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A new mud-dwelling species of the genus *Alpheus* Fabricius, 1798 (Decapoda: Alpheidae) from anoxic mangrove swamps of South Vietnam

Новый вид рода *Alpheus* Fabricius, 1798 (Decapoda: Alpheidae) из илистых биотопов аноксичных мангровых болот Южного Вьетнама

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KEY WORDS: Crustacea, diversity, mangroves, communities, Asia, Indo-West Pacific.
КЛЮЧЕВЫЕ СЛОВА: Crustacea, разнообразие, мангры, сообщества, Азия, Индо-Вест Пацифика.

ABSTRACT. The article describes a new species of the genus *Alpheus* Fabricius, 1798 (Decapoda: Caridea: Alpheidae), referring to the "*Alpheus malabaricus*" species complex, which is characterized by unusually long and thin fingers of minor cheliped (pereiopod I). *Alpheus cangiopalus* sp.n. was found to live exclusively in highly specific shallow water muddy lagoons located in deep anoxic mangrove swamps of the Cần Giờ Mangrove Biosphere Reserve in South Vietnam. Detailed morphological comparison with *Alpheus malabaricus* (Fabricius, 1775) and other taxa earlier synonymized with the former species are provided. The trophic position of the new species was evaluated based on analysis of $\delta^{15}N/\delta^{13}C$ stable isotopes, and a discussion on other ecological features of the species is also represented in the article.

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РЕЗЮМЕ. В статье представлено описание нового вида рода *Alpheus* Fabricius, 1798 (Decapoda: Caridea: Alpheidae) из видового комплекса "*Alpheus malabaricus*", который в первую очередь характеризуется необычно длинными и тонкими пальцами малой клешни (переоподы I). *Alpheus cangiopalus* sp.n. обнаружен исключительно в высокоспецифичных мелководных илистых лагунах, расположенных в глубоких бескислородных мангровых болотах в мангровом биосферном заповеднике Канзе, Южный Вьетнам. В статье также представлено подробное морфологическое сравнение с видами, ранее синонимизированными с *Alpheus malabaricus* (Fabricius, 1775). Трофическая позиция, основанная на анализе стабильных изотопов $\delta^{15}N/\delta^{13}Cб$ и обсуждение экологических особенностей видов из этого видового комплекса также представлена в статье.

Introduction

The snapping shrimps from the "*Alpheus edwardsii*" group (Decapoda: Caridea: Alpheidae) (sensu Coutière [1899]; Banner, Banner [1982]; De Grave, Fransen [2011]) includes the species with elongated chela of minor pereiopod I (cheliped). Sometimes, the fingers of the minor cheliped of these shrimps are densely intertwined with long setae and bristles, which are necessary to digging and foraging in a soft substrate. Similar long-fingered minor chelipeds are also found in other species groups of the genus *Alpheus,* for example, in the "*Alpheus brevirostris*" group, which also live in similar habitats with muddy bottom.

Currently, the scientific name "*Alpheus malabaricus* (Fabricius, 1775)" refers to a complex of several morphologically similar species [Anker, De Grave, 2016; Anker, 2023] that live and well adapt to soft bottom habitats. The taxonomic confusion surrounding *A. malabaricus* is due to a very brief and sometimes formal diagnosis provided by Fabricius [1775], as well as an insufficient re-description of the species lately given by Henderson [1893] that was not based on the type or topotypic specimens. This has led to confusion regarding the morphological features of the species (e.g., Anker, De Grave [2016]; Sha *et al.* [2019]; Banner, Banner [1976]). It is very likely that "*Alpheus malabaricus*" species complex contains a large number of morphologically similar, but often even unrelated, but convergently adapted to similar soft bottom habitats. Johnson [1979], for example, noted that "*almost every local population of this species seems*

to be different, and therefore there are many described varieties" (after Anker, De Grave [2016]). Recently, a species previously referred to this complex, *A. malabaricus songkla* Banner et Banner, 1966, was redescribed and it was shown that it apparently belongs to the "*Alpheus euphrosyne*" species complex [Anker, 2023]. Therefore, the "*Alpheus malabaricus*" species complex, obviously, needs to be revisited.

A detailed study of the biodiversity of mangrove swamps in the Cần Giờ Mangrove Biosphere Reserve, South Vietnam, conducted in September 2021 and April 2022, revealed the presence of a morphologically specific species of the genus *Alpheus* with unusually long and thin fingers of minor cheliped (pereiopod I). This species is well morphologically distinct from its congeners and is described below as new to science.

Material and methods

Sampling was conducted in the wide shallow water lagoons in the upper zone of deep mangrove swamps, which are mostly overgrowing with coastal thickets of *Sonneratia caseolaris* (L.) (Lythraceae) and deep forests of *Rhizophora apiculata* Bl. (Rhizophoraceae) in the Cần Giờ Mangrove Biosphere Reserve, Hồ Chí Minh, South Vietnam, in September (dry season) 2022 and April (wet season) 2023. Shrimps were collected using a yabbi-pump or manually by digging holes (burrows) in the soft muddy sediment. The collected shrimps were relaxed in a clove oil and then photographed alive using a Canon G16 digital camera. They were then preserved in 90% ethanol and transported to the laboratory. Morphological drawings were made using a lucida camera attached to an Olympus SZX10 stereomicroscope in the laboratory.

Postorbital carapace length (pcl., in mm), measured from the tip of the rostrum to the midpoint of the posterodorsal margin of the carapace, and total body length (tbl., in mm), measured from the tip of the rostrum to the distal margin of the telson, are used as standard measurements. The type material and additional specimens are deposited in the collection of the Zoological Museum of Moscow State University, Moscow, Russia (ZMMU) (type material), the first author's collection at the A.N. Severtsov Institute of Ecology and Evolution of Russian Academy of Sciences, Moscow, Russia (LEMMI) and Laboratory of Hydrobiology of the Southern Branch of the Joint Vietnam–Russia Tropical Research and Technological Center, Ho Chi Minh, Vietnam (LH).

The material for the stable isotope analysis was collected in the same locality. The muscle tissue from the dorsal side of the body of each collected shrimp was oven dried at 50 °C for 4–5 days, and then were wrapped in tin foil (1200–1500 μg and 400–600 μg, respectively). The composition of stable isotopes ($\delta^{13}C/\delta^{15}N$) was determined using a Thermo–Finnigan Delta V Plus continuous-flow mass spectrometer (Thermo Electron GmbH, Bremen, Germany) coupled with an elemental analyzer (Thermo Flash 1112, Thermo Electron) at the Joint Usage Center at the A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences. The isotopic composition of N and C was expressed in the δ-notation relative to the international standard (atmospheric nitrogen or VPDB): $\delta X(‰)=[(Rsample/Rstandard)-1]\times1000$, where R is the ratio of the heavier isotope to the lighter isotope. Samples were analyzed with reference gases calibrated against IAEA (Vienna, Austria), reference materials USGS 40 and USGS 41 (glutamic acid). The drift was corrected using internal laboratory standards (acetanilide, casein). The standard deviation of $\delta^{15}N/\delta^{13}C$ values in our laboratory standards (n=8) was <0.15‰.

Results

Order Decapoda Latreille, 1802
Infraorder Caridea Dana, 1852
Family Alpheidae Rafinesque, 1815
Genus *Alpheus* Fabricius, 1798

***Alpheus cangiopalus* sp.n.**

Figs 1–5.

