A new record of a tardigrade species from mangrove of Vietnam and a pictorial key for *Florarctus* species (Tardigrada: Heterotardigrada: Halechiniscidae)

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ABSTRACT: *Florarctus hulingsi* Renaud-Mornant, 1976 is recorded for the first time on Vietnam coast in silty sand in upper sublittoral zone. Up to date, the species was known in only Mediterranean, Brazil coast, Celtic Sea, Seychelles and Maldives but not in the Pacific region. The species is redescribed and illustrated, secondary clavae and cephalic vesicles are revealed for the first time for this species. A pictorial key for *Florarctus* species identification is constructed.
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KEY WORDS: *Florarctus*, Heterotardigrada, mangroves, marine tardigrades, pictorial key, redescription, Tardigrada, Vietnam.

Новая находка тихоходки из мангрового биотопа Вьетнама и пикториальный ключ для определения видов *Florarctus* (Tardigrada: Heterotardigrada: Halechiniscidae)

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РЕЗЮМЕ: Морская тардиграда *Florarctus hulingsi* Renaud-Mornant, 1976 впервые обнаружена на побережье Вьетнама (верхняя сублитораль, заиленный песок). До настоящего времени *F. hulingsi* вид был известен из Средиземного моря, побережья Бразилии, Кельтского моря, вод Сейшельских и Мальдивских островов, но не из Тихого океана. Даётся подробное иллюстрированное переописание вида; впервые для этого вида отмечаются головные пузыри и вторичная клава. Сконструирован пикториальный ключ для определения видов *Florarctus*.
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КЛЮЧЕВЫЕ СЛОВА: *Florarctus*, Heterotardigrada, Tardigrada, мангровый биотоп, морские тардиграды, переописание, пикториальный ключ, Вьетнам.

Introduction

Marine tardigrades are micrometazoans occurring in the Ocean worldwide everywhere from intertidal beaches to abyssal, in various sediment types and in fouling. But the marine tardigrades remain poorly known because of their tiny size, rareness, low population density and difficulty of extraction from milieu. Exploration of the Vietnam tardigrades and particularly marine heterotardigrades is still at the outset. The only marine tardigrade identified at species level for Vietnam coast remains *Halechiniscus jejuensis* Chang et Rho, 2002 found in silty sand just below the level of mangrove saplings area in the Nha Trang region, Central Vietnam (Tchesunov, 2011). Unidentified *Florarctus* species and *Batillipes* species were found together with *H. jejuensis* and recorded in the same issue. Here, the first species is described closely with inclusion of more details missing in the original diagnosis.

The marine heterotardigrade genus *Florarctus* includes now fifteen species (Degma, Guidetti, 2023) distributed worldwide but primary in tropical and subtropical regions (Kaczmarek *et al*., 2015). *F. hulingsi* is definitely the most often recorded *Florarctus* species but until recently it was never found in the Pacific region and in South China Sea. Here, a redescription of *F. hulingsi* is presented together with a pictorial key for *Florarctus* species identification.

Material and methods

The material consists of two males, one female and two specimens of unidentified gender and in poor condition. Samples of silty sand bottom sediment were collected by hand with a cylinder during the low tide and fixed *in situ* with 4% formaldehyde solution on sea water. The samples were stained by Bengal rosa, then the meiofauna was isolated with decantation and filtration of the supernatant through a sieve of 70 μm mesh size. The tardigrades were picked up under a stereomicroscope and put into watch glass with alcohol-glycerine-distilled water mixture in proportion 29:1:70 and processed to glycerin by means of slow evaporation at 40°C. Three specimens, two males and one female were mounted in permanent glycerin slides with a paraffin ring, glass bead separators and glyceel seal.

The specimens were observed, measured, drawn and pictured at objective magnification x100 under the light microscope Leica DM5000 equipped with Leica Application Suite Version 3.8.0 software and Leica DFC 425C digital camera. Two specimens of unidentified gender were prepared for scanning electron microscopy. The specimens were dehydrated in a series: 20% ethanol, 40% ethanol, 60% ethanol, 80% ethanol, 95% ethanol+acetone I, acetone II, and then the specimens were critical point dried. Once dried, the specimens were mounted on a stub to be coated with platinum-palladium and examined with a scanning electron microscope JEOL JSM.

Terminology for the description is generally adopted from Fontoura *et al*. (2017).

Taxonomic part

Phylum Tardigrada Doyère, 1840
Class Heterotardigrada Marcus, 1927
Family Halechiniscidae Thulin, 1928

(according to Renaud-Mornant, 1989: 571; Grimaldi de Zio *et al*., 1999; Fontoura *et al*., 2017)

No sclerotized dorsal plates. Complete set of cephalic appendages, usually consisting of unpaired median cirrus, three pairs of cirri and two pairs of clavae, buccal clavae may be indistinguishable or consist of fused secondary and tertiary clavae. Cirrus E often with a basal accordion-shaped articulation Unmodified papillate sensory organs on leg IV. Adult feet terminate in either four digits with claws or four suction pads with or without claws. Peduncles present in only external digits, or as tarsal cuticular bars or absent. Single-pointed, crescent shaped claws either simple or with accessory hooks may bear dorsal spurs and/or minute calcars. Rosette-like female gonopore and paired seminal receptacles.

