**PROCEEDINGS**

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XXIII, No. 33, pp. 481-502, pl. 43, text-figs. A-D. JULY 30, 1942

# REDESCRIPTION OF THREE SPECIES OF THE POLYCHAETOUS FAMILY POLYNOIDAE FROM CALIFORNIA*

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## INTRODUCTION

Our knowledge of the marine invertebrates on the west coast of North America is, generally speaking, very incomplete and uncertain. Such regions as the European seas and the waters off the coast of New England were explored faunistically in an intensive manner for a long period before the birth of modern experimental biology. The period of predominantly faunistic exploration was comparatively short on the west coast of North America for two reasons: first, the biological sciences began to flourish rather late in that region and, second, they soon became nearly exclusively experimental. Some of the invertebrate groups of the west coast of North America, such as the Echinoderms, the decapod Crustacea, and a few others, have been submitted to competent analyses, but the great majority of the groups have been woefully neglected. One of the latter category is the polychaetous annelids. Several years ago, the author of this report undertook a study of these worms, but circumstances prevented the continuation of this work. In order that at least some of the results obtained may be made useful, the present report was prepared.

A most serious obstacle in the road of anybody who attempts to identify polychaetous worms is the confused state of the bulk of the literature, not only that pertaining to the forms living on the west coast of North America, but also that of the group in general. The delimitations of many of the genera are extremely vague, and a great number of the species are described so incompletely that their

*Printed from the John W. Hendrie Publication Endowment

identification becomes either tentative or even impossible. A new, broader, and more secure foundation for the taxonomy must be established. The generic descriptions must be as inclusive as possible and the species must be dealt with much more in detail. In other words, a much larger number of characters should be examined and descriptions should contain the fullest possible accounts not only of the more or less constant features but also of the variable ones. It is, of course, well known that characters behave differently in the different groups. For instance, while in one group a certain feature is very variable, being perhaps different even on the right and left sides of one and the same individual, in closely related groups it may be relatively or nearly absolutely constant. Statements in regard to the relative variability of the various characters will help us to reach not only a better understanding of the taxonomy of the group studied, but it will also promote a better insight in the evolutionary processes.

Polynoidae, the family to which the species treated below belong, is very well represented in California. About fifty species, belonging to thirteen genera, have been described so far, a very large number, indeed, even if some of them must be reduced to the status of synonyms. Many of these species appear to be very variable and a thorough revision of all of them is necessary. The present paper is a small contribution towards this end. In the following descriptions, consideration has been given to the variability of the characters. It should be observed that the descriptions have been standardized. In order to facilitate comparisons the characters have been presented in a standard order and the phraseology has been stereotyped. Characters not mentioned in the descriptions are supposed to be generic in nature. Due to the limitation of specific material, no attempt at generic description and analysis has been made.

## **Halosydna brevisetosa** Kinberg

Plate 43; text figure A

*Halosydna brevisetosa*, KINBERG, 1855, p. 385; 1857-1910, p. 18; BAIRD, 1865, p. 186; MOORE, 1909, p. 240; TREADWELL, 1923, p. 4; SEIDLER, 1924, p. 125.

*Polynoë brevisetosa*, JOHNSON, 1897, p. 167; *non* TREADWELL, 1902, p. 186.

*Lepidonotus insignis*, BAIRD, 1863, p. 106.

*Polynoë insignis*, JOHNSON, 1901, p. 387.

*Halosydna insignis*, MOORE, 1908, p. 330; 1910, p. 329; TREADWELL, 1914, p. 180; CHAMBERLIN, 1918, p. 173; 1919, p. 252; 1928, p. 311; BERKELEY, 1935, p. 767.

*Lepidonotus grubei*, BAIRD, 1863, p. 107.

*Halosydna grubei*, BAIRD, 1865, p. 189.

*Description:* The largest free-living specimen measured by me was 61 mm long, while the largest commensal one was not less than

100 mm; see also below, under the heading "Remarks." Some specimens are rather robust, while others are fairly slender; robust and more or less slender shapes occur among the small as well as among the large specimens. Ratio between the length and the greatest width of body (measured between tips of parapodia, exclusive of bristles) is 6.0 (4.9–7.1):1. Usually the body tapers slightly posteriorly; anterior and posterior extremities well rounded. Setigerous somites 36, as usual in the genus. In only one specimen 37 setigerous somites were found; the supernumerary somite, just in front of the pygidium, was very small, and of its small parapodia each contained only one bristle, the aciculum. The elytra may cover the body nearly completely; generally, however, the members of each pair barely touch each other and sometimes a zone, about half as wide as each of the corresponding elytra, is naked along the median line. Prostomium may be exposed, but in about 90% of the specimens examined it was completely covered by the first pair of elytra. The anus, which is located on somite XXXV or between somites XXXIV and XXXV, or else between somites XXXV and XXXVI, was covered by elytra in about 80% of the specimens examined.

Prostomium, measured from base of ceratophore of median tentacle, about 1.4 to 1.8 times wider than long and usually widest at about the middle; sometimes its greatest width is located just in front of or somewhat behind the middle. Its lateral outlines either moderately and evenly convex, or more or less rounded angular. It is slightly grooved along the mid-dorsal line; usually the fine and narrow groove can be detected only just behind median ceratophore, but sometimes it can be seen also at the posterior end of prostomium; only in a few specimens can it be traced along the entire mid-dorsal line. Ceratophores of the lateral tentacles about 0.5–0.7 as long as the prostomium, approximately twice as long as wide, and not quite so long as ceratophore of median tentacle. Prostomium, always with two pairs of fairly large eyes, located on its posterior half, the members of each pair being far apart. In a few specimens there are also two pigmented spots which may easily be mistaken for eyes, and which are located postero-laterally to the anterior pair of eyes. The lateral tentacles about twice as long as the prostomial protuberances (ceratophores) on which they are located, and about half as long as the median tentacle or somewhat less; of moderate thickness, and either cylindrical or slightly bulbous distally; their distal filamentous appendage about as long as or slightly longer than their width; always smooth. Ceratophore of the median tentacle subobovoidal, truncated anteriorly, and about 1.1–1.5 times longer than wide. Median tentacle of about the same shape and structure as the lateral, and about 2.5–3.5 times longer than its ceratophore. Along the postero-dorsal margin of the prostomium, there is frequently a narrow, slightly pigmented zone. Prostomial protuberances usually quite heavily pigmented, except distally

where they sometimes completely lack pigment. Lateral tentacles more or less heavily pigmented proximally and with a dark, subterminal zone; in the middle the pigment may be absent or developed to varying degrees. Ceratophore of median tentacle always more or less pigmented proximally, and frequently more or less lightly colored distally. Pigmentation of median tentacle approximately the same as that of lateral tentacles.

The palpi are whitish. Even in the darkest specimens observed by me, no pigment was detected. However, according to Johnson (1897, p. 167), they are somewhat pigmented in very dark specimens; the darkest specimens found by this author were commensal (see below, under "Remarks"). The palpi are thickest near the base and taper very gradually to a fine point; about as long as or somewhat longer than the median tentacle in preserved specimens, but extremely contractile, "being about thrice the length of the tentacle when fully extended" (Johnson, 1897). They are beset with a varying number of exceedingly minute papillae which apparently always are arranged irregularly, frequently very numerous and closely set, but sometimes more or less widely spaced.

