ALLAN HANCOCK PACIFIC EXPEDITIONS

VOLUME 7 NUMBER 4

SOME CONTRIBUTIONS TO THE BIOLOGY AND LIFE HISTORY OF SPIONIDAE FROM CALIFORNIA

With keys to species and genera and descriptions of two new forms

(PLATES 45-48)

by

OLGA HARTMAN

ALLAN HANCOCK FOUNDATION

THE UNIVERSITY OF SOUTHERN CALIFORNIA PRESS
LOS ANGELES, CALIFORNIA
1941

REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA, AND GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935, IN 1936, IN 1937, IN 1938, IN 1939, AND IN 1940.

SOME CONTRIBUTIONS TO THE BIOLOGY AND LIFE HISTORY OF SPIONIDAE FROM CALIFORNIA

With keys to species and genera and descriptions of two new forms

(PLATES 45-48)

By OLGA HARTMAN

The University of Southern California Publications
Allan Hancock Pacific Expeditions
Volume 7, Number 4
Issued April 7, 1941
Price $1.50

The University of Southern California Press
Los Angeles, California

SOME CONTRIBUTIONS TO THE BIOLOGY AND LIFE HISTORY OF SPIONIDAE FROM CALIFORNIA

With keys to species and genera and descriptions of two new forms

(Plates 45-48)

By Olga Hartman

ALLAN HANCOCK FOUNDATION

The present report concerns itself with members of the family Spionidae (polychaetous annelids) from California. The collections originate from different sources. Most were made by the author over a period of years; when they are from other sources, recognition is made. Most of the larval stages reported on were taken from the pier of the Scripps Institution of Oceanography at La Jolla during the spring of 1938; some collections were made in southern California during the author's tenure at the Allan Hancock Foundation of The University of Southern California. The types of new species are deposited in the Allan Hancock Foundation.

The author is deeply indebted for valuable aids from the Scripps Institution of Oceanography at La Jolla during the spring of 1938, and to Dr. Martin W. Johnson, in whose laboratory plankton samples were examined; to Professor S. F. Light of the University of California, with whom the collections in San Mateo County were made during 1933-1936; and for many opportunities made available at the Allan Hancock Foundation of The University of Southern California.

Members of the family Spionidae are largely inhabitants of the intertidal zones, particularly abounding in sandy or muddy sand beaches, in crevices, and in rocky situations. Most are free living; a few are known to be destructive *(Polydora ciliata);* rarely they are commensal *(Polydora commensalis).* Though largely intertidal, some species have been recorded from over 400 fathoms. They are to be classed with the smaller chaetopods, since their length ranges usually from a few to about 50 mm; rarely they may attain twice that length or even more. Because of their small size, they are frequently overlooked in casual collecting. Records from California include Fewkes (1889, pp. 37-38) with one species *(Spio californica),* Treadwell (1914, pp. 199-203) with one (or two?) species *(Spio acuta* and *Polydora californica?),* Chamberlin (1919, p. 17) with one species *(Morants duplex),* Moore (1923, pp. 179-186) with four species *(Prionospio alata, Spionides foliata, S. sacculata,* and *Spiophanes*

fimbriata), and Hartman (1936b, 1940) with six species *(Boccardia brachycephala, B. truncata, Polydora amarincola, Pygospio californica, Rhynchospio arenincola,* and *Streblospio lutincola).* The present report brings the total to 23 species, with one other regarded as indeterminable and another a possible synonym.

The following lists 11 genera and 23 species recorded from California. Ten of these, preceded by an asterisk, are newly reported; 2, *Polydora citrona* and *Spiophanes missionensis,* are believed to be new to science.

Boccardia proboscidea Hartman, p. 299
*?*Boccardia redeki* (Horst), p. 304
Boccardia truncata Hartman (1936b)
**Boccardia uncata* Berkeley, p. 304
Laonice cirrata (Sars), p. 293
Morants duplex Chamberlin (1919)
Nerinides acuta (Treadwell), p. 294
**Polydora armata* Langerhans, p. 306
Polydora brachycephala Hartman (1936b)
**Polydora ciliata* (Johnston), p. 308
Polydora citrona, new species, p. 311
**Polydora commensalis* Andrews, p. 308
**Polydora giardi* Mesnil, p. 309
Polydora ligni Webster, p. 309
**Polydora socialis* (Schmarda), p. 310
Polydora tricuspa Hartman (1940)
Prionospio alata Moore, p. 298
Pygospio californica Hartman (1936b)
Rhynchospio arenincola Hartman (1936b)
**Spio filicornis* (O. F. Müller), p. 293
Spiophanes fimbriata Moore (1923)
**Spiophanes missionensis,* new species, p. 296
Streblospio lutincola Hartman (1936b)

Two other names in the literature merit consideration. *Spio californica* Fewkes (1889, pp. 37-38) is a *Polydora* or *Boccardia,* species indeterminable (Hartman, 1936a, 1940), which renders the next name a homonym. *Polydora californica* Treadwell (1914, pp. 203-204) from unknown locality, though named for California, is perhaps what has since been designated *Boccardia proboscidea.*

CHART OF THE GENERA OF SPIONIDAE KNOWN FROM CALIFORNIA, WITH SOME DIAGNOSTIC FEATURES

	Frontal horns	*First appearance of branchiae*	*Kind of branchiae*	*Number of branchiae*	*Presence of hooks*	*Kind of hooks*	*Nature of pygidium*	*Other unique features*
Spio	absent	first setiger	simple	present throughout	neuropodia	bidentate	with cirri	
Laonice	absent	second setiger	simple	present anteriorly	neuropodia	bidentate	with cirri	with parapodial pouches
Prionospio	absent	second setiger	pennate	3-11 pairs	neuro- and notopodia	multidentate	with cirri	
Spiophanes	partly produced	none	none	none	neuropodia	bi- or tridentate	disklike	
Nerinides	absent	second setiger	simple	many	neuropodia	usually bidentate	disklike	
Pygospio	absent	about nineteenth setiger	simple	through a median region	neuropodia	bidentate	4 short cirri	
Rhynchospio	present	second setiger	simple	many	neuropodia	tridentate	8 short cirri	
Polydora	absent	after fifth setiger	simple	few to many	neuropodia	bidentate	disklike (rarely cirri)	fifth setiger with modified spines
Boccardia	absent	before fifth setiger	simple	many	neuropodia	bidentate	disklike	fifth setiger with modified spines
Morants	present	first setiger	simple	?	neuropodia	bidentate	with 2 cirri	sixteenth setiger with modified spines
Streblospio	absent	first setiger	simple	one pair	neuropodia	tridentate	simple	with dorsal membrane on second segment

KEY TO THE 11 GENERA OF SPIONIDAE FROM CALIFORNIA

1. With a modified segment 2
1. Without a modified segment 5
2. Sixteenth segment modified; branchiae present from the first setiger; pygidium with 2 cirri . . . . . *Morants* (*M. duplex* Chamberlin)
2. Fifth segment modified; branchiae present after the first setiger; pygidium usually disklike (rarely with cirri) 3
3. Branchiae present anterior and posterior to the modified segment . . . . . *Boccardia,* p. 299
3. Branchiae present only posterior to the modified segment . . . . . *Polydora,* p. 305
4. Without branchiae; prostomium with laterally directed processes at its anterior margin; anus with cirri . . *Spiophanes,* p. 296
4. With branchiae; prostomium with or without such processes; anus with or without cirri 5
5. With only one pair of branchiae, these simple, inserted just posterior to the paired palpi; second segment with a raised dorsal membrane; pygidium simple, without disk or cirri . . . . . *Streblospio* (*S. lutincola* Hartman)
5. With more than one pair of branchiae; without such raised dorsal membrane on second segment; pygidium disklike or surrounded by cirri 6
6. Prostomium with articulating lateral horns at its frontal margin; branchiae present from second setiger and on most segments thereafter; uncini distally tridentate . . . . . *Rhynchospio* (*R. arenincola* Hartman)
6. Prostomium without articulating horns; branchiae present from second setiger or later; uncini bidentate to multidentate . . 7
7. Branchiae pennate, limited to a few anterior segments; uncini distally multidentate . . . . *Prionospio (P. alata),* p. 298
7. Branchiae simple, cirriform or straplike, present on several to many segments; uncini usually bidentate (sometimes tridentate) 8
8. Successive neuropodia in a long posterior region connected by interramal pouches . . . . . *Laonice,* p. 293
8. Without such neuropodial pouches 9

9. Branchiae present from first setiger, continued throughout length; pygidium with cirri . . . . . *Spio,* p. 293
9. Branchiae present after the first setiger; pygidium disklike or with cirri 10
10. Pygidium disklike; branchiae present from second setiger through a long region . . . . . *Nerinides,* p. 294
10. Pygidium with cirri; branchiae present from about the nineteenth setiger, continued through the median region; pygidium with 4 short cirri . . *Pygospio* (*P. californica* Hartman)

Genus **SPIO** Fabricius
Spio filicornis (O. F. Müller)

McIntosh, 1910, pp. 172-176, pl. 98, fig. 11, pl. 97, fig. 9, pl. 105, fig. 13; Berkeley, 1936, pp. 475-476; Okuda, 1937, pp. 224-225, figs. 5*a-e*.

