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A NEW REEF-BUILDING SERPULID GENUS AND SPECIES FROM THE GULF OF ELAT AND THE RED SEA, WITH NOTES ON OTHER GREGARIOUS TUBEWORMS FROM ISRAELI WATERS

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ABSTRACT

Filogranella elatensis, n. gen., n. sp., has built a serpulid reef within a crevice of a coral knoll near Elat port, Gulf of Elat (= Gulf of 'Aqaba). The knoll is in a shallow area subject to thermal and chemical pollution. The species and its habitat are described. Previously undescribed material from the Red Sea coast of Saudi Arabia is referred to this species. Some other gregarious species of Serpulidae in Israeli waters are considered.

INTRODUCTION

Serpulid species from the Gulf of Elat (= Gulf of 'Aqaba) have been studied by Fauvel (1933, 1957), Fishelson and Rullier (1969), Ben-Eliahu (1976) and Amoureux et al. (1978), and some species were reviewed by ten Hove (1970a, b) and Zibrowius (1970a, b). The number of identified serpulid species in the Gulf comes to 27. We describe a new species of tubeworm which has built a fragile reef within a crevice of a coral knoll near Elat port. The reef was found by the junior author during a study of the effects of pollution in the vicinity of the port. It is located in a disturbed area near the outflow of the Elat power and desalination plant's cooling system. Additional material collected off the Arabian coast by the South Red Sea "Calypso" Expedition, sent to us by Dr. H. Zibrowius, proved to belong to this species, indicating that its range extends from the Gulf of Elat to the south Red Sea. The reef is a comparatively large, striking serpulid aggregate of white tubes and crimson animals, 1.5 m in diameter at the base, and 50 cm high.

METHODS

The branchial crown and thorax were dissected and mounted in glycero-formalin. Setae and uncini were examined under oil immersion in lactic acid, and with the scanning electron microscope.

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To prevent distortion of minimum values for specific characters which are affected by size, e.g. length of thoracic membranes, or numbers of radioles in branchial crown, their range of variation was described from larger individuals. The values for the holotype are marked by an asterisk.

Genus *Filogranella* n. gen.

Type species: *Filogranella elatensis*, described herein and designated. Gender: feminine.

Gregarious, aggregated tubes. Body symmetrical with 12 or more thoracic setigers and more than 60 abdominal ones. Branchial crown without operculum or pseudooperculum, with more than 4 pairs of radioles. Well-developed collar continuous with thoracic membranes ending in midthorax. Prominent prostomium with eyespots. Collar setae limbate, similar to those of following setigers, and fine needle-like (non-limbate) capillaries. Remaining thoracic setigers with limbate and "*Apomatus*" setae. Thoracic uncini with reduced apical attachment area, intermediate between saw-like and rasp-like; with approximately 16 teeth in vertical row (side view), horizontal rows proximal to fang with several teeth, decreasing to rows of single teeth; fang concave. Abdominal setae geniculate, grading into fine capillary setae with recurved tips in posterior setigers. Abdominal uncini rasp-like with many teeth in vertical row (side view); fang concave.

Filogranella elatensis n. sp.

Type locality. Gulf of Elat, near Elat, northern beach opposite power station, 3 m depth, Coll. J. Dafni, 16.III.79. Sample of tubes with ca. 20 worms (Fig. 2a–d) taken

Fig. 1. *Filogranella elatensis* n. gen., n. sp., photographed in situ. Average tube, 19 mm.

