

Redescription of *Leocrates chinensis* Kinberg, 1866 (Annelida, Hesionidae)

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Zhi Wang, Jian-Wen Qiu, and Sergio I. Salazar-Vallejo (2018) *Leocrates chinensis* Kinberg, 1866 is the type species of *Leocrates* Kinberg, 1866 (Annelida, Hesionidae). Its original description, based upon a single specimen collected in Hong Kong waters, was brief; its illustrations were published almost 50 years afterwards, and the type specimen was dried out before it could be redescribed. The late Marian Pettibone redescribed the species in 1970 but her illustrations of the species were based on specimens from the Mediterranean Sea, the Virgin Islands, and Samoa, not Hong Kong. In order to define the morphological features, we herein redescribe this species based upon newly collected specimens from the type locality. This species is characterized by the following features: prostomium subrectangular with a posterior notch, lateral antennae slightly longer than palps, palps with palpophores about 2.5 times longer than palpostyles, anterior eyes twice larger than posterior ones, slightly emarginated, posterior ones circular, median antenna fixed slightly ahead of posterior eyes, nuchal organs C-shaped; pharynx with a prominent dorsal papilla, a mid-dorsal jaw and a mid-ventral jaw; first four chaetigers subbiramous, others biramous with neuroacicular lobes blunt, as long as wide, or longer than wide; notochaetae spinulose capillaries; most neurochaetae with blades bidentate, guards approaching subdistal tooth; a few neurochaetae with long, tapered hoods. A key to identify all species in the genus is also included.

Key words: Taxonomy, Polychaete, *Leocrates*, Hesionidae, Redescription, Hong Kong.

BACKGROUND

As a result of the *Eugenie* Expedition around the world in 1851-1853, Kinberg (1866, 1910) published a series of articles dealing with the annelid polychaetes. He proposed several families and genera, and described many new species. Diagnoses and descriptions were telegraphic and written in Latin, but the illustrations - prepared by P.D. Holm, C.E. Åkerman, A. Ringdahl, and himself - were of remarkably high quality. However, the plates were mostly published in the posthumous compilation, since only 8 out of 29 ones were available in 1858 (Théel 1910).

Leocrates was proposed with *L. chinensis*

as its type and only species, based upon a single specimen collected off Hong Kong (Kinberg 1866). The number of valid species belonging in the genus has changed over time out of the 19 nominal species; Pettibone (1970:212) included only seven, Fauchald (1977:76) indicated 11, and it has currently 13 recognized species (Read and Bellan 2013). However, at least partly due to the brief original description of *L. chinensis*, morphological features to delineate species in this genus are poorly defined, leading to the proposition of a few doubtful synonyms. The taxonomic history of this species is briefly reviewed below.

Kinberg (1866) distinguished *Leocrates* from *Hesione* Savigny in Lamarck, 1818 that also has

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16 chaetigers by three morphological features: a pharynx with jaws, a median antenna, and biramous parapodia with denticulate notochaetae. The original diagnosis for *L. chinensis*, translated from Latin, was: “prostomium wide, rectangular; first three segments of similar length; palps short, about half as long as lateral antennae; dorsal cirri longer than body width” (Kinberg 1866:244).

The illustration, published as part of plate 23 (Kinberg 1910) shows that the prostomium is slightly wider than long; eyes are small, with the anterior pair slightly more separated than the posterior pair, but of about the same size; lateral antennae are about 1/3 longer than palps; the median papilla (facial tubercle *ex auctore*) has a transverse constriction; the dorsal sharp jaw is exposed and a lateral vesicle is present on the left side of pharynx. In chaetiger 10, the parapodium has a well-defined dorsal cirrophore, but there seems to be no ventral cirrophore, and the ventral cirrus is medial to neurochaetal lobe. Notochaetae are delicate and very finely denticulate, whereas neurochaetae are compound with blades 3-11 times longer than wide.

All of Kinberg specimens were deposited in the Swedish Museum of Natural History, Stockholm, and the type material of *L. chinensis* has been examined by a number of authors. Ehlers (1901:83-84) indicated that the type specimen was in poor condition, and that he found no differences between it and his specimens collected from Juan Fernández off the Pacific coast of Chile. Ehlers' illustrations (1901, Pl. 11, Figs. 10-15); however, show some differences despite the fact that the pharynx was exposed in both specimens. For example, in the specimens from Juan Fernández the prostomium is trapezoidal without a posterior notch, wider anteriorly, or about as long as wide, median pharyngeal papilla (facial tubercle) is larger than palps, anterior eyes are smaller than posterior ones, and neurochaetal blades are 4-7 times longer than wide.

Hartman (1940: 212) thought that a Mediterranean species, *L. claparedii* (Costa in Claparède, 1868), could be a junior synonym of *L. chinensis*, and listed several publications recording these two species from Japan, Indonesia, Australia, Juan Fernández archipelago, and the Indian Ocean. Hartman (1949) examined Kinberg's polychaetes; she indicated that there was a single type specimen of *L. chinensis*, that it has been dried out in 1913, but confused the type locality by saying it was from Honolulu, Hawaii (Hartman 1949:47). She also added that *L. chinensis* was

recorded “from tropical seas of both hemispheres,” hence cosmopolitan, and cited her previous publication. Pettibone (1970) made a revision of *Leocrates*, concurred with Hartman's supposed synonymy of *L. claparedii*, and included four other species as junior synonyms of *L. chinensis*: two from the Philippines (*L. cupreus* Grube, 1867 and *L. iridus* Grube, 1878), one from Japan (*L. anonymus* Hessle, 1925), and the other from Saint Thomas, Virgin Islands (*L. longicirrata* (Treadwell, 1902)). This conclusion indicates the cosmopolitan status for the species. Although the specimens she examined came from around the world, they did not include the type specimen. Thanks to a good editorial idea, the illustrations of some of her specimens were included such that their differences from the original description of the species can be readily noted. For example, there are differences in the size proportions between palpophore and palpostyle, between lateral antennae and median pharyngeal papilla (facial tubercle), the shape and development of nuchal organs, the position of median antenna, and the size of ventral cirri. These differences make the synonymy questionable, and stress the need to properly describe the species.

In this contribution, we redescribe *L. chinensis* and give details about the variation of several diagnostic features based on recently collected topotype specimens, such that delimitation among different species of *Leocrates* can be made. This is especially relevant because, as indicated above, *L. chinensis* is the type species of *Leocrates*. Further, a key to identify all described species is also included.

