

AVERAGE OF THE SPECIMENS.

Length of head in total length without caudal (times) .....	4.62
Interorbital area in total length without caudal (times).....	43
Snout in total length without caudal (times).....	17
Upper jaw in total length without caudal (times).....	14.05
Mandible in total length without caudal (times).....	11
Distance of dorsal from snout in total length without caudal (times).....	4.73
Base of dorsal in total length without caudal (times).....	1.26
Distance of anal from snout in total length without caudal (times).....	2.17
Base of anal in total length without caudal (times) .....	1.84
Distance of pectoral from snout in total length without caudal (times).....	4.51
Length of pectoral in total length without caudal (times).....	5.95
Distance of ventral from snout in total length without caudal (times).....	4.79
Length of ventral in total length without caudal (times).....	13.74
Branchiostegals .....	VI
Dorsal rays .....	48-50
Anal rays .....	33-37
Caudal rays.....	21-22
Pectoral rays.....	15
Ventral rays .....	3

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**REPORT ON THE LIMPETS AND CHITONS OF THE ALASKAN AND ARCTIC REGIONS, WITH DESCRIPTIONS OF GENERA AND SPECIES BELIEVED TO BE NEW.**

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The following report has been drawn up chiefly from material collected in Alaska from 1865 to 1874 inclusive, but includes references to the few Arctic or northern species which are not common to Alaskan waters.

The northwest coast of America, which I have already stated I have reason to think is the original center of distribution for the group of *Docoglossa*, at least of the littoral forms, is unquestionably the richest field where these animals may be found. This is true not only in regard to the number of species, but also in regard to the number of peculiar and remarkable forms of genera and subgenera; in one sense, the development and specialization of the soft parts, even at the expense of the shelly envelope, is a test of relative rank in restricted groups. Hence it may not be erroneous to regard the gigantic *Cryptochiton* as representing the highest development of the group, though belonging in the section of Irregular Chitons; especially as paleontological evidence shows part of the section of Regular Chitons to represent the Chitons of paleozoic times and embryonic structure. As was pointed out in my previous paper on the phylogeny of the *Docoglossa*, the embryonic types, represented by *Lepeta* and *Cryptobranchia* among the Limpets, are represented on the N. W. coast by a larger number of species and by larger individuals than in any other region; so the embryonic types of *Chitonidae* in the same district are here to be found more largely repre-

sented in species and by larger individual species than anywhere else in the world. That this is also true of other groups of Mollusca, such as the *Fissurellidæ*, *Trochidæ*, *Haliotidæ*, *Buccinidæ*, and others, I hope hereafter to be able to show conclusively.

Since I have elsewhere\* treated in considerable detail the Limpets of the northwest coast of America, I shall here present only a list of the species with such additional material as six years' study and collections have brought to hand, and reserve for the Chitons a more detailed account. This is the more desirable, since this group has been very generally neglected, and even the most modern descriptions often fail to give those details by which a species can be assigned a place among its proper associates.

Had the late Dr. Carpenter survived, the report on this group would have been delegated to his more able hands; the material passed for a time into his possession, but his premature demise came to pass before anything except the identification of the already known species and some correspondence on the general subject had been accomplished. For sufficient reasons, it is not to be hoped that his materials for a monograph of the group, as a whole, will be published for some time, and I have therefore been authorized to use some extracts from his MSS. which have a direct bearing on the particular species here referred to. I have in all cases followed him in framing descriptions of species, and have quoted his original descriptions (giving due credit) where it was practicable. Research into several undecided questions has resulted in decisions in several cases different from those he had anticipated; but in which conclusions, from my intercourse with him, I have no doubt he would have eventually coincided, had he lived to follow out the investigations he began.

The caution, in assigning values to the higher divisions of this singular group, which was exercised by Dr. Carpenter, has been fully justified, and it does not seem that our knowledge of them is yet sufficiently complete to authorize definite conclusions. Examination of the radula, heretofore almost wholly neglected, emphasizes the necessity of continued caution. The numerous characters presented by the insertion-plates, the characters of the girdle, branchiæ, sexual organs, development, radula, and the presence or absence of pores on the upper surface, are apparently interchangeable to a greater extent than would be supposed. In this sense they present a remarkably homogeneous group. In spite of numerous important and peculiar features, their position, as a subdivision of the Gasteropodous Mollusca, appears to me to be definitely settled beyond any reasonable question. By very numerous characters, their continued association in the neighborhood of the Limpets as their nearest (if still somewhat distant) relatives appears to me to be assured, and requires only some knowledge of the embryology of

\*"On the Limpets," &c., Am. Journ. of Conchology, vi, pp. 228-282, pl. 14-17, April, 1871.

Limpets to be placed on a definite footing. That any classification founded on single characters, or a small proportion of characters, may result unfavorably to this view, I am not prepared to deny; but whatever advantages such a method may present, it is not one which appears worthy of the name of philosophical treatment, or likely to endure as our knowledge becomes more definite and extended.

It is not yet certain how far the indications of the dentition may be relied on in this group, as will presently be shown. Whether, as in the inplacental mammalia, the teeth will prove an insecure basis for generalization beyond genera, or whether a classification based upon them will present a more favorable aspect when a larger number of species have been examined, it is yet impossible to say. What is known presents some anomalies to which the key is at present wanting. So far as investigation has proceeded, greater weight seems due to the character of the shelly plates than to any other single feature, and the tentative classification of Dr. Carpenter is in this way justified. Any division of the group into families seems premature without more light. The genera and subgenera are, in most cases, reasonably sure on their foundations; but on an examination of the dentition, such as is contemplated by Dr. Troschel, and is urgently needed, much will depend. But until this has been made very full and thorough, it is to be hoped that generic distinctions based on the teeth alone may be suspended, or at least left without names.

A sketch of the outlines of Dr. Carpenter's classification will not be out of place here, but is best preceded by an explanation of certain terms used in description.

In all Chitons with exposed valves, the seven posterior valves are divided more or less plainly by lines radiating from the apex to the opposite anterior edge. The sculpture of the posterior triangular areas (*areae laterales*) thus cut off is almost uniformly like that of the whole anterior valve and the part behind the apex (*muero*) of the posterior valve. The central or anterior triangles (*areae centrales*) are sculptured alike, but generally in a different pattern from the sides. The *areae laterales* are usually raised a little above the rest. It is very rare that the bounding diagonal lines cannot be traced, and they usually correspond to the slit in the side-laminae of insertion, which project into the zone or girdle, and are free from the peculiar porous superficial layer characteristic of the exposed test in the whole group of Chitons. This superficial layer usually projects over the anterior and posterior laminae of insertion or teeth (*dentes*) in the first and last valves, forming what Dr. Carpenter terms the 'eaves' (*subgrundæ*). These may exhibit the spongy character of the layer of which they are formed, or may be varnished over at their edges with a thin layer of true shelly matter, as in the Ischnoid group. In the typical Chitons they are short, leaving the teeth projecting; in the Mopaloids they are hardly developed, and in some groups they quite overshadow the teeth.



In many genera there is a small portion of peculiar sculpture marked off along the ridge of the median line of the back. This is the *area jugali*, and corresponds to the *sinus* or space between the inner terminations of the two anterior *sutural laminae* which pass forward from each of the posterior seven valves under the valve in front. The sutural laminae are also destitute of the porous layer. The *sinus* is either open,

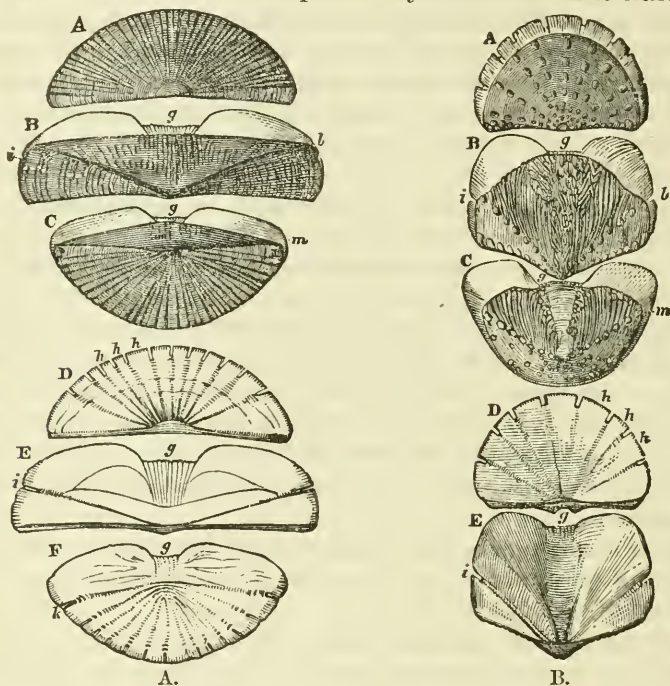


FIG. A.—*Chiton olivaceus* Sowerby. *A*, anterior, *B*, middle, and *C*, posterior valve, seen from outside; *D*, *E*, *F*, the same valves, from within; *g*, *sinus jugali*, between the two anterior sutural laminae; *h*, *h*, *dent*es, or teeth between the notches or slits in the laminae of insertion; *i*, *k*, slits in lamina of insertion; *l*, outer end of line separating the *area lateralis* of the middle valve from the *area centralis*; *m*, end of the line separating the central area of the tail-plate from the posterior portion; the angulation of this line in the median line of the animal forms the *muero*.

FIG. B.—*Enoplochiton niger* Barnes.—*A*, anterior valve from above, showing the laminae of insertion and notches; *B*, the middle valve, from above; *g*, *sinus jugali*, in front of the jugum, or *area jugali*, and between the two sutural laminae; *i*, *l*, notches between the sutural and insertional laminae, and forming the ends of the line forming the anterior border of the lateral and posterior border of the central areas; *C*, tail-plate; *g*, *sinus jugali*; *m*, end of line separating the areas; *D*, anterior valve, from within, showing teeth (*h*, *h*) and notches of lamina of insertion; *E*, middle valve, from within; *g*, jugal sinus, between the sutural laminae; *i*, notch, between sutural lamina and side-lamina of insertion.

or part of the jugular area projects forward between the sutural laminae, forming a false apex; or a keystone-like piece, either solid, or fimbriated like the teeth of a comb, may exist between the laminae and partly fill the sinus. The *sinus posticus* is the wave, notch, or indentation which in some genera is found in the posterior edge of the posterior valve. In

some of the Irregular Chitons, *posterior sutural laminae* are found, but these are very exceptional.

In the vast majority of genera, the side-laminae of insertion have only one slit on each side of the valve; occasionally a valve may be abnormal in a regular species, and the number of slits in the anterior and posterior valves may vary within moderate limits.

The girdle (*zona*), which is distinct from the true mantle, is variously ornamented with scales, bristles, spines, down, or hairs, either singly or combined, which exhibit most beautiful forms tolerably constant in generic groups, and worthy of a special and exhaustive research.\* These may be solid or hollow, shelly or keratose, single or combined in bunches, and in some forms are hollow and annulated, precisely like the setae of Brachiopods. In certain genera they issue from pores, usually at the sutures, and these pores have a certain value as a systematic character, but much less than has been assigned to them by some authors.

The Chitons in the adult condition are destitute of eyes or tentacles, and exhibit evidences of degradation anteriorly. The anus is always median and posterior; on each side of it are the sexual openings or *fenestrae*. These may open by several slits or pores directly into the perivisceral cavity, or form the aperture of a sexual duct. The gills, as pointed out by me in 1871, are composed of a row of branchiae, starting from near the tail, extending a third (*posticae*), half (*mediae*), or all the way (*ambientes*) toward the head, each leaflet of which corresponds to a whole branchial plume, such as is found in *Aemca*. Each single gill is conical, with the lamellae projecting inward, somewhat resembling in outline the shell of *Carinaria*. The mantle, inside the coriaceous margin of the girdle, often forms a lamina or fringe. A lappet called the 'veil' generally surrounds the front of the rostrum, which has sometimes a double veil. The muzzle is semicircular, usually plain, and exhibits a tendency to form a lobe at the two posterior corners. The radula is always present. Like the Limpets, Chitons possess a laminated crop before the true stomach. The nervous system, beautifully worked out by Brandt† in a paper singularly overlooked by most writers, is also comparable with that of *Patella vulgata* (simultaneously examined and figured), though by no means identical. The cephalic ganglia appear to be suppressed, forming another evidence of the degeneration or want of development of the cephalic region in this group. A valuable paper by Dr. H. von Ihering of Erlangen, I have not yet had access to, but understand that it contains a description of the nervous system of Chitons.‡

\* Cf. Reinecke, Beitr. zur Bildungsges. der Stacheln, u. s. w.; Zeitschr. für Wiss. Zool. 1858.

† St. Petersburg, Imp. Acad. Sci. Mélanges Biolog. vii, p. 146, f. 2, 1838, *Acanthochiton fascicularis*.

‡ Since this paper was written, I have been kindly furnished by Dr. v. Ihering with copies of his extremely important work on the "Anatomy of the Nervous System and the Phylogeny of the Mollusca," and two valuable papers concerning the *Chitonidae*.

Since differences exist between the results obtained, in working out the nervous system of *Chiton*, by different naturalists, it is thought best (from Gegenb. Morph. Zeitschr. iv, April, 1877), and their allies. In the first-mentioned work, the author comes to somewhat different conclusions from Brandt in regard to the details of the nervous system, both in *Chiton (cinereus)* and *Patella vulgata*, though the differences are not so fundamental as a first glance at the somewhat diagrammatic figures might suggest. In the "Anatomy" the author considers as a separate phylum (*Amphineura*) the Chitons, together with *Neomenia (Solenopus Sars)* and *Chatederma*, placing them under *Ferres*, while the *Dogoglossa* and most of the Prosobranchiate Mollusks form the third phylum (*Arthrocochliides* Ihr.) of the Mollusca. In the later paper on *Neomenia*, &c., Ihering seems disposed to concede a more intimate relation between the *Fissurellidae* and Limpets on the one hand and the *Chitonida* on the other. His figures would indicate a more near relation between *Fissurella* and *Chiton* than between the latter and *Patella*, so far as the nervous system goes. It must be borne in mind, while considering his differences with Brandt in regard to *Chiton*, that the species examined by Ihering, *Trachydermon cinereus* Lowe, is one of the lower forms of *Chitonida*, closely related to the lowest existing genus, *Leptochiton*; while that dissected by Brandt belongs to the higher of the two great groups of *Polyplaciphora*. It would be natural, therefore, that the nervous system of the former should more nearly resemble the wormlike forms from which the Chitons may have come out, and that the latter should be closer to the Limpets, which, though less specialized, I can hardly doubt sprang from the same original stock. It is also within the bounds of probability that in the details of the nervous system, as in all other details, the characteristic variability (within certain limits) of the group of *Chitonida* may assert itself.

I cannot refrain from expressing, here, my conviction that there are at least two points of view from which the classification of these invertebrates may be regarded in a scientific sense. The army of embryologists, to whom, in these later days, we owe so much new light, with the enthusiastic self-confidence born of successful innovations, as a general rule deny the existence of more than one scientific point of view. More than one of them has dogmatically asserted that science in natural history now consists in the study of embryology alone, and phylogenetic classifications deduced therefrom. It has been said that careful and minute anatomical investigations and histological researches based upon adult animals no longer deserve the name of science. It has even been averred that the only object of classification now is the representation in words of phylogenetic diagrams, or the derivative relations of animals according to the particular author's hypotheses. It is therefore somewhat refreshing to find that a school of naturalists is gradually forming, for whom anatomy as compared with pure embryology has still some attractions.

No one denies that a classification may be grounded exclusively upon the embryonic development, and may possess a high scientific character, nor that among the higher animals such a basis must form a principal part of the foundation of any scientific classification which may be applied to them.

But what seems to be lost sight of by some of those who have escaped from the bonds of the Cuvierian system, is the fact that some of the derivatives from two parallel stocks may resemble one another more closely than specialized forms derived from the same stock; that in the early stages of the development of organisms before well-defined lines of specialization for the adults had been fixed by natural selection and other factors, variations were necessarily rather the rule than the exception among the embryonic forms, even when of common origin; that the missing stages, "abridged development," etc., reported by most later embryologists, are, in all probability, the traces of the original vacillations and accelerations of primal evolution, and that a truly philosophical classification must take these things into account.

It must not be forgotten that we have to deal with results as well as methods, with





(*Trachydermon*) *cinereus* is from Ihering. It will be seen that there are comparatively few important differences between the two; the pedal commissures (*npc*); the separation of the ganglia *App* from close connection with the anterior (*iape*) and posterior (*pipe*) loops; the larger and more conspicuous buccal ganglia (*Sp*) and the less complete coalescence of the strands forming the pedo-branchial commissure (*PBC*) are the most conspicuous features. Further research is required to determine how much of these differences is due to the diagrammatic character of the figures, and how much to the systematic difference between *Trachydermon* and *Acanthochiton*.

The nervous system of *Acanthochiton fasciularis* chiefly consists of two large angular ganglia bound together by a large flat commissure. These two principal ganglia, which lie on the sides of the buccal mass, may be taken as a consolidation of the *ganglia pedalia* and the *ganglia branchialia seu visceralia*; thence springs out a *nervus pedalis*, which supplies the foot and muscles with minute rami on each side of the nerve; also a *nervus branchialis*, which passes along a furrow on the inner edge of the mantle, giving out secondary rami to the branchiae. The cerebral ganglia are wanting, unless we consider with Middendorf that they form part of the pedo-branchial commissure. Brandt objects to this view on the ground that the commissure throughout its whole breadth is similarly formed and gives out similar nerves; namely, *nervi labiales* from in front, and a multitude of minute nerves to the pharynx behind. As Chitons have in the adult condition neither eyes nor tentacles, so the absence of these ganglia (from which in other forms nerves are given out to those two organs only) seems very natural. This commissure may also be called the *pedo-branchialis*, and it may correspond with the *commissura cerebralis*, from which similar nerves have been demonstrated to spring. This commissure also presents resemblances to the nerves and ganglia of the stomato-gastric system, common to many gasteropods, in its intense yellow color. A commissure binds each pedo-branchial ganglion with a little inferior pharyngeal ganglion, and the same also connects these inferior pharyngeal ganglia with one another by an inferior interpharyngeal commissure (as in *Patella vulgata*,

tures, generally more characteristic of *Annulosa*, from the different times at which they started from the common stock on an independent career of specialization.

All this in no wise authorizes the combination in one group of worm-like mollusks and molluscoid worms. The writer has persistently opposed such ill-considered conglomerations as wholly unphilosophical. Even were there embryological identity, which no one has claimed, such a course seems to him to indicate an ignorance of the meaning of terms in systematic nomenclature, or the confounding of the two starting points for classification, to which allusion has been made. He will even venture to predict that when the anatomy and development of two hundred, instead of two, species of Chitons and Limpets, are worked out, a single phylum will express their relations to the worms, to each other, and to the other true gasteropods; and to assert that, in his opinion, nothing is so likely to conduce to this simplification than the continuation and amplification of the really admirable work upon which Dr. v. Ihering and others have of late been engaged.



in which also it is bow-shaped, with the concavity forward), and through still another commissure with the two upper pharyngeal ganglia.

From each inferior pharyngeal ganglion, a long, thin commissure extends, binding it with a large subovate ganglion, which may be called the posterior inferior pharyngeal ganglion; and the others must then take the name of the anterior inferior pharyngeal ganglia. The two former are connected by a little arched commissure, and lie behind the aorta. From the anterior inferior pharyngeal ganglia three pairs of nerves proceed before and one behind the buccal muscle. The anterior superior pharyngeal ganglia are connected by five commissures with each other and other ganglia. From the superior anterior pharyngeal ganglia proceed two small nerves for the upper buccal muscles. The posterior superior pharyngeal ganglion sends out a small nerve to the upper lateral buccal muscle, and from the superior posterior post-pharyngeal two small nerves are traceable to the radula.

*Circulation.*—Our knowledge of this is due to Middendorf, to whose ponderous and not very satisfactory monograph of *Cryptochiton Stelleri* the student is referred. More light is needed on this subject.

*Sexual Organs.*—The *Chitonida* are of two sexes, wherever they have been examined by the writer, and the number of forms which has passed under review is so large that there can be no doubt this is the rule throughout the group.\* The histological characters of the male and female gland resemble those of the Limpets, at least in general appearance. The most superficial observer can separate the sexes when the characters have once been called to his notice. It is true that Middendorf found, or believed he found, spermatozoa in the ovisac of *Chiton (Symmetrogephyrus) Pallasii*, but this may be accounted for in another way; and I may say, definitely, that I have examined both males and females of that species. The glands of both sexes open on each side of the anus, in some species quite close to the latter, in others much further forward and in advance of the most posterior branchiæ. The opening may be a simple pore or small aperture forming the termination of a sexual duct, or it may consist of what I have termed a *fenestra*, or elongated slit, crossed by several bands of tissue, so that there may seem to be from two to seven oblique slits, each extending partly behind the front end of the slit behind it. In these cases, I have not been able to determine the existence of a continuous oviduct, and am inclined to believe that the ova may pass from the oviduct into the perivisceral cavity, and from thence, through the fenestræ, reach the exterior.

The ovisac and spermsac are more or less convoluted and asymmetrical. They are probably the result of fusion of two original glands in the median line, if, indeed, they are not partly separated in some species, as seemed in one or two instances to be the case. The ducts, when carefully examined, are seen to spring from the anterior abdominal side of the sac, not from the posterior end.

\* Dr. v. Ihering arrives at the same conclusion.

Clark observed the eggs being ejected in a sort of stream from the openings into the water and settling in loose clusters on adjacent objects. Verrill and Carpenter have confirmed these observations, and add that the hinder part of the foot is so raised as to form a sort of funnel, out of which the eggs emerge. But these eggs, in some cases at least, are already impregnated, and somewhat far advanced in development before they leave the oviduct. I have myself observed, in several individuals which had been some years in spirit, eggs developed as far as the first stage figured (47*a*), which had never left the ovisac. In this connection it may be observed that, if the sperma be ejected into the water, there is nothing to prevent the spermatozoids from entering the wide apertures of the fenestrae (in some species at least), and thus impregnating the eggs in the ovary. In this way may be explained the presence of spermatozoa in the female *Chiton Pallasii* noted by Middendorf. In some species with very small ovarian openings, this internal impregnation would be attended with more difficulty. In some species, a large so-called "slime gland" is present, lying under the middle line of the ovisac. Gray states that in some Chitons the egg is enfolded in a thick, vesicular, folded envelope, but I did not notice anything of the kind in those I examined. I observed no micropyle, but having only specimens hardened by long immersion in spirits these observations cannot be deemed conclusive. In all the species specially examined to determine the character of the ova, the eggs were spherical, with a rather tough skin, quite smooth, with no trace of lime in it, and apparently in no way attached to the walls of the ovary when ripe.\*

*Development.*—Nothing later than the brief but admirable researches of Lovén, now thirty years old, has come to hand. His figures are here reproduced, with a summary of what has been observed, to stimulate further enquiry in those favorably situated.