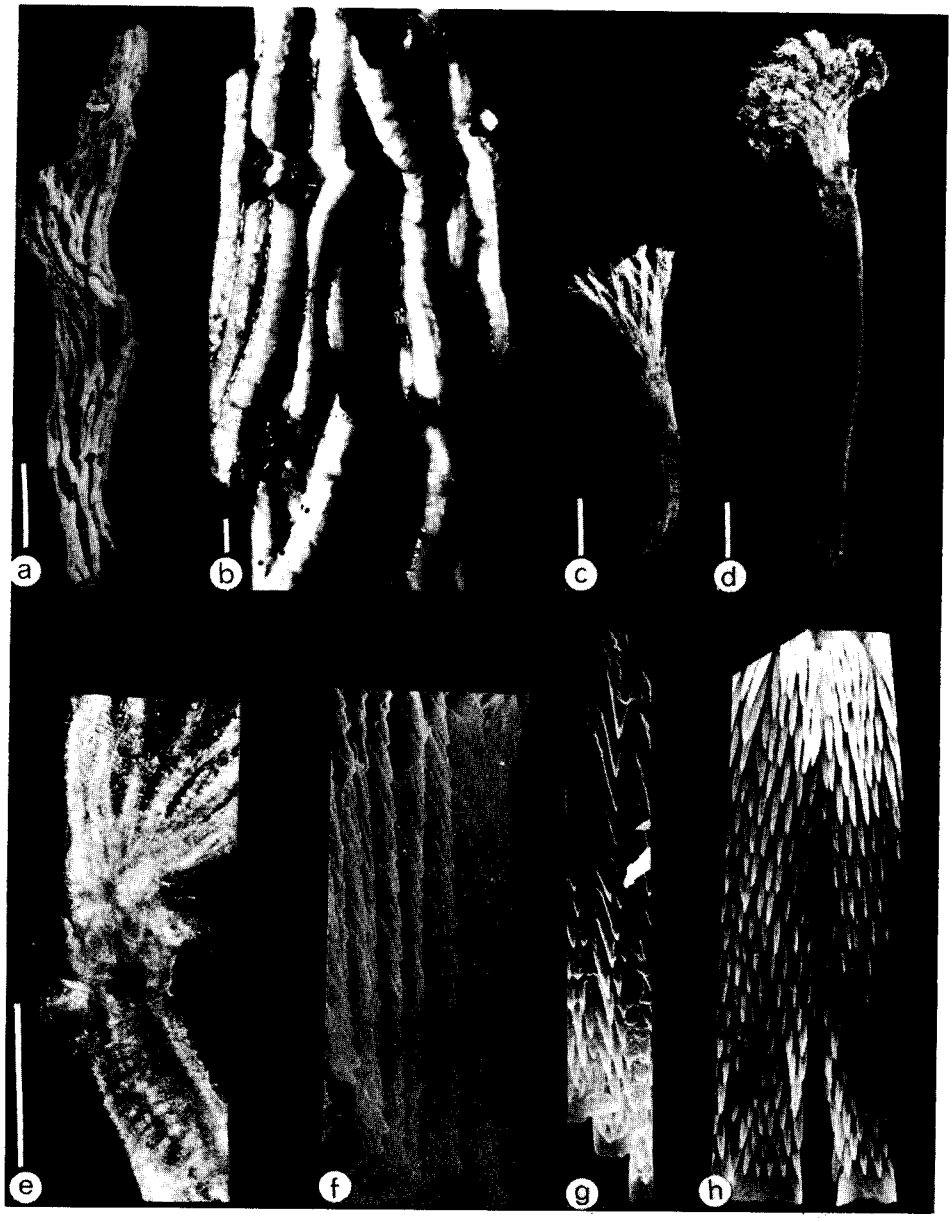

Fig. 2. *Filogranella elatensis* n. gen., n. sp. a. Aggregated tubes, scale 10 mm. b. Same, scale 1 mm. Note lengthwise keels and transverse growth rings. c. Whole worm, dorsal aspect, setal bundles visible, scale 1 mm. d. Whole worm, ventral aspect, tori of uncini visible. e. Thorax, right ventral aspect, thoracic membrane pulled out, reaches middle of 6th bundle of setae but not 6th tore of uncini; eyespots on prostomium anterior-medial to collar setae; gland medial to collar setae. Scale 1 mm. f. Thoracic uncini, scanning electron microscope (SEM) × 4,700. g. Thoracic uncini, SEM, edge-on view, × 5,650. h. Abdominal uncini, SEM, edge-on view, × 7,800.

from an aggregate of ca. 1.5 m base diam. X 60 cm height. Living worms present throughout the formation (Fig. 1).

Repository. British Museum (Natural History): holotype (ZB. 1979.3), 4 paratypes (ZB.1979.4–7) and mass of tubes (ZB.1979.8–17). Hebrew University of Jerusalem, Department of Zoology Museum: paratypes (AN.I.129).

Additional material. Shab Sulein, Saudia Arabia, Red Sea: sample taken by "Calypso" South Red Sea Expedition, XI.1951–II.1952, 4 m depth. Aggregate of abraded tubes, specimens in poor condition. Lent by H. Zibrowius, Stn. Mar. Endoume, France.

