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Martensina thailandica gen. et sp. nov. a freshwater ostracod representing a new subfamily of Cyprididae, Martensininae subfam. nov. (Crustacea: Ostracoda) from Thailand

Sukonthip SAVATENALINTON

Department of Biology, Faculty of Science, Mahasarakham University,
Maha Sarakham 44150, Thailand.
Email: sukonthip.s@msu.ac.th

urn:lsid:zoobank.org:author:254994A1-C8E1-4242-ADF8-184661366B2D

Abstract. *Martensina thailandica* gen. et sp. nov., a freshwater ostracod species representing a new subfamily, Martensininae subfam. nov., in the family Cyprididae, is here described from a swamp in Maha Sarakham Province, Thailand. The new genus and species is mainly characterized by the 7-segmented antennula which has a Rome organ and remarkably long aesthetasc ya, the morphology of the sexually dimorphic antenna (A2), the markedly elongated A2 terminal segment, the short and thin α- and β-setae on the mandibular palp, the elongated terminal segment of the maxillula, the obviously 2-segmented male prehensile palp, the presence of d1 and d2 setae on the protopod of the second thoracopod (T2), the sexually dimorphic T2, the distinctive terminal segment of the third thoracopod bearing three long setae, the well-developed caudal ramus, the large hemipenis which has a complex internal structure, and the Zenker organ with funnel-shaped ends and numerous spiny whorls.

Keywords. Taxonomy, biodiversity, new species, new subfamily, microcrustacean.

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Introduction

A total of 2330 species in 270 genera of non-marine ostracods is classified in four superfamilies: Darwinuloidea Brady & Robertson, 1885, Cytheroidea Baird, 1850, Cypridoidea Baird, 1845 and Terrestricytheroidea Schornikov, 1969 (Meisch *et al*. 2019). The classification at the superfamily level is based primarily on patterns of muscle scars and the morphology of soft parts, particularly the three pairs of thoracopods (see Karanovic 2012; A.J. Smith *et al*. 2015; Horne *et al*. 2019). The superfamily Cypridoidea presently composes of four families: Cyprididae Baird, 1845, Candonidae Kaufmann, 1900, Notodromadidae Kaufmann, 1900 and Ilyocyprididae Kaufmann, 1900. Among these, Cyprididae constitutes the most speciose family comprising 43.2% of all species (Meisch *et al*. 2019). The identification to genus or subfamily is simply made if the key characteristics of the genera/subfamily exist in animals. However, some taxa have shared characters of several groups, which could affect their correct taxonomic positions. For example, *Pseudocypretta* Klie, 1932 and *Cyprettadopsis*

Savatenalinton, 2020, members of the Cyprididae, share characters of the Cyprettinae Hartmann, 1971 (e.g., marginal septa) and of the Cypridopsinae Kaufmann, 1900 (e.g., reduced caudal ramus) (see Ma & Yu 2020; Savatenalinton 2020a). Detailed examination, and perhaps together with molecular work, could solve these types of taxonomic problems and more accurate allocations could occur, such as in the case of *Bennelongia* De Deckker & McKenzie, 1981 and *Neocypridella* Vávra, 1895. *Bennelongia* was originally placed as a genus in the subfamily Cypridinae Baird, 1845 and subsequently raised to the subfamily rank, Bennelongiinae Martens, Halse & Schön, 2012 (see Martens *et al*. 2012). *Neocypridella*, previously a member of Cypricercinae McKenzie, 1971, was recently reexamined and allocated to a new rank, subfamily Neocypridellinae Savatenalinton, 2022 (see Savatenalinton 2022a). Another example is the case of the enigmatic *Indiacypris* Hartmann, 1964, which combines characteristics of several groups. It thus was placed in several families, namely Cyprididae, Candonidae and Notodromadidae, but it is presently a member of Ilyocyprididae (see George & Martens 2004). In Thailand, all four families of the Cypridoidea have been reported and the most diverse group is the Cyprididae comprising 50 taxa (Savatenalinton & Suttajit 2016). In the last five years, new taxa, at both generic and specific levels, have been continuously reported from Thailand (e.g., Savatenalinton 2020a, 2020b, 2021a, 2021b, 2022b). This reflects the high ostracod diversity in this region and further discoveries of new taxa are also possible. The present work deals with a new subfamily, new genus and new species of Thai ostracod, which resembles several representatives of cypridoidean families.

Material and methods

Samples were taken from Nong Bua swamp, Kantharawihai District, Maha Sarakham Province on 22 October 2021 and 22 January 2022. Ostracods were collected with a hand net (mesh size 200 µm), preserved in 70% ethanol and then specimens were sorted using a binocular microscope in the laboratory. Soft parts and valves were separated under a stereo microscope (Olympus SZ40) and subsequently soft parts were dissected in glycerine, sealed on glass slides and valves were stored dry in micropalaeontological slides. The drawings of soft parts were made with the aid of a camera lucida, attached to a compound lens microscope. Valves were examined and illustrated using a Scanning Electron Microscope (JEOL JSM6460LV – at the Faculty of Science, Mahasarakham University, Thailand). The model of limbs chaetotaxy proposed by Broodbakker & Danielopol (1982) is followed, together with the revised version for the second antenna and for the thoracopods proposed by Martens (1987) and Meisch (2000), respectively. All type materials of species are deposited in the ostracod collection of the Faculty of Science, Mahasarakham University, Maha Sarakham, Thailand.

Studied site

The sampled locality, Nong Bua, is a large natural swamp of the Kantharawichai District. It has an area of 3.2 km^2 and is situated close to a community forest. The swamp is a permanent water body although the water level considerably decreases in summer, especially in March and April. At present, the local community has expanded reaching some parts of the swamp and modifications have been made, e.g., a wooden bridge as a check-in point for tourists and a park. However, some other parts are difficult to reach. The swamp is used as a water source for local agriculture, fisheries, cultural activities and consumption. It is also a habitat of water birds, especially ducks, which are a dominant group. They can be seen throughout the year, but are more abundant in the cool season (November and December) in which migratory birds inhabit. The name 'Nong Bua' means swamp of lotus, which is a dominant aquatic plant in the swamp. Most of the swamp is covered by aquatic plants, and vegetation is different between various parts of the water body. Some parts are full with reeds.

Abbreviation used in text and figures

A1 = first antenna
A2 = second antenna

Cp = carapace
CR = caudal ramus
H = height of valves
Hp = hemipenis
L = length of valves
ls = lateral shield of hemipenis
LV = left valve
Md = mandibular
ms = medial shield of hemipenis
Mx1 = maxillula
R = Rome organ
RV = right valve
T1 = first thoracopod (maxilliped)
T2 = second thoracopod (walking leg)
T3 = third thoracopod (cleaning leg)
W = width

Repositories

MSU = Mahasarakham University, Maha Sarakham, Thailand
MSU-ZOC = ostracod collection of Faculty of Science, Mahasarakham University, Maha Sarakham, Thailand

Results

Taxonomic descriptions

Class Ostracoda Latreille, 1802
Subclass Podocopa G.O. Sars, 1866
Order Podocopida G.O. Sars, 1866
Suborder Cypridocopina Jones, 1901
Superfamily Cypridoidea Baird, 1845
Family Cyprididae Baird, 1845

Subfamily **Martensininae** subfam. nov.

Type genus

Martensina gen. nov. (here designated).

Diagnosis

Largely as for the genus. For differential diagnosis: see discussion.

Genera included

Martensina (monogeneric subfamily).

Genus ***Martensina*** gen. nov.
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Type species

Martensina thailandica gen. et sp. nov. (here designated).

Diagnosis

Cp large (length ca 1.5 mm). Rome organ on A1 present, A1 7-segmented, terminal segment very elongated. A2 natatory setae well developed, A2 sexually dimorphic with setae and claws on penultimate and terminal segments modified in male. Md-palp with very elongated penultimate segment. Mx1-palp with elongated terminal segment. Prehensile palp of T1 in males 2-segmented and asymmetrical between left and right palps, T2 basal segment with d1 and d2 setae, penultimate segment divided, h2 claw sexually dimorphic with robust apical spinules in male. T3 distinctively 4-segmented, terminal segment with three long setae, g seta absent, basal segment with d1 and dp setae (d2 seta absent). CR well developed with Sp seta situated close to Gp claw, CR attachment well-developed with two distal branches. ms and ls large with widely rounded distal margins. Zenker organ with numerous spiny whorls and funnel-shaped at both ends.

Etymology

The genus is named in honor of Prof. Dr Koen Martens (The Royal Belgian Institute of Natural Sciences, RBINS) for his outstanding work on taxonomy of non-marine Ostracoda.

Remarks

Martensina gen. nov. is chiefly characterized by the absence of marginal septa, the presence of a Rome organ, the 2-segmented prehensile palps, the presence of d1 and d2 setae on the T2, the sexually dimorphic T2, the distinctive T3 terminal segment bearing three long setae, the well-developed CR on which the claw-like Sp seta inserts close to the Gp claw, the internal reticulated structure of the hemipenis and the funnel-shaped ends and numerous spiny whorls of the Zenker organ. The combination of these features has not yet been reported in any other genus of the Cyprididae.