The Chitons differ from most Mollusks in that the shell does not appear on the embryo until some time after they are hatched. In this connection, the observations of Krohn on *Marseniidae* may be referred to.

The embryo of *Chiton cinereus* is oval, with no trace of shelly valves or depressions for them, and is divided into two nearly equal parts by a transverse depression, the margins of which are ciliated. On the middle of the upper part is a tuft of filaments which move slightly. At each end of the depression are two dark points, representing the eyes.

The young when hatched (Fig. 47 *b, c*) become more elongated, the front part is finely ciliated, and the tuft occasionally vibrates. The hinder part extends more rapidly and becomes conic. The back is marked by seven furrows; between these the first rudiments of the shelly

\* Dr. v. Ihering describes the egg of *C. squamosus* as covered with peculiar thorns, five-sided solid columns, expanding at the distal end into a cup whose edge is cut into five points. *C. Cajetanus* and *fascicularis* had eggs covered with a grooved and irregularly furrowed membrane, as described by Gray, but without thorns. The vesicular membrane thus may be considered as a chorion. In the immature stages, the eggs are enclosed in follicles of the tissues of the ovisac.

valves make their appearance in the form of fine granulations. Soon after this, the animal can crawl as well as swim, and the mantle becomes separated from the foot by an indentation. The eyes are placed on the ventral side, and hardly visible from above. The upper anterior part of the animal is marked with acute tubercles. The mouth is not yet visible. The valves first appear in the form of seven narrow bands with irregular margins; the tuft disappears. The head and mouth then develop (Fig. 47 *e*). The eyes are on distinct lateral protuberances. No gills have appeared. The mantle and front valve advance over the head (Fig. 47 *f*) and eyes; the tuberculated area in front of the valves is gradually diminished, and the tail-plate appears behind the seventh. The valves are at first irregular, but increase from below, and deep notches, persistent in the adult, are formed on the front edges, one on each side. It will be seen that the valves are formed each in one piece, and not by the coalescence of parts corresponding to the various areas of the adult valve. There are eight valves in all Chitons, though monsters with seven valves have been occasionally reported; they lack the horny jaw possessed by Limpets.

*Renal Organs.*—Middendorf indicated the existence of a renal organ in the delicate glandular structure which in some species covers the upper posterior surface of the foot below the viscera. This does not seem to be uniformly present; at least, I did not detect it in some cases, and I failed to find any excretory opening. It is probable that this exists, but the contraction of the tissues of my specimens by alcohol may have obliterated it.\* Schiff in *C. piceus* did not detect any renal organ, and unless in an abortive condition it seems probable that it is not always present.

*Dentition.*—The dentition of the Chitons has received hardly any attention. The only figures which have been given, so far as known to me, are those of *C. larvis* and *C. cinereus* by Lovén† in his original paper, the latter of which has been copied by Gray;‡ a figure, intended to represent the radula of *C. Stelleri*, by Middendorf;§ of *C. piceus* by Schiff;|| of "*C. marmoratus*" by Eberhard;¶ and a figure of *Chitonellus* sp. by Gray.‡ Of all these only the figure of Lovén possesses any value, the others being more or less erroneous, or conveying an erroneous impression. Even the number of teeth is not correctly represented by any one but Lovén. On the basis of the teeth, the Chitons were combined with the Dentalia and Limpets in the order *Docoglossa* by Tröschel, a proceeding justified by that single character; for the characteristics of

\* Dr. v. Ihering has succeeded in finding an orifice immediately below the anus, in some species.

† Ofv. K. V. Akad. Forh. June 9, 1847, t. 6.

‡ Guide to Brit. Mus. 1857, pp. 182, 187.

§ Beitr. Mal. Ross. i, pl. iii, f. 11, 1847.

|| Zeitschr. Wiss. Zool. ix, pl. ii, Beitr. zur Anat. v. *Chiton piceus*.

¶ Programm Herz. Realschule zu Coburg, 1865, f. 77. (Since the above was written, Prof. Sars has figured the dentition of several species.)



the teeth in composition and general form (though not in number) are somewhat similar to one another and differ from all other groups much more than they differ among themselves. But other characters of greater importance seem to turn the scale unequivocally in favor of a somewhat wide separation of these groups, and the term *Docoglossa* was adopted by the writer some years since for the order containing the Limpets alone.

The teeth agree in number and in general character in all the genera and subgenera of Chitons which I have been able to examine; comprising about half of the groups recognized by the late Dr. Carpenter. No large group of genera or subgenera remains of which some form has not been studied. Hence we may reasonably infer, until the contrary is proved, that all the genera agree in the most essential characters of the dentition. Some doubt exists in my own mind as to the proper distribution of the eight side-teeth into true laterals and uncinals, since the fifth from the centre is constantly spatulate, yet separated from the cuspid teeth by two boss-like or non-cuspidate teeth resembling uncini. The formula therefore may be read either as

$$\frac{1}{3+1+2+2 \times 2+2+1+3'} \quad \frac{1}{3+5 \times 5+3'} \quad \text{or} \quad \frac{1}{6+2 \times 2+6'}$$

The most natural division is into six uncinal and two true laterals. For convenience in description, I shall term the spatulate third uncinus the *major uncinus*, the second lateral the *major*, and the first the *minor lateral*. The "inner" side of a tooth is that toward the middle line of the radula. In all Chitons examined, there is a simply cuspid rhaclidian tooth, and on each side a translucent minor lateral of varying form; a major lateral larger than any of the other teeth with a conspicuous black cusp, which may have from one to four denticles; two boss-like or thickened uncinal plates of irregular shape; a twisted spatulate uncinal and three scale-like or slightly thickened external uncini. With the exception of the spatulate uncinus (which is abortive in a very few species), none of the uncini are much raised above the plane of the odontophore, and none present any characters of importance. The characters of the other teeth, though preserving a tolerable uniformity within the particular subgenera, so far as observed are rather variable within a certain narrow range, and on the whole it would be premature to say that they offer more than specific distinctions.

The absence of any well-marked types by which the order might be divided into families, or even subfamilies, is very remarkable, and in this respect the variations of the dentition agree with the other characters of shell-plates, girdle, and internal structure. This has already been remarked as regards the girdle and shell by Dr. Carpenter, who recognized that even his chief divisions of the order into Regular and Irregular Chitons failed to possess distinct family value.

The only other dental formula which recalls in any degree that of *Chitonida* is that of *Triopa laevis* as figured by Gray in his Guide.

The teeth of the Chitons are excessively difficult objects to make out, though some of the species are quite large. The teeth project strongly from the odontophore, so that only a small portion of any one tooth can be had in focus at one time. Moreover, they overlie one another to such an extent that part of them, especially the two inner uncini, are hidden from view. The radula has to be pulled to pieces, to get at the form of the individual teeth. They will, like the teeth of Limpets, disintegrate under prolonged boiling in *liquor potassæ*, so that it is difficult to clean the radula from adherent mucus or remains of food. The teeth on the anterior edge of the radula are always worn or broken by use; those at its posterior termination are of course immature and pulpy; the scaly uncini differ slightly in form with age. The rhachidian tooth is usually more or less embraced by the wings of the minor laterals, so that it appears as if set on a plate or in an open box, and must be disentangled before its form can be made out.

In these descriptions, the front of a tooth is taken to be the side opposite to that by which it is attached to the radula. The figures of dentition do not pretend to represent the transverse rows as they appear on the unbroken radula. On the contrary, the teeth are represented diagrammatically as they would appear if separated from one another, yet, as nearly as practicable, in their relative positions. Only in this way could any idea be given of their forms and number. A series of exquisite drawings, made by one of the best zoölogical draughtsmen living, for Dr. Carpenter, nearly led me into serious error, and have been totally rejected, because they represented only what could be seen without dismembering the radula. The diagrams given, if somewhat rude, are, it is believed, tolerably reliable, and the result of a surprising amount of work, considering their small number.

The rhachidian tooth, as has been stated, always has a simple cusp, which may possess a somewhat sinuous edge or a tendency to a median sinus. The points by which it is attached to the odontophore are darker than the rest, and, seen through the translucent shaft, modify its appearance. A side view of the tooth generally presents an S shape, and it usually projects from the surface of the radula in a conspicuous manner. The shaft and base have not been observed to present any ornamentation.

The minor laterals present many modifications of form which may be referred to one type fundamentally. They consist of two parts, a shaft, and wings bearing the same relation to the shaft that the sides of a leaf do to its midrib. One or both of the wings may be almost abortive, leaving only the shaft twisted into a cusp at its apex, or the edges of the wings may be bent over into a cusp at the top of the tooth, and a small process like a bud or button is thus sometimes formed on the outer upper angle of the tooth. The most common form is that where the teeth are somewhat leaf-shaped, with both wings partly developed. The outer wing aborts before the inner one. These wings meet the midrib at an angle with each other, and this angle is sometimes less than a right angle.

Usually, the two inner wings nearly meet one another behind the rhachidian tooth, while the two outer ones extend toward each other before the rhachidian tooth. In the unbroken radula, the rhachidian teeth each seem as if enclosed or fenced in by this arrangement of the two adjacent laterals.

The major laterals show fewer modifications. They are always the largest and most prominent teeth on the radula. They consist of a recumbent shaft, which is partly hollow or excavated behind, crowned by a cusp whose opaque consistency contrasts strongly with the brown translucent shaft and other teeth. This cusp is usually black, or yellowish with a black margin. In some species, a peculiar areolated spot is visible on the margin, and this may exist in some species in which I have not figured it, as it is difficult to observe except with a very strong reflected light. It does not appear to mark a pore or indentation, but from its constant occurrence in some species must have a certain significance.

The cusp may be rounded, or ovate, or elongated and simple, or it may be divided into two, three, or four denticles of uniform or varying size. The value of these characters cannot yet be definitely stated; they can hardly yet be said to present more than specific value, so far as the number of cusps is concerned, yet the general features agree, for the most part, in the same or nearly related groups.

In *Leptochiton*, the cusp is greatly elongated, with a small secondary denticle on the inner side, which is abruptly turned up, and, on an ordinary view, resembles a spur or thorn set on the principal cusp. In general, the northern species show a tendency to elongated cusps, simple or divided; the tropical species, including the typical Chitons, a tendency to a rounded, simple cusp. The majority of all species, however, have a tridentate cusp.

The shaft and cusp are separated by a distinct line of demarcation where the color changes from black or opaque to translucent. The shaft tapers from the cusp to the lower extremity, which is usually a little expanded. Extending downward from the base of the cusp, the groove or tube in the back part of the shaft is clearly visible. There are thin expansions of the shaft on each side, and sometimes a median keel on the front of the shaft, which in several species is produced into a slender, translucent process, of lanceolate or varied form, extended somewhat inward (toward the rhachidian tooth) and upward toward the cusp of the tooth upon whose shaft it is borne. These processes are most strongly marked in the teeth of the typical Chitons.

The two inner uncini, between the major lateral and the spatulate or major uncinus, are very irregular in form, even on the same radula. They lie prone on the radula and possess no true cusps, though thickened and elevated into knobs of various form. The major uncinus rises from a very small base, which is twisted and bent under it (as if the tooth was kneeling), and has a twisted, slender shaft, which is expanded at its extremity into a spatulate or feather-formed cusp. The whole tooth



is so twisted and bent that the distal ends of the major uncini, as a rule, are protruded between the cusps of the major laterals. In a very few species, chiefly of *Cryptoidea*, the shaft and cusp are abortive, leaving only the small base or knob from which they spring in other species. No very salient characters are afforded by the major uncini.

The outer uncini have essentially the same characters in nearly all the species. They are flat and scale-like, their edges free and overlapping slightly. The outer ones forming the edge of the radula are usually more transverse than the others. In *C. articulatus*, they are remarkably transversely extended.

It will be seen from this description that, except in their construction and chemical character, the teeth of Chitons are quite dissimilar to those of Limpets, or, indeed, any other described group.

While not affording grounds for generic distinction by itself alone, the dentition of Chitons, as far as yet investigated, confirms, in many respects, the classification adopted on other grounds by Dr. Carpenter. For instance, his separation of the northern *Tonicella* from the tropical *Tonicia* of Gray, with which they have usually been united, is fully justified by differences in the dentition. It is possible that when the dentition of the majority of species is determined, some reformation in the limits of subordinate groups may be made practicable by its indications, but this is not yet the case.

The following list of the chief groups recognized by Dr. Carpenter, with the character of the dentition when known, will give a clue to the extent of the work done, and that which is still a desideratum.

#### A.—REGULAR CHITONS.

##### LEPTOIDEA.

**Leptochiton** Gray. (Type *L. asellus* Lowe.)

*L. cancellatus* Sby. Minor lateral reduced by abortion of the wings nearly to a simple shaft. Cusp of major lateral elongate bidentate; inner denticle much the smallest, spur-like; shaft simple; other teeth quite simple. Fig. 1, 1 *a*, showing major lateral from above. *L. rugatus* agrees.

**Hanleyia** Gray. (Type *H. debilis* Gray.)

*H. mendicaria* M. & Ad. Minor lateral normal, bi-alate; major lateral tridentate; major uncinus short, other uncini with thickened edges. Fig. 2.

*Deshayesiella*, *Microplax*, and *Hemiarthrum* not examined.

##### ISCHNOIDEA.

**Trachydermon** Cpr. (Type *T. cinereus* Lowe.)

*T. ruber* Lowe. Minor lateral normal, leaf-shaped, with the upper edge of the outer wing bent over into a sort of cusp; cusp of major lateral with one large and one small denticle on the inner side, shaft normal; major uncinus short, with a widely expanded apex with fine radiating grooves on the edge. Fig. 3; 3 *a* shows the major uncinus from below.

*T. albus* L. Minor lateral with small wings bent backward; shaft cusped at the top; major lateral bidentate, as in the case of *T. ruber*, but with the small denticle on the outer side; major uncinus long, spatulate. Fig. 4.

*Trachyradsia*, *Callochiton*, and *Stereochiton* not examined.

**Tonicella** Carpenter. (Type *T. marmorea* Fabr.)

? *T. lineata* Wood. Minor lateral with a long shaft, bi-alate, normal; major lateral with two small denticles on the inner side of the cusp and one large outer denticle, shaft normal; major uncinus spatulate, normal. Fig. 5.

*T. marmorea* Fabr. As in the last, but with only one small inner denticle on the cusp of the major lateral. Fig. 6.

*T. submarmorea* Midd. Minor lateral shaped like a ploughshare; other teeth much as in the last. Fig. 7.

**Schizoplax** Dall.

*S. Braudtii* Midd. (Type.) Minor lateral a broad shaft with a simple cusp, base with a groove or sinus, no wings; major lateral tridentate. Fig. 8.

*Leptoplax* not examined.

**Chætopleura** Shuttleworth. (Type *C. Peruviana* Lam.)

*C. gemma* Cpr. Rhaehidian tooth broad and short; minor lateral normal, outer wing inconspicuous; major lateral tridentate, shaft keeled, keel with a small elongate cuspidate process. Fig. 9.

? *C. Hartwegii* Cpr. Minor lateral reduced to a broad cusped shaft with a remnant of an inner wing and a thickened base; major lateral tridentate, with no keel or process, shaft normal. Fig. 10.

**Maugerella** Cpr.

*M. conspicua* Cpr. (Type.) Minor lateral bi-alate, top of inner wing and shaft bent into a twisted cusp with a small process extending outward from the apex of the shaft; major lateral tridentate, shaft with a keel and cuspidate process. Fig. 11.

*Spongiochiton* not examined.

## ISCHNOCHITONS.

*Heterozona* not examined.

**Stenoradsia** Cpr.

*S. magdalenensis* Hinds. (Type.) Shaft of minor lateral with a cusp and process, inner wing normal, outer wing inconspicuous; major lateral tridentate, with a keel and cuspidate process on the front of the shaft. Fig. 12.

**Stenoplax** Cpr.

*S. limaciformis* Sby. (Type.) Rhaehidian tooth very small; minor lateral normal, shaft with a minute hook at the apex; major lateral with a simple cusp, shaft bearing a keel and cuspidate process; major uncinus very small. Fig. 13.

**Ischnoplax** Cpr.

*I. pectinatus* Sby. (Type.) Minor lateral with broad, stout, cusped shaft, inner wing expanded, outer wing reduced to a rudiment, with a linguiform process; major lateral with a simple rounded cusp, shaft with a triangular keel but no projecting process. Fig. 23.

**Ischnochiton** Cpr. ex Gray. (Type *I. longicymba* Quoy.)

*I. cooperi* Cpr. Minor lateral with the outer wing reduced to a button near the cusp of the shaft, inner wing small; major lateral with simple cusp, shaft with a keel, bearing a cuspidate process; major uncinus broad, spatulate, thicker near the edges. Fig. 15.

*I. interstinctus* Gld. Minor lateral composed of a shaft with large, twisted, hooked cusp, and possessing only slight rudiments of wings; major lateral tridentate, keeled on the shaft, with a spatulate process on the keel; uncini rugose, major uncinus sharply bent, strengthened by narrow ridges on the spatulate cusp. Fig. 16.

*I. regularis* Cpr. Teeth closely resembling those of *I. Cooperi*, but minor lateral with a small outer wing. Fig. 14.

**Ischnoradsia** Cpr. non Shuttleworth.

*I. trifida* Cpr. Minor lateral with no outer wing, but a small process near the apex of the shaft, which may represent it; inner wing normal; major lateral shaft normal, cusp bidentate, with a spot behind the notch (Fig. 17 a); uncini rugose, normal. Fig. 17.

**Lepidopleurus** Cpr. non Risso.

*L. Mertensii* Midd. Minor lateral with no outer wing; shaft cusped at apex, inner wing normal; major lateral with a simple cusp, shaft normal, deeply channelled behind. Fig. 18. Fig. 18 a shows the appearance of the minor laterals and their wings extending behind the rhachidian tooth as they do when in their natural position.

**Lepidoradsia** Cpr. (*Lophyrus* pars Adams.)

*L. australis* Sby. Minor lateral with a singular mushroom-like cusp with rudiment of inner and no outer wing; major lateral bidentate, shaft keeled with spatulate process; major uncinus short, broad, other uncini rather small. Fig. 19.

**Callistochiton** Cpr.

*C. palmatus* Cpr. Minor lateral with a narrow inner wing parallel with and no wider than the shaft, cusped at the top, outer wing absent or represented by a minute cuspidate process; major lateral with a simple cusp, shaft with an anterior keel bearing a sublancoleate process. Fig. 20.

*Callistoplax*, *Ceratophorus*, and *Newcombia* not examined.

**Pallochiton** Dall (= *Hemphillia* Cpr. MSS. nom. præoc.)

*P. lanuginosus* Cpr. Minor lateral normal, bi-alate; major lateral tridentate, shaft normal. Fig. 21.

LOPHYROIDEA.

**Chiton** Cpr. Lin. not Adams. Type *C. tuberculatus* Lin. (*Lophyrus* H. & A. Ad. not Poli).

*C. articulatus* Sby. Minor lateral with no outer wing, shaft small, narrow, prone, from which extends the greatly elongated cusped inner wing external to the rhachidian tooth; major lateral with a simple rounded yellowish cusp with a black margin marked by a peculiar spot; shaft normal, with an inner lateral expansion produced into a linguiform process; major uncinus broad, long, spatulate; outer uncinus transversely elongated. Fig. 22. Fig. 22 a, side view of rhachidian tooth.

*C. Stokesii* Brod. Minor lateral with expanded inner wing, shaft cuspidate, cusp twisted and outer wing reduced to a portion of this cusp or absent; major lateral with an elongated simple cusp, shaft thick, strong, keeled in front, keel bearing a blade-shaped process attached to the keel at two points, with a small foramen between them; major uncinus short, broad, somewhat plume-shaped. Fig. 24. Fig. 24 a, major uncinus, from below.

*C. Cumingii* Frembly. Minor lateral normal, with wings recurved above and on each side; major lateral with simple elongate cusp, shaft with a strong keel bent outward below and produced above into a strong spoon-shaped process; two inner uncini nodulose; major uncinus with a slender and rather straight shaft. Fig. 25.

*C. assimilis* Rvc. Minor lateral; shaft with small or nearly abortive wings, base long and recurved; major lateral with a simple rounded cusp, a keel on the shaft bearing a spatulate process; major uncinus feather-shaped, the vane on the inner side. Fig. 26.

**Tonicia** Gray.

*T. elegans* Frembly. (Type.) Minor lateral leaf-shaped, normal, apex curved forward; major lateral with an orange, black-edged, rounded, simple cusp with a spot on the margin, shaft normal; major uncinus very much twisted and decurved, spatulate. Fig. 27.

*Radsia*, *Fawujia*, *Eudoxochiton*, and *Craspedochiton* not examined.



## ACANTHOIDEA.

*Sclerochiton*, *Francisia*, *Dinoplax*, *Dawsonia*, *Beania*, and *Arthuria* not examined.

**Acanthopleura** Cpr. ex Guilding.

*A. spinigera* Sby. (Type.) Minor lateral large, shaft long, cusped, wings long, narrow, linguiform; major lateral with a simple rounded cusp, shaft keeled, keel with a cuspidate process; inner uncini nodulose; major uncinus short, broad, thick. Fig. 28.

**Lucia** Gld.

*L. confossa* Gld. (Type.) Minor lateral twisted, peculiar, outer wing broad, recurved at tip, inner wing small, strengthened by a branch from the shaft (Fig. 29a); rhachidian minute; major lateral with a quadridentate cusp, shaft with its inner expansion terminating in a cuspidate process above; inner two uncini ridged; major uncinus feather-shaped, vane on the inner edge (29b). Fig. 29.

**Corephium** Gray (not Brown).

*C. echinatum* Sby. (Type.) Minor lateral with the shaft expanded above, with a cusp confluent with the upper edge of the small inner wing, outer wing small; major lateral with a rounded tridentate black-margined cusp bearing a spot on the middle denticle, shaft keeled in front, keel produced into a thin linguiform process; major uncinus asymmetrical, somewhat spoon-shaped. Fig. 30.