MATERIALS AND METHODS

Fourteen specimens of *Leocrates chinensis* were collected during macrobenthic ecological surveys conducted in 2012 (Wang et al. 2017) and 2015 (Wang et al. submitted). The two surveys covered the same set of 28 stations across Hong Kong waters, divided into three areas: an estuary, a transitional zone, and an oceanic zone. Benthic samples were taken on board the survey vessel using a Van Veen grab and sieved through a 0.5 mm mesh. Materials retained on the sieve were fixed in a 5% formalin-seawater solution and stained with 1% Rose Bengal, later sorted and the specimens transferred into 75% ethanol for preservation. It must be noted that *L. chinensis* specimens were found only at two transitional zone

sites in Victoria Harbour (stations 11 and 12 in Wang et al. 2017, at water depths of 14 m and 12 m, respectively). Specimens were deposited into two institutions: Swire Marine Institute, University of Hong Kong (SWIMS) and El Colegio de la Frontera Sur, Chetumal, México (ECOSUR).

Specimens were observed under an Olympus SZX9 stereo microscope and a Motic BA210 compound microscope. A relatively intact specimen was selected for redescription and selected specimens were prepared for observation under a LEO 1530 FESEM scanning electron microscope for finer details. The dissected materials were dehydrated in graded series of alcohol (75%, 95% and 100%), dried with graded series of hexamethyldisilazane (50%, 75% and 100%), observed under the light microscopes, then coated with gold, and observed under the electron microscope. Light microscopic photographs were taken using either a Canon 550D digital camera mounted on the dissecting microscope, or a True Chrome II camera mounted on the compound microscope. The depth of each photograph was enhanced by stacking 20-30 photographs of the same object with different focuses using the software Helicon Focus 6.

RESULTS

SYSTEMATICS

Family Hesionidae Grube, 1850
Subfamily Hesioninae Grube, 1850
Tribe Hesionini Grube, 1850
Genus *Leocrates* Kinberg, 1866

Type species: *Leocrates chinensis* Kinberg, 1866, by monotypy.
 Type locality: Hong Kong.
Leocrates Kinberg, 1866: 244, 1910: 57; Pleijel 1998:108-109 (synonymy).

Diagnosis: Body with 16 chaetigers. Prostomium with two pairs of eyes, palps biarticulate; three antennae. Nuchal organs usually exposed, either horizontal C-, L- or U-shaped. Pharynx with prominent dorsal papilla, and a ventral jaw and one or two dorsal jaws. Peristomium with eight pairs of tentacular cirri. Parapodia biramous, except a few anterior subbiramous ones. Notochaetae subdistally spinulose capillaries. Neurochaetae heterogomph compound falcigers; blades uni- or bidentate, guards present, approaching subdistal tooth or

slightly surpassing it.

***Leocrates chinensis* Kinberg, 1866 restricted**
 (Figs. 1-3, Table 1)

Leocrates chinensis Kinberg, 1866: 244; Kinberg 1910: 57, pl. 23 fig. 7; Pettibone 1970: 14-20, Figs 12-15 (*partim*).

Material examined: Victoria Harbour, Hong Kong: Three specimens (SWIMS-ANN-18-001, SWIMS-ANN-18-002, SWIMS-ANN-18-003), 22°17'29.91"N, 114°09'29.98"E, 14 m, sand, 6 Jun. 2012, 12.0-20.2 mm long, 4.5-5.0 mm wide including chaetae; 10 specimens (SWIMS-ANN-18-004, SWIMS-ANN-18-005, SWIMS-ANN-18-006, SWIMS-ANN-18-007, SWIMS-ANN-18-008, SWIMS-ANN-18-009, SWIMS-ANN-18-010, SWIMS-ANN-18-011, and ECOSUR 2905, ECOSUR 2906), 22°17'36.72"N, 114°09'21.06"E, 14 m, sand, 30 Jun. 2015, 9.5-20 mm long, 2.5-6.0 mm wide including chaetae; 1 specimen (ECOSUR 2904), 22°18'14.34"N, 114°11'46.68"E, 12 m, sandy silt, 8 Jun. 2015, 23.2 mm long, 8.0 mm wide including chaetae.

Description: Best preserved specimen (ECOSUR 2904) nearly complete; body stout with most cirri still present; integument without pigmentation in ethanol (Fig. 1A).

Prostomium subrectangular, slightly wider anteriorly, posterior notch about 1/4 as long as prostomium (Figs. 1B, C). Lateral antennae tapered, slightly longer than palps, about as long as prostomium. Palps biarticulate, palpophores thicker and about 2.5 times longer than palpostyle. Eyes black, trapezoidally distributed; anterior pair about twice as large as posterior ones, wider apart, oval, with a small anterolateral notch; posterior eyes smaller, oval. Median antenna tapered; base slightly anterior to top of posterior notch, parallel with posterior eyes. Nuchal organs C-shaped; refringent ciliated bands along posterolateral and posterior prostomial edges (Fig. 1C).

Pharynx with prominent dorsal papilla located immediately anterior to frontal edge of prostomium; subconical, wider than long, not apparently constricted subdistally, base width about 1.5 times of palpophores, half as long as lateral antennae (Figs. 1D, E). Pair of swollen vesicles, located laterofrontally to prostomium (Fig. 1D); 20 papillae on outer edge (Fig. 1E, Table 1). Two chitinous sharp jaws (Fig. 1E); dorsal jaw single, larger than ventral one (Fig. 1F).

Tentacular cirri biarticulate; cirrophores cylindrical with 8-9 rings; aciculae black, as long

as half cirrophore; cirrostyle filiform multiarticulate, superior cirrostyles longer than inferior ones, longest ones reaching chaetiger 5 (Figs. 1A-B, G).

First 4 chaetigers with subbiramous parapodia (Fig. 2D). Dorsal cirri biarticulate, similar in shape and length to superior tentacular cirri, longer than body width (Fig. 1A); aciculae extending along half the length of cirrophores. Parapodia lobe-shaped with upper acicular lobes globose, prechaetal; about twice longer than wide; aciculae black, extended into acicular lobes. Ventral cirri without cirrophore, filiform, extending to tip of

neurochaetae.

Chaetigers 5-16 with biramous parapodia (Figs. 2E-G). Dorsal cirri biarticulate; cirrophore cylinder-shaped, with 8-12 rings; cirrostyle filiform, as long as 4-5 chaetigers (Fig. 1A). Notopodia conical, positioned anteriorly to dorsal cirri. Notoaciculae black, extending to near tip. Neuropodia much larger than notopodia, lobe-shaped with upper acicular lobes globose, prechaetal, 1.5 times longer than wide. Ventral cirri without cirrophore, filiform, extending to near tips of neurochaetae (Figs. 2E-G).