Species included

Martensina thailandica gen. et sp. nov. (monospecific genus).

Distribution

Thailand (present study).

Martensina thailandica gen. et sp. nov.

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Figs 1–8

Diagnosis

Cp large (ca 1.5 mm length), Cp in lateral view rounded with greatest height situated at mid-length, anterior and posterior margins strongly curved to dorsal margin, Cp in dorsal view narrow with greatest width ca mid-length. A1 7-segmented, terminal segment very elongated, aesthetasc ya extraordinary long (reaching tip of long seta), Rome organ present, Wouters organ not seen. A2 natatory setae long, terminal segment markedly long (length ca five times of width), male A2 with markedly short Gm claw. Md-palp with elongated penultimate segment, terminal segment with two claws and one seta, α- and β-setae short and slim. Terminal segment of Mx1-palp elongated with one large claw and four slender setae, two large bristles on 3rd endite smooth. Prehensile palps 2-segmented, right palp with large, subtriangular terminal segment, terminal segment of left palp strongly hook-like and with pointed projection on outer margin. T2 basal segment with d1 and d2 setae, d1 seta very long (ca two times as long as d2 seta), penultimate segment divided, h2 claw with robust apical spinules in male. T3 terminal segment distinctly separated with three long setae, d1 and dp setae present (d2 seta absent). CR well developed with short Sa seta, Sp seta short and claw-like situated close to Gp claw. Hp with large ms and ls, distal margins widely rounded, and with reticulated structure on outer part of main lobe. Zenker organ with 23 spiny whorls and funnel-shaped at both ends.

Differential diagnosis

As *Martensina* gen. nov. is presently monospecific, the differential diagnosis is the same for the genus.

Etymology

The species is named after Thailand, where the new species was discovered.

Type material

Holotype

THAILAND – **Maha Sarakham Province** • ♂ (soft parts dissected in glycerine on a sealed glass slide and valves stored dry in a micropalaeontological slide); Nong Bua (swamp), Kantharawichai District; 16.320841º N, 103.296405º E; 22 Oct. 2021; MSU-ZOC.317.

Allotype

THAILAND – **Maha Sarakham Province** • ♀ (stored as the holotype); same collection data as for holotype; MSU-ZOC.318.

Paratypes

THAILAND – **Maha Sarakham Province** • 5 ♂♂ (stored as the holotype), 4 ♂♂ (carapaces stored dry in micropalaeontological slides); same collection data as for holotype; MSU-ZOC.319 to ZOC.327 • 5 ♀♀ (stored as the holotype), 3 ♀♀ (carapaces stored dry in micropalaeontological slides); same collection data as for holotype; MSU-ZOC.328 to ZOC.335.

Type locality

A total of 28 female and 20 male specimens were collected at the type locality on 22 Oct. 2021. Accompanying ostracod fauna: *Bradleystrandesia weberi* (Moniez, 1892), *Cypretta aculeata* Savatenalinton, 2018, *Dentocypria mesquitai* Savatenalinton, 2017, *Dentocypria chantaranothaii* Savatenalinton, 2017, *Fabaeformiscandona subacuta* (Yang, 1982), *Pseudocypretta maculata* Klie, 1932, *Pseudostrandesia mamarilorum* (Victor & Fernando, 1981), *Pseudostrandesia striatoreticulata* (Klie, 1932), *Pseudostrandesia* cf. *calapanensis*, *Stenocypris* sp., *Strandesia kraepelini* (Müller, 1906), *Thaicypridopsis longispinosa* Savatenalinton, 2018, *Vestalenula* sp.

Repository

The type specimens are deposited in the ostracod collection in the Faculty of Science, MSU (Maha Sarakham, Thailand).

Description

Male

Measurements (in µm). Male. Cp (n = 5), L = 1335–1413, H = 787–813, W = 523; LV (n = 1), L = 1387, H = 845; RV (n = 1), L = 1394, H = 839.

Cp. In dorsal view (Fig. 1A) elongated, greatest width situated at mid length, RV slightly overlapping LV anteriorly, anterior extremity slightly compressed, posterior extremity narrowly rounded, hinge adont. Cp in ventral view (Fig. 1B): LV overlapping RV ventrally. Cp in lateral view (Fig. 1C–D) subglobular (length ca 1.4 mm), greatest height situated at mid length, dorsal margin strongly arched, ventral margin sinuated at mid length, anterior and posterior margins widely rounded. Valve surface (Fig. 1E) scattered with shallow pits and rimmed-pore setae. No pigmentation on valve surface.

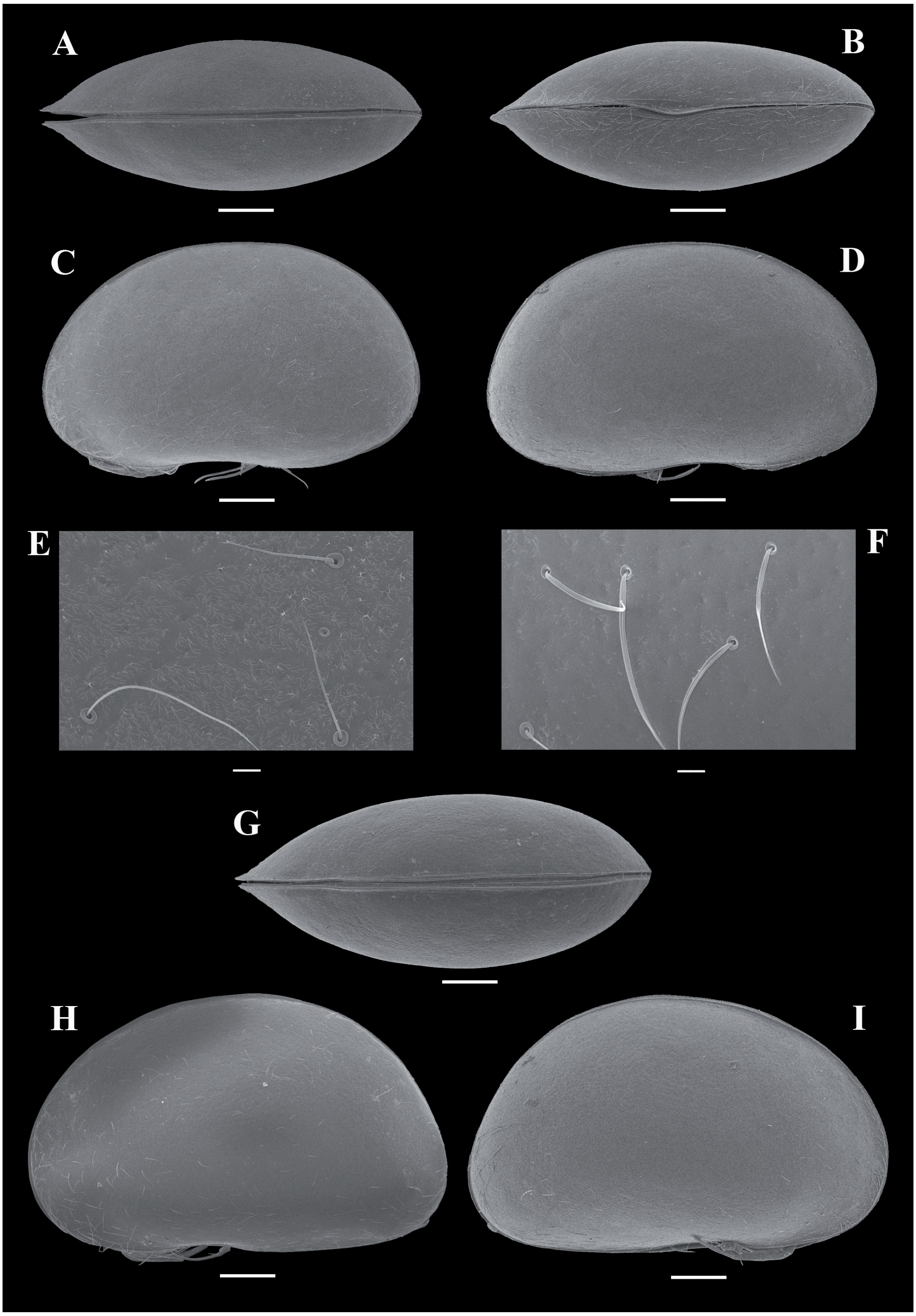

Fig. 1. *Martensina thailandica* gen. et sp. nov., paratypes. **A–E**. Males. **F–I**. Females. **A**. Cp, dorsal view (MSU-ZOC.321). **B**. Cp, ventral view (MSU-ZOC.324). **C**. Cp, left lateral view (MSU-ZOC.322). **D**. Cp, right lateral view (ditto). **E**. Cp, left lateral view, valve surface (ditto). **F**. Cp, left lateral view, valve surface (MSU-ZOC.330). **G**. Cp, dorsal view (MSU-ZOC.329). **H**. Cp, left lateral view (MSU-ZOC.330). **I**. Cp, right lateral view (ditto). Scale bars: A–D, G–I = 200 µm; E–F = 10 µm.