When fully everted, the proboscis is cylindrical, about twice as long as wide or somewhat less; its anterior edge with 18 papillae, 9 of which are dorsal and 9 ventral. The papillae are subequal in size, or those near the median plane are somewhat larger than the lateral ones. When seen from the outside, they appear leaf-like or triangular, but they have on the inside a large, mammilliform process. The proboscis either lacks or has a very slight pigmentation. In the mouth, there are two pairs of fairly large, subequal, triangular teeth, one dorsal and one ventral pair. The members of each pair are located close together on either side of the median plane. To the outside of each of the four teeth a fairly large, chitinous plate is attached, the outer edge of which is free and appears to be cutting; the right and left members of each of these pairs of plates can be pressed against each other (Pl. 43, figs. 7, 8).

The uniramous, first parapodium is pigmented, and has 1–3 fine, simple, and rather short bristles which are pectinated along the greater part of the length. Its two cirri are either subequal in length, or the ventral is slightly shorter; they have about the same pigmentation as the lateral tentacles, or the pigment in the middle is somewhat less developed. All cirri smooth. Dorsal cirri are present on the following somites: III, VI, VIII, and on alternate somites to XXVI inclusive, and then on XXIX, XXXII, XXXIV, XXXV, and XXXVI. Each of the cirri has a subconical cirrophore, about as large as or somewhat larger than the ceratophore of the median tentacle. The cirrophores usually somewhat pigmented, each having a subterminal zone of pigment and generally also some pigment proximally. Ventral cirrus of second somite may have nearly the same pigmentation as the cirri of the first somite, but in most specimens it is more or less devoid of pigmentation. The remaining

ventral cirri about as long as or slightly longer than the cirrophores of the dorsal cirri, subulate, and usually without pigment.

Notopodia small, only about 0.2 or less the length of neuropodia, with bristles in 3 subhorizontal rows, all placed somewhat dorsally to aciculum. In most somites, there are 5 or 6 bristles in the most dorsal row, seldom 4 or 7 are found; in the middle row, there are 5–9; and in the ventral row, 5–10 bristles; the middle and ventral rows are so closely placed that their bristles are difficult to count with full certainty. In the last few somites the number of bristles frequently is decidedly less than in the remaining ones. Bristles in the middle and ventral rows extend at the most to or very slightly beyond tip of neuropodium, and are about 2–5 times longer than those of the dorsal row; they end in a long and very fine point and have fine frills along the greater part of their length. Bristles of the dorsal row very short, with fine frills along their entire free portion, and end in a short, strong point. Neuropodia are strong, subquadrangular, obliquely truncate, and armed with setae placed in two groups, one on either side of aciculum; their surface not pitted. In the dorsal group there are usually 5-9, in the ventral group 9-15 bristles; the numbers may, however, be somewhat smaller. The bristles are decidedly stronger than those of the notopodia, and about as long as the neuropodia or somewhat shorter; straight except distally, where they are gently curved; with simple, pointed, or more or less blunt tip; and furnished somewhat below the tip with about 8-15 frills of which the distal ones bear very strong, the remaining ones exceedingly fine spines; in the last few parapodia the bristles frequently are very short and few. In the second somite the bristles sometimes are somewhat more numerous than in the remaining ones, and they have a structural type approaching that of the bristles of the notopodia. Notopodium frequently more or less pigmented; neuropodium always lacks pigment.

The two cirri of the pygidium of about the same size, shape, structure, and pigmentation as the dorsal cirri of most segments.

The typical pre-elytrophore resembles the elytrophore but is somewhat smaller and lower and, of course, lacks the cup like structure onto which the elytron is attached.

The nephridial papillae are rather prominent, approximately as long as the ventral cirri are wide, somewhat longer than wide, well rounded or truncate distally, and slightly fluted. They begin on somite VIII and cease either on somite XXXV or on somite XXXVI (about 50% of the specimens examined had papillae on somite XXXVI); thus in all there are either 28 or 29 nephridial papillae.

In dark specimens there are two cross bars of pigments, on most of the segments, one of which may extend across the larger part of the width of the body; in light colored specimens these cross bars may be in part absent. The ventral aspect of the body is not pigmented, or is washed with ashy grey in melanistic individuals.

The elytra, which are very difficult to remove in preserved specimens, are very varied in shape; the first pair is suborbicular, the last pair rounded triangular, and the remaining ones subreniform or subovate to subelliptical; all of them are almost flat; furthermore, the elytra of different specimens show fairly pronounced differences in shape. All elytra have a series of small, short spines

