

REMARKS ON THE ANATOMY OF THE GENUS SIPHONARIA, WITH A DESCRIPTION OF A NEW SPECIES.

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The genus *Siphonaria*, described by Sowerby in 1824, is one of the most natural and homogeneous instituted at that early day. It comprises some ninety species, principally from the tropics, but has representatives in most parts of the temperate zone. Probably the most northern species yet described is one mentioned in this paper—*S. thersites*, Cpr., from Sitka and the coast of Alaska in lat. 57° N.

If a conchologist were to take a specimen of this species in one hand and in the other a specimen of *S. gigas*, Sby., from Panama, he would hardly be inclined, however, to place both of them in the same group. One is smooth, horny and minute, with the apex subterminal, and the siphon rib very large; and the other is very large, solid and heavy, with the apex central, and no outward indication of the siphon. Between these forms, however, we find gradations; yet the genus, from the shells alone, may be separated into two natural groups, perhaps of subgeneric value, of which one contains the greater proportion of the species. The dentition of a species of *Siphonaria* (specific name not given) is figured by Woodward in his manual, and has been copied by all subsequent authors, or described (as by H. and A. Adams) as representing the dentition of the genus. The species is from the Cape of Good Hope, and from that locality all the described species belong to the *S. siphon* group. I have not been able to obtain the soft parts of more than one of the species of that group, to confirm Woodward's figure.

The examination of several species of the group typified by *S. thersites*, shows a decided difference in the dentition.

The following is suggested as an arrangement of the family:

Family SIPHONARIIDÆ.

Syn. *Siphonariadæ*, Gray, Syn. Brit. Mus. 1840. Mrs. Gray's Moll. vol. iv, p. 181, 1859. Cpr. Maz. Shells, p. 181, 1856.

Siphonaridæ, D'Orb., Voy. Amer. Meridionale, 1841.

Siphonariidæ, H. and A. Adams, Vol. ii, p. 270. Gen. Rec. Moll., Nov., 1855. Binney, L. and F. W. Sh. of N. Amer. ii, 152. Chenu. Man., vol. i, p. 485, 1859.

Genus SIPHONARIA, Sby.

Syn. *Siphonaria*, Sby., Genera of shells, part xxi, 1824. Proc. Zool. Soc., 1835, p. 6. Blainville, Dict. Sci. Nat. vol. xxxii, p. 267, 1825. Rang, Man. des. Moll. p. 141, 1829. H. and A. Adams (as of Blainv.) Gen. Rec. Moll. vol. ii, p. 270. Woodw. Rec. and Foss. Shells, pp. 155 and 174. Hanley P. Z. S., 1858.

Muretia, D'Orb., (as of Sby.) Voy. Amer. Meridion. p. 682, 1841.

Trimusculus, Schmidt., MSS., 1832. Isis, p. 132.

Liria, Gray, MSS. Phil. Mag., 1824.

Lepas sp. (*Le Mouret*) Adans., Coq. du Senegal, p. 34, 1757.

Patella sp. various authors.

Nacella, sp., Cpr.

Type *Siphonaria sipho*, Sby. China, Japan.

The genus may be divided into two natural sections, as follows :

A. (*Siphonaria*.)

Shell solid, porcellanous ; apex central or sub-central ; provided with more or less elevated radiating ribs or ridges, which by their projection render the margin irregular. In many of the species the siphonal groove is produced internally beyond, or passes around, the apex on the left side. In Quoy's figure of *S. diemenensis* the gill is represented as passing before the heart. The inner lateral teeth have a broad, somewhat oblique, cusp, emarginate at the tip. (The outer laterals are also described as similar by Woodward, but this does not agree with my observations.) The outer laterals are broad and tridentate. The central tooth is slender with a lozenge-shaped cusp. The jaw is simple and arcuated. This section of the genus is best typified by *S. gigas*, Sby., and *S. sipho*, Sby. Most of the species are tropical.

B. (*Liriola*.)

Shell thin, horny; smooth, or furnished with fine radiating lines, which do not interrupt the margin. Apex marginal or submarginal, twisted to the left of the median line in most of the species. The gill passes behind the heart and lung. The jaw is simple and arcuate. The rhachidian tooth is moderate, with a simple pointed cusp. The inner laterals are long, narrow and strongly bidentate. The outer laterals are broad and tridentate with short cusps.