Type genus *Halechiniscus* Richters, 1908.

Subfamily Florarctinae Renaud-Mornant, 1982

(according to Kristensen, 1984; Renaud-Mornant, 1989; Grimaldi de Zio *et al*., 1999; Fontoura *et al*., 2017; Gąsiorek *et al*., 2021)

Halechiniscidae with aliform expansions around the body with or without caestus. Complete set of cephalic sense organs with secondary clavae transformed to dome-shaped papillae or H-shaped flat sacs. Primary clavae may be featured by sexual dimorphism. No tertiary clavae. Four digits with claws present in adults; external digits usually with hook-shaped pedunculus and uncus with a calcar externum, internal claws with a tiny dorsal spur. Females with two seminal receptacles, each consisting of a spheroid vesicle and S-shaped genital duct; gonopore as six-lobed rosette.

Genus *Florarctus* Delamare Deboutteville et Renaud-Mornant, 1966

(according to Renaud-Mornant, 1989: 577; Fontoura *et al*., 2017, slightly modified)

Florarctinae. Lateral and posterior broad wing-like expansions (alae) three or five in number, partly overlapping the legs. A narrow frontal glass-transparent visor may be present. Procuticular protuberances (caestes) inside the alae often present.

Type species *Florarctus heimi* Delamare Deboutteville et Renaud-Mornant, 1965.

Annotated list of *Florarctus* species

1. ***Florarctus acer*** **Renaud-Mornant, 1989.** Renaud-Mornant, 1989: 585–589, figs 9–11 (France, Bay of Morlaix, depth 25 m; Roscoff, intertidal).

2. ***Florarctus antillensis*** **van der Land, 1968.** Van der Land, 1968: 140–146, figs 104–115 (Curaçao, depth 3 m, coral sand). Renaud-Mornant, 1971: 1268–1271, figs 1–2 (Bermudes, 1 and 4.5 m deep). Renaud-Mornant, 1979: 265–267, fig. 4 (Madagascar, Tulear, coral sand; description of paratype male).

3. ***Florarctus asper*** **Renaud-Mornant, 1989.** Renaud-Mornant, 1989: 580–585, figs 6–8 (New Caledonia, 3 m, coral sand).

4. ***Florarctus bellahelenae*** **Gąsiorek, Kristensen et Kristensen, 2021.** Gąsiorek *et al*., 2021: 3–6, figs 1–5 (Pacific Ocean, Coral Sea, Chesterfield Reefs, coralline sediment).

5. ***Florarctus cinctus*** **Renaud-Mornant, 1976.** Renaud-Mornant, 1976: 326–328, fig. 1 (Mediterranean, Bay of Naples, sublittoral 11.5 m deep, sand; Madagascar, Tulear). Renaud-Mornant, 1979: 262–264, fig. 3 (Madagascar, Tulear, coral sand).

6. ***Florarctus glareolus*** **Noda, 1987.** Noda, 1987: 323–328, fig. 1 (Pacific coast of Japan, depth 10 m, gravel).

7. ***Florarctus heimi*** **Delamare Deboutteville et Renaud-Mornant, 1966.** Delamare Deboutteville, Renaud-Mornant, 1966: 151–153, fig. 1 (New Caledonia, coral sand). Renaud-Mornant, 1987: 360–364, fig. 3, as *Florarctus cervinus* (New Caledonia, coral sand). Gąsiorek *et al*., 2021: 6–10, figs 6–10 (Australia, Shark Bay, Heron Island), *F. cervinus* Renaud Mornant, 1986 is accepted as a junior synonym of *F. heimi*.

8. ***Florarctus hulingsi*** **Renaud-Mornant, 1976.** Renaud-Mornant, 1976: 328–332, figs 2, 3 (Mediterranean, Tunisia, sandy beach, 15–20 cm deep in sand). Grimaldi de Zio *et al*., 1980: 50–52, figs 4, 5, table 2 (Mediterranean). The specimen on fig. 4 is depicted with lateral alae not divided by deep incisure in antero-lateral and postero-lateral parts that contradicts to the original diagnosis; it is not clear whether is a phenomenon of individual variability or another species.

9. ***Florarctus kwoni*** **Chang et Rho, 1997**. Chang, Rho, 1997: 419–421, fig. 1 (Philippines, Palawan, shallow subtidal coralline sand and shell gravel).

10. ***Florarctus pulcher*** **Grimaldi de Zio, Lamarca, D'Addabbo Gallo et Pietanza, 1999.** Grimaldi de Zio *et al*., 1999: 384–388, figs 1. 2. 3 (Maldive Islands, intertidal coarse coral sand).

11. ***Florarctus salvati*** **Delamare Deboutteville et Renaud-Mornant, 1966.** Delamare Deboutteville, Renaud-Mornant, 1966, figs II, III A, B, D, G, P (New Caledonia, coral sand). Renaud-Mornant, 1979: 267–268 (Madagascar, Tulear, coral sand beach).

12. ***Florarctus stellatus*** **Renaud-Mornant, 1989.** Renaud-Mornant, 1989: 577–580, figs 4, 5 (Polynesia, Moorea, depth 32 m).