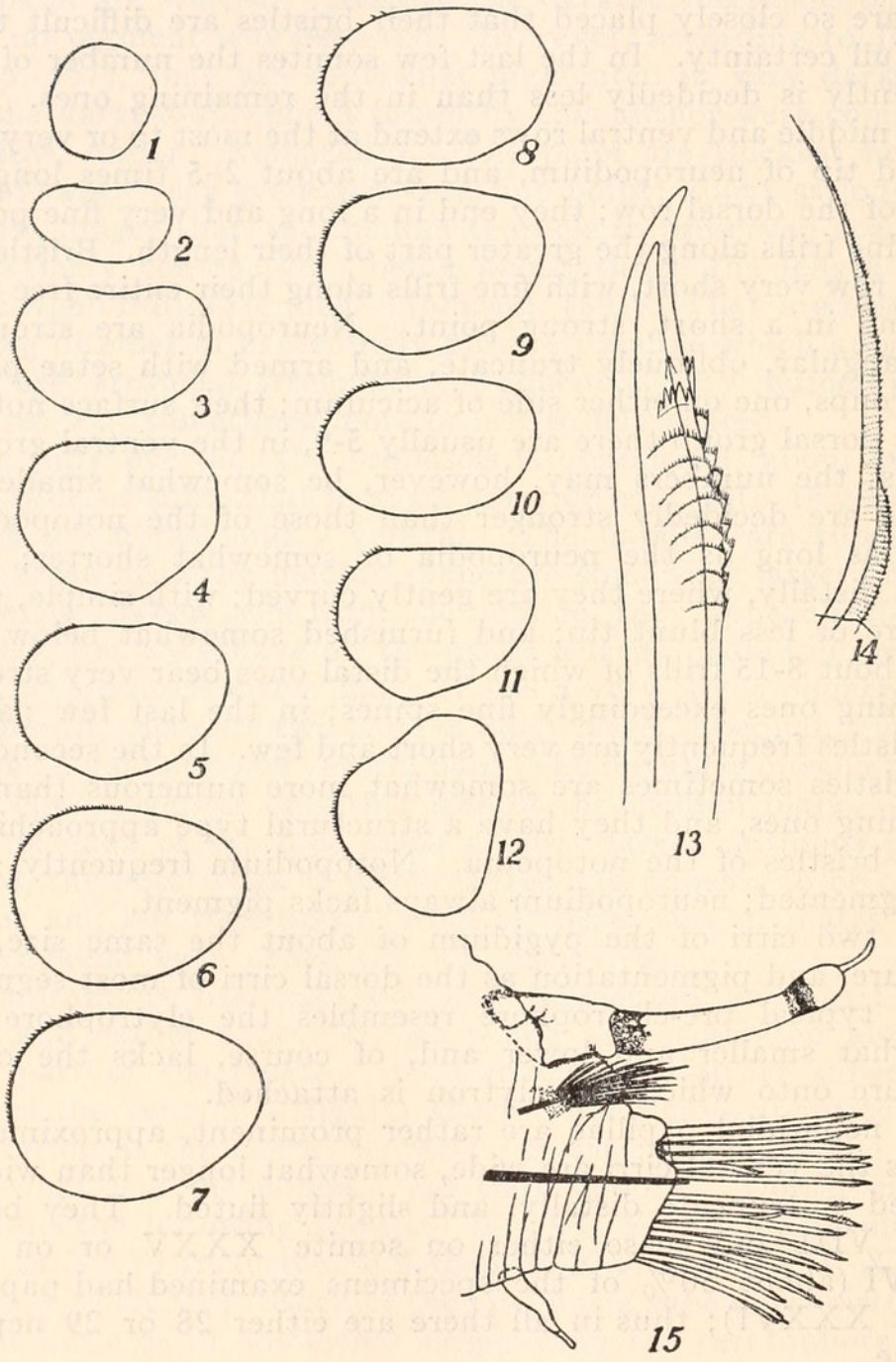


Figure A. *Halosydna brevisetosa* Kinberg. 1–6. Elytra Nos. 1 to 6. Elytron No. 7 of the same shape as No. 6, × 6.5; 7. Elytron No. 8, of same shape as Elytra Nos. 9–13, × 6.5; 8–12. Elytra Nos. 14 to 18, × 6.5; 13. Tip of bristle from neuropodium of 20th parapodium, × 195; 14. Notopodial setae from fifth somite, × 85; 15. Left parapodium of 20th somite, under cover glass, × 17.

on the external border. The first three or four pairs have large, bluntly conical, chitinous tubercles in a moderate number and in addition numerous small tubercles; the remaining ones have only small tubercles. The development of the tubercles is rather strongly variable within the species. Each elytron has a white spot just above the elytrophore, but in other respects its color pattern is highly variable. In most specimens, however, there is a more or less dark spot (black, grey, brown, or orange) just in front of the white ocellus; sometimes this spot lies behind the ocellus, sometimes it is entirely absent. In most specimens the remainder of the elytron is more or less densely mottled with pigments of the kinds mentioned above; and in some this mottling is nearly or completely absent. "Coloration highly variable, but in all cases the fundamental or ground color is white. This is overlaid by pigmented areas of iron-grey, tawny, brown, yellow, or orange. Melanistic specimens are common, in which the iron-grey is intensified to almost jet black, and even the ventral side is dark." This statement by Johnson (1897, p. 168) agrees closely with my own experience.

Sex products appear to be limited to somites XI to XXXIV or XXXV, inclusive.

*Remarks:* The maximum length of the body of free-living specimens given above is based on the measurements of more than one hundred preserved specimens from Monterey Bay and vicinity. Twenty-five specimens from the same region were examined for the following characteristics: ratio between length and width of body; number of somites; number and arrangement of elytra and nephridial papillae; number and distribution of cirri; and the location of anus. The number and types of bristles in all the somites were established in four specimens; the number and types of proboscidial papillae and teeth in seven cases. The relative size, the shape, and the coloration of the elytra were examined in more than thirty specimens. Most of the observations were made on specimens preserved in formalin, but living material was also studied especially in regard to the coloration.

The description given above is based exclusively on free living (non-commensal) specimens taken in tide pools and on piling in Monterey Bay and Carmel Bay, California, thus at a distance of only about 120 miles south of the type locality of *Halosydna brevisetosa*, viz., Sausalito Bay, just inside the Golden Gate at San Francisco. In most respects it agrees quite well with the rather sketchy description and figures given by Kinberg (1857) of this species. However, in some characters important differences are to be recorded. Perhaps the most significant among these is the length of the neuropodial bristles. In Kinberg's plate 5, fig. 25F, the length of these bristles is only a small fraction of the length of the neuropodium (hence the specific name!), while in all the specimens seen by me the lengths of these two structures are subequal. A close scrutiny of this figure, however, suggests that it is at least not ex-

cluded that Kinberg drew only the bases of these bristles. This conclusion is apparently borne out by Kinberg's plate 5, fig. 25 G, u, representing a single neuropodial bristle at high magnification. This figure resembles quite closely the neuropodial setae examined by me, but does not agree with these structures in Kinberg's plate 5, fig. 25F. Another important difference is to be found in regard to the notopodial setae (Kinberg's Pl. 5, fig. 25 G, s). According to Kinberg, these setae have strong and rather blunt tips, while I found them characterized by the features represented in my text-figure A, 14. It does not seem impossible to me, however, that both the bristles figured by Kinberg were taken from the neuropodium. A minor difference is to be noted in the shape of the body. The specimen figured by Kinberg (Pl. 5, fig. 25, A) tapered rather strongly posteriorly, while in my material the body had either a subuniform width throughout, or the posterior taper was rather slight. That a doubt about the correctness of my identification may not be out of place is indicated by the fact that other species of the genus do exist in central California. On the other hand, in all probability it is correct, since the region around the type locality is well investigated, and no species has as yet been found which agrees with the peculiarities contained in Kinberg's original description.

It may be noted as a matter of curiosity that in one of the specimens from Monterey Bay, the acicula of the right neuropodia of somites XXIV and XXVI extended to the tips of the respective neuropodial bristles. This condition presumably was the result of an abnormal development.

The species, as conceived in the present paper, is highly variable. The most variable features are the intensity, shade, and pattern of the pigmentation. The shape of the prostomium, and the shape, relative size, and structure of the elytra are also fairly variable. I have made a careful attempt to split the species into smaller units, but without success. In all probability, we are dealing with a single, although variable systematic unit. Johnson (1897) also included in his description a number of specimens found commensally. These commensal individuals evidently differed more or less distinctly from the free-living ones: one of them was not less than 75 mm long, thus distinctly larger than any of the free-living ones in my material. Johnson's commensal specimens also tended to be more slender; their pigmentation usually was heavier, one specimen being nearly black; their elytra were "thinner, smoother, sometimes destitute of any except microscopic tubercles, with few or no marginal 'cilia', etc." Not having had the opportunity of examining any of the specimens referred to this species by Johnson and taken commensally, I am not in the position to judge the correctness of this assignment. However, in all probability, this species, like several other free-living polynoids, tends to assume a commensal existence. One fact worthy of notice in this connection is that all specimens

found commensally were old ones; no young ones have ever been seen in this type of habitat. Does this fact indicate that the species tends to become commensal after it has reached a certain age?

*Distribution:* *Halosydna brevisetosa* is extremely common in the central California waters. In this region it is by far the most common representative of the family in its particular habitat. It seems to prefer rocky bottom between tide marks and just below the tidal region. Here it seeks shelter in crevices, underneath stones, and under or among sessile organisms. Another preferred habitat is under such organisms on piling. The species always seems to seek shelter, a character which perhaps pre-disposes it to a commensal mode of life, *e. g.*, in large worm tubes.

The species extends at least from Alaska to southern California. In southern California, its frequency evidently is low. In regard to its bathymetric range, nothing can be said, except that it has been taken down to a depth of 15-20 meters or even slightly deeper.

