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Research article

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Contributions to the knowledge of Eylaoidea (Acari: Hydrachnidiae) from China

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Abstract. This paper enriches the taxonomic study of Eylaoidea Leach, 1816 from China. *Eylais* (*Meteylais*) *hamata* Koenike, 1897 is described to improve the taxonomy of adult Eylaidae Leach, 1816. Meanwhile, a new genus and a new species *Pentachares sinensis* Li & Guo gen. et sp. nov. is described and illustrated, which belongs to the subfamily Rhyncholimnocharinae Lundblad, 1936 in the family Limnocharidae Grube, 1859. The diagnosis of Rhyncholimnocharinae is modified. Rhyncholimnocharinae is first reported for Chinese fauna. A new key is provided for the subfamilies, genera and subgenera of Limnocharidae.

Keywords. Water mite, adult system, Rhyncholimnocharinae, new genus, new species.

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Introduction

Eylaoidea Leach, 1816 is a superfamily of ancient water mites, it includes four or five families, Eylaidae Leach, 1816; Limnocharidae Grube, 1859; Piersigiidae Oudemans, 1859; Apheviderulicidae Gerecke, Smith & Cook, 1999; and Zelandothyadidae Cook, 1983 (uncertain) (Cook 1974, 1983; Viets 1987; Jin 1997; Gerecke *et al.* 1999, 2017; Gerecke 2020). So far, only Eylaidae and Limnocharidae were reported from China (Uchida & Imamura 1951; Jin 1997, 1999).

Family Eylaidae is characterized by having an eye plate bearing a pair of setae. This family comprises two genera, *Eylais* Latreille, 1796 and *Rhyncheylais* Lundblad, 1938. In China, 10 species, belonging to five subgenera in *Eylais*, had been reported (Uchida & Imamura 1951; Jin 1997), of which, unfortunately,

seven species were just shortly noted and not described in detail. Only Jin (1997) redescribed *Eylais* (*Pareylais*) *tantilla* Koenike, 1897. In this paper, we also described *Eylais* (*Meteylais*) *hamata* Koenike, 1897 which was collected from Qinghai-Tibet Plateau, P.R. China in order to improve the taxonomy of adult Eylaidae.

Limnocharidae presents well-developed distribution capacities, and is scattered all over the zoogeographic regions because of their larval parasitism on Hemiptera Linnaeus, 1758 and Coleoptera Linnaeus, 1758 (Tuzovskij & Gerecke 2009). Currently, three subfamilies (Limnocharinae Grube, 1859; Rhyncholimnocharinae Lundblad, 1936 and Neolimnocharinae Gerecke, Wohltmann, Smith & Judson, 2020), nine genera (*Limnochares* Latreille, 1796; *Neolimnochares* Lundblad, 1937; *Laterolimnochares* Jin, 1999; *Rhyncholimnochares* Lundblad, 1936; *Austrolimnochares* Harvey, 1998; *Veliacola* Gerecke, Wohltmann, Smith & Judson, 2020; *Archaeveliacola* Gerecke, Wohltmann, Smith & Judson, 2020; *Armaveliacola* Gerecke, Wohltmann, Smith & Judson, 2020 and *Isoveliacola* Gerecke, Wohltmann, Smith & Judson, 2020), and about 64 species (including eight species based on larvae and one fossil) are accepted in the world (Viets 1987; Harvey 1990, 1998; Jin 1999; Davids *et al.* 2005; Smith & Cook 2005; Tuzovskij 2008; Tuzovskij & Gerecke 2009, 2020; Smit & Pesic 2014; Gerecke *et al.* 2020). In China, only two species, *Li. aquatica* (Linnaeus, 1758) and *La. huangshanensis* Jin, 1999, were reported, of which the former was documented by Uchida (1941) under the name of *Li. holosericeus* (Geer, 1778) (Viets 1987; Jin 1997). In this paper, a new genus and species of Limnocharidae, *Pentachares sinensis* Li & Guo gen. et sp. nov. is established according to the specimens from Guangdong Province, P.R. China.

Material and methods

A 250 μm mesh size net, two stacked sieves (mesh size: 4 mm above, 250 μm below), a 2 mL dropper and a white tray were used to capture water mites. Specimens were preserved in Koenike's fluid and mounted in gelatin mounting fluid (gelatin 8–10 g, phenol 0.8 g, glycerin 50 mL, distilled water 50 mL) (Jin 1997).

Specimens were observed and illustrated under a Leica DM3000 microscope, and the illustrations were edited with Adobe Photoshop CS6. Specimens were measured using Nikon DS-Ri2 (Gu *et al.* 2020).

In the SEM observation, specimens are kept overnight in 2% glutaraldehyde at 4ºC. The following day, the samples are dehydrated through a graded ethanol series of 30%, 50%, 75%, 85% and 95% (for 30 min each), then fully dehydrated in 100% ethanol (two times for 6 hours each). After drying (40ºC) in the electric blast drying oven (WGLL-125BE) for 30 min, the specimens are attached to a holder using electric adhesive tape, sputter-coated with gold, examined and photographed with a JCM6000 Desktop SEM (at 15.0 kV).

The terminologies and abbreviations used follow Jin (1997):

a.s.l.	=	above sea level
A_1	=	preantennal glandularia
A_2	=	postantennal glandularia
ACG	=	anterior coxal group (Cx-I+Cx-II)
Cx-I–IV	=	coxae I–IV
D_1–D_4	=	dorsoglandularia 1–4
E_1–E_4	=	epimeroglandularia 1–4
L_1–L_4	=	lateroglandularia 1–4
leg.	=	legere
O_1	=	preocularia
O_2	=	postocularia

P-1–P-5 = first–fifth segment of palp
PCG = posterior coxal group (Cx-III+Cx-IV)
V_1–V_4 = ventroglandularia 1–4

Roman signs I–IV in combination with L and Arabian signs 1–6 = first–sixth segments of the legs 1–4 respectively (trochanter, basifemur, telofemur, genu, tibia and tarsus), for instance: I-L-1–6 = first–sixth segments of the first leg,

All measurements are given in μm.

All observed specimens are deposited in the Institute of Entomology, Guizhou University, Guiyang, P.R. China (GUGC) (Zhang 2018).

Results

Class Arachnida Lamarck, 1801
Order Trombidiformes Reuter, 1909
Superfamily Eylaoidea Leach, 1816

Family **Eylaidae** Leach, 1816

Eylaidae Leach, 1816: 399.

Eylaidae – Cook 1974: 42–46. — Viets 1987: 236.

Genus ***Eylais*** Latreille, 1796

Eylais Latreille, 1796: 182.

Subgenus ***Meteylais*** Szalay, 1934

Meteylais Szalay, 1934: 277.

Eylais* (*Meteylais*) *hamata Koenike, 1897
Figs 1–5

Diagnosis

Eye-plate relatively long; eye bridge almost uniform-in-width, straight or slightly curved; longer than eye capsules; O_2 inserted into a pair of sclerotic loops on eye bridge; excretory pore with a sclerotized ring; E_4 behind the middle of Cx-IV.