MATERIAL EXAMINED. Holotype, ♂, pcl. 8.0 mm and tbl. 24 mm, ZMMU Ma-6233, VIETNAM, Ho Chi Minh District, Cần Giờ Mangrove Biosphere Reserve, 10°27′30.0″N 106°53′30.8″E, inside burrows in shallow water lagoon located deep in mangroves, coll. I. Marin, 12 September 2022. Paratype, ♀, pcl. 7.8 mm and tbl. 23 mm, ZMMU Ma-6234, same locality and date as for holotype.

Paratypes, 1♂, 1♀ (ZMMU Ma-6235), 11 ♀♀, 6 ♂♂ (LEMMI), the same locality as for holotype, 18–25 September 2022.

Additional material: 7 ♀♀, 3 ♂♂, (LEMMI), Cần Giờ Mangrove Biosphere Reserve, 10°25′19.7″N 106°54'25.0"E, inside burrows along the banks of canals deep in mangroves, coll. I. Marin, 12 April 2023; 3 ♀♀, 2 ♂♂ (LH), Cần Giờ Mangrove Biosphere Reserve, 10°25′19.7″N 106°54′25.0″E, inside burrows along the banks of canals deep in mangroves, coll. I. Marin, 15 April 2023.

ETYMOLOGY. The species name, *cangiopalus*, was given after Cần Giờ Mangrove Biosphere Reserve; and the habitat of the new species, "*palus*" (Latin.) means "swamp". The species epithet can be translated as "living in the swamps of Can Gio".

DESCRIPTION. Moderately-large species. Body non-setose, not compressed or flattened. Carapace smooth, tuberculate, not compressed or pubescent (Figs 1, 5). Rostrum slightly flattened dorsally, distinctly longer than wide, distally tapering and ending in acute point, overreaching orbital hoods, without setae, reaching half-length of basal antennular article (Fig. 2*a*); middorsal carina feebly developed, without any tubercles, extending posteriorly to about 1/3 of carapace; orbital hoods swollen, anterior margin without teeth, separated from middorsal carina by shallow groove. Pterygostomial angle smooth, not protruding, unarmed (Fig. 2*b*). Cardiac notch distinct. Eyes completely concealed by orbital hoods, with well-defined cornea.

Abdomen smooth, not pubescent, pleuras of somites I–IV with rounded posterior margins, somite V about 0.6X length of telson, sharply projected posteriorly (Fig. 5).

Telson (Fig. 2*d*) slightly tapering, its length about 2.4–2.5X of proximal width (as widest point); dorsal surface without a medio-longitudinal depression, with two relatively strong spines inserted at some distance from lateral margin and situated approximately at 0.5X and 0.8X5 of telson length; posterior margin uniformly bluntly rounded, furnished with long plumose setae; each posterolateral angle with a pair of posterolateral spines, with inner spine longest, slightly extending beyond posterior margin of telson; anal tubercles well developed.

Antennular peduncle (Fig. 1*a*, *b*) with a basal article short, about as long as wide, article II elongate, about 2.5X longer than wide, distal article short, about as long as wide; stylocerite with sharp tip, not reaching to distal margin of basal article; ventromesial carina (Fig. 1*c*) with stout blunt triangular tooth.

Antenna (Fig. 1*a*, *b*) with a stout basicerite, bearing a sharply produced distoventral tooth (Fig. 2*b*); scaphocerite with well-developed blade and strong distolateral tooth, slightly overreaching blade; carpocerite about 4X longer than wide, overreaching antennular peduncle and distal margin of the scaphocerite.

Mouthparts typical of the genus. Maxilliped III (Fig. 2*a–f*) slightly overreaching antennular peduncle by distal part of ul-

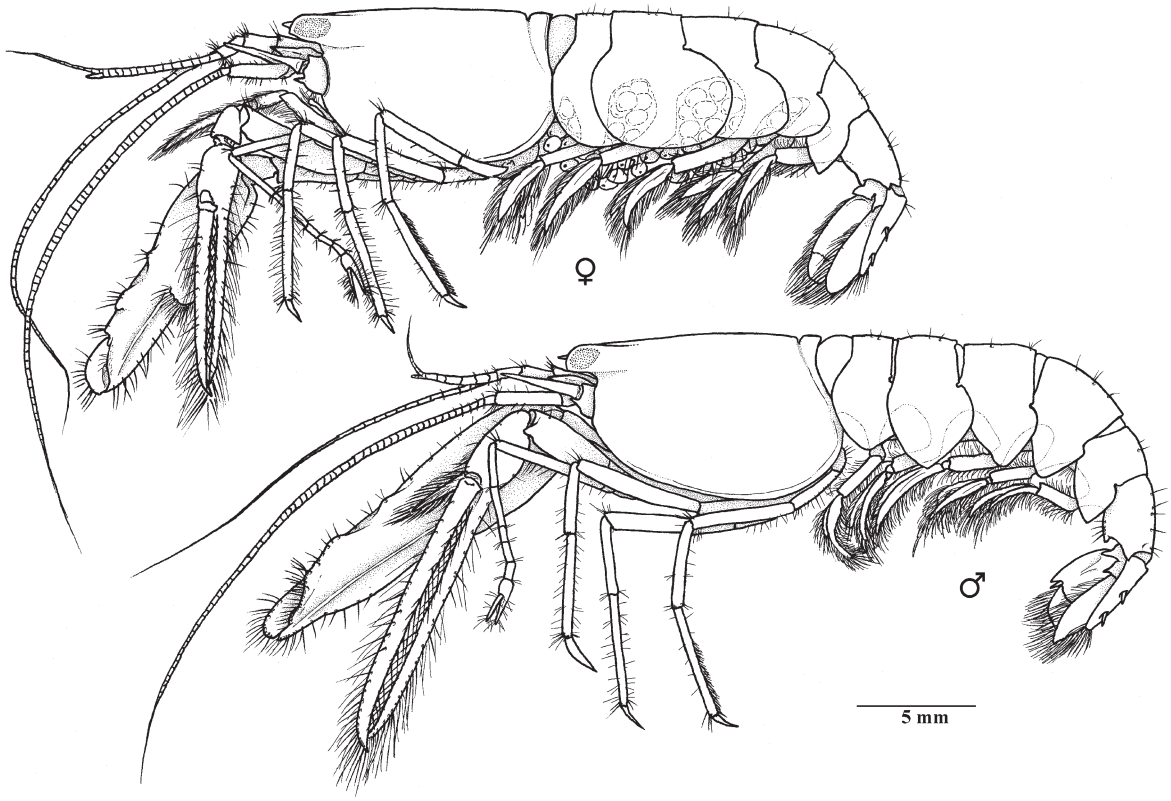

Fig. 1. *Alpheus cangiopalus* sp.n., habitus in lateral view. Paratype ovigerous ♀, ZMMU Ma-6234, and holotype ♂, ZMMU Ma-6233, collected together as a heterosexual pair.

Рис.1. *Alpheus cangiopalus* sp.n., общий вид, вид сбоку. Паратип, яйценосная ♀, ZMMU Ma-6234, голотип, ♂, ZMMU Ma-6233, собранные вместе как гетеросексуальная пара.

timate article; ultimate article elongated, about 6–6.5X longer than wide, tapering distally, fringed with long setae; penultimate article about 3.5–4X longer than wide, about 0.6X length of ultimate segment; antepenultimate segment about 5X longer than wide, richly setose, unarmed; exopod relatively long, about 0.9X of length of antepenultimate article, spade-like expanding distally; epipod small, strap-like; epipodal plate relatively large and flap-like.