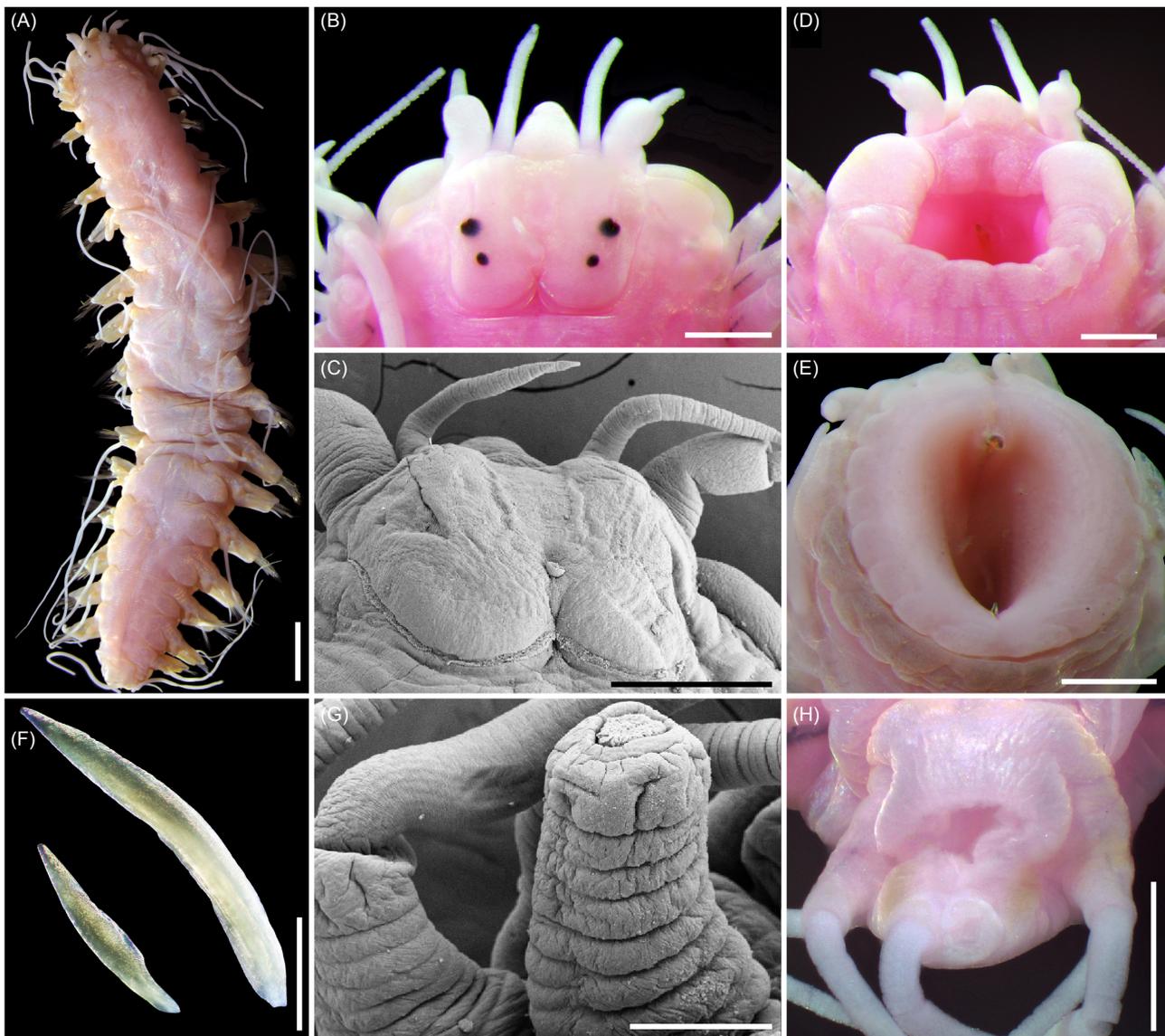


Fig. 1. *Leocrates chinensis* Kinberg, 1866. A, C, F: Sample 13 (ECOSUR 2904; middle antenna missing); B, D, G: Sample 10 (SWIMS-ANN-18-007); E: Sample 7 (SWIMS-ANN-18-003). (A) dorsal view; (B-C) dorsal view of prostomium; (D-E) ventral view of pharynx; (F) dorsal (larger) and ventral (smaller) jaws, lateral view. (G) tentacular cirri, showing cirrophore and basis of cirrostyle; (H) posterior end, dorsal view (right anal cirrus missing). Scale bars: A = 2 mm; B-E, G = 500 μ m; F = 200 μ m.

Notochaetae capillaries, cross-striated, subdistally spinulose to near tips, spines arranged in transverse series, decreasing in number distally (9-10 spines per series basally, 1-2 distally) (Figs. 3A-F). Notochaetal numbers more abundant in mid-body segments (20 in chaetigers 5 and 16, 50 in chaetiger 8) (Figs. 2E-G). Most neurochaetae heterogomph falcigers; blades bidentate; distal teeth stronger in longer blades, while subdistal teeth stronger in shorter blades, but variable due to abrasion; guard (spine) extending to or slightly beyond subdistal tooth; (Figs. 3G-P). Blade cutting edges finely spinous, especially distinct in longer blades. Neurochaetal numbers variable; more abundant in median parapodia (about 30 in chaetiger 2, 50 in chaetiger 5, 35 in chaetiger 8, 15 in chaetiger 16); shorter blades straight; longer blades bending downward slightly (Figs. 3G-N). Delicately hooded falcigers rarely present, 0 or 2 per parapodia, usually distributed as most ventral neurochaetae, sometimes among non-hooded neurochaetae (Figs. 2H-I, 3O-P).

Pre-anal segment without chaetae but with two pairs of lateral cirri; dorsal cirri with cirrophore, ventral ones without it; ventral cirri shorter and thinner than dorsal ones (Fig. 1G). Pygidium with anus dorsally, pair of anal cirri attached ventrally, about as long as those in previous segment.