Material examined

CHINA • 3 ♂♂, 2 ♀♀; Qinghai Province, Qinghaihu National Nature Reserve; 36°36′23″ N, 100°46′35″ E; 3209 m a.s.l.; 7 Aug. 2020; Dong-Dong Li & Hai-Tao Li leg.; water depth 20–40 cm, located in a prairie, with many aquatic plants on the bottom; GUGC, slides No. QH-EY-20200801 to 20200805.

Description

Male (n = 3)

Body. Dull red color. Idiosoma extremely soft and oval; integument with fingerprint-like striae. No sclerites except eye-plate in dorsal view (Fig. 1A). Eye-plate relatively long; eye bridge almost uniform-in-width, straight or slightly curved; O_2 inserted into a pair of sclerotic loops on eye bridge; a pair of humps existed sometimes (Figs 1B, 2A–B).

Coxae. The apical angles of Cx-I–IV with 2–4 setae, line of setae on each coxa; all coxae striated, like elephant skin (Fig. 1E).

Genitalia. Genital field with numerous tapered setae; a pair of sclerotic genital flaps with many fine setae and two small and narrow transverse genital sclerites surrounding gonopore (Fig. 2C); V_1 free and close to rear side of ACG; acetabula rounded and stalked, occupying all over the integument; excretory pore with a sclerotized ring; E_4 behind the middle of Cx-IV and at the level of the excretory pore (Fig. 1E).

Gnathosoma. Cuticle porous; basal segments of chelicera large, cheliceral claws short and blunt, projecting through the center of the filled wheel-like membrane; pharynx with a pair of bulges at the lateral bottom, two strongly sclerotized rings on pharynx (Figs 1C, 2D).

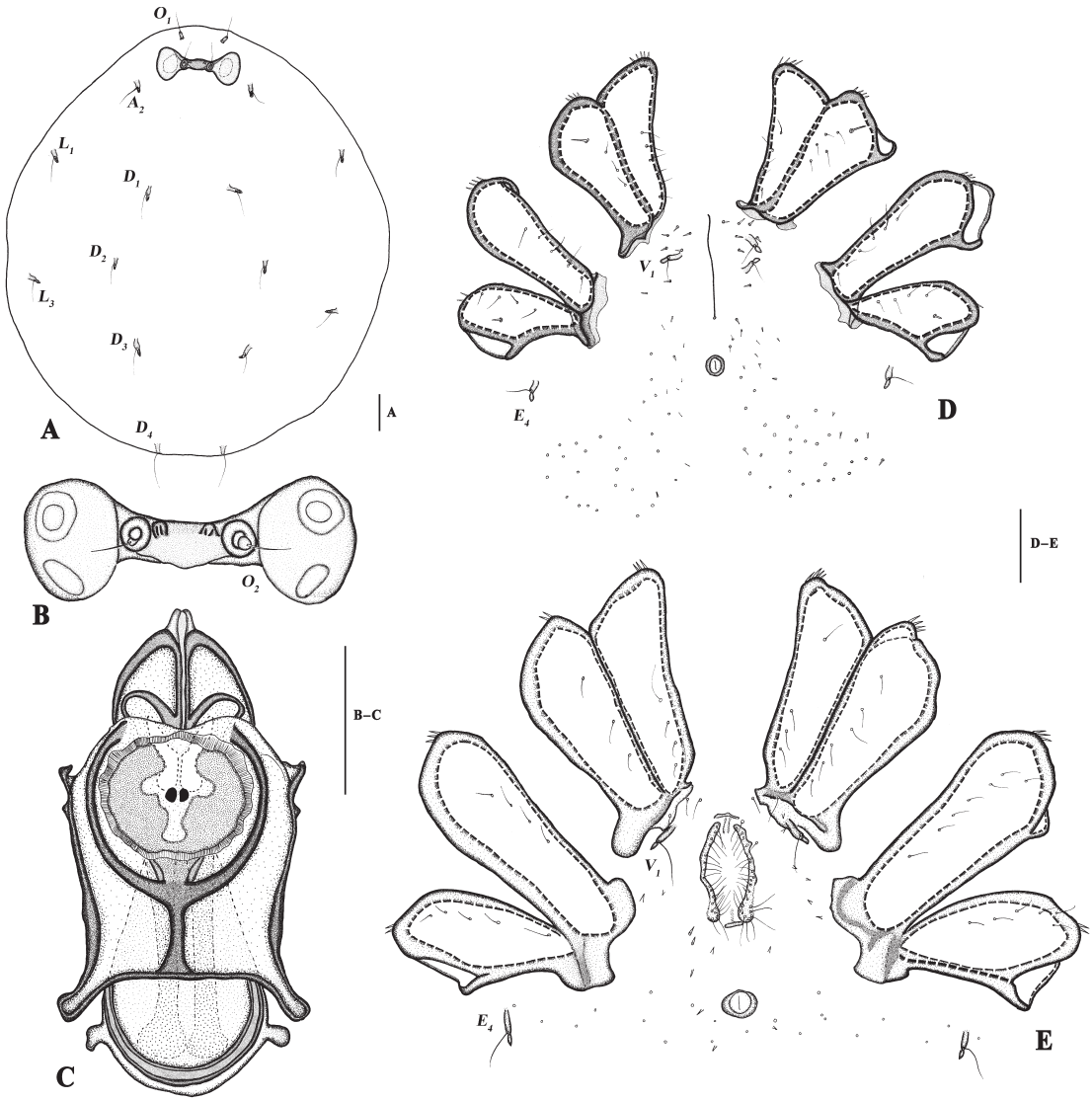

Fig. 1. *Eylais* (*Meteylais*) *hamata* Koenike, 1897. **A–C, E**. ♂ (GUGC QH-EY-20200801). **D**. ♀ (GUGC QH-EY-20200804). **A**. Idiosoma, dorsal view. **B**. Eye plate (with a pair of humps). **C**. Gnathosoma. **D–E**. Idiosoma, ventral view. Scale bars = 200 μm.

Palp. Five-segmented; P-I with 1–2 dorsal setae, apical setae feathered or smooth; P-II with three setae on dorsum, three lateral setae in a line (feathered or not) on outer side, and 4–5 distal setae (feathered or not) and 1–2 lateral setae on inner side; P-III with six ventrodistal feathered setae on inner side, 5–6 setae in a line (feathered or not) and one anteroventral seta (feathered or not) on outer side; P-IV relatively long, with one seta at about ⅓ of the total length of the segment on outer side, and numerous setae on inner side; P-V with two dorsal and 3–4 lateral setae, and 1–2 heavy setae on outer side, 2–3 setae on inner side, and with a six-toothed claw at distal end (Figs 3C–D, 4A–B).

Female (n = 2)

Bright red color; similar to male; gonopore without sclerotized genital flaps; excretory pore relatively round (Fig. 1D); P-IV as broad as in the male but shorter, P-V hook-like (Fig. 3A–B).

