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An abundant new genus and species of fan worms (Polychaeta: Sabellidae) from Hawaii

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Abstract

A new genus and species of Hawaiian sabellid polychaete, *Euchonoides moeone* **n. gen. et n. sp.** is described. This new species has consistently been one of the most abundant polychaetes collected in Mamala Bay, Hawaii, reaching densities of 141,046 ind. m^{-2} and representing up to 30.6% of all polychaetes collected in that region. The species has a small body (~2 mm length) with a reduced number of abdominal chaetigers (8–10), and is distinguished by the presence of the following features: 1) three pairs of radioles; 2) radiolar skeleton with two longitudinal rows of cells from radiole base to third proximal pair of pinnules, remainder of each radiole skeleton with single rows of cells; 3) pinnules unpaired, alternating (snowflake arrangement); 4) thoracic uncini acicular with a large tooth above the main fang followed by a series of small ones; 5) thoracic chaetiger 3 enlarged; 6) a wide belt on third abdominal chaetiger; and 7) a pre-pygidial depression composed of three chaetigers, with lateral wings, among a combination of several others features. Histological sections have shown that the abdominal belt seems to be a clitellum-like structure where oogenesis takes place. The new genus is compared with other plesiomorphic genera sharing similar morphological features. Patterns of abundance of the new species are presented for the past 27 years in Mamala Bay.

Keywords: *Euchonoides*, *Euchone,* clitellum-like segment, histology, sewage outfall, abundance

Introduction

Numerous individuals of a small sabellid worm have been collected since 1990 adjacent to the Barbers Point ocean outfall (*e.g.* Nelson *et al.* 1991; Ambrose *et al.* 2017) and Sand Island ocean outfall (*e.g.* Bailey-Brock *et al.* 2001, 2002; Ambrose *et al.* 2014), both in Mamala Bay, South shore of Oahu, Hawaii. These specimens were attributed to the genus *Euchone* Malmgren, 1866 due to the presence of a pre-pygidial depression and have been known as *Euchone* sp. B (Bailey-Brock *et al.* 2001, 2002).

Euchone is a sabellid genus with about 34 species having few or several posterior abdominal chaetigers forming a pre-pygidial depression (Banse 1970; Read & Fauchald 2019). The number of anterior abdominal chaetigers as well as the number of chaetigers forming this pre-pygidial depression have traditionally been used for separating *Euchone* species (Fitzhugh 2002; Giangrande & Licciano 2006) and additional characters include the shape of the abdominal uncini, the anterior margin of the collar, the presence and shape of ventral shields and methyl green staining patterns (Banse 1970, 1972; Bick & Randel 2005).

The monophyly of *Euchone* was questioned by Cochrane (2003) because of the existence of two morphological and ecological groups, one with 'feather-duster' crowns relying mainly on suspension feeding and another with 'snowflake' crowns that could also be surface deposit feeding. *Euchone* species having 'snowflake' type crowns are usually very small and all four species assigned to this clade have the pre-pygidial depression formed by three chaetigers (Cochrane 2000, 2003).

Several small *Euchone* species have been collected in high densities in soft bottom sediments. The undescribed

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Euchone x *sensu* Cochrane (2000) was found in densities as high as 6,000 ind.m^{-2} (Mannvik *et al.* 1990). *Euchone limnicola* Reish, 1959, was the most abundant polychaete species in Richmond Harbor, California with densities ranging from 9.6–209.7 ind. per 0.1 m^{-2} (COE and Port of Richmond 1996). *Euchone analis* (Krøyer, 1856) was found in densities as high as 6,200 ind.m^{-2} in Spitsbergen (Bick & Arlt 2005). The high densities of *Euchone incolor* Hartman, 1965 (29–1,352 ind. m^{-2}) in low-oxygen, food-rich environments were explained by its opportunistic life style including brooding larvae to late stages within brood pouches in their tubes (Levin *et al.* 1991). *Euchone incolor* and *E. elegans* Verrill, 1873 have been considered as two of the most tolerant species to contaminants in the New York Bight (Chang *et al.* 1992).

In order to properly describe the species from Mamala Bay, a peculiar clitellum-like structure on the third abdominal chaetiger was investigated in detail and its morphology, histology and reproductive importance are presented. As a consequence, this Hawaiian species could not be attributed to the genus *Euchone sensu stricto* neither *Euchoneira* Licciano, Giangrande & Gambi, 2009 only by the presence of a pre-pygidial depression. In this contribution, a new genus is proposed and its patterns of abundance at the type locality is presented for the past 27 years.

Materials and methods

Specimens of the undescribed sabellid genus and species have been collected since 1990 adjacent to the Barbers Point ocean outfall and Sand Island ocean outfall, both in Mamala Bay, South shore of Oahu, Hawaii. Samples have been collected with a 0.16 m^2 modified van Veen grab and subsamples of 7.6 cm in diameter by 5.0 cm deep taken at seven stations for the Barbers Point outfall at up to 70 m in depth and 15 stations for the Sand Island outfall at up to 103 m in depth. Sample handling, processing, and preservation followed U.S. EPA procedures (U.S. Environmental Protection Agency 1987).

Specimens were examined using a phase contrast light microscope and some specimens were drawn using an attached camera lucida. Measurements of length including radiolar crown and maximum width at the thorax were recorded using digital images and the ImageJ computer application. Some specimens were stained with a saturated solution of Methyl Green in 70% ethanol to observe the staining pattern as well as with Shirlastain A to emphasize the external morphology. Photographs of preserved specimens were taken with a Nikon D3100 attached to a dissecting or light microscope. Two individuals were examined with a Scanning Electron Microscope (SEM) and were dehydrated through a series of increasing concentration of ethanol with three changes of absolute ethanol followed by critical point drying in a SAMDRI-795. The specimens were then mounted on stubs and coated with gold/palladium for observation on the Hitachi S-4800 at the Biological Electron Microscopy Facility (BEMF), University of Hawaii at Manoa.

About 30 mature and immature individuals were prepared for histological sections at the Histopathology Core, John A. Burns School of Medicine (JABSOM) of the University of Hawaii at Manoa. Samples were dehydrated through ethanol series, cleared in two changes of xylene, infiltrated and embedded in paraffin for longitudinal sections. Sections were made using a rotary microtome and placed on uncoated glass slides. Sections were stained with haematoxylin and eosin (H&E).

Type material is deposited at the Bernice Pauahi Bishop Museum, Honolulu (BPBM) and the Natural History Museum of the Federal University of Bahia, Salvador, Brazil (UFBA). Features for adult stage of *Euchone analis* (Krøyer, 1856) presented on Table 2 were based on Bick and Randel (2005) whereas those of *Euchoneira* were taken from Licciano *et al*. (2009). Reproductive features for *E. analis* were taken from Curtis (1977). Features for *Amphicorina bicincta* summarized on Table 1 were taken from Ozolinsh (1988).