Pereopods I (chelipeds) similar in size and shape in ♂♂ and ♀♀ (Fig. 3). Major chela (Fig. 3) slightly setose, generally similar in shape in both sexes, not significantly larger in males (Fig. 3*a*); basis about as long as wide, unarmed; ischium short, stout, slightly longer than wide, unarmed, not compressed (Fig. 3*b*); merus about 2.2–2.3X longer than maximal width, triangular in cross section, flexor (mesial) margin smooth, distal margin produced in sharp tooth, lateral margin smooth, with several small setae, extensor (dorsal) margin smooth, unarmed, with distal margin ending sharply; carpus short, cup-shaped, about 1.0–1.2X length of palm, surface smooth, with broadly rounded distal lobes (Fig. 3*a*); chela with a palm about 2.0–2.2X longer than fingers, distodorsal margin with a broad transverse groove extending onto lateral surface and posteriorly to linea impressa, and into mesial surface and then posteriorly, almost reaching linea impressa; dorsal shoulder feebly developed, distally rounded, sloping smoothly into a transverse groove; ventral margin with a deep, broad transverse groove, ventral shoulder blunt, with granulated distal margin; dactylus slightly overreaching pollex, with a stout plunger, latter furnished with stamen-shaped sensillae not twisted, adhesive discs well developed; fixed finger with curved and sharp tip. Minor chela (Fig. 4*a–f*) not sexually dimorphic, significantly slender than major chela; basis about as long as wide, unarmed; ischium short, stout, slightly longer than wide, unarmed, not compressed (Fig. 4*b*); merus subcylindrical, relatively slender, about 4X longer as wide, flexor (mesial) margin smooth, distal margin produced in a stout sharp tooth, lateral margin smooth, with several small setae, extensor (dorsal) margin smooth, unarmed, with distal margin ending sharply; carpus short, cup-shaped, about 0.5X length of propodus, surface smooth, with broadly rounded distal lobes and several long setae near extensor margin (Fig. 4*a*); palm (propodus) subcylindrical, with a smooth surface lacking any grooves and crests; fingers equal in length, extremely long and straight, about 16–17X longer than wide, about 4X longer than propodus, slightly crossing by their tips, deeply covered with straight long setae, cutting margin of dactylus almost straight, with small double triangular teeth situated on proximal part close to articulation, cutting margin of pollex straight, without teeth.

Pereopod II (Fig. 4*g*) slender, reaching beyond antennular peduncle by distal part of mero-carpal articulation, with slender and unarmed articles; ischium slightly longer in length than merus; carpus divided into five articles, with approximate ratio 1/0.9/0.2/0.2/0.3; chela about 0.25X longer than carpus, and about 2X longer than distal carpal article; fingers about twice longer than palm, with straight and simple cutting margins.

Pereopod III (Fig. 4*h*) robust, overreaching antennular peduncle by a distal half of propodus; ischium about 2X longer than wide, about 0.4X length of merus, with a large movable spine on lateral surface ventrally; merus robust, unarmed, about 5X longer than wide; carpus unarmed, about 4.5X longer than wide, about 0.4–0.5X length of merus; propodus about 7X longer than wide, about 1.3–1.4X longer than carpus, unarmed, covered with numerous simple setae; dactylus (Fig. 4*j*)

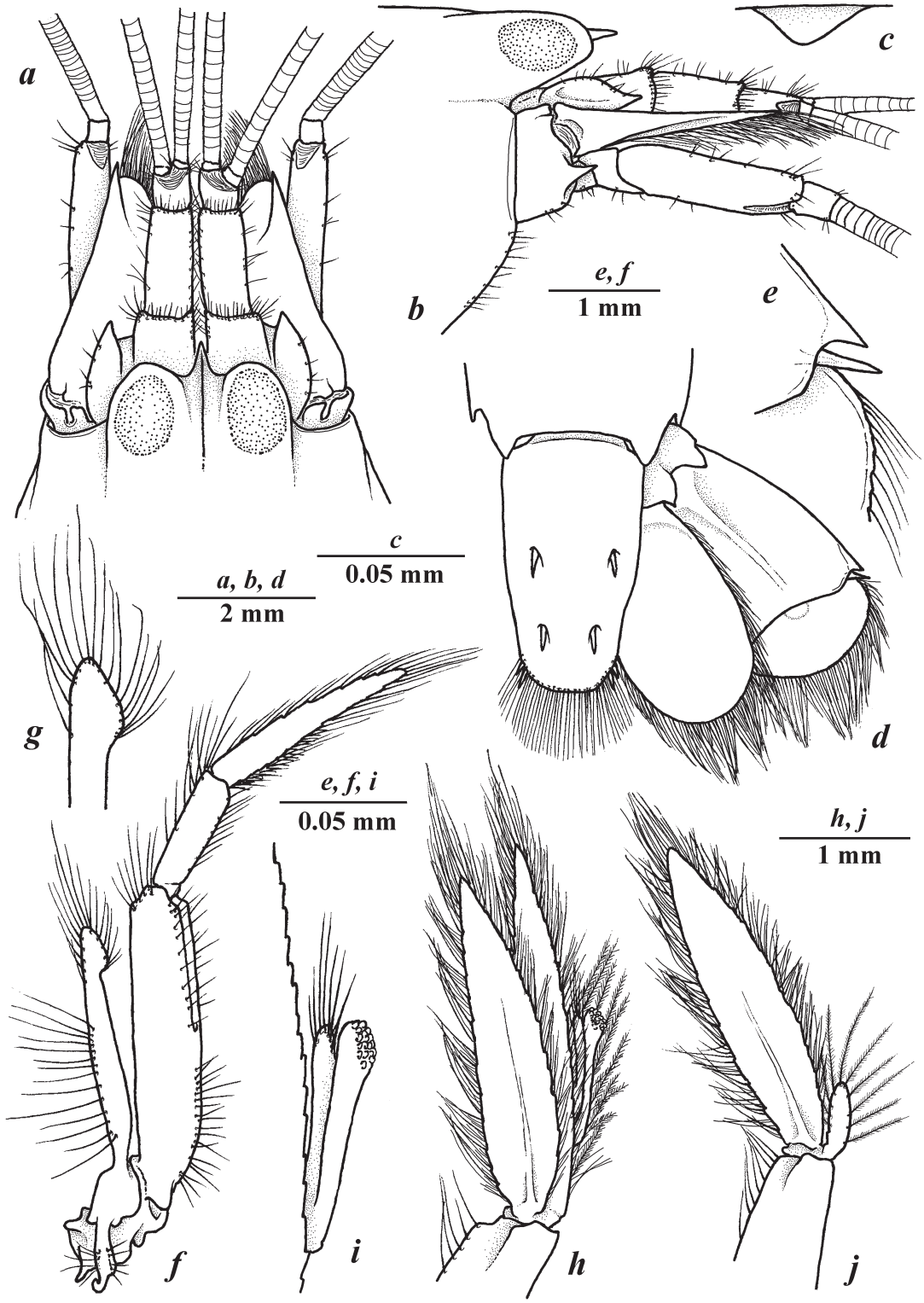

Fig. 2. *Alpheus cangiopalus* sp.n., holotype, ♂, ZMMU Ma-6233 (*a–i*), paratype ♀, ZMMU Ma-6234 (*j*): *a* — anterior part of carapace, dorsal view; *b* — anterior part of carapace, lateral view; *c* — tooth on ventromesial carina of first segment of antennular peduncle, lateral view; *d* — telson and uropod; *e* — distal angle of uropodal exopod; *f* — maxilliped III (MxpIII); *g* — distal part of exopod of MxIII; *h* — pleopod II; *i* — appendix interna and appendix masculine; *j* — pleopod I.