13. ***Florarctus vulcanius*** **Renaud-Mornant, 1987.** Renaud-Mornant, 1987: 364, figs 4, 6 (Madagascar, Tulear, coral sand).

14. ***Florarctus wunai*** **Fujimoto, 2015.** Fujimoto, 2015: 152, figs 2–3, table 2 (Japan, Ryukyu Islands, Okinawajima, depth 6 m).

15. ***Florarctus yucatanensis*** **Anguas-Escalante, De Jesús Navarette, Demillo, Pérez-Pech et Guldberg Hansen, 2020.** Anguas-Escalante *et al*., 2020: 377–385, figs 1–4, table 1 (Yucatan, Quintana Roo, reef lagoon, 0.5 m deep).

Florarctus hulingsi **Renaud-Mornant, 1976**

Figs 1–4, Table 1.

LOCALITY. Central Vietnam, Nha Trang Bay, Tre Island, Dam Bay (a narrow armlet at the south side of the Island), upper subtidal zone just downward to intertidal plantation of mangrove trees *Rhizophora stylosa*, silty sand. March 27, 2007.

DESCRIPTION

Body compact, nearly rectangular from the median view, with the cephalic region clearly set off from the trunk by a narrowing neck. Dorsal body surface is mostly covered with stuck foreign particles and hence may look dirty. No certain sculpture or punctuations discernible on the dorsal body cuticle. Head with a transparent frontal visor extended straight along the anterior head edge between bases (cirrophores) of left and right internal cirri, then even more narrow laterally between the internal cirri and summits of the lateral head projections. Body fringed with broad transparent plated expansion divided into five broad lobes (alae): two antero-lateral (ALAL), two postero-lateral (PLAL) and one caudal lobe (CAL). Lateral alae cover all the limbs almost completely except tarsi and toes. ALAL with three shallow notches, PLA and CAL with one notch each. No procuticular processes (caestes) inside the alae. Paired ALAL broad and the longest, extended from the neck to the level of the legs III. On either ALAL, there two notches passing to the tucks continuing to the body side at the levels

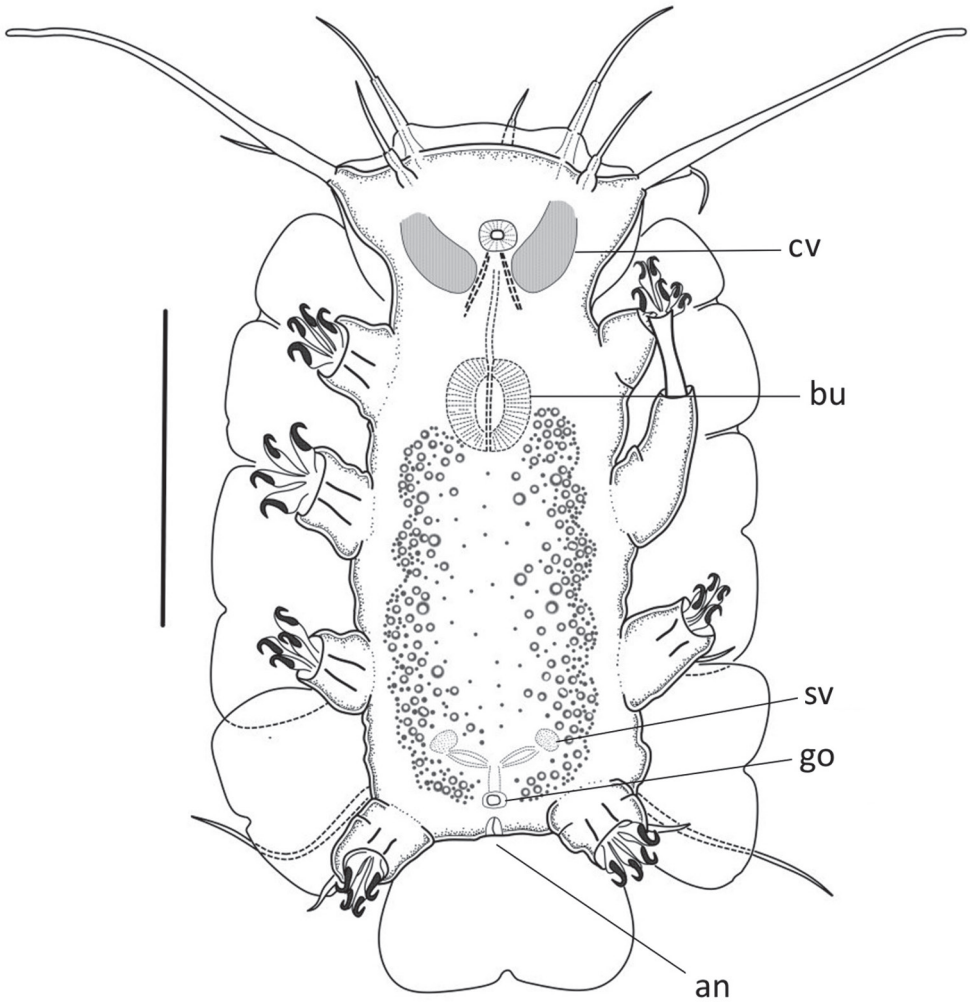

Fig. 1. *Florarctus hulingsi*, male, entire, ventral view.
Abbreviations: an — anus; bu — pharyngeal bulb; cv — cephalic vesicle; go — gonopore; sv — seminal vesicle. Scale bar 50 μm.