Measurements

Male (n = 3)

Idiosoma 1859–2539 in length, 1427–2138 in width; ACG length 695–792 (from apex of Cx-I to Cx-II base angle); PCG length 699–855 (from apex of Cx-III to Cx-IV base angle); eye plate 393–464 in length, eye bridge length 158–197, eye capsules 151–176 in length, 114–133 in width; capitulum

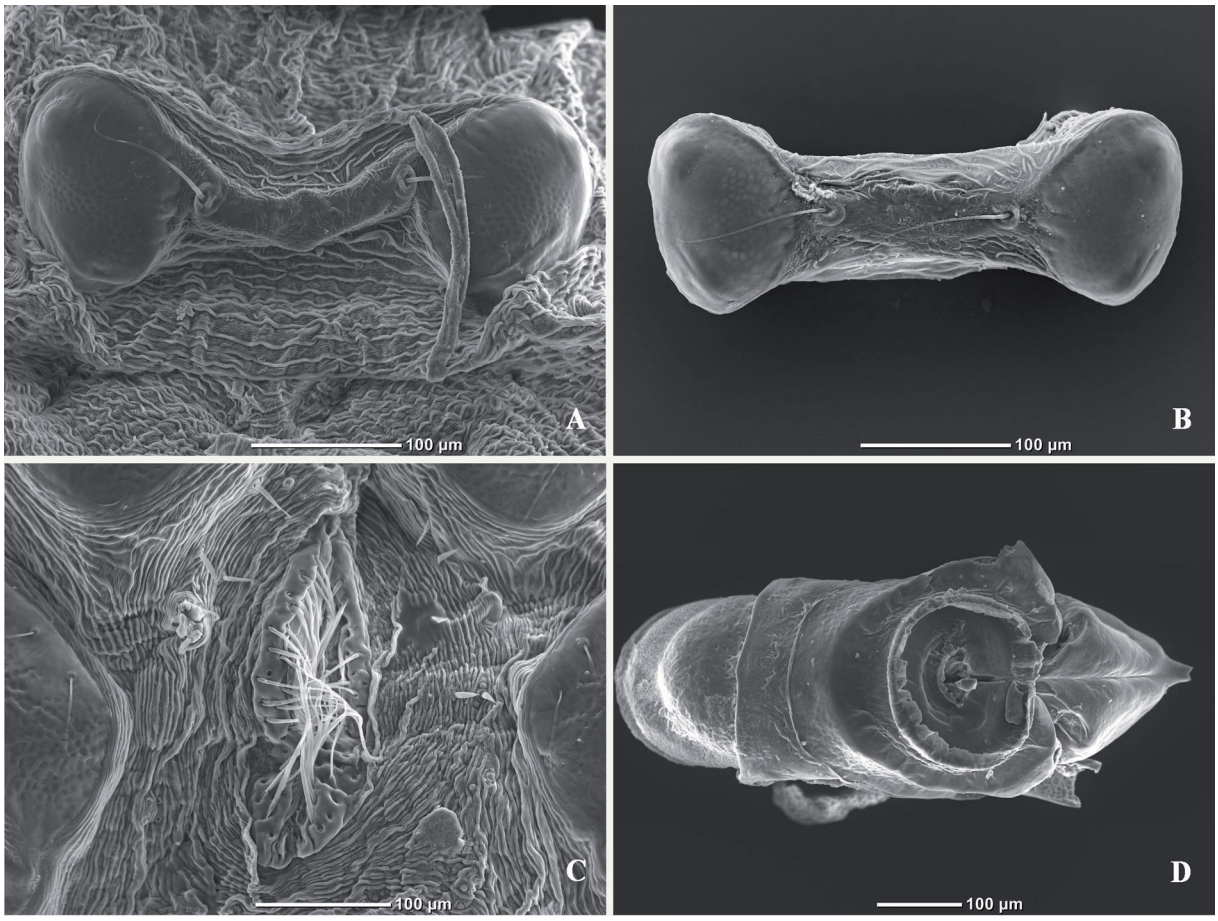

Fig. 2. *Eylais* (*Meteylais*) *hamata* Koenike, 1897, SEM photographs, ♂. **A**. GUGC QH-EY-20200802. **B–D**. GUGC QH-EY-20200803. **A**. Eye plate (curved). **B**. Eye plate (straight). **C**. Genital field (cuticle crumpled). **D**. Gnathosoma.

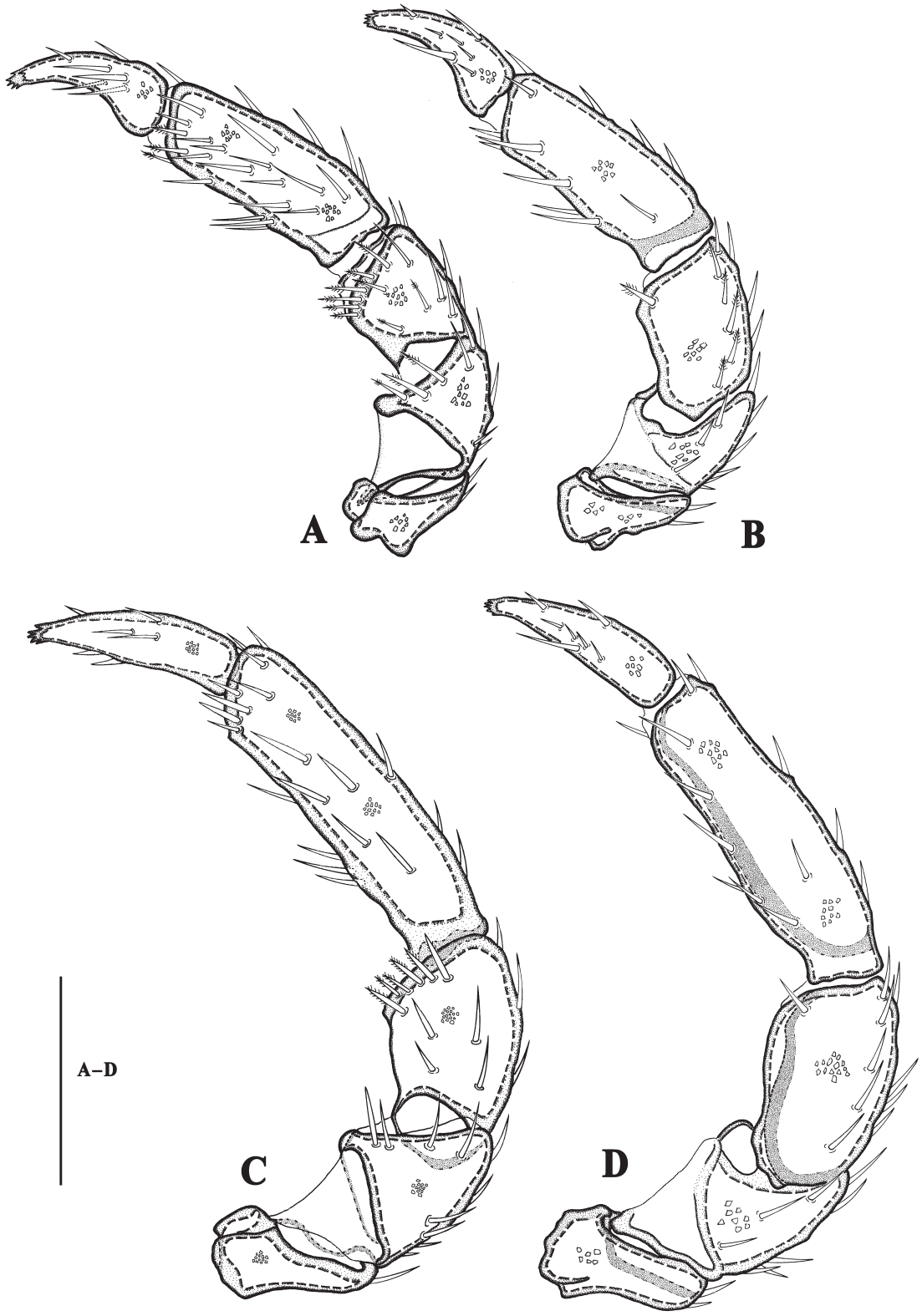

Fig. 3. *Eylais* (*Meteylais*) *hamata* Koenike, 1897. **A–B**. ♀ (GUGC QH-EY-20200804). **C–D**. ♂ (GUGC QH-EY-20200801). **A**. Palp, inner side. **B**. Palp, outer side. **C**. Palp, inner side. **D**. Palp, outer side. Scale bar = 200 μm.