Variation: All specimens have 16 chaetigers and the parapodia become biramous from

chaetiger 5. The prostomium is wider than long, but the width/length ratio depends upon pharynx eversion, ranging from 1.20 to 1.40 when only slightly exposed, and 1.33 to 1.76 when nearly fully exposed (Table 1). The posterior notch in prostomium is always visible, even in pharynx extended specimens where the nuchal organs are partially hidden by the posterior prostomial edge and the anterior margin of tentacular segments (Figs. 1B, C; 2A-C). The ratio of palp length/lateral antenna length varies slightly according to the condition of fixation, but close to 1 in most specimens. The anterior eyes are always roughly twice the size of anterior eyes, but the eye shape varies slightly: in most specimens the anterior eyes are oval with a small anterolateral notch, while few others are fully oval without notch; posterior eyes are always round, sometimes with a small black spot near one of them (Figs. 1B, 2A-C). The middle antenna is tapered, 1/4 as long as prostomium; in some specimens the median antenna is lost but its place of attachment is indicated by a scar (Figs. 1B-C, 2A-C). The palpophores are always much thicker and about 2.5 times the length of the palpostyles. The pharynx has a circlet of 20 terminal papillae along the outer edge, but they are only visible when the pharynx is nearly fully extended (Figs. 1D-E). Two swollen lateral vesicles at the base of pharynx are visible in all specimens, but they are more distinct when

Table 1. Morphological features of *Leocrates chinensis*. Body width data (with chaetae, and without chaetae) were taken from a middle chaetiger. Prostomium (W/L) are ratios of prostomial width/length. Hooded neurochaetae represent the number of hooded chaetae and hooded chaetae bearing parapodia in one specimen. Blade (L/W) are the range of blade length/width ratio

Catalogue	Body length (mm)	Body width (mm)	Prostomium (W/L)	Pharynx extension	Marginal papillae*	Hooded neurochaetae	Blade (L/W)
SWIMS-ANN-18-001	20.2	5.0, 4.0	1.50	near fully	20	9 in 9 parapodia	5.2-14.8
SWIMS-ANN-18-002	12	4.5, 3.5	1.20	slightly	12	7 in 7 parapodia	4.6-19.6
SWIMS-ANN-18-003	16.9	4.5, 3.5	1.33	near fully	20	6 in 5 parapodia	4.0-18.8
SWIMS-ANN-18-004	20	6.0, 5.0	1.40	slightly	20	4 in 4 parapodia	5.3-20.0
SWIMS-ANN-18-005	20	5.0, 4.0	1.29	slightly	20	1 in 1 parapodium	5.0-15.0
SWIMS-ANN-18-006	16.5	5.0, 4.0	1.38	slightly	20	4 in 4 parapodia	5.2-16.9
SWIMS-ANN-18-007	16.6	5.5, 4.5	1.38	slightly	12	2 in 2 parapodia	4.4-18.1
SWIMS-ANN-18-008	15	5.0, 4.0	1.25	slightly	20	4 in 4 parapodia	5.5-18.5
SWIMS-ANN-18-009	20	5.0, 4.0	1.64	near fully	20	2 in 2 parapodia	5.3-17.6
SWIMS-ANN-18-010	15	5.0, 4.0	1.69	near fully	20	4 in 4 parapodia	5.8-12.6
SWIMS-ANN-18-011	9.5	2.5, 1.8	1.28	slightly	not distinct	1 in 1 parapodium	5.1-19.2
ECOSUR 2904	23.2	8.0, 6.0	1.33	slightly	12	9 in 9 parapodia	5.2-18.7
ECOSUR 2905	14.9	5.0, 3.5	1.45	near fully	20	4 in 4 parapodia	4.6-16.3
ECOSUR 2906	18.2	5.5, 4.5	1.76	near fully	20	1 in 1 parapodium	4.3-14.4

*These are not papillae; they are wrinkles. Some have 12 only because the pharynx is not fully extended.

the pharynx is nearly fully extended. The dorsal papilla in all specimens is subconical, without apparent constriction in any specimens; the length of the dorsal papilla apparently varies substantially among the specimens, but when the pharynx is extended and the papilla, lateral antennae and palps are in the same plane, it is 1/2 to 2/3 as long as the lateral antennae (Figs. 2A-C). The falciger blade length/width (L/W) ratios are smaller in the inferior chaetae than in the superior ones in all chaetigers. The largest ratio in each chaetiger declined from anterior to posterior. For instance, in the largest specimen, the largest ratio changes

from 18.7 in chaetiger 3 to 14.6 in chaetiger 7 and to 11.4 in chaetiger 16; however, the smallest ratio does not change substantially, ranging from 5.2 to 5.5 along the whole worms (Figs. 3G-N; Table 1). The hooded neurochaetae are present in all 14 specimens, from chaetiger 2 to 16, but their number varies from 0-2 per parapodium, 1-9 per specimen, and 1-8 parapodia with this type of chaetae (Figs. 2D, H-I, 3O-P; Table 1). However, since the hooked chaetae are shorter than other neurochaetae and are difficult to see without dissecting the parapodia, the true numbers of this type of chaetae might be underestimated. The