Description. Based on 15 specimens from Elat.

Dimensions. Length 10–12 mm, branchial crown 1/4 (1/3) length, width 0.7 mm; (*)11 mm, 4 mm branchial crown and 7 mm body, contracted; width 0.7 mm. Typical (modal) tube, 19 mm length, 1 mm diam.

Tubes. Cross section circular. Fine longitudinal keels (ca. 5) on exposed side (side free of aggregate), and faint transverse growth rings. Tube opening without expanded peristome.

Coloration (living worms). Body crimson. Base of branchial lobe and base of radioles crimson, radiole itself not pigmented except for band of crimson at distal end, appearing as crimson circle in extended open branchial crown.

Segments. Typically 12 (11–14) thoracic setigers, followed by few asetigerous segments. Holotype(*) ca. 81 setigers: 13 thoracic, ca. 3 asetigerous, 65 abdominal setigers. Paratype of 11 mm, 69 setigers, 12 thoracic. Some specimens with asymmetric development of last thoracic setiger (i.e. with posterior torus of uncini or with setae and uncini not developed on one side) (Table I).

Branchial crown. No operculum or pseudo-operculum. 7–9 radioles in each lobe (*8). Ca. 40 pairs of pinnulae on radiole of 7-radiole lobe. Tip (preserved specimen) covered with pinnulae; tips and group of terminal pinnulae with glandular cells.

Collar. Trilobed: latero-dorsal lobes lower than and clearly separated from ventral lobe. Tonguelets between ventral and latero-doral lobes have not been observed as, for instance, in *Spirobranchus* (ten Hove, 1970b). Ventral lobe shallower in midline, with inner membrane pleat at midline furrow connecting right and left halves. Thoracic membranes continuous with collar, terminating in midthorax (on line with 6th bundle of notosetae, anterior to 6th torus of uncini (3 specimens), on line with 5th bundle of setae, anterior to 5th torus (1 specimen)).

Prostomium prominent with two comma-shaped groups of ca. 20 eyespots with lenses, pigment crimson to purple. First setiger with prominent paired glands medial to collar setae. Pygidium with 2 rounded papillae. A posterior glandular field (pygidial gland) as in the *Vermiliopsis pygidialis* Willey- *V. glandigerus* Gravier- *V. infundibulum* Phillipi group (Ben-Eliahu, 1976) was not observed.

TABLE I
Variation in configuration of thoracic setae and uncini in *Filogranella elatensis*

No. thoracic setigers	*Configuration*[1]	*No.*	*Subtotal*	*Total*
Elat				
11 + 11	(1 + 9 + 1) – (1 + 9 + 1)	1	1	
12 + 11	R(1 + 10 + 1) – (1 + 10)L	1	1	
12 + 12	(1 + 10 + 1) – (1 + 10 + 1)	3		
	(1 + 11) – (1 + 10 + 1)	3		
	(1 + 11) – (1 + 11)	3	9	
13 + 12	L(1 + 11 + 1) – (1 + 11)R[2]	1		
	(1 + 12) – (1 + 11)	1	2	
14 + 12	(1 + 12 + 1) – (1 + 11)	1	1	14
Shab Sulein				
11 + 10	(1 + 10) – (1 + 9)	1	1	
11 + 11	(1 + 10) – (1 + 10)	1	1	2

[1] Configuration: 1 (collar setae) + (no. thoracic setigers with setae and with torus of uncini) + setae (without torus of uncini)
[2] Holotype

Setae. Thorax: 1st setiger (collar setae) with limbate setae and needle-like (non-bordered) capillary setae (Fig. 3a, b; Fig. 4a, b). Remaining thoracic setigers with limbate setae. "*Apomatus*" setae (Fig. 3d–f; Fig. 4c_1, c_2) present from 3rd–4th setiger. Uncini with 16 teeth above concave fang (side view) (Fig. 2f, g; Fig. 4e–f) appearing bifid under oil immersion. Rows proximal to fang with several teeth, decreasing apically to 1 tooth (formula: F:4:4:3. . ., F:3:3:3:3:2:2:2:1. . .). Most uncini conform to F:4 configuration, F:3 uncini appear restricted to dorsal part of the torus. Third torus with ca. 80 uncini. *Abdomen*: Geniculate setae from ca. 9th abdominal setiger (Fig. 3c; Fig. 4e), grading into fine capillaries with bent tips in posterior setigers (ca. 15 setigers). Abdominal uncini rasp-like with 19 teeth in side view, 6 or 7 teeth in transverse rows, fang concave (Fig. 2h, Fig. 4g). Tenth abdominal torus with ca. 18 uncini.

