

NOTES ON THE SPECIES OF THE MOLLUSCAN SUBGENUS
NUCELLA INHABITING THE NORTHWEST COAST OF
AMERICA AND ADJACENT REGIONS.

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The species of *Nucella* Bolten, more familiarly known as *Purpura* but not the *Purpura* of the classical writers nor of Martyn in 1784, are so far as known confined to the Northern Hemisphere, and flourish especially in its cooler waters, some species extending their range nearly to the Arctic Circle. The type of the subgenus is the solitary North Atlantic species *N. lapillus* of Linnaeus, the genus *Thais* Bolten, covering both the northern and tropical groups. The synonymy has been exhaustively treated in another publication.¹ The history of *N. lapillus* has been worked up by the Rev. Dr. A. H. Cooke in a recent paper² and he included a notice of the Pacific species, the synonymy of which had been previously considered by Vanatta.³

The very rich series of these shells contained in the United States National Museum and the doubts expressed as to the relations of several of the nominal species suggested that a review of the North Pacific forms might properly supplement Doctor Cooke's admirable paper on the Atlantic species.

The nucleus of the northern species of *Nucella* is smooth, white, slightly gibbous, with an apical dimple and one and a half whorls. No essential variation from this type has been noted in any of the species. In adults it has generally been lost through attrition. The extreme tip is bulbous and relatively large. The transition from the nuclear to the adolescent stage is abrupt, the newer surfaces taking on at once, above the suture, two or three strong spiral ridges.

The nucleus of the tropical species is different. It is very difficult to obtain specimens in which it is intact, even in the very young.

¹ U. S. Geological Survey, Professional Paper No. 59, Washington, 1909, pp. 46-51.

² Proceedings of the Malacozoological Society of London, vol. 11, 1915, pp. 192-209.

³ The Nautilus, vol. 24, 1910, pp. 37-38.

In the instances when I was able to detect it the color was invariably reddish brown. Instead of the bulbous, slightly irregular nucleus noted in *Nucella*, *Thais biserialis* has a regular, somewhat dome-shaped nuclear spire, with very minute apical portion and two and a half regularly coiled smooth whorls. *Patellipurpura patula* has the nuclear spire elevated and trochiform, the apex very minute and whitish, the remainder dark reddish brown, smooth and polished; in all about four and a half whorls. *T. columellaris*, though not so well preserved, seems to have a similar nucleus. In all cases the transition between the nucleus and the adolescent sculpture is abrupt.

The sculpture in *Nucella* may be axial or spiral or both. It may be entirely obsolete over the greater part of the shell, but no matter how smooth the latter appears there are always traces of the spiral ridges which immediately follow the smooth nuclear portion, provided the apical part of the specimen is not worn.

The spiral ridges of the nepionic shell between the sutures are persistent in sculptured specimens. They increase by intercalation, and the number of major ridges is quite constant in each species; the differences arising largely from the close or lax coiling of the whorls, which may sometimes leave exposed ridges which are usually hidden under the suture. Between the major ridges there are frequently numerous minor threads which are irregular in number and strength. In rare cases one or more major ridges will split into two or more small ones, which do not materially differ from the minor threads in size or appearance, but usually the discrimination between the two classes is not difficult.

Beside the regular threads on *N. lamellosa* there are fine, almost microscopic, more or less obsolete spiral striations, which are hardly perceptible except in specimens entirely free from surface erosion.

In one variety of *N. canaliculata* the major spirals are, as it were, flattened down until the interspaces are reduced to sharply incised lines, and the shell exhibits a very marked contrast to the variety with elevated ridges and channeled interspaces which Middendorff named *decemcostata*. But there are intermediate variations.

In some mutations, while one or two major spirals persist near the periphery of the whorls, the space between them and the preceding suture will be flattened, giving a conical aspect to the whorls. In others the spiral sculpture, after the first nepionic turn or two, may have become quite obsolete, the whorls inflated, and the sutures deep, giving the shell the aspect of a *Chrysodomus*. The axial sculpture in *lamellosa* usually takes the form of elevated sharp lamellae crenulated by their intersection with the major spirals. In some cases the lamellae are low except where they cross the spirals, and in a few instances they may take the form of fine low close imbrications such as characterize the form *imbricata* of the Atlantic *N. lapillus*.

In the other northwest coast species the lamellations do not become marked; in extreme cases they convey the impression of low close imbrication, or they may be reduced to mere elevated lines or even be altogether absent.

In only one of the species, *N. emarginata*, do we find nodulation of the spirals, and this not accompanied by any axial ribbing.

The suture is simple and closely appressed in this group, though the proximity of an elevated spiral, as in *N. canaliculata* gives the shell an aspect of being channeled at the suture.

The whorls are usually of a moderate convexity modified in particular instances by the external sculpture. There is little variation in their numbers within the species; it frequently happens that the short stumpy specimens and the slender elevated ones prove on examination to have the same number of post-nuclear whorls. The variation between specimens fully adult and of the same general type rarely exceeds one whorl, and that toward the apex of the shell. In coiling there is great variation more or less correlated with environment.

The sheltered rocky beaches of a well-protected harbor will afford slender elongated and lamellose specimens with small apertures. The outer rocks exposed to the ocean surf have short-spined, relatively smooth, wide-mouthed shells, which afford the least leverage to the waves. For, washed from his perch and carried to the muddy bottom off the shore by the undertow, an adult *Nucella* can hardly survive; and those offering the least friction and having the stronger hold on their situs are most likely to survive. There is also a connection between the situs and the shell which is less easily explained, and that is that, on rough surfaces such as an "oyster reef," or bar, the specimens of *lamellosa* are almost unanimously rough and laminate, while in undisturbed water on rocks with sandy surroundings the finest and most delicate development of lamellae and crenulations is to be found, according to the reports of collectors. In all cases *Nucella* seems to prefer a rocky habitat, especially if it affords young oysters or other sessile or sluggish species serving it as food.

