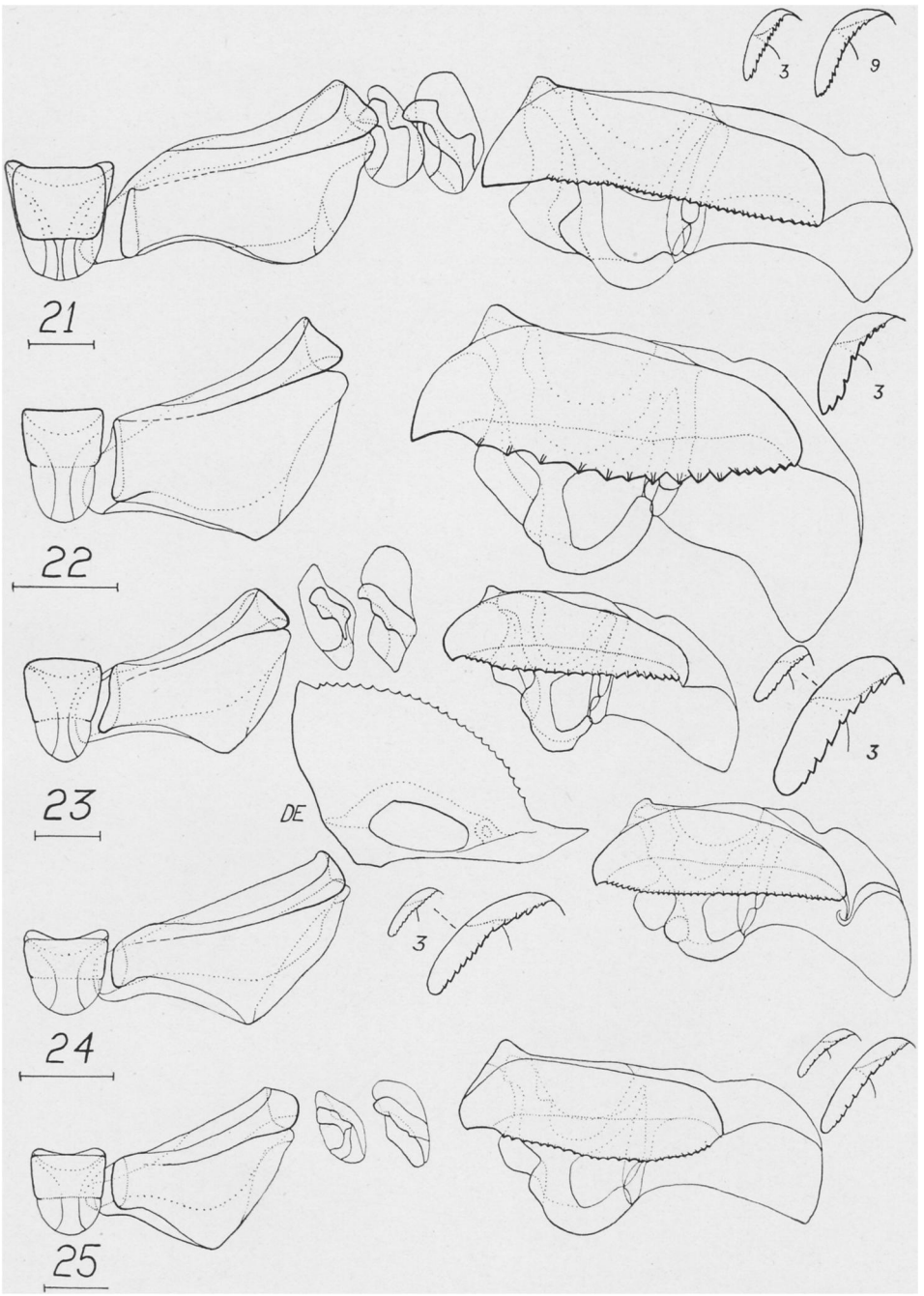