Рис. 1. Самец *Florarctus hulingsi*, общий вид с брюшной стороны.
Обозначения: an — анус; bu — фарингеальный бульбус; cv — головной пузырь; go — гонопор; sv — семенной пузырь. Масштаб 50 μm.

of the legs I and II. The tucks do not break the alae but subdivide them into three lobes. Besides, there smaller marginal notches on each lobe not passing to tuck; these notches may be weak or not developed on the anterior and middle lobes of the ALAL. PLAL broad, but much shorter, extended from the level of the legs III to the level of the legs IV, with distinct notch (but without tuck) in the middle of the distal edge. Caudal ala broad, extended between bases of legs IV, with small but distinct notch (without tuck) in the middle of the distal edge. In one specimen, the CAL bears three notches, the median one of them the deepest while two other (submedian) notches shallow.

Sensory cuticular structures. Median cirrus (MC) directed straight up and hence indistinctly visible in most specimens lying medially in the slides. Internal (dorsal) cirri (IC) directed askew upward and ahead. External (ventral) cirri (EC) smaller than the internal cirri; directed askew downward and ahead. Lateral cirrus A (cA) shares large conical cirrophore with primary clava. All the head sensory organs except clavae consist of conical cirrophore, subcylindrical

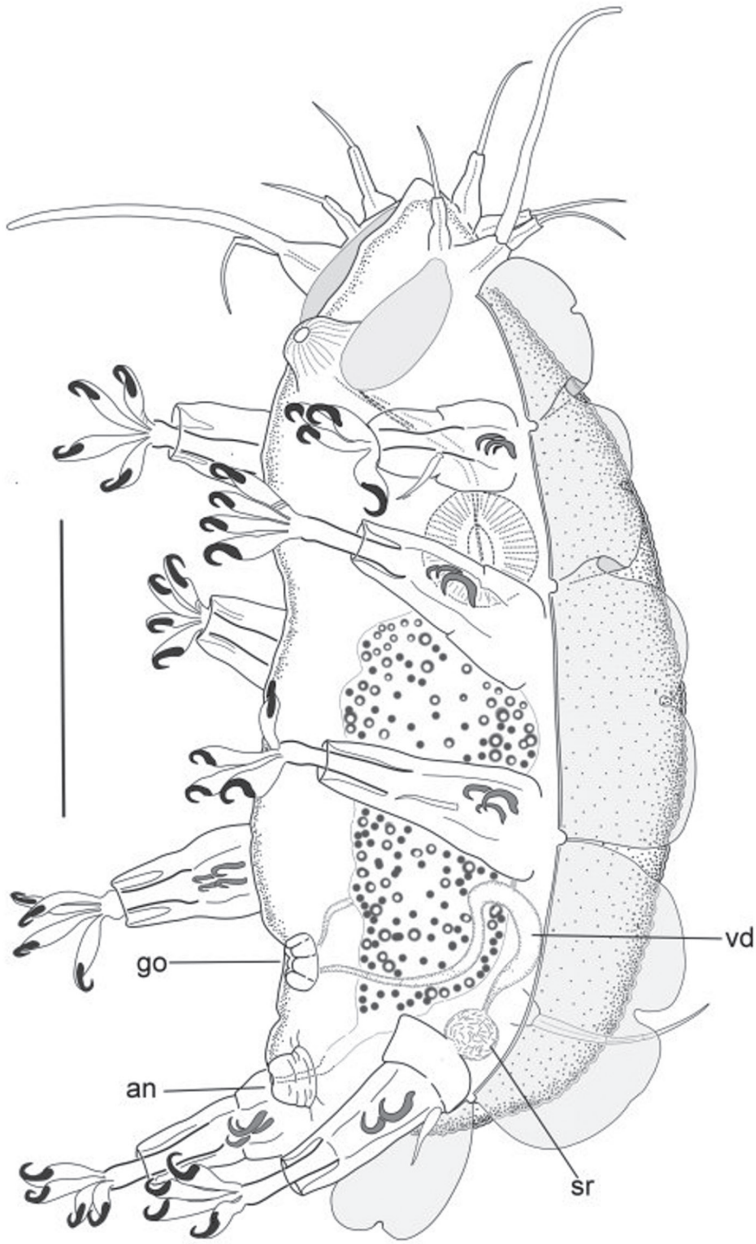

Fig. 2. *Florarctus hulingsi*, female, entire, left side view.
Abbreviations: an — anus; go — gonopore; sr — seminal receptacle; vd — ventral duct. Scale bar 50 μm.
Рис. 2. Самка *Florarctus hulingsi*, общий вид с левой стороны.
Обозначения: an — анус; go — гонопор; sr — семенной рецептакул; vd — вентральный канал. Масштаб 50 μm.