length 596–691 (from chelicera peak to pharynx bottom), mouth opening 173–199 in diameter, pharynx 282–334 in length; gonopore length 238–282; sclerotization of excretory pore 76–79 in diameter; dorsal lengths of palp segments: P-I 114–142, P-II 157–180, P-III 154–210, P-IV 304–364, P-V 173–199; P-IV 81–97 in width; dorsal lengths of leg segments: I-L-2 340–355, I-L-3 309–324, I-L-4 382–391, I-L-5 378–385, I-L-6 384–397. II-L-2 374–389, II-L-3 362–368, II-L-4 422–431, II-L-5 489–492, II-L-6 383–389. III-L-2 450–454, III-L-3 418–427, III-L-4 450-459, III-L-5 502–506, III-L-6 431–434. IV-L-2 453–462, IV-L-3 496–501, IV-L-4 551–557, IV-L-5 585–591, IV-L-6 448–454.

Female (n = 2)

Idiosoma 1725–1814 in length, 1412–1468 in width; ACG length 529–540; PCG length 540-561; eye plate 343–365 in length, eye bridge length 168–184, eye capsules 123–130 in length, 88–89 in width; capitulum length 501, mouth opening 127–152 in diameter, pharynx 254–256 in length; gonopore length 253–259; sclerotization of excretory pore 45–48 in diameter; dorsal lengths of palp segments: P-I 95–110, P-II 130–135, P-III 136–148, P-IV 246–256, P-V 156 (147–156), P-IV 87 (87–95) in width; dorsal lengths of leg segments: I-L-2 233–238, I-L-3 204–210, I-L-4 239–240, I-L-5 289–296, I-L-6 285–296. II-L-2 262–265, II-L-3 233–241, II-L-4 274–278, II-L-5 328–334, II-L-6 316–321. III-L-2 320–322, III-L-3 270–274, III-L-4 324–326, III-L-5 337–347, III-L-6 345–352. IV-L-2 228–231, IV-L-3 269–274, IV-L-4 331–338, IV-L-5 383–391, IV-L-6 369–380.

Remarks

Eylais (*M.*) *hamata* is widely distributed all over the world (Piersig 1897–1900; Halbert 1903; Sezek & Özkan 2000). Lundblad (1936) had reported this species from Northwest China, while the previous descriptions were relatively simple (Uchida & Imamura 1951). Current specimens, which were also collected from Northwest China (Qinghaihu National Nature Reserve), are similar with the description mentioned above, especially their eye plate, which is considered as the most distinguishing feature. The only difference with the Turkish population is the body size: males ranging from 1859 to 2539, females ranging from 1725 to 1824 in our specimens, but with the Turkish population, 2250 for the male and 4200 for the female (Sezek & Özkan 2000). This problem can be interpreted by Lanciani (1969, 1970) that the size of newly emerged eylaid mites could increase continuously in both sexes, even during their adult stages, and the gravid females could grow twice as long. In summary, we attribute our specimens to *E.* (*M.*) *hamata*.

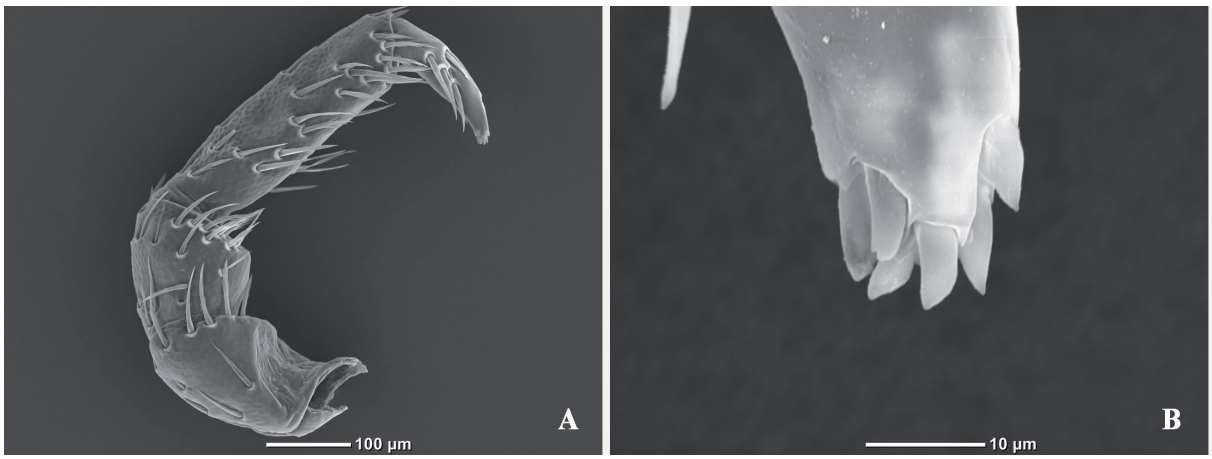

Fig. 4. *Eylais* (*Meteylais*) *hamata* Koenike, 1897, SEM photographs, ♂ (GUGC QH-EY-20200803). **A**. Palp-2–5. **B**. Palp-5, terminal.