Рис. 2. *Alpheus cangiopalus* sp.n., голотип, ♂, ZMMU Ma-6233 (*a–i*), паратип, ♀, ZMMU Ma-6234 (*j*): *a* — передняя часть карапакса, вид сверху; *b* — передняя часть карапакса, вид сбоку; *c* — зубец вентромезиального отростка первого сегмента антеннулярного стебелька, вид сбоку; *d* — тельсон и уропода; *e* — дистальный угол экзопода уропод; *f* — максиллипеда III (MxpIII); *g* — дистальная часть экзопода MxIII; *h* — плеопода II; *i* — appendix interna и appendix masculine; *j* — плеопода I.

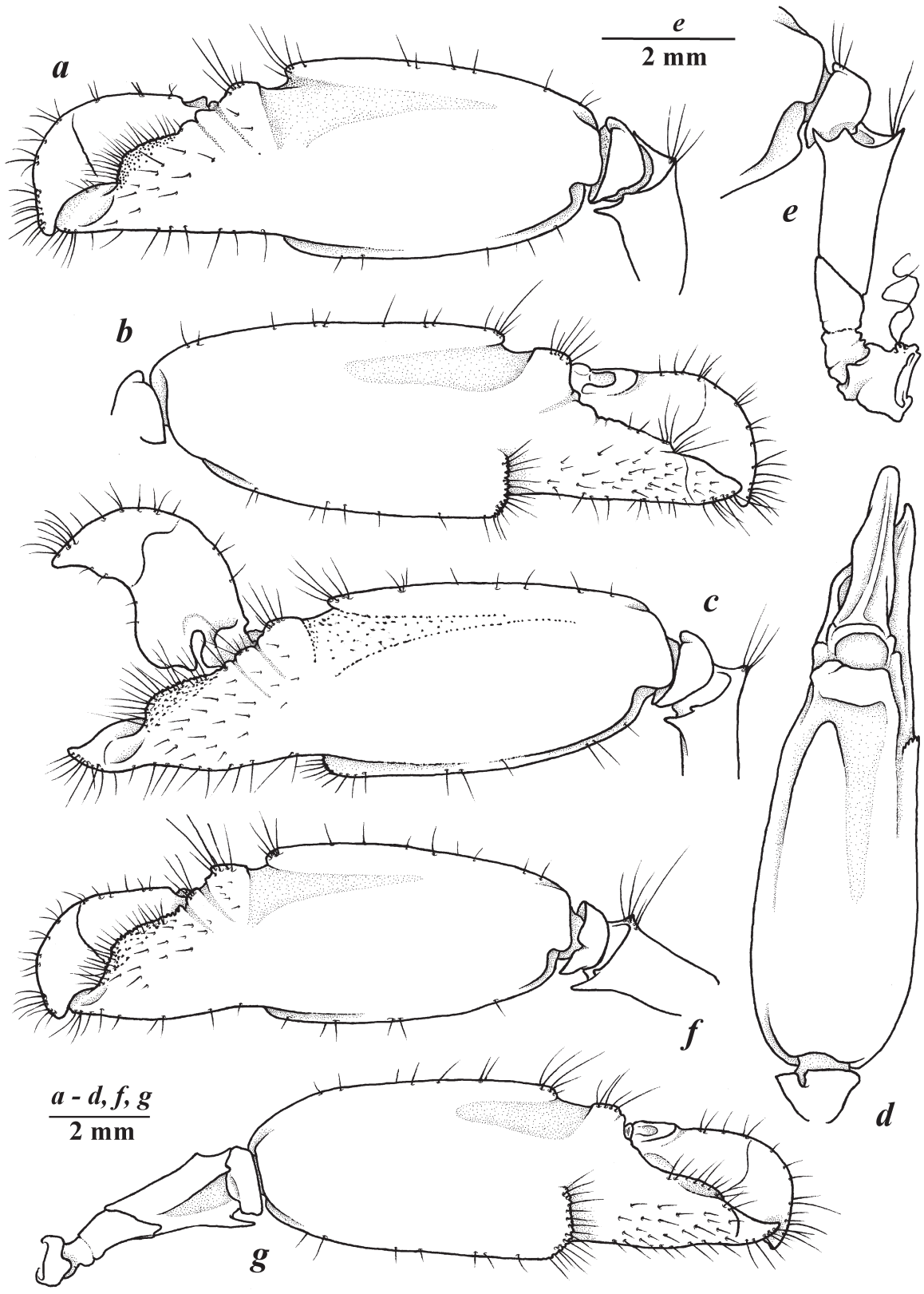

Fig. 3. *Alpheus cangiopalus* sp.n., holotype ♂, ZMMU Ma-6233 (*a–e*), and paratype ♀, ZMMU Ma-6234 (*f*, *g*): *a–d*, *f*, *g* — chela of major (right) pereiopod I (cheliped), different views; e — proximal segments of major cheliped.

Рис. 3. *Alpheus cangiopalus* sp.n., голотип, ♂, ZMMU Ma-6233 (*a–e*) и паратип, ♀, ZMMU Ma-6234 (*f*, *g*): *a–d*, *f*, *g* — клешня большого (правой) переоподы I (хелипеды), разные виды; *e* — проксимальные сегменты большого клешни (хелипеды).

