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REMARKS ON THE NORTH PACIFIC *HARMOTHOE TENEBRICOSA* MOORE (POLYCHAETA, POLYNOIDAE) AND ITS ASSOCIATION WITH ASTEROIDS (ECHINODERMATA, ASTEROIDEA).

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Ectocommensal associations between various animal groups are often overlooked during routine trawling or dredging operations unless special attention is given to removing the commensal animals from their hosts at the time the collections are made. For example, in the usual method of sorting, a polynoid commensal would be preserved with the echinoderm host or, should it become detached, it would remain free in the trawl material and be sorted with the other polychaetes, with no indication of its association. The receipt of a sizeable collection of polynoid worms, observed to have been ectocommensal on asteroids, initiated the preparation of this report. This collection was made by Mr. Miles S. Alton during his study of the bathymetric distribution of the Asteroidea off the northern Oregon coast, in trawls made by the M/V *Commando* and *John N. Cobb* in 1961 to 1964 (Alton, 1966; fig. 1). The polynoids were found associated with three species of sea stars, two species of the family Solasteridae, *Solaster borealis* (Fisher) and *Heterozonias alternatus* (Fisher), and one species of the family Goniasteridae, *Hippasteria californica* Fisher. Some 172 polynoid specimens were collected from 17 stations (32 collections) in 165 to 1050 fathoms. Of these, 120 specimens were taken from *H. alternatus,* 27 from *S. borealis,* and 4 from *H. californica* (see Table I, columns 4–6). In addition, 21 specimens were found free in the trawl material and sorted with the other polychaetes; they were probably removed acciden-

TABLE I. Stations off northern Oregon coast at which the commensal polynoids, *Harmothoe tenebricosa*, were taken, station depths, latitude and longitude, number of specimens of polynoids taken on three species of sea star hosts or free in trawl material:

Station Designation	Depth (fathoms)	Latitude N	Longitude W	Number specimens *Harmothoe tenebricosa* on *Solaster borealis* [(+) = *S.b.* taken]	on *Heterozonias alternatus* [(+) = *H.a.* taken]	on *Hippasteria californica* [(+) = *H.c.* taken]	Free in trawl material	Total number
6A	165	46° 02′	124° 44′	(+)	(+)	—	2	2
9A	250	46° 00′	124° 48′	2	1	—	1	4
10A	275	45° 58′	124° 46′	(+)	(+)	—	1	1
11A	300	46° 00′	124° 50′	1	18	(+)	2	21
12A	325	45° 56′	124° 48′	2	2	—	1	5
13A	350	45° 58′	124° 51′	(+)	27	—	1	28
14A	375	45° 55′	124° 48′	(+)	8	—	—	8
15A, 16A	400–425	45° 57′	124° 53′	2	20	(+)	2	24
17A	450	45° 52′	124° 52′	(+)	30	(+)	1	31
23A	600	45° 45′	124° 54′	3	4	1	1	9
25A	650	45° 43′	124° 55′	1	6	(+)	—	7
29A	750	45° 36′	124° 54′	3	4	—	—	7
31A	800	46° 02′	125° 04′	1	(+)	3	—	4
33A	850	45° 54′	125° 09′	4	(+)	—	1	5
35A	900	45° 50′	125° 11′	8	—	—	6	14
41A	1050	45° 42′	125° 13′	(+)	—	—	2	2
Total				27	120	4	21	172