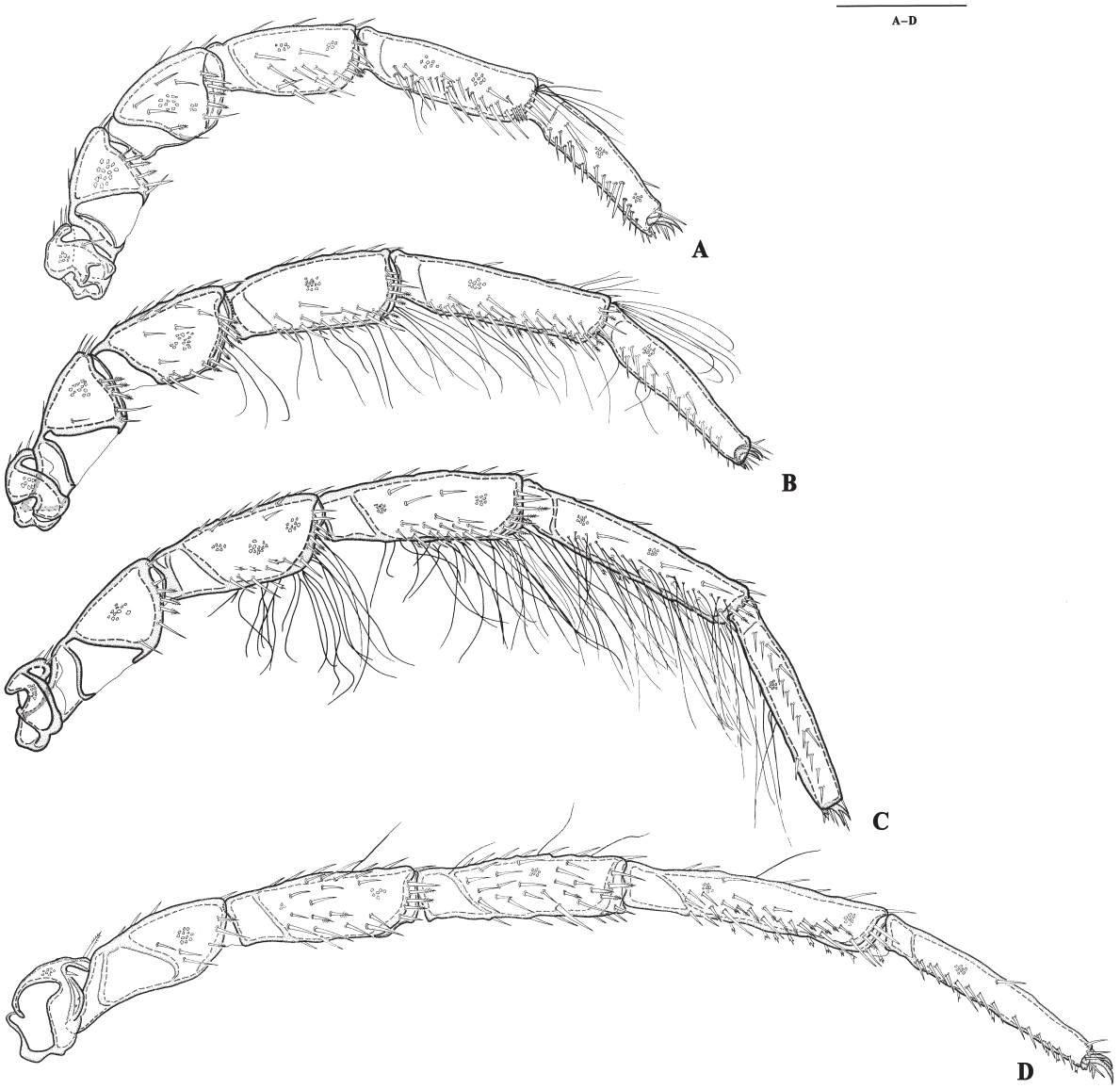

Fig. 5. *Eylais* (*Meteylais*) *hamata* Koenike, 1897, ♀ (GUGC QH-EY-20200804). **A**. I-L-1–6. **B**. II-L-1–6. **C**. III-L-1–6. **D**. IV-L-1–6. Scale bar = 200 μm.

Family Limnocharidae Grube, 1859

Subfamily **Rhyncholimnocharinae** Lundblad, 1936

Rhyncholimnocharinae Lundblad, 1936: 203.

Rhyncholimnocharinae – Cook 1974: 41. — Viets 1987: 679.

Diagnosis (after Cook 1974, modified)

Character of the family Limnocharidae; gnathosoma attached to a long tubular extension of integument; palp segments 3 (but terminal segment may be greatly reduced giving the appearance of a two-segmented palp), occasionally 2, 4 or 5; dorsum with or without paired sclerites (Tuzovskij & Gerecke 2020).

Habitat

Running waters (sediment of organic detritus, dead wood and leaf litter of pools, or in mosses at stronger flow velocity).

Distribution

Nearctic, Neotropical, Australian and Oriental realm.

Remarks

There are a total of 24 species in this subfamily including the new species herein described (Tuzovskij & Gerecke 2020). Most species have a three-segmented palp, while *Rhyncholimnochares tapiarum* Tuzovskij & Gerecke, 2020 presents a two-segmented palp and *R. expansiseta* Cook, 1980 shows the phenomenon of its dorsal and ventral edges of P-I merged with the second segment (Tuzovskij & Gerecke 2020). The palp of *Austrolimnochares womersleyi* (Lundblad, 1952) has 4 or occasionally 3 segments (Harvey 1990). The new genus *Pentachares* Li & Guo gen. nov. established herein presents a five-segmented palp without any fusion. So, we modified the previous diagnosis.

Genus ***Pentachares*** Li & Guo gen. nov.
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Type species

Pentachares sinensis Li & Guo gen. et sp. nov.

Etymology

Five-segmented palp is the main diagnosis feature of this new genus. “Pent-” means five, just represents the five segments of palp in this new genus.

Diagnosis

Characters of Rhyncholimnocharinae; palp five-segmented, P-V attached to the middle surface, rather than the distal end of P-IV; dorsalia absent; without swimming setae on legs.

Habitat

Same as subfamily.

Distribution

Oriental realm.

Remarks

The new genus presents the diagnostic features of both two subfamilies in Limnocharidae: a long tube of protrusible integument proves that it belongs to Rhyncholimnocharinae, meanwhile the palp with five segments indicates it is from Limnocharinae. The phylogenetic value of the palp-fused as a character has been questioned (Cook 1974; Gerecke *et al.* 2020). Therefore, we arrange the new genus in Rhyncholimnocharinae, according to the feature of a tubular extension of integument.

Pentachares sinensis Li & Guo gen. et sp. nov.
urn:lsid:zoobank.org:act:EAE7CCA4-5C4C-410E-B226-09B3FC6D913D
Figs 6–9

Diagnosis

Capitulum attached to a long tubular extension of integument; palp five-segmented, P-V attached to membranous protuberance at medioventral surface of P-IV, heavy seta and a pair of setae at distal end;

dorsum without sclerites except for the frontal plate; on frontal plate, median eye invisible, rod-like O_1 and A_1 sitting at anterior part, A_2 at the middle of eye capsules, bifurcated O_2 near the middle of posterior part; 50–60 acetabula per side of genital field; excretory pore with a sclerotized ring; legs without swimming setae, claws simple.

Etymology

Named after the country where the specimen collected. "Sina-" means China.

Type material

Holotype

CHINA • ♀; Guangdong Province, Xiangtoushan National Nature Reserve; 23°16′14″ N, 114°22′14″ E; 491 m a.s.l.; 24 Aug. 2019; Min Ao & Hai-Tao Li leg.; water depth 5–10 cm, located at the top of a hill, with organic detritus, dead wood and leaves on the bottom; GUGC, slide No. GD-LI-20190801.

Fig. 6. *Pentachares sinensis* Li & Guo gen. et sp. nov., holotype, ♀ (GUGC GD-LI-20190801). Dorsal view, alive.