The siphonal fasciole in these shells is usually strong, with the callus of the pillar lip folded over the inner half of its cavity. The elevation or depression of the shell seems to have no effect on the axis of the pillar, but occasional specimens, usually old and more or less pathologic, show a decided umbilical chink. The canal in well-developed specimens is rather strongly recurved.

The aperture in all the species, when mature, is margined by a continuous callus, sometimes thin and closely appressed, but in solid and heavy specimens thick, with an elevated edge on the body and pillar. The outer lip, while hardly reflected, has a certain flare and is slightly expanded. The pillar lip is smooth and in exceptionally

developed specimens of *lamellosa* there is an obscure thickening on the middle of the pillar. Well within the aperture in this species, when well developed, is a group of three (or occasionally four) teeth separated by a marked gap from the posterior sinus of the aperture, and by a less conspicuous gap from two more or less dentiform nodulations near the constriction at the proximal end of the canal. Many apparently well-developed individuals, however, show no trace of denticulation. For a long time it was supposed that *N. lamellosa* was the only west coast species developing teeth, but Miss Bertha M. Challis by careful search has found individuals of other species which also do so. As a general rule, however, it may be stated that the development of teeth in these northwest coast species is much less constant than in the North Atlantic *N. lapillus*.

The coloration of the shell varies in all the species. In most specimens of *lamellosa* it is uniform over the entire individual and ranges from pure white through various shades of yellow and yellowish brown to a very dark brown. Specimens from quiet water are frequently of a gray or greenish gray from an algal deposit which when removed shows the true color of the shell. Some specimens have a white band at or slightly below the periphery, but any breaking up of the other colored areas by additional white spiral bands is extremely rare.

This species never shows flammulation or banding of a darker or different color. The margin of the aperture is generally pale, the throat darker, brownish, or purplish brown in dark specimens; white or slightly yellowish in white specimens.

In *N. canaliculata* the range of coloration is about the same, except that when banded there are usually two white bands, one near the periphery and one on the base, and the resulting brown bands are frequently broken up into patches or flammulations by gaps of paler or whitish color. The outer lip is usually crenulated at the edge by the exterior sculpture, and the interspaces between the spirals are more or less reticulated by close-set axial elevated lines. The production of teeth in this species is rare; when present, following a posterior smooth space, there is a continuous line of eight or nine small teeth to the beginning of the canal. In *N. lima* the color characteristics are much the same as in *N. canaliculata*, though it is rarely flammulate; but, even in the heaviest and most callous adults, I have not been able to detect any trace of denticulation in the aperture.

In *N. emarginata* the most conspicuous feature, after the nodulation of the spiral bands, is (except in unicolored specimens) the presence of narrow, usually dark-brown bands between the lighter colored, usually white, major spirals. None of the other species has this feature. While the nodules are sometimes subspinose, there is never any prominent axial lamellation. The pillar is conspicuously con-

cavely arched, and there are occasionally from three to eight obscure denticulations within the outer lip. The colors range about the same as in the other species, but there seem to be fewer light colored and more melanitic specimens. The proportion of unicolored individuals is markedly less.

The operculum throughout the group has the usual characters belonging to the genus. It seems to be rather larger, in proportion to the aperture, and perhaps generally darker in color in *N. emarginata* and smaller and paler in *N. lamellosa* than in the other two species.

Thinking that the major spirals might afford some specific characters, all the specimens in the collection were subjected to a careful count, 1,753 in all. The count was taken at the end of the penultimate whorl from the commissure of the outer lip with the body whorl to the suture behind. Only adult specimens were included in the count.

Of 529 specimens of *N. emarginata* 433 had two, 78 had only one, and 18 had three major spirals. The intercalary spiral threads in the whole space between the sutures varied from none to three, 290 specimens having none, 118 having one, 109 having two, and 12 having three.

Of 315 specimens of *N. lima* 110 had three major spirals, 130 had four, 71 had five, 2 had six, and 2 had seven. Of intercalary threads two had none, 135 had three, 114 had four, 31 had five, and 3 had six.

Of 363 specimens of *N. canaliculata* 27 had three major spirals, 135 had four, 136 had five, 63 had six, 1 had seven, and 1 had eight. Of intercalary threads, 112 had none, 6 had one, 43 had two, 57 had three, 78 had four, 56 had five, 7 had six, and 4 had seven.

Of 549 specimens of *N. lamellosa* 32 had one major spiral, 417 had two, 4 had three, and 2 had four. On the last whorl 368 had nine major spirals and the others varied from one to thirteen.

Of 21 specimens of *N. freycinetii* 18 had two major spirals and the others three. The intercalaries varied from two to five; but the number of specimens being so restricted, the result in this case is not conclusive.

If these figures for the major spirals be platted, it will be evident that the profile of the curve for each species has its own characteristics, and it is quite possible that the few scattering exceptions to the rule may be due to hybridization.

The species of *Nucella* are in the main carnivorous, and have been observed by me to feed on small bivalves like *Anomia*, on Ascidian colonies, and on the ovicapsules of their own and other species of gastropods. In scraping off other small invertebrates from kelp and rockweeds it is probable they swallow a certain amount of vegetable matter, and on one occasion I found several feeding on the rather putrid body of a dead fish. Yet I have never observed them attack-

ing other mollusks in which the shell had attained a certain degree of solidity, and conclude that they confine their predatory work to animals and substances only moderately well protected from such attacks.