Several specimens have been collected from low tidal pools at Marine View, San Mateo County. This species inhabits sandy beaches, where overgrown with some vegetation, at low-water line. Its distribution is cosmopolitan.

Genus **LAONICE** Malmgren
Laonice cirrata (Sars)

Berkeley, 1936; Hartman, 1936a.
Aricidea alata Treadwell, 1902, p. 202, figs. 58-60.
Spionides japonicus Moore, 1907, pp. 204-206, pl. 16, figs. 31-34.
Spionides foliata Moore, 1923, pp. 182-183.
? *Spionides sacculata* Moore, 1923, pp. 184-185.

This has been obtained in shallow dredgings from off La Jolla, off Half Moon Bay (collected by Dr. T. H. Bullock), and off southern California (collected by the *Velero III,* Allan Hancock Foundation). In the specimens from La Jolla the first hooks are present (1) in the last branchial segment, (2) in the last 3 branchial segments, and (3) in the first postbranchial segment, indicating a certain amount of variation in this respect. In other specimens the variation falls within the limits mentioned above. In all examined, the dorsal transverse fold reaches only a short distance from the dorsal face of the notopodium to the trunk region.

Two species of *Laonice* (as *Spionides*) have been described from California—*S. foliata* and *S. sacculata* by Moore (1923). These were separated as follows:

	S. foliata	S. sacculata
Presence of interpodal membrane	from twenty-ninth to thirty-seventh, posteriorly	from twenty-ninth to thirty-second, posteriorly
Presence of branchiae	to segments 43-49	to segments 50-60
Dorsal transverse fold	unites notopodia to body above and to neuropodia below	much less conspicuous than in *S. foliata*
Presence of hooks	immediately posterior to the branchial region	from about the fifty-fifth segment

Because of individual variations noted above, it appears doubtful that these two (*S. foliata* and *S. sacculata*) are to be considered distinct; as shown above, the presence of hooks varies within the specified limits. The observed difference in the transverse folds may be at least partly due to differences in age of specimens and methods of fixation. *Spionides japonicus* has been referred to *Laonice cirrata* (Söderström, 1920, p. 220); *S. foliata* by Hartman (1936a, p. 32). The type of *Arcidea alata* has been examined at the United States National Museum and found to be not a member of the family Paraonidae, but rather a spionid, with palpi broken off near their bases. In all other respects the type specimen agrees perfectly with *Laonice cirrata* (Sars).

L. cirrata is cosmopolitan in distribution.

Genus **NERINIDES** Mesnil

Nerinides acuta (Treadwell)

Plate 45, Figs. 1-8; Plate 47, Fig. 29

Spio acuta Treadwell, 1914, pp. 199-201, pl. 11, figs. 14-20. Hartman, 1936a, p. 32.

Extensive beds of this species have been found in intertidal sandy beaches in southern California, especially along the strand where accumulated debris and kelps are swept in, such as the coves at La Jolla, Laguna Beach, etc. It sometimes forms compact beds, or may be present where *Thoracophelia mucronata* (Treadwell) is dominant. Its vertical burrows in the sand are recognizable at the surface as minute apertures; these may be closely packed when abundant. In life the animal is light green, the pigment contained largely in the walls of the alimentary tract and palpi.

The prostomium is greatly prolonged anteriorly, pointed, widest where it meets the peristomium at the anterior margin. There is a transverse groove just anterior to the eyes (pl. 45, fig. 1). A high nuchal ridge is continued posteriorly a short distance to the third setiger. The palpal bases are at the sides of the ocular ridge. The peristomium is a long, achaetous ring at the sides of the prostomium. The first setigerous segment has only neurosetae; the second is the first branchial segment. Hooded hooks are distally tridentate (pl. 45, figs. 4, 5).

During the early part of May, 1938, eggs and spermatozoa were removed by breaking open the body wall of seemingly mature individuals of *Nerinides acuta*. The egg is elongate ellipsoid, measures approximately 0.21 by 0.129 millimeters, and is greatly depressed when seen from the side. It is covered by a thick membrane, its surface highly sculptured with larger and smaller depressions (pl. 45, figs. 7, 8). It is semitranslucent; a clear vesicle may be distinguished near its center, and smaller clear spots at the narrowed ends. The spermatozoa are highly motile, minute, oval bodies with long tail (pl. 45, fig. 6).

Attempts to inseminate eggs artificially in May resulted in a shrinking away of the cytoplasm from the egg membrane. Normal development was not obtained. Numerous planktonic young individuals of what is believed to be this species were collected during May. Also, early sedentary stages were found in great numbers in sandy beaches at Spindrift, near La Jolla, on May 4, 1938. A comparison of various stages from the plankton and from sandy beaches suggested a probable picture of its development. The youngest sedentary stages observed had 23 segments and measured 1.6 mm long in life. General appearance was much like that of the adult, with greatly prolonged prostomium. The palpi, however, were short, extending posteriorly only to about the fourth or fifth setiger. Branchiae were present from the second segment. The gastric area between segments 8 and 15 was dark. Hooded hooks were present from the thirteenth setiger. The pygidium was nearly hemispherical, provided with a ciliated telotroch.

A similar, earlier stage was taken in plankton late in May, and kept in culture for about a week. The same greenish color with a deep black streak marking the alimentary tract was visible through the body wall, just as in early sedentary stages; palpi were short. The prostomium and anterior end were prolonged, pointed, with 4 dark eyespots (pl. 45, figs. 2, 3). The pygidium was collarlike, with dorsal groove and well-developed telotroch.

A 15-segmented larva, perhaps of this species, was taken in tow on April 28. The prostomium and anterior parts had the proportions shown in pl. 47, fig. 29. From the fourth setiger the alimentary tract was darkly pigmented. Neurotrochs were present on setigers 3, 6, 9, and 10. The pygidium was hemispherical, without cirri, but with well-developed telotroch. The prototroch was still strong, but the anterior end had long smooth capillaries directed anteriorly and laterally. Tridentate hooded hooks, such as characterize adults, were present in neuropodia from the twelfth segment; segments 1 to 11 had smooth capillary setae only. The general appearance of this larva was reminiscent of another larva seen in the plankton on several occasions; in the latter, however, the anterior bristles were markedly spinous; it is believed to have been that of a Disomidae—a small family nearly related to the Spionidae.

The latest stage observed in the plankton was a 32-segmented larva, taken on April 25. In general appearance and color pattern it was much like the smaller larvae observed. The first setiger had a ventral fascicle of capillary setae; from segment 17 neuropodia had 2 tridentate hooks between superior and inferior capillary setae.

Genus **SPIOPHANES** Grube

This genus is characterized in lacking branchiae; the frontal margin of the prostomium is usually produced in a pair of laterally directed processes that are continuous with the prostomium or articulate with it. Notopodia have only long pointed setae; neuropodia, after a number of anterior segments, have hooded hooks that are distally bi- or tridentate. Only 5 species have been ascribed to it—*S. bombyx* Claparède, cosmopolitan in distribution; *S. cirrata* Sars, from cold waters of the Northern Hemisphere; *S. fimbriata* Moore, dredged off California; *S. kroyeri* Grube, reported from many seas; and *S. malayensis* Caullery, from Amboina. *S. missionensis,* described below, is believed to be new to science.

Spiophanes missionensis, new species

Plate 46, Figs. 17-21

The general form is minute, slender, total length about 10 to 15 mm, number of segments about 110. The prostomium is longer than broad, with a depressed, laterally produced frontal margin (pl. 46, fig. 17) but not strictly with lateral horns. There are 4 minute eyespots, disposed in trapezoidal arrangement, the anterior pair wider apart and less distinctly

visible, the posterior pair dorsal in position. The prostomial ridge extends back to the region between the palpal bases.

The first segment has well-developed noto- and neuropodia, with long, tapering cirri; the notosetae are entirely smooth, slender, directed forward; the neurosetae include similar, though shorter, capillary setae and a single stout, recurved, pale spine (pl. 46, fig. 21). The second segment resembles the first save that its cirri are a little smaller than others near them but have thick, glandular areas. Neuropodia shift from a lateral to a ventrolateral position between setigers 14 to 16. The first 14 segments have only long, pointed, capillary setae in both rami. These setae are continued throughout in notopodia. From the fifteenth neuropodium, uncini are present, at first few in number, accompanied by capillary setae, but increasing in number posteriorly. They are distally tridentate (pl. 46, fig. 18).

The first 16 segments are notably more depressed than those following. From the seventeenth segment a transverse dorsal membrane is present and continued through the rest of the body length. Where best developed it consists of 18 to 20 short, transverse bands of long cilia, the whole forming a trim, straight row across the dorsum, between paired notopodia. Interramal pouches have not been observed, even in individuals with large eggs.