Description

Female (n = 1)

Body. Amber in color, lateral eyes red, gnathosoma invisible in dorsal view when alive (Fig. 6). Idiosoma extremely soft and extensible, integument papillate. Dorsum without sclerites in addition to frontal plate (Fig. 7A). Gnathosoma porous, in the ventral view rounded, rostrum relatively short; mouth disk with a loop of fine setae; porous basal segment of chelicera relatively large, proximal part of cheliceral stylet connected with basal segment vertically (Fig. 7B). Anterior part of frontal plate longer than eye capsule region; anterior margin concave, sclerotized inward; median eye invisible; O_1 rod-like and terminal expanded; A_2 at the middle of eye capsules; O_2 on the convex lateromedial plate and bifurcated; posterior part of frontal plate long, lateral margins covered by small tubercles densely; posterior margin straight; keel approximately as long as the frontal plate (Fig. 7C).

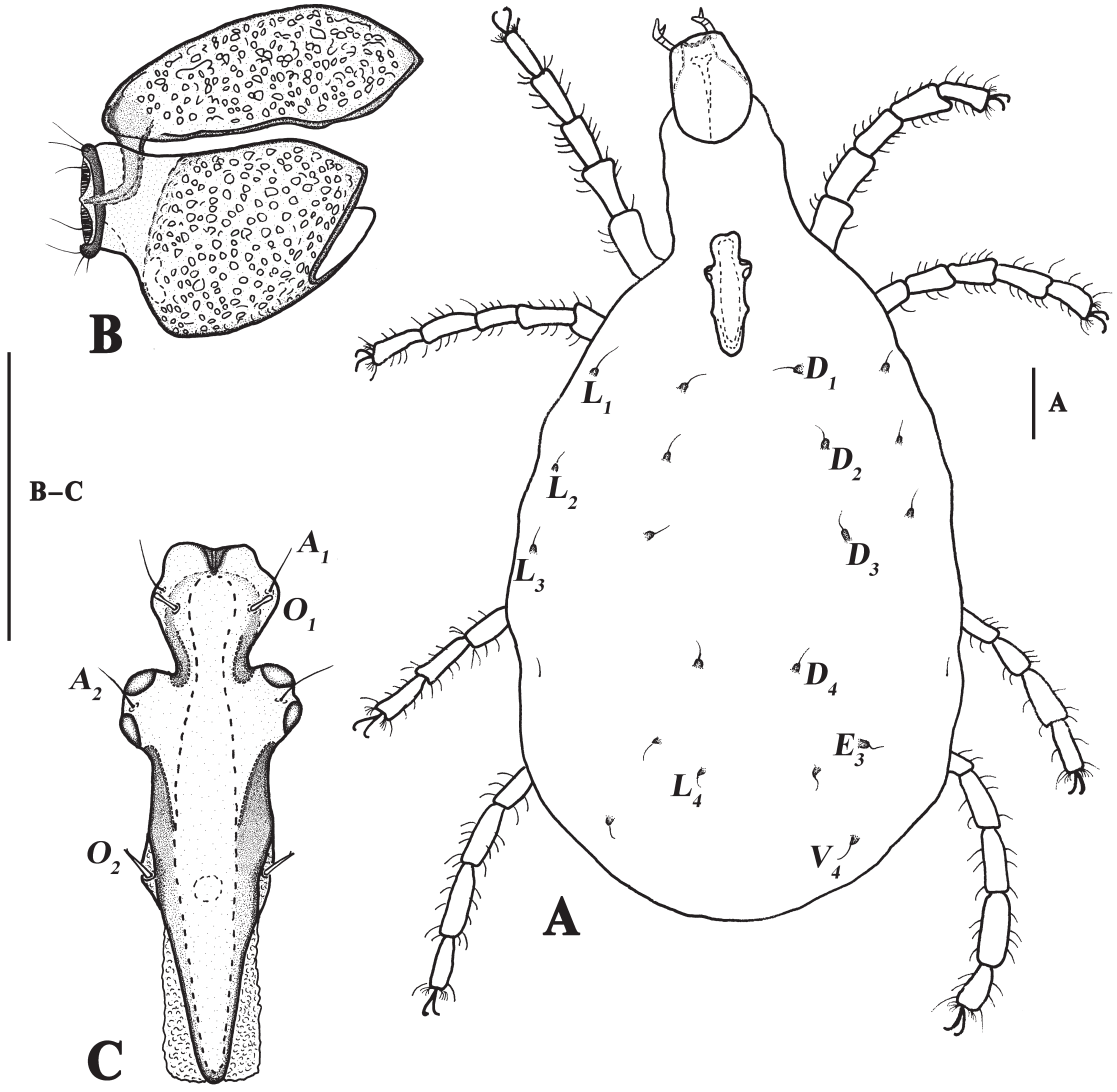

Fig. 7. *Pentachares sinensis* Li & Guo gen. et sp. nov., holotype, ♀ (GUGC GD-LI-20190801). **A**. Idiosoma, dorsal view. **B**. Gnathosoma. **C**. Frontal plate. Scale bars = 200 μm.

Palp. Five-segmented; P-I without seta; P-II with one dorsal and 3–4 ventral setae; a dorsodistal and 2 ventrolateral setae on P-III; P-IV with three ventral setae and one lateral heavy seta; P-V attached to a membranous protuberance at medioventral surface of P-IV, and bearing three setae at distal end (Fig. 8A–B).