These animals prefer a rocky habitat, especially one well covered with fucus, underneath which they remain concealed, and they are rarely seen exposed to the glare of the sun. They occur from the vicinity of high-water mark to a depth of several feet below low water, and have been dredged from a considerably greater depth, in one case in over 60 fathoms. But these specimens are usually not living, and their presence at such a depth can be ascribed to accident, such as the disgorging of a recently swallowed shell by a fish, or washing from their actual situs by the surf. Some species, like *N. lamellosa*, appear to frequent banks of rock or coarse gravel which are rarely uncovered by the tide and yet are favorite haunts of barnacles, and of oysters, anomias, and other rough bivalves upon whose young the *Nucella* feeds. The smaller species, like *emarginata*, seem to prefer the rocks covered with bladder-weed along shore.

I have not observed *Nucella* among the shells in the aboriginal middens of the Alaskan coast, nor are they eaten by the natives at the present time, although abundant enough to form an article of food. Jeffreys states that the British species is found in some of the Pictish middens, and that it is destructive to mussels and limpets, but on the Alaskan coast during many years collecting I have never found a drilled limpet shell or a *Nucella* attacking any but very young mussels.

The ovicapsules are abundant in early spring and, like those of the tribe elsewhere, are elongate slender yellowish vaselike objects of a parchmentlike texture, with a flat circular top, and are mounted on slender cylindrical peduncles in groups on rocks or dead bivalves.

The young, of which a considerable number occur in a single capsule, are cannibals, the weaker ones being devoured by their brethren while still in the capsule, from which the survivors emerge at the top, leaving the vase unsealed. The adults also browse on the capsules, which are easily cut through by the sharp teeth of the radula.

Like the other species, these produce a purple dye, which I tested on an old handkerchief. It gave a dull purple color, which faded badly; but I afterwards learned that it could be made permanent by the addition of lemon juice, which is used with the purple of the tropical species by the natives of Central America and Peru. However, I have never seen any articles dyed with this substance which had any brilliancy or attractiveness of tint. If the classical descriptions of the Tyrian dye are correct, the American purple can not compete with it.

Jeffreys says that the fluid contained in the *N. lapillus* ovicapsules is also purpuriferous (besides having a disagreeable peppery taste),

and I have noticed in Alaska that the brownish-yellow groups of capsules sometimes have a purplish tinge. In the animals themselves the secretion bears no comparison in amount or color with that afforded by the tropical species, especially *Patellipurpura*.

THAIS (NUCELLA) LAMELLOSA Gmelin.

Plate 74, figs. 5-8.

Buccinum plicatum MARTYN, Univ. Conch., 1784, fig. 44; not of Linnaeus, Syst. Nat., ed. 10, 1758, p. 735.

Buccinum compositum CHEMNITZ, Conch. Cab., vol. 10, 1788, p. 179, vign. 21, figs. a, b (nomenclature not Linnean).

Buccinum crispatum CHEMNITZ, Conch. Cab., vol. 11, 1795, pp. 70, 84, pl. 187, fig. 1802-1803, (nomenclature not Linnean).—DILLWYN, Recent Shells, vol. 2, 1817, p. 613; not of Solander in Dillwyn, vol. 2, p. 707.

Buccinum lamellosum GMELIN, Syst. Nat., vol. 7, 1792, p. 3498.—DILLWYN, Recent Shells, vol. 2, 1817, p. 612.

Buccinum lamellosum BOLTEN, Mus. Bolt., ed. 1, 1798, p. 113, Nos. 1462-1463 (23); ed. 2, 1819, p. 80, Nos. 1435-1436 (23), pl. 1, fig. 4.

Polyplex rugosus PERRY, Conch., 1811, pl. 9, fig. 2.

Murex crispatus LAMARCK, Anim. s. Vert., vol. 7, 1822, p. 174; Encycl. Meth., 1816, pl. 492, fig. 2; Deshayes' Lamarck, Anim. sans Vert., vol. 9, 1845, p. 576.

Murex ferrugineus ESCHSCHOLTZ, Zool. Atlas, pt. 1, 1829, p. 10, pl. 9, figs. 2 A-B.

Murex lactuca ESCHSCHOLTZ, Zool. Atlas, pt. 1, 1829, p. 11, pl. 9, figs. 3 A-B; not of Bolten, Mus. Bolt., 1798, p. 141, as *Purpura* (= *Murex saxatilis* Linnaeus, Syst. Nat., ed. 10, 1758, p. 747; + *Purpura saxatilis* Meuschen, 1787).

Polytropha crispata SWAINSON, Malac., 1840, p. 305.

Purpura septentrionalis REEVE, Conch. Icon., vol. 3, 1846, *Purpura*, pl. 10, fig. 50.—MIDDENDORFF, Beitr. Mal. Ross., vol. 2, 1849, p. 117.

Murex lactuca MIDDENDORFF, Beitr. Mal. Ross., vol. 2, 1849, p. 120, pl. 7, figs. 1, 2.—FISCHER in Pinart, Voy. Côte N. W. de l'Amér., 1875, p. 38, pl. E, figs. 4, 4a.

Purpura crispata CARPENTER, Rep. Brit. Assoc. for 1863, p. 662, 1864 (Smithsonian reprint 1872, p. 148).—ARNOLD, Pal. San Pedro, 1903, p. 261.

Purpura plicata MARTENS, Mal. Blätt., vol. 19, 1872, p. 86.

Purpura lapillus var. *crispata* TRYON, Man., vol. 2, 1880, pp. 171-229, pl. 54, figs. 163-166.

Thais (Nucella) lamellosa DALL, Prof. Paper, No. 59, U. S. Geol. Survey, 1909, p. 80.

Thais plicata VANATTA, Nautilus, vol. 24, No. 4, 1910, p. 37.—COOKE, Proc. Mal. Soc., vol. 11, pt. 4, 1915, p. 203.