The egg (possibly near maturity) is oblong, approximately 0.12 x 0.096 mm, white; its surface appears punctate on account of numerous depressions under the surface membrane (pl. 46, fig. 19). This egg is reminiscent of that of *Poecilochaetus serpens,* a member of the Disomidae, described by Allen (1904, pp. 79-151).

The pygidium is a long ring, with dorsal anal opening, a pair of slender cirri inserted dorsolaterally, and a thick, somewhat depressed, unpaired median papilla ventrally (pl. 46, fig. 20).

S. missionensis inhabits well-constructed, sand-covered tubes open at both ends, disposed vertically in sandy beaches. It has been collected only at moderately high-tide line, in Mission Bay, near the place where it enters the ocean, on the north side; here it is common just east and south of a metal culvert that empties into the bay.

S. missionensis differs from other species of *Spiophanes* in the following complex of characters: (1) the prostomium is anteriorly produced but lacks true horns; (2) it lacks a median antenna on the prostomium; (3) there are no interramal parapodial pouches; (4) the pygidium has long, paired cirri and a thick, ventral papilla. *S. fimbriata* Moore (1923, p.

179), dredged from central and southern California (in 38 to 357 fms), differs from the new species in the following: (1) it has a slender, erect antenna near the truncated apex of the prostomium; (2) the dorsal transverse membranes are ruffled; (3) there are lateral interparapodial pouches after the fifteenth segment. The nature of the pygidium could not be determined because of fragmentary specimens.

Holotype.—AHF no. 32.

Distribution.—Mission Bay, California, intertidal.

Genus **PRIONOSPIO** Malmgren

Prionospio alata Moore

Moore, 1923, pp. 185-186.

A single specimen, agreeing with the original description, has been dredged off La Jolla, in about 45 fms, during a cruise of the *E. W. Scripps* of the Scripps Institution of Oceanography, April 19, 1938. Moore's single type specimen was dredged off Point Pinos Light in 56-57 fms.

Discussion on the Genera **Boccardia** Carazzi and **Polydora** Bosc

These 2 genera have long been separated on the basis of a single character—presence or absence of branchiae anterior to the modified segment. The artificiality of this separation may be argued, especially since the presence of branchiae on segments posterior to the modified one has only specific significance. It is of interest that among the species of these genera, some of each have 2 kinds of heavy spines in the modified segment. Thus, among species of *Boccardia, proboscidea* has 2 kinds whereas *uncata, redeki,* and *truncata* have but a single kind. Among species of *Polydora, tricuspa* and *citrona* have 2 kinds; most of the others have but a single kind. Furthermore, among the species of these genera, *B. uncata, P. hamata,* and *P. hoplura* possess heavy hooks, greatly resembling one another, in some posterior segments. These characters would seem to have phylogenetic significance. It is thus not convincing that the species comprising these genera are clearly separable as are those of most other genera. However, their separation is here maintained for convenience.

The modified segment is herein designated the fifth (setigerous) segment, although it is recognized that the peristomium (achaetous) is actually a segment. Some authors have therefore called the modified one the sixth.

Genus **BOCCARDIA** Carazzi

Branchiae are present anterior to the modified fifth setiger; modified hooks in the fifth are of one or 2 kinds; heavy spines in posterior segments are present or absent.

Key to Species of Boccardia from California

1. Major heavy spines in fifth (modified) segment of 2 kinds; branchiae present on setigers 2, 3, 4, 6 and to near end . . . . . *B. proboscidea,* p. 299
1. Major heavy spines in fifth segment of only one kind; branchiae disposed otherwise 2
2. A posterior region (preanal) with modified heavy spines . . . . . *B. uncata,* p. 304
2. Posterior region without modified heavy spines 3
3. Branchiae present on setigers 2, 3, 6 and to about the posterior fifth of the body . . . . . *B. truncata* Hartman
3. Branchiae present on setigers 2, 3, 7 and through a long median region . . . . . ? *B. redeki,* p. 304

Chart of the Species of Boccardia from California, with Some Diagnostic Features

	proboscidea	truncata	uncata	?redeki
presence of branchiae	on 2, 3, 4, 6, to near end	on 2, 3, 6, through a long region	on 2, 3, 6, to about posterior fourth	on 2, 3, 7, through a long region
heavy spines in posterior segments	absent	absent	present	(not known)
number of kinds of heavy spines in fifth setiger	2: simple falcate and bushy topped	1: simple falcate with subdistal concavity	1: simple falcate	1: simple falcate

Boccardia proboscidea Hartman[1]

Plate 46, Figs. 22-28; Plate 47, Figs. 30-37

Hartman, 1940, J. Wash. Acad. Sci., vol. 30, pp. 382-387, figs. 1*a-j*.
?*Polydora californica* Treadwell, 1914, pp. 203-204 (not Fewkes, 1889).
B. natrix Hartman, 1936a, p. 32 (not Söderström, 1920).

[1] Berkeley (in litt.) has called attention to the similarity of *B. proboscidea* to *B. columbiana* Berkeley (1927, p. 12) but the major spines in the fifth setiger are different (*cf.* Berkeley, pl. 1, fig. 6).

This is the commonest intertidal spionid in California, inhabiting particularly soft, reef-building shales, narrow interstices in harder rocks, and fine crevices among other suitable hard objects. If in shales, it occurs usually in vertical or oblique burrows made by the inhabitant; if in crevices, these are usually in oblique positions, the adjacent hard surface slightly grooved by the back-and-forth movement of the worm. A thin, mucoid, debris-covered tube covers it. The abundance of this species is often so great as to form a conspicuous part of the intertidal fauna. It may be found in low-lying, flat reefs, especially if these be of soft limestone or shale. When conditions are favorable, as they are in the vicinity of reefs at Moss Beach, San Mateo County, at Point Fermin, at Point Conception and other places, the burrows may be numerous, closely spaced, only a few millimeters from one another. Also, in high tidal pools, where temperature/salinity ratios may fluctuate greatly, this species successfully maintains itself.

B. proboscidea is not known to occur outside California. Its bathymetric range extends from the high intertidal pools to moderately low-water line; it has never been recovered from dredged collections. It is tolerant to salinities ranging from strictly marine to brackish, such as are found in the eastern end of San Francisco Bay, in the vicinity of Berkeley; its presence in high tidal pools indicates that it tolerates high salt content. Its ecologic niche is soft stones or narrow rocky crevices; it has never been found associated with sandy beaches or a strictly soft substratum.

B. proboscidea belongs to a small group in which the heavy spines of the modified fifth segment are of 2 kinds—(1) stout, smooth, falcate, and (2) bristle topped, in which the bristled area is limited to a region beyond the thickest part (pl. 46, fig. 24). The prostomium is prolonged anteriorly so as to extend beyond the peristomium; it is smooth, entire at its frontal margin (pl. 46, fig. 22). A caruncle extends posteriorly between the palpal bases to the posterior margin of the third setiger. A considerable sooty pigmentation is usually to be seen in the grooves between prostomium and peristomium. On the ventral side, the anterior portion of the prostomium has a median groove (pl. 46, fig. 23). In adult males, parapodial glands are present from the seventh to ninth segment; spermatozoa from the fourteenth; nephridia are greatly enlarged in this region. Hooded hooks are first present from the seventh setiger.

The interesting development of this species was first called to the author's attention several years ago by Professor S. F. Light, while at Moss Beach, near San Francisco. During the spring and summer months,

adults with developing stages are obtainable. They are tolerant to conditions in the laboratory and may be kept alive for weeks in small dishes. The translucency of the cocoon permits observation of activities within. Eggs are deposited in soft, capsulelike cocoons (pl. 47, fig. 33). They are spherical in shape, opaque, yellow, measuring 0.12 to 0.15 mm in diameter and number 20 to 80 in a cocoon. Size of eggs and cocoons varies directly with that of the adult depositing them. Fifteen to 20 or more cocoons are deposited within the loosely constructed tube of an adult, approximately in linear series; each cocoon is attached to the tube (pl. 46, fig. 28) by a double stalk.

Söderström (1920, pp. 185-191) has given the most plausible explanation of the manner of egg deposition and cocoon building as it is known to occur among some members of the Spionidae. His observations and conclusions were based on *Pygospio elegans* Claparède and 2 species of *Polydora*. Since these views are in striking contrast to others that have been forwarded by Whitlegge, Mesnil and Caullery, and others (see Söderström, 1920, p. 185), they are briefly summarized. Söderström maintains that the rim of the nephridial pores secretes the material making up the capsular membranes, and that the eggs (which sometimes measure considerably more than the diameter of the nephridial aperture at the time of egg laying) literally flow through the nephridial tube and only take their definitive form in the capsule. At the time of egg laying, the body of the adult is pressed close against the wall of the tube. A secretion emerges from a pair of nephridial pores of a particular segment and is applied to the wall of the tube until a pair of short stalks results. This substance is sticky when shed but does not adhere to the eggs. When the eggs are extruded, they cause the walls of the elastic membrane to extend, such that its inner walls merge, resulting in a single vesicular sack (pl. 46, fig. 27). Thus, eggs emerging from both nephridial pores at the same time come to occupy the same capsule. The free distal end of a cocoon terminates the process and may show a small papillar elevation on either side, or it may be evenly rounded (as in *B. proboscidea*). The end of the process is diagrammatically shown in pl. 46, fig. 27.