**Nuttallina** Cpr.

*N. scabra* Rve. (Type.) Minor lateral normal, bi-alate; major lateral normal, with plain shaft and tridentate cusp; major uncinus long, slender, with small expansion at the tip. Fig. 31.

**Phacellopleura** Cpr. ex Guilding.

*P. porphyritica* Rve. sp. unica. Minor lateral with an inner but no outer wing, otherwise normal; major lateral normal, with plain shaft and tridentate cusp; inner uncini nodulose; major uncinus normal, spatulate. Fig. 32.

## B.—IRREGULAR CHITONS.

## SCHIZOIDEA.

I have not been able to obtain the radula of any of the few species comprised in the genera *Lorica*, *Anlacochiton*, *Schizochiton*, *Enoplochiton*, and *Onithochiton*.

## PLACIPHOROIDEA.

**Placiphora** Cpr. ex Gray.

*P. Carmichaelis* Gray (= *C. setiger* King and *Fremblyi* Brod.). Type. Rhachidian tooth with its edges folded inward. Minor lateral with a large narrow inner wing, small outer wing, and a median keel on the slender shaft; major lateral with a large tridentate cusp, shaft slender, normal; major uncinus with a small expansion at the tip. Fig. 33.

*Euplaciphora*, *Fremblyia* (= *Streptochiton* Cpr.), and *Guildingia* not examined.

## MOPALOIDEA.

**Mopalia** Cpr. ex Gray.

*M. ciliata* Sby. (Type, = *muscosa* Gld. + *Hindsii* Gray.) Minor lateral normal, bi-alate; major lateral normal, tridentate with a plain shaft; inner two uncini ridged; major uncinus rather short, normal. Fig. 35, 35 a.

*M. Wossnessenskii* Midd. (*Kennerlyi* Cpr.). Similar to the last with a longer major uncinus. Fig. 34.

**Placiphorella** Cpr.

*P. relata* Cpr. (Type.) Rhachidian very large; minor lateral unusually small, both normal; major lateral tridentate, normal. Fig. 36, 36 a.

**Katherina Gray.**

*K. tunicata* Wood. (Type.) Minor lateral thin and coalescent with the inner wing above, outer wing small; major lateral normal, tridentate; uncini ridged or knobby, except major uncinus, which is elongate and narrow. Fig. 37.

**Acanthochiton Herrm. ex Leach.** (Type *A. fascicularis* Auct.)

*A. avicula* Cpr. Minor lateral with the shaft branched at base, leaf-shaped; major lateral with tridentate cusp; shaft with triangular keel, of which the tip is bent outward; major uncinus short, normal. Fig. 38.

*A. spiculosus* Rve. Minor lateral normal, bi-alate; major lateral and other teeth much as in the last. Fig. 39.

**Macandrellus Cpr.** (Type *M. costatus*, Ad. & Ang.)

*M. costatus?* Ad. & Angas. Like *Acanthochiton avicula*, but the shaft of the major lateral normal without a keel. Fig. 40. Specimen from Port Jackson, Australia.

*Stectoplax* and *Notoplax* not examined.

CRYPTOIDEA.

**Cryptoconchus Blainv.**

*C. monticularis* Quoy. (Type.) Minor lateral normal, leaf-shaped, base geniculate; major lateral with tridentate cusp and plain normal shaft; a rugosity on the second uncinus projecting inward over the first; major uncinus slender, short. Fig. 41.

**Amicula Gray.** (= *Symmetrogephyrus* Midd., *Stimpsoniella* Cpr.)

*A. vestita* Sby. = *Emersonii* Couth. Gld. (Type.) Minor lateral bi-alate, normal; major lateral tridentate, with plain shaft, whose lateral expansions are bent backward to the radula, forming a vaulted hollow arch beneath the upper part of the shaft; major uncinus aborted. Fig. 43.

*A. Pallasii* Midd. (Type of *Symmetrogephyrus*.) As in the last, except that the sides of the major lateral are bent forward, and the major uncinus is present and normal. Fig. 42.

*Chlamydochiton* not examined.

**Cryptochiton Midd. Gray.**

*C. Stelleri* Midd. (Type.) Minor lateral normal, leaf-shaped; major lateral with tridentate cusp and a small keel on the shaft; inner two uncini ridged, major uncinus aborted. Fig. 44.

**Chitonellus Blainville.**

*C. fasciatus* Quoy. (Type.) Minor lateral bi-alate, with a strongly curved shaft; major lateral normal, tridentate with a plain shaft; uncini more or less ridged, major uncinus nearly straight, long, slender, spatulate. Fig. 45, 45 a.

It will be seen that Gray's figure (here reproduced) is very erroneous, and seems to have been taken from the immature end of the radula.



FIG. D.—Teeth of *Chitonellus*, after Gray.

*Choneplax*, *Chitoniscus*, and *Cryptoplax* not examined.

**Nomenclature.**—The nomenclature of Chitons has suffered greatly from neglect of various writers to specify or adopt types of the genera they proposed or used. The neglect of internal characters in assorting species into genera has also been fruitful of difficulty; the Messrs. H. and

A. Adams being among the greatest sinners in these respects. The revision of the nomenclature by Dr. Carpenter with the co-operation of the writer was incomplete at the time of his death, and is not yet perfected. It would be out of place here, even if ready for publication; but a few words on the genus *Chiton* as restricted by Carpenter may not be superfluous.

1758.—Linné described the genus *Chiton* in the tenth edition of the *Systema Naturæ*, according four species to it, of which only one, *C. tuberculatus*, is identifiable.

1766.—S. N. ed. xii. Nine species were described by Linné, of which the first is unrecognizable and the second is *C. tuberculatus*.

1776.—Müller (Prodr. Zool. Dan.) describes several species, but selects no type.

1784.—Spengler monographs the group; his first species is *C. tuberculatus* L.

1798.—Tabl. Élém. p. 391, Cuvier gives an unrecognizable *C. punctatus* as his sole example.

1799.—Lamarck (Prodr. An. s. Vert. p. 90) gives as his sole example *C. tuberculatus* Lin.

1801.—Lamarck (Système An. s. Vert. p. 66) gives as an example *C. gigas* Chemnitz, not a Linnean species.

1815-18.—Wood (Gen. Conch. and Index Test.) gives as his first species in both cases *C. tuberculatus* L. These works antedate Lamarck's Hist. An. s. Vert.

1854.—Messrs. Adams selected, as the type of *Chiton*, *C. aculeatus* Anet., an unfortunate proceeding, since the *C. aculeatus* of Linné is unrecognizable. This arrangement was properly rejected by Dr. Gray and Dr. Carpenter.

From the rules for zoölogical nomenclature it follows that a type cannot be selected by any one for a genus proposed by any author which type was not known to and included by that author in his original list of species, if he himself omitted to specify a type.

*C. tuberculatus*, though described from an imperfect seven-valved specimen, is recognized by Hanley as *Chiton squamosus* of Born. It is figured by Reeve as *C. squamosus* L. var.  $\beta$  (Conch. Ic. pl. iv, f. 23), and in the index is called "*striatus* Barnes." It has not been generally united with the *C. squamosus* of L. (S. N. ed. xii), but is not improbably a variety of it, and belongs to the same restricted group. It comes from the West Indies. Under the circumstances, there can be no doubt that it should be considered as the type of the genus, not only because it is the only recognizable species of those originally described, but because it was selected by Lamarck as his sole example of the genus in 1799, and served as the first species in many of the earlier works in which the Chitons were enumerated or described. The genus *Chiton* was called *Lophyrus* by Adams, from the name applied to the animal by Poli, who was a non-binomial writer. It was more correctly treated by Gray and by Dr. Carpenter in his later writings, though at one time he had, without investigation, followed the lead of Messrs. Adams.

The first authors to whom science is indebted for discriminating the different groups or genera of Chitons are chiefly Guilding, Lowe, Shuttleworth, and Gray. As all the characters were not perceived at the outset, even these writers were not perfectly consistent in their grouping, as has since become evident. But this was inevitable, and it only



remains to rectify the disorder by the light of present knowledge, a task which may not long be delayed. If some modern authors, who have instituted wholesale changes in nomenclature, had followed a consistent and uniform plan, and not neglected or hurriedly decided on doubtful points, the work of rectification might have been much more simple, though perhaps not less urgently needed.

A few words may be added in regard to the names given by Middendorf. In spite of the opportunities afforded by his study of the Russian Chitons, this distinguished savant seemed to fail to catch the permanent as distinguished from merely individual characters, and his classification and nomenclature are not borne out by subsequent researches. His chief characters were derived from the dimensions of the soft or coriaceous girdle, dimensions which differ not only in the same species, but in the same individual, respectively, if preserved in spirit (when it may be broad) or dry (when it shrinks to a narrower compass). From this cause it is not surprising to find the same species figuring in both of his chief divisions of Chitons with exposed valves. In the attempt to utilize this impracticable classification, and unwilling to admit that the *Chitonidae* contain more than one genus, he adopted a singular nomenclature, in which the genus was divided into a great number of sections, subsections, sub-subsections, etc., so that his work can hardly be classed as binomial in the Linnean sense. Fortunately, without exception, the groups indicated had previously been properly named by Gray, and only by courtesy can the genus *Cryptochiton*, on which his industrious research was largely expended, be assigned to him as authority, since it was denominated by the same name by Dr. Gray but a short time previously, the researches of each being unknown to the other.

To Blainville, in 1816, is due the credit of first recognizing the anomalous characters of the *Chitonidae*, and their separation as an independent group from other gasteropods. While the value of a class in view of later researches may be held to be too high, yet few will be disposed to deny them the ordinal value assigned by Gray in 1825. The name is preferably spelled *Polyplaciphora*, though numerous other forms have been used.

The order *Polyplaciphora* can with certainty be asserted to contain but one family, so far as our present knowledge is concerned. No groups of subfamily value have yet been recognized, and it is a question whether any exist. It would be out of place here to attempt any *résumé* of the various systems of classification proposed by authors who have written on Chitons, as that proposed by Dr. Carpenter has solely been followed, and the process would occupy too much space.

Dr. Carpenter's arrangement is founded upon the plan of structure in the valves, the extent of the branchiæ, and the ornamentation or character of the girdle and its covering. He divides the *Polyplaciphora* into two great divisions:

#### I. REGULAR CHITONS.

Head and tail plates of similar character.

## II. IRREGULAR CHITONS.

Tail-plate with a sinus behind.

The Regular Chitons comprise—

A. *Leptoidea*.

Destitute of teeth or slit insertion-plates.

B. *Ischnoidea*.

Insertion-plates slit, sharp, thin; protected by eaves.

This contains by far the largest number of species, and might be considered typical; but the organization is not as complete in all points as in the next group.

C. *Lophyroidea*.

Insertion-plates broad, pectinated; jugular sinus broad, dentate.

D. *Acanthoidea*.

Insertion-plates sharp, grooved externally, eaves furrowed beneath, mucro posteriorly extended.

This forms a passage toward II.

The Irregular Chitons comprise—

E. *Schizoidea*.

Mantle and tail-plate both slit, behind.

F. *Placiphoroidea*.

Posterior insertion-plates only represented by a pair of swollen ribs. Mantle hairy.

G. *Mopaloidea*.

Tail-plate with one slit on each side and waved behind.

H. *Cryptoidea*.

Valves covered, or nearly so, with posterior as well as anterior sutural laminae.

I. *Chitonelloidea*.

Tail-plate twisted into a funnel, body anteriorly extended.

Of these groups, Dr. Carpenter says: "I have purposely abstained from giving the usual terminations in *ida* and *ina* because I am not sure that the groups here proposed are entitled to rank even as subfamilies."

It seems to the writer that these groups are by no means of equal value, and that the Regular Chitons might well be reduced to two: Leptoids, and the remainder combined into one group; while the second section might be assorted into Schizoids (including F and G), Cryptoids, and Chitonelloids.

The opinions of Dr. Carpenter, the result of years of study, and an examination of all the principal collections of these animals in the world, are, however, not to be lightly set aside.

The Chitons of Alaska forming the principal subject of this report, together with notes on allied or extra-limital forms, are now in order. For the use of the figures illustrating this article, and many other favors and facilities for study, I am indebted to the Smithsonian Institution, in charge of Prof. S. F. Baird.

## CHITONES IRREGULARES.

## MOPALOIDEA.

## Genus MOPALIA Gray.

*Mopalia* Gray, P. Z. S. 1847, pp. 65, 69, 169.—H. & A. Adams, Gen. Rec. Moll. i, p. 478, 1854. (*M. Hindsii* Sby.)

*Molpalia* Gray, Guide, p. 184, 1857 (err. typ.).—Gould, Otia, p. 118.

Lorica regularis; laminae longiores, suffultae; v. ant. plurifissatâ, v. caet. unifissatâ, ad caudam sinuatae; sinus angustus; mucro medianus, depressus; suturae indentatae; zonâ latior, setosâ, interdum simplex, interdum postice fissata, interdum antice projecta; branchiae mediae.

Subg. *Mopalia* s. str.

Zonae setae irregulariter obsitae. (*M. Hindsii* Sby.)

Sect. *a.*, normales; Sect. *β.*, aberrantes.

Subg. *Placiphorella* Cpr.

Zonae setae ad suturam fasciculatae. (*P. velata* Cpr.)

Sect. *a.*, zonâ antice dilatatâ. (*P. velata* Cpr.)

Sect. *β.*, zonâ et loricâ normales. (*P. sinuata* Cpr.)

The genus *Mopalia* is the most regular in growth of all the Irregular Chitons. It is characterized by a hairy or lanugate girdle extending on or between the valves to some extent in all the species, thin insertion-plates with one slit on each side of the hind valve, which is waved inward from behind in the median line. There is generally a pronounced wave or slit in the tail end of the girdle, but this is an inconstant character even in the same species. The anterior valve has six or more slits in most cases. The typical subgenus is divided into normal and aberrant forms, the latter having the anterior portion of the girdle much produced, as in *M. Blainvillei* Brod.; both sections having the hairs irregularly distributed. In *Placiphorella* the hairs or part of them issue in fasciculi from pores at the sutures. These also are divided into two sections, the first having the anteriorly expanded girdle as in the last section of *Mopalia*, while the second resumes the normal type of shell and girdle. Many species have been described, but it becomes necessary, as will be seen, to reduce the number.

**Mopalia ciliata.**

*Chiton ciliatus* Sowerby, Conch. Ill. p. 79, 1838.—Reeve, Conch. Icon. Mon. Chiton, pl. xix, f. 124, 1847.

*Mopalia ciliata* H. & A. Adams, Gen. Rec. Moll. i, p. 478, 1854.

*Chiton setosus* Sowerby, Beechey's Voy. Zool. p. 150, pl. 41, f. 17, 1839 (not of Sow. 1832).

*Chiton Colliei* Reeve, Conch. Icon. Mon. Chiton, pl. xxi, f. 136, 1848.

*Leptochiton Colliei* H. & A. Adams, Gen. Rec. Moll. i, p. 473, 1854.

*Chiton muscosus* Gould, Proc. Boston Soc. Nat. Hist. ii, p. 145, July, 1846; Moll. Expl. Exp. p. 313, f. 436, 1852.—H. & A. Adams, Gen. Rec. Moll. i, p. 475, 1854.—Gould, Otia, p. 6, 1862.



**Mopalia ciliata.***Chatopleura muscosa* Gould, Otia, p. 242, 1862.*Mopalia muscosa* Carpenter, Suppl. Rep. Br. As. 1863, p. 648.*Chiton Wosnessenskii* Midd. Mal. Ross. i, p. 101, 1847; in part only; figure and part of diagnosis excl.*Chiton armatus* (Nutt.) Jay, Cat. 1839, No. 2678. No descr.*Chiton ornatus* Nuttall, MS. Brit. Mus. Col. etc. and*Chiton consimilis* Nuttall, MS. loc. cit. never described.**Subsp. Mopalia lignosa.***Chiton lignosus* Gould, Proc. Boston Soc. Nat. Hist. ii, p. 142, July, 1846; Otia, p. 3, 1862; Exp. Sh. p. 330, f. 424, 1852.*Chatopleura lignosa* Gould, Otia, p. 248, 1862.*Mopalia lignosa* Carpenter, Suppl. Rep. Br. As. 1863, p. 648.*Chiton Merckii* Midd. Bull. Imp. Acad. Sci. St. Petersburg. t. vi, p. 20, 1846; Mal. Ross. i, p. 115, pl. xi, f. 5-6, 1847.*Chiton Eschscholtzii* Midd. Bull. l. c. p. 118; Mal. Ross. l. c. p. 114, pl. xi, f. 4 (t. jun.).*Chiton (Hamachiton, Stenosemus) Merckii* Midd. l. c. p. 34.*Chiton Montreycensis* Cpr. P. Z. S. 1855, p. 231.*Chiton vespertinus* Gould, Moll. U. S. Expl. Exp. p. 323, f. 426, 426 a, 1852.*Chatopleura vespertina* Gould, Otia, pp. 230, 242, 1862.*Mopalia vespertina* H. & A. Adams, Gen. Rec. Moll. i, p. 479, 1854.*Mopalia Simpsoni* Gray, P. Z. S. 1847, p. 69.—H. & A. Adams, Gen. Rec. Moll. i, p. 479, 1854; Brit. Mus. Coll. In all cases name only; never described. (From type.)*Chiton californicus* (Nutt. MS.) Reeve, Conch. Ic. Mon. Chiton, pl. xvi, f. 89, 1847.**Var. M. Hindsii.***Chiton Hindsii* (Sowerby MS.) Reeve, Conch. Icon. Mon. Chiton, pl. xii, f. 67, a, b, 1847.*Mopalia Hindsii* Gray, P. Z. S. 1847, pp. 69, 169.—H. & A. Adams, Gen. Rec. Moll. i, p. 478, pl. liv, f. 7, 1854.—Cpr. Suppl. Rep. Br. As. 1863, p. 213.

M. t. intus, v. posticâ ad caudam sinuatâ; v. centr. unifiss., v. ant. octofissatâ; dent. longis, suffultis, saepe extus rugosis; subgrundis minimis spongiosis; sinu minimo, acuto, lam. sutur. ab apice antico solum separatis; zonâ setiferâ seu lanuginosâ; valvis parum postice, antice valde apicata; zonâ postice haud sen varius fissatâ.

Lon. 25-60, Lat. 15-40 mm. Div. 140°.

*Hab.*—Shumagin Islands (rare) to California; Dall! between tide-marks and at lowest water. Many specimens (hundreds) examined.

Typical form: sculpture variable, but strong; girdle thickly set with tubular hairs, varying from long, strong bristles to fine, soft pilæ. The best distinguishing features are brown or blackish olive color outside; inside, bluish green and lilac; jugular and caudal sinuses narrow, the latter often not visible externally.

Subsp. *lignosa*: sculpture faint; inside greenish; sinus variable; hairs of the girdle variable, but always softer and shorter than in well-marked *ciliata*, often hardly perceptible in dry specimens; external colors grayish or greenish, with streaks and flammules of brown and white.

Var. *Hindsii*: exterior uniform, smoothish; sculpture evanescent; color outside, light olive to nearly black; inside, whitish, carmine in the me-

dian line; tail notched in the young, but not in the adult; tail-sinus visible outside; girdle with few and short hairs.

This species can be distinguished from all varieties of *Wossnessenskii* by its blackish and proportionately much narrower girdle, and by a sort of prolongation of the external layer of the shell forward under the apex of the next anterior valve in the median line, forming a sort of anterior false apex, which is hidden until the valves are separated. In *Wossnessenskii* this part is squared off, the girdle is yellowish (when alive), and the valves are much less transverse.

It will be surprising if those who have only observed these animals by a few dry specimens in collections are willing to accept the synonymy above given. I confess that not long since I would have been unwilling to believe that the rough, bristly, typical *muscosa* and the dark, smooth *Hindsii* could be properly combined under one name with each other or with the finely reticulated and painted *lignosa*. But the study of a large multitude of specimens has convinced me no arbitrary line can be drawn anywhere in a fully representative series, beginning with coarsest *ciliata* and ending with a practically smooth *Hindsii*. The characters of girdle, sculpture, and form are not only variable in themselves, but are found variably combined, except that it is rarer to find coarsest sculpture with a downy than with a bristly girdle. However, even this occurs. On the other hand, out of such a series a dozen forms might be selected which, if only the characters were constant, every one would acknowledge as good species.

In his description of *Wossnessenskii*, Middendorf, according to Dr. Carpenter, had both species under his observation, and did not observe it. His figures, however, belong solely to the following species. Sowerby's *setosus*, in the Zoology of the Blossom's Voyage, is not his species so named in 1832, and the former was renamed *Collici*, by Reeve, in the Conch. Iconica. The sculpture figured by Sowerby was not characteristic; Reeve's figure is better. From an examination of the type, Dr. Carpenter became convinced that the undescribed *M. Simpsoni* Gray was identical with *lignosa*. There is very little doubt that Middendorf's *Chiton Eschscholtzii* was merely a young *ciliata*. Dr. Gould's original types have been consulted during the preparation of this description.

#### **Mopalia Wossnessenskii.**

*Chiton Wossnessenskii* Midd. Bull. Imp. Acad. Sci. St. Petersburg. t. vi, p. 119, 1847 (pars); Mal. Ross. i, p. 101 (diagn. maj. pars), pl. xi, f. 1-2, 1847.

*Chiton (Hamachiton, Platysemus) Wossnessenskii* Midd. Mal. Ross. l. c. p. 34, 1847.

*Chiton coelatus* Reeve, Conch. Icon. Mon. Chiton, pl. xvii, f. 101, 1847 (loc. err.).—H. & A. Adams, Gen. Rec. Moll. i, p. 475, 1854.

*Mopalia Kennerleyi* Carpenter, Suppl. Rep. Br. Assoc. 1863, p. 648; Proc. Phil. Acad. Nat. Sci. April, 1865, p. 59.

*Mopalia Grayi* Carpenter, Suppl. Rep. l. c. p. 603, name only.

*M. Kennerleyi* var. *Swanii* Cpr. Suppl. Rep. l. c. p. 648, 1863.

M. t. valvis haud antice apicatis; v. post. extus valde sinuatâ; intus v. post. late ad caudam sinuatâ, et v. centr. 1-, v. ant. 8- (rarius 9-, 10-)

fiss.; sinu latiore; zonâ postice fissatâ, setis tenuioribus, planatis, pallidis, minus confertim obsitâ. Lon. 50, Lat. 25 mm.

Var. *Suaniï*: t. omnino rufâ, sculpturâ tenuiore.