Finally, it may be noted that Treadwell (1902, p. 186) recorded the species from Porto Rico. This record, however, requires further checking before it can be accepted.

## **Arctonoë vittata** (Grube)

Text figures B, C, and D, 1–5

*Polynoë vittata*, Grube, 1855, p. 82 (Sitka, Alaska; type in Leningrad Museum).

*Lepidonotus lordi*, Baird, 1863, p. 107 (Vancouver Island; type in British Museum); 1866, pp. 9, 345.

*Halosydna vittata*, Baird, 1865, p. 188.

*Halosydna lordi*, Baird, 1865, p. 190; Moore, 1908, p. 330; Treadwell, 1914, p. 181; 1926, p. 1; Chamberlin, 1920, p. 9B; Berkeley, 1923, p. 212.

*Halosydna succiniseta*, Hamilton, 1915, p. 234.

*Polynoë lordi*, Johnson, 1897, p. 175; 1901, p. 388; Treadwell, 1923, p. 4.

*Acholoë vittata*, Marenzeller, 1902, p. 576 (north Pacific Ocean).

*Arctonoë lia*, Chamberlin, 1920, p. 6B (Alaska).

*Halosydnoides vittata*, Seidler, 1924, p. 134; Okuda, 1936, p. 565.

*Description:* The largest specimen in my collection measured not less than 100 mm in length, exclusive of prostomial appendages. This specimen, taken in Monterey Bay, thus was nearly twice as long as the largest one measured from the same region by Johnson (1897), who gives 57 mm as the maximum recorded by him. Most specimens are comparatively slender, but fairly robust ones may also be found. Ratio between the length and the width (between tips of parapodia, exclusive of bristles) of the body is 6.5-12.5:1; in the large specimen noted above, it was 12.5:1. Number of chaetigerous somites approximately 70-75 in a specimen about 50-57 mm long; greatest number of such somites recorded was 89. Dorsum broadly exposed between elytra; width of exposed zone frequently

subequal to width of the elytra of the measured somite; middle of prostomium usually not covered; and anus is also uncovered.

Prostomium quite variable in shape: in some specimens it is subcircular, truncate anteriorly; in others it is more or less irregular. due to presence of two lateral expansion at or slightly behind middle,

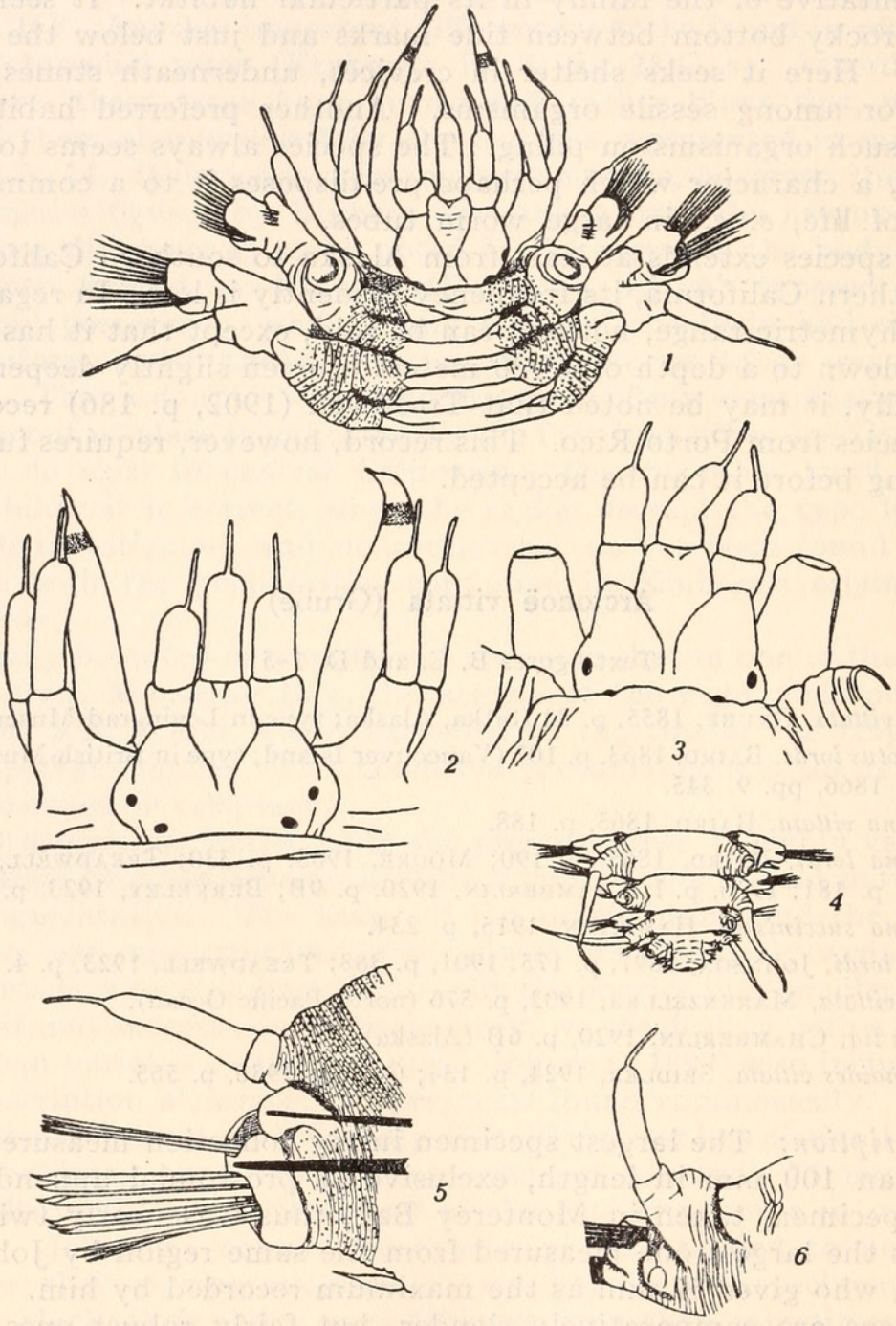


Figure B. *Arctonoë vittata* (Baird). 1. Dorsal aspect of anterior part of body after removal of elytra, × 4.5; 2. Anterior end of body in dorsal view, × 12; 3. Anterior end of body in dorsal view, × 15; 4. Dorsal aspect of posterior part of body after removal of elytra, × 4.5; 5. Right parapodium of 42nd somite; cover glass not used, × 17; 6. Dorsal aspect of right parapodium of 16th somite. To the right of cirrophore a pre-elytrophore is indicated; below the cirrophore and to the right of the bases of the bristles the small notopodium is to be found. × 20. The dots in 1 and 5 indicate small pits and not pigmentation.