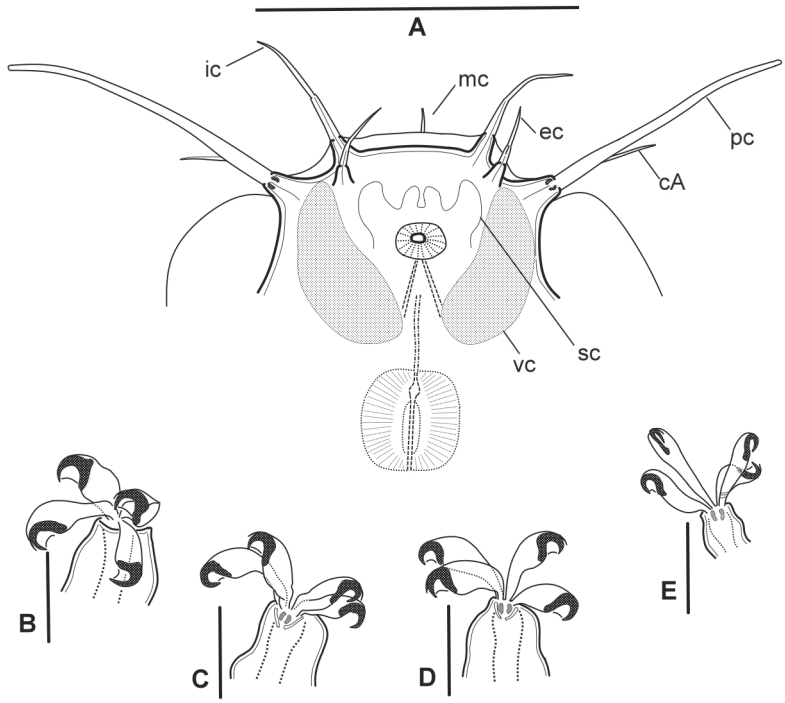

Fig. 3. *Florarctus hulingsi*, female, details. A — head ventrally; B–E — digits of I (B), II (C), III (D) and IV (E) feet.
Abbreviations: cA — cirrus A; ec — cirrus externus; ic — cirrus internus; mc — cirrus medianus; pc — primary clava; sc — secondary clava; vc — cephalic vesicle. Scale bars: A — 50 μm, B–E — 10 μm.
Рис. 3. Самка *Florarctus hulingsi*, детали. A — голова с брюшной стороны; B–E — пальцы: I конечности (B), II конечности (C), III конечности (D) и IV конечности (E).
Обозначения: cA — циррус A; ec — наружный циррус; ic — внутренний циррус; mc — медианный циррус; pc — первичная клава; sc — вторичная клава; vc — головной пузырь. Масштаб: A — 50 μm, B–E — 10 μm.

scapus with apical socket, and flagellum. Primary clava (PC) long and almost cylindrical but slightly swollen in the basal fourth, with rounded terminal tip. Primary clava rooted on common cirrophore ventrally to the cA. There is a distinct van der Land's body (refractive collar) inside the cirrophore of the PC. Secondary clavae (SC) fused anteriorly but scarcely discernible posteriorly on either side of the mouth cone.

There are two large kidney bean-shaped vesicles (CV) situated at either side of the mouth laterally of the SC; they are convex and blister-like. Anterior ends of the CV indistinct, slightly narrowed and converged, while their posterior ends widened and rounded, and widely divorced.

Cirri E (CE) similar in shape to the head sensory organs but the cirrophore is rather hemispherical than cylindrical, scapus elongate subcylindrical, scapus and two-jointed flagellum; the CE situated just above the postero-lateral alae. Femurs of all four legs bear about equally long simple leg cirri (LCi). LCi I–III rather short and elongate conical; LCi IV also short, but notably thick and stout.

Ocelli not found.

Legs I–IV telescopic jointed, consisting of basal low truncate conical coxa (often indistinct), elongate truncate-conical femur and retractile cylindrical tibia terminated with tarsus.

Four flat and transparent **digits** (toes) come out as a bouquet from a very minute palm (tarsus). All the digits nearly equal in length or two internal digits may seem to be a bit longer than external ones. Each digit broadened to the claw, external digits basally often with very faint oblique striation. Peduncles of the external digits not evident. All the **claws** of a foot are of the same size and shape, sickle-like. Internal claws provided with fine dorsal accessory spine while external claws not. Calcars not developed. The claws may be withdrawn into fine transparent claw sheath. Claws of the feet I a bit bigger than those of the feet II–IV.