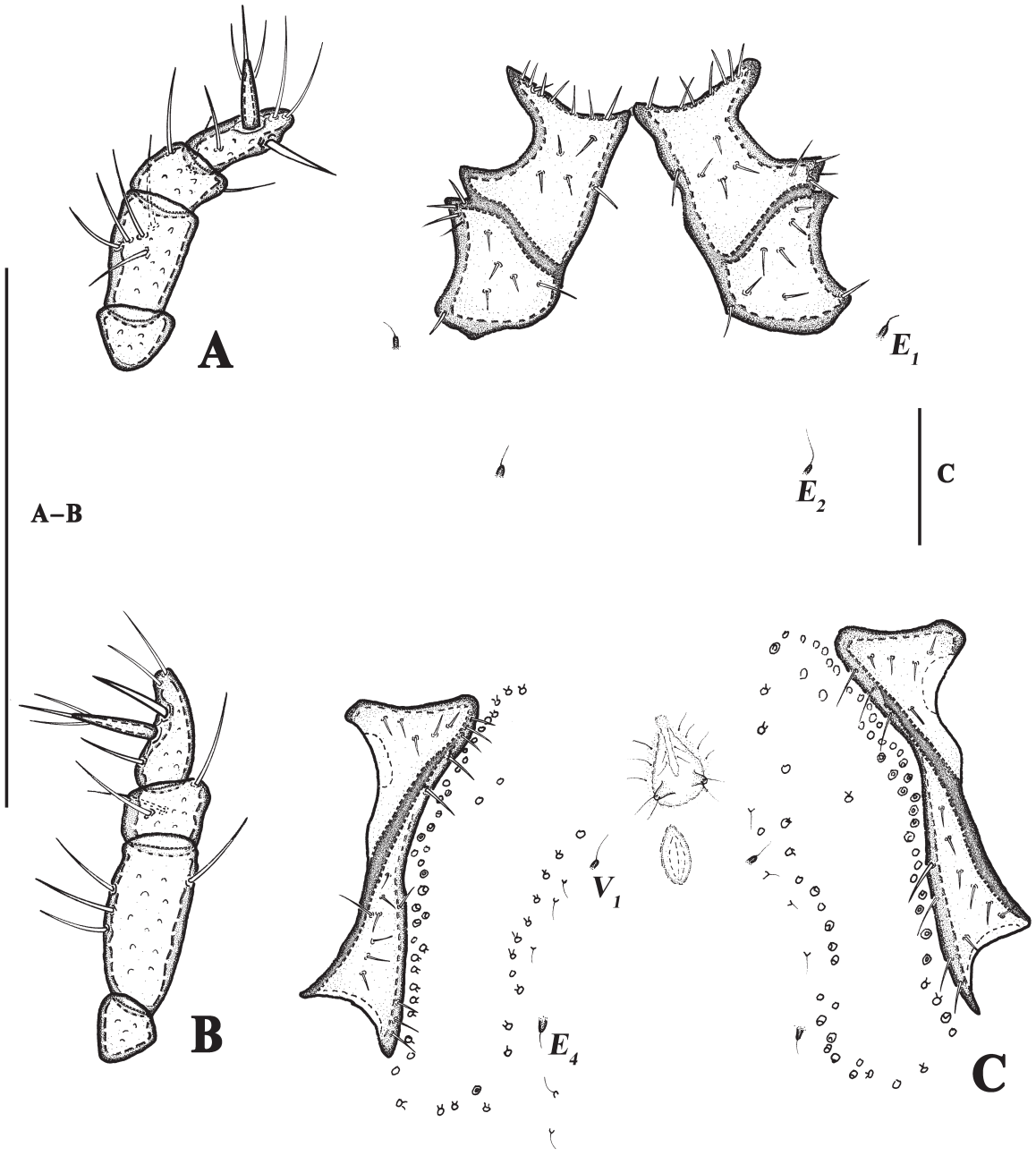

Fig. 8. *Pentachares sinensis* Li & Guo gen. et sp. nov., holotype, ♀ (GUGC GD-LI-20190801). **A**. Palp, ventral view. **B**. Palp, lateral view. **C**. Idiosoma, ventral view. Scale bars = 200 μm.

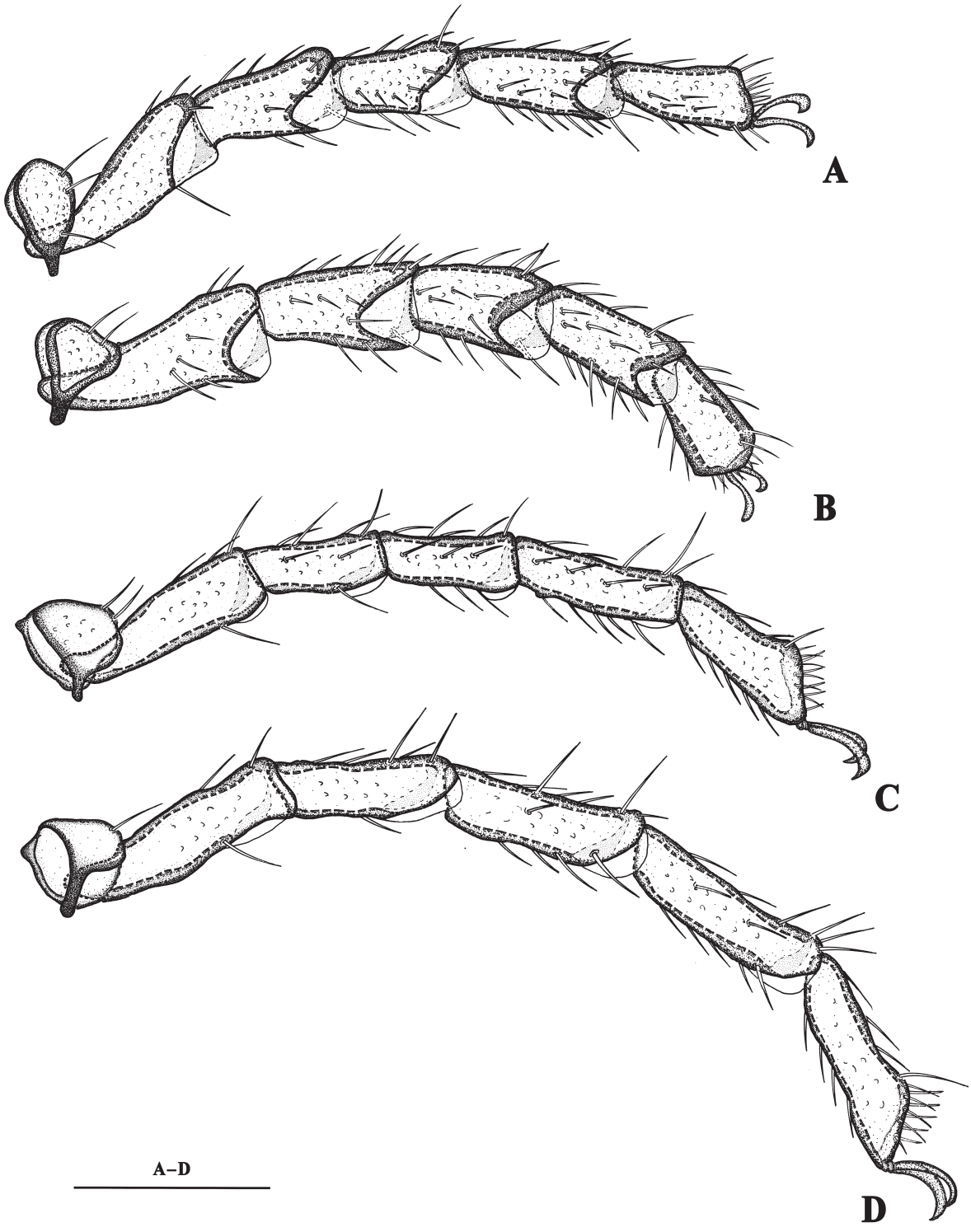

Fig. 9. *Pentachares sinensis* Li & Guo gen. et sp. nov., holotype, ♀ (GUGC GD-LI-20190801). **A**. I-L-1–6. **B**. II-L-1–6. **C**. III-L-1–6. **D**. IV-L-1–6. Scale bar = 200 μm.

Coxae. Cx-I inner-apical angles connected by a narrow bridge. Cx-I anterior margins concave, with uniformly stout setae. E_1 and E_2 on the membranous interspace between coxal groups. Cx-III triangular; Cx-IV elongated and triangular; all coxae porous (Fig. 8C).

Genitalia. Genital field with 50–60 acetabula per side, acetabula inverted teardrop-shaped; gonopore with a slightly sclerotic plate with fine setae surrounded; a pair of elevated, longish sclerites with two apical setae behind gonopore; excretory pore with a sclerotized ring (Fig. 8C).

Legs. With numerous stout setae except by the swimming setae, terminal segments of all legs with a loop of short setae; claws simple (Fig. 9A–D).

Male

Unknown.