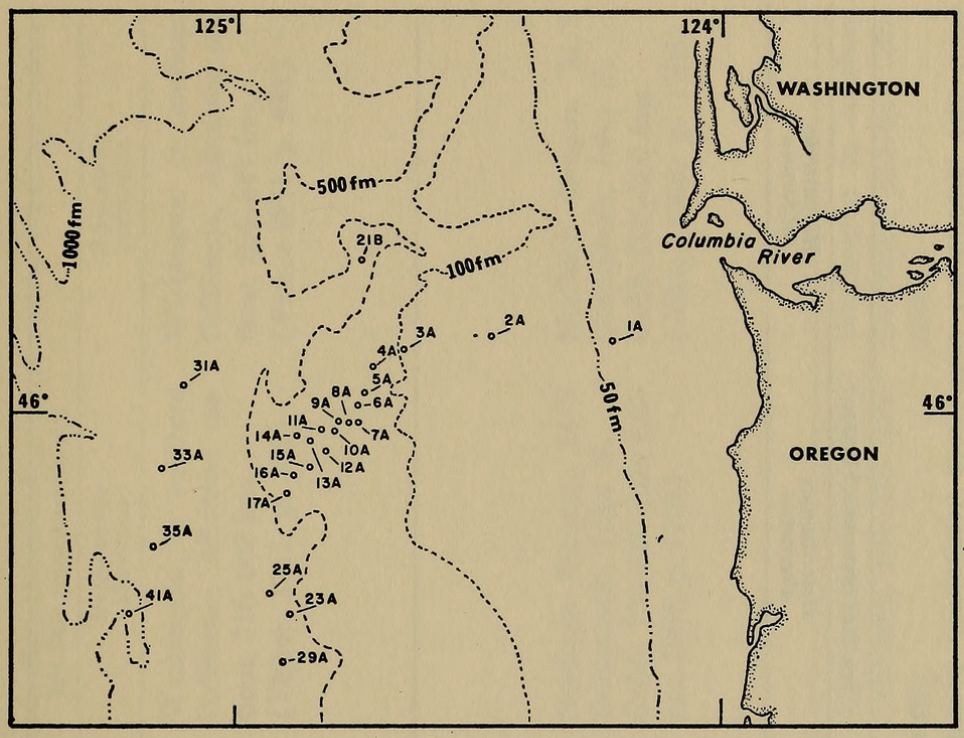

FIG. 1. U. S. Bureau of Commercial Fisheries-Atomic Energy Commission trackline study area off the northern Oregon coast, showing approximate trawling station locations of M/V *Commando* and *John N. Cobb,* 1961–1964, from 50 to 1050 fathoms (91 to 1920 meters). (Prepared by Miles S. Alton.)

tally from their sea star hosts. That this is a definite possibility is indicated by the fact that all 21 specimens were obtained from stations where at least one of the three sea star hosts was also taken (Table I, columns 4–7). In addition to the collection of polynoids from off Oregon, three specimens of *H. tenebricosa* were collected in the Bering Sea in 250 fathoms by the M/V *Arthur H.*, where they were associated with *Solaster borealis.*

The polynoids were identified as *Harmothos tenebricosa* Moore, originally described from three specimens collected by the Steamer *Albatross* off Southern California in 500 to 800 fathoms (Moore, 1910). The same species was later described by Treadwell, as *Eunoe exoculata,* from two specimens collected by the *Albatross* from Lower California in 475 fathoms (Treadwell, 1923) and subsequently referred to *H. tenebricosa* by Hartman (1938, p. 118). Uschakov (1950) described

TABLE II. Summary of geographic and bathymetric distributions of polynoid commensal, *Harmothoe tenebricosa*, and three species of sea star hosts:

Region	Polynoid commensal: *Harmothoe tenebricosa*	Sea Star commensal hosts: *Solaster borealis*	*Heterozonias alternatus*	*Hippasteria californica*
Okhotsk Sea and Japan	Okhotsk Sea, *Vityaz* stations, 232–328 fms. (Uschakov, 1950, p. 161, as *H. pellucelytris*)	Okhotsk Sea, *Vityaz* stations, 60–323 fms. (Djakonov, 1950, p. 72, as *Crossaster borealis ochotensis*) Japan, *Albatross* stations, 175–305 fms. (Fisher, 1911, p. 322; Hayashi, 1940, p. 184)		
Bering Sea	*Vityaz* stations, 422–1088 fms. (Levenstein, 1961, p. 152, as *H. pellucelytris*) M/V *Arthur H.*, 250 fms. (on *Solaster borealis*, see p. 37)	*Albatross* stations, 184–1044 fms. (Fisher, 1911, p. 323) *Vityaz* stations, 800–1222 fms. (Baranova, 1957, p. 165, as *Crossaster borealis*) M/V *Arthur H.*, 250 fms. (see p. 37)		

TABLE II (Cont'd.)