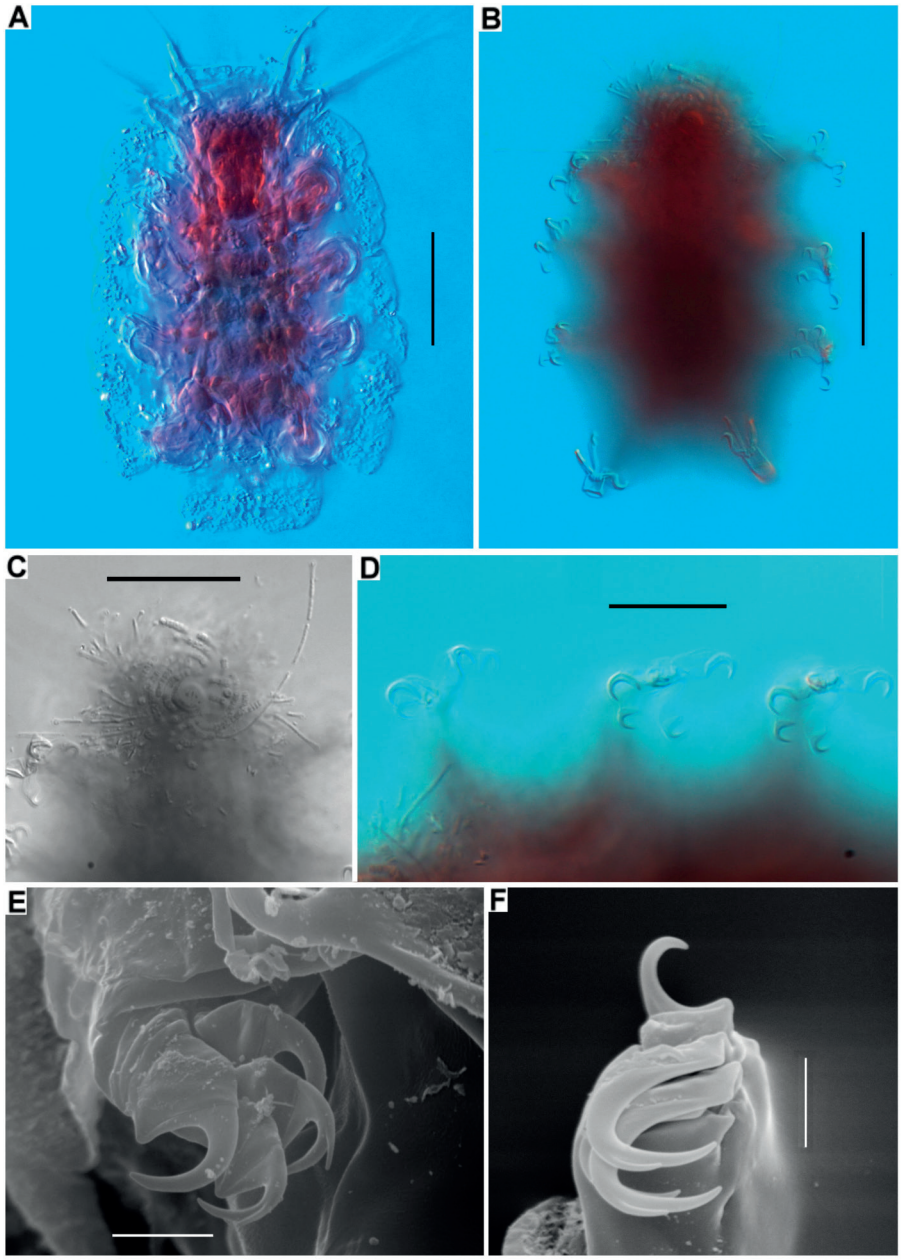

Fig. 4. *Florarctus hulingsi*, light (A–D) and SEM (E–F) pictures. A — entire, ventral view, focused on alae; B — entire, ventral view, focused on crawls; C — circumoral scrubs of procaryotes; D — crawls of left I to III feet; E — claws of right foot II; F — crawls of right I foot.
Scale bars: A, B — 50 μm; C — 30 μm; D — 20 μm; E, F — 3 μm.
Рис. 4. *Florarctus hulingsi*, фото- (A–D) и СЭМ- (E–F) изображения. A — общий вид с брюшной стороны, фокусировка на латеральных крыльях; B — общий вид с брюшной стороны, фокусировка на когтях; C — циркуморальная щётка прокариот; D — когти I, II и III конечностей с левой стороны; E — когти II правой конечности; F — когти I правой конечности.
Масштаб: A, B — 50 μm; C — 30 μm; D — 20 μm; E, F — 3 μm.

Table 1. *Florarctus hulingsi*, measurements.
Таблица. 1. Морфометрия особей *Florarctus hulingsi*.

Character	**Specimen 1, female, lateral view**	**Specimen 2, male, ventral view (genitalia poorly visible)**	**Specimen 3, male, ventral view (genitalia poorly visible), fouling around the mouth, green midgut**
Body length, μm	152	111	110
Body width between legs II and III, μm	71	56	58
Median cirrus–entire, μm (cirrophore+scapus+flagellum in %% of entire length)	20 (15+27+58)	?	?
External cirrus–entire, μm (cirrophore+scapus+flagellum in %% of entire length)	12 (20+20+60)	12 (27+22+51)	18 (27+31+42)
Internal cirrus–entire, μm (cirrophore+scapus+flagellum in %% of entire length)	27 (26+27+47)	20 (17+30+53)	33 (16+29+55)
Lateral cirrus A–entire, μm (cirrophore+scapus+flagellum in %% of entire length)	21 (34+22+44)	22 (28+35+37)	19 (26+34+40)
Primary clava (without cirrophore	54	42	42
Cirrus E–entire, μm (cirrophore+flagellum in %% of entire length)	31 (13+87)	24 (16+84)	18 (14+86)
Sense organ on leg I	11.6	8.0	7.7
Sense organ on leg II	?	5.4	?
Sense organ on leg III	8.2	?	?
Sense organ on leg IV	11	5.0	7.7
Internal claw leg I	4.0	4.2	3.9
External claw leg I	5.8	4.5	4.0
Internal claw leg IV	3.9	2.8	3,o
External claw leg IV	5.4	4.4	3.8

Mouth opening as a small round pore on the apex of the mouth papilla on the ventral side of the head. Buccal tube and stylets obscure. Bulb rounded apple-shaped, muscular. Midgut with unclear outline, with swollen internal lumen. Anal opening as a short longitudinal cleft on the apex of the anal papilla.