*Hab.*—Unalashka, Aleutian Islands (rare and small) to Sitka, and southeastward to Monterey, California; from low water to twenty fathoms, adhering to solid objects, stones, and shells! Two hundred and fifty-four specimens examined.

This species may be recognized by its broad, yellowish, downy girdle, when fresh, often encroaching far into the sutures; by the absence of false apices, such as are found in *ciliata*; by its color, in which vermilion and verdigris green are beautifully mingled (except in the var. *Suaniï*, which is pure red); and by the softness of the flattened and less crowded hairs. The girdle-fissure is not constant, though usual. It is nearly white inside; the sinus is broader and the valves, as a whole, longer in an axial direction, making them less transverse than in *ciliata*. It is one of the most beautiful of all Chitons, when closely examined.

An examination of the soft parts afforded the following notes on this species:

The "fringe," or true mantle-edge, is entire, extending around the whole body within the edge of the girdle, and slightly notched at the posterior sinus of the girdle. Veil short in front and broad at the sides, ending behind in two broad, squarish lappets, the edge crenulate throughout. Anus median, distinct. Ovary single, tortuous, overlying the viscera, with no distinct oviduct, so far as could be observed. In texture, the ovary resembles that of *Aemava*. If there be an oviduct, it passes from the under side of the sac, one-third of the way forward from the posterior end of the ovary. Behind the ovary are two "slime glands" (Midd.), one on each side, opening outward by a plain opening in a fold of the integument, one on each side between the branchiæ and the anus. They are not present in all Chitons. Schiff did not find them in *C. piceus*. Gills about thirty-eight in number on each side, extending forward about two-thirds the length of the foot.

• *Extra-limital Species.*

Subgenus PLACIPHORELLA Cpr.

*Placiphorella sinuata.*

*Mopalia sinuata* Cpr. Proc. Acad. Nat. Sci. Philad. 1865, p. 59.

P. t. lam. sutur. planatis, ab apice antico-externo separatis, sinu angustissimo; dent. valde suffultis.

*Hab.*—Puget Sound and San Francisco Bay, Cal.

*Placiphorella imporcata.*

*Mopalia imporcata* Carpenter, l. c. p. 59, 1865.

P. t. lam. sutur. et apice antico ut in *P. sinuatâ*, sinu paullo minus angusta; dent. parum suffultis; v. ant. octofissatâ.

*Hab.*—Puget Sound; Santa Barbara Ids., Cal.



These species are known to me only by the types; they may extend their range into the Alexander Archipelago.

In *Plaeiphorella velata* Cpr., type of the subgenus, the gill-rows are as long as the foot, branchiæ about twenty-five in number, widely separated behind. Mantle-edge behind narrow and plain; in front produced and fringed with long fleshy processes. No oviduct could be traced, though the ovary was crowded with eggs, some of which were 0.25 mm. in length. In them the embryo could be plainly distinguished. There were no furrows for the shelly plates, but the eyes were quite prominent and the cephalic lobe comprised nearly half the animal. There were no bands of cilia, but the edge of the cephalic lobe was strongly ciliated.

## CRYPTOIDEA.

### Genus AMICULA Gray.

Gray, Syn. Brit. Mus. 1840, also ed. 1842 (no description); P. Z. S. 1847, pp. 65, 69, 169.—H. & A. Adams, Gen. Rec. Moll. i, p. 480, pl. 55, f. 2, 1854.—Gray, Guide, p. 187, 1857.

Type *Chiton vestitus* Sowerby.

Corpus regulare; loricâ expositâ parvâ, mucronatâ, seu subcoordatâ; laminae insertionis mopaloideæ, lam. sut. post. magnæ; zonâ plus minusve pilosâ, interdum poriferâ.

Subgenus *Amicula* s. str. (Gray).

Branchiæ mediæ. *A. vestita* Sowerby.

Subgenus *Chlamydochiton* (Dall).

Branchiæ ambientes. *C. amiculata* Pallas.

Both groups are provided with pores bearing fasciculi of bristles of a soft or horny character, and which, while often irregularly disposed or even almost entirely absent (in particular individuals), have a tendency to arrange themselves in two rows on each side of the median line, one row behind the exposed point of the valve and another near its submerged lateral posterior angle, on each side. The mantle is also provided with a coating of fine, chaffy, deciduous scales.

### Subgenus AMICULA (Gray) Dall.

*Amicula* Gray, l. c. 1847. (*C. vestitus* Sow.)

*Symmetrogephyrus* Middendorf, Mal. Ross. i, p. 98, 1847. (*C. Pallasii* Midd.)—Chenu, Man. i, 383, 1859.

*Stimpsoniella* Carpenter, Bull. Essex Inst. v, p. 155, 1873. (*C. Pallasii* Midd. and *Emersonii* Couch.)

*Middendorfia* Carpenter, MS. 1871.

#### **Amicula vestita.**

*Chiton vestitus* Sowerby, Zool. Journ. iv, p. 368, 1829; Conch. Ill. f. 128, 128a (from type-specimen), 1839; Zool. Beechey's Voy. p. 150, pl. xli, f. 14, 1839.

? *C. amiculatus* Wood, Ind. Test. pl. 1, f. 12, 1828 (probably).—Reeve, Conch. Icon. Mon. Chiton, pl. xi, f. 59, 1847.

**Amicula vestita.**

*Amicula vestita* Gray, P. Z. S. 1847, pp. 65, 69, 169.—H. & A. Adams, Gen. Rec. Moll. i, p. 480, pl. 55, f. 2, 1854.—Gray, Guide, p. 187, 1857.  
*Amicula vestita* Cpr. Bull. Essex Inst. 1873, p. 155.

(? *Var. Emersonii.*)

*Chiton Emersonii* Couthouy, Bost. Journ. Nat. Hist. ii, p. 83, pl. iii, f. 10, 1838.  
*Chiton Emersonianus* Gould, Inv. Mass. p. 151, f. 19, 1841.—Reeve, Conch. Icon. Mon. Chiton, pl. xi, f. 59, 1847.  
*Amicula Emersonii* Gray, P. Z. S. 1847, p. 69.—H. & A. Adams, Gen. Rec. Moll. i, p. 481, 1854.—Gray, Guide, p. 185, 1857.—Stimpson, Smithsonian Checklist of East Coast Shells, 1830.—Binney's Gould, p. 264, f. 527 (bad), 1870.  
*Amicula vestita* Stimpson, Shells of N. Engl. p. 29, 1851.  
*Stimpsoniella Emersonii* Cpr. Bull. Essex Inst. 1873, p. 155.

A. t. valvarum parte expositâ (huic generi) majore, latâ, subreniforme, antice acutâ sed haud prolongatâ, lateribus rectangulatis, postice bilobatis, sinu latiore; ar. jug. centr. et lat. haud definitis; totâ superficie granulosâ, supra jugum leviori; circa marginem undique (nisi ad mucronem in sinu postico) bicostatâ; intus, v. post. typice mopaloideo, utr. lat. unifissatâ, sinu caudali lato, brevior; v. centr. 1-, ant. 6-fiss.; laminis acutis, fissuris parvis, sulcis ex fissuris haud loricam tenuis continuis; lam. sut. ant. haud separatis, sinu lato, brevi; post. minoribus sed à sinu postico alto latiore omnino separatis; (Cpr.) Zonâ tenui, levior; setulis furfuraceis et fasciculis setarum plus minusve irregularis suprâ zonam expositâ. Lon. 50, Lat. 35 mm.

*Hab.*—Arctic Ocean, extending southward in the Pacific region to Hagmeister and St. Paul Islands, Bering Sea; on the Atlantic south on the New England coast to Cape Cod; in 5-30 fathoms, mud and stones. Two young specimens, not certainly of this species, in 60 fathoms, Captain's Bay, Unalaska. Thirteen specimens examined.

The "ovarian" openings, bilaterally symmetrical, are situated just behind and, as it were, under the shadow of the posterior branchia on each side. They are not simple orifices, but fenestrae, composed of two openings somewhat oblique and linear; the anterior a little nearer the girdle and a little larger than the posterior one.

I have no doubt whatever that the original *vestitus* of Sowerby (from Beechey's original locality I have examples) is identical with the *Emersonii* of Couthouy.

Much has been said about the presence or absence of 'pores' and hair-tufts. I find from examination of a series that the young *Emersonii* is usually smooth, the large ones always setiferous. These setae are, as described by Dr. Gould, in two rows on each side, or rather six in all if we count the pretty constant tufts behind the exposed apices of the shell. These rows are (1) two behind the shell points as above; (2) two, one on each side at the posterior angle of the submerged expansion of the valve; (3) a series, more or less irregular, along the margin of the girdle. Beside this, in old ones, there are irregular tufts all over the girdle, and some of the regular tufts *may* be missing.

Dr. Carpenter, seeing young specimens, could not recognize the porcellanous of Gould. Shortly before his death, however, he sent me specimens which showed them plainly; it is evidently a character in this group of very little importance.

As regards its identity with *vestita*; when dry, the New England form precisely resembles the figures from Sowerby's type-specimen in his Conchological Illustrations, taken from a dried specimen. He considered *Emersonii* a synonym, and I fully agree with him, but have kept the two separated in the foregoing synonymy for the convenience of those who may doubt this.

This species is very close to *A. Pallasii*, but is distinguishable by the larger and laterally much more expanded exposed portions of the valves, by its flatter form, and proportionally sparser and longer setæ. When dry, the whole form of the valves is visible in *vestita* from above, like the bones of a Peruvian mummy; in *Pallasii*, however, the integument is so much more coriaceous and thick, that in dry specimens hardly anything of these outlines is visible. Middendorf's figure, copied by Chenu, well represents *A. Pallasii* when fresh. In cabinets it is rare, and is not common in the field where collectors have searched for it.

**Amicula Pallasii.**

*Chiton Pallasii* Midd. Bull. Acad. Sci. St. Petersburg. vi, p. 117, 1847.

*Chiton* (subg. *Phanochiton*, sect. *Dichachiton*, subs. *Symmetrogephyrus*) *Pallasii* Midd. Mal. Ross. i, p. 28, 1847; Sib. Reise, p. 163, t. xiii, f. 1-9; t. xiv, f. 1-6, 1851.

*Amicula Pallasii* H. & A. Ad. Gen. i, p. 431, 1854.—Chenu, i, p. 383, 1859.

*Stimpsoniella Pallasii* Cpr. Bull. Essex Inst. 1873, p. 155.

A. t. valvarum mucrone cordiformi solum externe conspicuâ; intus v. post. mopaloideâ, utr. lat. unifissatâ, sinu caudali minore, laminâ posticâ extus rugosâ lato, brevi; v. centr. 1-, v. ant. 6-8-fissatis; lam. aentis ex fissuris umbonem tenuis sulcatis; lam. sutur. ant. modicis haud separatis, sinu lato brevi; post. latis, regulariter arcuatis, à sinu postico lato alto separatis, (Cpr.) Limbus (zonâ) luxurians in pallium extenditur, totum animalis dorsum rotundatum obtegens, valvas obvolvens et occultans, solis octo aperturis minutis, rotundatis, in linea mediana, quibus aditus ad umbonem valvarum patet; color squalido lutescens; epidermis dorsalis undique versum fasciculis pilorum erinitâ. Lon. 67, Lat. 48, Alt. 21 mm. Div. 120°.

*Hab.*—Okhotsk Sea, Midd.; Pribiloff, Aleutian, and Shumagin Islands, Dall! 3 to 10 fathoms, very rare. Seven specimens examined.

The rounded back, tough and hairy girdle with minute holes for the tips of the valves, the valves themselves less transverse as a whole and much less exposed than in *vestita*, are the characters by which this species may be readily distinguished from the latter. My specimens have only six fissures in the anterior valve against eight in a specimen of *vestita* of the same size.



It is even rarer than the last species, and hardly known in collections. The gills are median; mantle-edge broad and even; the veil is pectinated and the anterior edge of the muzzle has a sort of rim or margin, besides.

Subgenus *CHLAMYDOCHITON* Dall.

*Amicula* Cpr. pars; non Gray, Adams, etc.

*Chlamydochiton* Dall, Proc. Nat. Mus. p. 1, Jan. 1878.

***Chlamydochiton amiculatus*.**

*Chlamydochiton amiculatus* Dall, l. c.

*Chiton amiculatus* Pallas, Nova Acta Petrop. ii, p. 241, pl. vii, f. 26-30, 1788.—Gmelin, Syst. Nat. p. 3206, 1790.—Wood, Gen. Conch. p. 13, 1815.—Dillwyn, Cat. Rec. Shells, i, p. 6, 1817.—Blainville, Diet. Sci. Nat. xxxvi, p. 546, 1825.—Midd. Mal. Ross. i, p. 96, 1847.—H. & A. Adams, Gen. Rec. Moll. i, p. 480, 1854.

Not *C. amiculatus* Sowerby, Conch. Ill. f. 80, 1839, nor of Gray, P. Z. S. 1847, pp. 65, 69, 169, = *C. Stelleri* Midd.

Not *C. amiculatus* Wood, Ind. Test. f. 12, 1828, = *C. vestitus* (probably).—? Reeve, Conch. Icon. Chiton, f. 59, 1847.

*C. t. extus* Cr. *Stelleri*, jun. simili, sed apicibus valvarum rotundatis extantibus; intus, laminis v. post. mopaloideis, utr. lat. (et v. centr.) unifissatis; sinu caudali lato, altiore; lam. sut. anticis modicis junctis, sinu lato; posticis majoribus, regulariter arcuatis, extus haud sinuatis, postice sinu lato, alto, subapicem planato, haud laminato; fissuris usque ad apices sulcatis; zonâ coriaceâ, læviore poris seriebus 2 circa suturas et marginem, majoribus; seriebus inter valvas et irregulariter supra zonam sparsis, minoribus; setis porarum paucis, longioribus, haud spiculis. Lon. 75, Lat. 40 mm. (*Cpr.*)

*Hab.*—"Japan," London dealer; Kuril Islands, Pallas and Steller; Farallones Islands, California, Newcomb! Two specimens examined.

This species probably has about the same distribution as *C. Stelleri*, though much rarer, and may by collectors have been taken for an imperfect or immature specimen of that mollusk; when dry, to a casual glance they appear very similar, the minute apices of the valves being hardly visible. The coating of the girdle is, however, of a wholly different character. Dr. Carpenter would have reserved the name *Amicula* Gray for this species, but that name cannot legitimately be separated from its typical species (*vestita*), which belongs in the other subgenus. The ambient gills are the only sound character. The pores, which gave Dr. Carpenter a great deal of unnecessary trouble, are in this group not even of specific importance. I have only seen specimens in Dr. Carpenter's hands, and insert his description of the characters. It is doubtless one of the very rarest of the Chitons. Its nearest allies are *A. Pallasii* and *vestita*.

The figures given by Pallas are sufficient to identify the species very well, but in his remarks he quotes notes by Steller, which refer to the

great *Cryptochiton Stelleri* of modern authors. Some specimens of *Stelleri* in the Berlin Museum are marked *amiculatus* on very ancient labels, so there can be little doubt that the two species were confounded by the earlier authors.

Genus CRYPTOCHITON Midd. and Gray.

Midd. Mal. Ross. i, pp. 1-96, pl. 1-9, 1847. Type *C. stelleri* Midd.—Gray, P. Z. S. 1847, pp. 65, 69, 169; Guide, p. 185, 1857.

Valvæ omnino in zonâ immersæ; laminæ insertionis rude mopaloideæ; lam. sutur. tam postice quam antice junctæ, postice trisinuata; zonâ minutissime fasciulatum pilosâ; branchiæ ambientes.

This genus was simultaneously described under the same name by Gray and Middendorf, apparently without knowledge of each other's labors, and both having the same species in view, though Gray erroneously supposed his type to be the *C. amiculatus* of Pallas, and called it by that name; his diagnosis and synonymy, however, showing that he really referred to *C. Stelleri*.

It appears probable, from some of Pallas' specimens examined by me in the Berlin Museum, that he included this species with the *amiculatus* in his distribution, and, in fact, unless carefully examined, almost any one might do the same.

**Cryptochiton Stelleri.**

*Chiton Stelleri* Midd. Bull. Acad. Sci. St. Pétersb. vi, p. 116, 1846.

*Chiton (Cryptochiton) Stelleri* Midd. Mal. Ross. i, p. 93, t. i-ix, 1847; Mém. de l'Acad. Imp. Sci. St. Pétersb. 6me sér. vi, p. 101, 157, 1849.—Schreuek, Amur-Land Moll. p. 271, 1867.

*Chiton amiculatus* Sowerby (not Pallas), Conch. Ill. f. 80, 80 bis, 1839.—Gray, P. Z. S. 1847, pp. 65, 69, 169.

*Chiton sitkensis* Reeve, Conch. Icon. Chiton, pl. x, f. 55, 55 b, 1847. (Not *C. sitkensis* Midd.)

*Chiton chlamys* Reeve, l. c. pl. xi, f. 60, 1847 (from type, Cpr.).

*Cryptochiton Stelleri* Gray, Guide, p. 185, 1857.—H. & A. Adams, Gen. Rec. Moll. i, p. 479, iii, pl. iv, f. 1, 1 a, 1854.—Carpenter, Suppl. Rep. Brit. As. 1863, p. 648.

(*Patella longæ Rondeletii* auf Kurilisch Kéru, Steller, Beschreib. Kamtsch. p. 177, 1774.)

C. t. intus; v. post. mopaloideâ, mucrone obtuso ad posticam trientem; sinu caudali alto, lato; fissuris utr. lat. unâ, subposticis, conspicuis; lam. sut. anticis latioribus, junctis, sinu jugali alto, modico, subplanato; v. ant. mucrone ad quartam partem posticam, normaliter utr. lat. 1- et ant. 3- (id est omnino 5-, sed interdum 4-6-, seu 7-) fissatâ; lam. sut. posticis longis, lateraliter conspicue sinuatis, medio junctis, sinu postico altissimo, pyramidalis, frustrato; v. centr. mucr. ad quintam partem posticam; haud seu interdum 1-fiss.; lam. lat. et sutur. ant. haud separatis, sinu jugali angustiore, altissimo, irregulariter arcuato,

hand planato; lam. post. super-suturalibus minoribus, longis, à sinibus marginalibus conspicue separatis; sinu pestico altissimo, irregulariter gothico, lam. junctis; valvis omnibus mucronatis, mucrone seu umbilicoideo seu punctato seu pustuloso; zonâ omnino fascieulis minutis spicularum minimarum irregulariter conferte instructâ. (*Cpr.*) Lon. 200, Lat. 75 mm. Div. 130°.

*Hab.*—Japan Sea; Sakalin Id.; Kuril Ids.; Kamchatka (southern extreme); the Aleutian Islands and the whole coast southward to Monterey and the Santa Barbara Islands, California. Usually found just below tide-marks, and often cast up on the beach in great numbers by severe gales. Collected abundantly at Unalaska and Sitka, also at Monterey; Dall!

This the largest and in many other respects the most remarkable of all Chitons is readily recognized by its wholly covered valves, no indication of which is evident, even under the skin, in fresh examples. It is covered with cells, each holding a fascicle of small spines, which, when dry, have an urticating effect upon the skin of those who may handle them. The foot and softer parts are used as food by the Aleuts and Indians; they are eaten in the raw state. The back is of a fine ferruginous red when fresh; dried specimens are usually more or less distorted and mauled; one of those figured by Reeve appears to have been partly rotten.

There is a good deal of variation in the size and relative proportions of the valves in different individuals, and the fissures are sometimes partly abortive or abnormally multiplied.

The soft parts of this species have formed the subject of an extensive monograph by Dr. Middendorf in his first part of the Beitr. Mal. Rossica. To that work the student is referred for details.

### Genus KATHERINA Gray.

*Katherina* Gray, P. Z. S. 1847, p. 65. Type *K. tunicata* Wood.

Lorica parva; zonâ lævis, in suturas valde expansâ; laminæ valde antice projectæ, v. post. sæpe lobatæ; sinus altissimus, spongiosus; branchiæ ambientes.

This is an aberrant genus. In the smallness of the exposed portion and smoothness of the girdle it resembles *Phacellopleura*; in the extreme anterior projection of the plates, and in the deep spongy sinus, it is most like *Nuttallina*, of which it might be regarded as an exaggeration with a smooth girdle; but the tail-plate has most affinity with the *Mopaloidea*. Specimens may be found with many lobes like *Phacellopleura*; but on comparison of many individuals it will be found that the normal arrangement is a mopaloid slit on each side, with an angular sinus at the tail, and that the extra slits are extremely irregular and secondary. In *Nuttallina*, the plan, on the contrary, is perfectly regular, and *Phacello-*

*pleura* appears to be of the regular type. Middendorff's figures of the plates are inaccurate, and Gray's description in the Guide differs from his more correct account in the Proc. Zool. Soc. (Cpr. MS.).

In the sole species of this genus, the ovary is convoluted and single. The ovarian openings are found on each side between the line of the branchiæ and the side of the foot. They are placed in the vicinity of the fifth branchia from the posterior end of the row. There are no slime glands. The organ of Bojanus appeared to be represented by a glandular deposit on the floor of the visceral cavity behind. The muzzle is plain, drawn down to corners behind on each side, but without flaps. Veil narrow, thin, plain, produced in a flap on each side of the muzzle. Mantle-edge narrow, plain. Branchiæ about sixty on a side in a row as long as the foot. Anus papillate, median, with a ridge extending each way from it. Soft parts yellowish to deep orange, girdle shining blue black.

#### **Katherina tunicata.**

*Chiton tunicatus* Wood, Gen. Conch. p. 11, fol. 2, f. 1, 1815; Ind. Test. Chiton, pl. 1, f. 10, 1828; Ib. ed. Hanl. 1856.—Sowerby, Beechey's Voy. Zool. p. 150, t. xli, f. 15, 1839.—Reeve, Conch. Icon. Mon. Chiton, f. 61 (good), 1847.

*Chiton* (*Phanochiton*, *Hamachiton*, *Platysemus*) *tunicatus* Midd.—Mal. Ross. i, p. 98, t. x, f. 1-2, 1847.

*Katherina tunicata* Gray, P. Z. S. 1847, p. 69; Ib. Guide, p. 185, 1857.—Cpr. Suppl. Rep. Br. As. 1863, p. 648.

*Katherina Douglassæ* Gray, P. Z. S. 1847, p. 69.

*Katherina tunicata* H. & A. Adams, Gen. Rec. Moll. i, p. 479, iii, pl. 54, f. 8, 1854.