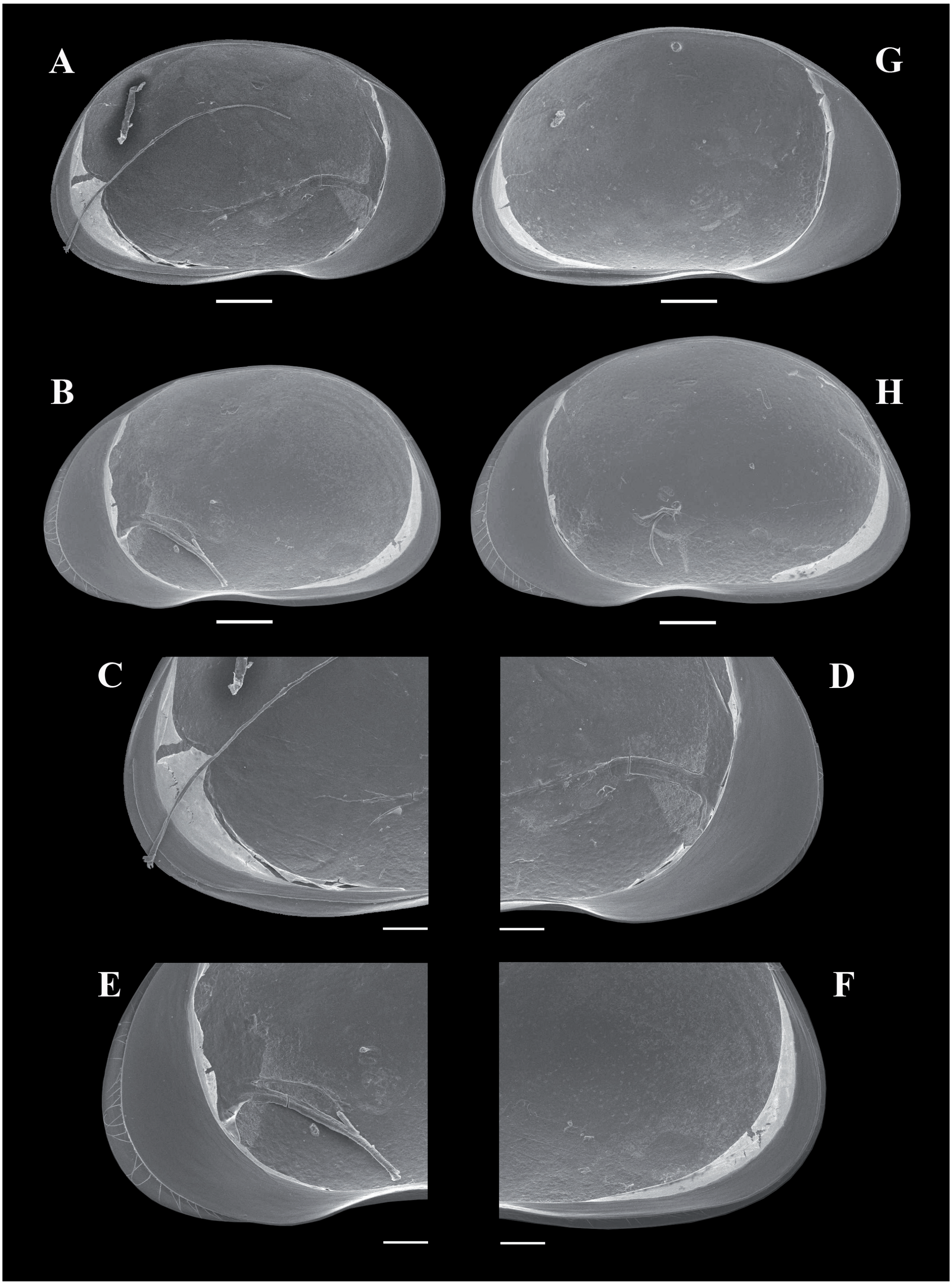

Fig. 2. *Martensina thailandica* gen. et sp. nov. **A–F**. Paratype, ♂ (MSU-ZOC.319). **G–H**. Allotype, ♀ (MSU-ZOC.318). **A**. LV, internal view. **B**. RV, internal view. **C**. LV, internal view, posterior part. **D**. LV, internal view, anterior part. **E**. RV, internal view, anterior part. **F**. RV, internal view, posterior part. **G**. LV, internal view. **H**. RV, internal view. Scale bars: A–B, G–H = 200 μm; C–F = 100 μm.

LV. In internal view (Fig. 2A, C–D) with both valve margins rounded, slightly wider rounded posteriorly, dorsal margin strongly arched, ventral margin sinuate in front of mid length, marginal selvage anteriorly and posteriorly, anterior calcified inner lamella wide without inner list, posterior calcified inner lamella narrow without inner list. Muscle scars comprising two mandibular muscle scars and a group of adductor muscle scars. The latter group not tightly arranged.

RV. In internal view (Fig. 2B, E–F) with both valve margins rounded, slightly wider rounded posteriorly, dorsal margin strongly arched, ventral margin sinuate, submarginal selvage anteriorly, marginal pore canals present anteriorly, calcified inner lamella wide anteriorly, narrow posteriorly, without anterior and posterior inner lists.

A1 (Fig. 4A). Seven-segmented, first segment with one long dorso-subapical seta (reaching tip of next segment), two long ventro-apical setae, Wouters organ not seen. Second segment ca 1.5 times as wide as long, with one very short dorso-apical seta (ca ¼ of next segment) and small Rome organ. Third segment bearing two setae: one short dorso-apical (reaching mid-length of next segment) and one short ventro-apical setae (reaching mid-length of next segment). Fourth segment with two long dorsal setae and two shorter ventral setae (shortest one reaching beyond mid-length of next segment). Fifth segment dorsally with two long setae, ventrally with two (one long, one shorter) setae, shorter one reaching beyond tip of next segment. Penultimate segment with four long apical setae. Terminal segment with three (two long, one short) apical setae and remarkably long aesthetasc ya, short seta ca half as long as long seta, length of aesthetasc ya almost same as that of long seta).

A2 (Fig. 4B). Basal segment with two proximal setae and one long ventro-apical seta. Exopodite with three (one longer, two short) setae, longer one not reaching half of first endopodal segment. First endopodal segment with five long natatory setae (reaching tips of terminal claws) and one short accompanying seta (length ca ¼ that of penultimate segment), aesthetasc Y short and thin, situated at ca ⅓ of its segment length, ventro-apical seta long, extending far beyond tip of penultimate segment. Penultimate segment undivided, distally with claw-like z1 and z2 setae (almost same length), z3 seta long, reduced claw G1 and G2 and with claw G3 considerably reduced to thin setae, claw G1 and G2 with stronger teeth than other claws, aesthetasc y2 long (almost reaching mid-length of terminal segment); this segment medially with two subequally short dorsal setae, four ventral setae of unequal length (t1–4) and small y1. Terminal segment markedly elongated, distally with two serrated claws (GM and Gm), claw Gm considerably reduced (length of Gm ca half of that of GM), markedly long aesthetasc y3 (almost reaching tip of claw GM) and accompanying seta (reaching mid-length of aesthetasc y3), g-seta not seen.

MD-COXA (Fig. 5A). Elongated, distally with rows of teeth and small setae, and with one long, slender dorso-subapical seta.

MD-PALP (Fig. 5B–B’). First segment with two setae (S1 and S2), one long and slender seta, and α-seta, the latter smooth and very short. Second segment dorsally with three unequal long apical setae, shortest seta reaching mid-length of next segment; ventrally with group of three long setae, one shorter seta and smooth, short and thin β-seta. Penultimate segment bearing three groups of setae: dorsally with group of four unequal, long, subapical setae; laterally with thin, long apical γ-seta (ca 2 times as long as terminal segment) and three further apical setae subequal in length (ca 1.7 times as long as terminal segment); ventrally with two subapical setae, one long (length ca two times that of terminal segment), one short (reaching slightly tip its segment). Terminal segment bearing two large claws and one seta, length of terminal claws ca 2.2 times that of terminal segment. All setae on Md-palp set with tiny setules.

RAKE-LIKE ORGAN. Stout, T-shape with eight blunt teeth.

Mx1 (Fig. 5C). With two-segmented palp, basal segment of palp dorsally with group of four long, unequal apical setae; terminal segment elongated, apically with one claw and four setae. Two large bristles (Zahnborsten) on third endite smooth. Two sideways-directed bristles on first endite long, subequal in length. Respiratory plate large, semicircular shape comprising six reflexed setae on anterior margin and a number of long, setulous setae along posterior and ventral margins.

T1 (Fig. 6A–C). Protopodite with two a-setae, subequal in length and long b-and short d-setae, c-seta absent; distally with nine hirsute apical setae of unequal length and five subapical setae. Endopodite large and very elongated, 2-segmented, forming asymmetrical prehensile palps, right palp (Fig. 6A) with one subapical spine and apical protrusion on basal segment, terminal segment subtriangular; left palp (Fig. 6B) with one subapical spine and blunt-tip apical protrusion on basal segment, terminal segment strongly hook-like with small pointed projection on outer margin of hook corner. Respiratory plate with six hirsute setae.