? *Purpura lapillus* var. *quillayutea* REAGAN, Trans. Kansas Acad. Sci., vol. 22, Geol. ser., 1909, p. 221, pl. 6, figs. a-b.

Range.—Bering Strait at Port Clarence; south on the west to the Japan Sea off Sado Island in 161 fathoms (dead); on the east to the Aleutian Islands and to Cook's Inlet, Oregon, and Santa Barbara, California. Pleistocene of California and Oregon. Pliocene of San Diego and San Mateo Counties, California, and Clallam County, Washington.

This species submits to such changes, incident to situs, that single specimens, or even numerous specimens from single localities, might well be taken for different species, especially as specimens from a

single locality often exhibit a singular uniformity of characters, even in factors which would seem not likely to be subject to influences of the environment, such as the number of the major spirals. These uniformities are probably due to inheritance from common ancestors. The only way to get a broad view of the range of characters is to have not only many specimens but specimens from many localities. Then the gradations can be recognized in a way not otherwise possible.

There are some of these forms which exhibit characteristics of a uniformity which entitles them to be called varieties, irrespective of the differences due to color-variation, and other mutations.

THAIS LAMELLOSA Gmelin, typical form.

Type locality (to which it is by no means confined) Nootka Sound, Vancouver Island.

Shell large, heavy, with a conic spire shorter than the aperture in most specimens, prominently laminated with from 9 to 20 sharp-edged elevated lamellae, crenulated and produced where they intersect a major spiral; on the penultimate whorl there are two, on the last whorl seven to nine major and an indeterminate number of minor spirals, the former most prominent near the shoulder of the whorl, diminishing in size and more adjacent progressively toward the canal; aperture large, the outer lip flaring, the throat sometimes dentate, the umbilical chink usually sealed by callus (63873).

In the following measurements in millimeters the nucleus is not included:

Measurements.

TYPICAL FORM.

Whorls.	Height of shell.	Height of last whorl.	Breadth.
6.....	72	54	38
6.....	81	65	46
7.....	86	57	42

LAMINATE FORM.

Whorls.	Height of shell.	Height of last whorl.	Breadth.
4.....	40	35	26
4½.....	38	34	27
5.....	39	32	28.5

SMOOTH FORM (60125).

4.....	46	41	32
4½.....	48	42	30
4¾.....	30	31	24

THAIS LAMELLOSA, new variety FRANCISCANA.

San Francisco Bay.

Shell subfusiform, heavy, with a subconic spire shorter than the aperture, laminae reduced to obsolete low imbrications or usually none; whorls flattened behind the shoulder; major spirals low, feeble, two on the penultimate whorl, seven or more on the last whorl, minor spirals obsolete or none; aperture large, the outer lip flaring, umbilical chink usually distinct but closed (63909).

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Breadth.
4½.....	50	40	28
4½.....	52	41	29
5.....	51	42	29

THAIS LAMELLOSA, new variety HORMICA.

Inner part of Sitka Harbor, Alaska.

Shell of smaller size than either of the preceding, thin, with spire subacute, produced, longer than the aperture; whorls angular with more or less prominent axial laminae, 10 or more to the last whorl, often produced at the angles into guttered spines; major spirals two on the penultimate, five or six on the last whorl; aperture small, the outer lip hardly expanded, only moderately callous; the umbilical chink usually obsolete (88862).

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Breadth.
6.....	48	30	21
6.....	53	34	25
6½.....	48	32	20

THAIS LAMELLOSA, new variety NEPTUNEA.

Cook Inlet.

Shell large, heavy, smooth, with rounded whorls and deep though appressed sutures, resembling a very thick and heavy *Chrysodomus*.

The measurements are about the same as in the typical form.

THAIS LAMELLOSA, new variety CYMICA.

Typical locality: Rocks exposed to the surf, coast of Washington.

Shell short, robust, heavy, very thick, spire short-conic, shorter than the aperture, one mutation being sparsely laminate, the other with a smooth surface; whorls flattened behind the shoulder; major spirals obsolete or none; when present, there is one on the penultimate whorl and five or six on the last whorl; aperture large, outer lip flaring, umbilical chink usually concealed by the callus.

THAIS LAMELLOSA, new variety SITKANA.

Inner harbor of Sitka, Alaska.

Shell resembling var. *hornica*, but smaller and thinner, the spire produced, subacute, longer than the aperture; whorls rounded, with no lamination; major spirals conspicuous, two on the penultimate, five or six on the last whorl; aperture small, outer lip not reflected, usually with a deep umbilical chink.

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Breadth.
4½	36	24	17
4½	36	24	17
5	38	25	18

If names were given to mutations such as color markings, etc., the number might be indefinitely increased. All the varieties seem to run through the same gamut of color, and to have banded mutations. I have not been able to satisfy myself as to the existence of differences in the shell due to sex, but the subject requires further study.

THAIS (NUCELLA) LIMA Martyn.

Plate 75, figs. 4-6.

Buccinum lima MARTYN, Univ. Conch., vol. 2, 1784, pl. 46.

Purpura saxicola VALENCIENNES, Voy. *Venus*, Atlas, 1846, p. 4, pl. 8, figs. 4, 4a.

Purpura attenuata REEVE, Conch. Icon., vol. 3, September, 1846, *Purpura*, pl. 10, fig. 49.

Purpura freycinetii (part), MIDDENDORFF, Sib. Reise, vol. 2, 1851, p. 219, pl. 12, figs. 5-9 (not of Deshayes, 1839); also in Beitr. Mal. Ross, 1849, p. 117.

Purpura canaliculata et saxicola (part), CARPENTER, Rep. Brit. Assoc., for 1863, p. 662, 1864. (Smithsonian reprint, 1872, p. 148.)