The fertilized egg gives rise to a smooth, spherical, opaque blastula. If development is allowed to proceed normally (in the absence of cannibalism), a weakly ciliated, nearly spherical, modified trochophore develops. The cephalic region is identifiable by a pair of clear spots at the anterior end (pl. 47, fig. 30). In many cocoons development of all zygotes seemingly proceeds at such tempo that all embryos are in about the same

stage of development. In others such is not the case; a few more precocious individuals soon attack the more retarded ones, so that the cellular contents are withdrawn (see below).

The earliest embryos in which structures are visible have a slightly lobed appearance (pl. 47, figs. 30, 31). The oral area of the anterior region is well ciliated. There are weak indications of segmentation and shallow transverse grooves on the ventral side, set apart by rows of short cilia. No long trochal cilia are observable, such as characterize typical planktonic polytrochs. The region of the alimentary tract is filled with yellow granular yolk particles. Not long thereafter prototroch and telotroch are present, and the cephalic region is better defined (pl. 47, fig. 32). This short, rotund form gives rise to a triangular-shaped, 3-segmented larva (pl. 47, fig. 37). The prostomium is clearly marked with 2 pairs of dark eyespots dorsolaterally and a pair of clear pouches opening anteriorly. On the ventral side the oral aperture is well ciliated, the lower lip bounded by large columnar cells. Before setae have emerged, elongate cells in the setigerous sacs may be seen with slender, rodlike spines. Setae that finally emerge are entirely slender, capillary, provisional, without limbate region such as those in the adult. These setae from the first 3 segments elongate rapidly and extend posteriorly so as to surpass the anal end. The alimentary tract is complete when the full length of the setae has been attained. If a cocoon be broken open in which such larvae are encased, they squirm rapidly out of the case and swim about, alternately holding the setae along the sides of the body or thrusting them laterally (pl. 47, fig. 37).

Several such cocoons were isolated in separate culture dishes, on March 2, to determine the fate of the larvae if left undisturbed, and whether they could effect their own release from the capsule. After 6 days they were still moving about in the cocoon, though considerably impeded by the proximity of others in the case. Many setae had been pulled out and were packed in the stalk end of the capsule. After 8 days the larvae were dead. Rate of survival of other cocoons differed somewhat, but in no case did they bring about their own release from the cocoon. It seems that an external stimulus must be applied, such as might be produced by the brooding individual in passing back and forth through the tube.

Other similar cocoons were broken open, permitting the young to escape. These were kept in culture for several weeks. They were capable of foraging for themselves and kept alive with no difficulty. When sup-

plied with a matrix in which adults had been present, the young settled and built tubes. During the spring months of 1938 similar larvae were frequently encountered in the plankton, especially over areas where adults were known to occur.

In a young (4-segmented) larva there is slight trace of dark pigment, at the anterior end of the prostomium and anal ring. There are as yet no dorsal melanophores such as in later stages. Eyes are irregular in shape and number, forming a transverse band of 4 to 8 spots along the dorsal side of the prototroch. Capillary setae are long, limited to the first 3 segments, those of the first longest, extending distally beyond the body. The prostomium is strongly ciliated. The ventral lobes at the anterior margin of the mouth have numerous short cilia, continued in the pharynx. The peristomium is recognizable as a pair of pouches at the sides of the outer pair of eyes. A pair of thick ridges posterior to the lateral eyes are the palpal rudiments.

In capsules where cannibalism occurs, the larger individuals gradually and effectively not only ingest blastulae but attack younger larvae and devour them. In some tubes examined, it was found that all cocoons were of this kind. Whether this fact was due to an inherent trait or to physical conditions has not been ascertained. The more robust larvae continue to develop at the expense of other capsular contents, adding segments posteriorly, far beyond the 3-segmented stage, to the 12- or 15-segmented one. They remain relatively quiescent, perhaps because of their greatly extended condition. Like their relatives in the plankton, they have dorsal melanophores in a similar pattern and deeply pigmented eyespots (pl. 46, fig. 26). It is not unlikely that when escape is finally accomplished, they settle without entering the plankton.

Three to 15-segmented planktonic larvae of this species are common elements in plankton in spring. They are recognizable by a complex of characters distinguishing them from other spionid larvae. The prostomium is broad, truncate in front, with eyespots approximately in crescentic arrangement. Each segment has a medially placed, black spot on the dorsal side. These are broad, dendritically branched on the first 6 segments, diminishing in size thereafter (pl. 47, fig. 34). They are capable of expansion and contraction. During larval life the long capillary setae are replaced by thicker limbate setae in the first 4 setigerous segments, and from the postmodified (fifth) segment to the anal end. The modified fifth has typically 2 pairs of stout spines on either side, resembling those in the adult but much smaller (pl. 47, fig. 36). Palpi are short, thick,

heavily ciliated, folded over as seen in lateral view. When this stage has been reached, settling occurs if a suitable substratum is provided. The latest planktonic larvae observed had 15 segments.

Boccardia uncata Berkeley

Plate 48, Fig. 46

Berkeley, 1927, p. 418, pl. 1, figs. 9-13; Okuda, 1937, pp. 238-240, figs. 16, 17.

This occurs abundantly in masses of oysters in Mission Bay, on the south side of the bridge over which the San Diego electric railway tracks pass. It is recognizable in having branchiae on the second and third setigerous segments, and from the sixth posteriorly; a long, closely crowded posterior portion lacks branchiae, but has heavy modified hooks (pl. 48, fig. 46).

Originally described from British Columbia, it has since been reported by Okuda (1937) from Japan. This is the first record from southern waters.

?**Boccardia redeki** (Horst)

Plate 48, Figs. 44, 45

Polydora redeki Horst, 1920, p. 111, 2 figs.
Polydora (Boccardia) redeki Okuda, 1937, pp. 240-241, fig. 18*a-d*.

A single incomplete specimen was taken with numbers of *Polydora socialis* from Mugu Lagoon, and another fragment from Mission Bay, southern California. Branchiae are present on setigers 2, 3, 7 to the end of the piece. The prostomium has 4 large eyespots, disposed in trapezoidal arrangement. A caruncle extends posteriorly to the end of the third setiger. The anterior end of the prostomium is somewhat prolonged, weakly incised. The first setiger lacks dorsal setae but has a ventral fascicle on either side. The stout spines of the fifth are smooth, slightly falcate, their companion pennoned setae fairly large (pl. 48, fig. 44). Hooded hooks are distally bifid, the hooked end oblique to the main stalk (pl. 48, fig. 45). The nature of the pygidium could not be determined. These specimens agree very well with the description by Okuda, but differ in some details from the original description.

P. redeki Horst was originally shown with a caruncle extending only to the middle of the second setiger; in the present specimens it is continued to the end of the third segment. Also, Horst shows the 4 prostomial

eyes in a nearly transverse line and says, "De koplob is zwak ingesneden en voorzien van twee paar oogen, die alle op één dwarse lijn staan." In ours the 4 eyes are in quadrangular arrangement. The nature of uncini and the kind of pygidium were not disclosed by Horst.

Genus **POLYDORA** Bosc

Polydora is distinguished from *Boccardia* in lacking branchiae on segments anterior to the modified fifth segment. It was originally erected for *P. cornuta* Bosc, from South Carolina, but was not sufficiently defined to reidentify; the type of the genus remains unknown except as a member of this group. The genus has been revised by Mesnil (1896), Söderström (1920), and others.