Results

Taxonomic account

Family Sabellidae Latreille, 1825

Euchonoides n. gen.

Type species. *Euchonoides moeone* **n. sp.**, herein designated, by monotypy.

Diagnosis. Body short with a reduced number of abdominal chaetigers (8–10). Three pairs of radioles. Radiolar skeleton present in branchial lobes, radioles and pinnules. Each radiolar skeleton with two longitudinal rows of cells from radiole base to third proximal pair of pinnules, remainder of each radiole and all pinnular skeletons with single rows of cells. Pinnules unpaired, alternating (snowflake arrangement). Basal membrane absent; radiolar flanges absent; radiolar eyes absent. Dorsal lips without radiolar appendage. Ventral lips absent. Dorsal pinnular appendages absent. Ventral pinnular appendages present. Parallel lamellae absent. Ventral sacs absent. Radiolar lobes fused along dorsal midline; without dorsal or ventral basal flanges. Anterior peristomial ring distinctive, but no visible annulation between anterior and posterior peristomial ring. Peristomial eyes present. Peristomial vascular loops absent. Posterior peristomial ring collar incised ventrally; separated dorsally by distinct gap. Collar chaetae fascicles protruding from a short lobe, narrowly hooded chaetae. Glandular ridge on thoracic chaetiger 2 present. Superior thoracic notochaetae elongate, narrowly hooded. Inferior thoracic notochaetae includes bayonet and broadly hooded chaetae. Thoracic neuropodial uncini acicular, handles long, hoods absent, a large tooth above the main fang followed by a series of small ones. Companion chaetae absent. Thoracic chaetiger 3 always enlarged (2–3 times longer than wide). Ventral thoracic shields not differentiated. Neuropodial abdominal fascicles with elongate, narrowly hooded chaetae. Anterior abdominal uncini with square breasts, handle absent, and rasp-shaped dentition. Belt (clitellum-like) on third abdominal chaetiger present. Pre-pygidial depression composed by three chaetigers, with lateral wings. Uncini from pre-pygidial depression similar to those from anterior abdomen. Pygidium without anal cirrus. Pygidial eyes absent.

Etymology. The genus name is a free combination of *Euchone* and the Latin sufix *-oides*, in relation to the similarities between the new genus with the genus *Euchone*.

Gender. Neuter.

TABLE 1. Comparative table including selected morphological characters of *Euchonoides moeone* **n. sp.** and *Amphicorina bicincta* (Ozolinsh, 1988).

	Euchonoides moeone **n. sp.**	*Amphicorina bicincta* (Ozolinsh, 1988)
Type locality/sediment	Mamala Bay, Hawaii in 70 m, sediment composed primarily of fine and medium sand.	Kamchatka and Kurile islands in 33–46 m in fine silted sand.
Size	Holotype 2.15 mm long (including 0.48 mm of crown).	Holotype 4.4 mm long (1.4 mm of crown); up to 8 mm long (with crown).
Pairs of radioles	Three pairs, each with 6–12 pinnules	Three pairs, each with 6–8 pinnules
Radiolar tips	Short	Long
Length of pinnules	Basal pinules short, then markedly long towards the last third of radiolar length	All pinnules of similar length along radioles
Ventral radiolar appendages	One pair, short or as long as radioles	One pair, as long as a half of radioles
Peristomial eyes	Present	Absent
Number of thoracic chaetigers	Seven in holotype (3–7 in paratypes)	Eight
Glandular ridge on thoracic chaetiger 2	Narrow all around, light brown in color	Wide all around, clearly visible, bearing a basal notch mid-dorsally
Abdominal belt (clitellum-like) on third abdominal segment	Present, pre-chaetal	Present, pre-chaetal
Number of chaetigers forming the pre-pygidial depression	Three	?
Pygidial cirrus	Absent	Present

TABLE 2. Comparative table of selected morphological features of the new genus and diagnostic features of the genera *Euchone* Malmgren, 1866 restricted (based on type species), *Euchoneira* Licciano, Giangrande & Gambi, 2009 and *Terebrasabella* Fitzhugh & Rouse, 1999 (based on type species description and modified diagnosis of genus by Murray & Rouse, 2007).

	Euchonoides **n. gen.**	*Euchone* restricted	*Euchoneira*	*Terebrasabella*
Type species	*Euchonoides moeone* **n. sp.**	*Euchone analis* (Krøyer, 1856)	*Euchoneira knoxi* Licciano, Giangrande & Gambi, 2009	*Terebrasabella heterouncinata* Fitzhugh & Rouse, 1999
Basal membrane	Absent	Present	Present	Absent
Radiolar flanges	Absent	Present	Present	Absent
Pairs of radioles	3	9–11	16	2
Pinnular arrangement	Snowflake (unpaired, alternating pinnules)	Feather duster (paired pinnules)	Feather duster (paired pinnules)	Described as “Pectinately arranged”, but according to Fig. 2 in Fitzhugh & Rouse, these are unpaired pinnules.
Radiolar skeleton	Each radiolar skeleton with two longitudinal rows of cells from radiole base to third proximal pair of pinnules, remainder of each radiole with single rows of cells	Two, four or more cells, irregularly arranged	Two rows of cells	Each radiolar skeleton with two longitudinal rows of cells from radiole base to second proximal pair of pinnules, remainder of each radiole with single rows of cells
Dorsal lips	Digitiform, without mid-rib (radiolar appendage)	Elongate, distally tapered, with mid-rib (radiolar appendage)	Broadly rounded, without mid-rib (radiolar appendage)	Elongate with mid-rib (radiolar appendage)
Dorsal pinnular appendages	Absent	Present, but number not defined	Present: 1–2 appendages	Absent
Ventral lips	Absent	Present	Present	Absent
Ventral radiolar appendages	Present: one pair	Present: 1 to 8 pairs	Present: up to 16	?
Peristomial eyespots	Present	Absent	Absent	Absent
Peristomial vascular coils	Absent	Present	?	?
Glandular ridge on thoracic chaetiger 2	Present	Present	Present	Absent
Third thoracic segment	Always enlarged: 2–3 times longer than wide	Not enlarged: similar length than other thoracic segments	Not enlarged: similar length than other thoracic segments	Not enlarged: similar length than other thoracic segments
Ventral thoracic shields	Not differentiated, visible only using staining	Well differentiated, visible without staining	Well differentiated, visible without staining	Well differentiated, visible without staining

....*Continued next page*

TABLE 2. (Continued)