Measurements

Idiosoma 2083 in length (with gnathosoma not extended), 1384 in width; protrusible membrane length 291 (flexibility maybe leading to inaccuracy); ACG length 368 (from anteromedial to posteromedial corner), PCG length 451 (from anteromedial to posteromedial corner); ocular plate 388 in length (from anteromedial to posteromedial corner), anterior part length 90, eye capsule region 49 in length, 114 in width, keel length 346; chelicera length 281; infracapitulum 154 in length (from the middle of infracapitulum furrow to rostrum); excretory pore length 71, sclerotic ring 81; dorsal lengths of palp segments: P-I 18, P-II 63, P-III 27, P-IV 39, P-V 33, P-IV heavy seta length 35, P-V apical seta length 23; dorsal lengths of leg segments: I-L-1 66, I-L-2 236, I-L-3 164, I-L-4 147, I-L-5 164, I-L-6 130. II-L-1 67, II-L-2 235, II-L-3 155, II-L-4 142, II-L-5 160, II-L-6 142. III-L-1 71, III-L-2 217, III-L-3 138, III-L-4 137, III-L-5 177, III-L-6 139. IV-L-1 62, IV-L-2 264, IV-L-3 184, IV-L-4 199, IV-L-5 218, IV-L-6 172.

Remarks

Pentachares sinensis Li & Guo gen. et sp. nov. with five-segmented palp is clearly distinguished from other species of the subfamily Rhyncholimnocharinae, but similar to *Laterolimnochares huangshanensis* Jin, 1999 and *Limnochares spinosa* Smit & Pesic, 2014. *Pentachares sinensis* Li & Guo gen. et sp. nov. differs from *La. huangshanensis* in the following aspects: 1) with a protrusible tube of soft integument in *P. sinensis* Li & Guo gen. et sp. nov., while without in *La. huangshanensis*; 2) body color amber in *P. sinensis* Li & Guo gen. et sp. nov., while pink in *La. huangshanensis*; 3) O_1 rod-shaped in *P. sinensis* Li & Guo gen. et sp. nov., while pectinate in *La. huangshanensis*; 4) terminal heavy seta of P-V smooth in *P. sinensis* Li & Guo gen. et sp. nov., while feathered in *La. huangshanensis*; and 5) the setae on coxae short in *P. sinensis* Li & Guo gen. et sp. nov., but long in *La. huangshanensis*. *Pentachares sinensis* Li & Guo gen. et sp. nov. differs from *Li. spinosa*: 1) with a protrusible tube of soft integument in *P. sinensis* Li & Guo gen. et sp. nov., while without in *Li. spinosa*; 2) O_1 and O_2 not smooth in *P. sinensis* Li & Guo gen. et sp. nov., but smooth in *Li. spinosa*; 3) terminal heavy seta of P-IV smooth in *P. sinensis* Li & Guo gen. et sp. nov., but feathered in *Li. spinosa*; and 4) the number of acetabula 50–60 in *P. sinensis* Li & Guo gen. et sp. nov., while only 40–50 in *Li. spinosa*.

The key to the subfamilies, genera and subgenera of Limnocharidae

1. Gnathosoma attached to a long protrusible tube of soft integument, the former well separated from the first coxae; palp segments 3, occasionally 2, 4 or 5; legs without swimming seta .... Subfamily **Rhyncholimnocharinae** Lundblad, 1936 2
– Gnathosoma not attached to a long protrusible tube of soft integument; gnathosoma always adjacent to the first pair of coxae; palp segments 4 or 5; swimming setae absent or present 5

2. Palp segments not fused, with 5 segments; P-V attached to the ventral surface, rather than the distal end of P-IV; dorsalia absent .....Genus ***Pentachares*** Li & Guo gen. nov.
– Palp segments fused, palp with 3, occasionally 2, 4 segments 3

3. Palp with 4 segments or occasionally 3; medial part of palp curved dorsally; without dorsalia .... Genus ***Austrolimnochares*** Harvey, 1998
– Palp with 3 segments or occasionally 2; dorsal margin of the second palp segment straight; dorsum with or without paired sclerites .....Genus ***Rhyncholimnochares*** Lundblad, 1936 4

4. Terminal segment of palp relatively large, with much of the segment visible proximal to the terminal setae ..... Subgenus ***Paralimnochares*** Lundblad, 1937
– Terminal segment of palp greatly reduced, the terminal setae are prominent but the actual segment somewhat hidden ..... Subgenus ***Rhyncholimnochares*** Lundblad, 1936

5. Palp segments not fused, palp with 5 segments .....Subfamily **Limnocharinae** Grube, 1859 6
– Palp segments fused, palp with 4 segments .... Subfamily **Neolimnocharinae** Gerecke *et al.*, 2020*

6. P-V inserted on the medioventral portion of P-IV ..... Genus ***Laterolimnochares*** Jin, 1999
– P-V normally inserted on the distal end of P-IV .....Genus ***Limnochares*** Latreille, 1796 7

7. Legs with swimming setae .....Subgenus ***Cyclothrix*** Wolcott, 1905
– Legs without swimming setae .....Subgenus ***Limnochares*** Latreille, 1796

* The definition of Neolimnocharinae is mainly based on larval characters. This larval-based taxonomy results in a parallel system in Limnocharidae, for which taxa have previously been based on adults. On the other hand, Gerecke *et al.* (2020) provided sufficient conditions to make us think that the establishment of subfamily Neolimnocharinae is reasonable. To avoid confusion in the taxonomy, four larval-based genera (*Veliacola*, *Archaeveliacola*, *Armaveliacola*, *Isoveliacola*) and genus *Neolimnochares* are not listed in this adult-charactered binomial key.

Discussion

Eylaidae: about taxonomy of Eylaidae

There are some problems with the current taxonomy of Eylaidae. (1) The classification is mixed. Some taxa are based exclusively on the larval stage (e.g., subgenus *Spineylais* Wainstein, 1968 and about 20 species), and some others on the adult stage, in consequence, it is not comparable (Lanciani 1969, 1970; Cook 1974; Smith 1986). (2) The classification of the adults relied on few features, such as eye plate. But polymorphic phenomena often occur on eye plate within the same species (Halbert 1903). This classification system is relatively confused and consequently arbitrary. More detailed features of adults are needed to identify and achieve the correspondence between the two systems, which is crucial.

Limnocharidae: about *Laterolimnochares* and *Pentachares* Li & Guo gen. nov.

Laterolimnochares Jin, 1999 and *Pentachares* Li & Guo gen. nov. are both from Oriental realm. Their morphological similarities are in the following aspects: 1) the shape and the chaetotaxy position of frontal plate; and 2) the structures of palp, especially P-V attached to the middle surface, rather than the distal end of P-IV. Meanwhile, their similar characters are obviously distinct from other Limnocharid genera.

According to Tuzovskij & Gerecke (2020), the frontal plate is of great significance in the taxonomy of Limnocharidae as a special feature. And as for palp, it plays an important role in the identification of mites. All mentioned above indicate that *Laterolimnochares* and *Pentachares* Li & Guo gen. nov. could have a close systematic relationship. But, they are attributed to different subfamilies due to the latter presents a long protrusible tube of soft integument. We have to consider if the protrusible integument of Laterolimnochares has degenerated, or the phylogenetic value of this feature should be questioned. For this problem, the future work should be focus on discovering more new species, improvement of larval stage taxonomy and applications of molecular technology.

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