K. t. extus, valvis postice fere rectangulatis; areâ jugali longissimâ, antice inter lam. sutur. projectâ, tenuissime punctulata; area centr. rotundatis, quincuncialiter fortiore punctatâ; ar. lat. haud definitis, fere obsoletis; mucrone subpostice mediano, elevato; intus, v. post. laminis ad caudam angulatum sinuatis, præcipue utr. lat. unifissatis, sed interdum in lobas irregulares  $\frac{1}{2}$ ,  $\frac{1}{3}$ ,  $\frac{2}{2}$ ,  $\frac{3}{4}$ ,  $\frac{4}{4}$  fiss.; v. centr. 1-, ant. 7-fissatis; laminis prælongis, antice valde projectis, acutis, extus striatis, fissuris parvis, suffultis, ad subgrundas solidas, curtissimas valde spongiosas, sulcis continuis; sinu altissimo, angusto, spongioso; lam. sutur. separat. prælongis; zonâ nigrâ, supra valvis tenui, omnino levi. Lon. 50, Lat. 20 mm.

*Hab.*—Kamchatka (Cpr.); the entire Aleutian group; on the north side of the peninsula of Aliaska to Port Möller, and on the south side east to Cook's Inlet, and south to Catalina Island, California; low water (chiefly), to 20 fathoms. Several hundred specimens examined.

This unmistakable shell, characterized, when fresh, by its broad shining black girdle and almost covered valves, is eaten raw by the natives of the northwest coast, and is said to act as an aphrodisiac. The supposed second species of Gray is merely a result of an irregular drying of the girdle. The soft parts are of a salmon color in northern speci-



mens. The less important details are very variable in different individuals.

In taking leave of the Irregular Chitons, a few notes on exotic species of this section may be properly incorporated.

In *Chitonellus fasciatus*, the representative of the most highly developed type of Chiton, the gill-rows are confined to the posterior quarter of the foot, but the separate branchiæ of which they are composed are very large, twenty-six or eight in number, and rather long. There was no well-marked crop, as in ordinary Chitons. The muzzle was inconspicuous, angulated at the posterior corners, with no veil. Mantle hardly visible. There seemed to be two oviducts leading from a single ovary (compounded of two?) to small orifices, one on each side of the anus.

In *Cryptoconchus monticularis* Quoy, which much recalls the northern *Katherina*, the girdle varied from black to light brown. A veil was present, but narrow and simple, while the mantle-edge was hardly perceptible. Gill-rows one-third as long as the foot, containing each about eighteen branchiæ. Muzzle very transverse, with flaps at the posterior corners. Ovisac single.

## CHITONES REGULARES.

### LEPTOIDEA.

#### Genus LEPTOCHITON Gray.

*Leptochiton* Gray, P. Z. S. 1847, p. 127; Guide, p. 182, 1857.

< *Leptochiton* H. & A. Adams, Gen. Rec. Moll. i, p. 473, 1854.—Chenu, Man. Conchyl. i, p. 381, 1859, etc.

< *Lepidopleurus* Risso (ex Leach MS.), 1826.—Sars, Moll. Reg. Arct. Norvegiæ, p. 110, 1878.

Lam. insertionis nullis; zonâ minutissime sabulosâ; sinus lævis; haud laminatus; branchiæ breves. Type *L. asellus* Lowe.

The diagnosis of Gray determines the genus, but he includes in the examples cited *C. albus* L., which is a *Trachydermon*. Two out of twenty-five species cited by the brothers Adams are real *Leptochitons*; the example cited by them as typical is not a *Leptochiton*, neither is the example cited by Chenu. The other Leptoid genera are as follows:

**Hanleyia** Gray, Guide, p. 186, 1857.

Anterior valve with an unslit insertion-plate; other valves without even the plates. *H. debilis* Gray.

**Hemiarthrum** Carpenter, Bull. U. S. Nat. Mus. iii, p. 44, 1876.

Insertion-plates present on all the valves, but entire without slits. *H. setulosum* Cpr. l. c.

**Deshayesiella** Carpenter MS.

Loricâ elongatâ; valvæ curvatæ, antice tendentes; mucro planatus, zonâ spiculosa; lam. insert. nullis; lam. sut. triangulares, extantibus. *D.* (*Leptochiton*) *curvatus* Cpr.

**Microplax** H. Adams.

Resembling *Chitonellus* externally; submerged laminae unslit, entire, fused in an undistinguishable manner with the parts which usually constitute the sutural laminae. *M. Grayi* Ad. & Ang.

The paleozoic *Helminthochiton* Salter, *Priscochiton* Billings, *Gryphochiton* Gray, and several unpublished names of Dr. Carpenter, all belong to the Leptoidea. A large number of the fossils described as Chitons (for instance *Sulcochiton Grayi* Ryckholt) are not mollusks; many of them being valves of *Balani* or fragments of isopod crustaceans.

**Leptochiton cancellatus.**

*Chiton cancellatus* Sowerby (as ? of Leach MS.), Conch. III. f. 104-5, 1839.

*Chiton albus* Pulteney, non Lin. fide Hanley.

*Chiton cancellatus* Reeve, Conch. Ic. pl. lix, f. 152, 1847.

*Chiton asellus* Midd. Mal. Ross. i, p. 122, 1847, not of Lowe.

*Chiton cancellatus* Forbes & Hanley, Brit. Moll. ii, p. 410, pl. lix, f. 3, 1853 (outlines inverted in figure).

*Leptochiton cancellatus* H. & A. Adams, Gen. Rec. Moll. i, p. 473, 1854.

*Chiton cancellatus* Jeffreys, Brit. Conch. iii, p. 217, 1865; v, p. 198, pl. lvi, f. 1, 1869.

*Chiton alveolus* Jeffreys, l. c. iii, p. 218, 1865; not of Sars.

*Chiton Rissoi* auct. not of Payraudeau.

*Lepidopleurus cancellatus* Sars, Moll. Reg. Arc. Norv. p. 111, t. 7, f. 6 a-h, 1878, dentition t. I. f. 8, (imperfect).

? *Lepidopleurus arcticus* Sars, l. c. p. 112, t. 7, f. 7 a-h.

? = *Chiton islandicus* Gmelin, S. N. 3206, 1788.—Schröter, Einl. iii, p. 509.—Dillwyn, Rec. Shells, i, p. 10, 1817.

L. t. minimâ, elongata, valde elevatâ, regulariter arcuatâ; jugo nullo; aurantiâ plus minusve cinereo tinctâ, interdum albidâ; valvis angustioribus, haud rectangulatis, apicibus nullis; mucrone centrali, valde elevato, sculpturâ ut in *L. asello*, sed granulis parum majoribus; areis centr. parum divergentibus, areis lat. satis definitis, vix elevatis; *intus*, laminis sut. minimis, triangularibus; sinu latissimo, marginibusque valvarum à sculpturâ externâ paullulum crenulatis; *zonâ*, angustâ, squamulis tenuibus, haud imbricatis, haud striulatis, dense obsitâ. Lon. 6, Lat. 3 mm. Div. 80°.

*Hab.*—British seas; Norwegian coast in 50-100 fms.; Greenland; Gulf of Lyons (Jeffr.); Lofoten, 300 fms. (Sars); Vigo, Spain (McAndrew); Dalmatia (Brusina); Alaska, at Unalashka, Shumagins, Port Etches, and Sitka Harbor, 6-100 fms. Dall! Ninety-four specimens examined.

This species without careful inspection will usually be confounded with small specimens of *Trachydermon albus*, but a glance at the sculpture is sufficient to separate it. From several other species of *Leptochiton* it is less readily distinguished, and a magnifier is indispensable. The differential characters are as follows:

The pustules which constitute most of the sculpture are arranged like overlapping coins or a solid-linked chain in lines which in the dor-

sal area are nearly parallel with the longitudinal axis of the animal. The lateral areas are distinct, and the pustules upon them are arranged in rather indistinct lines radiating toward the lateral ends of the valves, at nearly right angles to the lines on the dorsal area. The sculpture on the muero is more delicate than elsewhere. The apex of the posterior valve is not sunken, and is not so sharp as in other species compared with it here; the girdle is scaly, with also some small spinose transparent scales near the margin. There are five gill-plumes on each side, prominent and near the vent. There appear to be two fenestræ on each side. The lateral areas and other portions of the valves are nearly always colored with blackish or ferruginous patches, but these, as with *Trachydermon albus*, seem to be really composed of extraneous matter.

In *L. fuliginatus* Ad. & Rve., the pustules are much smaller, and while having a general longitudinal arrangement on the dorsum, do not form regularly defined rows or chains. The areas are not raised above the dorsum. The shell is much larger and more elevated, with a somewhat sunken and quite sharp posterior muero. The other mucrones are not raised, but about them the sculpture is more regularly aligned than elsewhere. I have compared the valves of a typical specimen from Korea collected by Belcher. Reeve's figure of the sculpture is very bad, as are most of his details. *L. alveolus* Sars is a very distinct species, though it has been confounded with this. Its sculpture is composed of larger and rather more sparse, isolated pustules, absolutely irregular in distribution and of the same size on the muero and elsewhere. Nowhere do they form lines. The arch of the back is peculiarly round, the lateral areas not raised and barely distinguishable. The girdle seems similar. I have compared typical examples.

*L. concinnus* Gould, from the types, is of a different color, and has a much stronger and different sculpture, like lines of rope.

*L. internexus* Carpenter and var. *rugatus* Cpr. are more like *concinnus*, but distinguished from either by the peculiar girdle covered with subequal scales.

*L. nexus* Carpenter more nearly resembles *cancellatus*, but the sculpture is of separate, not lapping, rounded-rhomboidal pustules; the mucrones are much more pronounced, and the white ground is prettily marbled with black and gray inherent coloration.

The name *cancellatus* is a misnomer, since it is only in certain lights that any trace of reticulation can be observed faintly. The young are flatter than the adults. It bears no resemblance to *L. asellus*, with which Middendorf united it, probably without a comparison.

*L. arcticus* of Sars seems to be a finely grown variety of this species, if one may judge from the figures; at least no differential characters are given which seem to be of a permanent character, and not subject to variation within the limits of a species.

The specimens of this species obtained by me in Alaska were at first referred to *fuliginatus* by Dr. Carpenter, and some specimens were distributed under that name, or the name of *fuliginosus*, before I had the

opportunity of making the correction, which, had Dr. Carpenter survived to finish his work, he would undoubtedly have done himself.

In the hurry of field-work, the specimens were confounded with young *T. albus*, and hence no observations on the living animal were made. Had attention been drawn to it, it might, doubtless, have been obtained throughout the Aleutian chain, but no specimens occurred in the collections from more northern localities. Jeffreys states that the under edge of the girdle and the soft parts are yellowish white, tinged with flesh color; also that littoral specimens from Herm are larger than those found in deeper water. In Alaska it has been obtained only with the dredge.

The gills occupy a space corresponding to the posterior quarter of the foot; there are about eight or ten on each side. The mantle-edge is plain and thick. The veil is plain. The muzzle is rounded, with a little papilla at the posterior corner on each side.

**Leptochiton alveolus.**

*Leptochiton alveolus* (Sars MS.) Lovén, Ind. Moll. Lit. Scand. p. 27, 1846.  
Not of Jeffreys, etc.

*Lepidopleurus alveolus* G. O. Sars, Moll. Reg. Arc. Nor. p. 110, t. 7, f. 3 a-i; t. 1, f. 7 (good), 1878.

*Hab.*—Bergen, Lofoten, Finmark, 150–360 f. (Sars); Gulf of St. Lawrence, in 220 fathoms, between Cape Rosier and the S. W. point of Anticosti Island, Whiteaves! St. George's Bank, Gulf of Maine, 150 fathoms, U. S. Fish Com., 1872!

This extra-limital species is inserted here because of its possible relations with the next species, and also to call attention to the addition to our Northeast American fauna made by Mr. Whiteaves. It is a remarkably distinct species, and if typical examples had been examined by the authors who have referred it to *L. cancellatus*, it would seem unlikely that it would have been so referred.

**Leptochiton Belknapii.**

*Leptochiton Belknapii* Dall, Proc. U. S. Nat. Mus. p. 1, Jan. 1878.

*L. t. elongatâ, valde elevatâ, dorsaliter angulatâ; albidâ plus minusve cinereo et nigrotinetâ; valvis elevatis, apicibus distinctis; mucrone centrali conspicuo; sculptura ut in L. alveolo, sed granulis in arcis dorsalis sparsim et quinquennialiter dispositis. Valva posticâ sub apicè concavâ, posticè sinuatâ. Zona minimâ, spiculis tenuibus versus marginem munita. Lon. 10.0, Lat. 3.0 mm. Div. 90°.*

*Hab.*—North Pacific Ocean, in lat. 53° 08' N., lon. 171° 19' W., at a depth of 1006 fathoms; black sand and shells. Brought up in the sounding-cup by Capt. Geo. E. Belknap, U. S. N., on the sounding expedition of U. S. S. Tuscarora in 1874, bottom temperature 35° 5 F. (Specimens obtained by H. M. S. Challenger in Balfour Bay, Royal Sound, Kerguelen Id., Southern Ocean, in 20–60 fms., for examination of which I am indebted to the courtesy of Rev. R. J. Boog Watson, are apparently identical with Capt. Belknap's species.)



This specimen much resembles *L. alveolus*, to which I at first referred it. A careful microscopical examination, however, shows differences which I am disposed to consider specific; but I have but one specimen, and others might show modifications in these particulars.

The differential characters are as follows: In *alveolus* the pustules are distributed evenly, closely, and in no pattern whatever, all over the surface. In *Belknapi*, they are more widely separated, and arranged in quin-cunx on the dorsum, the spaces seeming to radiate from the median dorsal line. In *alveolus*, the lateral areas are barely perceptible; in *Belknapi*, they are raised, concentrically rugose, and the pattern of the pustular arrangement is different and more irregular than that on the dorsum. In *Belknapi*, also, the girdle is very thin, narrow, and sparsely set with small pellucid spicules near the margin. The posterior mucro, or apex of the posterior plate, in *Belknapi*, is prominent, overhangs a shallow concavity, and from its point there diverge anteriorly four depressed lines, the outer two to the anterior lateral angles of the plate, the inner two equidistant from each other and the outer lines. Between these lines the plate is swelled, forming three rounded ridges, extending forward like the leaflets of a trefoil or clover. Nothing resembling this has been observed on any of the other species which have come under my notice.

The soft parts, in spirits, appear to resemble the other species compared with it. It is evidently adult.

It was certainly unexpected that a stone-clinging mollusk like a *Chiton* should reach such great depths as those from which this was obtained. In the same region, and at about the same depth, a *Cylichna* and a *Natica*, both apparently identical with certain Arctic species, were also obtained in the same way. Its enormous range in latitude, as indicated by the Kerguelen specimens, reminds one of the range of species in earlier geological times, and points out how relatively modern our littoral marine faunæ may be. It is not the only form common to the southern and northern oceans.

#### *Extra-limital Species.*

##### **Leptochiton asellus.**

*Chiton asellus* (Chemn. Spengl.) Lowe, Zool. Journ. ii, p. 101, pl. v, f. 3, 4, 1825.

*Chiton cinereus* Montague, Turton, and others, not of Linné.

? *Lepidopleurus cinereus* Sars, l. c. p. 112, pl. 7, f. 8 a-h, 1878; as of Linné.

*Hab.*—Northern seas of Europe; Lofoten Ids.; Greenland? (Morch); not New England, as erroneously stated by authors. The *cinereus* of Linné, from his type, was a *Trachydermon*.

##### **Leptochiton fuliginatus.**

*Chiton fuliginatus* Ad. & Rve. Conch. Icon. pl. xxvi, f. 174, 1847.

*Hab.*—Korea, Belcher.

##### **Leptochiton concinnus.**

*Leptochiton concinnus* Gld. Otia, p. 117, 1860.

*Hab.*—Hakodadi, Japan; Stimpson.

**Leptochiton nexus.**

*L. nexus* Cpr. Suppl. Rep. Br. As. 1863, p. 650.

*Hab.*—California, Cooper.

**Leptochiton internexus** and var. **rugatus.**

*L. internexus* Cpr. MSS.

*Hab.*—California, Cooper, Canfield and Hemphill.

**Hanleyia mendicaria.**

*Chiton mendicarius* Mighels & Adams, Boston Journ. N. H. iv, p. 42, pl. iv, f. 8, 1842.

*Hanleyia mendicaria* Cpr. N. Engl. Chitons, l. c. p. 154, 1873.

*Hab.*—Casco Bay; Grand Manan, Stimpson; Portland Harbor, Me., U. S. Fish Commission. Deep-water specimens much larger than those from shallow water.

**Hanleyia debilis.**

*Hanleyia debilis* Gray, Guide, p. 183, 1857.

*Chiton Hanleyi* Bean, Brit. Mar. Conch. p. 232, f. 57, 1844.—Sars, l. c. p. 109, pl. 7, f. 5 *a-i*, 1878.

*Hab.*—British seas northward; Mageroe near North Cape, 25–300 f., Sars. Stellwagen Bank, Mass. Bay, 38 fathoms, gravel; U. S. Fish Com., 1878. Type of the subgenus. A recent addition to our North-east American fauna.

**Hanleyia (?) abyssorum.**

*Chiton abyssorum* M. Sars, MSS.—G. O. Sars, l. c. p. 109, pl. 7, f. 4 *a-c*, pl. I, f. 6 *a-c*, 1878.

*Hab.*—Bergen, Norway, 150–200 fathoms, Sars, l. c.

The teeth of this species as figured by Sars agree pretty well with those of *H. mendicaria*, but neither Prof. Sars' figures nor his description afford means for determining its generic position. The valves of the two specimens figured exhibit rather remarkable differences, and, this variation admitted, the question arises, Is this more than a gigantic form of the preceding?

**Hanleyia tropicalis.**

A large and beautiful species from the deep waters of the Gulf of Mexico is the only other recognized species of the genus, and will be described by the writer in the Report on the Deep-sea Dredgings made under the supervision of Prof. A. Agassiz, on the U. S. Coast Survey steamer Blake, in 1878.

ISCHNOIDEA.

Genus TRACHYDERMON Cpr.

*Trachydermon* Cpr. Suppl. Rep. Br. As. 1863, p. 649, as a subgenus of *Ischnochiton*, type *Chiton cinereus* Lowe.

*Lepidopleurus* sp. auct.

> *Craspedochilus* G. O. Sars, l. c. p. 114.

*Lophyrus* sp. G. O. Sars, l. c. p. 114, not of Poli.

< *Boreochiton* G. O. Sars, l. c. p. 115.

*Leptochiton* sp. auct.

*Char.*—Laminae inserentes acutæ, læves; valvæ extus et intus *Ischnochiton* exacte simulans; zonâ non poriferâ, squamulis minutissimis lævibus confertissime granulatâ; branchiæ breves.

This name was originally proposed as a subgenus of *Ischnochiton* to include Gray's second section, "mantle scales minute, granular" (P. Z. S. 1847, p. 147; Guide, p. 182, 1857). In all other conchological characters, the group accords with that genus, but the animal differs in having the gills either entirely posterior or reaching forward from the tail only to about the middle of the foot, while in *Ischnochiton* and *Chiton* they travel to its anterior extremity. These characters indicate a transition between the Ischnoid and Leptoid Chitons by means of *Trachydermon* and *Tonicella*. Guilding called the radula of Chitons "Trachyderma"; but as the name has not been adopted, no inconvenience is likely to ensue. (Cpr. MSS.)



FIG. E.—Teeth of *Trachydermon cinereus*  
Lowe; after Lovén.

The genus is chiefly northern in its distribution. *Chiton marginatus* of authors (Pennant's species being indeterminable) and *C. cinereus* (Linn.) Lowe, are identical, according to Dr. Carpenter, the best authority on the subject, as well as Hanley and others. The "*Lepidopleurus*" *cinereus* of Sars is not the Linnean species, which is the type of *Trachydermon*, but a *Leptochiton*. His *Craspedochilus marginatus* (whether the *Chiton marginatus* of Pennant or not) is a *Trachydermon*, and not improbably the true *cinereus* of Linné, which has been recognized, not from the insufficient description in the *Syst. Naturæ*, but from his typical specimens, through the invaluable labors of Mr. Hanley.

#### **Trachydermon ruber.**

*Chiton ruber* Linn. S. N. ed. xii, p. 1107, 1766.—Lowe, Zool. Journ. ii, p. 101, pl. 5, f. 2, 1825.—Gould, Inv. Mass. p. 149, f. 24, 1841.—Forbes & Hanley, Brit. Moll. ii, p. 399, pl. lix, f. 6; AA, f. 6, 1853.—Hanley, Shells of Lin. p. 17, 1855.—Sowerby, Conch. Ill. Chiton, f. 103-4, 1839.—Reeve, Conch. Icon. Mon. Chiton, pl. 23, f. 175, 1847.—Jeffreys, Brit. Conch. iii, p. 224, 1835; v, p. 199, pl. lvi, f. 4, 1869.—Binney's Gould's Inv. Mass. p. 260, f. 523, 1870.

*Chiton cinereus* O. Fabr. Faun. Grönl. p. 423, 1780; not of authors, nor of Linn.; Ib. Dillwyn, Cat. Rec. Sh. p. 12, 1817.

*Chiton minimus* Spengler, Skrift. Nat. Selsk. iv, 1, 1797, fide Lovén, not of Gmelin and Chemnitz.

*Chiton lævis* Lovén, Ind. Moll. Lit. Scand. p. 28, 1846; not of Montagne, Forbes and Hanley, etc.

*Chiton lævis* Pennant (probably), Brit. Zool. ed. iv, vol. iv, p. 72, pl. 36, f. 3, 1777 (bad).

*Chiton latus* Leach, Moll. Brit. p. 231, 1852, Dec., fide Jeffreys; not of Lowe, 1825.

**Trachydermon ruber.**

*Chiton puniceus* Couthouy (MS.).—Gld. Otia Conch. p. 5, 1846 (probably).

*Leptochiton ruber* H. & A. Adams, Gen. Rec. Moll. i, p. 473, 1854.

*Chiton (Lepidopleurus) ruber* Jeffreys, Brit. Moll. iii, p. 210, 1865.

*Trachydermon ruber* Carpenter, Bull. Essex Inst. v, p. 153, 1873.

*Boreochiton ruber* G. O. Sars, Moll. Reg. Arc. Norv. p. 116, t. 8, f. 4 a-l, t. II, f. 3 a-c (imperfect), June, 1878.

Tr. t. mucrone mediano, satis elevato: *intus*, v. post. 9-11-, ant. 8-11-, centr. 1-fiss. laevi; dent. interdum solidioribus, interdum postice rugulosis; subgrundis modicis; sinu lato, planato; *zoná* normali; branchiis submedianis. Lon. 25, Lat. 8 mm.