	Euchonoides **n. gen.**	*Euchone* restricted	*Euchoneira*	*Terebrasabella*
Dentition of thoracic uncini	Acicular uncini with one large tooth above main fang followed by transverse rows of smaller teeth	Acicular uncini with all small teeth, gradually decreasing in size away from main fang	Acicular uncini, all small teeth, of near uniform size above main fang	Two or three types of thoracic uncini: acicular uncini with main fang surmounted by a series of homodont or heterodont teeth; palmate uncini and or avicular uncini.
Hood of thoracic uncini	Absent	Absent	Absent	Absent
Abdominal uncini breast	Square	Square	Avicular, narrow swelling	Poorly developed
Abdominal uncini handle	Absent	Absent	Poorly-developed, as long or slightly longer than crest	Well-developed, longer than 5 times the length of crest
Pre-pygidial depression	Composed of three chaetigers	Composed of 10–12 chaetigers (other species of 'Chiade' with at least three chaetigers)	Composed of nine chaetigers	Absent
Lateral wings	Present	Present (an anterior bordering margin may also be present)	Present	Absent
Belt (clitellum-like) on abdominal chaetiger 3	Present, pre-chaetal	Absent	Absent	Absent
Number of abdominal chaetigers	8–10	up to 29	30	Three
Oocytes diameter	37–50 µm	150 µm	100–250 µm	?
Gamete distribution	Abdominal segments 1–3	Thorax and abdomen	Thorax and abdomen	Thorax and abdomen (spermiogenesis in chaetiger 8 and oogenesis in chaetigers 9 and 10)
Sperm head	?	Spherical	Conical (nip-like)	Elongate
Brooding or free-spawning	Intratubular brooding? Developing individuals have been found together with adults inside the tube	Intratubular brooding (embryos measuring 300–400 µm in diameter present in the tube)	?	Intratubular brooding. Young are brooded in the adult burrow to a late larval stage with 6 chaetigers

Remarks. The new genus is proposed based on a combination of distinctive characters (see Table 2) but especially by the presence of an oblique, broad belt on the third abdominal chaetiger (Figs 1A–B; 3A) instead of the typical glandular ridges. This abdominal structure is not morphologically similar to the usual, glandular ridge on thoracic chaetiger 2 or to the glandular abdominal ridges in other *Chone*, "Chiade" or *Dialychone* species (Tovar-Hernández 2008). These typical glandular ridges are whitish and occupies only the external half of the epithelium; these are composed of strongly differentiated acidophil glandular cells, tubular-shaped with granulose secretions such as described by Tovar-Hernández & Sosa-Rodríguez (2006). The abdominal belt of *E. moeone* **n. sp.** is conspicuous (visible without staining), but histological sections show that it is not a differentiated epithelium from the rest, it is only a thicker epithelium as the clitellum of clitellates, with markedly basophil glands. Reproductive features associated to the abdominal segment 3 such as presence of modified chaetae, genital pores or markings were not found, but germ cells and oocytes in different phases of development were found in abdominal chaetigers 1–3.

A similar abdominal belt was reported for *Amphicorina bicincta* (Ozolinsh, 1988) and on another undescribed *Amphicorina* species from Chukchi Sea (Leslie Harris pers. com.). These three species are similar and the differences are presented on remarks for the new species and on Table 1. In her review of *Oriopsis*, Giangrande *et al.* (1999: 196) emphasized that *A. bicincta* probably belonged to a new genus. In addition to the belt on abdominal chaetiger 3; the pinnular arrangement (snowflake); the presence of three pairs of radioles and a pre-pygidial depression composed of three chaetigers, the new genus is established based also on a combination of unique features as supported above.

Among these unique set of characters, the radiolar skeleton of *Euchonoides* **n. gen.** is similar to that present in *Terebrasabella* Fitzhugh & Rouse, 1999: each radiolar skeleton has two rows of cells from radiole base to third proximal pair of pinnules, and the remainder of each radiole with single rows of cells. The genera *Terebrasabella*, *Caobangia* Giard, 1893 and *Amphiglena* Claparède, 1864 also lack ventral lips.

A low number of radioles have been reported in few sabellids. *Terebrasabella* has only two pairs of radioles whereas the presence of three pairs of radioles have been reported in *Desdemona ornata* Banse, 1957, some species of *Amphicorina* Claparède, 1864, *Euchone incolor*, *E. scotiarum*, *E. trilobata*, *E. hanckocki* and *Euchone* x *sensu* Cochrane and the new genus here described.

The new genus is quite remarkable in having such a small number of abdominal chaetigers (8–10 chaetigers). In comparison, *Terebrasabella* present only three abdominal chaetigers, *Amphiglena lindae* Rouse & Gambi, 1997 has 26 abdominal chaetigers and *Caobangia* presents 25–40 abdominal chaetigers.

Enlargement of some chaetigers (not depending of contraction) has been observed in *Terebrasabella* where posterior abdominal segments are notoriously longer than wide. In the new genus, thoracic chaetiger 3 is also markedly longer than remainder of body segments.

Comparing with other sabellid genera having a pre-pygidial depression with lateral wings, radioles are free in *Euchonoides* **n. gen.**, not joined by a basal membrane and lacks flanges (both, membrane and flanges present in *Euchone* restricted and *Euchoneira*). Arrangement of pinnules as snowflake (unpaired, alternating pinnules) is present in *Euchonoides* **n. gen.** (feather duster= paired pinnules in *Euchone* restricted and *Euchoneira*). Dorsal lips are digitiform without mid-rib support in *Euchonoides* **n. gen.** whereas lips are distally tapered with mid-rib in *Euchone* and broadly rounded without mid-rib in *Euchoneira*. In *Euchonoides* **n. gen.**, the third thoracic chaetiger is always enlarged (*versus* not enlarged in *Euchone* and *Euchoneira*). Ventral shields are well differentiated, swollen in *Euchone* and *Euchoneira*, but not differentiated in *Euchonoides* **n. gen.** Dentition of thoracic uncini of *Euchonoides* **n. gen.** is characterized by uncini with a large tooth above the main fang in contrast to the small teeth of *Euchone* and *Euchoneira.* The number of abdominal uncini is reduced in *Euchonoides* **n. gen.** (8–10) but larger in *Euchone* (up to 29) and *Euchoneira* (30). See Table 2 for additional comparisons.

***Euchonoides moeone* n. sp.**

(Figs 1–6)

Euchone sp. B: Nelson *et al.* (1991), Bailey-Brock *et al.* (2001; 2002), Ambrose *et al.* (2017 and previous years).

Material examined. Holotype: Mamala Bay, Oahu, Hawaii, Sta. HB3R2, 21°17’ 02.8” N, 158°01’ 39.5” W, Jan/2016, 70 m, sediment composed primarily of fine and medium grain sand (BPBM R-3914). Paratypes: same locality, station and date as holotype (20, BPBM R-3915; 10, UFBA 1582).

Description

Body short, rounded in cross section (Fig. 1A–B). Holotype total thorax-abdomen length 1.67 mm (radiolar crown 0.48 mm), maximum width 0.1 mm. Paratypes ranging from 1.8–2.1 mm long (radiolar crown 0.3–0.45), maximum width 0.1 mm.