Purpura lapillus var. TRYON, Man., vol. 2, 1880, p. 175; not of Linnaeus.

Purpura lima (part), TAYLOR, Trans. Roy. Soc. of Canada, ser. 2, sect. 4, 1895, p. 72.

Thais lima VANATTA (syn. excl.) Nautilus, vol. 24, August, 1910, p. 37.—KEEP, W. Coast Shells, 1911, p. 180, fig. 169.

Purpura lima COOKE (syn. excl.) Proc. Mal. Soc. London, vol. 11, pt. 4, 1915, p. 203.

Range.—From Kotzebue Sound, Arctic Ocean, south to Bering Strait and on the west to Bering Island, Kamchatka, the Kuriles and Japan. On the east to the Aleutian Islands, southeastern Alaska to California at Monterey, San Pedro Point, San Diego, and off Lower California on Cerros Island.

Shell of three and a half to four rounded whorls, not including the nucleus; moderately thick with a spire much shorter than the aperture, the last whorl much the largest; with a tolerably uniform spiral sculpture of alternated major and minor spiral cords; aperture large, outer lip not reflected and seldom thickened, more or less crenulated

by the sculpture; pillar slightly arcuate, flattened anteriorly, the canal narrow and curved to the left; umbilicus sometimes sealed, at others showing a deep narrow perforation behind the callus of the reflected pillar.

Type locality, Nootka Sound.

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Breadth.
3½	43	40	30
3½	50	45	30
3½	60	54	36

THAIS (NUCELLA) CANALICULATA DUCLOS.

Plate 74, figs. 1-4.

Purpura canaliculata DUCLOS, Ann. Sci. Nat., vol. 26, Mai, 1832, p. 104, pl. 1, fig. 1, California.—HUMBOLDT and BONPLAND, Recueil d'obs. de Zool., vol. 2, 1832, p. 316.

Purpura analoga FORBES, Proc. Zool. Soc. London, 1850, p. 273, pl. 11, fig. 12, California.

Purpura decemcostata MIDDENDORFF, Beitr. Mal. Rossica, vol. 2, 1849, p. 116, pl. 9, figs. 1-3.

Purpura lapillus var. *beringiana* MIDDENDORFF, Sib. Reise, vol. 2, 1851, pt. 1, p. 222, pl. 12, figs. 10, 11 (only), Okhotsk Sea.

Purpura freycinetii MIDDENDORFF, (part) Beitr. Mal. Ross., 1849, p. 117.

Purpura canaliculata CARPENTER, Rep. Brit. Assoc., for 1863, p. 662, 1864 (Smithsonian reprint, 1872, p. 148), (syn. ex. parte excl.); Puget Sound to San Francisco, California.

Purpura lapillus var. TRYON, Man., vol. 2, 1880, p. 175, pl. 53, fig. 156.

Purpura lima, (part), TAYLOR, Trans. Roy. Soc. Canada, ser. 2, vol. 1, sect. 4, 1895, p. 72, not of Martyn, 1784.—VANATTA, Nautilus, vol. 24, No. 4, August, 1910, p. 37.—KEEP, W. Coast Shells, 1911, p. 180, fig. 169.—COOKE, Proc. Mal. Soc. London, vol. 11, pt. 4, March, 1915, p. 203.

Range.—Aleutian chain from Attu eastward to Sitka and southward to Puget Sound and Monterey, California.

This species has been confounded with *Thais lima* by several authors and with *T. freycinetii* by others. Tryon, as usual, "lumps it" with *T. lapillus*. The reasons for considering it distinct will follow later.

At the same time that this species was described by Forbes under the name of *analoga* another species was named *fuscata*, figured, and said to come from the Hawaiian Islands. Carpenter in his report of 1864 says the types of *fuscata* in the British Museum comprise one brown and one immature white specimen, which he describes as a "large smooth rather elevated variety of *saxicola*" (p. 592). This does not at all agree with Forbes's figure. On the other hand, Cooke (p. 204) states that "The type of *fuscata* is the larger of two specimens in the British Museum, collected by Captain Kellett and

Lieutenant Wood, R. N. * * * The spire is elevated and the spiral ridges well marked." This is probably correct; at any rate, the observations on the species here made are based on the supposed accuracy of the figure in the Proceedings of the Zoological Society.

The figure is excellent and portrays a shell with two strong spiral ribs on the penultimate whorl separated by deep axially threaded channels. On the last whorl there are six of these ribs. The aperture is about one-fifth longer than the spire. No species with these characters is known from the northwest coast. The Hawaiian Islands have long been known for the great number of shells from all parts of the Pacific brought there by whalers and traders, many of which in the literature have erroneously been supposed to form part of the fauna of the Hawaiian group. The figure of the *Purpura fuscata* of Forbes agrees almost exactly with the Indo-Pacific species named by Velain *P. dumasi* variety *cincta*,¹ and I have a suspicion it is either that or a closely related Indo-Pacific species.

THAIS CANALICULATA, typical form.

Type locality, "California."

Shell bucciniform, of three and a half to four rounded whorls exclusive of the nucleus, moderately thick, with a spire about one-half shorter than the aperture, the last whorl largest, with a very uniform sculpture of strong elevated spiral ridges separated by distinctly channeled interspaces crossed by small slightly elevated axial lamellae or elevated lines; minor spirals very rarely occur; there are 4 to 6 major spirals on the penultimate whorl and about 10 on the last whorl; outer lip not reflected and only slightly thickened, usually crenulated by the external sculpture; pillar moderately arcuate, flattened in front where the callus conceals but does not seal a long narrow umbilical chink; canal narrow, recurved (220973).