This section is typified by *S. thersites*, Cpr., and would include *S. lateralis*, Gld., *S. redemiculum*, Rve., *S. Macgillivrayi*, Rve., *S. Lessoni*, Blainv., and all the similar species, such as *S. tristensis*, *S. lineolata* and others from the South American coast. The species are more numerous in the temperate zone, though not confined to it.

If it be considered desirable to give a name to this group, *Liriola* might be used in a restricted sense to indicate it.

The following species belongs to the first section :

SIPHONARIA ALTERNATA, Say.

Patella alternata, Say, Journ. Phil. Acad. Sci. vol. v, p. 215, Feb., 1826.

Siphonaria alternata, Say, Am. Conch. part iv, pl. 38, 1832.

Binney's Say's Works, pp. 124, 192, pl. 38. Binney L. and F. W. Shells of N. Am. part ii, p. 153, fig. 254. Chenu, 50, pl. xiii, fig. 3.

Shell conical, with more or less elevated, unequal ribs, thirty or more in number. Apex subcentral, recurved obliquely, the tip pointing in a nearly parallel direction with the longitudinal axis of the shell, and acute. Color brown, radiated with white; base oval. Length three-tenths of an inch.

Say's figure of this species in Binney's reprint is represented as with too few ribs and too smooth interspaces. The wood-cut copy in the L. and F. W. Shells of N. A. is also very poor.

The external appearance of the animal is much like the next species. The mantle edge is brown, thick and somewhat corrugated. The remainder is livid slate color. The lobe which closes the pulmonary opening is large and thin, gray and edged with brown. There were no eyes visible, yet they probably exist and are very minute. The anatomy resembles that of the next species, except that the penis is larger in proportion to the size of the animal.

The jaw is simple and arcuated. The central tooth is very slender; the cusp has a simple point. The inner laterals have a

broad emarginated cusp nearly twice as long as the base. The laterals grow broader and shorter toward the edge. The outer thirteen laterals are tridentate. The inner laterals from the eleventh to fifteenth are bidentate. The formula is 30·1·30 or 15·15·1·15·15. There are about two hundred rows in all.

The following species belong to the second section :

SIPHONARIA THERSITES, Cpr., Annals and Mag. Nat. Hist., 1864, xiv, p. 425.

Cpr. (MSS.) Suppl. Rep. to the Brit. As., 1863, pp. 627 and 676. Stearns, shells of Alaska, Pr. Cal. Ac. Sci. Vol. III, p. 334.

Testa parva, tenui, haud elevata, valde inequilaterali, dense nigro-castanea, lævi seu interdum costulis paucis, obtusis, obsoletis, radiatim vix ornata; epidermide lævi, tenui, fugaci; costa pulmonali intus et extus valde conspicua, tumente; vertice obtuso, plerumque ad quadrantem, interdum ad trientem totius longitudinis sito; intus intense nigro-fusco, margine acuto. Lon. ·46, Lat. ·33, Alt. ·17 in.

Hab. Neeah Bay; Sitka; Vancouver's Island; Fort Simpson; N. W. C. Am.

The external appearance of the animal is very plain. The mantle edge, sides of the foot, and head are smooth and even. The lobe is stout and short. The head is small, and the eyes could not be found with a high power. The soft parts are entirely contained within the shell. The color in spirits was a dusky slate-color.

The jaw is simple, arcuated and rounded at the ends. The rhachidian tooth is slender with a simple pointed cusp.

The inner nine laterals are provided with an oblique, equibidentate cusp. The tenth, eleventh and twelfth are tridentate. The remainder are much broader and shorter, tridentate; the central point more prominent than the others, and, in the thirteenth, fourteenth and fifteenth slightly emarginate at the tip. The cusps grow less conspicuous toward the outer edge, and in the outer three teeth are hardly perceptible. The formula is, 22·1·22, or 7·3·3·9·1·9·3·3·7.

This species having been obtained in lat. 57° N., is probably the most northern representative of the genus.

SIPHONARIA TRISTENSIS, Sby.