Three pairs of radioles (Figs 1D; 2D), each with 6–12 pinnules, with snowflake (unpaired, alternating pinnules) distribution; radiolar rachis slightly thicker than pinnules (Fig. 1D). Basal pinnules short, then increasing abruptly in size towards last third of radiolar length, most of pinnules terminate at approximately same height distally (Figs 1A–B, D; 2D). Radiolar tips filiform, as long as one quarter of radiolar length (Fig. 2D). Dorsal lips digitiform, as long as ¼ of the radiolar crown length, without mid-rib (radiolar appendage) (Figs 1D; 2D). Ventral lips absent. A pair of ventral radiolar appendages as long as radiolar length (shorter in some paratypes) (Figs 1D; 2D). Inter-radiolar membrane and radiolar lateral flanges absent (Fig. 3B–C). Each radiolar skeleton with two longitudinal rows of cells, in cross section, from radiole base to third proximal pair of pinnules, remainder of each radiole with single rows of cells (Fig. 5B–C). Radiolar eyes absent.

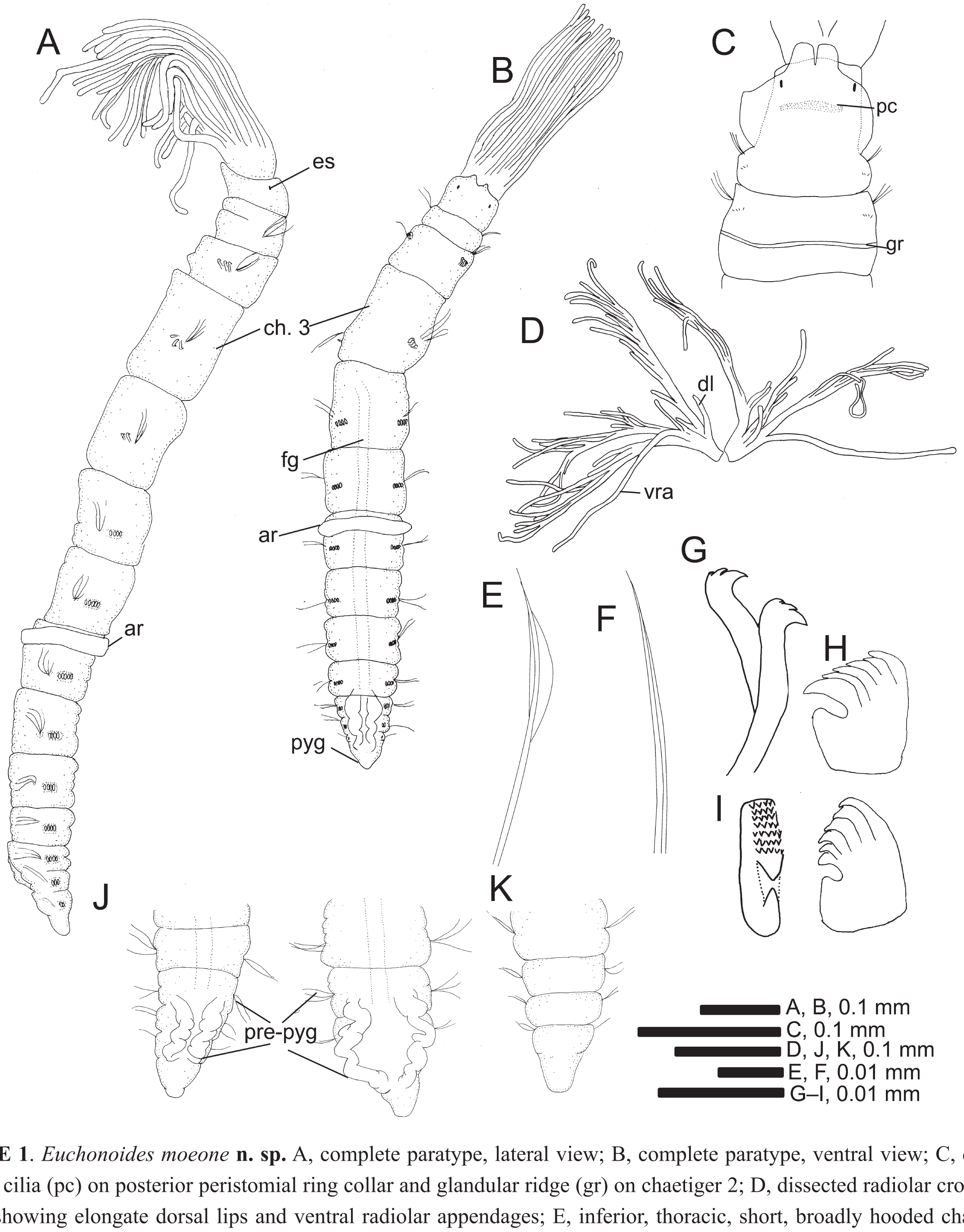

FIGURE 1. *Euchonoides moeone* **n. sp.** A, complete paratype, lateral view; B, complete paratype, ventral view; C, detail of patch of cilia (pc) on posterior peristomial ring collar and glandular ridge (gr) on chaetiger 2; D, dissected radiolar crown with arrows showing elongate dorsal lips and ventral radiolar appendages; E, inferior, thoracic, short, broadly hooded chaetae; F, inferior, thoracic bayonet chaeta; G, thoracic acicular uncini; H, anterior abdominal uncinus; I, posterior abdominal uncini, frontal and lateral view, respectively; J, posterior end showing pre-pygidial segments and pygidium, ventral view; K, posterior end, dorsal view. Abbreviations: ar, abdominal ridge; ch, chaetiger; es, eyespots; fg, faecal groove; gr, glandular ridge; pc, patch of cilia; pyg, pygidium; pre-pyg, pre-pygidial chaetigers. Pinnules in A–B may be confused with radioles, there are only three pairs or radioles.

Anterior peristomial ring exposed partially on lateral sides (Fig. 3B, D), fully exposed dorsally (Fig. 3C). A pair of brown peristomial eyes (Figs 1A–B; 2C). Posterior peristomial ring collar well-developed with entire smooth margins (Figs 1A–C; 3C–D). Ventral margin of collar longer than dorsal, with deep mid-incision forming rounded ventral lappets (Figs 1B–C; 3D). Lateral collar margins diagonal (oblique) (Figs 1A; 3B, D). Dorsal collar margins fused to faecal groove, forming a narrow gap (Fig. 3C). Collar chaetiger with 4–6 elongate, narrowly hooded chaetae of equal length (Fig. 3C). Ventral shield of collar rectangular (Fig. 2A), with a transverse patch of cilia (Figs 1C; 3D).