T2 (Fig. 6E). On first segment with d1 and d2 setae long, subequal in length. Second segment with long e-seta (reaching beyond mid-length of penultimate segment). Penultimate segment divided, medially with f-seta (reaching beyond tip of terminal segment), distally with apical short g-seta and one very short

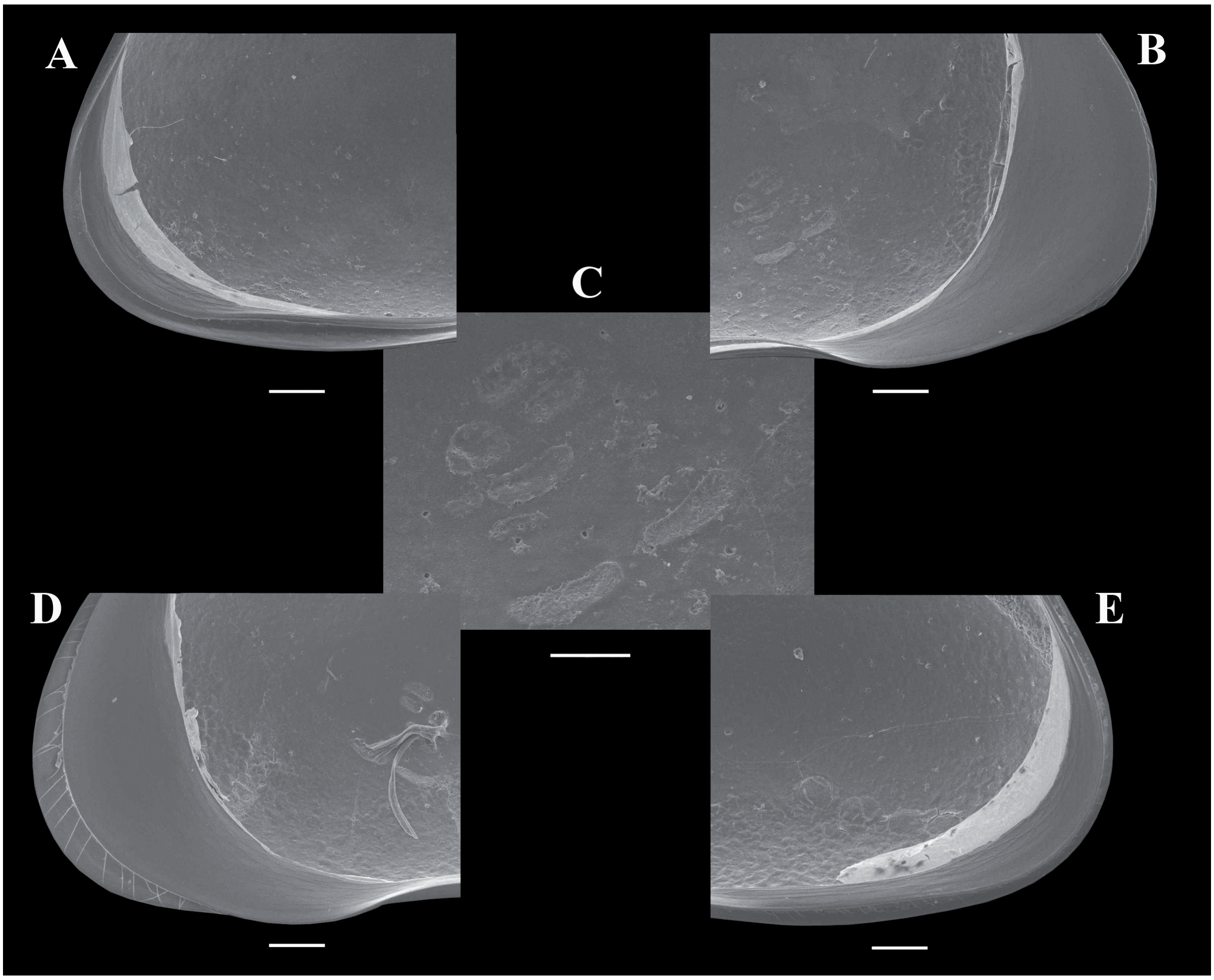

Fig. 3. *Martensina thailandica* gen. et sp. nov., allotype, ♀ (MSU-ZOC.318). **A**. LV, internal view, posterior part. **B**. LV, internal view, anterior part. **C**. LV, internal view, muscle scars. **D**. RV, internal view, anterior part. **E**. RV, internal view, posterior part. Scale bars: A–B, D–E = 100 µm; C = 50 µm.

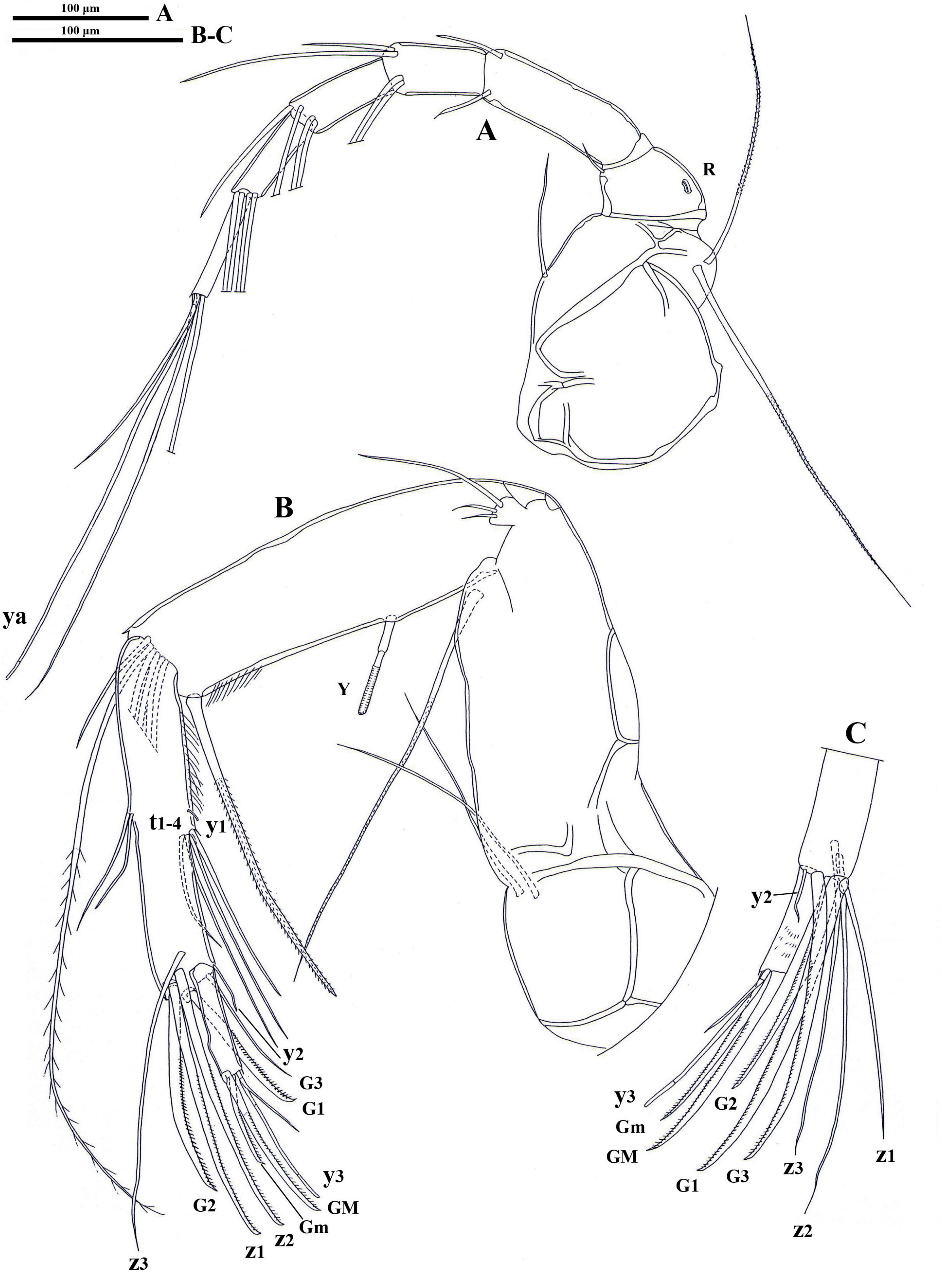

Fig. 4. *Martensina thailandica* gen. et sp. nov. **A**–**B**. Holotype, ♂ (MSU-ZOC.317). **C**. Allotype, ♀ (MSU-ZOC.318). **A**. A1. **B**. A2. **C**. A2, last two segments. Scale bars = 100 µm.

accompanying seta (length ca ⅓ that of g-seta). Terminal segment with two (one dorsally, one ventrally) short apical h1 and h3 setae and serrated claw (h2), distal part of h2 with strong spine-like setules.

T3 (Fig. 7A). First segment with d1 and dp setae subequal in length (d2 seta absent). Second segment with long apical e-seta (reaching tip of next segment). Third segment with f-seta (almost reaching tip of segment), g-seta absent. Terminal segment without pincer organ and bearing three long setae (h1–h3 setae), all subequal in length.