Region	Polynoid commensal: *Harmothoe tenebricosa*	Sea Star commensal hosts: *Solaster borealis*	*Heterozonias alternatus*	*Hippasteria californica*
West coast North America	Southern California, *Albatross* stations, 500–800 fms. (Moore, 1910, p. 351) Lower California, *Albatross* station, 475 fms. (Treadwell, 1923, p. 4, as *Eunoe exoculata*) British Columbia, 505–800 fms. (Berkeley, 1966, p. 841)	Alaska to southern California, *Albatross* stations, 131–876 fms. (Fisher, 1911, p. 323)	Washington to southern California, *Albatross* stations, 316–603 fms. (Fisher, 1911, p. 333)	Washington to southern California, *Albatross* stations, 266–847 fms. (Fisher 1911, p. 236)
	Northern Oregon, M/V *Commando, John N. Cobb*, 165–1050 fms. (on *Solaster borealis, Heterozonias alternatus, Hippasteria californica*, see p. 37)	Northern Oregon, M/V *Commando, John N. Cobb*, 165–1050 fms. (Alton, 1966, p. 1704)	Northern Oregon, M/V *Commando, John N. Cobb*, 165–850 fms. (Alton, 1966, p. 1705)	Northern Oregon, M/V *Commando, John N. Cobb*, 225–800 fms. (Alton, 1966, p. 1703)
Geographic and bathymetric distributions	Okhotsk Sea, Bering Sea to Lower California, 165–1088 fathoms	Japan, Okhotsk Sea, Bering Sea to southern California, 60–1222 fathoms	Washington to southern California, 165–850 fathoms	Washington to southern California, 225–847 fathoms

Harmothoe pellucelytris from eleven specimens collected by the R/V *Vityaz* in the Okhotsk Sea in 232 to 328 fathoms; *H. pellucelytris* is herein designated a synonym of *H. tenebricosa.* Levenstein (1961) reported the species (as *H. pellucelytris*) from nine *Vityaz* stations in the deep parts of the Bering Sea in 422 to 1088 fathoms. Berkeley (1966) recorded three specimens of *H. tenebricosa* from British Columbia in 505 and 800 fathoms. In none of the above five records was the association of the polynoids with asteroids reported. On the catalogue card of the paratype of *H. tenebricosa* (USNM 17153), collected from *Albatross* station 4528, is written the note: "Commensal with salmon-colored *Solaster*"; this note was somehow overlooked by Moore when the species was described and by Hartman (1938, p. 118) when the types were re-examined. Fisher (1911, p. 323) recorded two specimens of *Solaster borealis* from this same *Albatross* station. The holotype of *H. tenebricosa* (USNM 16877) was collected at *Albatross* station 4400 from which Fisher (1911, p. 333) recorded three specimens of *Heterozonias alternatus.* The records of *H. tenebricosa* (including the synonyms *Eunoe exoculata* and *Harmothoe pellucelytris*) are for the most part within the known geographic and bathymetric distributions of the three sea star hosts. See Table II.

The locations of the stations off northern Oregon at which the commensal polynoid, *Harmothoe tenebricosa,* were taken are shown on Figure 1 and listed in Table I. The collections were made in 50 to 1050 fathoms (91 to 1920 meters) during the U. S. Bureau of Commercial Fisheries-Atomic Energy Commission trawling investigations in 1961 to 1964. For further details of this study see Alton (1966).

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FAMILY POLYNOIDAE MALMGREN

Harmothoe tenebricosa Moore

Fig. 2

Harmothoe tenebricosa Moore, 1910, p. 351, pl. 29, figs. 23–28.—Hartman, 1938, p. 118.—Berkeley, 1966, p. 841.—Alton, 1966, p. 1705.

Eunoe exoculata Treadwell, 1923, p. 4, figs. 1–4.

Harmothoe pellucelytris Uschakov, 1950, p. 161, fig. 5, pl. 1, fig. 2; 1955, p. 154, fig. 39; 1965, p. 135, fig. 39.—Levenstein, 1961, p. 152.

Material examined: Albatross station 4400, north of San Diego, California, 32° 50'N, 118° 03' W, 500–507 fathoms, green mud, 1904.—Holotype of *H. tenebricosa* (USNM 16877). *Albatross* station 4528, Monterey Bay, Point Pinos Light, 545–800 fathoms, soft grey mud, 1904.—Paratype of *H. tenebricosa* (USNM 17153). *Albatross* station D5698, off Point Surf, Lower California, 475 fathoms, 1911.—Paratype of *Eunoe exoculata* Treadwell (USNM 19148).

International Pacific Halibut Commission, M/V *Arthur H.*, Bering Sea, 54° 30' N, 166° W, 250 fathoms, June 4, 1963, on *Solaster borealis* —3 specimens (USNM 34051).

U. S. Bureau of Commercial Fisheries-Atomic Energy Commission, M/V *Commando,* M/V *John N. Cobb,* off northern Oregon coast, 165–1050 fathoms, mud, silty-clay, clayey-silt, on asteroids *Solaster borealis, Heterozonias alternatus, Hippasteria californica,* and free in trawl hauls, M. S. Alton, collector, 1961–1964—172 specimens (USNM 34001–34006, 34014–34032, 34039–34050, 34052–34053).