Note. The material from the Saudi Arabian coast has slight differences: eyes are not visible, possibly due to prolonged preservation in alcohol; thoracic membranes end at 4th bundle of setae (2 specimens).

Habitat

The serpulid aggregation was found within the crevice of a coral knoll 3–4 m deep in the port of Elat. The knoll reached a height of 1.5–2 m above a sandy bottom covered with *Halophila stipulacea*. It is located in a disturbed area, ca. 100 m northwest of the outflow of the cooling system of the Elat desalination-power plant which

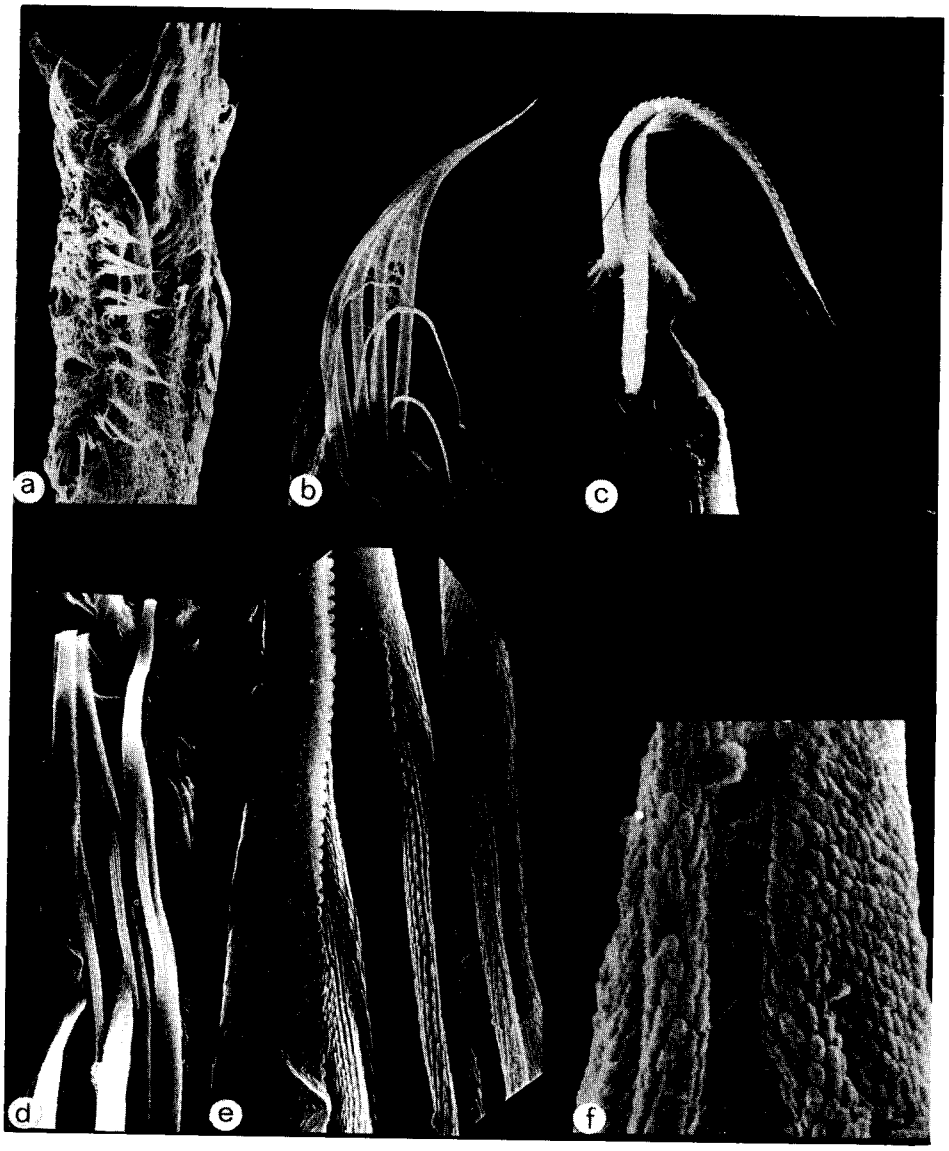

Fig. 3. *Filogranella elatensis* n. gen., n. sp. SEM. a. Thorax, left dorsal aspect, collar setae directed anteriad, 13 bundles of setae, X 90. b. Collar setae, limbate setae and fine capillary setae, X 470. c. Geniculate abdominal seta, X 2,830. d. "*Apomatus*" setae from thorax, X 1,300. e. Same, X 3,333; note saw-like edge, visible under oil immersion, denticulate structure of shaft. f. Same, shaft, X 9,190.