CR (Fig. 7C). Symmetrical with well-developed claws and setae, claw Ga long (length ca half of that of ramus), claw Ga long (ca half length of ramus), claw Gp short (ca half length of claw Ga), Sa seta very short (ca ¼ of claw Gp), Sp seta short and robust (claw-like) (reaching tip of ramus). CR attachment (Fig. 7B) thin with two branches distally.

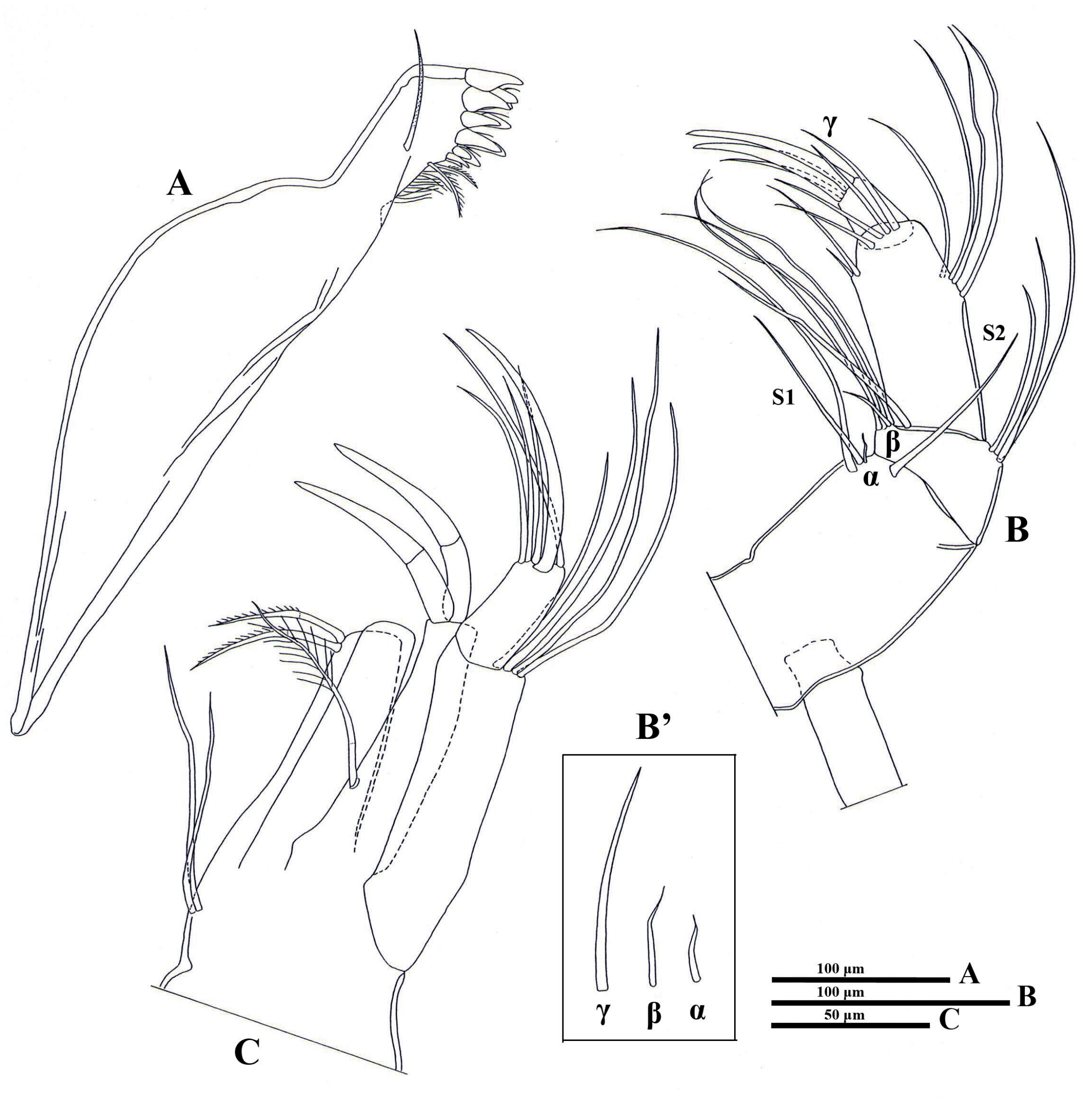

Fig. 5. *Martensina thailandica* gen. et sp. nov., holotype, ♂ (MSU-ZOC.317). **A**. Md-coxa. **B**. Md-palp. **B'**. Md-palp, α, β, γ setae. **C**. Mx1. Scale bars: A–B = 100 µm; C = 50 µm.

Hp (Fig. 7D). With ms and ls large, widely rounded distal margins (lateral shield wider), without protrusion and with strong muscles; proximal part of ms with reticulated structure on outer margin; postlabyrinthal spermiduct curved, copulatory process with pointed tip. Zenker organ (Fig. 7E) elongated and set with 23 spiny whorls, proximal and distal ends funnel shaped.

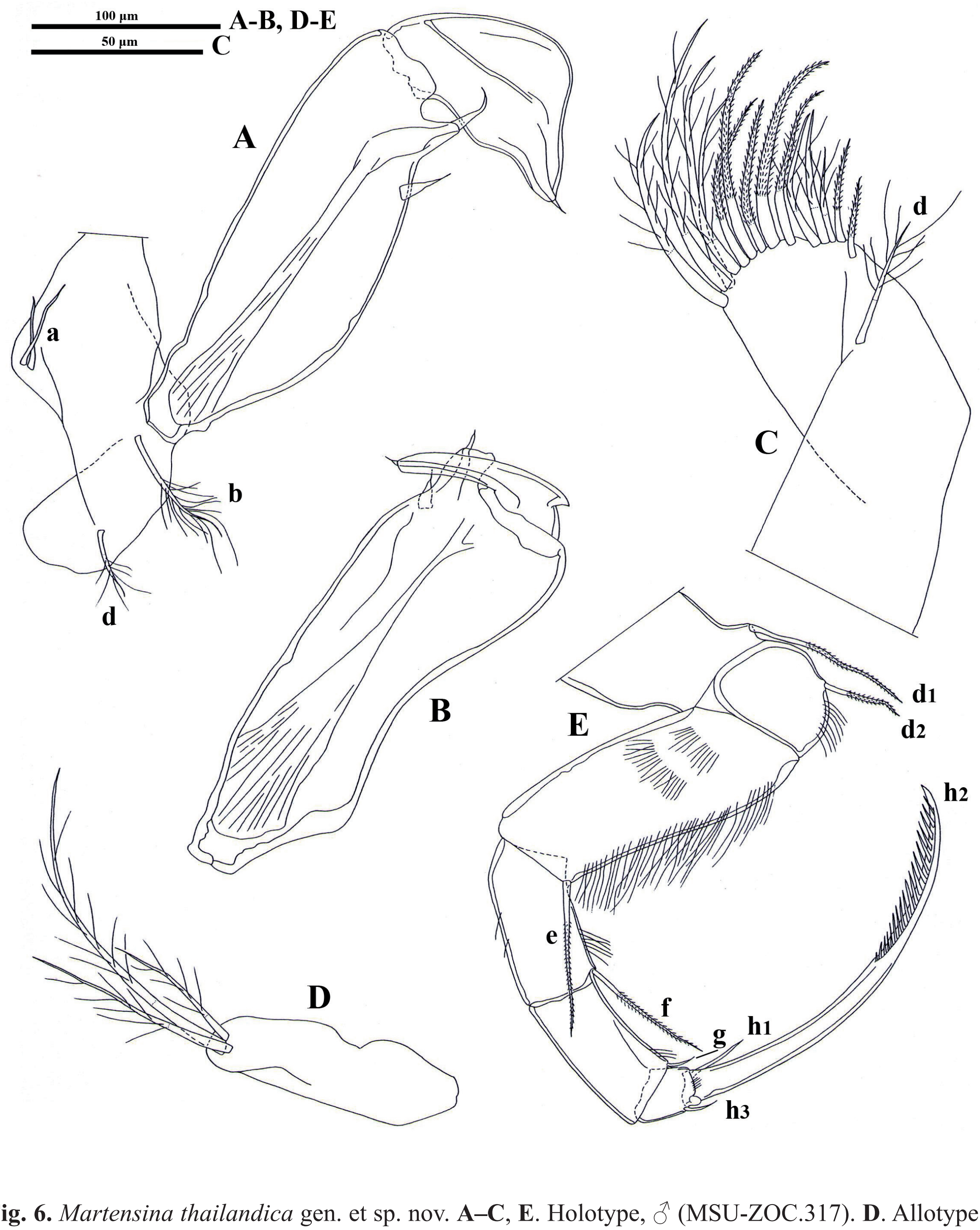

Fig. 6. *Martensina thailandica* gen. et sp. nov. **A–C**, **E**. Holotype, ♂ (MSU-ZOC.317). **D**. Allotype, ♀ (MSU-ZOC.318). **A**. Right T1. **B**. T1, left prehensile palp. **C**. T1 protopodite. **D**. T1 endopodite. **E**. T2. Scale bars: A–B, D–E = 100 µm; C = 50 µm.