S. Tristensis, Sby., Genera of Shells, fig. 3. Rve. Mon. *Siphonaria*, Pl. V, fig. 23a, b.

Patella Tristensis, Leach, teste Rve.

Siphonaria Lessoni, Blainv., teste Rve.

S. testa ovato-conica, tenuicula, vertice sub-oblique acuminato et intorto; sordide virescente, lineis fuscis irregulariter radiatim filosa, intus nitente castanea.

Hab. Tristan d'Acunha, Rve. (in error.) Orange Harbor, Tierra del Fuego. U. S. Exploring Expedition.

External Appearance. The epidermis on the head and sides of the foot is granulose, rough to the touch. The mantle edge is simple, slightly tuberculose and continuous over the head and lobe. The colors, as far as could be judged from the alcoholic specimens, had been purplish. The edge of the mantle was distinctly marked by well defined stripes of dark brown or blackish, and white; corresponding to the riblets and dark intervals of the shell. The head or muzzle is rounded, with the corners somewhat produced or triangular. The sides of the foot are broad, and the sole is smaller in proportion to the aperture of the shell than in most patelliform shells. The lobe beneath the pulmonary opening is triangular and large. It is pierced for the anus. On the neck behind the head is a small papilla, indicating the foramen of the genitalia. It is on the right side. The end of the muzzle is flattened, and the mouth is not conspicuous.

Alimentary System. The buccal mass is proportionately small, and not as muscular as in most pulmonates. The œsophagus leaves it from the middle of the superior surface, and at the posterior end of the buccal body is constricted and bound down by a collar of nerves and muscular fibres. A small elongated salivary gland lies on the upper surface of the buccal mass, on each side of the œsophagus, and empties into it by the posterior termination of the gland. Behind the collar the alimentary canal is broadly dilated, forming a sort of crop. This is slightly constricted, and behind the constriction is the true stomach. This is rhomboidal in shape. The intestine leaves the stomach at its anterior end, on the left side, and is reflected over the latter in a broad loop to the right, when it turns again, and passing around the posterior end of the body opens through the lobe, which closes the pulmonary orifice. Some small muscular fibres bind the posterior end of the stomach to the foot.

The jaw is horny and dark brown. The cutting edge is smooth and arcuated. The portion which is inserted into the flesh is striated and produced into long, stout, muscular filaments, which are not represented in the figure. There are two well marked notches on the superior edge. The jaw is deeply grooved behind and the inner surface striated.

The radula is stout and of a dark brown color.

The formula is 50·1·50 or 20·30·1·30·20.

The rhachidian tooth is broad, rounded before, and with the base arcuate behind. The cusp is simple, rounded before, and more or less pointed behind. In some individuals this point is more prolonged than in others, and in such cases the tip is transparent, while the rest of the cusp is yellowish. The inner twenty-seven laterals have a longitudinally arcuated rhomboidal base, of which the anterior edge is produced before the cusp. The latter is long, with one prominent long denticle, and one short and triangular on the inner side. The tips of these denticles are more or less transparent, while the body of the cusp is yellow, and the thick base showing through is liable to mislead the observer, as to the form of the cusp. The twenty-eighth lateral is similar but broader, with a shorter denticle, more or less bifid or arcuate at the tip, and the cusp is broadly rounded on the outer side. The twenty-ninth has the prominent denticle emarginate, broad and rounded, and has a third denticle on the outer side. The emargination of the chief denticle is more obvious in young specimens, and in old ones is not always noticeable, except in a smaller number of the laterals. The laterals gradually increase in width and decrease in length toward the edge of the radula, and in the extreme outer teeth have the three denticles rounded, sub-equal, and the base more than twice as wide as it is long.

The cusps of the inner laterals are, to a certain extent, bayonet-shaped, as will be seen by the figure. There are about two hundred and fifty rows.

Muscular System. There are no internal bands of muscular fibre as in *Melampus* or *Gadinia*. The muscles which control the buccal mass are not strongly developed. The muscles of the *preputium* are spirally arranged in two layers.