Thorax composed of seven chaetigers in holotype (paratypes with 3–7 chaetigers). Glandular ridge homogeneously narrow on chaetiger 2 (Figs 1C), light brown in color, when fixed. Thoracic segments increasing in length from chaetigers 1–3, chaetiger 3 always longest, 2–3 times longer than wide (Figs 1A, B; 3A). Ventral glandular shields not differentiated (Figs 1A–B; 3A). Notopodia: superior group of chaetae with a row of two elongate, narrowly hooded chaetae; inferior group with one row of two bayonet chaetae (Figs 1E; 4A), and one row of broadly hooded chaetae (Figs 1F; 4B). Neuropodia: acicular uncini numbering 3–4 per torus, handles longer than 5 times the length of crest, hoods absent (Fig. 1G), a large tooth above the main fang (Fig. 4C), followed by a series of small ones, dentition covers half of the main fang length (Fig. 4C).

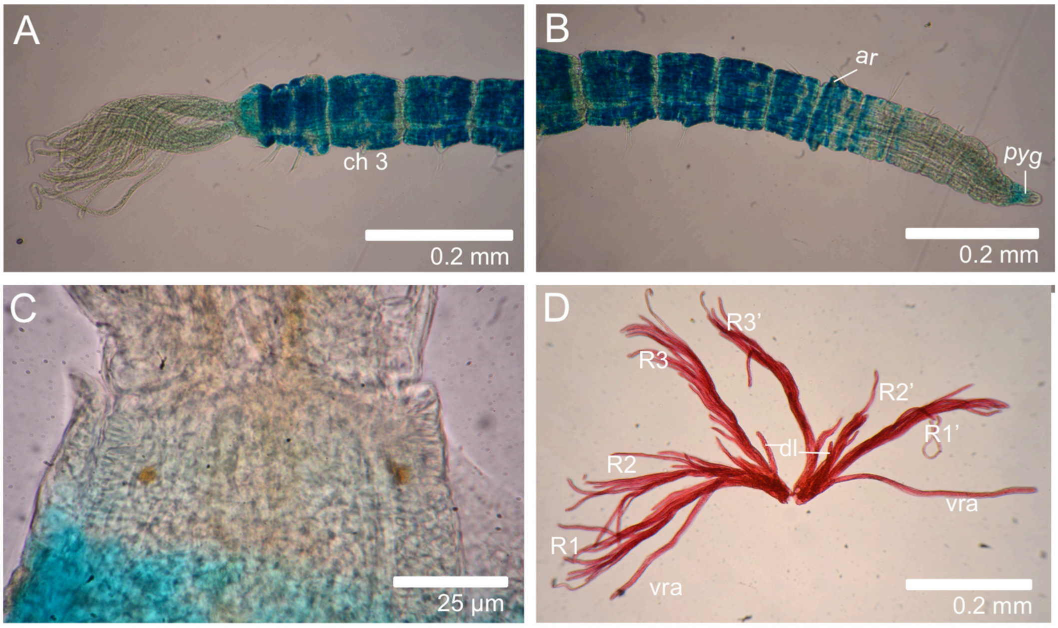

FIGURE 2. *Euchonoides moeone* **n. sp.** A, anterior end, ventral view, stained with methyl green; B, posterior end, dorso-lateral view, stained with Methyl Green; C, peristomium in ventral view showing brownish eyespots; D, dissected radiolar crown stained with Shirlastain A. Abbreviations: ar, abdominal ridge; ch, chaetiger; dl, dorsal lip; pyg, pygidium; R, radiole; vra, ventral radiolar appendage.

Abdomen with nine chaetigers in holotype, posterior three forming pre-pygidial depression (8–10 chaetigers in paratypes, all paratypes with pre-pygidial depression composed of three segments). Third abdominal chaetiger (A3) with unusual, broad belt (clitellum-like), readily distinct and present in all specimens (Figs 1A–B; 3A); dorsally entire, ventrally interrupted by faecal groove; composed of wide glandular, columnar epithelium (Fig. 5A, E–H, J). Neuropodia with 3–6 elongated, narrowly hooded chaetae, slightly longer on posterior-end chaetigers. Anterior abdominal notopodia with 4–6 uncini per torus with square breasts, handle absent, and at least nine rows of small, equal sized teeth covering most than 3/4 of main fang length (rasp-shaped dentition) (Figs 1H; 4D). Pre-pygidial depression with raised membranous lateral flanges (Figs 1B, J; 3E; 6D); tori shorter than anterior abdominal segments, and with decreasing number of uncini (4, 3, 2, respectively); uncini not distinct in shape than rest of anterior abdominal uncini (Fig. 1I). Pygidium enlarged, bluntly rounded, lacking pygidial eyespots and pygidial cirrus (Figs 1J, K; 3E; 5D).

Body color and methyl green staining pattern: Preserved specimens lacking pigmentation. Ventral shields only distinct with staining (Fig. 2A–B). Methyl green stained more intensely transverse glandular bands of thorax and anterior abdomen (Fig. 2A–B); posterior abdomen staining lightly, pygidium staining more distinctly than pre-pygidial depression (Fig. 2B); thoracic ventral region staining more intensely than respective dorsal region, especially ventral shields (Fig. 2A–B).

Tubes: Tube composed of fine and medium grain sand particles and shell fragments bound by mucus membrane and fine layer of silt.