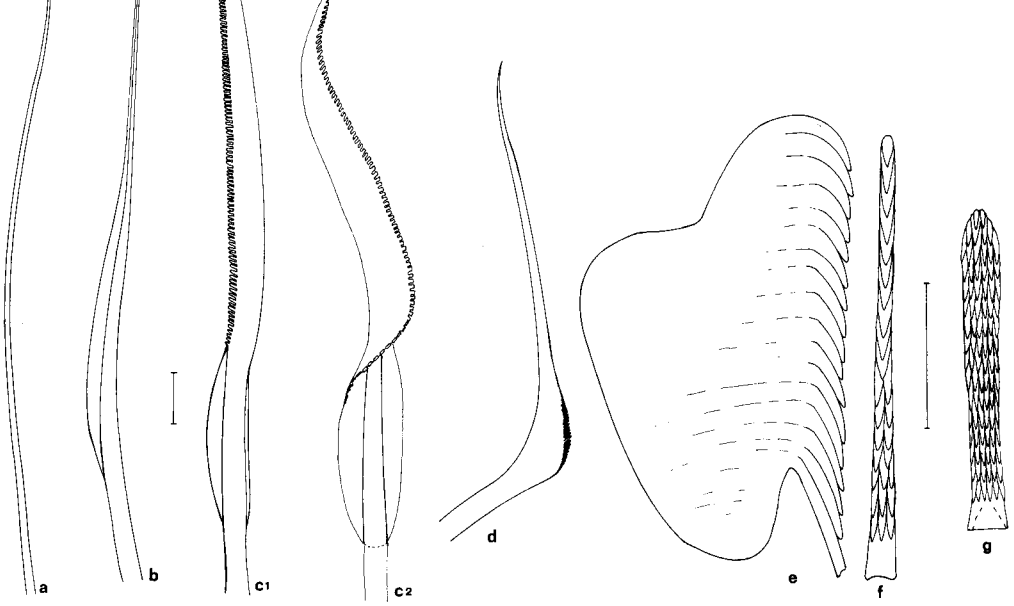

Fig. 4. *Filogranella elatensis* n. gen., n. sp. a. Collar seta, capillary. b. Limbate seta. c_1, c_2 "*Apomatus*" seta. d. Geniculate seta. e. Thoracic uncinus, side view. f. Thoracic uncinus, edge-on view. g. Abdominal uncinus, edge-on view. Scale, a–d, 10 μm. e–f, 10 μm.

releases water of increased temperature and salinity (Dafni, 1974), enriched in ions of heavy metals (Fe, Cu, Zn) (Fishelson, 1975). The area opposite the outflow is characterized by low diversity of the biota, with a high dominance of algal mats and Nematoda (Dafni, 1974), indicative of the pollution.

The knoll itself appears to have undergone regeneration after damage. Only ca. 10% is covered by living corals, mainly *Porites lutea* and *Lobophyllia crymbosa*. The dead coral surface has only a slight covering of algae, grazed by the sea urchin *Tripneustes gratilla*, rather than by *Diadema setosum* and *Echinometra mathaei* which frequent knolls in other areas of the bay. This difference in the echinoderm populations is also attributed to pollution. The crevice of the knoll is rich in fishes, particularly *Archamia fucata* and *Pempheris ouvalensis*, which shelter there during the day.

Filogranella elatensis may or may not be restricted to habitats with reduced turbulence; in less protected situations, the fragile reef would be continually abraded and a massive aggregation such as that found within the crevice could not be built up.