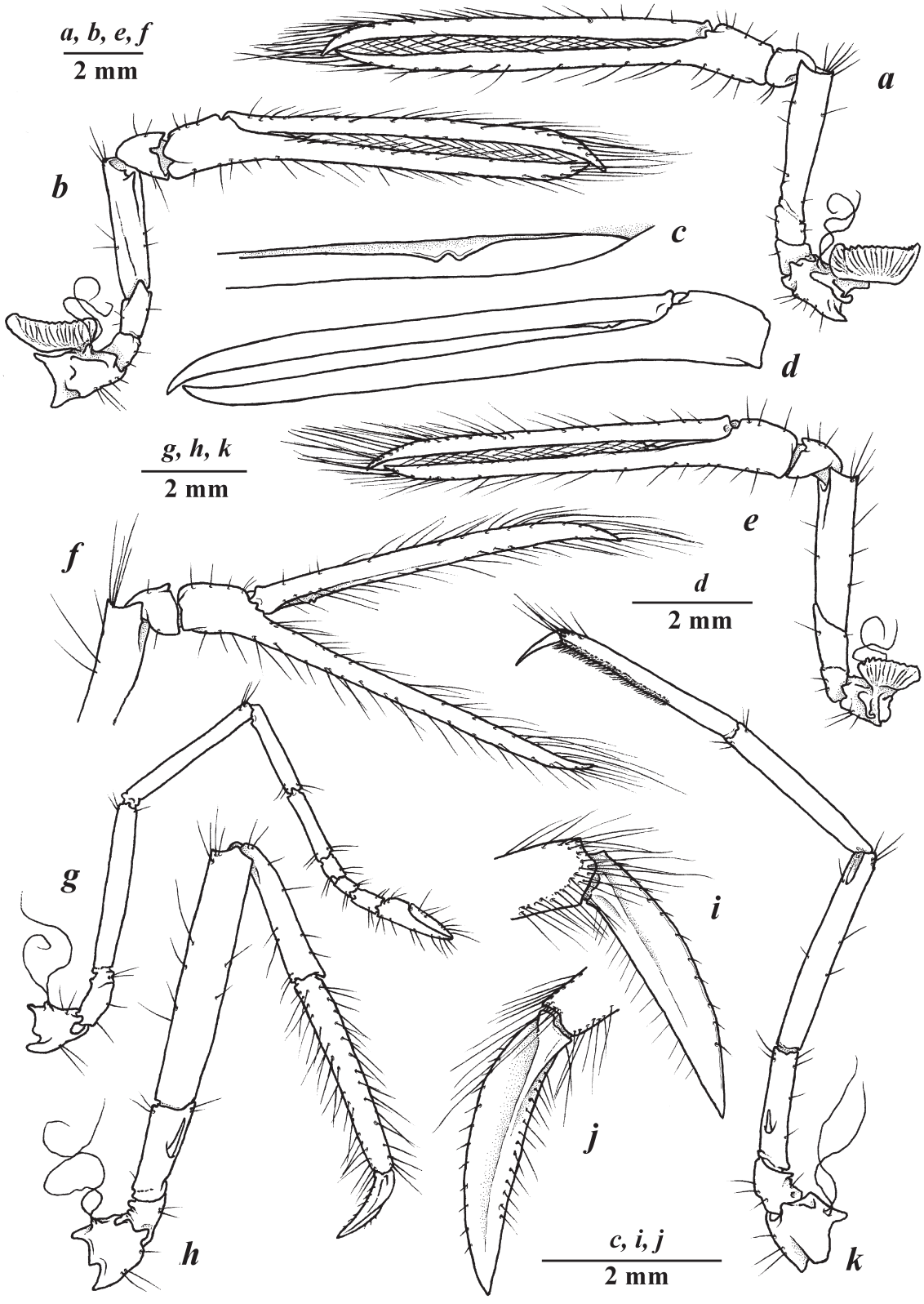

Fig. 4. *Alpheus cangiopalus* sp.n., holotype ♂, ZMMU Ma-6233 (*a*–*d*, *g*–*k*), and paratype ♀, ZMMU Ma-6234 (*e*, *f*): *a*, *b*, *e*, *f* — minor (left) pereiopod I (cheliped), different views; *c* — chela of — minor (right) pereiopod I (cheliped), lateral view; *d* — proximal part of fingers of minor cheliped; *g* — pereiopod II; *h* — pereiopod III; *i*, *j* — dactylus of pereopod III, different views; *k* — pereopod V.

Рис. 4. *Alpheus cangiopalus* sp.n., голотип, ♂, ZMMU Ma-6233 (*a*–*d*, *g*–*k*) и паратип, ♀, ZMMU Ma-6234 (*e*, *f*): *a*, *b*, *e*, *f* — малая (левая) переопода I (хелипеда), разные виды; *c* — клешня малой (левой) переоподы I (хелипеды), вид сбоку; *d* — проксимальная часть пальцев малой хелипеды; *g* — переопода II; *h* — переопода III; *i*, *j* — дактилус переоподы III, разные виды; *k* — переопода V.

Fig. 5. *Alpheus cangiopalus* sp.n., habitus, showing living coloration: *a* — holotype ♂, ZMMU Ma-6233, lateral and dorsal views; *b* — paratype ♂, ZMMU Ma-6235, lateral and dorsal views.

Рис. 5. *Alpheus cangiopalus* sp.n., общий вид, прижизненная окраска*: a* — голотип ♂, ZMMU Ma-6233, вид сбоку и сверху; *b* — паратип ♂, ZMMU Ma-6235, вид сбоку и сверху.

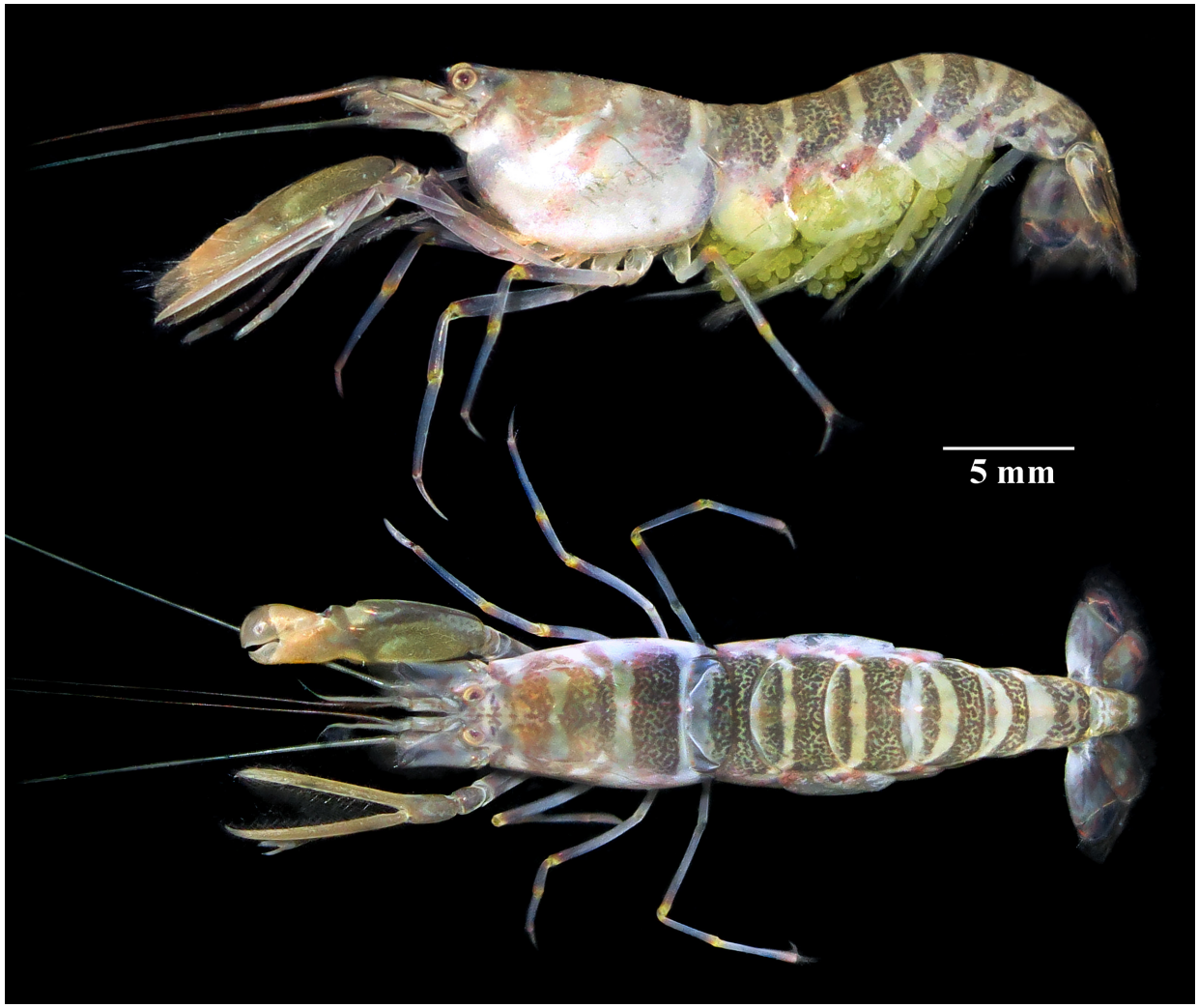

Fig. 6. *Alpheus cangiopalus* sp.n., paratype ♀, ZMMU Ma-6235, general lateral and dorsal views, showing living coloration.
Рис. 6. *Alpheus cangiopalus* sp.n., паратип ♀, ZMMU Ma-6235, общий вид сбоку и сверху, прижизненная окраска.

subspatulate, about 0.2–0.25X length of propodus, terminating in acute tip, with extensor surface bearing short setae, flexor surface glabrous.