*Hab.*—Northern seas, widely distributed; whole coast of Norway, low water to 40 f. (Sars); Arctic and northern seas of Europe; Adriatic? (Olivi!); Spitzbergen, Iceland and Greenland, New England, Gulf of St. Lawrence and Labrador coasts; Tartary (Lischke); Kamchatka; and in Alaska from the Pribiloff Islands westward to Attu and southward to Sitka, low water to 80 fathoms, on stones and shells; probably also to Bering Strait northward. Two hundred specimens examined. ?Orange Harbor, Patagonia, as *C. puniceus*.

This shell is apparently smooth, as described by Forbes and Hanley, but under a high power appears finely reticulated, as observed by Jeffreys. Its color is very variable, being usually marbled red and whitish, like *Tonicella marmorea*, but the valves may be uniform dark red or nearly pure white. I have one specimen with the four central valves dark red and the rest white; one valve in a specimen is often dark red, while all the others are marbled. It is most likely to be confounded with *Tonicella marmorea* and some varieties of *T. lineata*, both of which have leathery girdles, while this species can almost always be determined by its farinaceous girdle, dusted with alternate red and whitish patches, the latter nearly opposite the sutures.

The identity or locality of Dr. Gould's specimen, described as *C. puniceus* Couthouy, and supposed by Dr. Carpenter to be probably the same as our northern species, seems questionable.

This species has been much confused by European authors, who have persisted in referring the Linnean name to *T. marmorea* Fabr., and resurrecting the indeterminate figure of Pennant for this species, though Mr. Hanley has determined the identity of the Linnean specimen with this species, and he did not possess the *marmorea*. The synonymy here quoted is only such as certainly belongs to this species.

Though not collected in a fresh state by me north of the Pribiloff Islands, I have little doubt that broken valves found in bird-dung at Plover Bay, near Bering Strait, are properly referable to this species. It is one of the most abundant Alaskan Chitons, and grows to the length of an inch.

The gill-rows extend forward for three-quarters the length of the foot, each row containing twenty to twenty-five branchiæ. The mantle-edge is very narrow and plain; there is no veil, and the muzzle is plain, some-



what produced behind into two corners. The eggs in part of the ovisac were well developed, and resembled the figure of the youngest stage given by Lovén. Anus median, inconspicuous, close to the mantle-edge. On each side of it, midway between it and the posterior ends of the gill-rows, is a fold containing the ovarian fenestra. The number of openings varies from three to six in different individuals. They are linear, oblique, and close together. They are more strongly marked in this species than in any other *Chiton* I have examined.

**Trachydermon albus.**

*Chiton albus* Lin. S. N. ed. xii, p. 1107, No. 8, 1766.—Lowe, Zoöl. Journ. iii, p. 80, 1826.—Fabricius, Faun. Grönl. p. 422, 1780.—Sowerby, Conch. Ill. *Chiton*, f. 99, 100, 1839.—Gould, Inv. Mass. p. 150, f. 21, 1841.—Lovén, Ind. Moll. Lit. Scand. p. 27, 1846.—Middendorf, Mal. Ross. i, p. 120, 1847.—Forbes & Hanley, Brit. Moll. ii, p. 405, pl. lxii, f. 2, 1853.—Hanley, Shells of Lin. p. 17, 1855.—Stimpson, Sh. of New Engl. p. 28, 1851; *Ib.* Mar. Inv. Grand Manan, p. 22, 1853.—Jeffreys, British Conch. iii, p. 220, 1865; v, p. 199, pl. lvi, f. 3, 1869.—Binney's Gould, p. 263, f. 525, 1870.

? *Chiton oryza* Spengler, Skrift. Nat. Selsk. Bd. iv, Hft. 1. 1797 (fide Jeffreys).

*Chiton aselloides* Lowe, Zool. Journ. ii, p. 103, t. 5, f. 3, 1825.—Wood, Ind. Test. Suppl. pl. 1, f. 9, 1828.

*Chiton sagrinatus* Couthouy, Am. Journ. Sci. xxxiv, p. 217, 1838; *Ib.* Bost. Journ. Nat. Hist. ii, p. 82, 1838.

*Leptochiton albus* H. & A. Adams, Gen. Rec. Moll. i, p. 473, 1854.

*C. (Lepidopleurus) albus* Jeffreys, Brit. Conch. iii, p. 210, 1865.

*Trachydermon albus* Carpenter, New Engl. Chitons, Bull. Essex Inst. v, p. 153, 1873.

*C. (Leptochiton) albus* Mörch, Moll. Greenl. 147, 1875.

*Lophyrus albus* G. O. Sars, Moll. Reg. Arc. Norv. p. 114, t. 8, f. 2 a-b (probably not t. I, f. 9 a-b), June, 1878.

? *Lophyrus exaratus* G. O. Sars, l. c. p. 113, t. 8, f. 1 a-k, t. ii, f. 1 (bad).

? *C. minimus* Gmel. S. N. p. 3205, 1788. (Bergen.)

Tr. t. mucrone mediano, parum elevato; *intus*, v. post. 10-, ant. 13-, centr. 1-fiss.; dent. acutissimis, posticis interdum serratis; subgrundis spongiosis; sinu modico, undulato, haud angulato, lævi; *zonâ* squamulis solidioribus; branchiis medianis. Lon. 10, Lat. 5-6 mm. Div. variable.

*Hab.*—Arctic and boreal seas, Atlantic and Pacific. British seas south to the Isle of Man; Scandinavian seas, 10 to 100 fathoms (as *exaratus* to 200 fathoms); Spitzbergen; Iceland; Greenland, White Sea; Gulf of St. Lawrence; Massachusetts Bay; on the Pacific from the Arctic Ocean south to the Shumagins and west to Kyska and probably to Attu, low water to 80 fathoms, on stones and shells. Two hundred and forty-eight specimens examined.

The synonymy of this species might have been much enlarged under the old name of *Chiton albus*, but to no particular purpose. It is a well-known and characteristic Arctic shell. American and particularly deep-water Alaskan specimens are larger, finer, and better display the scales of the girdle than European specimens. Sars' *exaratus* would seem to be probably of this description.

It seems also to be more common to the westward. Its chief pecu-

ilarity is that the central plates of the tail-valve are broken by serrations, and that the scales are large and gravelly.

The gills are twenty to twenty-five in number, the rows extending to the head. Mantle-edge narrow, plain. There is no veil, and the semi-circular muzzle is also plain. Anus terminal, papillate. Ovarian openings single, on each side, the posterior end of the gill-row passing behind them. The oviducts, as in some other species, could not clearly be made out. The ovisac or ovary is irregularly shaped and single.

The figure (pl. I, f. 9 a) strongly suggests that Prof. Sars, by inadvertence in selecting a specimen for examination of the radula, got hold of one of the extremely similar *Leptochitons*, since it does not resemble the radula of *T. albus*, of which I have examined both American and European specimens. On the other hand, the not particularly commendable figure of the radula of *L. exarvatus* Sars looks more like *albus* than anything else.

? *Trachydermon lividus*.

*Chiton lividus* Midd. Mal. Ross. i, p. 124, pl. xiii, f. 3 a-g, 4, 1847.

*Hab.*—Sitka, Alaska Territory.

This species (and *C. scrobiculatus* Midd. from California) probably belongs to this genus, but the descriptions and figures are not sufficiently clear to have admitted of their identification up to the present time. The character most emphasized by Middendorf in *C. lividus* is a keystone-like projection filling the anterior sinus between the two sutural laminae. The specimen on which the description was based was a very small and perhaps immature creature, with faint sculpture, somewhat recalling *Mopalia Hindsii*.

*Extra-limital Species.*

*Trachydermon cinereus*.

*Chiton cinereus* (Lin.) Lowe, Zoöl. Journ. ii, p. 99, 1825.—Forbes & Hanley, Brit. Moll. ii, 402, pl. lviii, fig. 1, 1853 (not of Sars).

*Trachydermon marginatus* Cpr. New Engl. Chitons, l. c. p. 153, 1873.

*Craspedochilus marginatus* Sars, l. c. p. 115, t. 20, f. 16 a-h, t. II, f. 2, 1878.

*Hab.*—British and Scandinavian seas, north to Lofoten, south to Vigo Bay, between tides and to the Laminarian zone. Type of the genus.

*Trachydermon denticens*.

*Chiton denticens* Gld. Otia, pp. 6, 242, 1862.

*Ischnochiton (Trachydermon) pseudodenticens* Cpr. Suppl. Rep. l. c. p. 649, 1863.

*Hab.*—Puget Sound and Vancouver Island.

The fact that the "teeth" are merely peculiar color-marks does not render it necessary to dispense with the original name of Dr. Gould.

Subgenus TRACHYRADSLIA Cpr. MSS.

*Trachydermon*, valvis centralibus bi- seu pluri-fissatis. Type *Chiton fulgetrum* Reeve.

*Trachyradsia aleutica*.

*T. aleutica* Dall, Proc. Nat. Mus. p. 1, Jan. 1878.

T. t. parvâ, rufocinereâ, oblongâ, fornicata, jugo acutissimo; mucrone

submediano, apicibus prominentibus; ar. lat. inconspicuis; totâ superficîe quincuncialiter minute reticulatâ; *intus*, v. ant. 16, post. 11, centr. 2-fissatâ; dent. parvis perspongiosis, late separatis; subgrundis spongiosis, curtis; sinu parvo; *zonâ* squamulis minutis obsitâ. Lon. 6, Lat. 3 mm.

*Hab.*—Kyska Harbor, Kyska Id. Constantine and Kiriloff Harbors, Amchitka Island, and Nazan Bay, Atka, in the Western Aleutians, at low-water mark, under stones on the beach, Dall! Fifteen examples.

This modest little species is of a dull livid purplish red, with an ashy tinge, especially on the narrow girdle. Except for the well-marked ridges of growth, it appears smooth, but possesses (like all Chitons) a fine reticulation, only visible under a magnifier. The lateral areas are not distinct, the back is very much rounded, and the valves well hooked in the median line. The substance of the valves from within appears remarkably spongy, as if rotten, or even like vesicular punice, especially under the eaves. The anterior slits are marked by radiating lines of holes, though the teeth between them can hardly be made out. The posterior valve, however, has not this aid to counting, and in the general sponginess it is almost impossible to say how many teeth or denticles exist. It bears no marked resemblance to any other species of the region.

#### Genus TONICELLA Cpr.

*Tonicella* Cpr. Bull. Essex Inst. v, p. 154, 1873. Type *T. marmorea* Fabr.

*Tonicia* sp. Adams, Gray, Cpr. and others.

< *Boreochiton* G. O. Sars, Moll. Reg. Are. Norv. p. 116, June, 1878.

Valvæ, mucro, laminae et sinus plerumque ut in *Ischnochiton*; *zonâ* ut in *Tonicia*, coriacea, laevis, seu sublævis: branchiæ mediæ.

The genus *Tonicia* Adams and Gray, to which the species of *Tonicella* have often been referred, has pectinated insertion-plates and ambient gills like the typical Chitons, while *Tonicella* has sharp plates and short rows of gills. The two groups also differ in their dentition. The major lateral of *Tonicella* is strongly tridentate; in *Tonicia* the cusp of the major lateral is scoop-shaped, rounded, with a plain edge, and the radula recalls that of *Chiton* (typical) and *Corephium*. Prof. Sars appears to have been unaware of Dr. Carpenter's publication on the New England Chitons.

#### *Tonicella marmorea*.

*Chiton marmoreus* Fabricius, Fann. Grönl. 420, 1780.—Midd. Mal. Ross. i, p. 103, 1847; Sib. Reise, 182, 1851.—Forbes & Hanley, Brit. Moll. ii, p. 414, pl. lviii, f. 2, pl. lix, f. 4, 1853.—Jeffreys, Brit. Conch. iii, p. 227, 1865, v, p. 199, pl. lvi, f. 7, 1869.

*Chiton ruber* Spengler, Skrift. Nat. Selsk. iv, p. 92, 1797.—Lovén, Ind. Moll. Scand. p. 28, 1846; not of Linné.

*Chiton lavigatus* Fleming, Edin. Encycl. p. 113, t. vii; Brit. An. p. 290, 1828.—Reeve, Conch. Icon. Chiton, pl. 27, f. 179, 1847.

? *Chiton punctatus* Ström (Jeffreys)?, Acta Nidr. iii, p. 433, t. vi, f. 14.

**Tonicella marmorea.**

- Chiton latus* Lowe, Zool. Journ. ii, p. 103, pl. 5, f. 6-7, 1825.—Sowerby, Conch. Ill. Chiton, f. 113, 1839.
- Chiton fulminatus* Couthouy, Bost. Journ. Nat. Hist. ii, p. 80, pl. 3, f. 19, 1838.—Gould, Inv. Mass. i, p. 148, f. 3, 1841.
- Chiton pictus* Bean, Thorpe's Brit. Mar. Conch. p. 264, pl. —, f. 56, 1844.
- Chiton Flemingius* Leach, Moll. Gt. Brit. p. 230, Dec. 1852.
- Tonicia marmorea* H. & A. Adams, Gen. Rec. Moll. i, p. 474, 1854.
- Tonicella marmorea* Carpenter, Bull. Essex Inst. v, p. 154, 1873.
- Borcochiton marmorcus* G. O. Sars, Moll. Reg. Arct. Norv. p. 116, t. 8, f. 3 a-l, t. II, f. 4 (not good), 1878.

T. t. elongatâ, valvis ut in "*Trachydermon ruber*" picturata; zonâ coriaceâ, expansâ, lævi; intus, v. post. 8-9, v. ant. 8-10, v. centr. 1-fis-satâ; sinu angusto, altiore, lævi. Lon. 40, Lat. 24 mm.

*Hab.*—Aleutian Islands, 8-10 fms., rare; east coast of North America from Massachusetts Bay northward to Greenland; every part of the North Atlantic north of Great Britain, and as far south as Dublin Bay on the west and the shores of Holland on the east; in 5-100 fathoms, according to temperature.

This well-known species has almost exactly such a color-pattern as *Trachydermon ruber*, and in dry specimens the pilose girdle of the latter is the most convenient means of distinction. A comparison of European with Greenland specimens shows that the latter are usually more elevated, and the posterior valve has usually seven slits instead of eight or nine. This form, of course, is the typical one; those from Europe may perhaps retain the varietal name of *T. latus* Lowe. The Alaskan specimens, as is often the case with mollusca of this region, are more like European than East American specimens, and in the fresh condition exhibit a very broad, smooth, yellowish girdle, sometimes as wide on each side of the valves as the whole width of the shelly part. Otherwise they agree with Norwegian specimens. The measurements given above are for the very largest; they average about an inch in length. It doubtless extends to the Arctic Ocean on the shores of Alaska, though all our specimens happened to come from the Aleutians.

Jeffreys states that this may be identical with *C. punctatus* Ström, but the name would be an evident misnomer, as it is in no way punctate, and the identification requires further confirmation.

Middendorf found a variation in the number of anterior slits, being five to seven, and in posterior slits six to nine, in all, in the specimens he examined, which came from the White Sea and Arctic coast of Russian Lapland.

An attempt has been made to identify this species with *C. ruber* Lin., but the examination of the Linnean Chitons by Mr. Hanley has left this theory no sound foundation, and it hardly requires further notice.

The gill-rows of this species extend forward three-quarters the length of the foot, and each contains twenty to twenty-five branchiæ. Mantle-edge plain, inconspicuous, very narrow. The margin of the muzzle is



pucker up in front, with the posterior corners produced into lappets. There is no veil. Oviducts not clearly made out. The ovarian openings are simple and close on each side of and a little behind the anus, from which a ridge extends in front of them on each side. But there appear, also, to be two openings in the vicinity of the fourth or fifth branchia from the posterior end of the gill-rows, one on each side. The contracted condition of the specimens, from the effect of the alcohol in which they were preserved, prevented a satisfactory confirmation of these appearances.

**Tonicella lineata.**

*Chiton lineatus* Wood, Gen. Conch. p. 15, pl. 2, f. 4-5, 1815.—Midd. Mal. Ross. i, p. 109, t. xii, f. 8-9, 1847.—Reeve, Conch. Icon. Mon. Chiton, pl. vii, f. 33, 1847.

*Tonicia lineata* H. & A. Adams, Gen. Rec. Moll. i, p. 474, 1854.

*Chiton (Hamachiton, Stenoscomus) lineata* Midd. Mal. Ross. i, p. 34.

*Tonicella lineata* Carpenter, MS.

T. t. mucrone antice mediano, satis elevato; intus, v. ant. 9-12-, v. post. 8-10-, v. centr. 1-fissatâ; dent. obtusioribus (t. jun. acutis), posticis curtioribus, vix interdum rugulosis; subgrundis curtis, spongiosis; sinu angusto, alto, lævi, angulato; branchiis medianis; testâ externâ subelevatâ, tegmentum læve, areis lateralibus vix distinctis; flavum aut fuscum, lineolis albis pictum, zonâ coriaceâ, oculo nudo lævis. Lon. 30, Lat. 15 mm. Div. 120°.

*Hab.*—From Bering Strait south, on both coasts; westward to Japan and the Okhotsk Sea; eastward to the Bay of Monterey, California, and including the whole Aleutian chain; low water to 60 fathoms. Two hundred and eighty specimens examined of the typical form.

The painting of this very characteristic species is very variable, even on different valves of the same individual. Nothing can appear more distinct than the coloration of typical specimens of some varieties, but in a large series the differences do not hold equally good. The number of slits is also somewhat variable, occasional abnormal or injured specimens having only six or seven slits in the tail-valve. But fine and normal specimens of both varieties show no more than individual variations.

Middendorf, while pointing out the distinctions between the following species and *T. marmorea*, appears to have overlooked the connection between the former and *T. lineata*, and his description does not always agree with his figures.

From *Tonicia lineolata* Sowerby, from South America, beside the internal generic characters, the exterior differs by the absence of punctures and raised granules at the sides.

*T. submarmorea* is further distinguished from *lineata* by the somewhat raised lateral areas, which are hardly perceptible in the present form. It is one of the handsomest Alaskan Chitons. The southern specimens, especially those from Monterey, generally have the yellow and brown lines marginated with blue, which produces a peculiar color-effect.

The gill-rows extend forward two-thirds the length of the foot. They contain about twenty-seven branchiæ on each side. The mantle-edge is very narrow, hardly distinguishable around the head. There is no veil. The edge of the muzzle is margined all around, and drawn into flaps at the posterior corners.

**Tonicella submarmorea.**

*Chiton submarmoreus* Midd. Bull. Acad. Sci. St. Pétersburg, iv, No. 8, 1846; Mal. Ross. i, p. 98, 1847; Ib. Sib. Reise, p. 178, pl. xiv, f. 7-10, xv, f. 7-8, 1851.

*Chiton insignis* Reeve, Conch. Icon. Mon. Chiton, pl. xxii, No. 149, f. 148, 1847.

T. t. ut in forma præcedente, sed testâ externâ ex rosea flavoque alba, maculis flammulisque sed rufis, sed albis pictâ; tegmentum zonæ leviusculum, nitidulum, flavum aut fuscum pictum.

*Hab.*—Japan and the Okhotsk Sea, Aleutian Islands to Sitka and Fuca Strait. It has not been found north of the Aleutians or south of Washington Territory.

In the description of this form, Middendorf, in distinguishing it from *T. marmorea*, seemed to overlook its relations to *T. lineata*, from which, for some time, I was indisposed to specifically separate it. The peculiar color of the valves is reproduced sporadically on some valves of *T. lineata* in occasional specimens; though these may be due to hybridization. The dentition, elsewhere figured, indicates, however, that the two forms are specifically distinct. The soft parts are very similar to those of *T. marmorea* in every respect except that the openings near the anus were absent. The specimen was a male, and the structure of the spermsac recalled that of *Aemœa*. Some of these differences may be sexual; at all events, the subject requires investigation from living specimens.

**Tonicella saccharina.**

*Tonicella saccharina* Dall, Proc. Nat. Mus. p. 2, Jan. 1878.

T. t. parvâ, oblongâ, totâ superficie saccharinâ rufo et albescente pictâ; mucrone submediano, inconspicuo; ar. lat. inconspicue elevatis, ar. dors. sanguinosis, æque quincuncialiter lente reticulatâ; v. ant. 10-11-, v. post. 8-10-, v. centr. 1-fissatâ; dent. parvis, spongiosis; sinu parvo; subgrundis spongiosis, medioeris; zonâ coriacea ut in *Tonicellæ* aliis. Branchiis mediis. Lon. 6.5, Lat. 4 mm.

*Hab.*—Aleutian and Shumagin Islands; Kyska, Unalashka, and Koniushi, 3 to 13 fathoms on stones! St. Paul, Pribiloff Ids., 15 fathoms. Seven specimens examined.

This interesting little species has the lustre of rock-candy, through which the microscopic reticulation is barely perceptible. It is marked, in all the specimens obtained, by the red wine colored dorsal areas contrasted with a waxy white color of the lateral areas, rendering its recognition easy. The girdle is dark, leathery, narrow, slightly pubescent,

and furnished at its extreme margin with a fringe of fine spiny hairs or spicules, as in *T. marmorea*.

? **Tonicella Sitkensis.**

*Chiton Sitkensis* Midd. Bull. Acad. Sci. St. Pétersb. vi, p. 121, 1846; Mal. Ross. i, p. 112, t. xiii, f. 1-2, 1847.

*Tonicia Sitkensis* H. & A. Adams, Gen. Rec. Moll. i, p. 474, 1854.

Not *Chiton Sitkensis* Reeve, Conch. Icon. sp. 55, 1847.

?*T. t. externa* depressa; tegmentum læviusculum, arcis lateralibus indistinctis, sub lente sparsim granulosum, rubicundum; limbi læviusculi epidermis zonalis submicroscopio stroma exhibet spinulis latentibus erectis munitum; v. ant. 8-, v. post. 10-, v. centr. 1-fissata; branchiæ posticæ, paræ, no. circ. 24. Lon. 10, Lat. 6 mm. Div. 130°.

*Hab.*—Sitka, one specimen (Midd.).

The above species described by Middendorf, if not a variety of one of the others, has not yet been identified or collected by any other naturalist. His description differs very much from his figures, while the anterior teeth are figured as grooved outside; if correct, an unusual character. It is said to be nearest to *T. submarmoreus*, and may well be a young specimen of one of its numerous varieties.

Genus SCHIZOPLAX Dall.

*Schizoplax* Dall, Proc. Nat. Mus. p. 2, Jan. 1878.