Key to Species of *Polydora* from California

1. Prostomium and palpi very short; major spines of fifth modified segment falcate with a long, lateral sheath; pygidium with about 14 papillae; commensal with hermit crab *P. commensalis,* p. 308
1. Prostomium with palpi otherwise; major spines of fifth segment without a long sheath if falcate; pygidium without numerous papillae; not commensal with hermit crab 2
2. Pygidium with 4 cirri disposed in a cross; major spines of fifth segment of 2 kinds, both with bristly top (pl. 45, figs. 12, 13); prostomial ridge very narrow, greatly eclipsed by the large peristomium; bright yellow in life . . . . *P. citrona,* p. 310
2. Pygidium disklike; major spines of fifth segment otherwise; prostomial ridge not so reduced 3
3. With conspicuous bundles of heavy spines in a few posterior segments; major spines of fifth segment falcate, with a large overhanging flange (pl. 48, fig. 39); in coralline hummocks . . . . . *P. armata,* p. 306
3. Without such spinous fascicles in posterior segments; major spines of fifth segment without overhanging flange 4
4. Prostomial caruncle with a median antenna; major spines of fifth segment falcate with sharp accessory tooth in concavity (pl. 48, fig. 48) . . . . . *P. ligni,* p. 309
4. Prostomial caruncle without median antenna; major spines of fifth segment otherwise 5

5. Major spines of fifth segment falcate with pectinate top . . . . . *P. brachycephala* Hartman
5. Major spines of fifth segment otherwise 6
6. Branchiae present from tenth setiger to about the twenty-fifth, a posterior region abranchiate . . . . *P. giardi,* p. 309
6. Branchiae present from seventh or eighth setiger 7
7. Major spines of fifth setiger of 2 kinds, falcate and tricuspid . . . . . *P. tricuspa* Hartman
7. Major spines of fifth of a single kind, not tridentate . . . 8
8. Major spines of fifth segment with a lateral, sheathlike tooth (pl. 48, fig. 40); branchiae present from seventh segment . . . . . *P. ciliata,* p. 308
8. Major spines of fifth segment falcate, with boss in concavity (pl. 48, fig. 41); branchiae present from eighth segment . . . . . *P. socialis,* p. 310

Polydora armata Langerhans

Plate 48, Figs. 38, 39

Langerhans, 1880, pp. 93-94, pl. 4, fig. 5; Fauvel, 1927, pp. 55-56, fig. 19; Okuda, 1937, pp. 230-231, fig. 10.

Along much of the intertidal zone of southern California, where low-lying reefs, flat rocks, and shallow crevices are found, harder surfaces are frequently covered over by an encrusting pale red alga. Some of these masses appear coarsely prickly; at the tip of each small elevation a small aperture may be distinguished. These mark the openings of burrows of *P. armata.* The burrows ramify irregularly through the calcareous matrix.

Specimens from La Jolla are small, inconspicuous, number of segments about 32. The prostomium is weakly bifid at its anterior margin; it lacks eyespots (observed in life). Branchiae are first present from the seventh segment, number only 5 or 6 pairs, and are continued on segments 7 to 12 or 13; they are large, with long cilia continued along their length. The first segment has both dorsal and ventral setal fascicles.

The fifth segment has a dorsal fascicle of stout spines accompanied by bipinnate setae and a ventral fascicle of about 5 slender capillary setae. The modified spines have a falcate tip with heavy flange at the geniculate portion (pl. 48, fig. 39). Hooded hooks are distally bifid (pl. 48, fig. 38), present from the seventh segment to the end. Parapodial glands occur in segments 7 to 11. Fascicles of heavy spines are present in notopodia of the

Chart of the Species of *POLYDORA* from California

Name of species	*Branchial pairs, presence and number*	*First setiger*	*Posterior spines*	*Major spines in fifth*	*Prostomial eyes*	*Hooded hooks*	*Nature of pygidium*	*Other unique features*
armata	from seventh, 5-7 pairs	with dorsal and ventral fascicle	with close fascicle of many	1 kind: falcate with broad flange	absent	from seventh segment	disklike	burrows in corallines
brachycephala	from seventh to about twentieth last	with dorsal and ventral fascicle	absent	1 kind: falcate with pectinate top	present	from seventh segment	disklike	
ciliata	from seventh to about tenth last	with only ventral fascicle	absent	1 kind: falcate with accessory sheath	present	from seventh segment	disklike	burrows in calcareous structures
citrona	from seventh through anterior third	with dorsal and ventral fascicle	absent	2 kinds: with bristly tops	present	from tenth segment	with 4 cirri	minute prostomium; pointed hooded setae post
commensalis	from sixth through most of length	with dorsal and ventral fascicle	absent	1 kind: falcate with lateral flange	present	from twelfth segment	with about 14 papillae	very short palpi and prostomium; commensal
giardi	from tenth to about twenty-fifth	dorsal and ventral fascicle vestigial	absent	1 kind: falcate with close accessory tooth	absent?	from seventh segment	disklike	
ligni	from eighth to about tenth last segment	with only ventral fascicle	absent	1 kind: falcate with sharp accessory tooth	present	from seventh segment	disklike	
socialis	from eighth nearly to end	with only ventral fascicle	absent	1 kind: falcate with small subterminal boss	present	from seventh segment	disklike	
tricuspa	from eighth to about twenty-fifth	with only ventral fascicle	absent	2 kinds: simple falcate and tricuspid	present	from seventh segment	?	

last 6 segments; those in the fifth and sixth last segments are unusually conspicuous bundles; those in the last 4 segments are much smaller; the neuropodia of these segments are provided with a series of about 4 hooded hooks and a lanceolate seta.

The pygidium is a narrow collar, not much wider than the posterior end of the body. A simple gregarine has been found in the alimentary tract.

This is the first record of *P. armata* from the eastern Pacific. Okuda (1937, pp. 230-231) has recorded it from Japan, associated with coral, algae, sponge, and a mollusk.

Polydora ciliata (Johnston)

Plate 48, Fig. 40

Fauvel, 1927, pp. 49-50, fig. 16; Berkeley, 1936, p. 472; Okuda, 1937, p. 230, fig. 9.

Numerous collections from Point Richmond, San Francisco Bay, Muir Beach, San Mateo County, and others from Mission Bay near San Diego, all from the intertidal zones, are attributed to this species. They agree with descriptions indicated in the synonymy above. The heavy modified spines of the fifth setiger are falcate, with a lateral sheath; their companion pennoned setae are proportionately large (pl. 48, fig. 40).

P. ciliata has been widely reported from many seas; it is known especially for perforating calcareous shells and has been shown to be injurious to shell-fish industries (Lunz, 1940, p. 310).

Polydora commensalis Andrews

Andrews, 1891, pp. 25-35, 2 pls.; Berkeley, 1936, pp. 469-471; Annenkova, 1938, p. 178, fig. 14.

This has been recovered from shells of Ilyanassa occupied by hermit crabs, from beaches in southern California. Unique features of this species include: (1) the large robust body with short, thick palpi and short prostomium; (2) broad, straplike branchiae; (3) modified falcate spines in the fifth segment, with a long, narrow sheath. First described from Beaufort, North Carolina, it has since been reported from British Columbia (Berkeley) and the North Japan Sea (Annenkova). Another specimen in our collections comes from Mazatlan, Mexico (collected by Dr. Martin W. Johnson), also found with a hermit crab.

Polydora giardi Mesnil

Plate 48, Fig. 43

Mesnil, 1896, pp. 195-202, pl. 13, figs. 1-12.

Numerous collections have been made from La Jolla, California, from narrow crevices in low-lying shales, occupying a niche much like that of *Boccardia proboscidea,* but in a lower zone. This is a much smaller, slenderer species than that of the Boccardia, hardly exceeding 10-15 mm in length, and differs in other morphological characters. Branchiae are first present from the tenth setiger, and continue posteriorly through at least 24 segments; a long posterior region is abranchiate.

The prostomium is distinctly bifid at its anterior margin; a caruncle extends back nearly to the middle of the fourth setiger. Modified spines of the fifth are falcate, with an accessory, closely appressed tooth on those embedded; those exposed are simple, falcate, or with only a minute tooth. A series of hooks from one side is shown in pl. 48, fig. 43. Hooded hooks are distally bifid, the stalk at an oblique angle to the tip. The pygidium is a thick, collarlike disk, nearly half as long as broad, only slightly flaring, with dorsal and dorsolateral notches. Prostomial eyes have not been distinguished.

P. giardi has remained unreported save from Europe. Because of its small size and inconspicuous niche, it may have escaped detection in some places.

Polydora ligni Webster

Plate 48, Figs. 47-49

Webster, 1879, p. 119. [The figures here cited were not published until 1886, in the 39th Ann. Report.]

Berkeley, 1936, pp. 471-472.

P. amarincola Hartman, 1936, p. 49, figs. 6-10.

Both adults and what are believed to be planktonic juveniles of this species have been collected from central and southern California. The following features are characteristic: (1) the prostomium is distinctly bifid at its anterior margin; (2) the prostomial caruncle has a slender, cirriform antenna; (3) branchiae are present from the seventh setiger nearly to the posterior end; (4) the pygidial disk is broad, flaring; and (5) the modified spines of the fifth setiger are falcate with a sharp secondary tooth in the concave region (pl. 48, fig. 48).

Planktonic stages of what are believed to be this species have been taken during April at La Jolla. The 3-segmented larva has conspicuous dark eyespots and paired black stripes dorsally (pl. 48, fig. 49). Later stages, up to a 19-segmented, have been taken from tows. One of the later stages is shown in pl. 48, fig. 47. These larvae have modified spines (pl. 48, fig. 48) in the fifth setiger as typical of the adult.