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Height of aperture.	Breadth.
3½.....	34	27	20	18
4.....	40	30	21	20
4.....	41	33	23	23

THAIS CANALICULATA, var. ANALOGA Forbes.

"California."

Similar to the preceding but stouter, usually with one more whorl, and with a minor spiral regularly intercalated between the major spirals.

¹ Arch. Zool. Exper., vol. 6, 1876, p. 102, pl. 2, fig. 15.

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Height of aperture.	Breadth.
4 $\frac{1}{2}$	43	36.0	28.0	27
4 $\frac{3}{4}$	46	36.5	25.0	25
4 $\frac{1}{4}$	47	37.0	27.5	27

THAIS CANALICULATA, new variety COMPRESSA.

Monterey, California (60102).

Shell similar to the typical form but with the elevated ridges or major spirals flattened down until the interspaces become almost linear. There are 6 or 7 on the penultimate whorl and 12 or 13 on the last whorl.

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Height of aperture.	Breadth.
3 $\frac{1}{2}$	36	30	24	21.5
3 $\frac{3}{4}$	38	34	25	23.0
4.....	34	29	23	22.0

THAIS (NUCELLA) EMARGINATA Deshayes.

Plate 75, figs. 1-3.

? *Purpura lagenaria* DUCLOS, Ann. Sci. Nat., vol. 26, Mai, 1832, p. 112, pl. 2, fig. 11; not of Lamarck, 1822.

? *Purpura rupestris* VALENCIENNES, Voy. Venus, Atlas, 1846, pl. 9, fig. 1, a-b, (Magnified figure.)

Purpura emarginata DESHAYES, Rev. Zool. Soc. Cuv., 1839, p. 360; Mag. de Zool. (Guerin), 1841, pl. 25. (Pathologic.)

Purpura lapillus var. *anomala* MIDDENDORFF, Beitr. Mal. Ross., vol. 2, 1849, p. 115, pl. 9, figs. 4, 5 (only).

Purpura emarginata REEVE, Conch. Icon., vol. 3, *Purpura*, 1846, pl. 10, fig. 46.—COOKE, Proc. Mal. Soc. London, vol. 11, 1915, p. 203.

Purpura conradi (Nuttall MS.) REEVE, Conch. Icon., vol. 3, 1846, in synonymy.

Purpura saxicola var. *CARPENTER*, Rep. Brit. Assoc., for 1863, p. 662, 1864 (Smithsonian reprint, 1872, p. 148). Not of Valenciennes.

Purpura ostrina GOULD, U. S. Expl. Exped., Mollusca, 1852, p. 244; Atlas, 1857, pl. 18, figs. 310 a, b. Oregon.

Purpura saxicola TAYLOR, Trans. Roy. Soc. Canada, ser. 2, vol. 1, sect. 4, 1895, p. 72. Not of Valenciennes.

Thais emarginata VANATTA, Nautilus, vol. 24, No. 4, 1910, p. 37 (syn. exclus.).

Thais saxicola KEEP, West Coast Shells, 1911, p. 179, fig. 168.

Range.—Bering Island and the Okhotsk Sea on the west. On the east Hagemester Island and Bering Sea south of the winter floe-line, and southeastward to California; Cerros Island, Lower California; Mazatlan and Topolobampo, Mexico.

The first two figures named in the above synonymy have a remarkable likeness to some smooth varieties of the present species. Tryon refers the first to *P. scobina* Quoy, from New Zealand and the Cape of Good Hope, but some of his other combinations are not so happy that they lead to much reliance on his opinion in this case.

The name *emarginata* is founded on a pathological feature of the type specimen, yet it is not obnoxious enough to make it necessary to reject it solely on that account. How Carpenter came to identify this species with *saxicola* of Valenciennes is a puzzle; the original figure of the latter is clearly a form of *Thais lima*, exactly duplicated by many specimens from the Northwest in our collection. The reference of *saxicola* to *T. freycinetii* is more reasonable, as the relations between that species and *T. lima* are very close, if indeed *freycinetii* is more than a subspecies of *T. lima*.

The original locality, as for many west coast shells, is given as "New Zealand." As this is erroneous, I name San Miguel Island, California, where the typical form is abundant, as the type locality.

THAIS EMARGINATA, typical form.

Shell thick, solid, rotund, with a short spire of about three whorls without the nucleus, the body rude, with coarse nodulous or sub-spinose major spirals, a more or less flaring thickened outer lip, a very arcuate flattened pillar, short and hardly recurved canal, and sealed umbilical concavity (220975).

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Height of aperture.	Breadth.
3.....	30	28	23	23
3.....	31	29	22	22
3½.....	32	28	21	20
3.....	34	30	23	23

THAIS EMARGINATA, var. OSTRINA Gould.

Tillamook, Oregon.

Shell thinner than the preceding, nearly smooth, the major spirals represented by interrupted bands of dark-brown color but not raised above the general surface, and generally with a more elevated spire (32176).

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Height of aperture.	Breadth.
3½.....	27	24	19	16
3½.....	27	25	20	17
3½.....	36	31	26	23

THAIS EMARGINATA, new variety PROJECTA.

Sitka, Alaska.

Shell thinner, more elongate and with a pointed spire, the major and minor spirals more nearly equal, two strong spirals on the earlier whorls and the sutures more constricted. This is the more northern form (88842).

Measurements.

Whorls.	Height of shell.	Height of last whorl.	Height of aperture.	Breadth.
4.....	29	22	17.0	15.0
4 ¹	32	24	18.5	17.0
5.....	31	24	19.0	16.5

THAIS (NUCELLA) FREYCINETII Deshayes.

Purpura freycinetii DESHAYES, Rev. Zool. Soc. Cuv., 1839, p. 360; Mag. de Zool. (Guerin), 1841, pl. 26.