The adductor is divided into three parts. On the right a broad passage exists where the opening of the pulmonary cavity lies. The small portion of the right limb of the adductor, anterior to this, is rounded-triangular. The mantle is attached to the shell, over the head, so that the scar is continuous. The right extremity of the posterior part of the adductor is broadly rounded. On the left the scar appears continuous, but the anterior and posterior parts, though approximate, are separated by a suture, showing a tendency to bilateral symmetry. The left anterior portion closely approaches the buccal mass.

The foot is moderately thick and muscular, and divided by a very faint median line in its internal muscular structure. The nerves and blood vessels mostly enter the foot in this line.

Circulatory System. The heart is enclosed in a sac, of which

the longitudinal diameter is parallel with the axis of the body. This sac is situated on the left side, between the lung and the renal organ. Several large vessels traverse the lung, and one crosses it, and follows the median line of the gill. The smaller vessels could not be traced, as the specimens had been many years in spirits and were extremely rigid.

Respiratory System. The lung resembles that of *Auricula*, but is less developed than in that genus. It is rounded triangular, and terminates in a multifid papilla, through which the renal organ also discharges its secretions by a special duct.

The branchiæ are simply triangular folds of the lining membrane of the mantle, somewhat attached to each other by a raphe, in the line of which the principal vein passes. These folds are more or less numerous in different individuals, apparently more conspicuous in the older specimens, but by no means constant.

Some authors have considered the lungs of mollusca as invaginated gills. The present instance does not bear out the homology. The gills are simple modifications of the mantle lining, while the lung is a special organ, which serves a specified purpose, and none other, and does not involve the mantle lining, except as one of the membranes between which the lung is situated.

Reproductive System.—The genitalia have a common opening into a small papilla on the right side of the neck, behind the head. The penis is very large and stout. It is contained in a *preputium*, consisting of two spirally coiled muscular layers. These are continued in a kind of sac, which is reflexed anteriorly, and contains the testicle. The latter is very small and easily overlooked, and the prostate is also inconspicuous.

The ovary is large and kidney shaped. It is really doubled up upon itself. There is a small spiral mucus gland at the posterior extremity, but the duct of this gland is very long, and only enters the oviduct beyond the ovary. The latter leaves the ovary with a double flexure, and is prolonged as a simple, slender tube entering the rounded-triangular uterus by the left posterior angle. The genital bladder enters on the other side by a short, stout tube. The former is rounded and transversely ovate. The uterus is large and somewhat produced at the posterior corners. The vagina, if we may term it so, is moderately large, and opens into the genital papilla before mentioned. The latter is very small in young examples.

Nervous System.—This principally consists of a stout, nervous collar, of ganglia united by nerve fibres, encircling the œsophagus just behind the buccal mass. More numerous fibres are given out below than above. One of the former connects with a small accessory ganglion near the ovary.

Other organs.—The eyes in this species are exceedingly minute, so as to be invisible to the naked eye unless well trained. They are circular and deep seated. In alcoholic specimens the skin must be carefully shaved away and examined by transmitted light in order to find them at all. They can be of little real use to the mollusk, as vision must be out of the question, and they can hardly be more than sensible to light and darkness. No organs of hearing were detected.

This dissection does not agree with the figures of Quoy (*S. Diemenensis*), which, as is the case with many of Quoy's figures, seem to owe a good deal to the imagination of the artist. I am inclined to refer the differences, especially those of the genitalia, rather to this cause than to any real differences of structure between the species.

SIPHONARIA PELTOIDES, Dall ex Cpr. Plate 4, fig. 11, a, b.

Nacella peltoides, Cpr., Ann. and Mag. Nat. Hist. 1864, i, p. 474, No. 15. Sup. Rep. Br. Ass. 1863, pp. 418 and 545.

Nacella, sp. indet., Cpr., Maz. Cat. No. 262, p. 202. Rep. Br. Assoc. 1856, p. 252.

Nacella (?) *subspiralis*, Cpr., Proc. Cal. Acad. Sci. iii, p. 213, 1866. Sup. Rep. Br. Assoc. 1863, p. 612, No. 65; p. 650, No. 240 (name only). Coop. Geogr. Cat. Cal. Moll. p. 23, No. 443, 1867.

Nacella ? *vernalis*, Dall, MSS. 1866. Stearns, Shells of Purissima and Lobitas, Proc. Cal. Ac. Sci. Vol. iii. p. 345, 1867. Hepburn's Shells, do., p. 284. Shells of Santa Barbara, do., p. 344.