Female reproductive organs. Ovary not clearly observable. Female gonopore situated midventrally between the legs IV; a small pore surrounded with six minute lobes forming together a rosette. Left and right ducts diverge from the gonopore to each side; the ducts gradually widen, make a loop anteriad and terminate with small spherical seminal receptacles at the base of the legs IV.

Male reproductive organs. Testis not discernible. Transversally oval gonopore situated between coxae of the legs IV anteriorly to the anus. Seminal vesicles and ventral ducts converging to the gonopore well discernible.

SYMBIONTS. Ventral surface is covered with thread-like colonies of prokaryotes, especially dense around the mouth opening. Thickness of the threads (cell chains) 0.7–1.1 μm, length up to 17 μm.

REMARKS AND DISCUSSION. *Florarctus hulingsi* is characterized by lateral alae divided by a deep indentation and lack of caestus. The only species sharing these features is *F. stellatus*; *F. hulingsi* differs from *F. stellatus* by smooth dorsal body cuticle (*versus* papillate sculpture over asterial pattern) and seemingly by lack of calcar on claws and peduncles on external digits (see Renaud-Mornant, 1989).

Vietnamese specimens generally fit in with the original diagnosis of *Florarctus hulingsi* (Renaud-Mornant, 1976) with possible exception of some fine details concerning claws. The external claws are described and depicted by Renaud-Mornant (1976) as larger and having more evident calcars than internal ones, when compared to Vietnamese specimens. I

Table 2. Characters of *Florarctus* species.
Таблица. 2. Признаки представителей видов рода *Florarctus*.

Species	Characters			
	Dorsal body surface	**Lateral alae**	**Caudal ala**	**Cestus**
F. acer	papillae	divided	four-lobate	discontinuous, tree lobes lateral, two-lobate caudal
F. antillensis	smooth	divided	four-lobate	absent
F. asper	papillae	divided	four-lobate	continuous, three-to-six-lobate lateral, two-lobate caudal
F. bellahelenae	smooth	divided	two-lobate	laterally continuous trilobate, caudally discontinuous two-lobate
F. cinctus	papillae	divided	four-lobate	laterally continuous three-lobate, caudally continuous two-lobate
F. glareolus	smooth	divided	four-lobate	laterally continuous three–four-lobate, caudally continuous two-lobate
F. heimi	smooth	divided	four- to ten-lobate with acute lobes partly strongly elongated	laterally discontinuous or continuous two–three-lobate, caudally absent
F. hulingsi	smooth	divided	two-lobate	absent
F. kwoni	papillae	fused	even border	laterally and caudally continuous, even bordered
F. pulcher	finely punctated	divided	four-lobate	continuous, laterally six-lobate, caudally two-lobate
F. salvati	finely punctated	fused	even border	laterally discontinuous three-lobate, caudally two-lobate
F. stellatus	weak papillae on reticulate pattern underneath	divided	two-lobate	absent
F. vulcanius	punctated	fused	slightly two-lobate	laterally discontinuous three-lobate, caudally two-lobate
F. wunai	smooth	divided	four-lobate	continuous, laterally three–four-lobate, caudally slightly two-lobate
F. yucatanensis	smooth	divided	four-lobate	continuous, laterally five–seven-lobate, caudally four- or slightly two-lobate