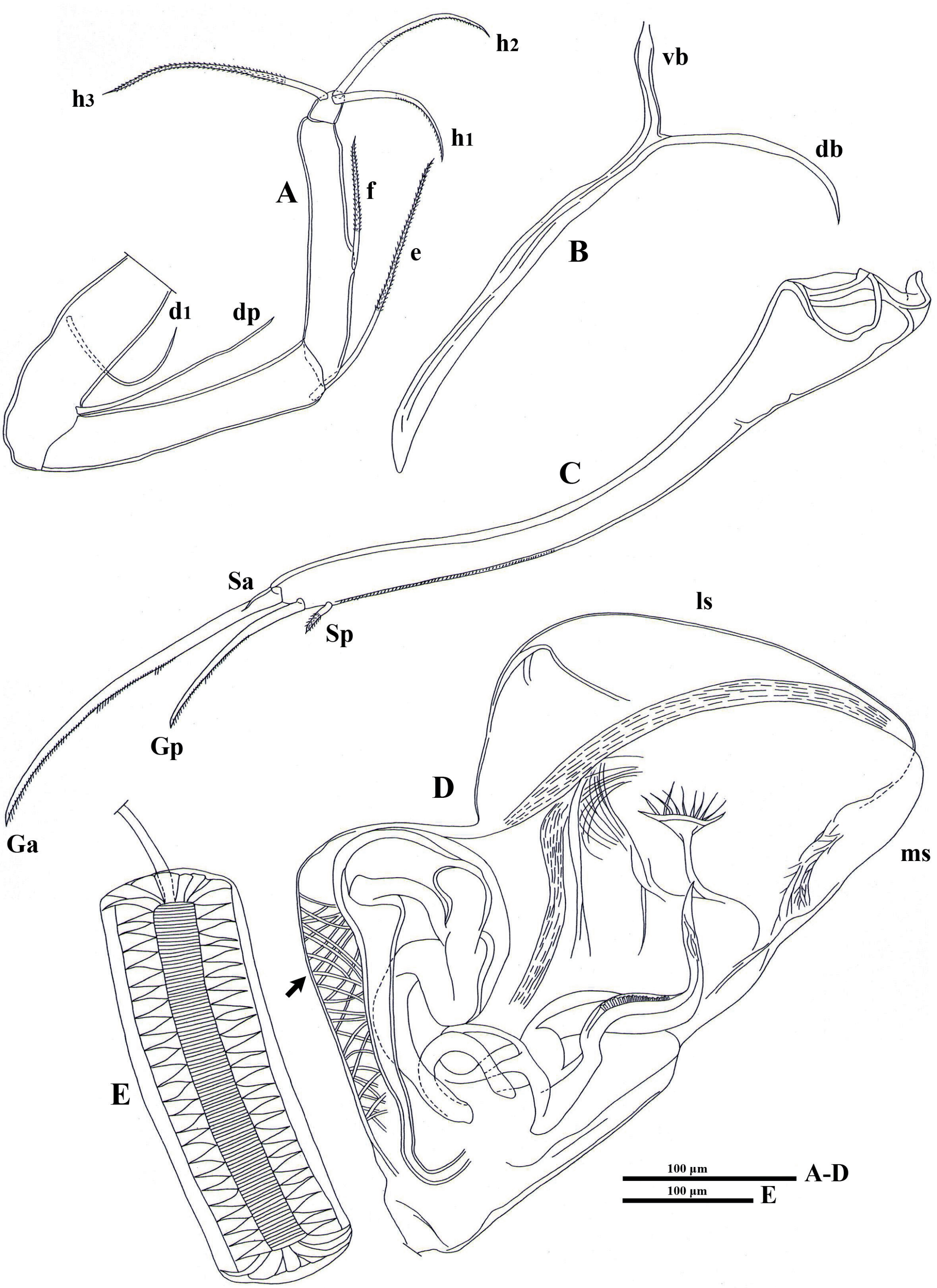

Fig. 7. *Martensina thailandica* gen. et sp. nov. **A–B, D**. Holotype, ♂ (MSU-ZOC.317). **C, E**. Paratype, ♂ (MSU-ZOC.319). **A**. T3. **B**. CR attachment. **C**. CR. **D**. Hemipenis. **E**. Zenker organ. Arrow indicates reticulated structure. Scale bars = 100 µm.

Female

Measurements (in µm). Cp (n = 4), L = 1374–1497, H = 871–903, W = 613; LV (n = 1), L = 1510, H = 890; RV (n = 1), L = 1542, H = 923.

Carapace and valves as in male, although somewhat bigger (length ca 1.5 mm) (Figs 1F–I, 2G–H, 3). All limbs as in male, except for last two segments of A2, T1, and T2. Penultimate segment of A2 (Fig. 4C) with two large, serrated claws G1 and G3, claw G2 shorter and slenderer than claws G1 and G3, z1–z3 long, z1 and z3 subequal in length (almost reaching tip of claw G3). Terminal segment with large, serrated claws GM and Gm (length of claw Gm ca 5/6 that of claw GM), aesthetasc y3 markedly long

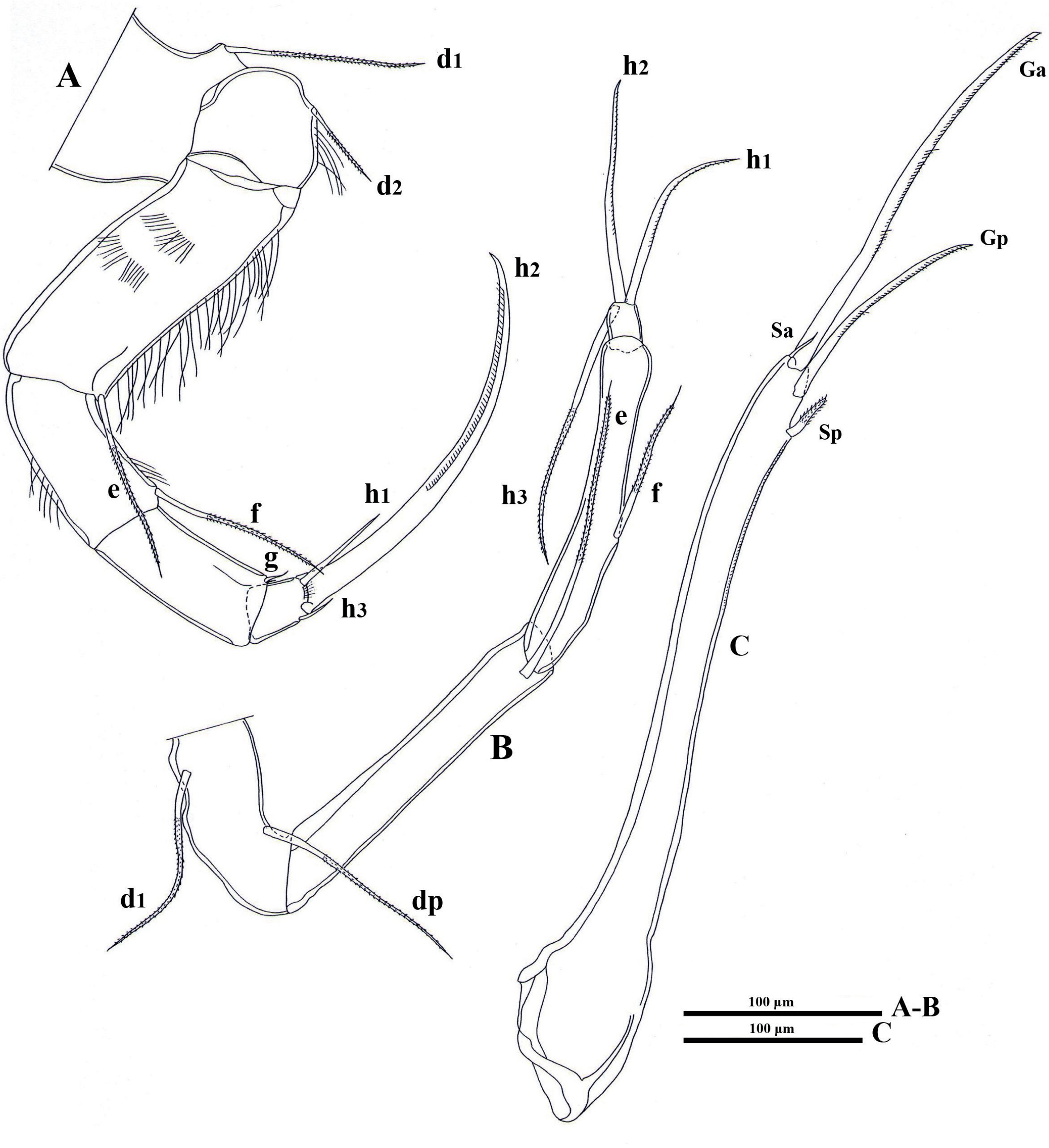

Fig. 8. *Martensina thailandica* gen. et sp. nov., allotype, ♀ (MSU-ZOC.318). **A**. T2. **B**. T3. **C**. CR. Scale bars = 100 µm.