Purpura freycineti MIDDENDORFF, Beitr. Mal. Ross., 1849, p. 117 (part); Sibir. Reise, vol. 2, pt. 1, 1851, p. 219, pl. 12, figs. 1-9.

Purpura freycinetii REEVE, Conch. Icon., vol. 3, *Purpura*, September, 1846, pl. 10, fig. 51.—SCHRENCK, Amurland Moll., 1867, p. 388.

Polytropha lapillus A. ADAMS, Ann. Mag. Nat. Hist., vol. 5, 1870, p. 423, not of Linnaeus.

Purpura freycinetii LISCHKE, Jap. Meeres Conch., vol. 2, 1871, p. 40, pl. 4, figs. 15-19.

Purpura lapillus DUNKER, Ind. Moll. Mar. Japan, 1882, p. 4, not of Linnaeus.—PILSBRY (following Adams), Cat. Mus. Moll. of Japan, 1895, p. 45.

Purpura freycinetii var. *alabaster* PILSBRY, Proc. Acad. Nat. Sci. Phila., for 1907, p. 246, pl. 20, fig. 2. Chishima, Japan.

Range.—Southern Kamchatka, the Kuril Islands, the south and west coasts of the Okhotsk Sea, Sakhalin Island and Northern Japan to Kushiro.

The shell described and figured by Deshayes is immature, the complete outer lip and labial callus are not yet formed. It is further exceptional in its feeble spiral sculpture and extremely low spire. However, the peculiarities of the pillar lip and the general form enable one to connect it with the common Japanese species with a reasonable degree of probability. Since the species goes through practically the same phases of variation as *T. lima*, and both are present over part of their range, more or less confusion has resulted in the literature either from a superficial examination or a paucity of material.

The variety *alabaster* has a certain analogy with the shorter heavy forms of *T. lamellosa*, other mutations recall *T. lima*, but the most common type of all among the specimens I have been able to bring together most resembles the rougher type of *T. emarginata*. If these all belong to one species, the process of divergent evolution is less complete in Japan than in America.

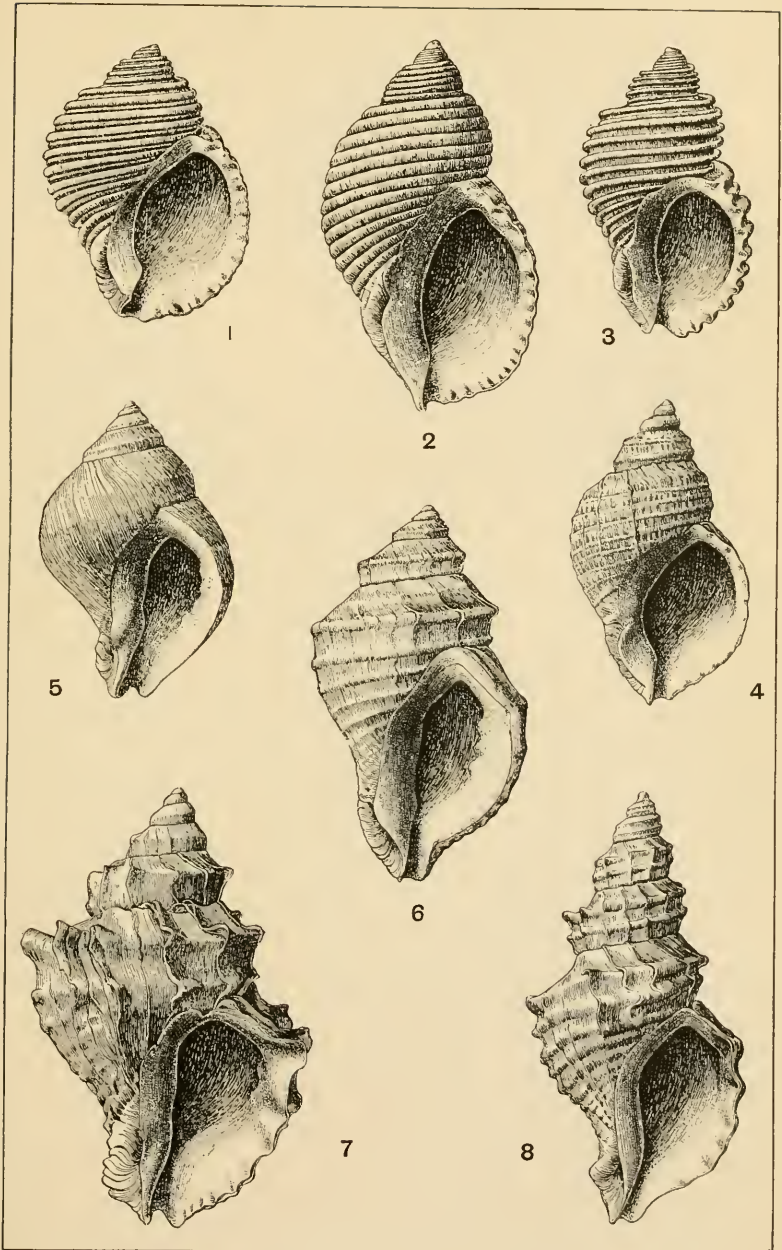
EXPLANATION OF PLATES.

PLATE 74.