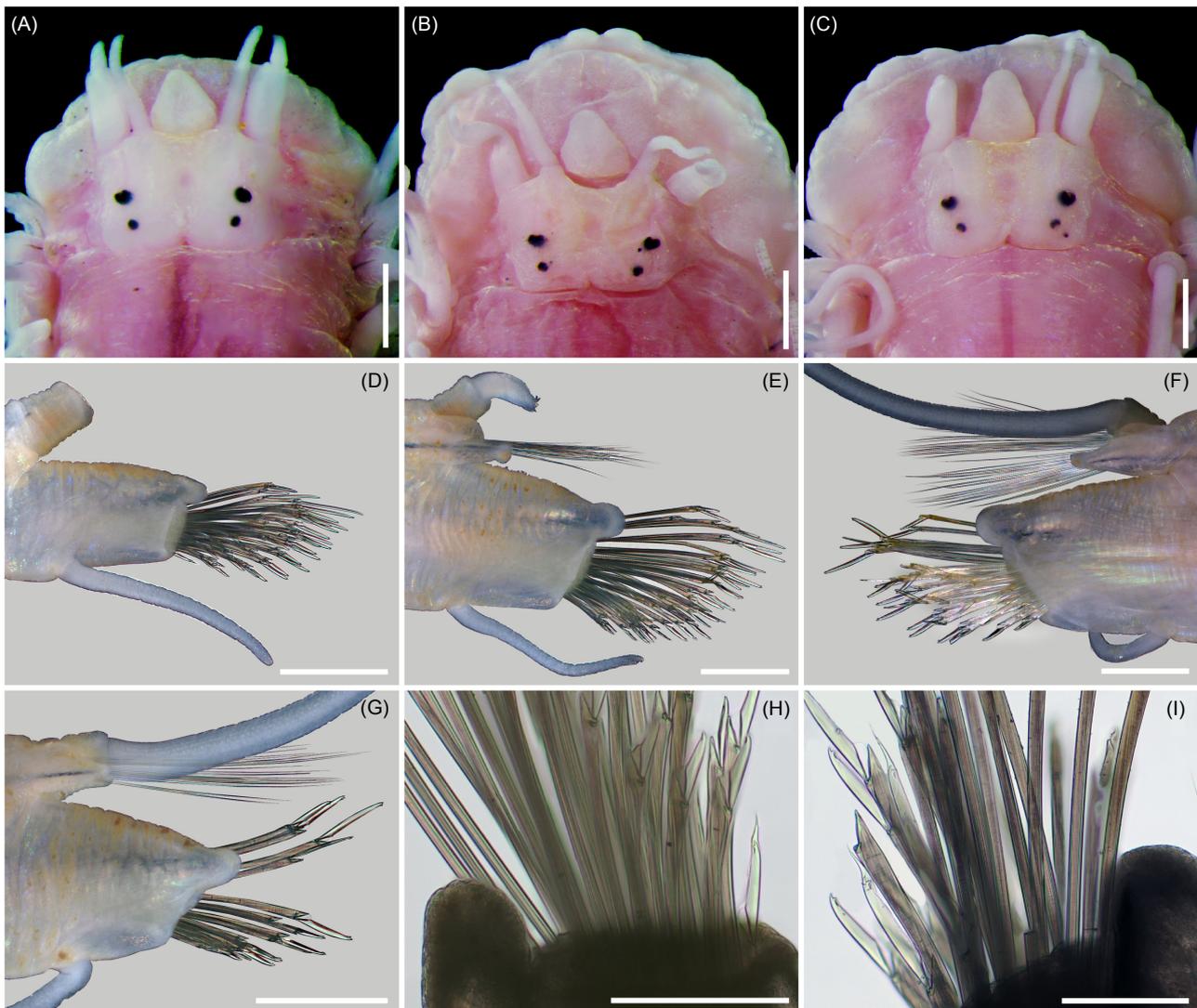


Fig. 2. *Leocrates chinensis* Kinberg, 1866. Anterior end of three specimens with extended pharynx, dorsal view, and parapodial features. (A) Sample 9 (ECOSUR 2905); (B) Sample 11-3 (ECOSUR 2906); (C) Sample 11-1 (SWIMS-ANN-18-009). Sample 13 (ECOSUR 2906). (D) chaetiger 2, anterior view (cirrostyle missing); (E) chaetiger 5, anterior view (cirrostyle broken); (F) chaetiger 8, anterior view; (G) chaetiger 16, anterior view; (H) chaetiger 2, anterior view, with a hooded neurochaeta in inferior position; (I) chaetiger 7, posterior view, with two hooded neurochaetae. Scale bars: A-C = 500 μ m; D-G = 500 μ m; H-I = 200 μ m.

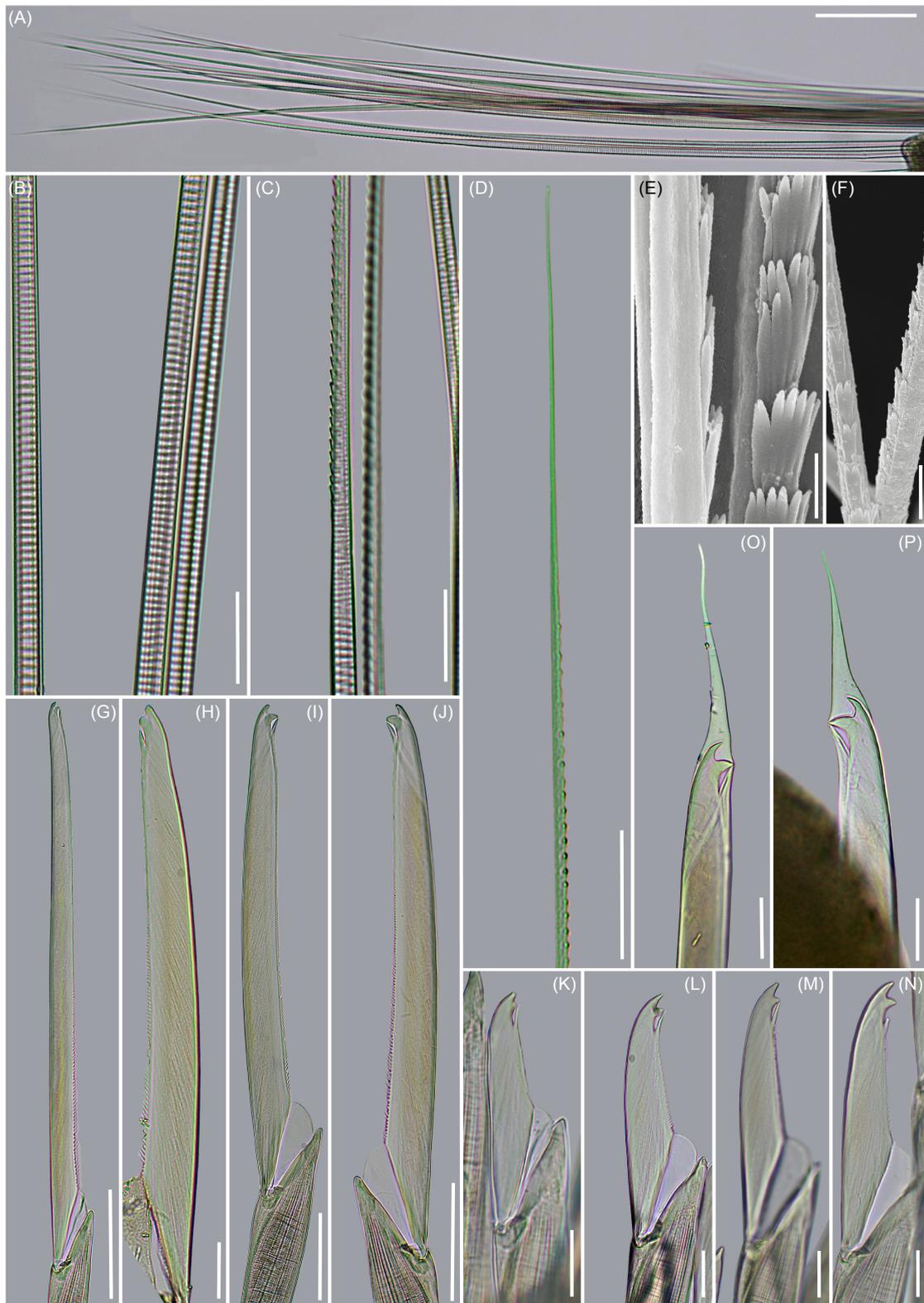


Fig. 3. *Leocrates chinensis* Kinberg, 1866. Sample 13 (ECOSUR 2904). A-D, H, L: Chaetiger 6; E, J: Chaetiger 16; F: Chaetiger 8; G, K: Chaetiger 3; I: Chaetiger 9; M: Chaetiger 7; N: Chaetiger 15. (A) notochaetae; (B) notochaetal basal region; (C) notochaetal median region; (D) notochaetal tip; (E) notochaetal median region with transverse series of spines; (F) same, under lower magnification; (G-J) subdorsal neurochaetae with longest blades; (K-N) ventral neurochaetae with shortest blades; (O-P) hooded neurochaetae. Scale bars: A-D, K-P = 100 μ m; E-F = 3 μ m; G-J = 250 μ m.

anal cirri are usually lost; if present, they can reach chaetiger 14. The anus is dorsal in all specimens. No oocytes were observed in any specimens.