DISCUSSION

The species is named *elatensis* for its type locality. The genus is named *Filogranella* to indicate the resemblance of its aggregation to *Filograna* (= *Salmacina*) Berkeley, 1827. Zibrowius (1973) united the non-operculate genus *Salmacina* with the operculate *Filograna. Filograna* differs from *Filogranella* in having bayonet-type collar setae with proximal denticulate area well separated from distal limbate zone (Fauvel, 1927); well-developed thoracic membranes; rasp-like thoracic uncini. *Filogranella* differs from *Subprotula* Bush, 1910, a non-operculate genus with limbate collar setae and short thoracic membranes, but which has only 7 thoracic setigers. Moreover, *Subprotula* is apparently solitary.

Allocation of genera to higher categories in Serpulidae is currently problematic due to different emphases on criteria for rearranging genera (Uchida, 1978; Fauchald, 1977). The new tubeworm belongs to a non-operculate genus and species of the subfamily Filograninae Rioja sensu Fauvel, 1927, and the shape of its uncini presumably ensures its being grouped with filogranine species. In the revised filogranine scheme of Uchida (1978) based on Japanese species, *Filogranella* belongs with the grouping of genera with "*Protula*-type" uncini (as in *Protula tubularia* (Montague, 1803)) and limbate collar setae, including Japanese species of *Protula, Apomatus* and *Protulopsis*. However, the emendation of genera in this scheme is restrictive. For example, *Protula soofita* Ben-Eliahu, 1976 from the Gulf of Elat has different thoracic uncini. Fauchald (1977) places *Protula* and *Membranopsis* of this group within Serpulinae.

In 1979, ten Hove reviewed possible factors associated with gregariousness in serpulids. Most species which are gregarious are also found as solitary individuals. Three factors which might be involved in the gregariousness of *Filogranella* are: sexual reproduction, attraction of conspecific larvae and environmental factors including pollution and protection from abrasion. Although budding was not observed among the *Filogranella* specimens examined, *Filogranella* resembles three gregarious genera, *Filograna, Filogranula* and *Josephella* which reproduce by budding from the posterior abdomen as well as sexually (ten Hove, 1979). Aggregates can develop from one individual (Dew, 1959). Once a critical size has been exceeded, aggregation might be catalyzed by attraction of conspecific larvae which settle on tubes of living worms (ten Hove, 1979).

Aberrant environmental factors, e.g. salinity, temperature and chemical pollutants are positively correlated with aggregation. For example, the increased temperature and salinity released by cooling systems of Mediterranean power plants has also resulted in aggregation of certain serpulid species (ten Hove, 1979). Polluted environments may enhance growth both by providing favorable conditions for tolerant species and by eliminating sensitive competitors. Within the range of normal marine conditions, aggregations of serpulids are usually conglomerates of several species along with calcareous algae, encrusting on dead coral or rocky surfaces, e.g. forming belts on intertidal rocks. In the Elat formation, the reef appears to be made only of *F. elatensis* individuals, which is attributed, at least in part, to a pollution effect. The small sample from the Red Sea Arabian coast included another serpulid species.

Two other species of Filograninae reported by ten Hove (1979) as being gregarious have been recorded in the Gulf of Elat, both much smaller species than *F. elatensis: Josephella marenzelleri* Caullery & Mesnil, 1896, was a cryptofaunal component of an intertidal vermetid reef in the Gulf of Elat (Ben-Eliahu, 1976) and tubes were not visible; *Filograna implexa* Berkeley, 1827, a widely distributed species in the Gulf of Elat and northern Red Sea (Amoureux et al., 1978), forms aggregates of minute tubes (Ben-Eliahu, pers. obs.).

Two other aggregations of serpulids in habitats with aberrant salinities are known in this region: (a) A notable ridge of *Vermiliopsis pygidialis* Willey in the metahaline pool of El Kura, near Dahab (Gulf of Elat) (salinity 40–60‰) (Por and Dor, 1975). Individuals of this species were among the cryptofaunal component in the intertidal vermetid reef mentioned above with other serpulid species (Ben-Eliahu, 1976). (b) A brackish-water species, *Ficopomatus enigmaticus* (Fauvel, 1923) (syn. *Mercierella enigmatica* Fauvel, 1923 (ten Hove and Weerdenburg, 1978)) used to be present on piers in Israeli Mediterranean estuaries, e.g. the Alexander River. Salinity monitored in the Alexander River in 1964 ranged from 0.5 to 20‰, typically from 2 to 9‰ (S. Pisanti, pers. commun.). The *Ficopomatus* populations in the estuaries died, presumably due to pollution of the rivers, but in an artificial pool near the Acre shore a flourishing population survived, encrusting on aging lumber. When the factory maintaining this pool stopped operating, the pool dried up along with its biota of brackish species sensitive to industrial pollution. This is a rare recorded case of the local extinction of an invertebrate species.