- FIG. 1. *Thais* (*Nucella*) *canaliculata* Duclos, variety *analoga* Forbes, unusually swollen and depressed form, from Lituya Bay, Alaska. Cat. No. 220974, U.S.N.M. Alt. 31 mm., p. 568.
2. *Thais* (*Nucella*) *canaliculata* Duclos, variety *compressa* Dall, from Monterey, California. Cat. No. 60102, U.S.N.M. Alt. 38 mm., p. 569.
3. *Thais* (*Nucella*) *canaliculata* Duclos, typical form (+*decemcostata* Middendorff) Unalashka, Alaska. Cat. No. 220973, U.S.N.M. Alt. 38 mm., p. 567.
4. *Thais* (*Nucella*) *canaliculata* Duclos, mutation with obsolete sculpture from Sitka, Alaska. Cat. No. 32197, U.S.N.M. Alt. 33 mm., p. 567.
5. *Thais* (*Nucella*) *lamellosa* Gmelin, variety *cymica* (smooth mutation) from Port Ludlow, Washington. Cat. No. 60125, U.S.N.M. Alt. 38 mm., p. 565.
6. *Thais* (*Nucella*) *lamellosa* Gmelin, variety *franciscana* Dall, from San Francisco Bay. Cat. No. 63909, U.S.N.M. Alt. 50 mm., p. 565.
7. *Thais* (*Nucella*) *lamellosa* Gmelin, typical form, from oyster reefs, Vancouver Island. Cat. No. 63873, U.S.N.M. Alt. 67 mm., p. 563.
8. *Thais* (*Nucella*) *lamellosa* Gmelin, variety *hornica* Dall, from inner harbor of Sitka, Alaska. Cat. No. 88862, U.S.N.M. Alt. 53 mm., p. 565.

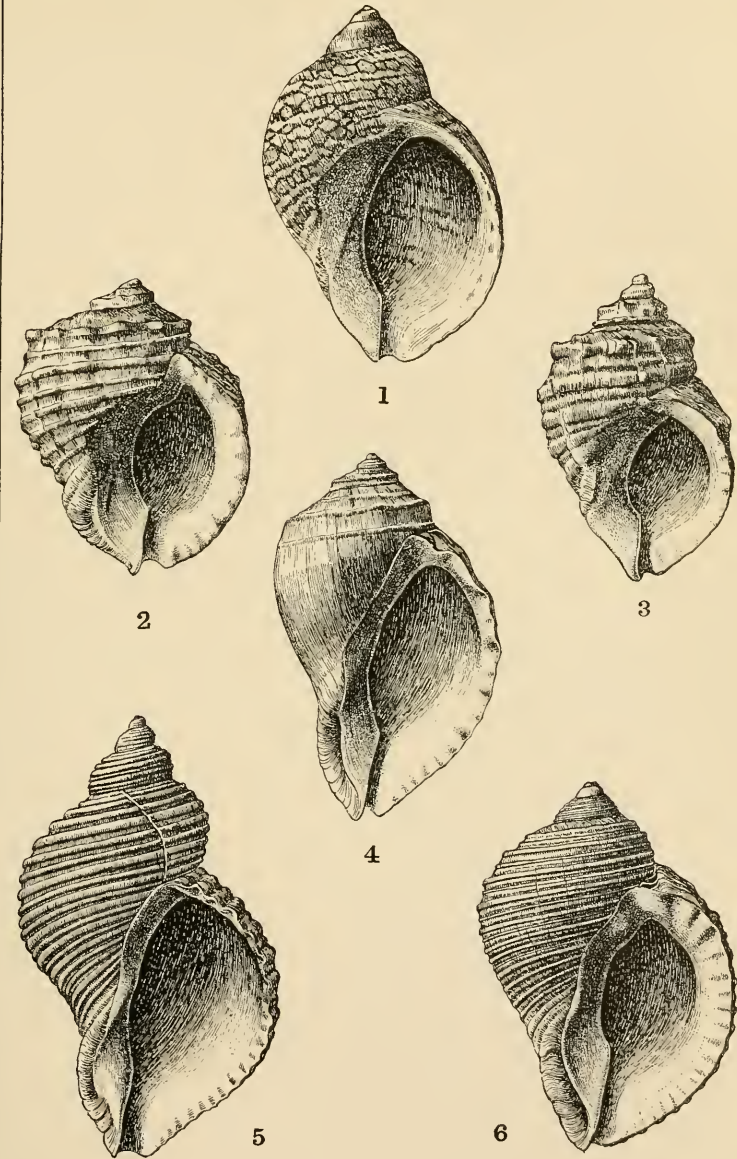
PLATE 75.

- FIG. 1. *Thais* (*Nucella*) *emarginata* Duclos, variety *ostrina* Gould, from Monterey, California. Cat. No. 32176, U.S.N.M. Alt. 36 mm., p. 570.
2. *Thais* (*Nucella*) *emarginata*, typical short and stout form, from Lituya Bay, Alaska. Cat. No. 220975, U.S.N.M. Alt. 30 mm., p. 569.
3. *Thais* (*Nucella*) *emarginata*, elevated form, from Monterey, California. Cat. No. 32179, U.S.N.M. Alt. 33 mm., p. 569.
4. *Thais* (*Nucella*) *lima* Martyn, typical form, smooth mutation, from Kadiak Island, Alaska. Cat. No. 60105, U.S.N.M. Alt. 33 mm., p. 566.
5. *Thais* (*Nucella*) *lima*, abnormally elevated mutation, from Unalaska, Alaska. Cat. No. 60084, U.S.N.M. Alt. 49 mm., p. 566.
6. *Thais* (*Nucella*) *lima*, normal form, heavy mutation, from Port Möller, Alaska. Cat. No. 220976, U.S.N.M. Alt. 40 mm., p. 566.



THAIS (NUCELLA) CANALICULATA AND THAIS (N.) LAMELLOSA.

FOR EXPLANATION OF PLATE SEE PAGE 572.



THAIS (NUCELLA) EMARGINATA AND THAIS (N.) LIMA.

FOR EXPLANATION OF PLATE SEE PAGE 572.