Description: Length 17–48 mm, width including setae 5 to 16 mm, segments 31 to 43. Body flattened dorsoventrally, widest in middle region, tapering gradually anteriorly and more so posteriorly. Elytra and elytriphores 14–15 pairs, on segments 2, 4, 5, 7, alternate segments to 23, 26, 29, and 32. Anterior pair of elytra (fig. 2b) small, circular; rest of elytra larger, subreniform, overlapping and nearly covering dorsum (fig. 2c); elytra soft, membranous, colorless, lacking marginal papillae and tubercles except for numerous colorless microtubercles on anterior curved part where covered by more anterior overlapping elytra; some elytra with elongate-conical papillae near posterior border.

Prostomium (fig. 2a) bilobed, slightly wider than long, with distinct cephalic peaks; 4 eyes small, of pale color or completely lacking pigment. Median antenna with short cylindrical ceratophore in frontal fissure of prostomium; style long, slender, tapering gradually to filamentous tip. Lateral antenna with short ceratophores, inserted ventrally; styles about half length of median antenna. Palps longer than median antenna, tapered, with short filamentous tips. Tentacular segment (I) with 2 pairs tentacular cirri lateral to prostomium, dorsal pair similar to median antenna, ventral pair shorter; cirrophore with single seta; facial tubercle slightly developed ventrally. Buccal segment (II) with first pair of elytra; ventral or buccal cirri similar to lower tentacular cirri.