S. testa tenuissima, conica, parva; vertice subacuto, subpostico; lævi seu interdum costulis paucis, obsoletis radiatim vix ornata; epidermide tenui subfusco seu viridi clari, non lævi, fugaci; costa pulmonali intus et extus valde inconspicua; testa, extus subfusco cum luteo-virido radiatim; intus lævissime. Lon. .48, Lat. .36, Alt. 23 in.

Habitat, Monterey, Purissima, Lobitas, Santa Barbara and San Diego, California. Gallapagos Islands, Dr. Hable. Mazatlan (Reigen coll.), Cpr. Cape St. Lucas, Xantus. Catalina Id., Cooper, 6—10 fms., dead.

Shell small, thin, conical; apex recurved, nearly in the median line, more or less acutely pointed; generally somewhat eroded in old specimens. Epidermis thin, not polished, smooth, brownish red on the apex and in dead shells; in fresh or young individuals of a bright grass green, somewhat wrinkled and frequently overlapping the border of the shell; fugacious. Shell smooth, reddish brown, with fifteen or more light yellow green

rays of color, radiating from the spire. There are no ribs or costæ, but occasionally a moderately sharp line or two may be observed radiating from the apex, and impressed, as it were, from below. The apex is lighter than the rest of the shell. The interior is extremely polished and brilliant, and only in dead specimens is the mark of the siphon perceptible without a glass. The external colors are visible within, from the translucency of the shell. The siphonal groove is not visible from the outside, nor does it cause any extension or emargination of the edge of the shell. The aperture is roundly oval and the edge simple.

Some thirty specimens of this beautiful little species were found dead on the Halfmoon beach at Monterey. One was found adhering to the frond of a *Laminaria*. Dr. Newcomb obtained it at Santa Barbara; Mr. Hepburn at San Diego; Mr. Stearns at Purissima and Lobitas, San Mateo county, Cal. Among a large number of beach shells obtained on the Gallapagos Islands by Dr. Hable, this species was not uncommon; the specimens were generally thinner, lighter colored, and smaller than those obtained from further North. When this shell was first obtained at Monterey, in a hurried list of species found by me at that locality, I gave it the MSS. name of *vernalis*, from the bright green epidermis, and referred it doubtfully to the genus *Nacella*, which it externally resembles. Being called away by other duties to a more northern station, the MSS. and specimens were referred to Dr. Carpenter. At first that gentleman was disposed to refer the shell to a lost species described by Middendorf under the name of *Acmæa pileolus*. As the shell in question has not been found north of San Francisco, it is not probable that Middendorf ever saw it, and, moreover, I am informed that his type specimens do not agree with his diagnosis, and are probably young *Acmæas*, while his figures differ from this species.

Dr. Carpenter called my attention to the mark of the siphon, and a more thorough examination showed that it belonged to the genus *Siphonaria*.

A careful examination of the type specimens in the Smithsonian Cabinet has developed the following unexpected coincidences:

Nacella peltoïdes, Cpr. (S. I. Cat. No. 4023) is exceedingly minute, but appears to be identical with this species. The type is so young that it is almost colorless, but the mark of the siphon is perceptible with a magnifier. It is a pity that so inelegant a name must be applied to this pretty species.*

? *Nacella subspiralis*, Cpr. (S. I. Cat. No. 11,847). A careful

* The nuclear whorls, usually broken off, are preserved in the unique type of *subspiralis*, and in the types of *peltoïdes*. I also found them on a very few specimens from Mty. and Gal. Ids.

study of the type convinces me that it differs from normal adult specimens of *peltooides* only in being abnormally elevated, dead and faded. The siphon mark is evident under a glass. The epidermis is gone; and the margin is irregular, showing that its station must have been unfavorable to lateral expansion, hence the unusually elevated and conical form.

The animal has not, as yet, been observed. For a littoral species it has an extraordinary range; from Monterey to the Gallapagos Islands, and its discovery at the latter point by Dr. Hable is extremely interesting. The only other species known from Monterey and the Gallapagos are *Semele rupium*, Sby.; (?) *Modiola capax*, Conrad; (?) *Bulla Quoyi*, Gray; and (?) *Purpura triangularis*, Blainv. The three latter are doubtful. Two other species of *Siphonaria* [*S. gigas* and *S. scutellum*(?)] are reported from the Gallapagos. (The locality of *S. scutellum* is given by Reeve as New Zealand.)