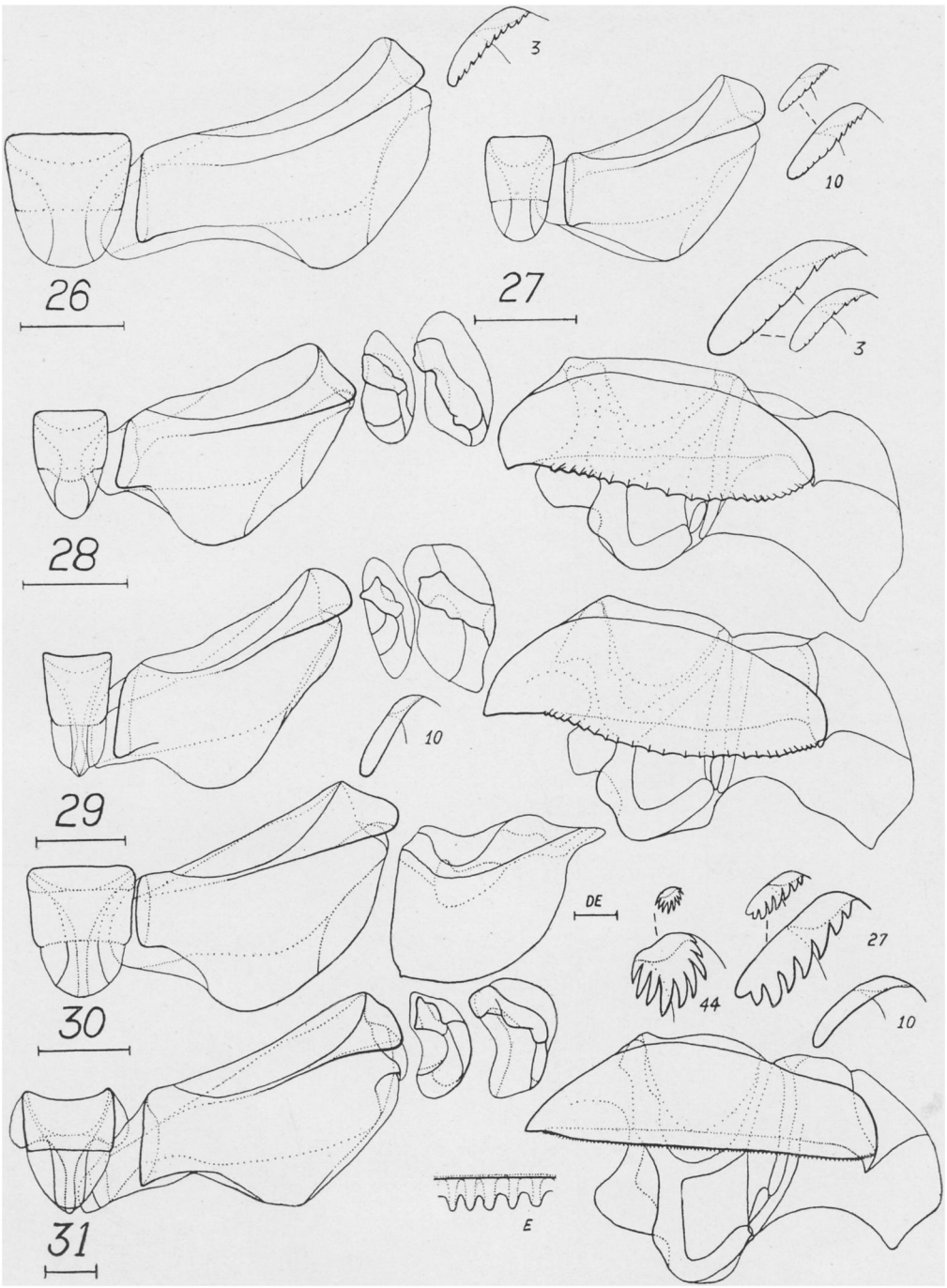


BAKER: RADULA OF NERITIDAE.