Parapodia subbiramous, prominent, as long as or longer than body

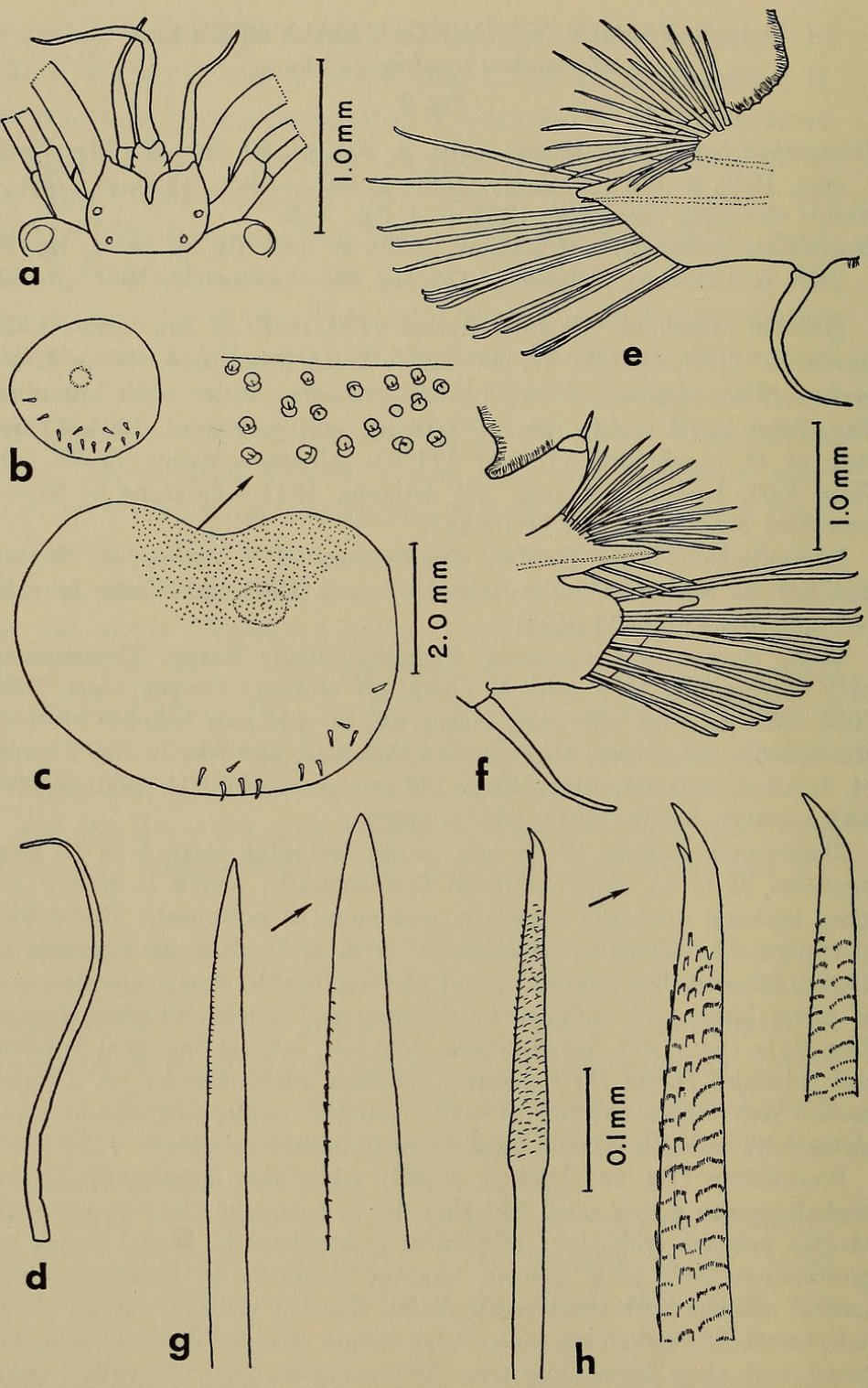

FIG. 2. *Harmothoe tenebricosa:* a, Anterior end, dorsal view; elytra omitted; only bases of palps and tentacular cirri shown; b, first elytron; c, elytron from middle of body; d, style of dorsal cirrus; e, elytrigerous parapodium, anterior view; f, cirrigerous parapodium, posterior view, style of dorsal cirrus omitted; g, notoseta; h, neuroseta.

width, with acicula dark basally, tapering distally to slender colorless tips projecting slightly from rami; setae yellow amber-colored, slightly darker distally (fig. 2e, f). Notopodia low, rounded, with lower part prolonged into digitiform acicular process. Notosetae moderate in number, rather short, forming spreading tufts. Notosetae slightly stouter than neurosetae, straight, nearly smooth except for indistinct spinous rows along one border, tapered to blunt tips (fig. 2g). Neuropodia with neurosetae arranged in vertical series; presetal lobes diagonally truncate, upper parts slightly projecting as rounded supra-acicular process; postsetal lobes shorter, rounded. Neurosetae longer and more slender than notosetae, with slightly enlarged distal spinous regions; transverse spinous rows low, close and numerous; tips hooked, with slender subterminal accessory tooth; latter smaller or absent in lower neurosetae (fig. 2h). Dorsal cirri with elongate cylindrical cirrophores; styles extending beyond neurosetae, slender, tapering to filamentous tips (fig. 2d). Ventral cirri shorter than neuropodial lobes, tapering to slender tips. Dorsal tubercles, medial to dorsal cirriphores, subconical. Ciliated areas on anterior and posterior sides of parapodia, elytriphores and dorsal tubercles; transverse ciliated bands extending between elytriphores and dorsal tubercles, two bands per segment. Nephridial papillae beginning on segment VI, continuing posteriorly, and extending dorsally between parapodia.

Pygidium with pair of long slender anal cirri, similar to dorsal cirri. Pharynx (not extended in available specimens) large, muscular, somewhat reddish, extending to segment 14, causing body to bulge somewhat in this region, sometimes visible through thinner middorsal body wall; 4 amber-colored jaws, darker distally.

Color (preserved): whitish, yellowish to brownish, without pigmented pattern; elytra colorless.

Biology: Fragmentation and regeneration appear to be rather common in *Harmothoe tenebricosa* as indicated by the presence of regenerating posterior ends on some individuals, as well as smaller regenerating elytra, antennae, and dorsal cirri. Some specimens of *H. tenebricosa,* collected in 600 to 900 fathoms on May 27, 29, and 31, 1964, were filled with small eggs (approximately 87 μ in greatest diameter), with large germinal vesicles. In one of the collections from station 17A, numerous small specimens were collected in 450 fathoms on August 27, 1963; some were only 10 mm in length, with 31 segments and 14 pairs of elytra. In this same collection, 28 specimens of *H. tenebricosa* were collected from 19 specimens of *Heterozonias alternatus,* indicating that some sea stars serve as hosts to at least two of the polynoids, at least when the polynoids are young.