It is usually more or less wider than long; widest at or somewhat behind the middle, at about the level of the anterior pair of eyes. It is always bilobed. The two lobes separated anteriorly by ceratophore of median tentacle; posteriorly they are either separated by a shallow groove (Johnson, 1897, pl. 7, fig. 35), or they may merge completely; and anteriorly they are either truncate or obliquely pointed. The two pairs of eyes moderate and subequal in size. Ceratophores of lateral tentacles comparatively large and thick, and about as long as wide. Lateral tentacles short and stubby; when contracted, they are about 1.5–3.0 times longer than their ceratophores and about 1.5–2.5 times longer than wide; the filamentous tip may be somewhat longer than the tentacle proper, but usually it is somewhat shorter. The ceratophore of the median tentacle, which begins at or somewhat behind the middle of the prostomium (its posterior extension frequently not possible to establish with certainty), is truncate anteriorly and either subconical or, and this seems to be the rule, subpentagonal. The median tentacle, which has about the same shape and structure as the lateral ones, either is about as long as or slightly longer than these; i. e., it is, exclusive of the distal filamentous appendage, approximately as long as or somewhat shorter than the prostomium. Prostomium and its appendages whitish, without visible pigment cells.

The palpi, which are whitish with a dark cross band near the tip, are rather thick at the base, tapering gradually to a fine point, and are about 2.5–4.0 times longer than the median tentacle exclusive of its filamentous appendage.

The proboscis, which agrees closely with that of *Halosydna brevisetosa*, may be whitish, or it may have a slight general pigmentation.

The two cirri of the uniramous first parapodium either subequal or the ventral is slightly shorter than the dorsal. Dorsal cirri present on all somites without elytra. Cirrophores of moderate size or rather large, and frequently their proximal portions are more or less swollen; in some specimens the proximal swelling is not present, in which case the cirrophores are subcylindrical, tapering somewhat distally. Dorsal cirri whitish, as are also their cirrophores with the exception of those on the eighth somite which are brownish. Ventral cirri lack pigmentation.

Notopodium small (about $\frac{1}{6}$ or less of neuropodium), rounded verruciform, or somwhat elongated. The one of somite II usually has a varying number (about 4–15) of very short bristles near the base. The ones of somites III-VI either lack bristles or have but a few. The remaining notopodia seem always to lack bristles. The neuropodia, which are more or less truncate distally and somewhat longer to somewhat shorter than thick, have a moderate number of bristles. According to Johnson (1897, p. 176), there are "about 20 setae in all". Two specimens examined by me showed the following numbers on the right side of the body.

*Specimen A* (73 somites):

Somite II: 6 bristles in the dorsal group and 20 in the ventral group;
III: 8 " " " " " " 19 " " " "
IV: 9 " " " " " " 18 " " " "
V: 12 " " " " " " 23 " " " "
X: 8 " " " " " " 18 " " " "
XV: 9 " " " " " " 21 " " " "
XX: 7 " " " " " " 13 " " " "
XXV: 6 " " " " " " 15 " " " "
XXX: 4 " " " " " " 5 " " " "
XXXV: 5 " " " " " " 12 " " " "
XL: 5 " " " " " " 11 " " " "
XLV: 6 " " " " " " 11 " " " "
L: 5 " " " " " " 9 " " " "
LV: 3 " " " " " " 11 " " " "
LX: 4 " " " " " " 8 " " " "
LXV: 4 " " " " " " 8 " " " "
LXX: 2 " " " " " " 6 " " " "

*Specimen B* (81 somites):

Somite II: 6 bristles in the dorsal group and 27 in the ventral group;
III: 11 " " " " " " 21 " " " "
IV: 9 " " " " " " 19 " " " "
V: 10 " " " " " " 20 " " " "
X: 11 " " " " " " 17 " " " "
XV: 12 " " " " " " 18 " " " "
XX: 9 " " " " " " 18 " " " "
XXV: 8 " " " " " " 16 " " " "
XXX: 6 " " " " " " 12 " " " "
XXXV: 6 " " " " " " 14 " " " "
XL: 5 " " " " " " 13 " " " "
XLV: 5 " " " " " " 12 " " " "
L: 5 " " " " " " 11 " " " "
LV: 4 " " " " " " 13 " " " "
LX: 5 " " " " " " 12 " " " "

In the remaining segments of specimen B, the number of bristles decreased gradually although irregularly towards the posterior end of the body; at the same time the size and the differentiation of the bristles also declined. In other words, even though the number of bristles within this species is always moderate, it varies very decidedly not only among the individual representatives, but also from one segment to the next.

In somite II all the bristles are of about the same type as those in the dorsal group of the typical parapodia; no hooked bristles are present; the bristles in the dorsal group are slightly heavier than those in the ventral group, and the most ventral of the latter are the finest. In the remaining parapodia the bristles in the two neuropodial groups are different. In the dorsal group the bristles are about as long as or somewhat longer than the distal width of the neuropodium, subequal in length, straight, narrow, somewhat lanceolate distally, with blunt tips, and furnished along the distal part with numerous cross rows of exceedingly fine spines. The bristles in the ventral group are of about the same length as those in the dorsal;

they differ from these in being somewhat hooked and well pointed distally; the distal curvature sometimes is rather slight, sometimes quite pronounced. Some distance from the tip these bristles have a fairly great number of cross rows of exceedingly fine spines. While all the bristles of the dorsal group are of subuniform thickness, those in the ventral group vary in this respect; most of the dorsal ones are comparatively strong, while the ventral are more or less slender, about the same strength as those in the dorsal group. Sometimes some of the bristles of the dorsal as well as of the ventral group are more or less hooded; the hood is transparent and apparently without structure and in the case of the strong bristles it may be quite large. The surface of the parapodia may or may not be pitted. No pigment is present in the parapodia, except in those of somite VIII; see below.

The typical pre-elytrophores are rather small and verruciform; some of the anterior ones are quite large and mammilliform.

The nephridia open on rounded, knob-like papillae which sometimes are so small that they are fairly difficult to detect. They are not distinguishable on the last few somites but distinct on all the other somites from the sixth on; however, these structures are not really well differentiated before somites VIII-IX.

"The dorsum is marked with numerous irregular, transverse bands, lines, and streaks of burnt sienna; the pigment massed in a broad, solid fillet on somites eight and nine." (Johnson, 1897, p. 176). In some of the specimens examined by me the "irregular, transverse bands, lines, and streaks" were not developed; only the "solid fillet" was present. The fillet is developed mainly on somite VIII, and frequently extends onto the parapodia and their notocirri.

The elytra, which are non-deciduous, i. e., difficult to remove from preserved specimens, have a very varied arrangement behind somite XXXIII.

*Specimen A* (73 somites):

2 elytra were present on somite XXXIII and on alternate somites to somite LXV, inclusive, and on somite LXVI; 2 cirri on somite XXXIV and on alternate somites to somite LXIV, inclusive, and on somite LXVII; somites LXVIII, LXX, and LXXII had an elytron on the right side and a cirrus on the left; the reversed condition was found on somites LXIX and LXXI.

*Specimen B* (81 somites):

2 elytra and 2 cirri alternated in a regular manner, such as given for specimen A, from somite XXXIII to somite LXXIV, the latter with 2 cirri; somite LXXV, LXXVII, and LXXIX had an elytron on the right side and a cirrus on the left; and the reversed condition was found on somites LXXVI, LXXVII, and LXXX.

*Specimen C* (89 somites):

2 elytra on somites XXXIII, XXXV, XLIII, XLIX, and on alternate somites from LIII to LXXXVII, inclusive; 2 cirri on somites XXXVI, XLIV, and on alternate somites from LII to LXXXVIII, inclusive; somites XXXIV, XXXVII, XXXIX, XLI, XLVI, XLVIII, and L had an elytron on the right side and a cirrus on the left side; and the reverse was true on somites XXXVIII, XL, XLII, XLV, XLVII, and LI.