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REFERENCES

Amoureux, L., F. Rullier and L. Fishelson. 1978. Systématique et écologie d'annélides polychètes de la presqu' ile du Sinaï. Isr. J. Zool. 27: 57–163.

Ben-Eliahu, M.N. 1976. Polychaete cryptofauna from rims of similar intertidal vermetid reefs on the Mediterranean coast of Israel and in the Gulf of Elat: Serpulidae (Polychaeta Sedentaria). Isr. J. Zool. 25: 103–119.

Dafni, J. 1974. Animal communities on dead corals under pollution conditions at Eilat, Red Sea. M.Sc. Thesis, Tel Aviv University (in Hebrew).

Dew, B. 1959. Serpulidae (Polychaeta) from Australia. Rec. Aust. Mus. 25: 19–56.

Fauchald, K. 1977. The polychaete worms, definitions and keys to the orders, families and genera. Nat. Hist. Mus. Los Angeles Cty. Contrib. Sci. 28: 1–190.

Fauvel, P. 1927. Polychètes Sédentaires, Faune de France 16. Le Chevalier, Paris. 494 pp.

Fauvel, P. 1933. Mission Robert Ph. Dollfus en Egypte. Annélides Polychètes. Mem. Inst. Egypte 21: 31–83.

Fauvel, P. 1957. Sur quelques Annélides Polychètes du Golfe d'Akaba. Sea Fish Res. Stn. Haifa Bull. No. 13: 3–11.

Fishelson, L. 1975. Environmental extremes and changes on point diversity of invertebrates and fishes caused by recent changes in the coral reef environment at Eilat (Red Sea). Proc. VIth Conf. Isr. Ecol. Soc.: 53–63.

Fishelson, L. and F. Rullier. 1969. Quelques Annélides Polychètes de la Mer Rouge. Isr. J. Zool. 18: 49–117.

Hove, H.A., ten. 1970a. Additional notes on the polychaetes of the Iranian Gulf (Annelids, Polychaeta, Serpulidae). Steenstrupia 1: 55–60.

Hove, H.A., ten. 1970b. Serpulinae (Polychaeta) from the Caribbean: I. The Genus *Spirobranchus*. Stud. Fauna Curacao Other Caribbean Islands 32: 1–57, 5 pl.

Hove, H.A., ten. 1979. Different causes of mass occurrence in serpulids. In: Biology and Systematics of Colonial Organisms. G. Larwoods and B.R. Rosen (eds.). Academic Press, London and N.Y. pp. 281–297.

Hove, H.A., ten and J.C.A. Weerdenburg. 1978. A generic revision of the brackish-water serpulid *Ficopomatus* Southern 1921 (Polychaeta: Serpulinae) including *Mercierella* Fauvel, 1923, *Sphaeropomatus* Treadwell, 1934, *Mercierellopsis* Rioja, 1945 and *Neopomatus* Pillai, 1960. Biol. Bull. 153: 96–120.

Por, F.D. and I. Dor. 1975. Ecology of the metahaline pool of Di-Zahav, Gulf of Elat, with notes on the Siphonocladacea and the typology of near shore marine pools. Mar. Biol. 29: 37–44.

Uchida, H. 1978. Serpulid tube worms (Polychaeta, Sedentaria) from Japan with the systematic review of the group. Bull. Mar. Park Res. Stn. 2: 1–98.

Zibrowius, H. 1970a. Contribution à l'étude des Serpulidae (Polychaeta Sedentaria) de Bresil. Bol. Ins. Oceanogr. 19: 1–32.

Zibrowius, H. 1970b. Les espèces Méditerraneenes du genre *Hydroides* (Polychaeta Serpulidae). Remarques sur le prétendu polymorphisme de *Hydroides uncinata*. Téthys 2: 691–746.

Zibrowius, H. 1973. Serpulidae (Annelida Polychaeta) des Côtes ouest de l'Afrique et des Archipels voisins. Mus. R. Afr. Cent. Tervuren Belg. Ann. Ser. Octavo Sci. Zool. No. 207: 93 pp.