Pereopod IV similar to pereopod III in shape and armature, but slenderer, reaching beyond distal end of antennular peduncle by distal part of propodus; ischium with a large movable spine on lateral surface ventrally; dactylus subspatulate.

Pereopod V (Fig. 4*k*) significantly slender than ambulatory pereopods III–IV, reaching distal end of antennular peduncle; ischium about 3–3.5X longer than wide, about 0.5X length of merus, with a small movable spine on lateral surface ventrally; merus slender, unarmed, about 6X longer than wide; carpus unarmed, slender, about 7X longer than wide, equal to merus and propodus; propodus about 8X longer than wide, unarmed, distal ventral part with numerous rows of grooming setae; dactylus simple, dactylus narrower than those of ambulatory pereopods III–IV.

Gill/exopod formula typical of *Alpheus:* pleurobranchs on PpI–V, one arthrobranch on MxpIII; lobiform epipods present on MxpI–II; mastigobranchs on MxpIII and PpI–IV; setobranchs on PpI–V; and exopods on MxpI–III. Pleurobranchs absent.

Pleopod. Pleopod I similar in males and females, with almost equal endopod and exopod, bearing long marginal setae. Pleopod II with a relatively long appendix interna, reaching about 0.3X of length of endopod in males and females; appendix masculine present in males, robust than appendix interna, slightly overreaching it in length (Fig. 2*i*). Pleopods III–V similar in males and females, with almost equal endopod and exopod, with appendix interna on endopod.

Uropod (Fig. 2*d*, *e*) longer than telson, with exopod overreaching endopod; protopod stout, with two sharply produced lobes; exopod with short fixed tooth and large stout lateral spine distolaterally; endopod smooth, unarmed dorsally; diaeresis concave, unarmed.

VARIABILITY. To study the interspecific variability, a significant number of individuals of this species were captured during fieldwork. Additionally, we attempted to find individuals at different ages (stage of maturity) in order to identify variations in a key feature of this species — the length of the fingers in minor cheliped (pereopod I) both in ♂♂ and ♀♀. However, no significant variability or changes in this feature were observed among sexually mature males and ovigerous females, as well as among immature smaller sized specimens. Furthermore, we also did not notice any significant variations in other morphological features.

In all the specimens studied, the fingers of the minor chelipeds are equal in length, extremely long and straight, are about

16–17X longer than wide and about 4X longer than propodus, with their tips slightly crossing each other, without a gap between fingers when they are closed together, the cutting margins of the dactylus and the pollex almost straight. Therefore, we conclude that this morphological feature does not vary significantly, and that shrimp specimens with different finger length of the minor cheliped described by other authors (see below) most likely belong to different species.

COLOURATION. Both females and males are similar in coloration. The body is generally whitish-transparent, covered with evenly spaced green-reddish transverse stripes; the antennae are greenish transparent; the scaphocerites are bluish transparent; the telson and the uropods are covered with wide green-reddish transverse stripes, and with blue-colored distal parts; pereopods I (chelipeds) are generally greenish, and the ambulatory pereopods are covered with broad blue-yellow wide transverse bands; eyes are goldish (Fig. 5).

BODY SIZE. Males and females are similar in size. The largest collected male has pcl. 8.2 mm and tbl. 25 mm; the largest collected ovigerous female has pcl. 8.1 mm and tbl. 27 mm.

TAXONOMIC REMARKS. "*Alpheus malabaricus* (Fabricius, 1775)", obviously, represents a complex of several species, as recognized by various authors (e.g., Anker, De Grave [2016]; Anker [2023]). The species names currently recognized as its junior synonyms are *A. dolichodactylus* Ortmann, 1890, *A. dolichodactylus* var. *leptopus* De Man, 1910, *A. malabaricus mackayi* Banner, 1959 and *A. malabaricus trefzae* Banner et Banner, 1982 [Anker, 2023]. A complete revision of this complex is outside the scope of our study, and the taxonomic status of these taxa will not be discussing here. Instead, below, in the following section, we will conduct a morphological comparison between *Alpheus cangiopalus* sp.n. and each of the previously described and synonymized species.

Alpheus malabaricus (Fabricius, 1775) was described from the Malabar Coast in southwestern India. The original diagnosis of the species was very short and did not provide enough information to identify the species accurately. Lately, Henderson [1893] re-described the species based on specimens collected from the backwater at Pulicat on the eastern coast of India, providing more detailed information about the anterior part of carapace and chelipeds (pereopod I). Our new species can be distinguished from the one described by Henderson [1893] in: 1) the stouter antennular peduncle, not reaching the distal margin of the antennal peduncle (vs. equal in size to the antennal peduncle (see Henderson [1893: Pl.40,1]); 2) longer fingers of the minor cheliped (pereopod I), which are more than 4X longer than palm and about 16–17X longer than wide (vs. 3X longer than palm and about 9X longer than wide); 3) slender major cheliped, which palm about 2.0–2.2X longer than fingers, with feebly marked dorsal shoulder of the propodus (vs. about 1.3X longer, with stout strong shoulder [Henderson,1893: Pl. 40,2]). Although, the minor cheliped of *A. malabaricus* resembles that of our new species in some way, the shape of the palm (propodus) of the large cheliped obviously separates these two taxa. At the same time, Tiwari [1963: fig. 32] described individuals identified as *A. malabaricus* var. *dolichodactylus* from the muddy sand bank of Cửa Bé in Central Vietnam (Beach of Cua-Be, Sandbank), which largely agreed with the Henderson's description [1893] in terms of having the antennular peduncle equal to the antennal one, the palm of the major cheliped about 1.2X longer than the dactylus and fingers of the minor cheliped are about 3X longer than the palm and about 10X longer than wide, without significant gap between them, the dactylus with a strong tooth near the base.

Besides, different individuals also identified *A. malabaricus* were published [Banner, Banner, 1976; Anker, De Grave, 2016; Sha *et al.*, 2019]. There is a significant difference in the proportions of minor and major chelipeds, and, of course, this taxon requires a more detailed re-description and clarification of its taxonomic status. For example, Sha *et al.* [2019] based on the material from the South China Sea (East Sea) illustrated a female of *A. malabarcius* (MBM 158925, 1 ♀, Wenling, Zhejiang, 26 June 1955) (see Sha *et al.* [2019: fig. 2.58]), which has the minor cheliped with fingers about 3.5X longer than the palm, similar to *Alpheus cangiopalus* sp.n. in proportion; the shape of the large cheliped and the telson also resembled the same features of *Alpheus cangiopalus* sp.n. Banner & Banner [1976: fig. 2j] described the minor cheliped of a male of *A. malabaricus* collected in Thailand with the fingers about 4X longer than the palm and 13–14X longer than wide, which also resembling that of the new species described.

Also, the new species can be easily distinguished from the shrimp identified by Anker and De Grave [2016] as *A. malabaricus* from Singapore in: 1) significantly longer and absolutely straight fingers of the minor cheliped (pereopod I), which are more than 4X longer than the palm and about 16–17X longer than wide (vs. 1.5–3X longer than the palm and about 6–9X longer than wide in *A. malabaricus* [Anker, De Grave, 2016: fig. 20]); 2) significantly slender major cheliped, which palm about 2.0–2.2X longer than the fingers (vs. about 1.8X longer [Anker, De Grave, 2016: fig. 20]); as well as 3) a different alive coloration (see Figs 5, 6), in the form of pronounced transverse stripes on the body and uniformly greenish chelipeds (the coloration of "*A. malabaricus*" is presented, for example, by Anker, De Grave [2016: Fig. 20] or MNHN, Chagnoux [2024]). There is some uncertainty about whether the individuals described by Anker, De Grave [2016] belonged to *A. malabaricus* sensu stricto, since they differ significantly from the specimens described by Henderson [1893] and Tiwari [1963], at least with respect to the length of the fingers of the minor cheliped.