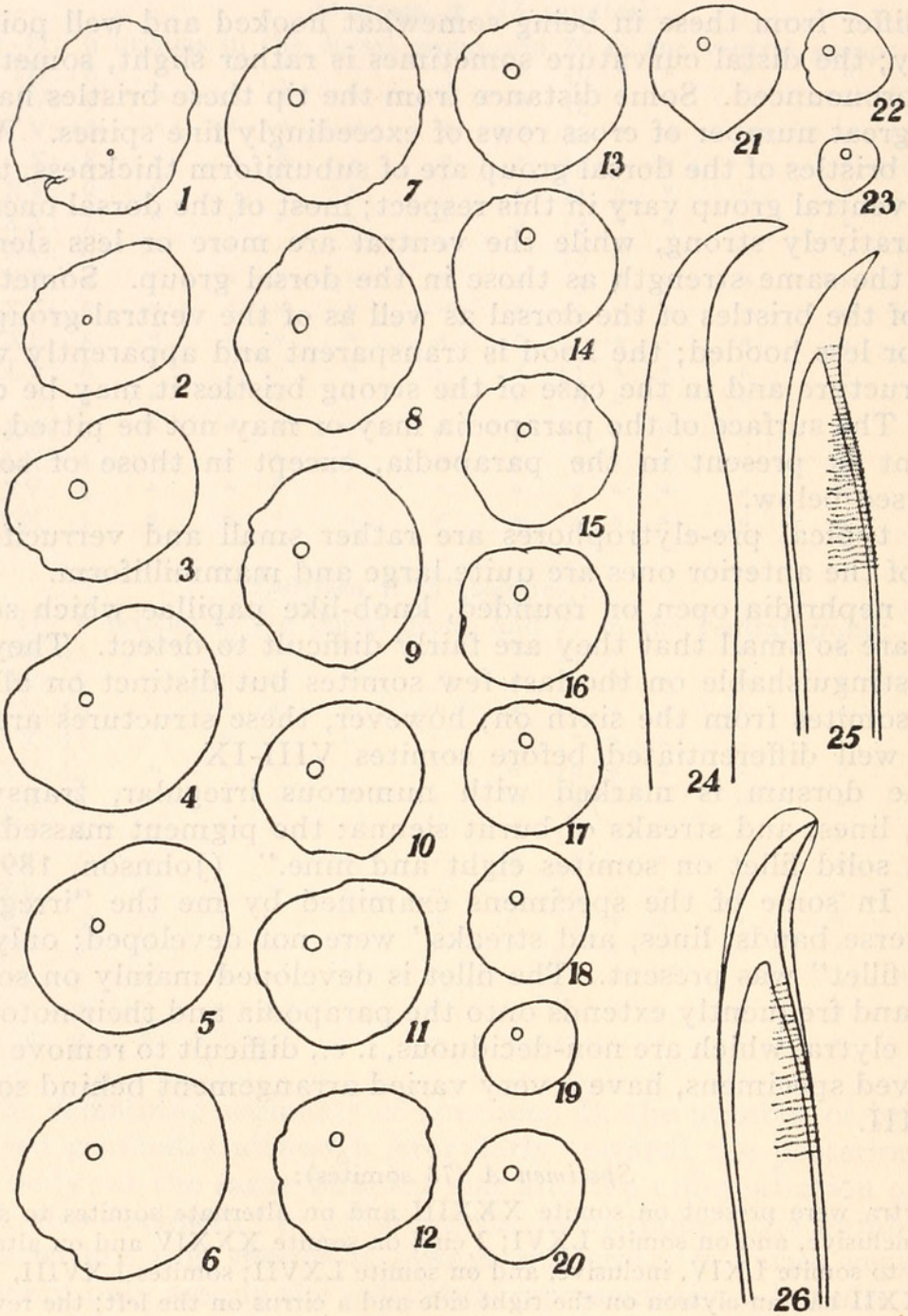


Figure C. *Arctonoë vittata* (Baird). 1–6. Left elytra Nos. 1–6, × 6; 7. Left 7th elytron, × 6. Elytra Nos. 8 and 9 of about the same shape and size as No. 7; 8. Left 10th elytron, × 6. This is of about the same shape but somewhat smaller than No. 11; 9. Left 12th elytron, × 6. No. 13 is slightly smaller and more regular; 10–14. Left 14th–18th elytra, × 6. Elytra No. 19 and 20 rounded and somewhat more irregular than No. 18; 15. Left 21st elytron, × 6. Elytron No. 22 about the same as No. 21; 16. Left 23rd elytron, × 6. Elytron No. 24 somewhat more rounded than No. 23; 17. Left 25th elytron, × 6. Elytra No. 26–28 somewhat more irregular than No. 25; 21. Left 29th–32nd elytra, × 6; 22–23. Left elytra No. 34 and 36, × 6. Elytron No. 33 almost circular, its size intermediate between Nos. 32 and 34; No. 35 similar to No. 34; 24. Heavy bristle in ventral group of right neuropodium of 15th somite, × 195; 25. One of the dorsal bristles in the ventral group of neuropodium of 20th somite, × 195; 26. Same as No. 31, but the bristle furnished with a hyaline hood, × 195.

In all the specimens the last somite had neither elytra nor cirri developed. A characteristic feature of the irregularity is thus that a varied number of somites are asymmetrical, i. e., there are somites with an elytron on one side and a cirrus on the other. For instance, in specimens A and B there was the same characteristic alternation on the last five somites furnished with these structures. It should be observed, however, that while in specimen A the alternation began on somite LXVIII, in specimen B it did not begin before somite LXXV. In specimen C, the alternation began as far anteriorly as on somite XXXIV and it ended on somite LI, each one of the hindmost somites being furnished with either two elytra or two cirri. The elytra, generally speaking, decrease gradually in size posteriorly; those of somites II and III, however, are frequently somewhat smaller than those of somite IV. Their shape varies not only from somite to somite but also in different specimens. Most of them are suborbicular, as a rule, sometimes somewhat extended on one side; the first of them may be irregularly suborbicular to subovoidal; the second is often subreniform to subovoidal. Their margin is frequently somewhat undulating; their surface is nearly smooth, and there are no "cilia". The color is usually milky white, entirely immaculate; or "more rarely with a central black spot or flecks of black, or with a black border on posterior edge" (Johnson, 1897, p. 176). Only one of the specimens examined by me had central spots developed, and these were restricted to the anterior half of the body. This specimen was found in the mantle cavity of a Cryptochiton from Monterey Bay.