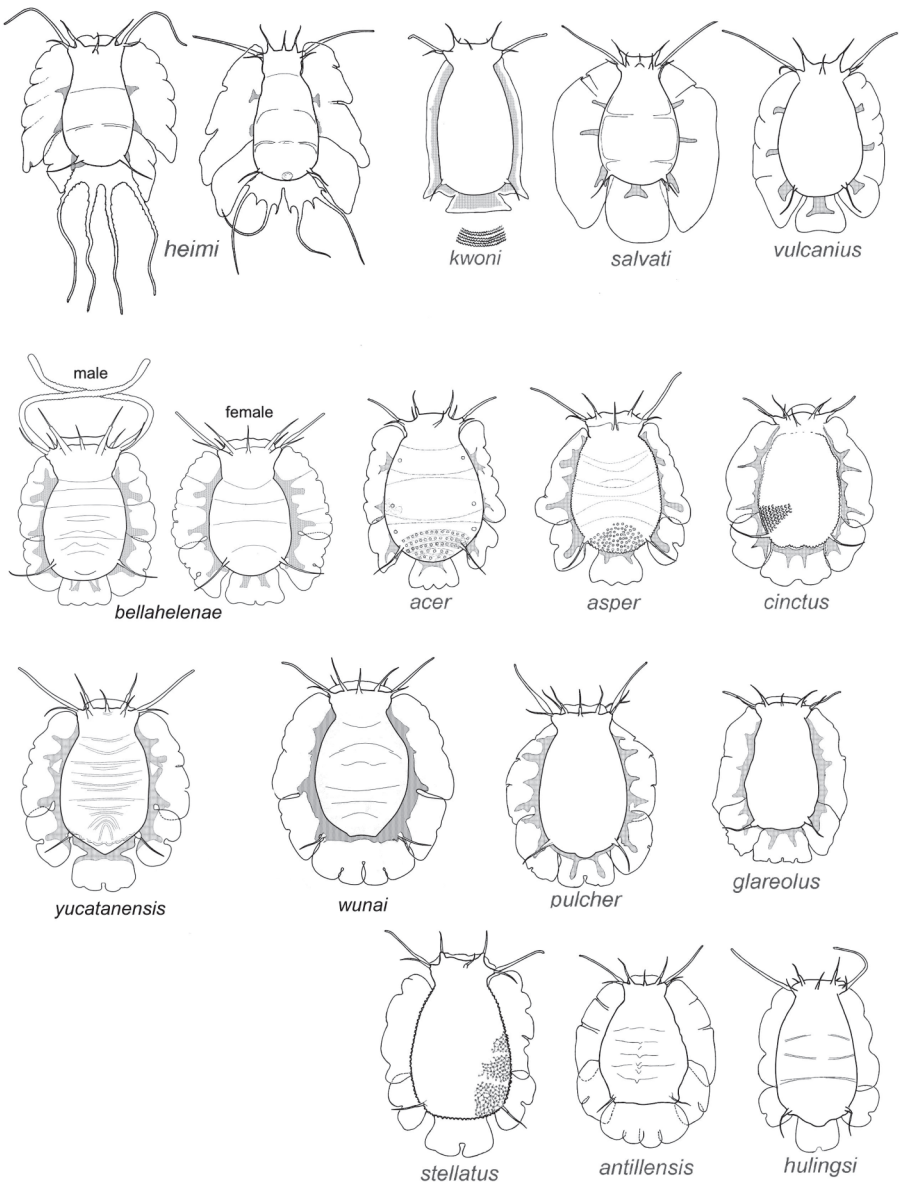

Fig. 5. Pictorial key to *Florarctus* species. The species are arranged in groups of similarity.
Рис. 5. Пикториальный (картиночный) ключ к видам *Florarctus*. Виды собраны в группы по сходству.

consider these differences minor and uncertain to cast down upon the species identification.

Secondary clava and cephalic vesicles were not mentioned in the original diagnosis of *F. hulingsi* as well as in some other *Florarctus* species. Secondary clava is a very faint structure which could be overlooked in older descriptions. Gąsiorek *et al*. (2021) noted that some structures such as different glands, elements of bucco-pharyngeal apparatus and cephalic vesicles are invisible in glycerol-mounted slides but can be observed and drawn on specimens mounted in distilled water.

Cephalic vesicles were discovered in all three genera of Florarctinae, *Florarctus* (Renaud-Mornant, 1989, Gąsiorek *et al*., 2021), *Wingstrandarctus* (Renaud-Mornant, 1967; Kristensen, 1984) and *Ligiarctus*

(Gomes-Júnior *et al*. 2018). Kristensen (1984) showed by using transmission electron microscopy that the cephalic vesicle is an intracuticular cavity filled with slime and serves as a habitat for symbiotic bacteria. The cavity connects with environment through pores, and it may evert and empty out to bacteria. The cephalic vesicles were found by Kristensen (1984) for *Florarctus antillensis*, *F. cinctus* and other three undescribed species of *Florarctus*, but not for *F. salvati* and *F. hulingsi*.

A comprehensive list of previous findings from 60 points has been given by Kaczmarek *et al*. (2015). *F. hulingsi* is the most often recorded species of *Florarctus* and certainly one of the most frequently registered species of marine heterotardigrades. Overwhelming number of records concern various regions of the Mediterranean Sea, the other belong to Brazil, Maldives, Seychelles and even Celtic Sea. The last locality is the only region out of tropics and subtropics. The present find is the first registration of *F. hulingsi* for the Indo-China coast and Pacific Ocean.

Pictorial Key for *Florarctus* species identification

Species of *Florarctus* can be differentiated from one another by several important characters: (1) cuticle sculpture on the dorsal body side, presented as papillate or coarse punctation, or smooth, (2) lateral ala divided by a deep slash into antero-lateral and posterolateral parts or continuous, (3) caestus inside alae, continuous, discontinuous or absent, (4) differentiations of caudal ala, lobate, with longer narrow projection or even border. Implicitly, details of toes and claws might serve as reliable characters for species discrimination, but now these delicate structures are described not evenly exactly and comprehensive for all *Florarctus* species to be compared.

The present key for identification of fifteen valid species of *Florarctus* is constructed based on species descriptions and redescriptions cited above in the" Annotated list of *Florarctus* species". The key consists of two components. (1) a set of species caricatured species icons (Fig. 5), and (2) a table of the most important structural characteristics (Table 2). On Fig. 5, the simplified silhouettes of species are arranged in groups shared similar features.

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