P. ligni has been collected from Mission Bay (with *P. citrona*) north to San Francisco Bay, especially from estuarine habitats. As *P. amarincola* (Hartman, 1936, p. 49) it has been reported from Lake Merritt, Oakland, an inland arm of the sea with highly fluctuating salinity, especially on the brackish side. Inclusion of these specimens with Webster's *P. ligni* (1879) from New Jersey was first considered doubtful because of the striking differences in size between the two. *P. ligni* was described as measuring only 1 to 4 mm long; specimens from California measure 25 to 30 mm long. Since these studies were begun, it has been possible to examine not only Webster's types but also collections from other parts of eastern America, and these all agree in morphological details with the specimens from California; individuals from North Carolina are approximately as large as those from southern California.

Polydora socialis (Schmarda)

Plate 48, Figs. 41, 42

Mesnil, 1896, pp. 193-194, pl. 12, figs. 30-32.

Numerous collections from Mugu Lagoon, southern California, and several from Point Richmond, San Francisco Bay, are referred to this species. The former are much smaller than their more northern representatives—their lengths only 8-10 mm as against 25-30 mm. At Mugu Lagoon it forms extensive beds, over a muddy sand substratum, the soft, gray, mucoid tubes lying over or near the surface, close to one another. The specimens from San Francisco Bay were taken from a low, intertidal eel grass bed. Originally described (1861) from Chile, this has remained unknown except through Mesnil's redescription (1896) of the type collection. This author concluded that this is "une espèce surtout voisine de *P. caeca*. Les ressemblances sont grandes, et les différences d'importance secondaire." Berkeley (1936, p. 468) has described a subspecies, *P. socialis plena* from Nanaimo, British Columbia, which differs from the stem form in having notosetae in the first segment.

Specimens examined have the following characters. The body is long, attenuate. The prostomium is clearly bifid at its anterior margin; its caruncle extends back to the posterior margin of the fourth setiger (hence much longer than in *P. caeca* Oersted). The first setiger has only a neurosetal fascicle. Branchiae are first present from the eighth setiger, though small; from the ninth they are larger and are continued posteriorly nearly to the end (in *P. caeca* they are missing from a long posterior end). Hooded hooks are first present from the seventh; they are distally bifid, the angle of the stalk and tip oblique (pl. 48, fig. 42). Stout spines of the fifth setiger are falcate, with an enlargement or boss in the concave region (pl. 48, fig. 41). The pygidium is a flaring disk, entire in its ventral portion, with deep dorsal notch (specimens from San Francisco) or also with shallow lateral notches (specimens from Mugu Lagoon).

P. socialis may be typically an estuarine form. The type locality was given only as "Chile."

Polydora citrona, new species

Plate 45, Figs. 9-16

The general form is long, attenuate, length 20-30 mm, number of segments 120 or over. It is ochre yellow in life, in striking contrast to the dark sandy mud in which it lives, associated with an anomurid crab *(Upogebia)*. Palpi (preserved) extend posteriorly to about segment 8-10. The prostomial ridge is greatly reduced, a minute longitudinal ridge superimposed on the much larger, inflated peristomial, pouchlike ring (pl. 45, fig. 10). Four minute black eyespots, nearly in a straight line, lie just in front of the palpal bases on the ridge. The anterior margin of the prostomium is bluntly rounded, somewhat turned up distally (in lateral view) (pl. 45, fig. 9). A caruncle extends posteriorly to the third setiger but is not conspicuous.

The first 4 setigers have noto- and neuropodial fascicles increasing in size gradually posteriorly, those of the first the smallest. The postsetal lamellae likewise increase in size proportionately, but nowhere are they larger than those of the postmodified segments. The fifth (modified) segment is large, inflated, fully twice as long as segments proximal to it. It bears a heavy dorsal fascicle of brown spines and a neuropodial fascicle of capillary setae which are nearly as large as those of the next segment,

thus not as in most species of *Polydora* where they are usually much reduced in size and number. The heavy spines are of 2 kinds—a larger anterior row of about 5 or 6, with a heavy cylindrical stem and an expanded, bushy top (pl. 45, fig. 12), accompanied by an equal number of smaller spines with weaker stem and weakly bifid, hooded top beset with short bristles (pl. 45, fig. 13).

Branchiae, first present from the seventh setiger, are continued through about 50 to 70 segments, but absent from about the posterior two thirds of the body. They are broad, straplike, those of opposite sides directed inward and backward, not quite touching medially (preserved). Hooded hooks are first present in the tenth neuropodium; here there are about 5 hooks medially, accompanied with capillary setae above and below. By the twelfth there are about 8 such hooks with only 1 or 2 capillaries. Hooded hooks in anterior parapodia have a bifid tip, the distal end at an oblique angle to the main stalk. In middle and posterior segments these are gradually replaced by hooded setae that are distally pointed (pl. 45, fig. 14). In a posterior segment there are about 12 such hooded setae; when their tips are broken off they somewhat resemble irregular hooks, but their incomplete condition may be checked by an examination of their hood, which extends far beyond the broken tip (pl. 45, fig. 15) or by comparison with others in the same fascicle (compare pl. 45, figs. 14, 15). In so far as I am aware, this is the only described species of *Polydora* with such hooded setae. Another aberrant feature is the pygidium—here provided with 4 subequal clavate papillae, disposed in a cross, instead of a flaring or disklike membrane (pl. 45, fig. 11).

The eggs are white, laid singly within the tube where the young develop. No stage later than a 3-segmented was observed. This is a typical spionid chaetiger; the long provisional setae of the first 3 segments extend well beyond the pygidial region (pl. 45, fig. 16); prototroch and telotroch are developed. This stage is colorless save for 4 black eyes and a dark alimentary tract.

P. citrona differs from other species of the genus in having a minute prostomial ridge, in having modified spines of 2 kinds, both with bristled tops, in having its posterior hooded neurosetae terminate in a point, and in having pygidium provided with 4 cirri. It has been found only in Mission Bay, near the Causeway, during September, 1938, in beds of *Upogebia,* but was probably not commensal.

Holotype.—AHF no. 33.

Type locality.—Mission Bay, California.

Spionid larva

Plate 48, Figs. 50-53

During April and May, 1938, a small, spionid larva was encountered many times in plankton taken from the pier of the Scripps Institution. This differed from all other spionid larvae in having a conspicuously prickly pygidium, hemispherical in shape (pl. 48, figs. 51, 52). It lacked pigment except for 4 dark eyes on the prostomium and yellow alimentary tract. Like other spionid chaetigers, when disturbed, it thrust its setae laterally; this is also the position assumed when fixed (pl. 48, fig. 50). In life the long, larval setae were directed posteriorly or laterally. In addition to prototroch and telotroch, there were paratrochs on the third and fifth setigers. A 9-segmented larva had bifid hooded hooks (pl. 48, fig. 53) in neuropodia of segments 8 and 9, 2 in each foot of segment 8, and 1 in each of the ninth. All other segments had smooth capillary setae only, those of the first 2 segments the longest.

Only a few spionids are known to have a papillated pygidium; none has been recorded from western America which agrees with the conditions in this larva.

LITERATURE CITED

Allen, E. J.

1904. The anatomy of *Poecilochaetus* Claparède. Quar. J. Micr. Sci., vol. 48, pp. 79-151, 6 pls., 1 fig.

Andrews, E. A.

1891. A commensal annelid. Amer. Nat. N.Y., vol. 25, pp. 25-35, 2 pls.

Annenkova, N. P.

1938. Polychaeta of the North Japan Sea and their horizontal and vertical distribution. Trudy Hydrobiol. Exped., U.R.S.S., in 1934 to the Japanese Sea, pp. 81-230, 16 figs.

Berkeley, E.

1927. Polychaetous annelids from the Nanaimo district. Pt. 3, Leodicidae to Spionidae. Contr. Canad. Biol. Toronto, n.s., vol. 3, pp. 405-422, 1 pl.

Berkeley, E. and C.

1936. Notes on Polychaeta from the coast of western Canada. I. Spionidae. Ann. Mag. Nat. Hist., ser. 10, vol. 18, pp. 468-476, 1 fig.

Chamberlin, R. V.

1919. New polychaetous annelids from Laguna Beach, California. Journ. Ent. and Zool., Pomona College, vol. 11, pp: 1-23.

Fauvel, P.

1927. Polychètes sedentaires. Faune de France, Paris, vol. 16, pp. 1-494, 152 figs.

Fewkes, J. N.

1885. New Invertebrata from the coast of California. Bull. Essex Inst., vol. 21, pp. 99-146, 7 pls.

Hartman, O.

1936a. Nomenclatorial changes involving California polychaete worms. J. Wash. Acad. Sci., vol. 26, pp. 31-32.

1936b. New species of Spionidae (Annelida polychaeta) from the coast of California. Univ. Calif. Publ. Zool., vol. 41, pp. 45-52, 22 figs.

1940. *Boccardia proboscidea,* a new species of spionid worm from California. J. Wash. Acad. Sci., vol. 30, pp. 382-387, fig. 1*a-j*.

Horst, R.

1920. Polychaete anneliden uit het Alkmaarder Meer. Zool. Meded. Leiden, vol. 5, pp. 110-111, 2 figs.

Langerhans, P.