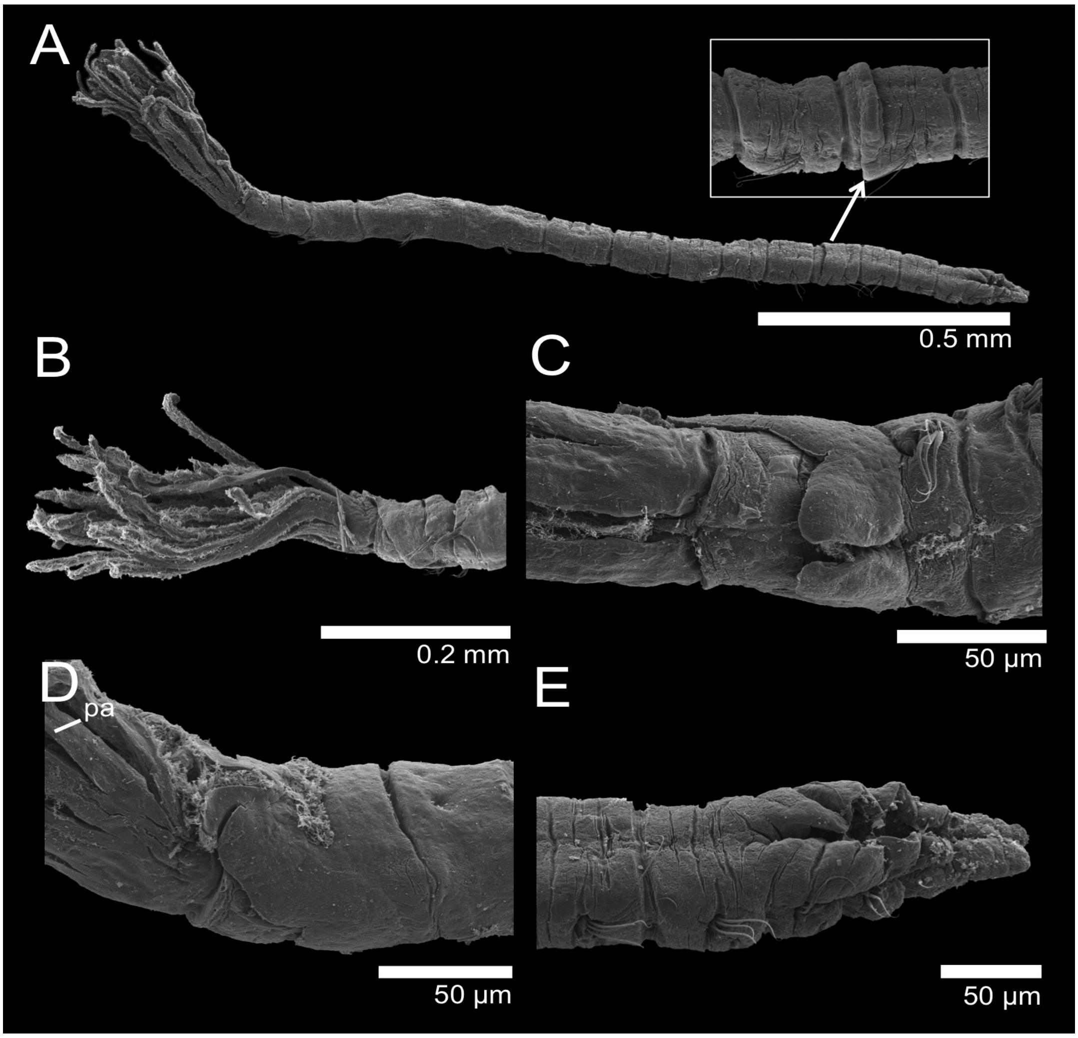

FIGURE 3. SEM of *Euchonoides moeone* **n. sp.** A, complete specimen in lateral view, inset showing glandular belt on third abdominal chaetiger; B, radiolar crown; C, anterior peristomial ring and posterior peristomial ring collar in dorsal view; D, posterior peristomial ring collar in ventro-lateral view; E, posterior end with pygidium, ventro-lateral view.

Reproduction: Several individuals with developing radiolar crowns and variable number of thoracic segments (3–7) were found within tubes of adults, indicating intratubular direct larval development. In these offspring, radioles are rudimentary (as small, rounded protuberances or short, digitiform radioles without pinnules) and thorax is not completely formed (few chaetigers are present and the first three thoracic segments are narrower and shorter than rest of the body). Ripe males or hermaphrodites were not found in the hundreds of examined specimens, but packages of germ cells were observed in abdominal segments A1–A3 (Fig. 5A, G). Oogenesis was observed only in abdominal segments A1–A3. Oocytes measured 37–50 µm in diameter, and few oocytes (three per specimen) were found in abdominal segments A1–A3 (Fig. 5G, I).

Remarks. Cochrane (2003) recognized a group of small-sized *Euchone* species with snowflake pinnular arrangement and the presence of three chaetigers in the pre-pygidial depression named by her as 'Chiade'. This clade is composed of *E. trilobata* (Banse, 1957) from the Falkland Islands, *E. incolor* Hartman, 1965 from off New England, *E. hancocki* Banse, 1970 from southern California, *E. scotiarum* Hartman, 1978 from Antarctica, and *Euchone* x *sensu* Cochrane, 2000 from the North Sea and the Norwegian Sea. These species of 'Chiade' differ in the number of abdominal segments anterior to pre-pygidial depression and on the presence of glandular ridges similar to that in thoracic chaetiger 2, but also present in some abdominal chaetigers. Abdominal glandular ridges are present in

E. incolor (pre-chaetal on third abdominal chaetiger), *E. hancocki* (post-chaetal on first abdominal chaetiger) and *Euchone* x (pre-chaetal on third abdominal chaetiger). *Euchone trilobata* do not have abdominal glandular ridges and these were not described or corroborated in *E. scotiarium* (Banse 1957). However, specimens from Hawaii here studied are unique among all the species of 'Chiade' by the presence of an oblique, broad belt on third abdominal chaetiger.

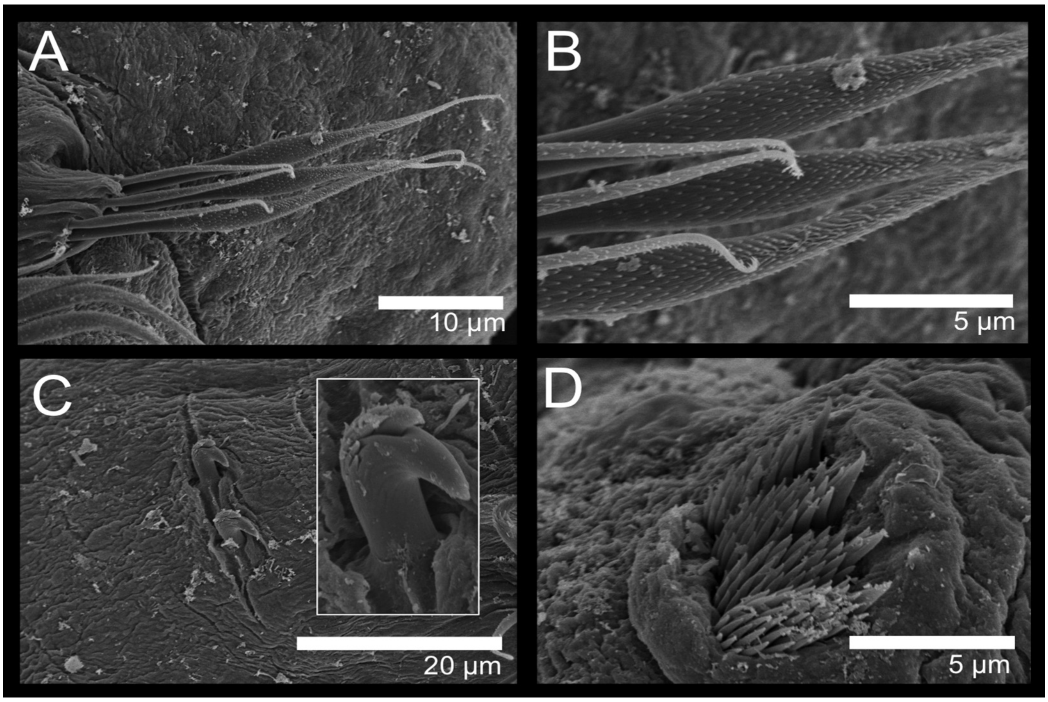

FIGURE 4. SEM of *Euchonoides moeone* **n. sp.** A, inferior group of thoracic notopodial chaetae (bayonet and broadly hooded); B, detail of inferior thoracic broadly hooded chaetae; C, thoracic neuropodial acicular uncini with inset showing large and single tooth above main fang; D, abdominal uncini.