Distribution: Victoria Harbour, Hong Kong. Other records require confirmation.

DISCUSSION

The holotype and only specimen of *Leocrates chinensis* Kinberg, 1866 was collected by the Swedish naval frigate *Eugenie* during a round-the-world cruise in 1851-1853. The original locality of *L. chinensis*, translated from Latin, is "China, sea next to the castle near Hong Kong, bottom 2 fathoms". During that period, the Hong Kong Island was under British control, and the castle Kinberg referred to was likely the Murray Barracks (22°16'40.8"N, 114°09'39.6"E), which was at the shore of Victoria Harbour. Since the water depth of the type locality was only 2 fathoms (about 3.7 meters), we suspect that the frigate *Eugenie* was anchored just in front of the military base, and specimens were collected near shore using a smaller boat. Specimens of *L. chinensis* studied here were all collected inside Victoria Harbour, close to the original locality, but in slightly deeper waters (12-14 m).

Our specimens match the description by Kinberg (1866 1910) in several key morphological features including the shape of the prostomium, the locations and relative sizes of the antennae, the palps and the dorsal papilla, the locations of the four eyes, the shape of the mid-dorsal tooth, the shapes of the dorsal capillaries and ventral non-hooked falcigers, the shape of the parapodia, and the length of the dorsal cirri. However, the newly collected specimens show the following differences: 1) in the original description the eyes are similar in size, but in our specimens the anterior pair is consistently twice as large as the posterior pair; 2) the C-shaped nuchal organs (*i.e.* cilia band along posterolateral and posterior prostomial edges) were not mentioned or illustrated in the original description, probably due to the fully everted pharynx that compressed the prostomium towards the peristomium, making them unobservable, as is the case for some of our specimens with extended pharynx (Figs. 2A-C); 3) in the original description, the dorsal papilla on the pharynx - located immediately anterior to the frontal prostomial margin - has a delicate transverse constriction, which could be an artifact of preservation; none of our samples

show this; and 4) the original illustration shows a swollen vesicle on the left side, close to the tip of the extended pharynx; in our samples, there are two swollen vesicles near the base, but this difference could be due to the difference in the extend of eversion of the pharynx, or an artifact of preservation.

Further, Kinberg also showed that the notochaetae of *L. chinensis* are capillary; the neurochaetae are compound heterogomph with bidentate blade, longer in superior position, straight guard reaching subdistal tooth. However, he did not observe the hooded neurochaetae, probably because this type of chaetae is not present in every parapodia, or because he did not check all parapodia.

Previous studies noticed the prominent dorsal papilla as a diagnostic feature for *Leocrates* (Pettibone 1970; Pleijel 1998), but the term "facial tubercle" they used might be inappropriate as it gives a false impression that it is a prostomial structure. Our observations (Fig. 2B) confirm Grube's (1878) and Ehlers' conclusions (1901) that it is a pharyngeal structure. It is homologous to the middorsal pharynx papilla in *Hesione* (*e.g.*, Kinberg 1910, Pl. 23, Fig. 8B for *H. eugeniae* Kinberg, 1866), but it is more basal in *Leocrates*. Therefore, we use dorsal papilla instead of facial tubercle when referring to this structure. Nevertheless, there are two differences between the dorsal papilla of *Leocrates* and that of *Hesione*: 1) this structure in *Leocrates* is much larger, and 2) as a consequence of this hypertrophy, when the pharynx is withdrawn, the dorsal papilla of *Leocrates* is clearly visible, whereas that of *Hesione* is not.

The additional morphological details of *L. chinensis* provided in the present study should help clarify the statuses of several species that were synonymized. For instance, among the 10 species and one subspecies proposed as junior synonyms of *L. chinensis* by Pettibone (1970), three specimens were illustrated. The specimens collected from St. Thomas in the Western Atlantic (Fig. 14 in Pettibone 1970) and Samoa in the Western Pacific (Fig. 15 in Pettibone 1970) both have prominent L-shaped rather than C-shaped nuchal organs. Consequently, they should not be included under the same species name. The specimen from the Mediterranean Sea has a prostomium that closely matches that of *L. chinensis*, but its notopodia are stronger and the notochaetae form a fan-shaped array (Fig. 13 in Pettibone 1970), rather than a bundle as in *L. chinensis*; further, the blade of the longest

neurochaetae appears to have lower L/W ratio than those present in our specimens of *L. chinensis*. However, *L. claparedii* was redescribed recently by Parapar et al. (2004) and their study helps to clarify the differences with *L. chinensis* and to restrict it. In *L. chinensis* palpophores are twice longer than palpostyles, anterior eyes are twice larger than posterior ones, and neurochaetal blades in median chaetigers are 5-15 times longer than wide, whereas in *L. claparedii* palpophores are three times longer than palpostyles, anterior eyes are slightly larger than posterior ones, and neurochaetal blades in median chaetigers are 3-10 times longer than wide.

On the other hand, there are two figures of specimens identified as *L. chinensis* in Pleijel's revision. The first one (Pleijel 1998:111, Fig. 6) depicts a juvenile (8 chaetigers; 1 mm long) specimen from the Great Barrier Reef which has C-shaped nuchal organs, groups of cilia over the median papilla, no notochaetae, and very long, delicate, twisted neurochaetae. We cannot confirm its identity because we have not studied juveniles or newly recruited larvae. The second is a larger specimen (Pleijel 1998:112, Fig. 7), collected from Madang, Papua New Guinea, which has a longer than wide prostomium, medially attached median antennae, and U-shaped nuchal organs (posterior notch extending to the middle of prostomium); these features differ from both the original description and our redescription. We think this specimen belongs to another species.

Pettibone (1970) recognized seven species of *Leocrates*. Among them, *L. djangkarensis* Augener & Pettibone in Pettibone, 1970 and *L. wesenberglundae* Pettibone, 1970 could be distinguished from *L. chinensis* by having unidentate, rather than bidentate neurochaetae. Two species of *Leocrates* have been reported from Hong Kong (Shin and Thompson 1982, Shin 1998, Wang et al. 2017). *L. chinensis* occurs in the coarser sandy to sandy silt bottom in Victoria Harbour, whereas *L. wesenberglundae*, having compound neurochaetae with a tapered fine tip, is distributed in muddy bottoms in more southern waters.