BAKER: RADULA OF NERITIDAE.



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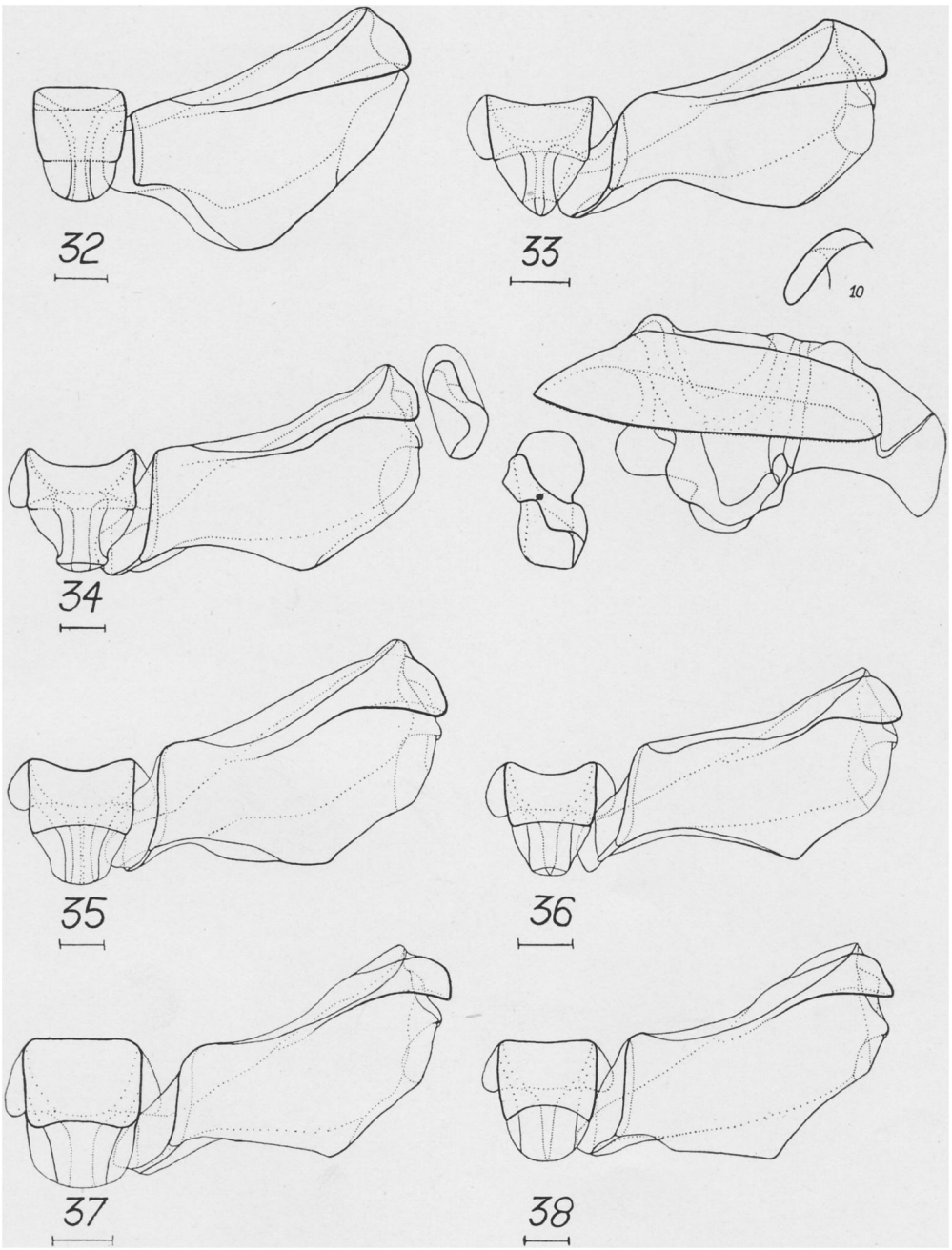