Alpheus cangiopalus sp.n. can be separated from *Alpheus dolichodactylus* Ortmann, 1890, which was described from Tokyo Bay [Ortmann, 1890] in the following features: 1) significantly longer and fully straight fingers of the minor cheliped, which are more than 4X longer than the palm and about 16–17X longer than wide (vs. 3X longer than the palm and about 7–8X longer than wide in *A. dolichodactylus* (after Ortmann [1890]; Yamashita *et al.* [2022])); 2) the absence of a gap between compressed together fingers of minor cheliped in ♂♂ (vs. distinctly visible gap present at least in mature ♂♂ (e.g., Ortmann [1890: fig. 11], Maenosono [2022]); 3) the proximal ventral tooth on the finger of the minor cheliped is significantly smaller (see Fig. 4b) (vs. large triangular tooth (after Maenosono [2022])); and 4) significantly slender major cheliped, which palm about 2.0–2.2X longer than the fingers (vs. about 1.5X longer (after Ortmann [1890: fig. 11]; Yamashita *et al.* [2022])). The specimens described by Yang & Anker [2003] as *A. malabaricus* from Korea with a distinct gap between the fingers of the minor cheliped may also belong to *A. dolichodactylus* sensu stricto. The alive coloration of *A. dolichodactylus* was described by Yamashita *et al*. [2020], and it is very similar to that of the new species (see Figs 5, 6). However, the coloration of the chelipeds of *Alpheus cangiopalus* sp.n. is uniformly greenish in contrast to the presence of the distinct spots in *A. dolichodactylus*. According to morphological data, it is very likely that *A. dolichodactylus* appears to be the closest relative (sister species) to the newly described species, differing in the presence of a gap between the fingers of its minor cheliped [Ortmann, 1890; Henderson, 1893], the habitats and the northern distribution (see below).

The new species can be distinguished from *Alpheus dolichodactylus* var. *leptopus* De Man, 1910, which was described from the area around the Lesser Sunda Islands in Indonesia

Fig. 7. Typical habitats in the Cần Giờ Mangrove Biosphere Reserve in South Vietnam, where *Alpheus cangiopalus* sp.n. was collected. The yellow arrows indicate the location of the holes of shrimp burrows, where shrimp specimens were caught. The people in the photo are standing in the soft silty sediments of lagoons, which can sometimes reach above the knee. The photos were taken by Tien Tran Van.

Рис. 7. Типичные биотопы в мангровом биосферном заповеднике Канзе, Южный Вьетнам, где был собран *Alpheus cangiopalus* sp.n. Желтыми стрелками указано расположение выходы нор, где креветки были собраны. Люди на фото находятся в мягких илистых отложениях лагун, иной раз доходящих выше колена. Фотографий Тьен Тран Вана.

[De Man, 1910] in: 1) longer second antennular article, which is about twice longer than the basal article (vs. "*2nd antennular article hardly one and a half or even only one third longer than basal article*" [De Man, 1910]); 2) significantly shorter merus of the minor cheliped, which is about 3.5–4X longer than wide (vs. about 6.2X longer than wide (after De Man [1910])); and 3) different proportions in the articles of pereopod III, with merus about 1.3X shorter than propodus (vs. 1.6X shorter in *A. dolichodactylus* var. *leptopus*), while propodus is relatively shorter, being about 7X longer than wide both in ♂♂ and ♀♀ (vs. about 10–10.9X longer than wide (after De Man [1910])). Unfortunately, the diagnosis of the species, presented by De Man [1910], did not specify the proportions of the palm and fingers, neither for the small nor for the large claws, but only the general proportions. It is likely that the fingers of the small claw were long, but the length of the palm may also be longer than that of *Alpheus cangiopalus* sp.n. According to the description of *A. dolichodactylus* var. *leptopus*, De Man [1910] compared his specimens with the typical form of *A. dolichodactylus*, which has many morphological features in common with the new species (see above) than *A. dolichodactylus* var. *leptopus*. Also, shrimp individuals studied by De Man [1910] were collected from various types of muddy bottoms at the depths of 18–289 m off the coastal area, not in mangrove habitats, which also indirectly indicates that they may be a completely different species.

Alpheus malabaricus trefzae Banner et Banner, 1982 was described from Brammo Bay, Dunk Island, Northern Queensland, Australia [Banner, Banner, 1982], based on ♀♀ without minor chelipeds (pereopod I). At the same time, based on remaining morphological features, carefully described by Banner & Banner [1982], it is possible to distinguish them by 1) the rostrum distinctly exceeding orbital hoods (vs. not exceeding); 2) the major cheliped has the palm about 2.5–3X longer than the fingers (vs. about 1.2X longer); 3) the exopod of the maxilliped with distally expanded tip (vs. without); 4) shorter article I of carpus, which is slightly longer or equal to article II (vs. about 1.3X longer); and 5) longer telson, which is about 2.0–2.2X longer than proximal width (vs. 1.3–1.5X longer than wide). The individuals of *A. malabaricus trefzae* were collected from a burrow under a rock, and Dr. Shirley Trefz (after Banner and Banner [1982]) described the habitat as consisting of a substrate with a mix of sand and mud, not so soft that a person walking would sink into it more than a centimeter or so. At the same time, *Alpheus cangiopalus* sp.n. builts burrows in a deep, about 1 meter, layer of soft mud, where a person would sink more than 50–70 cm into the mud (see Fig. 7).

The new species can be easily distinguished from *Alpheus malabaricus mackayi* Banner, 1959, described from the muddy bottom of a brackish Wailupe fish pond at Oahu, Hawaii [Banner, 1959], in the following features: 1) the rostrum distinctly exceeding the orbital hoods (vs. not exceeding); 2) the major cheliped with the palm about 2.0–2.2X longer than the fingers (vs. about 1.6X longer); 3) the slightly slender telson without expanding distal part; and 4) the significantly longer fingers of the minor cheliped, which are more than 4X longer than the palm and about 16–17X longer than wide (vs. 2.0–2.3X longer than the palm and about 7–8X longer than wide (after Banner [1959]). The specimens described by Banner [1959] were collected from muddy bottom of the fishing pond, and we also studied such habitats in the Can Gio area. At the same time, only specimens of *A.* cf. *euphrosyne* were collected there, while no individuals of *Alpheus cangiopalus* sp.n. were collected from the fishing ponds. We can assume that *Alpheus cangiopalus* sp.n. feeds on small invertebrates that live in the mud at the bottom, which are less abundant in the ponds due to the low oxygen levels. However, on the other hand, *Alpheus* spp with short usual finger of minor cheliped (including *A.* cf. *euphrosyne*) and can survive in these conditions being detritophagous, feeding on plant organic matter and debris (see below).