Sun and Yang (2004:82) keyed out two *Leocrates* species in China seas: *L. chinensis* and *L. claparedii*. They separated the former from latter according to the presence of balloon-like vesicles and bilateral spinous notochaetae. We think that, if no other difference is found, both records should belong to the same species. First, vesicles are present and visible in all our *Leocrates* specimens,

though in some they are not distinct due to slightly extended pharynx; their presence could be widely distributed in *Leocrates* species, and consequently, they cannot be diagnostic. Second, the successive transverse series of spines in notochaetae have a variable number of spines; when they are more abundant, they could extend up to half the chaetal diameter, and this would explain why they have been illustrated as being present along a single side, or along both sides. After the examination of these structures, and in confirmation of the findings by Parapar et al. (2004:223, Fig. 79C), these notochaetae have transverse series of spines instead of having lateral denticles. Again, the extent of the series of denticles along chaetae varies in the same chaetal bundle, and could not be used as a diagnostic character.

Several studies had shown the presence of hooded neurochaetae in *Leocrates* species. Ehlers (1901) illustrated this kind of chaetae for what he regarded as *L. chinensis* collected from the coast of Juan Fernández, but his illustration shows that the posterior eyes are twice the size of anterior eyes, therefore they differ from *L. chinensis*. Fauvel (1923:236, repeated in 1953:106) provided a figure of it in what he regarded as *L. claparedii* from India. However, no details about the number and distribution of hooded chaetae along body were presented. Our examination of the *L. chinensis* specimens indicates that the hooded chaetae, when present, are usually located among chaetae in the lower chaetal bundle, and that a large part of the shaft is usually embedded in the parapodia, with only the blade exposed, and this explains why they can be referred to as newly exposed chaetae. These chaetae are present in either side of the body, from anterior to posterior (except chaetiger 1) parapodia. These chaetae are more frequent in chaetigers 5-10, and 13-15, with frequencies of 52% and 28% respectively. In most parapodia when the hooded chaetae are present, the number is just one, and rarely two per bundle. Since the hooded neurochaetae are similar and as complex as the other neurochaetae, we conclude that their hoods are due to their recent emergence of the body wall, and that they could be widely distributed in *Leocrates* species.

Key to species of *Leocrates* Kinberg, 1866

(modif. Pettibone 1970; references therein)

- | | | |
|---|---|---|
| 1 | Neurochaetal tips bidentate | 2 |
| - | Neurochaetal tips entire, not bidentate; upper neurochaetae with very long blades; notochaetae from | |

	chaetiger 4; upper jaw single; pharynx without 'papillae' .	12
2(1)	Notochaetae from chaetiger 5 (rarely 6); pharynx without 'papillae'	3
-	Notochaetae from chaetiger 4	7
3(2)	Upper jaw single	4
-	Upper jaw double, in form of a bifid fan; lateral antennae twice longer than palps; palpostyles 1/3 as long as palpophores	
	..... <i>L. diplognathus</i> Monro, 1922, Macclesfield Bank (16°00'N, 114°30'E), South China Sea	
4(3)	Nuchal organs horizontal C-shaped	5
-	Nuchal organs L-shaped; anterior eyes twice larger than posterior ones; lateral antennae longer than palps	6
5(4)	Anterior eyes twice larger than posterior ones; palpophores twice longer than palpostyles; neurochaetal blades in median chaetigers 5-15 times longer than wide	
	.....<i>L. chinensis</i> Kinberg, 1866 Hong Kong (perhaps including <i>L. anonymous</i> Hessle, 1925, Japan)	
-	Anterior eyes slightly larger than posterior ones; palpophores three times longer than palpostyles; neurochaetal blades in median chaetigers 3-10 times longer than wide	
	<i>L. claparedii</i> (Costa in Claparède, 1868), Mediterranean Sea	
6(4)	Palpophores 3 times longer than palpostyles; median antenna between posterior eyes	
	..... <i>L. longicirratus</i> (Treadwell, 1902), Saint Thomas, Virgin Islands	
-	Palpophores 5 times longer than palpostyles; median antenna central to eyes	
	..... <i>L. auritus</i> Hessle, 1925, Japan	
7(2)	Upper jaw single; pharynx with about 20 papillae	8
-	Upper jaw double; pharynx without 'papillae'	10
8(7)	Eyes medium-sized; lateral eyes separated, anterior ones twice larger than posterior ones; lateral antennae and palps subequal; nuchal organs horizontal C-shaped; neurochaetal blades 2-12 times longer than wide	
	..... <i>L. giardi</i> Gravier, 1900, Red Sea	
-	Eyes large; lateral eyes close to each other, anterior ones slightly larger than posterior ones; lateral antennae larger than palps; nuchal organs U-shaped	9
9(8)	Middorsal pharynx papilla as long as palpophores; neurochaetal blades 5-16 times longer than wide	
	..... <i>L. oculatus</i> (Treadwell, 1906), Hawaii	
-	Middorsal pharynx papilla 1/4 longer than palpophores; neurochaetal blades 5-11 times longer than wide	
	.....<i>L. anomalus</i> Chamberlin, 1919, Marshall Islands (perhaps including <i>L. papillosus</i> Monro, 1926 Macclesfield Bank (16°00'N, 114°30'E), South China Sea)	
10(7)	Nuchal organs U-shaped; upper neurochaetal blades over 20 times longer than wide; notochaetae abundant, long	11
-	Nuchal organs L-shaped; upper neurochaetal blades 4 times longer than wide; notochaetae scarce, short	
	..... <i>L. greeffianus</i> Augener, 1918, Western Africa	
11(10)	Anterior eyes twice larger than posterior ones; palpostyles slightly shorter than palpophores; median antenna between posterior eyes	
	..... <i>L. atlanticus</i> (McIntosh, 1885), NE Atlantic	
-	Anterior eyes slightly larger than posterior ones; palpostyles markedly shorter than palpophores (1/3-1/4 as long); median antenna central to all eyes	
	..... <i>L. indicus</i> Horst, 1921, Banda Sea	
12(1)	Anterior eyes slightly larger than posterior ones; lateral antennae as long as palps; tips of neurochaetae taper abruptly to fine tips, without guards	

..... *L. wesenberglundae* Pettibone, 1970, Gulf of Oman
 - Anterior eyes twice larger than posterior ones; lateral antennae 1/3 longer than palps; tips of neurochaetae blunt, guards extended far beyond tips

.....*L. djangkarensis*
 Augener & Pettibone in Pettibone, 1970, Sulu Sea

Remarks: Pettibone (1970) included as junior synonyms some species based upon specimens from distant localities with different morphologies; after our study of variation in *L. chinensis*, they are herein regarded as distinct, and are included in the key. The anterior margin of *Leocrates* pharynx, when fully everted, has 12-20 wrinkles but they are not papillae (see Table 1).