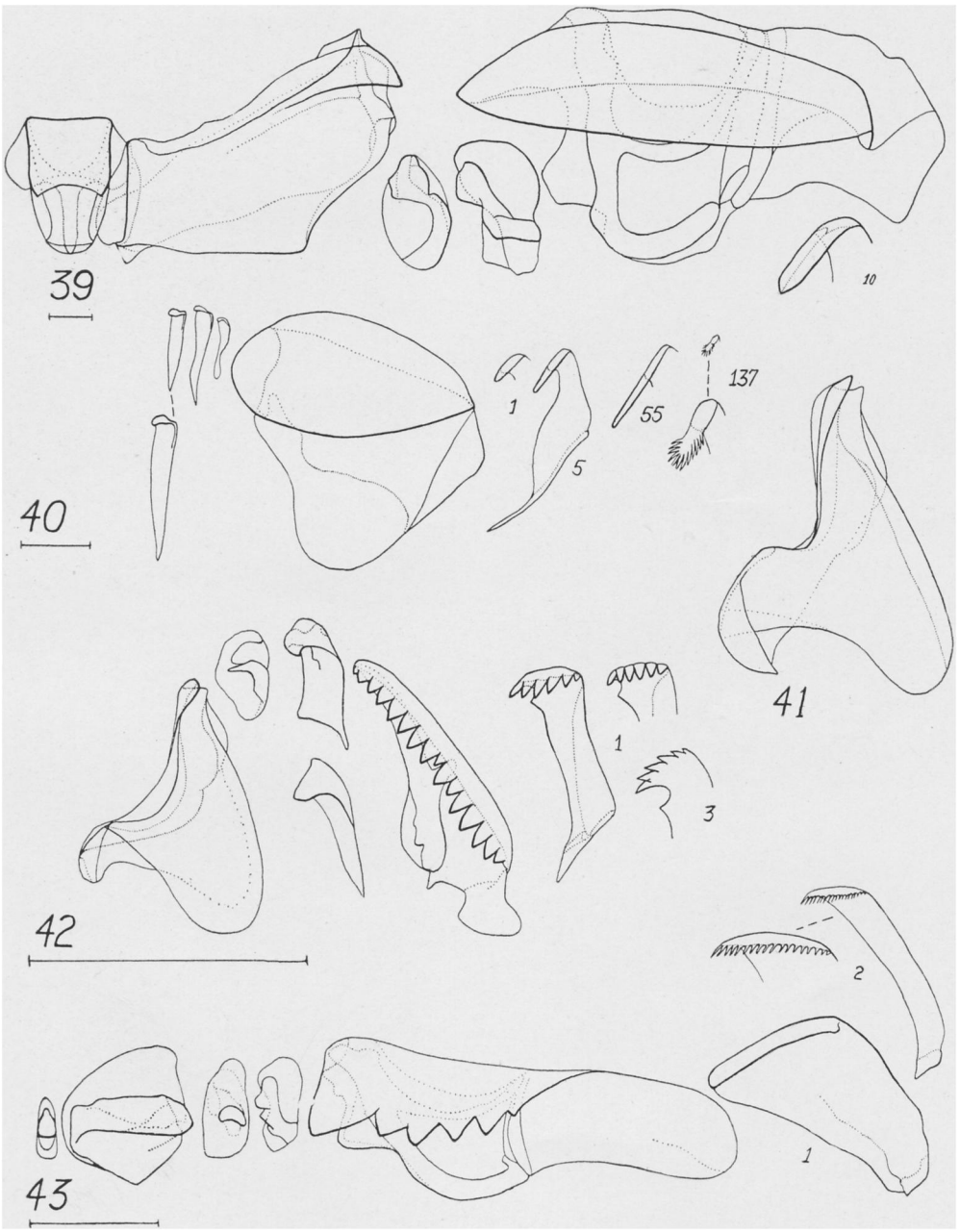


BAKER: RADULA OF NERITIDAE.



BAKER: RADULA OF NERITIDAE.