As indicated above and on Tables I and II, *Harmothoe tenebricosa* has been found associated with three species of sea stars, *Solaster borealis, Heterozonias alternatus,* and *Hippasteria californica.* According to Alton (1966, p. 1705), the polynoids were found on the oral sides of the discs of the sea stars, usually on the interradial areas but occasionally

within the ambulacral grooves. All three species of sea stars are confined to the North Pacific and commonly occur in the lower bathyal zone (275–500 fathoms) and bathyal-abyssal transitional zone (585–850 fathoms). *H. alternatus,* which bore the largest number of polynoid commensals (120 specimens), is one of the most common sea stars in the lower bathyal zone and the dominant sea star in the bathyal-abyssal transitional zone but is far less important at greater depths (Fisher, 1911; Alton, 1966; Table II). *Hippasteria californica* has essentially the same bathymetric distribution as *Heterozonias alternatus* but is less common; it was infested by the fewest number of commensal polynoids (4 specimens) (Fisher, 1911; Alton, 1966; Table II). Both species of sea stars have approximately the same geographic distribution—from Washington to southern California.

Solaster borealis harbored less than a fifth as many polynoid commensals as did *H. alternatus* (27 specimens). *S. borealis* has the most extensive geographic distribution of the three species of sea stars—from Japan, Okhotsk Sea, Bering Sea to Southern California, from 60 to 1222 fathoms and probably beyond, and forms an important part of the sea star fauna in the lower bathyal and bathyal-abyssal transitional zones (Fisher, 1911; Hayashi, 1940; Djakonov, 1950; Baranova, 1957; Alton, 1966; Table II). Similarly, the commensal polynoid, *Harmothoe tenebricosa,* has approximately the same range—Okhotsk Sea, Bering Sea to Lower California, in 165 to 1088 fathoms (Table II).

Distribution: Okhotsk Sea, Bering Sea to Lower California. In 165 to 1088 fathoms.

Literature Cited

Alton, M. S. 1966. Bathymetric distribution of sea stars (Asteroidea) off the northern Oregon coast. Journ. Fish. Res. Bd. Canada, 23, (11): 1673–1714, 9 tables, 5 figs.

Baranova, Z. I. 1957. [Echinoderms of the Bering Sea]. Issled. dalnevost morei SSSR (Explorations Mers d'USSR), 4: 149–266, 19 figs. [In Russian]

Berkeley, C. 1966. Records of some species of Polychaeta new to British Columbia and of extensions in distribution of some others. Canadian Journ. Zool., 44: 839–849.

Djakonov, A. M. 1950 [Sea stars (Asteroidea) of the far-eastern seas of the U.S.S.R.]. Akad. Nauk SSSR. Opredeliteli po Faune SSSR, No. 34: 1–152, 212 figs. [In Russian]

Fisher, W. K. 1911. Asteroidea of the North Pacific and adjacent waters. Bull. U. S. Nat. Mus., No. 76: 1–419, 122 pls.

Hartman, O. 1938. The types of the polychaete worms of the families Polynoidae and Polyodontidae in the U. S. National Museum and the description of a new genus. Proc. U. S. Nat. Mus., 86: 107–134, 41 figs.

Hayashi, R. 1940. Contributions to the classification of the sea-stars

of Japan. I. Spinulosa. Journ. Fac. Sci. Hokkaido Imp. Univ., ser. 6, 7: 107–204, pls. 7–13.

Levenstein, R. J. 1961. [Polychaete worms (Polychaeta) from the deep part of the Bering Sea.] Trudy Inst. Okeanol. Akad. Nauk SSSR, 46: 147–178, 10 figs. [In Russian]

Moore, J. P. 1910. The polychaetous annelids dredged by the U.S.S. *Albatross* off the coast of southern California in 1904: II Polynoidae, Aphroditidae and Segaleonidae. Proc. Acad. Nat. Sci. Philadelphia, 62: 328–402, pls. 28–33.

Treadwell, A. L. 1923. Polychaetous annelids from Lower California with descriptions of new species. Amer. Mus. Novitates, no. 74: 1–11, 8 figs.

Uschakov, P. V. 1950. [Polychaete worms (Polychaeta) from the Okhotsk Sea.] Issled. dalnevost morei SSSR (Explorations Mers d'USSR), 2: 140–234, 39 figs., 2 pls. [In Russian]

———. 1955. [Polychaeta of the far-eastern seas of the U.S.S.R.]. Akad. Nauk SSSR. Opredeliteli po Faune SSSR, No. 56: 1–445, 164 figs. [In Russian]

———. 1965. Polychaeta of the far-eastern seas of the U.S.S.R. (English translation). Pp. 1–419, 164 figs. Jerusalem Israel Program for Scientific Translations.