HABITAT AND ECOLOGY. All collected individuals of the *Alpheus cangiopalus* sp.n. were found in very specific biotopes — shallow areas of the cut parts of mangrove channels (lagoons) located deep in mangrove swamps, approximately 4 km from the coast in a straight line and about 6–7 km when moving along the channel (see Fig. 7). The lagoons were periodically filled with tidal marine water with the average salinity about 26–28‰ (April), and were completely exposed during the maximum low tide. Based on our observations, this new species always lives strictly in heterosexual pairs inside numerous deep, interconnected burrows that that open onto the surface through several nearby exits (holes). Shrimps were never found or observed on the mud surface. No individuals of this species were found in numerous invertebrate burrows located among nearby mangroves roots of *Rhizophora apiculata* Blume, where other alpheid shrimp species have been collected before (e.g., *Alpheus cf. lobidens* De Haan, 1849 and *Alpheus* cf. *euphrosyne* De Man, 1897 with associated *Salmoneus spiridonovi* Marin, 2021 and *Potamalpheops kisi* Marin, 2021 (see Marin [2021a, b])).

The study also conducted intensive trawling in nearby marine area, where this species had not been found. It appears that this species has adapted to living in specific anoxic mud lagoons located within deep mangrove swamps. According to the previous studies in this area, such anoxic swamps are inhabited by a highly specific and specialized fauna (see Marin [2021a, b]; Marin, Kolevatov [2021]; Marin *et al*. [2024a, b]), which differs significantly from the fauna of open-sea mangrove habitats (e.g., Dworschak *et al*. [2006]; Anker, Marin [2009]; Marin [2014]). It is also well known that the diversity of burrowing infauna in the upper mangrove zones of different Indo-Western Pacific regions is significantly depleted, and most of the species living there are highly specialized and genetically well separated [Ng, Sivasothi, 2002; Walters *et al*., 2008; Hossein, Nuruddin, 2016].

The ecological conditions of such lagoons are quite specific, since the burrows of the animals living here are digging in deep dark gray or black swamp mangrove soil with a low aeration and a specific smell of hydrogen sulfide resulting from the activity of anaerobic bacteria that restore sulfur. A species-limited, very specific community consisting of burrowing shrimps *Wolffogebia cangioensis* Kolevatov et Marin, 2022 (Decapoda: Gebiidea: Upogebiidae) with density of 1320±156 ind./m^2 (April) and 635±68 ind./m^2 (September) (see Marin, Kolevatov [2021]), tanaidaceans *Ctenapseudes vuxuankhoi* and *Pseudohalmyrapseudes alexeitiunovi* [Marin *et al.*, 2024a, b] and *Pagurapseudopsis* sp. (Tanaidacea: Parapseudidae), reaching the density values for 1,323±189 ind./m^2, 124±17 ind./m^2 and 49±17 ind./m^2, respectively (April) (totally 1,499±192 ind./m^2 for all tanaidacean species), several species of amphipods (Crustacea: Amphipoda), preliminary identified as *Grandidierella* sp. (Aoridae) (56±27 ind./m^2 (April)), *Victoriopisa cangio* Marin et Palatov, 2022 (Eriopsidae) (36±14 ind./m^2 (April)) (see Marin, Palatov [2022]), and *Melita* sp. (Melitidae) (17±4 ind./m^2 (April)) (about 119±19 ind./m^2 totally for all amphipods) (after Marin *et al.* [2024a, b]); burrowing mangrove-specific stomatopod *Clorida rotundicauda* (Miers, 1880) (Stomatopoda: Squillidae); differing burrowing polychaetas (Polychaeta) and anemones (Hexacoralia). In general, this community is represented by a relatively small number of specialized species (low diversity), most of which have very high numbers here (high density/biomass). A detailed study of the diversity of this community will be presented later (Marin, Kolevatov *et al*., in prep.).

During our work over the past few years since 2019, we have conducted research in different biotopes of the Cần Giờ

Mangrove Biosphere Reserve using a hand pump, fishing net sampling and trawling, both along mangrove channels and at their exits, as well as in the adjacent coastal areas of the Vung Tau Bay down to a depth of 40–50 m. However, the new species, like the other abovementioned animals, was collected only in such cut part of a channel (lagoon).

The nearby coastal area is also characterized by a relatively high level of endemism among Decapoda, as it falls within the area of influence area of the Mekong River. Endemic species described from this area (except for those already mentioned) include, for example, *Thalassina krempfi* Ngoc-Ho et de Saint Laurent, 2009 and *T. cangioensis* Marin, Kolevatov et Nguyen, 2024 (Thalassinidae), *Axianassa ngochoae* Anker, 2010 (Laomediidae), *Palaemon vietnamicus* (Nguyên, 1992), *P. curvirostris* Nguyên, 1992, *P. leucurus* Ashelby, De Grave et Nguyen, 2018 (Palaemonidae) and *Thuylamea camelus* Nguyen, 2001, *Salmoneus spiridonovi* Marin, 2021 and *Potamalpheops kisi* Marin, 2021 (Alpheidae) [Nguyên, 1992, 2001; Anker, 2010; Ashelby *et al.*, 2018; Marin, 2021a, b; Marin *et al.*., 2024].

ISOTOPIC ANALYSIS AND TROPHIC POSITION. The results obtained on stable isotopes ($\delta^{13}C/\delta^{15}N$) analysis indicated that *Alpheus cangiopalus* sp.n. (–25.34±0.62 for $\delta^{13}C$ and 10.72±0.45 for $\delta^{15}N$) belong to the secondary consumers (C2) that obviously feed on particles of animal origin (definitely not plant), such as various small invertebrates living in soft muddy substratum of mangrove swamps, like nematodes, harpacticoids and others. This trophic position is similar to that of some predatory crabs, penaeid shrimps and mysids that also live in the same habitats (Marin, Kolevatov *et al.*, in prep.). However, it differs from other members of the genus *Alpheus* living here, with its usual non-elongated minor cheliped (*Alpheus* sp., probably undescribed species) (–26.17±0.13 for $\delta^{13}C$ and 7.59±0.72 for $\delta^{15}N$), amphipods of the family Aoridae/Photidae and some burrowing polychaetes, which are at a trophic level lower (C1), being definitely primary detritophagous (primary plant and bacterial origin). A detailed study of the trophic structure of this community will be presented later (Marin, Kolevatov *et al.*, in prep.).

In conclusion, we would like to note that the presence of elongated fingers on the minor chelipeds is quite typical for representatives of the genus *Alpheus*, which are often unrelated to each other and inhabit different regions. For example, similar claws have been described in *Alpheus margaritae* Salgado-Barragán, Ayón-Parente et Zamora-Tavares, 2017 from Santa María-La Reforma, coastal lagoon, SE Gulf of California, *Alpheus ulalae* Bracken-Grissom et Felder, 2014 and *Alpheus floridanus* Kingsley, 1878 from Western Atlantic [Bracken-Grissom *et al.*, 2014; Kingsley, 1878], Indo-Pacific *Alpheus brevirostris* (Olivier, 1811) and *Alpheus digitalis* De Haan, 1844 [Anker, De Grave, 2016], as well as unusual *Alpheus kagoshimanus* Hayashi et Nagata, 2000 from Japan [Hayashi, Nagata, 2000], as well as others species. Apparently, species with such a morphology of the minor cheliped are united by their habitat on soft muddy substrates. It is likely that these long fingers are used to capture food particles or filter small invertebrates during feeding (predation). However, this is only a hypothesis, as the biology of these alpheid shrimps has not been extensively studied.

DISTRIBUTION. Presently, the species is known only from the shallow areas of the cut parts of mangrove channels (lagoons) located deep in mangrove swamps of the Cần Giờ Mangrove Biosphere Reserve, Hồ Chí Minh, South Vietnam.

Compliance with ethical standards

CONFLICT OF INTEREST: The authors declare that they have no conflict of interest.

Ethical approval: No ethical issues were raised during our research.

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