1880. Die Wurmfauna der Madeira. Zeits. Wiss. Zool., vol. 34, pp. 87-143, 3 pls.

LUNZ, G. R., JR.

1940. The annelid worm, *Polydora,* as an oyster pest. Science, N.Y., vol. 92, p. 310.

MCINTOSH, W. C.

1910. A monograph of the British Annelids. Vol. 2, pt. 2. Polychaeta. Syllidae to Ariciidae. Ray Society, London. Pp. 233-524, 27 pls.

MESNIL, F.

1896. Études de morphologie externe chez les Annélides. 1. Les Spionidiens des côtes de la Manche. Bull. Sci. France et Belgique, vol. 29, pp. 110-287, 9 pls.

MOORE, J. P.

1907. Descriptions of new species of spioniform annelids. Proc. Acad. Nat. Sci. Phila., vol. 59, pp. 195-207, 2 pls.

1923. The polychaetous annelids dredged by the U.S.S. "Albatross" off the coast of southern California in 1904. IV. Spionidae to Sabellariidae. *Ibid.,* vol. 75, pp. 179-259, 2 pls.

OKUDA, S.

1937. Spioniform polychaetes from Japan. J. Fac. Sci. Hokkaido Imp. Univ., Sapporo, ser. 6, vol. 5, pp. 217-254, 27 figs.

SODERSTROM, A.

1920. Studien über die Polychaetenfamilie Spionidae: Dissertation. (Uppsala, Almquist & Wicksells). 286 pp., 1 pl., 174 figs.

TREADWELL, A. L.

1902. The polychaetous annelids of Porto Rico. Bull. U.S. Fish Comm., vol. 20 (for 1900), pt. 2, pp. 181-210, 81 figs.

1914. Polychaetous annelids of the Pacific coast in the collections of the zoological museum of the University of California. Univ. Calif. Publ. Zool., vol. 13, pp. 175-234, 2 pls.

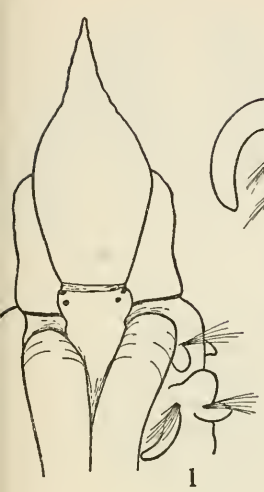
WEBSTER, H. E.

1879. The Annelida Chaetopoda of New Jersey. Ann. Rep. N.Y. Mus. Nat. Hist., no. 32, pp. 101-128. [The plates herein cited were not published until 1886, in the 39th Ann. Report.]

PLATE 45

Figures 1 to 8, *Nerinides acuta:* Fig. 1, anterior end of adult, from life, x 53; Fig. 2, anterior end of planktonic larva near the settling stage, in dorsal view, x 107; Fig. 3, same, in left lateral view, x 107; Fig. 4, tridentate hook from a posterior parapodium of adult, in frontal view, x 650; Fig. 5, same hook seen from side without hood, x 650; Fig. 6, spermatozoon from adult in May, x 650; Fig. 7, cross section of egg membrane, x 650; Fig. 8, surface view of egg membrane, the smaller circles represent punctations between the larger, raised areas, x 650.

Figures 9 to 16, *Polydora citrona:* Fig. 9, anterior end from left side, showing greatly reduced prostomium over large peristomial ring, with small eyespots at sides, x 107; Fig. 10, anterior end from front, the triangular area represents oral aperture, the small dorsal lobe the reduced prostomium, x 107; Fig. 11, pygidium in posterior view, with 4 clavate cirri, x 260; Fig. 12, one of 5 larger, anterior modified spines from fifth setiger, x 260; Fig. 13, 2 of the smaller, posterior modified spines from fifth setiger, x 260; Fig. 14, an unbroken hooded setae from a posterior neuropodium, x 370; Fig. 15, a similar seta with broken tip, showing the hooded cap extending far beyond the broken tip, x 370; Fig. 16, a 3-segmented larva taken from tube of adult, x 260.

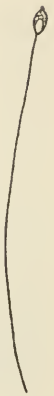

1


2

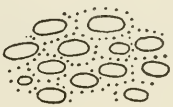

3

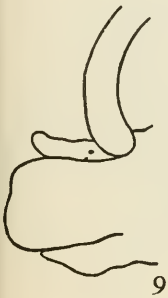

4


5


6

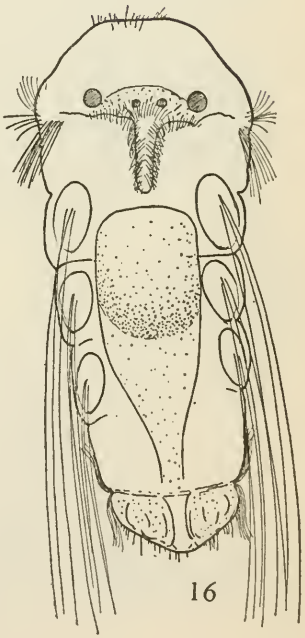

7

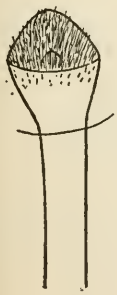

8


9

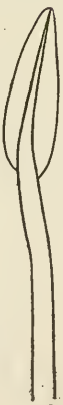

10


11


16


12


13


14


15

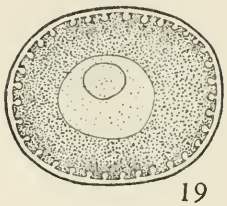
PLATE 46

Figures 17 to 21, *Spiophanes missionensis:* Fig. 17, anterior end in dorsal view, palpi removed, some setae indicated, x 32; Fig. 18, a tridentate hook from a posterior parapodium, x 650; Fig. 19, outline of egg from adult in May, enlarged; Fig. 20, posterior end in left lateral view, with long paired cirri and short median papilla, x 32; Fig. 21, first parapodium from left side in anterior view, showing position of heavy spine in neuropodium, x 65.

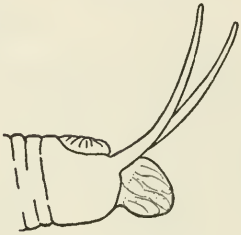
Figures 22 to 28, *Boccardia proboscidea:* Fig. 22, anterior end in dorsal view with most of left palpus removed, x 12; Fig. 23, same, in ventral view, x 12; Fig. 24, a pair of modified spines from modified fifth segment from a young, recently settled stage, x 650; Fig. 25, early larva from capsule, in left lateral view, enlarged; Fig. 26, capsule with 3 remaining larvae in which cannibalism has taken place, enlarged; Fig. 27, diagram illustrating possible method of cocoon formation near the close of the process, the body in cross section shown applied to the points of closure of the cocoon (after Söderström); Fig. 28, several capsules attached to wall of tube of adult, slightly enlarged.

17

18

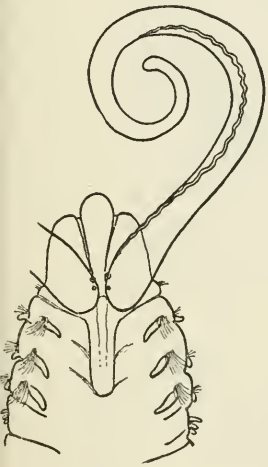


19



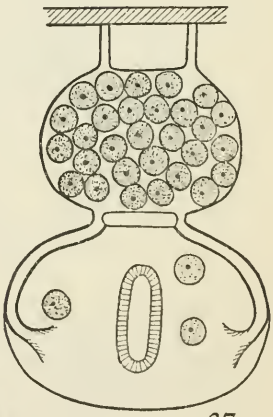
20

21



22

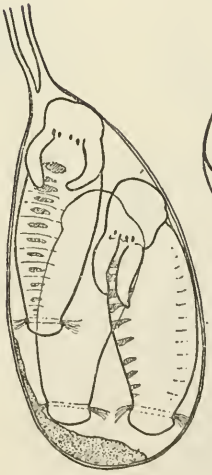
24



27

23

25



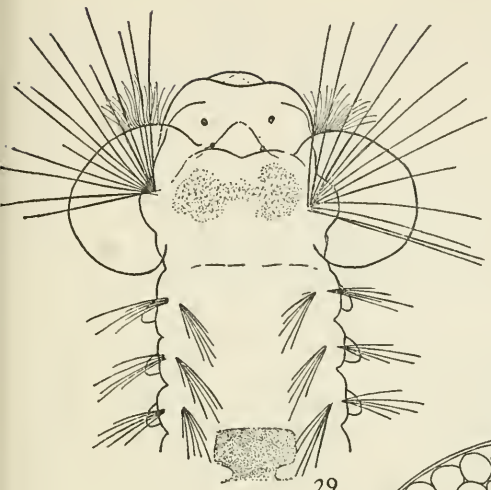
26

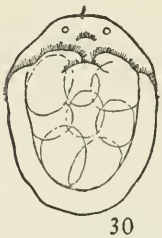
28

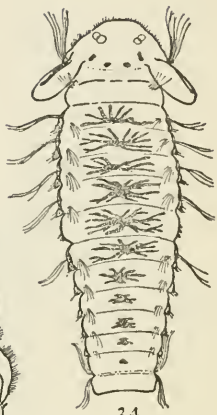
PLATE 47

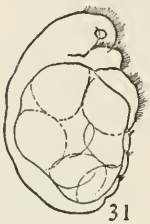
Figure 29, *Nerinides acuta,* anterior end of planktonic larva believed to be of this species, after fixation in formalin, x 240.