*Tonicia* sp. H. & A. Adams.

*Schizoplax* Cpr. MS. (subgenus of *Tonicella*).

Testa et zona Tonicellæ simulans; valvæ centrales sulco jugali medi-ano, anteo argute incisæ; branchiæ subambientes.

For this remarkable form, which is distinguished from all other known Chitons by the median slit in all the central valves, I propose to adopt the MS. name suggested by Dr. Carpenter on Middendorf's figures, raising its value, however, to the rank of a genus. The specimens obtained by us appear to be the first obtained by any one since the original specimens of Middendorf.

**Schizoplax Brandtii.**

*Chiton Brandtii* Midd. Bull. Acad. Sci. St. Pétersb. vi, p. 117, 1846; Mal. Ross. i, p. 128, 1847.

*Chiton (Hamachiton, Stenosemus) Brandtii* Midd. Sib. Reise, p. 174, t. xv, f. 1-6, 1851.

*Tonicia Brandtii* H. & A. Adams, Gen. Rec. Moll. i, p. 474, 1854.

*Schizoplax Brandtii* Dall, Proc. Nat. Mus. p. 2, Jan. 1878.

*S. t. ovali*, longiori, angustiori, satis elevatâ; jugo rotundato; olivaceo-fusca, cæruleo seu strigatâ, seu maculatâ seu nebulosâ; sæpe irregulariter castaneo; mucrone centr. irregulariter subplanato; v. post. omnino satis regulariter excurvatâ; ar. jug. nonnisi colore definitis, ar. lat. vix definitis, totâ superfâcie læviore, sub lente conspiciue quine. granu-

latâ; zona angusta, olivaceo-cinereo maculatâ, confertim spinulis minutis ornata, oculo nudo sublevis; submicroscopio epidermis dorsalis pubescens, stroma spinulis rarioribus latentibus erectis; mucro indistinctis in summa tamen linea mediana valvarum intermediarum superne sulcus decurrit linearis, longitudinalis, argute incisus; sinu jugali modico, alto, haud laminato, conspicue spongiosa, subgrundis minimis, maxime spongiosis; v. ant. 11-, post. 11-, centr. 1-fiss. Branchiæ circ. 22, subambientes. Lon. 16, Lat. 5 mm. Div. 140°.

*Hab.*—Shantar Bay, Okhotsk Sea, Midd.; Aleutian Islands eastward to Sitka Harbor, low water to 12 fathoms on stones and shells; Dall! Ninety-three specimens examined.

This very remarkable species is very prettily marbled with olive, chestnut, and blue; the girdle generally dark olive, dashed with ashy spots and in fine specimens having a pubescent appearance. The slit is occupied by a cartilaginous substance of a dark brown color, most visible from within. The branchiæ appear to reach nearly to the head. It is quite possible that it may reach as far south as Puget Sound.

The soft parts are yellowish white. The gill-rows extend three-fourths of the length of the foot forward from their posterior termination, and each contains about twenty-two branchiæ. Mantle-edge thick, plain; veil small, plain. Muzzle small, plain, with two large squarish lappets at the posterior corners. The supposed oviducts open on each side through a small rounded papilla in the vicinity of the third or fourth branchia counting forward, and between the line of the gill-row and the side of the foot.

### Genus CHÆTOPLEURA Shuttleworth.

*Chætopleura* Shuttlew. Bern. Mitth. Juni 1853. Type *Chiton Peruvianus* Lam.

<*Chætopleura* H. & A. Adams, Gen. Rec. Moll. i, p. 475, 1854.

<*Acanthopleura* Gray, P. Z. S. 1847, p. 67.

Testa *Ischnochitoni* similis; zonâ plus minusve pilosâ. Branchiæ ambientes.

#### *Chætopleura Hartwegii*.

*Chiton Hartwegii* Carpenter, P. Z. S. 1855, p. 231.

*Trachydermon Hartwegii* Cpr. Suppl. Rep. Br. Assoc. 1863, p. 649.

*C. t.* colore olivaceo, cinereo seu rufo-fusco seu cupreo-viridi, sæpe eleganter maculoso; intus, intense cæruleo-viridi; mucrone mediano satis elevato; valvis singulis tumentibus, eleganter arcuatis, apicibus conspicuis, suturis marg. distinctis; ar. diag. haud nisi costis tumentibus subobsoletis discernendis; totâ superficie super granulis minimis, sub lente solum distinguendis, granis parvis ubique sparsis; super ar. diag. et v. term. granis majoribus irregulariter verrucosis; intus v. post. 9-12-, ant. 10-11-, centr. 1-fissatis; dent. solidis, obtusis, interdum subru-



gulosis, valde separatis; subgrundis spongiosis, parum extantibus; sinu alto, lato, planato, spongioso, haud laminato; paginâ internâ callosâ; zonâ fuscâ, minutissime granulosâ, inter granulas setis pellucidis minimis huc et illic decurrentibus. Lon. 25, Lat. 16 mm. (Cpr. MS.)

*Hab.*—Columbian Archipelago, probably reaching the southern borders of Alaska, and southward to Magdalena Bay, Lower California. Forty specimens examined.

This species having been originally described from imperfect specimens, I insert Dr. Carpenter's amended diagnosis. It has not occurred in our collections, but being abundant in the Vancouver region, doubtless occurs in Southeastern Alaska. It is an aberrant species, and at some time may require to be separated from the genus to which Dr. Carpenter and myself have provisionally referred it.

#### *Chætopleura Nuttallii.*

*Chiton Nuttallii* Cpr. P. Z. S. 1855, p. 231.

*Trachydermon Nuttallii* Cpr. Suppl. Rep. Br. Assoc. 1863, p. 649.

*C. t.* mucrone satis planato; intus v. post. 11-, ant. 8-, centr. 1-fissatâ; aliter ut in *C. Hartwegii* formatâ.

*Hab.*—With the last, also probably in Alaska.

All the specimens examined appear to differ from *C. Hartwegii* in the broad non-swelling valves, squared at the sides, and not beaked or waved. It may yet prove merely a variety. The characters of the mantle and interior are aberrant, as in the last species.

### Genus ISCHNOCHITON.

*Ischnochiton* Gray §\*, P. Z. S. 1847, pp. 126-7.

*Lepidopleurus* Ad. Gen. Rec. Moll. i, 471, 1854.

Testa tenuior; lam. insert. regulares, acutæ, nec pectinatæ nec serratæ; subgrundæ majores; sinus plerumque lævis; zona squamosa, squamis plerumque striatis; branchiæ elongatæ. (Cpr.) Type *I. longicymba* Quoy.

The main character of this genus, which includes by far the largest number of species of any single group of Chitons, consists in the row of sharp smooth insertion-teeth, surrounded by more or less projecting eaves, as first described by Dr. Carpenter in the Mazatlan Catalogue (p. 194), and in the scaly girdle. Dr. Carpenter has divided the group by its minor characters into the following subgenera:

1. *Stenoplax* Cpr ..... *C. limaciformis* Sowerby.  
Body elongate. Scales elongate, chaffy, striated, irregular, and crowded.
2. *Stenoradsia* Cpr ..... *C. magdalenensis* Hinds.  
Like *Stenoplax*, with numerous side-slits.
3. *Ischnoplax* Cpr ..... *C. pectinatus* Sowerby.  
Like *Stenoplax*, but with occasional large scales rising above the rest, and a multitude of short striated bristles. Mucro raised, subposterior.

4. *Heterozona* Cpr.....*H. cariosa* Cpr.  
Body elongate; two kinds of rather solid, striated scales.
5. *Ischnochiton* (restricted) Cpr.....*C. longicymba* Quoy.  
Scales transverse, flattened, somewhat imbricated, generally striated.
6. *Ischnoradsia* Cpr. ex Shuttleworth ..... *C. dispar* Sowerby.  
Scales striated. Central valves with many slits.
7. *Lepidopleurus* Cpr ..... Ex *C. Mertensi* Midd.  
Scales solid, imbricated, smooth.
8. *Lepidoradsia* Cpr....., *C. australis* Sowerby.  
Similar to the last, with many slits in central valves.

The only Alaskan species of the restricted subgenus, so far as known, is the following form.

**Ischnochiton interstinctus.**

*Chiton interstinctus* Gould, Moll. U. S. Expl. Exp. p. 322, pl. 27, f. 423, a, b, 1852.  
*C. (Leptochiton) interstinctus* Gould, Otia, p. 230, 242, 1862.  
*Callochiton interstinctus* H. & A. Adams, Gen. Rec. Moll. i, p. 471, 1854.  
*Trachydermon interstinctus* Cpr. Suppl. Rep. Br. As. 1863, p. 649.  
*Ischnochiton interstinctus* Cpr. MS. 1871.

I. t. mucrone antice mediano, satis elevato; *intus* v. post. 12-, ant. 10-, centr. 1-fiss.; dent. acutis; subgrundis modicis; sinu lato, planato; *zonâ* squamulis subovalibus, tenuissime striatis. Lon. 17, Lat. 7 mm. Div. 110°.

*Hab.*—Sitka Harbor, 12 fathoms, mud and gravel! south to Monterey and the Santa Barbara Islands, California. Eighty-seven specimens examined.

This is a modest little species of a dark red color, mottled with light about the jugum. The riblets are somewhat broken into tubercles by the lines of growth. It appeared to be very abundant at Sitka in the locality where it was found. There are no other species likely to be confounded with it in this district.

The gill-rows are nearly as long as the foot. The muzzle is produced into lappets at the corners. No data in regard to the fenestræ could be obtained from the dry specimens.

**Ischnoradsia trifida.**

*Trachydermon trifidus* Cpr. Suppl. Rep. Br. As. 1863, p. 649; Proc. Phil. Acad. Nat. Sci. 1865, p. 60.

I. satis magnâ, satis elevatâ, regulariter ovali; rufo-castaneâ, pallidiore et intensiore maculatâ; jugo acutiore, gothico; mucrone mediano, planato; totâ superficie vix minutissime granulatâ; ar. centrali lineis transversis, jugo perpendicularibus circ. VIII altissime punctatis; ar. lat. valde definitis, costis obsoletis II-IV, interdum ad interstitiis punctim-depressis; *intus*, pagina internâ albido-carneâ, radiis II rufo-purpureis ab umbonibus planatis divergentibus; v. post. 13-, v. ant. 13-, centr. 2-fissatis, dentibus acutis interdum ad margines serratis, interdum extus striatis sed interdum normaliter levibus; subgrundis conspicuis sub-

spongiosis; sinu minore, laminato, laminâ atroque latere et interdum in medio fissatâ; zonâ squamulis perparvis, solidioribus, irregulariter instructis levibus, instructâ; branchiis fere ambientibus, per valvas VI posticus continuis. Lon. 40, Lat. 26 mm. Div. 135°.

*Hab.*—Sitka, Port Etches, 9–18 fms., gravel, rare; south to Puget Sound. Six specimens examined.

This rare and fine species is not particularly handsome, being of dull and livid colors, but is peculiarly characterized by the straight transverse ribs on the dorsal areas, with spongy interspaces, and by the pretty regular division of the lateral areas into three well-marked radiating costæ, which are separated in the insertion-plate by two fissures. No other species of the region resembles this in sculpture. Muzzle with a pectinated margin in front produced into rounded lappets at the corners. Gill-rows as long as the foot, containing each 28–35 branchiæ. Veil absent. Mantle-edge plain, narrow. There is a small spherical lump on each side of the girdle just behind the posterior ends of the gill-rows, which are turned out toward the girdle and widely separated behind. The anus is large, median, and crenate, opening on the upper part of the hinder end of the foot. No ovarian openings could be detected, and the species presents some peculiarities which call for further research with more material.

#### Subgenus LEPIDOPLEURUS s. s. Cpr.

##### *Lepidopleurus Mertensii*.

*Chiton Mertensii* Midd. Bull. Ac. Sci. St. Pétersb. vi, p. 118, 1846.

*Chiton* (*Phanochiton*, *Hamachiton*, *Stenosemus*) *Mertensii* Midd. Mal. Ross. p. 34, 125, pl. xiv, f. 1–3 a–h, 1847.

*Leptochiton Mertensii* H. & A. Adams, Gen. Rec. Moll. i, p. 473, 1854.

L. t. colore rubido, interdum intensiore nebuloso; mucrone subcentrali, laud elevato; *intus* v. term. 9–12-, centr. 1 fiss.; dent. acutis; subgrundis majoribus; sinu lato, planato, lævi; *zonâ* rubidâ seu pallidiore, squamis ovoideis, nitentibus, levibus vix regulariter confertissime imbricatâ. Lon. 20, Lat. 6 mm. Div. 100°.

*Hab.*—Sitka and vicinity, south to Monterey, Cal. Many specimens examined.

Middendorf's description and figures of this shell do not agree well together. Its fine red color, sharp and prominent sculpture, usually free from erosion or nullipore, and beautifully shining and regular scales, render this one of the most attractive and easily recognized of the Alaskan Chitons. There are no others in that region likely to be confounded with it. It rarely shows a white valve or a dash of white on some of the valves.

The soft parts of this species are whitish. The anus is on a papilla. Mantle-edge narrow, granulose, forming on each side behind the last branchia a rounded lump or tumor. Near this the ovarian openings were thought to be detected. Muzzle semicircular, cornered behind on

each side. No veil. Gill-rows three-quarters as long as the foot, each containing about forty branchiæ.

(In *Lepidoradisia australis*, the gill-rows were found to extend the whole length of the foot, and to contain forty-seven branchiæ in each. Mantle-edge plain, thin; muzzle plain, semicircular, without a veil; the ovarian openings situated close on either margin of the anus.)

## ACANTHOIDEA.

### Genus NUTTALLINA Cpr. MS.

Loricâ elongatâ, valvis antice projectis; mucro posticus, elevatus; laminae acutæ, læves, (nisi v. post.) elongatæ; v. centrales bifissatæ; sinus haud laminatus, planatus; zonâ spinosâ.

From *Acanthopleura* this genus differs in the smoothness of the sharp teeth, in their great length and Radsioïd slitting; in the thrown-back mucro, which often projects beyond the margin; in the throwing forward of the rest of the shell, as in *Katherina*, and in the deep spongy flat sinus which interrupts the sutural laminae. The name is given in honor of the late Thomas Nuttall, Esq., once professor of natural history at Harvard College, and the original discoverer of the typical species, as well as many others of the shells and plants of California. (Cpr.)

#### **Nuttallina scabra.**

*Chiton scaber* Reeve, Conch. Icon. Mon. Chiton, pl. xvii, f. 103, 1847.

*Chiton californicus* (Nutt. MS.) according to Carpenter.

Not *Chiton californicus* (Nutt. MS.) according to Reeve.

*Acanthopleura scabra* Cpr. Suppl. Rep. Br. Assoc. 1863, p. 649.

N. t. mucrone postico, sed haud terminali, maxime trans marginem posticum elevato; v. post. 7-8-, v. ant. 10-11-, centr. 2-fissatis; dent. acutis, lævibus, (nisi postice) prælongis, antice valde projectis; valvis centralibus dent. post. minoribus; subgrundis parvis, haud sulcatis; sinu altissimo, lato, planato, spongioso, haud laminato; zonâ latâ crassâ; spinis testaceis curtioribus densissime obsitâ. Lon. 36, Lat. 10 mm.

*Hab.*—Vancouver district, south to California, probably in the southern islands of Alaska; at and above high-water mark, in crevices of the rocks; at Monterey abundant.

This singular species, not yet obtained from Alaska, but which will probably be found there, like some Litorinas, seems habitually to prefer positions where it can at most be reached by the spray in storms, on exposed headlands, where the breeze comes in damp and cool from the sea. The pointed valves overlap each other so much that when the creature is curled up they project from the girdle, giving a pectinated outline, unusual in Chitons. The valves are almost always eroded, even the prominent mucro is often hollowed out, and the sculpture can rarely be seen except in young specimens. The color is grayish or brownish, with whitish streaks; the girdle has the aspect of dead brownish-black moss, sometimes with ashy spots at the sutures.



## ORDER DOCOGLOSSA.

## Suborder ABRANCHIATA.

## Family LEPETIDÆ.

## Genus LEPETA Gray.

*Lepeta* Gray, P. Z. S. 1847, p. 168.—Dall, Am. J. Conch. v, 1869, p. 140.

## Subgenus LEPETA Dall ex Gray.

*Lepeta* Dall, Mon. Fam. Lepetidæ, Am. J. Conch. v, 1869, p. 141.

**Lepeta cæca.**

*Patella cæca* O. F. Müller, Prodr. Zoöl. Dan. 1766, p. 237; Ib. Zoöl. Dan. i, p. 12.

*Lepeta cæca* Gray, P. Z. S. 1847, p. 168.—Dall, l. c. p. 141, pl. 15, f. 4. (Type.)

*Hab.*—In Alaska, in 23 fathoms, off the Sea Horse Islands, near Point Barrow, Arctic Ocean north from Bering Strait (Smith! 3 specimens). Elsewhere, northern seas of Europe and Eastern North America generally, 10–100 fathoms (Sars); Massachusetts Bay northward, in America. In Europe northward from Danish waters; on the Norwegian coast; the Hebrides, etc.

This species has not been found, though reported, erroneously, south from Bering Strait on the Pacific side. Such references refer to *L. (C.) concentrica*. Jeffreys found it in six hundred and ninety fathoms off Holsteinborg in Greenland, and it ranges from that depth to a few fathoms. That it has a curved, nearly spiral, deciduous nucleus when very young, was announced by me in 1869, and is confirmed by Dr. Jeffreys in his Report on the Mollusca of the Valorous Expedition. It is the *Patella candida* of Couthouy, *P. cerea* of Möller, and probably the *Lepeta Franklini* of Gray MSS.

## Subgenus CRYPTOBRANCHIA Dall ex Midd.

*Cryptobranchia* Midd. (pars), Sib. Reise, p. 183, 1851.—Dall, Mon. Lepetidæ, l. c. 1869, p. 143.

The name *Cryptobranchia* was previously used by Gray, Fleming, and Deshayes for different groups of mollusks of family or greater value, but has in none of these cases been used or adopted by other naturalists, and hence was not preoccupied for the group of Middendorf.

**Cryptobranchia concentrica.**

*Patella (Cryptobranchia) cæca*, var.  $\beta$  *concentrica*, Midd. Sib. Reise, p. 183, pl. xvi, f. 6, 1851.

*Cryptobranchia concentrica* Dall, l. c. p. 143, pl. 15, f. 2 a-f.

*Lepeta cæcoides* Cpr. Suppl. Rep. Br. As. 1863, pp. 603, 651.

*Hab.*—North Japan, Stimpson! Schrenck!, eastward throughout the Aleutians, along the southern coast of Alaska (Dall!), British Columbia

(Fisher!) to Puget Sound, W. T. (Swan and Kennerly!). Abundant from low water to eighty fathoms on stones and shells, sometimes attaining the length of an inch, but usually about four-tenths of an inch long. Five hundred and twenty-seven specimens examined.

This is the largest and most abundant species of the family. In it, beside differences in dentition, the apex is simply pointed or blunt, not deciduous, as in the typical *Lepeta*. The sculpture is usually faint, but sometimes raised in beautiful concentric frills, from which the name was derived. Small specimens from slight examination have been quoted as *L. cava* by authors. It has not yet been found north of the Aleutians.

**C. concentrica** var. *instabilis*.

? *Cryptobranchia instabilis* Dall, l. c. p. 145, pl. 15, f. 6.

I am now convinced that the provisional name which I applied to this singular form is only of varietal value. It seems, from later specimens, to be a form which, from living on the stalk of *Nercoecystis*, has become peculiarly arenated and greatly thickened, much like *Aemaea instabilis*, which has the same habit. It has only been found at Sitka in small numbers, dead, in 10-15 fathoms.

**Cryptobranchia alba**.

*C. alba* Dall, l. c. p. 145, pl. 15, f. 3 a-d, 1869.

*Hab.*—Plover Bay, E. Sib., Dall! Seniavine Straits, Stimpson! Akutan Pass, Aleutian Islands, Dall! Dead on beach. Alive at sixteen fathoms, gravel. Twenty-four specimens examined.

This species appears to fill the gap between the distribution of *L. cava* and *C. concentrica*. It is easily distinguished from the latter by its smooth surface and rounded apex and back, beside anatomical characters. It rarely reaches nearly an inch in length, and is of the purest whiteness.

*Extra-limital Species.*

Subgenus **PILIDIUM** Forbes.

*Pilidium* Forbes, Athenæum, Oct. 6, 1849, p. 1018.—Forbes & Hanley, Brit. Moll. ii, p. 440, 1849; not of Middendorf, Sib. Reise, p. 214, 1851.—Dall, l. c. 1869 (synonymy, etc., in full).

*Iothia* Gray, not Forbes, 1854 (cf. Dall, l. c. 1869).

*Tectura* Jeffreys, 1865, not of Gray (1847), nor of authors.

*Scutellina* Chenu (pars), Sars, not of Gray, 1847.

**Pilidium fulvum**.

*Patella fulva* O. F. Müller, Prodr. Zool. Dan. p. 227, 1776.

*Pilidium fulvum* Forbes, Athenæum, l. c. Oct. 6, 1849.—Dall, l. c. 1869.

*Pilidium rubellum* Stm. Checklist Sh. N. Am. E. Coast, No. 312, 1865.

*Tectura fulva* Jeffreys, Br. Conch. iii, p. 250, 1865.

*Patella forbesii* J. Smith, Wern. Soc. Mem. viii, p. 107, pl. ii, f. 3.

*Scutellina fulva* G. O. Sars, Moll. Reg. Aret. Norv. p. 122, 1878.

*Hab.*—Northern and Arctic seas of Eastern America and Europe; doubtfully reported from the Adriatic, where, if it be correctly identified,

it is probably the remnant of a polar colony, like that in the Gulf of Lyons. It ranges from five to one hundred and fifty fathoms.

This species, like *Cryptobranchia*, has a rounded non-spiral apex. When the Arctic shores of Alaska are more carefully searched, it may turn up there; but it does not seem to be a common species anywhere.

The name *Pilidium* has been used for a stage in the larva of certain invertebrates, but not as having an assured standing in systematic nomenclature. I see no reason, therefore, why it should be replaced by any other. It is hardly necessary to point out that it does not belong even to the same family as the *Tectura* of most authors, though erroneously called *Tectura* by Adams and others. It was sent by Möreh, under the name of *Patella rubella* Fabr., to Dr. Stimpson, which led him and the writer to erroneously unite that species (which is an *Acmæa*) with the present one in 1865 and 1869. To Prof. Sars is due the credit of pointing out the true place of the *P. rubella*. Clark speaks of finding the fry entangled in the mucus of the foot, but this can hardly be more than an accident.