*Distribution and Biology:* Grube's type specimen of *Polynoë vittata* was recorded from Alaska; a host was not mentioned. Baird's type of *Lepidonotus lordi* was taken from *Fissurella cratitia*, Vancouver Island. *Arctonoë lia* Chamberlin was described from a specimen taken in 2-3 fathoms, sandy bottom, in the vicinity of Port Clarence, Alaska. Johnson (1897, 1901) reported *Polynoë lordi* with Fissurellidae, *Cryptochiton*, and *Dermasterias imbricata*, from central California to Puget Sound, Washington. Moore's (1908) record is based on specimens from the starfish Luidia, Nanaimo, B. C., in 12 fathoms. Berkeley (1923) added *Thelepus plagiostoma* to the list of hosts, from Nanaimo, B. C. Okuda (1936) reported this species as taken in northern Japan with *Asterias amurensis*, *Haliotis kamtchatkana*, and *Patelloida sp.* Treadwell (1923, p. 4) reported *Polynoë lordi* even as far to the south as at Pichilinque Bay, Lower California. Even if the last identification should prove to be erroneous, it is evident from these data that the species has a wide range throughout the northern Pacific Ocean. Furthermore, it is probably an obligate commensal, but at the same time seems to have a very great tolerance in regard to choice of host.

*Systematic Discussion:* The species has a fairly extensive synonymy, due to a large extent to the various generic designations it has received. It is an excellent illustration of the confusion which

has prevailed in regard to the generic delimitations in this family. The specific confusion was caused mainly by the fact that this form is characterized by quite different color phases. The confusion of genera may be briefly exemplified as follows. Grube (1855) re-

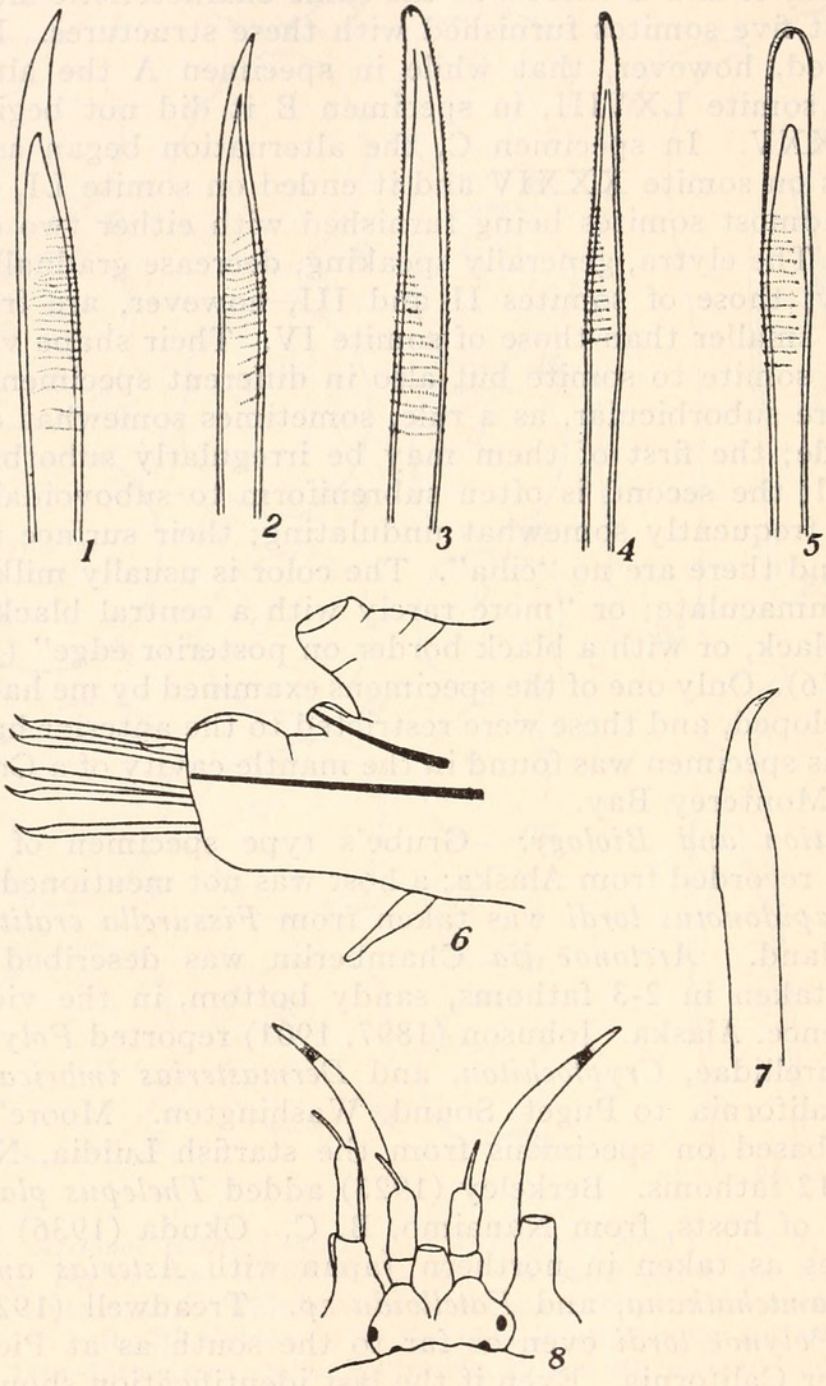


Figure D. *Arctonoë vittata* (Baird). 1–2. Ventral bristles in neuropodium, about 20th somite. Some of these narrower bristles may also have a hood. × 195; 3. Bristle from dorsal group of neuropodium of 20th somite, × 195; 4–5. Bristles from dorsal group of neuropodium of 60th somite. Number 4 is seen slightly on edge × 195.

*Arctonoë pulchra* (Johnson). 6. Parapodium of right 20th somite. 7. One of the ventral bristles of neuropodium of somite 21, × 75. Pectinae too small to be drawn. 8. Dorsal aspect of anterior end of body, × 8.

ferred his new species *vittata* to *Polynoë*, while Baird (1863) referred it (under the name of *lordi*) to *Lepidonotus*. When, two years later, Baird realized that *vittata* and *lordi* were identical, he assigned the species to *Halosydna*. Later Marenzeller (1902) transferred it to *Acholoë*, while a few years before Johnson (1897) had reëstablished it in *Polynoë*. Finally, Chamberlin (1920) assigned it to a new genus, *Arctonoë*, under the specific name of *lia*. His description and figures agree well with those for specimens from California which had been designated as *Polynoë lordi* by Johnson (1897). *Arctonoë* was separated from *Halosydna* primarily because its notopodial setae were bidentate, a very trivial feature from the viewpoint of generic distinction. Much more fundamental differences, of course, are to be found, *e. g.*, that the number of setigerous somites in *Halosydna* is constant from an early developmental stage, a character probably correlated with the fact that the anus shifts dorsally to one of the last segments in front of the pygidium, while in *Arctonoë* the number of segments apparently continues to increase throughout life, a feature connected with the peculiarity that the anus has maintained its original position on the pygidium, thus behind the teloblasts. Chamberlin (1920) did not compare his *lia* with either Grube's or Baird's species, but he referred *Lepidonotus fragilis* to his new genus. It is interesting to note in this connection that Chamberlin cited *Halosydna lordi* two pages farther on in the same article without any comment.

The description and figures of *Halosydna succiniseta* Hamilton, based on specimens from Laguna Beach, California, agree fairly well with those for *Arctonoë vittata*. The character of the so-called collar on the notosetae was based on a single specimen. A bristle of this kind, from a specimen of *A. vittata* taken in Monterey Bay, is shown in text figure C, 26. My identification is, however, in part based on the assumption that Hamilton's data are presented in a very superficial manner, and that as a consequence comparisons must be made *cum grano salis*. Compare, for instance, the prostomium as figured by Hamilton (1915, Fig. 3) and by me. Hamilton stated that *Halosydna succiniseta* "closely resembles *H. lordi*."