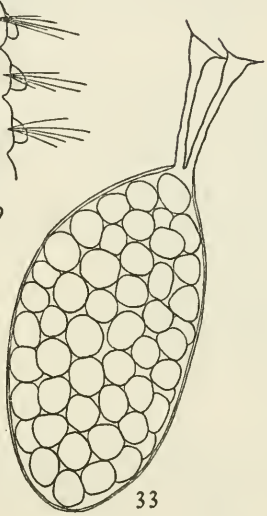
Figures 30 to 37, *Boccardia proboscidea:* Fig. 30, young larva from cocoon in ventral view, x 240; Fig. 31, a similar though slightly later stage in right lateral view, x 240; Fig. 32, young larva in cocoon attacking a proximal blastula, x 240; Fig. 33, a capsule shortly after laid down, showing double stalk and outline of eggs, x 50; Fig. 34, a 12-segmented, planktonic larva after fixation in Bouin's, x 85; Fig. 35, a 15-segmented larva from plankton, in ventral view, from life, x 85; Fig. 36, modified spine from fifth segment of same larva, x 240; Fig. 37, a 3-segmented larva from capsule, setae thrust laterally, x 240.

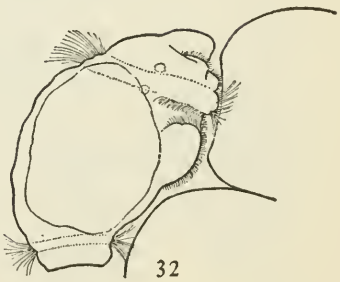

29

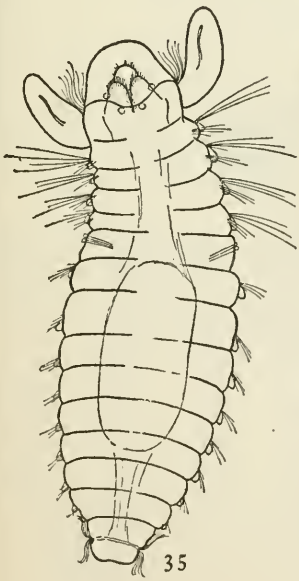

30


34


31


33


32


35


36

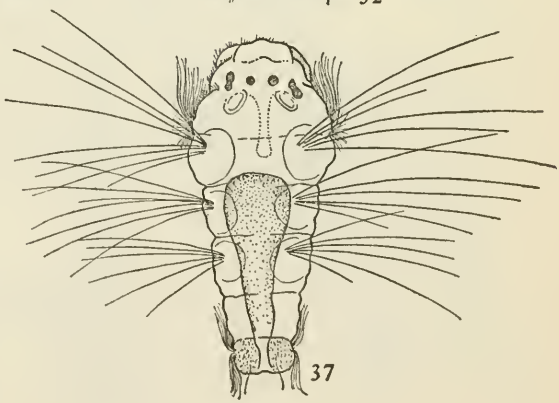

37

PLATE 48

Figures 38, 39, *Polydora armata:* Fig. 38, a hooded hook from a posterior segment, x 650; Fig. 39, two modified spines from fifth setiger, x 370.

Figure 40, *Polydora ciliata,* modified spine and its companion pennoned seta from fifth setiger, x 370.

Figures 41, 42, *Polydora socialis:* Fig. 41, modified spine from fifth setiger, x 290; Fig. 42, hooded seta from seventh setiger, x 290.

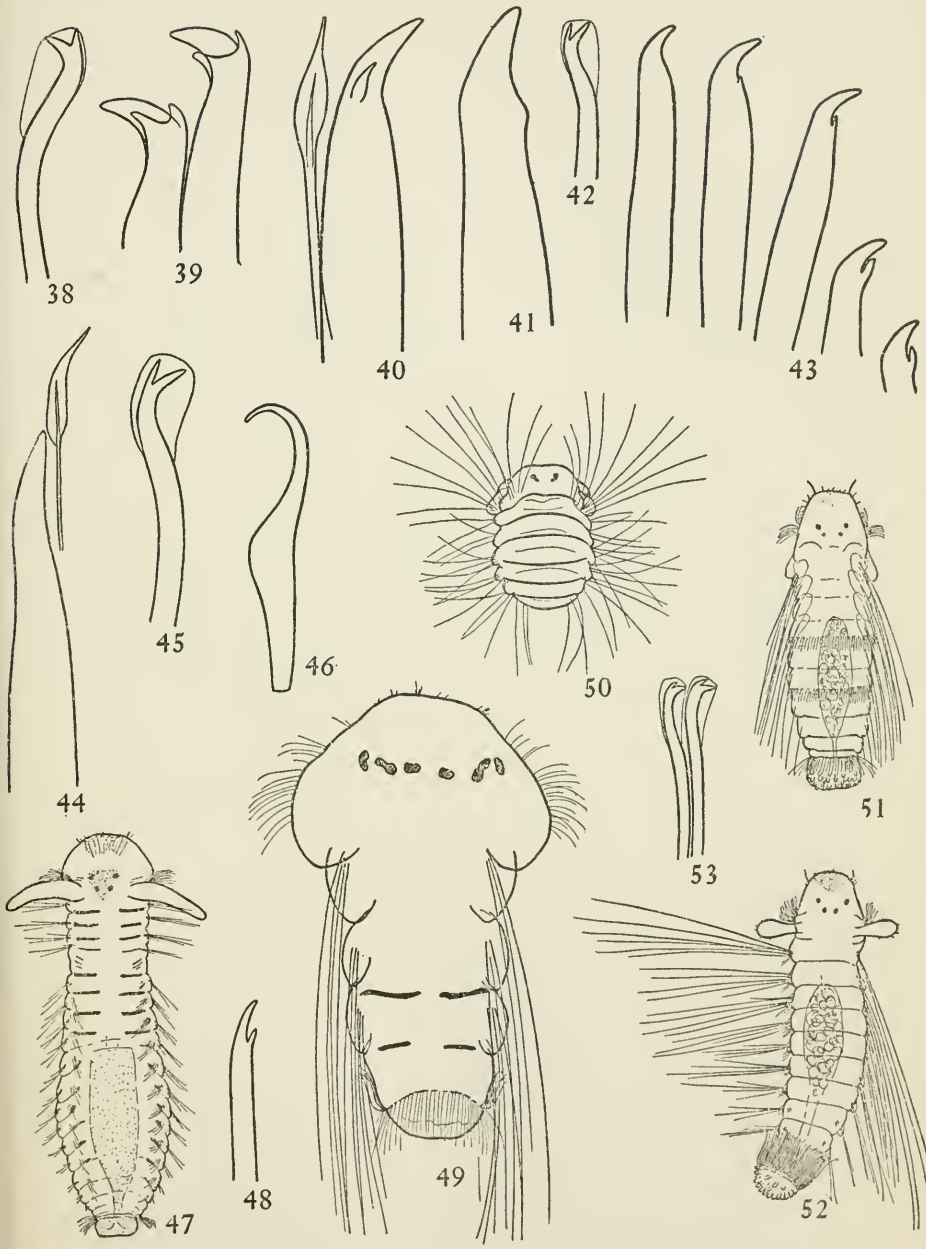
Figure 43, *Polydora giardi,* series of 5 modified hooks from one side of fifth setiger, showing gradation of changes in accessory tooth, x 370.

Figures 44, 45, ?*Boccardia redeki:* Fig. 44, modified hook with companion pennoned seta from fifth setiger, x 290; Fig. 45, hooded hook from a posterior segment, x 290.

Figure 46, *Polydora uncata,* a modified spine from a posterior parapodium, x 65.

Figures 47 to 49, *Polydora ligni:* Fig. 47, a 19-segmented larva from plankton, showing characteristic paired pigment pattern on anterior segments, x 53; Fig. 48, a modified spine from fifth segment from same individual, x 370; Fig. 49, a 3-segmented planktonic larva, believed to be this species, x 260.

Figures 50 to 53, Spionid larva: Fig. 50, chaetosphaere position after fixation, x 85; Fig. 51, a young planktonic larva with prickly pygidium, in life, x 85; Fig. 52, another similar larva with setae partly thrust laterally, x 85; Fig. 53, a pair of hooded hooks from ninth segment of preceding, showing bifid distal end, x 650.


38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53