## Suborder PROTEOBRANCHIATA.

### Family ACMÆIDÆ Cpr.

*Acmæide* Dall, l. c. p. 237, 1871.

#### Genus ACMÆA Eschscholtz.

*Acmæa* Esch. Appendix to Kotzebue's New Voyage around the World (Dorpat, 1825), London reprint, vol. ii, p. 350, 1830.—Dall, l. c. p. 237, 1871. Type *A. mitra*.

Having shown by evidence which cannot be successfully controverted, that the name of *Acmæa* has precedence in time of application over *Tectura* Aud. (*Tectura* Gray), no apology is necessary for following the lead of Forbes, Woodward, Hanley, Philippi, and Carpenter, in adopting the prior designation. Its very extensive synonymy will be found in my paper above quoted.

#### Subgenus ACMÆA Dall ex Eschscholtz.

*Acmæa* Dall, Am. J. Conch. vi, p. 241, 1871. Type *A. mitra* Esch.

*Erginus* Jeffreys, Ann. Mag. Nat. Hist. Mar. 1877, p. 231.

*Tectura* Sars, Moll. Reg. Aret. Norv. p. 121, 1878.

#### *Acmæa mitra*.

*A. mitra* (Esch.) Rathke, Zool. Atlas, v, p. 18, No. 1, pl. xxiii, f. 4, 1833.—Dall, l. c. p. 241, 1871, pl. 14, f. 1.

*Hab.*—Pribiloff Islands, Bering Sea, westward to Kyska in the Aleutians, and eastward and southward to Sitka, Oregon, and the coast of

California as far south as the Santa Barbara Islands, from low-water mark to eighty fathoms, Dall! Seventy-four specimens examined.

I showed in 1871 that this species has nothing in common with the genus *Scurria*, to which it has often been referred, except a very superficial resemblance of form of the shell. It is not very abundant anywhere. The partially striated variety *tenuisculpta* Cpr. has not been found in Alaska. *A. mitra* varies from white to pink or green, and is frequently covered with regular nodules or papillæ of nullipore, when it is *A. mammillata* of Eschscholtz. It is the most unmistakable shell of the genus, the members of the restricted subgenus *Acmæa* presenting a singular contrast with one another in respect to their shelly covering.

***Acmæa insessa.***

*Patella insessa* Hinds, An. Nat. Hist. x, p. 82, pl. vi, f. 3.

*Acmæa insessa* Dall, l. c. p. 244, pl. 14, f. 3.

*Hab.*—Sitka Harbor (one specimen), southward to San Diego, California, Dall! Thirty specimens, mostly from the beaches. It seems very rare in Alaska.

***Acmæa instabilis.***

*Patella instabilis* Gould, Proc. Boston Soc. Nat. Hist. ii, p. 150, 1846.

*Acmæa* (?) *instabilis* Dall, p. 245.

*Hab.*—Sitka, Fort Wrangell, very rare; southward to Vancouver (abundant), and Monterey, Cal. (rare); dead on beaches.

This species, like the last, lives on the stems of the giant fuci common to this coast, and I have never seen a fresh specimen with the soft parts. But a radula extracted from one by Mr. H. Hemphill, and kindly sent to me, enables me to say with confidence that it is a typical *Acmæa*.

*Extra-limital Species.*

***Acmæa rubella.***

*Patella rubella* Fabr. Fauna Grönl. p. 386, 1780.

*Pilidium fulvum* (pars) Dall, Am. J. Conch. v, part iii, 1869.

*Tectura (Erginus) rubella* Jeffreys, Ann. Mag. Nat. Hist. p. 231, Mar. 1877.

*Tectura rubella* G. O. Sars, l. c. p. 121, pl. 8, f. 5 a-b, pl. ii, f. 11, 1878.

*Hab.*—Greenland, Fabr., Möller, Jeffreys; Norway, in Finmark, Sars; 5 to 40 fathoms.

The shell is generally of a much more brilliant orange color than the *Pilidium*, with which it has been confounded. I am not sure that some very young and minute specimens of Limpets found in the Aleutian Islands may not belong to this species, but they are too small to determine their relations with any certainty.

It is unfortunate that Prof. Sars, while recognizing in part the characters which I used to separate this subgenus from *Collisella* in the genus *Acmæa* in 1871, should have applied the name *Tectura* to the true *Acmæas*, and used *Acmæa* for *Collisella*, in his very valuable work on the Arctic Mollusks of Norway; thus exactly reversing the original arrangement and inadvertently transgressing the laws of nomenclature.



*Acmæa virginea.**Patella virginea* Müller, Prodr. Zool. Dan. p. 227, 1776.*Acmæa virginea* Hanley, Br. Marine Conch. p. xxxii, 1844.*Tectura virginea* of authors.*Acmæa virginea* Dall, Am. J. Conch. vi, p. 243, 1871, q. v.

This species extends from Iceland and Northern Norway south to the Azores, but does not reach the shores of America. It ranges from low-water mark to sixty fathoms. The *Ancylus Gussoni* of Costa, which has been united with this species, belongs to the *Siphonariidae*.

## Subgenus COLLISELLA Dall.

*Collisella* Dall, Proc. Bost. Soc. Nat. Hist. Feb. 1871. (*Acmæa pelta* Esch.)*Acmæa* Sars, Moll. Reg. Aret. Norv. p. 120, 1878.

This group is distinguished by slight but constant external differences and by dental characters from the typical *Acmæas*. It comprises most of the Alaskan species as well as many from other parts of the world.

*Acmæa (Collisella) pelta.**A. pelta* Esch. Rathke, Zool. Atlas, v, p. 19, 1833.—Dall, l. c. p. 246, pl. 14, f. 6, 1871.*Tectura cassis* von Martens, Malak. Blätt. xix, p. 92, pl. 3, f. 9-10, 1872.

*Hab.*—Aleutian Islands and the southern coast of Alaska south and east to the Santa Barbara Islands, Cal., between or near tide-marks. Five hundred and ninety specimens examined from my own collection and many thousands in the field.

The numerous names which the variations of this species have received, and some account of its varietal forms, have been given by me in the paper alluded to. Only one of these forms, *A. pelta* var. *naelloides* D. (l. c.) seems sufficiently constant to deserve a separate name. In the examination of hundreds of these most variable shells, one's notions of the characters sufficient among them to constitute a species or variety become so enlarged as to receive little sympathy from those who know the group in question from a few specimens on a museum tablet. Constant field and museum experience for more than twelve years has only confirmed my conviction of the propriety of the views of Dr. Carpenter, on the west coast species, which have been expressed in his various publications. It is true that in selecting from simultaneously published names, if he had known at first all that we now know, perhaps a different selection might have seemed more judicious; but I agree with Dr. v. Martens that any change, now that those selections have become history, would be most objectionable, and not to be countenanced.

The strongly ribbed variety of *A. pelta*, which Dr. v. Martens has so well figured, and has identified with the *cassis* of the Zool. Atlas, appears to be the same. However, the Martensian shell (which I have represented by some magnificent examples) is so closely connected, specimen by specimen, with others nearly smooth, that I cannot admit that it requires or should receive a separate name, even if the identity were

proven. Other varieties, almost without number, might be selected from the series before me, which taken singly seem quite as distinct, and it seems preferable to err, if at all, in the matter of naming mere variations, on the side of conservatism.

**Acmæa (Collisella) persona.**

*Acmæa persona* Eschscholtz, Rathke, l. c. p. 20, pl. xxiv, f. 1-2, 1833.—Dall, l. c. p. 250, pl. 14, f. 8.

*Tectura digitalis* von Martens, l. c. p. 93, t. 3, f. 3-4.

*Tectura persona* Ib. l. c. p. 95, f. 5, 6.

*Hab.*—Adakh Id., Aleutians (one specimen), Shumagins, Cook's Inlet (Martens), Port Etches, and southward to California as far as the Santa Barbara Islands, between and sometimes above tide-marks. One hundred and twenty-eight specimens collected.

The varieties of this shell are often very beautiful, and, taken by themselves, apparently well marked; but in a large series these differences disappear in the general interchange of characters in a way which is impossible to fully realize without a very large series. The synonymy will be found in my paper above cited, and contains several variations much more striking than those separated by von Martens.

**Acmæa (Collisella) testudinalis.**

*Patella testudinalis* Müll. Prodr. Zool. Dan. p. 237, 1763.

*Collisella t.* Dall, l. c. p. 249, pl. 14, f. 13, 1871.

This well-known form was supposed by me to be pretty easily separable from *C. patina* Esch. in 1871, but the result of several years' additional study of the region about the Aleutian Islands has rudely shaken that cherished belief. There is a pretty constant difference in the relative size and proportion of the teeth on the radula of large and fully grown specimens; but of other characters (with seven hundred and thirty specimens before me of all sizes, ages, and localities) I find it impossible to formulate any. Dr. Carpenter at one time thought them distinct, but a re-examination by him resulted in his confessing his inability to distinguish one species from the other by the shells, and I can confidently assert that the exterior of the animals affords no characters whatever. Indeed, some of the varieties of what we have called typical *patina* are more different from the type than *testudinalis* can possibly claim to be. Specimens of adult *patina* from Sitka and the Aleutian Islands are indistinguishable from specimens of *testudinalis* of the same size from Eastport, Maine. It has been found impossible to rightly assort a mixed lot by every one who has tried it. I am therefore forced to divide the species as follows:

**Collisella testudinalis var. testudinalis.**

*Hab.*—In Alaska from the Arctic Ocean southward (on both sides of Bering Sea) to Sitka. On the eastern coast of America from Long Island Sound to the Arctic Ocean, Cumberland Gulf (Kumlein), and South Greenland. In Europe, it extends from the English Channel

northward to Finmark. In Asia, according to Schrenck, it reaches Yesso and the Tartarian coast. "Mexico" is quoted, ex B. M. tablet, by Jeffreys; of course due to ballast or some mixture of specimens or labels. North of the Pribiloff group, in Bering Sea, it appears to be the sole form of the genus.

**C. testudinalis var. patina.**

*Acmæa patina* Esch. Rathke, l. c. p. 19, pl. xxiv, f. 7-8, 1833.

*C. patina* var. *normalis* sive *pintadina* (Gld.) Dall, l. c. p. 247, pl. 14, f. 4, 1871.

*Tectura patina* Martens, l. c. p. 93, pl. 3, f. 7-8, 1872.

*Hab.*—Aleutian Islands, eastward and southward on the Alaskan side to San Diego, California. Six fathoms to high-water mark; usually between tides.

The characters assigned to *patina* by most naturalists are those of southern specimens (which were described as *Patella pintadina* by Gould), nineteen-twentieths of the specimens in museums having come from California.

In northern waters these distinctions are more or less obsolete, but on a comparison of Californian with Massachusetts Bay specimens it is very easy to draw the line between them, and this holds good for individuals as far as the Aleutians, but not for the generality.

**C. testudinalis var. alveus.**

*Hab.*—Sitka northward and elsewhere with the typical form in Atlantic seas, a variety formed the residence of the individual on a narrow frond of seaweed or *Zostera*. *Tectura alveus* of authors.

**C. testudinalis var. Cumingii.**

*Patella Cumingii* Reeve; Dall, l. c. p. 248.

*Hab.*—From the Pribiloff Islands southward with var. *patina*. Commonest toward Cook's Inlet, rare at the northern extreme of range and southward of Vancouver Island. Usually near low-water mark, and most frequently in isolated rocks washed by the surf.

**C. testudinalis var. ochracea.**

Dall, l. c. as var. *patina*, p. 249, pl. 17, f. 35.

Hitherto found chiefly in California, but reported from Vancouver Island by Hepburn; rare.

My largest specimen of var. *patina* is two and three-quarters inches long; another is an inch high. Every imaginable fluctuation in color, elevation, smoothness or striation, width in proportion to length, &c., may be found somewhere in the series before me. Yet, after uniting *patina* to the older form, there is a certain *facies* which distinguishes the species from any other with tolerable readiness. It is the commonest of all the species in Alaska and over the whole northwest coast of America.

***Acmaea* (*Collisella*) *peramabilis*.**

*A. peramabilis* Dall, Proc. Cal. Acad. Sci. iv, p. 302, Dec. 1872.

*Hab.*—Shumagin Islands, low water to six fathoms. Six specimens.

This most lovely species is most like some reddish varieties of *patina*, but none of them approach it in color, while numerous other features testify to its distinctness; which I have, as yet, seen no reason to doubt. It appears to be exceedingly local and rare, but all the specimens present a very uniform appearance.

***Acmaea* (*Collisella*) *sybaritica*.**

*Collisella sybaritica* Dall, Am. J. Conch. l. c. vi, p. 257, pl. 17, f. 34 a-c, 1871.

*Hab.*—Pribiloff Islands southward on the west to Hakodadi, Japan (Stm.), throughout the Aleutians, and on the southeast to Chirikoff Island, and perhaps Kadiak; from lowest water to twenty-five fathoms. One hundred and ninety specimens examined.

This beautiful little species, of which only a few specimens were known when it was described, has since been found over a very large area, and usually in rather deep water for the genus. It seems to represent *Acmaea virginica* on the Pacific side, though not very similar to it in appearance. The largest specimen found is an inch in length, but they are always very much flattened.

***Acmaea* (*Collisella*?) *triangularis*.**

*Nacella* (? *paleacea* var.) *triangularis* Cpr. Proc. Cal. Acad. Sci. iii, p. 213, 1866.

*Collisella?* *triangularis* Dall, l. c. p. 254, 1871.

*Hab.*—Sitka to Monterey, Cal.; dead on beaches.

This species varies from narrow, high, and elongated to rounded and rather flat, according to the place of its growth, as on a frond or leaf of some marine plant like *Zostera*, or on a flat unlimited surface. It appears very rare in Alaska, only one specimen having been collected there, but is tolerably common on the coast of California. I have never, however, been able to get it in the living state, so as to definitely decide its generic place.

***Acmaea* (*Collisella*?) *apicina* n. s.**

Testâ parvâ, conicâ, tenui, rotundatâ, plus minusve elevatâ; albidâ seu isabellina, apice erecto, luteo; intus luteo, albido, seu fusco, laevi; extus striulis incrementis subobsoletis munito. Lat. 5 mm., Lon. 6 mm., Alt. 4 mm.

*Hab.*—Pribiloff Islands on the north, the Aleutians from Amchitka eastward, extending to the Shumagins; twenty-two specimens, all dead except two, one of which was found at low water and the other dredged in seventy fathoms.

Among other small shells obtained from time to time on the beach or in the dredge, occasional specimens occurred which at first were supposed to be the young of *A. mitra* or pale specimens of *A. sybaritica*.



After eliminating some of these, there remained, after careful study, a residue, which do not appear to coincide in character with any described species. They are small, thin, conical, with a blunt, erect apex marked by a light yellow spot, the rest of the exterior white or faintly yellowish, marked by obsolete lines of growth, smooth, or nearly so, but not polished. Within, fresh specimens are yellowish, whitish, or orange-colored, and quite polished. The outside is almost always covered with nullipore. The chief characters are the rounded base, regularly conical and yellow spotted apex, with a thinner shell than young *A. mitra*.

## Fam. PATELLIDÆ.

### Genus NACELLA Schumacher.

*Nacella* (Schum.) Dall, l. c. p. 274, 1871. Type *N. mytilina* Gm.

#### *Nacella* ? *rosea*.

*Nacella* ? *rosea* Dall, Proc. Cal. Acad. Sci. iv, p. 270, pl. 1, f. 2, Oct. 1872.

*Hab.*—Dead on exposed ocean beaches at Kyska Island, Aleutians, and Simeonoff Island, Shumagins. Alive on fuci off shore? Forty-five specimens obtained, all dead.

This exquisite little rose-leaf of a shell exactly resembles the type of the genus *Nacella* in form, and is the only one of the so-called *Nacella* of the northwest coast which has not been proved to be an *Aemæid*. It is only provisionally referred to this family, and may prove, like the others, non-patelloid when the animal becomes known.

In this connection it may be of interest to quote the words of Eschscholtz in describing the genus *Aemæa*,\* words which at one time were partially discredited, but which the march of science has proved literally true:—"Here" (at Sitka) are found "six species of a genus which from its simple unwound shell would be immediately taken for a *Patella*; the creature, however, closely resembles the *Fissurella*, with the difference that only one gill is visible in the fissure over the neck. It is remarkable that on the whole northwest coast of America, down to California, no *Patella*, only animals of the genus *Aemæa* were to be met with."

It will be noticed from the preceding documents that in the Alaskan region fourteen species of Limpets, not counting the innumerable varieties, and twenty-six or seven species of *Chitonidæ*, are known, most of which have rewarded our researches, and a part of which are absolutely new. Additional species may be expected to recompense additional and more minute research; but that the chief members of these groups native to this region have been determined there is little reason to doubt.

\* From the English reprint, published in the spring of 1830, but dated by the author at "Dorpat, Jan. 7, 1828." I found the first edition in the Royal Library at Stockholm. It passed the censor in March, 1829, was issued in the winter of 1829-30, and is dated on the titlepage 1830.

*Extra-limital Species.*

## Genus PATELLA Linné.

*Patella* Lin. S. N. ed. x, 1758.—Dall, l. c. p. 266, 1871 (full synonymy).

**Patella vulgata.**

*P. vulgata* Lin. Syst. Nat. ed. xii, p. 1258.—Dall, l. c. p. 268, pl. 15, f. 23, 1861.

British and North European seas from the Mediterranean to the Northern Lofoten Islands, between tides. Type of the genus.

## Genus PATINA Leach.

*Patina* Leach, MSS. 1819; Moll. Gt. Brit. 1852, p. 223.—Dall, l. c. p. 279.

*Helcion* Jeffreys, not Montfort.

*Nacella* H. & A. Adams, Sars, not Schumacher.

**Patina pellucida.**

*Patella pellucida* Lin. S. N. ed. xii, p. 1260.

*Patina pellucida* Leach, l. c. p. 224, 1852.—Dall, l. c. p. 280, pl. 16, f. 20, 1871.

British and North European seas, northward to Lofoten; in most cases living on the stalks and fronds of large fuci.

DECEMBER 16, 1878.

## LIST OF THE FIGURES.

## PLATE I.

1. *Leptochiton cancellatus* Sby., Alaska: *a*, major lateral from above.
2. *Hanleyia mendicaria* Mighels & Adams, Casco Bay, Maine.
3. *Trachydermon ruber* Lowe, Greenland: *a*, major uncinus from below.
4. *Trachydermon albus* Lin., Alaska.
5. *Tonicella lineata* Wood, Alaska.
6. *T. marmorata* Fabr., Greenland.
7. *T. submarmorata* Midd., Alaska.
8. *Schizoplax Brandtii* Midd., Aleutian Islands.
9. *Chatopleura gemma* Cpr., California.
10. *C. ? Hartwegii* Cpr., California.

## PLATE II.

11. *Maugerella conspicua* Cpr., California.
12. *Stenoradsia magdalencensis* Hinds, California.
13. *Stenoplax limaciformis* Sby., west coast of Mexico.
14. *Ischnochiton regularis* Cpr., California.
15. *Ischnochiton Cooperi* Cpr., California.
16. *Ischnochiton interstinctus* Gld., Alaska.
17. *Ischnoradsia trifida* Cpr., Alaska: *a*, cusp of major lateral from above.
18. *Lepidopleurus Mertensii* Midd., Alaska: *a*, rhachidian *in situ*.
19. *Lepidoradsia australis* Sby., Port Jackson, Australia.
20. *Callistochiton palmulatus* Cpr., California.

## PLATE III.

21. *Pallochiton lanuginosus* Cpr., California.
22. *Chiton articulatus* Sby.: *a*, side view of rhachidian tooth.
23. *Ischnoplax pectinatus* Sby., West Indies.

24. *Chiton Stokesii* Brod., Peru: *a*, major uncinus from below.
25. *Chiton Cumingii* Frembly, Chili.
26. *Chiton assimilis* Reeve, West Indies.
27. *Tonicia elegans* Frembly, Chili.
28. *Acanthopleura spinigera* Sby., Aden.
29. *Lucia confossa* Gld., Patagonia: *a*, minor lateral; *b*, major uncinus.
30. *Corephium echinatum* Sby., South America.

## PLATE IV.

31. *Nuttallina scabra* Reeve, California.
32. *Phacellopleura porphyritica* Reeve.
33. *Placiphora Carmichaelis* Gray, South America.
34. *Mopalia Wossnessenskii* Midd., Alaska.
35. *Mopalia ciliata* Sby., Alaska: *a*, minor lateral.
36. *Placiphorella velata* Cpr., California: *a*, minor lateral from inner side.
37. *Katherina tunicata* Wood, Alaska.
38. *Acanthochiton aricula* Cpr., California.
39. *Acanthochiton spiculosus* Rve., West Indies.
40. *Macandrellus (costatus?* Ad. & Angas), Australia.

## PLATE V.

41. *Cryptoconchus monticularis* Quoy, New Zealand.
42. *Amicula Pallasii* Midd., Alaska.
43. *Amicula vestita* Sowerby, Massachusetts Bay. (*Emersonii* Couth.)
44. *Cryptochiton Stelleri* Midd., Alaska.
45. *Chitonellus fasciatus* Quoy, Gaspar Straits: *a*, minor lateral from outer side.
46. View of the anterior end of a *Chiton* from below: *a*, muzzle; *b*, veil; *c*, fringe or true mantle-edge; *d*, lower surface of girdle; *e*, end of row of "ambient" branchiæ; *f*, lower surface of foot.
47. Development of larval *Chiton*, *Trachydermon cinereus* Lowe (*T. marginatus* Jeffreys), after Lovén: *a*, embryo, in the egg; *b*, dorsal view of larva, showing the commencement of the grooves for the valves; *c*, lateral view of the same; *d*, larva further advanced, the valves beginning to be formed; *e*, the same, from beneath, showing the foot and eyes at the sides of the head; *f*, dorsal view of an older individual, showing the diminished size of the anterior tuberculate lobe or head.

NOTE.—The figures of dentition are diagrams, not portraits, designed to indicate the form of the individual teeth rather than the superficial appearance of the undisturbed radula. While the photographic relief process, by which these plates were obtained from the original drawings, has not been as satisfactory in its results as was at first hoped, it is believed that, inartistic as they may appear, the figures are more characteristic than if they had been redrawn and subjected to the artistic modifications of a professional draughtsman unacquainted with the subject.