### **Arctonoë pulchra** (Johnson)

Text figure D, 6–8

*Polynoë pulchra*, Johnson, 1897, p. 177; 1901, p. 390.

*Halosydna pulchra*, Moore, 1908, p. 329; 1909, p. 240; 1910, p. 328; Treadwell, 1914, p. 179; Berkeley, 1923, p. 212.

*Halosydna leioseta*, Chamberlin, 1919, p. 2.

*Halosydnoides vittata*, (Grube) var. *pulchra*, Seidler, 1924, p. 136.

*Description:* The longest specimen measured by me was 70 mm in length, exclusive of prostomial appendages. This Monterey Bay specimen thus was considerably longer than the longest specimen from the same bay taken by Johnson (1897); his longest specimen

measured only 51 mm. Ratio between length and width (between tips of parapodia, exclusive of bristles) of body, about 5.0–6.4:1. Usual number of somites recorded by me was 48 to 70, exclusive of pygidium. Dorsum usually exposed along the middle, but not quite so broadly as in *A. vittata;* the middle portion o prostomium usually uncovered; and the anus is not covered.

Prostomium always somewhat wider than long but otherwise is variable in shape; sometimes its sides are fairly evenly rounded, sometimes they are more or less irregular, due to the presence of two similar lateral expansions at or behind the middle, and sometimes the two sides are somewhat different mutually in this respect. It is always two-lobed. The two lobes are separated anteriorly by the ceratophore of the median tentacle; posteriorly they may be separated by a shallow groove, or they may merge completely; anteriorly they are either truncate or more or less rounded. The two pairs of eyes are moderate and subequal in size. Ceratophores of the lateral tentacles are comparatively large and thick, about as long as wide or even somewhat shorter relatively. Lateral tentacles short and stubby; when contracted, they are about 2.0–3.5 times longer than the ceratophore and about 1.5–2.5 times longer than wide; their filamentous tips may be somewhat longer than the tentacles proper, but usually they are somewhat shorter. Ceratophore of the median tentacle, which begins at or somewhat in front of the middle of the prostomium (its posterior extension is frequently not possible to establish with certainty), is truncate anteriorly, and either subobovate or, and this seems to be the rule, subpentagonal. Median tentacle of about the same shape and structure as the lateral ones and either about as long as, or slightly longer than these; in other words, it is, exclusive of the distal filamentous appendage, about as long as or somewhat shorter than prostomium. Its filamentous appendage sometimes is a little shorter than those of the lateral tentacles. Prostomium and its appendages whitish, without distinct pigment cells.

The palpi, which are whitish with a dark cross band near the tip, are fairly thick at the base, taper gradually to a fine point, and are about 3–4 times longer than the median tentacle exclusive of its filamentous appendage.

The two cirri of the uniramous first parapodium are either subequal or the ventral one is slightly the shorter. Dorsal cirri present whenever elytra are not developed. Cirrophores of moderate size or rather large; usually they are subcylindrical, tapering somewhat distally; sometimes they are more or less swollen at the base. Cirrophores, as well as the dorsal and ventral cirri, are whitish.

Notopodium small (from about $\frac{1}{6}$ to much less of the length of the neuropodium), rounded verruciform, and somewhat elongated. The one of the second somite usually has a varying number (about 4-10) of very short setae near the base (Johnson, 1897, pl. 8, fig. 50b). The ones of somites III–VI either lack bristles or have only

a few short ones. The remaining notopodia seem always to lack bristles. The neuropodia, which are more or less truncate distally and somewhat longer to somewhat shorter than thick, have a small number of bristles. According to Johnson (1897, p. 177), the number varies from 6 to 12; I have found 4–6 to be the usual number and the total range to be 3–9; in the last few somites only 2–3 bristles are found. The size of the bristles also gradually decreases posteriorly. All the bristles are of the same type, somewhat hooked distally with a quite sharp point. The only difference which we have found lies in the thickness of the bristles, and in some specimens all the bristles of each parapodium may have approximately the same thickness. The degree of curvature near the tip may be either somewhat more or somewhat less pronounced than in the figure of the neuropodial bristle given in this paper. The pectinae, located on the thickened portion of the bristle some distance from the tip, are moderate in number (about 8–15), or rather few, and they are so fine that they could not be shown in the appended figure without very decided exaggeration (Johnson, 1897, pl. 8, fig. 50a). Usually the bristles are about as long as or somewhat longer than the distal width of the neuropodium.

The typical pre-elytrophores are rather small and verruciform; some of the anterior ones are fairly large and mammilliform.

The nephridia open, in most segments, on very small, rounded papillae, which frequently are too minute to allow a certain statement as to on which somites they are present. However, the papillae certainly are absent from some of the anterior and from some of the posterior somites. According to Johnson (1897), the dorsum is "transversely marked with brown bands, two to each somite". In the specimens examined by me the dorsum lacked pigmentation.

The elytra, which are deciduous, i. e., they fall off readily in preserved specimens, had in one specimen a very regular arrangement behind somite XXXIII, being always paired and present on every other somite: on XXXV, XXXVII, etc. In another specimen, the same regularity was established to somite LIV, inclusive; then followed three somites with paired elytra, viz., LV, LVI, and LVII; LVIII had cirri; LIX and LX had paired elytra; and from that segment on there occurred a regular alternation of paired elytra and cirri.

In regard to the shape, structure, and pigmentation of the elytra, I found Johnson's (1897, p. 177) information correct. "Elytra slightly undulate at margin, broadly reniform, adorned with a black or dark brown spot over the elytrophore, and a narrow posterior border of the same color . . . very smooth." I did not find any "immaculate" specimens in Monterey Bay. It may be noted that Moore (1908) sometimes found the dorsum to be poppy red.

*Distribution:* Alaska south to San Diego, California. Occurs usually in the littoral or sublittoral, but Moore (1910) recorded it off Santa Catalina, southern California, from a depth of 162 fathoms.

*Biology:* Like *A. vittata*, this species appears to be an obligate commensal with a remarkable tolerance in regard to choice of hosts. The following host relationships have been observed:

*A. pulchra*—

*Stichopus californica*—sea cucumber.....Pacific Grove, Calif. (Johnson)
*Megathura crenulata*—keyhole limpet

*Solaster decemradiata*—starfish.....Washington; Alaska (Moore)
*Cryptochiton stelleri*.....Monterey, Calif. (Moore)
Sea Urchin.....Laguna Beach, Calif. (Moore)

*Asterias*—starfish.....Nanaimo, B. C. (Berkeley)
*Solaster stimpsoni*—starfish
*Pteraster tesselatus*—starfish
*Luidia*—starfish
*Stichopus*—sea cucumber

Systematic Discussion: *Halosydna leioseta* Chamberlin (1919, pp. 2–3), taken at Laguna Beach, California, was described as a commensal with a sea urchin. The description does not diverge from that of *A. pulchra* except that Chamberlin describes the color, after preservation, as grayish with no definite markings. Judging by the variability in the coloration of related species, this single feature should not be accepted as sufficient for specific differentiation.

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