A similar abdominal belt was reported for *Amphicorina bicincta* (Ozolinsh, 1988) and an undescribed species of *Amphicorina* from Chukchi Sea (Leslie Harris pers. com.). In their review of *Oriopsis*, Giangrande *et al.* (1999: 196) emphasized that *A. bicincta* probably belongs to a new genus. *Amphicorina bicincta* and *E. moeone* **n. sp.** are similar in relation to the presence and shape of the oblique abdominal belt on third abdominal chaetiger and presence of three pairs of radioles but these are readily distinguished by the presence of a broad glandular ridge on thoracic chaetiger 2 in *A. bicincta* (narrow in *E. moeone* **n. sp.**) (see Table 1 for a detailed comparison).

Terebrasabella heterouncinata Fitzhugh & Rouse, 1999 has one pair of densely ciliated sperm ducts present along the posterior margin of thoracic chaetiger 8. These ducts are located ventro-laterally, just posterior to neuropodial uncini, extending dorsally and sometimes slightly anteriorly as low ridges; these ducts terminate at the lateral margins of faecal grove (Fitzhugh & Rouse 1999). Reviewing SEM images by Fitzhugh & Rouse (1999: fig. 5), there is a great external similarity between sperm ducts of *Terebrasabella* and the belt of the new genus located on abdominal segment 3. Both are low ridges and terminate on lateral margins of the faecal groove. To date, spermatozoa have not been observed in the new Hawaiian genus.

Etymology. The new species epithet derives from the Hawaiian language and the implied meaning of *moeone* in Hawaiian is 'small worm that hides in the sand'.

Distribution. The type locality is Mamala Bay, Oahu, Hawaii at the vicinity of Barbers Point sewage outfall at 70 m. This species has also been collected at Ala Wai Canal, Kailua Bay, and Waianae on Oahu from shallow subtidal to up to 100 m in fine and medium sand.

Discussion

Euchonoides moeone **n. sp.** has been one of the most abundant polychaetes collected in Mamala Bay, reaching densities of 141,046 ind. m^{-2} at the type locality (Sta. HB3R2; Fig. 6). *Euchonoides moeone* **n. sp.** was the most abundant polychaete species collected during the 2016 biomonitoring effort in Barbers Point, representing 30.6% of all collected polychaetes (Ambrose *et al.* 2017). The abundance of *E. moeone* **n. sp.** varied greatly during the 27 year-study period and it has shown a steadily increase throughout the years, especially at the stations with direct influence of the Barbers Point sewage outfall (stations HB2 through HB6; Fig. 6). The two reference stations (HB1 and HB7) have had the lowest abundances of this new species and this may indicate that *E. moeone* **n. sp.** could be a good indicator of sediment organic enrichment. The sediment characteristics at the type locality (Sta. HB3R2, Jan. 2016), where this species was collected with its highest density, had values of ORP (148 mV), nitrogen (176 mg/dry kg) and TOC (0.376 % dry weight) showing no evidence of reducing conditions in the surface sediments (Ambrose *et al.* 2017).