(reaching slightly beyond tip of claw Gm), and accompanying seta (reaching mid-length of aesthetasc y3), g-seta not seen. T1-endopodites (Fig. 6D) elongated, weakly built palp with three (one long, two shorter) apical setae, long one ca two times as long as short one. T2 (Fig. 8A) same as in male, except for distal part of claw h2 being serrated, without strong spine-like setules. T3 (Fig. 8B) same as in male, except for tips of e and f setae being more pointed. CR (Fig. 8C) same as in male, except for slightly shorter ramus. Genital lobe rounded, without any extension.

Ecology

The new taxon was collected from the sediment surface in the littoral zone of the swamp, close to the village. The sampling site was densely covered by a number of aquatic plants, particularly lotus. The sediment was largely composed of organic matter, especially dead plant material.

Discussion

Taxonomic position of *Martensina* gen. nov.

At first glance, the appearance of the new genus and species is similar to that of members of *Candona* Baird, 1845 (subfamily Candoninae Kaufmann, 1900 of the Candonidae) and *Mnementh* Martens, 2007 (subfamily Cypridinae of the Cyprididae). However, a detailed examination on both valves and soft parts revealed that this Thai taxon shares characters of several families of Cypridoidea. The morphology of *Martensina* gen. nov. is enigmatic. The main characters are the 7-segmented A1, which has a Rome organ and a remarkably long aesthetasc ya, the sexually dimorphic A2, the markedly elongated A2 terminal segment, the elongated terminal segment of the Mx1-palp, the obviously 2-segmented male prehensile palps, the presence of d1 and d2 setae on the T2, the distinctive T3 terminal segment with three long setae, the well-developed CR, the large Hp which has an internal reticulated structure, and the Zenker organ with funnel-shaped ends and numerous spiny whorls.

The pattern of muscle scars is a primary distinguishing character used at the superfamily and family levels of the Cypridoidea. This pattern in *Martensina* gen. nov. is more similar to that of the Cyprididae than of other Cypridoidea families. It composes of two mandibular muscle scars and a group of adductor muscle scars. The latter group is not tightly arranged, which makes it different from that of Candonidae representatives (see Meisch 2000; A.J. Smith *et al*. 2015; Horne *et al*. 2019) and thus strengthen the position of a new genus in the Cyprididae.

The A1 bears some diagnostic structures, such as a Rome organ, which are used for distinguishing family and subfamily levels. A Rome organ is always absent in the Candoninae (e.g., Karanovic 2007, 2012; Smith & Janz 2008; Smith & Kamiya 2015) and Ilyocypridinae Kaufmann, 1900 (e.g., Smith *et al*. 2011, 2019), while it is present in the Cyclocypridinae Kaufmann, 1900 (e.g., Smith & Janz 2008; Karanovic 2012; Smith & Kamiya 2015; Savatenalinton 2017) and commonly exists with different degrees of size between taxa of the Cyprididae. It can be large as seen in, for example, *Ilyodromus* Sars, 1894 (see Shearn *et al*. 2014) or very small as in the cases of, for example, *Herpetocypris* Brady & Norman, 1889, *Humphcypris* Martens, 1997, *Thaicypris* Savatenalinton, 2022 (see Gonzalez Mozo *et al*. 1996; Martens 1997, 2001; Savatenalinton 2022b). This organ is small in the new genus.

In freshwater ostracods, the A2 is usually sexually dimorphic, with modifications occurring in the distal claws and setae on the last two segments. An exception occurs in some groups in which the t-setae are also modified in some genera of Candonidae (e.g., *Fabaeformiscandona* Krstić, 1972, *Keysercypria* Karanovic, 2011, *Physocypria* Vávra, 1897 and *Dentocypria* Savatenalinton, 2017 – Smith & Janz 2008; Karanovic 2011; Savatenalinton 2017). The segmentation of the penultimate segment also shows sexual dimorphism (divided in male, undivided in female) in some Candonidae genera, such as *Cypria* Zenker, 1854, *Cyclocypris* Brady & Norman, 1889, *Dentocypria*, *Fabaeformiscandona*, *Keysercypria*, *Undulacandona* Smith, 2011 and some representatives of *Pseudocandona* Kaufmann, 1900 (see Meisch 2000; Külköylüoğlu 2008; Smith & Janz 2008; Karanovic 2011; Smith & Kamiya 2015; R.J. Smith *et al*. 2015; Savatenalinton 2017), whereas in other families, no such segmentation occurs. In *Martensina* gen. nov., the t-setae and the segmentation of the penultimate segment are not sexually dimorphic and thus is unlike the Candonidae.

The morphology of the Md palp of *Martensina* gen. nov. is exceptional. The length of the third segment is about three times that of the second segment and the insertion of the respiratory plate is very far from the distal margin of its segment. Also, all setae are set with tiny setules and no large setules are seen. Therefore, when observed under low magnification, the setae seem to be smooth. Additionally, the remarkably slender and short β seta is very unlike that of the Cyprididae, which commonly has a dome-shaped and plumose β seta. Most cypridoidean members have large and long S1 and S2 setae on the Md-palp, but in *Martensina*, they are thin, short and lack large setules. Such an aspect is a rare character. A similar feature has been seen in *Hungarocypris* Vávra, 1906, a genus in Cyprididae, in which these S-setae are slender (without large setules) and intermediate in length (see Victor & Fernando 1981a; Savatenalinton & Suttajit 2016).

The presence of d1 and d2 setae on the T2 is an important character and used for discrimination in several taxonomic categories. These d-setae are variable in Candonidae members. They are absent or only one seta (d1 or d2) is present in the Candoninae, while in the Cyclocypridinae, d-setae are absent or only d1 is present (Karanovic 2011, 2012; Savatenalinton 2017a). Among the Candonidae, both setae are recognized only in the subfamily Paracypridinae Sars, 1923. Given the fact that only the d1 seta is present in the Cyproidinae Hartmann, 1963, only d2 seta exists in the Oncocypridinae De Deckker, 1979 (e.g., Savatenalinton 2015) and both d-setae are absent in Notodromadinae Kaufmann, 1900 (e.g., George & Martens 2003; Smith & Kamiya 2014), no representatives of the Notodromadidae have both d-setae. In the Ilyocyprididae, only d1 seta is present in *Ilyocypris* Brady & Norman, 1889 while the presence of d1 and d2 setae is a characteristic of *Indiacypris* (see George & Martens 2004). Both d-setae are commonly seen in Cyprididae subfamilies (such as Cyprettinae, Cypricercinae, Cypridinae, Cyprinotinae Bronstein, 1947, Eucypridinae Bronstein, 1947 and Herpetocypridinae Kaufmann, 1900), but exceptions occur in some members, such as Cypridopsinae, in which one seta (d1 or d2 setae) is found. Thus, the evidence on d-setae on the T2 seems to keep the new genus closer to the Cyprididae than other families. Nonetheless, the T2 is sexually dimorphic in *Martensina* gen. nov. which is different from most genera of the Cyprididae, but it has been seen in a cypridid member (*Cyprinotus cassidula* Smith & Chang, 2020), and *Gurayacypris* Battish, 1987, a monospecific genus in the family Notodromadidae (see discussion below).

Based only on the morphology of the T3, the new Thai taxon seems close to the Candonidae as the distinctive terminal segment with three setae is a typical character of this family. However, a T3 with three setae on the terminal segment is a plesiomorphic character of Cypridoidea. It is also recognized in the Ilyocyprididae (e.g., Smith *et al*. 2011, 2019; Karanovic & Lee 2013; Zhai & Zhao 2014; Savatenalinton 2021b), most of the Notodromadidae (such as *Notodromas* Lilljeborg, 1853 (see Smith & Kamiya 2014), *Oncocypris* G.W. Müller, 1898 (see Savatenalinton 2015)) and some genera of the Cyprididae (such as *Cyprettadopsis* and *Pseudocypretta* (see Ma & Yu 2020; Savatenalinton 2020a)). Apart from the T3 terminal segment, the presence or absence of setae on the T3 is also one of the taxonomic characters for subfamily or generic classification. All three d setae (d1, d2, dp) on the T3 first segment are commonly recognized in the Cyprididae and Notodromadidae, whereas the absence of either of them is usually seen in the Ilyocypridinae and Candonidae. *Ilyocypris* lacks d1 seta on this segment (see Smith *et al*. 2011, 2019; Savatenalinton 2021b), while the absence of the d2 seta, which is the situation of *Martensina* gen. nov., is found in Candonidae representatives, such as *Candona* and *Fabaeformiscandona* (see Smith & Janz 2008; Karanovic 2012). It should be noted that the very large male T1 palps also show similarity between *Martensina* and some genera of the Candonidae, such as *Candona* and *Areacandona* Karanovic, 2005 (see Karanovic 2007, 2012). This displays the existence of more share features between the new genus and Candonidae.