The following species are known on the West Coast, north of Panama:

Siphonaria gigas, Sby., Equador to Gulf of California.

S. lecanium, Phil., " " "

S. characteristic, Reeve (?-*gigas* var.), Gallapagos and Panama.

S. peltooides, Dall ex Cpr., Gallapagos to Monterey.

S. scutellum, Blainv., Gallapagos.

S. maura, Sby., Panama.

S. pica, Sby., Panama and Cent. Am.

S. costata, Sby., " "

S. æquilirata (Reeve), Cpr., Gulf of California.

S. (? var.) palmata, Cpr., Mazatlan.

S. thersites, Cpr., Puget Sound to Sitka.

There are probably several other species on the coast and Gulf of California, which I cannot determine from the material at hand. There are also one or two species in Japan, which may be found on some of the Aleutian Islands.

ANISOMYON, Meek, 1860.

Anisomyon, Meek and Hayden, Amer. Journ. Sci. and Art, xxix (2d series), p. 33, pl. 1 (*A. patelliformis*), Jan., 1860.

Type *A. borealis*, Morton sp. (as *Hipponyx*.)

This genus was constituted for several rounded, thin, sparsely striated, cretaceous, patelliform shells, which have the muscular impression interrupted on the right side, and the apex, when perfect, subspiral or reflected. They appear to form a passage

toward *Gadinia* in their rounded form, but are more closely allied to the *Siphonariidae*. They cannot be affiliated to the *Patellidae* or *Tecturidae*. The following species were enumerated in the paper alluded to, as having been definitely identified as belonging to this genus: *A. borealis*, Morton; *A. sexsulcatus*, *alveolus*, *patelliformis*, and *subovatus*, all of Meek and Hayden.

The student who desires to pursue the subject further, will do well to consult the *Conchologia Iconica* and the list of species of *Siphonaria* given by Hanley in the Proc. of the Zool. Society of London, 1858, page 151.

REFERENCES TO PLATE 4.

Fig. 8. a, side view of *Siph. thersites*, with the shell removed.
b, view of same in the shell, from below.

Fig. 9. Nervous system of *Siphonaria Tristensis*, Sby.

Fig. 10. Dentition of *Siphonaria (Siphonaria) alternata*, Say.
b, Rhachidian tooth.
a, section of 17th lateral.

Fig. 11. *Siphonaria (Liriola) peltoides*, Dall ex Cpr.
a, from above, enlarged one-fourth.
b, side view.

EXPLANATION OF PLATE 5.

Fig. 1. Dentition of *Siphonaria (Liriola) tristensis*, Sby.

1" a, side view of 45th tooth.

1" c, " " " 1st lateral 1" b, section of do.

Fig. 2. Dentition of *Siphonaria (Liriola) thersites*, Cpr.

1' a, side view of 1st lateral.

Fig. 3. Digestive and generative organs of *Siphonaria tristensis*, Sby. From above.

a, anus.

b, genital bladder.

c, crop.

g, genital papilla.

m, buccal mass.

o, ovary,

r, rectum.

st, stomach.

j, jaw.

l, l, l, boundary of liver.

l, a, left adductor muscle.

r, a, right " "

p, a, posterior adductor.

p, penis.

s, salivary gland.

t, testis.

Fig. 4. Jaw of *S. tristensis*.

a, anterior view.

b, posterior view.

Fig. 5. Jaw of *S. thersites* from in front.

Fig. 6. *Siphonaria tristensis* from below, in the shell.

Fig. 7. The same from above with the shell removed and the mantle turned back.

m, attachment of the mantle to the shell.

r, renal organ.

h, cardial sac cut open to show the heart.

p, pulmonary papilla and lung traversed by blood vessels.

b, branchia.

The dotted line indicates the course of the rectum.



Dall, William Healey. 1870. "Remarks on the anatomy of the genus Siphonaria with a description of a new species." *American journal of conchology* 6, 30–41.

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