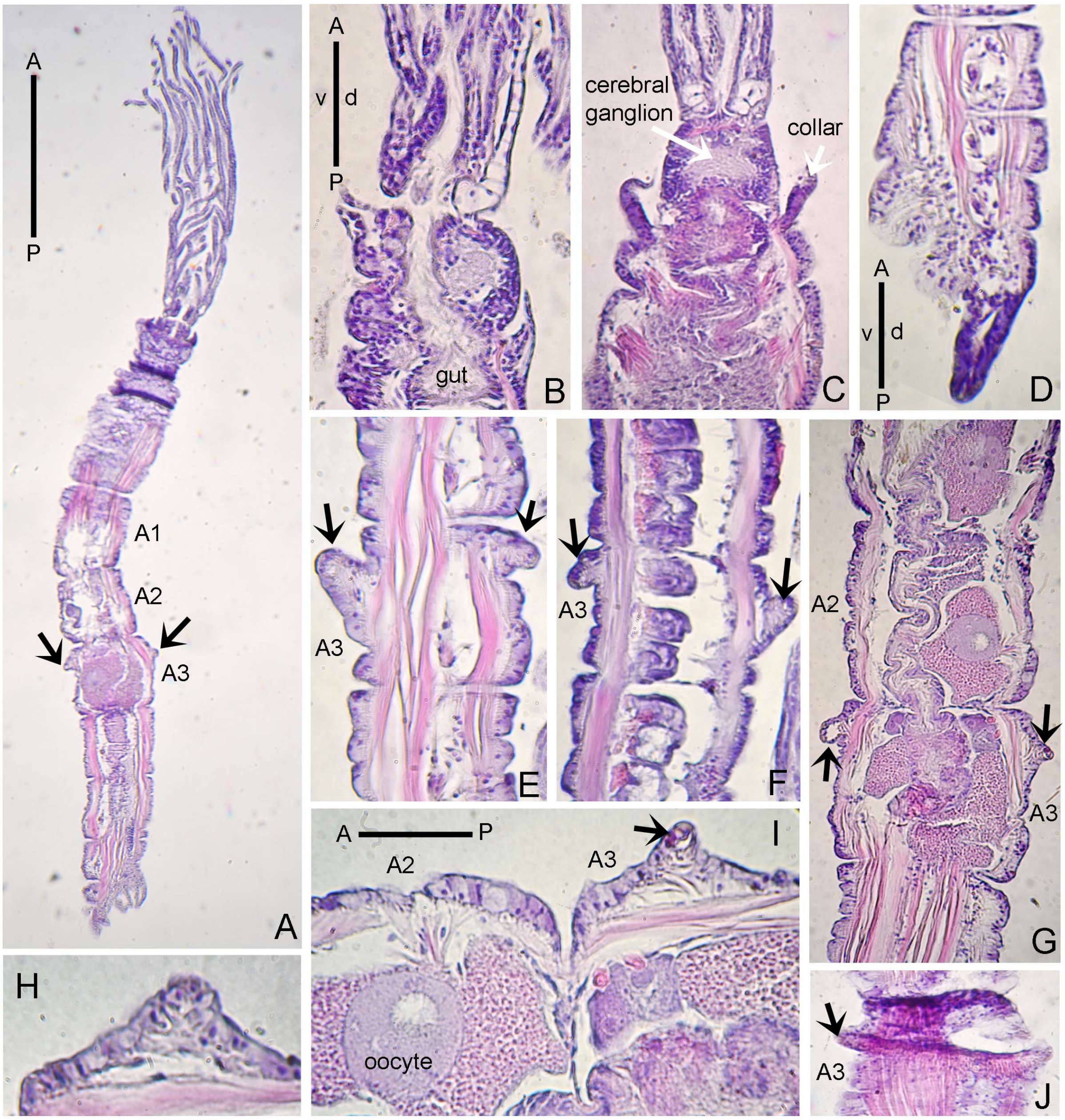

FIGURE 5. Longitudinal, histological sections of *Euchonoides moeone* **n. sp.** A, body, regenerating thorax; B, base of radiolar crown and collar, lateral view; C, same, frontal view; D, pre-pygidial depression and pygidium; E–F, belt on third abdominal chaetiger, G, sexual abdominal segments; H, J, details of glandular epithelium of belt of third abdominal chaetiger; I, detail of a mature oocyte and follicle cells. In A–B, D and I, the section plane is shown, where A refers to the anterior region, P to the posterior region, d dorsal zone and v ventral zone. Black arrows in A, E–G, I–J points to glandular belt on third abdominal chaetiger. Abbreviations: A1: abdominal chaetiger 1, A2: abdominal chaetiger 2, A3: abdominal chaetiger 3.

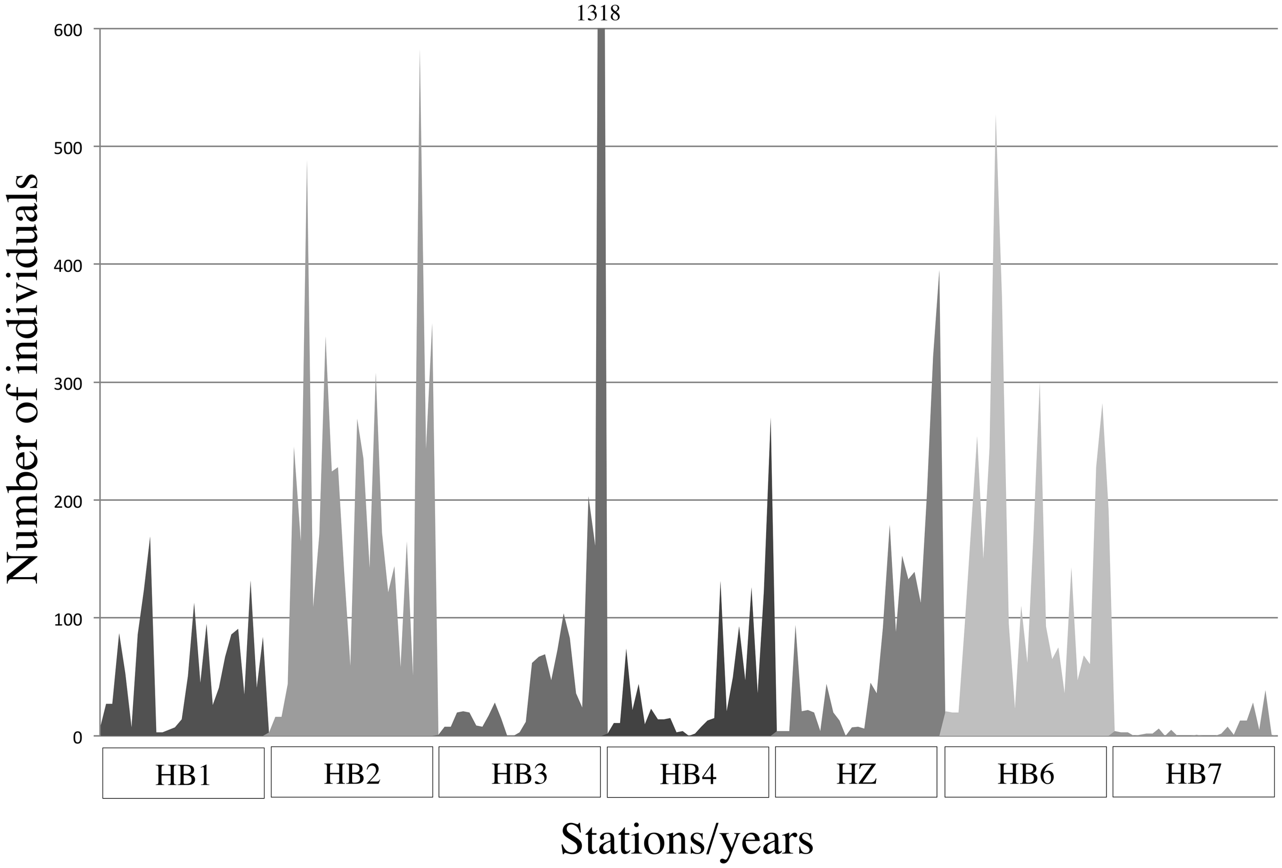

FIGURE 6. Pattern of abundance of *Euchonoides moeone* **n. sp.** along the Barbers Point ocean outfall sampling stations from 1990 to 2016. Stations HB2 through HB6 are located in the zone of initial dilution and stations HB1 and HB7 are reference stations.

Bailey-Brock *et al.* (2002) found out that the patterns of abundance of *E. moeone* **n. sp.** (as *Euchone* sp. B) in Mamala Bay were not consistent with an indicator species because it was more numerous at far field sites rather than station under the zone of initial dilution. Bailey-Brock (2002) also noticed that abundances of *E. moeone* **n. sp.** were depressed at sites where the dorvilleid species *Ophryotrocha adherens* Paavo, Bailey-Brock & Akesson, 2000 was more abundant. *Ophryotrocha adherens* is often dominant at station HB4 and rare or absent from other stations but the number of individuals at station HB4 has decreased over the years (Ambrose *et al.* 2017) whereas abundances of *E. moeone* **n. sp.** at the same station have increased (see Fig. 6). Population parameters of *O. adherens* suggest that it can rapidly increase within a short generation time (Paavo *et al.* 2000). Additional population studies of *E. moeone* **n. sp.** would be necessary to understand its potential as bioindicator of organic enrichment.

Euchonoides moeone **n. sp.** belongs to a group of small sabellid species having ‘snowflake’ type radiolar crowns that may collect sediment in suspension as well as from the surface of the sediment (Cochrane 2003). The small size of *E. moeone* **n. sp.** (usually 2 mm long) suggests that it may also be feeding within the sediment-water interface and benefitting from suspended particles in addition to creating enough flow to re-suspend newly-settled particles in conditions of weak or no current flow as suggested by Cochrane (2000). This may explain the success of this species at stations where they are not limited by fine sediment particles for tube construction or food availability.

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