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REFERENCES

- Augener H. 1918. Polychaeta. Beitr Kenntnis Meeresf West-Afrikas 2:67-625.
- Claparède E. 1868. Les annélides chétopodes du Golfe de Naples. Mém Soc Phys Hist Nat Genève 19(2):313-584.
- Ehlers E. 1901. Die Polychaeten des magellanischen und chilenischen Strandes: Ein faunistischer Versuch; pp 1-232, Pls 1-25 In: Festschrift zur Feier des

- Hundertfünzigjährigen bestehens der Königlich Gesellschaft der Wissenschaften zu Göttingen Abhandlungen der Mathematisch-Physikalischen Klasse. Berlin, Weidmannsche.
- Fauvel P. 1923. Polychètes Errantes. Faune France **5**:1-488.
- Fauvel P. 1953. Annelida Polychaeta. The Fauna of India. Indian Press, Allahabad.
- Fauchald K. 1977. The polychaete worms: definitions and keys to the orders, families and genera. Nat Hist Mus Los Angeles Cty, Sci Ser **28**:1-188.
- Gravier C. 1900. Contribution a l'étude des annélides polychètes de la Mer Rouge. Nouv Arch Mus Hist Nat, 4ème sér **2**:137-282.
- Grube AE. 1850. Die Familien der Anneliden. Arch Naturg **16**:249-364.
- Grube AE. 1867(1866). Neue Anneliden aus den Gattungen *Eunice*, *Hesione*, *Lamprophaë*s und *Travisia*. Jahr-Bericht Schles Gesell vaterländ Cultur **44**:64-66.
- Grube AE. 1878. Annulata Semperiana. Beiträge zur Kenntnis der Annelidenfauna der Philippinen nach den von Herrn Prof. Semper mitgebrachten Sammlungen. Mém Acad Imp Sci St.-Pétersbourg, sér 7, **25(8)**:1-300, Pls 1-15.
- Hartman O. 1940. Polychaetous annelids, 2. Chrysopetalidae to Goniadidae. Allan Hancock Pac Exped **7**:173-287, Pls 31-34.
- Hartman O. 1949(1948). The marine annelids erected by Kinberg, with notes on some other types in the Swedish State Museum. Ark Zool **42A**:1-137.
- Hessle C. 1925. Einiges über die Hesioniden und die Stellung der Gattung *Ancistrosyllis*. Ark Zool **17**:1-36.
- Imajima M, Hartman O. 1964. The polychaetous annelids of Japan. Allan Hancock Found Occ Pap **26**:1-452.
- Kinberg JGH. 1866(1865). Annulata nova (Nephtydea, Phyllodocea, Alciopea, Hesionida, Glycera, Goniadea, Syllidea, Ariciea, Spiodea, Aonidea, Cirratulida, Opheliacea). Öfv Kong Vetensk-Akad Förhand **22**:239-258.
- Kinberg JGH. 1910. Zoologi. Annulater. Kongliga Svenska Fregatten Eugénies Resa omkring jorden under befäl af C.A. Virgin Anen 1851-1853. Vetenskapliga laktagelser på Konung Oscar den Förstes befallning utgifna af Kongliga Svenska Vetenskapsakademin, Zoologi, 3, Annulaten, 33-78, Pls 9-29 [first part: pp 1-32, Pls 1-8 published 1853].
- McIntosh WC. 1885. Report on the Annelida Polychaeta collected by H.M.S. Challenger during the years 1873-76. Rep Sci Results H.M.S. Challenger 1873-76, Zool **12**:1-554.
- Monro CCA. 1926. Polychaeta of the H.M.S. Alert Expedition, 1881-1882. Families Hesionidae and Nereidae. J Linn Soc Zool **36**:311-323.
- Parapar J, Besteiro C, Moreira J. 2004. Familia Hesionidae. Fauna Ibérica **25**:210-267.
- Pettibone MH. 1970. Polychaeta Errantia of the Siboga Expedition, 4. Some additional polychaetes of the Polynoidae, Hesionidae, Nereidae, Goniadidae, Eunicidae, and Onuphidae, selected as new species by the late Dr. Hermann Augener with remarks on other related species. Siboga Exped Monogr **24(1d)**:199-270.
- Pleijel F. 1998. Phylogeny and classification of Hesionidae (Polychaeta). Zool Scripta **27**:89-163.
- Read G, Bellan G. 2013. *Leocrates* Kinberg, 1866. In: Read, G. & Fauchald, K. (Ed.) (2017) World Polychaeta database.
- Shin PKS. 1998. Biodiversity of subtidal polychaetes in Hong Kong coastal waters. In: Morton, B. (ed) The Marine Biology of the South China Sea. Proceedings of the Third International Conference on the Marine Biology of Hong Kong and the South China Sea, Hong Kong, 28 October-1 November 1996. Hong Kong University Press, Hong Kong, pp. 57-74.
- Shin PK, Thompson GB. 1982. Spatial distribution of the infaunal benthos of Hong Kong. Mar Ecol Progr Ser **10**:37-47.
- Sun R, Yang D. 2004. Annelida, Polychaeta II. Nereidida (= Nereimorpha): Nereididae, Syllidae, Hesionidae, Pilargidae, Nephtyidae. In: Huo C, Zhao G (eds) Fauna Sinica, volume 33 China Science Press, Beijing, 550 pp.
- Théel H. 1910. Postscript. pp 77-78 In Zoologi. Annulater. Kongliga Svenska Fregatten Eugénies Resa omkring Jorden under befäl af C.A. Virgin Anen 1851-1853. Vetenskapliga laktagelser på Konung Oscar den Förstes befallning utgifna af Kongliga Svenska Vetenskapsakademin, Zoologi, 3, Annulaten, 33-78, Pls 9-29.
- Treadwell AL. 1902(1900). The polychaetous annelids of Porto Rico. Bull US Fish Comm **20(second part)**:181-210.
- Treadwell AL. 1906(1903). Polychaetous annelids of the Hawaiian Islands collected by the steamer *Albatross* in 1902. Bull US Fish Comm **23(3)**:1145-1181.
- Wang Z, Leung KMY, Li X, Zhang T, Qiu JW. 2017. Marobenthic communities in Hong Kong waters: Comparison between 2001 and 2012 and potential link to pollution control. Mar Poll Bull **124**:694-700.
- Wang Z, Leung KMY, Sung YH, Dudgeon D, Qiu JW. (submitted) Back from the brink: rapid post-disturbance recovery of tropical marine benthos after a trawling ban.