The CR of the new genus is well-developed with the Sp seta situated close to the Gp claw. This aspect is identical to that of the Cyprididae, but different from that of the Candonidae, Ilyocyprididae and Notodromadidae. In the latter three subfamilies, the CR is reduced or well-developed and the Sp seta, if present and well-developed, inserts far from the Gp claw (e.g., Smith & Janz 2008; Karanovic 2011; Smith *et al*. 2011, 2019; Smith & Kamiya 2014; Savatenalinton 2015).

The hemipenes of *Martensina* gen. nov. are complex organs. They are large and most likely strong organs, evidenced by the appearance of internal musculature. This would imply their powerful function relating to sperm transfer. The general external morphology of the Hp is similar to that of Cyprididae, but the internal reticulated structure, which is on the edge of the proximal part of the medial shield, is unique. As such, this feature has not been seen in any Cyprididae genera, and thus it is regarded as a derived character in this lineage.

Martensina gen. nov. has a Zenker organ with funnel shaped ends and large numbers of spiny whorls (23 whorls). Such morphology in the new genus is different from that of all Candonidae and most Ilyocyprididae, which have rounded ends and a smaller number of spiny whorls of the Zenker organ (e.g., Smith & Janz 2008; Smith & Kamiya 2015; Savatenalinton 2017a, 2021b; Smith *et al*. 2019). The number of spiny whorls is not more than eight in the Candonidae and about 15–20 in Ilyocyprididae (Karanovic 2012). The morphology of the Zenker organ in the new genus is similar to that of the Cyprididae, such as the Cypricercinae, Hungarocypridinae Bronstein, 1947 (see Victor & Fernando 1981a; Savatenalinton & Martens 2009, 2010; Savatenalinton & Suttajit 2016) and Notodromadidae, such as *Notodromas*, *Gurayacypris*, *Newnhamia* King, 1855 and *Oncocypris* (see Battish 1987; George & Martens 2003; Smith & Kamiya 2014; Savatenalinton 2015; Smith *et al*. 2022). Nevertheless, several other features of the soft parts of the Notodromadidae differ from *Martensina*, for example, the larger number of Zahnborsten on the Mx1 third endite (in most species), the divided penultimate segment of the A2 and the larger β seta on the Md palp (e.g., George & Martens 2003; Smith & Kamiya 2014; Savatenalinton 2015). Additionally, the strong ornamented valve surface and the presence of eye tubercles, which are usually seen in the Notodromadidae, are absent in *Martensina*. Thus, the placement of the new genus in the Notodromadidae would seem to affect the monophyly of the family. The doubt on monophyletic status of Notodromadidae was also mentioned by Díaz & Martens (2018) and Smith *et al*. (2022).

Apart from the features discussed above, several other characters seem to exclude the new genus from the Ilyocyprididae. The valve morphology is very unlike that of the Ilyocyprididae, especially *Ilyocypris*. The structures of *Ilyocypris* valves are unique, with strong ornamentation, nodes, tubercles and sulci (e.g., Karanovic 2012; Horne *et al*. 2019). In addition, the slightly divided T1 palp in females, which is a major character of the Ilyocyprididae, is not present in the new genus (see Smith *et al*. 2011, 2019; Karanovic & Lee 2013).

Martensina gen. nov. shows differences from all three subfamilies of the Candonidae in many aspects. It differs from Candoninae genera by the presence of Rome organ, the 2-segmented prehensile palp on the male T1, the presence of d1 and d2 setae on the T2 and the insertion of Sp seta on the CR. The new genus cannot be a member of Cyclocypridinae due to many features, such as the large Cp, which has the length of 1.5 mm (less than 1 mm in the Cyclocypridinae), the presence of d1 and d2 setae on the T2 (only d1 seta present in the Cyclocypridinae), the presence of three long setae on T3 terminal segment, the insertion of Sp seta on the CR, which is close to the Gp claw (considerably far from the

Gp claw in Cyclocypridinae), the number of spiny whorls of the Zenker organ (23 in *Martensina* and 7 in Cyclocypridinae) and the reticulated structure of the Hp (absent in the Cyclocypridinae). Like in *Martensina*, Paracypridinae also has d1 and d2 setae on the T2 (see Wouters 1998, 2001) and in some representatives, such as *Renaudcypris* McKenzie, 1980 and *Mungava* Harding, 1962, 2-segmented prehensile palps have been recognized (see Wouters 1986, 1987). However, in the Paracypridinae, the T3 terminal segment bears one long and two short setae or two long and one short setae. There is no Sp seta in most Paracypridinae. In addition, the morphology of the Hp and Zenker organ is also different from the new genus. The Hp of the Paracypridinae is round with three lobes and its Zenker organ is set with a few spiny whorls and rounded ends (see Wouters 1998, 2001).

Consequently, based on the important taxonomic features discussed above, which show that *Martensina* gen. nov. has a combination of diagnostic characters of several Cypridoidea families and it is more similar to the Cyprididae than to others, the new genus is thus tentatively placed in the Cyprididae, and a new subfamily, Martensininae subfam. nov., is erected to accommodate this taxon. It could also be that Martensininae is a taxon intermediate between the Cyprididae, Candonidae and even the Notodromadidae. Such a situation would be confirmed by further information on, e.g., molecular data.

Among Cyprididae genera, *Martensina* gen. nov. is closer to *Batucypretta* Victor & Fernando, 1981 (subfamily Batucyprettinae Victor & Fernando, 1981), *Cyprettadopsis*, *Neocypridopsis* Klie, 1940 (subfamily Cypridopsinae) and *Pseudocypretta* (subfamily Cyprettinae) as they have a T3 with three setae on a terminal segment. The new genus differs from *Batucypretta*, *Cyprettadopsis* and *Pseudocypretta* by the absence of marginal septa (see Victor & Fernando 1981b; Ma & Yu 2020; Savatenalinton 2020a). It can mainly be distinguished from *Cyprettadopsis*, *Neocypridopsis* and *Pseudocypretta* by the well-developed CR and the presence of d1 and d2 setae on the T2 (see Klie 1940; Ma & Yu 2020; Savatenalinton 2020a). Given the fact that the presence of a pincer organ on the T3 occupies a large proportion of members in the Cyprididae, it is thus considered a plesiomorphic character in this lineage. Hence, the representatives without a pincer organ (*Batucypretta*, *Cyprettadopsis*, *Neocypridopsis*, *Pseudocypretta* and *Martensina*) belong to the derived group. It should also be realized that the members having a pincer organ could be a derived clade which occurs via the re-emergence of this plesiomorphic character. Another possibility could occur in which taxa with a pincer organ could have evolved from an ancestral group lacking this structure. Based on ontogenetic series of *Eucypris virens* (Jurine, 1820), a member of the Eucypridinae (see Smith & Martens 2000), the pincer organ appears only in the last three stages of development (stage A-2, A-1 and adult). This would strengthen the latter possibility.

Attention should also be paid to the terminal segment of the Mx1-palp. This segment of *Martensina* gen. nov. bears only one large and long claw and four slender setae. This aspect is different from that of most species of Cyprididae, which usually have two or three large claws on this segment. However, it has been recognized in *Cypretta karanovicae* Smith, Lee & Chang, 2015 (see Smith *et al*. 2015), which differs from other species of *Cypretta* (e.g., Cohuo-Durán *et al*. 2013; Savatenalinton 2018). Thus, this feature in the new genus could be considered a specific character.

Selected taxonomic characters of *Martensina* gen. nov. and related representatives

Based on sexual dimorphism on the limbs, freshwater ostracods can be divided into three groups. In group 1, the sexual dimorphism is recognized from modified claws and setae on the last two segments of the male A2 and modified male T1 palps. This is the basic pattern and commonly exists in the Cyprididae and Ilyocypridinae. Additional modifications are the segmentation of the A2 penultimate segment (divided in male, undivided in female), together with the modified t setae. These aspects are encountered in the Candonidae, which belongs to group 2. An additional sexual dimorphic character on the T2 is the incident of group 3, comprising some representatives of Notodromadinae (e.g., *Gurayacypris*), Cyprididae (e.g., *Cyprinotus cassidula*) and *Martensina* gen. nov. *Gurayacypris* shows strong sexual dimorphism of the T2, in which setae and the shape of the limb are different between male and female (see Battish 1987), whereas in the new genus and *Cyprinotus cassidula* (see Smith & Chang 2020), only the h2 claw is modified, appearing with a stronger claw in males. The segmentation of appendages can be related to motility. This suggests that more segments in a limb provides a more flexible movement. Hence, in group 2 ostracods, it could presumed that males are more flexibly motile than females, which perhaps is an adaptation for copulation (evidenced by its sexual dimorphism).

The male prehensile palps of *Martensina* gen. nov. are clearly 2-segmented and strongly asymmetrical between left and right palps. The left palp of the new genus has a small pointed protrusion on the outer corner of the hook-like terminal segment. This character could be regarded as a specific or generic character, which could be confirmed by further discovery of other species of this genus. Also, it should be noted that the prehensile palps are very large, compared to the entire limb. As the prehensile palp is a grasping organ when the animals are mating, its bigger size can point to a better copulation. The large and powerful male palps provide a stronger reinforcement of opening the female Cp resulting in a better chance to copulate (see also Smith & Kamiya 2007). The investigation of mating behavior in this species will also be required to determine the above phenomenon.

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