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Catailana whitteni, a new genus and species of stygobiotic cirolanid from a cave in Guangxi, China (Crustacea: Isopoda: Cirolanidae)

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Abstract. *Catailana whitteni*, a new genus and species of cirolanid isopod is described from a cave in the karsts of southern China. The new taxon, the first cirolanid isopod ever described from subterranean waters in China, is characterised by possessing five free pleonites, the fourth not overlapping the fifth, by a narrow frontal lamina, by the pereiopods 1 to 3 being haptorial, by the endopodites of pleonites bifid, and by the setation of exopodite of pleopods 1 to 5 and of endopods 1 and 2. It has no close relatives among the stygobiotic taxa reported from the Far East and is probably related to some genera from the Mediterranean Basin and the western side of the Atlantic, thus pointing to a Tethyan ancestry.

Keywords. karst, subterranean biology, relict

INTRODUCTION

Cirolanidae are a family of mainly marine isopods including 26 stygobiotic genera with about 91 described and a number of still undescribed species (Boyko et al., 2008). They are widely distributed in karstic and alluvial waters of all continents except Antarctica (Botosaneanu et al., 1986). In the Far East a few species of stygobiotic cirolanids had been reported from Palau Island (Bowman & Iliffe, 1987), anchialine caves of the Philippines (Bruce & Iliffe, 1992) and Indonesia (Botosaneanu, 2003). All belong to the genus *Cirolana* Leach, 1818.

Up to now, no cirolanid isopod had ever been reported from groundwaters of China, although several expeditions had been conducted in the past (Botosanenau et al., 1986; Chen et al., 2001; Latella & Chen, 2008). During a visit by the Chinese colleagues Zhihong Xue, Lei Gao and Wei Lin of the South China Agricultural University in two caves of the Guangxi Zhuang Autonomous Region (People's Republic of China), a few specimens of a new cirolanid isopod were discovered. All the specimens examined belong to a new species of a new genus, and on the basis of its characters, is related to some Cirolaninae genera of the '*Sphaeromides* group' (Botosaneanu et al., 1986) which is normally distributed in peri-Mediterranean regions and in continental northern America.

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MATERIAL AND METHODS

The specimens were dissected under a Wild M5 binocular microscope and mounted on slides in Hoyer liquid. Pencil drawings were made using a Wild M20 microscope with a camera lucida. Figures were inked digitally using Adobe illustrator CS4 (Coleman, 2003) and assembled as plates using Adobe Photoshop CS4. Microphotos were made through an HD camera (MC 170, Leica Microsystems Srl, Wetzlar, Germany) integrated to a Leica M80 stereomicroscope. The pictures were elaborated by LAS EZ vs. 3 software (Leica Microsystems Srl, Wetzlar, Germany) and the MacOSX Image Fuser.

The following abbreviations are used: MZUF, Museo di Storia Naturale dell'Università di Firenze, Sezione Zoologia 'La Specola'; SCAU, South China Agricultural University, Guangzhou; CH, coupling hooks; DS, denticulate seta; PS, plumose seta; SAS**,** seta with accessory seta; SS, spinulate seta; RS, robust seta.

TAXONOMY

Order Isopoda Latreille, 1817

Suborder Cymothoida Wägele, 1989

Family Cirolanidae Dana, 1852

Catailana, new genus

Type species. *Catailana whitteni*, new species.

Diagnosis. A large cirolanid, blind, depigmented, head suboval, moderately encapsulated by anterolateral lobes of

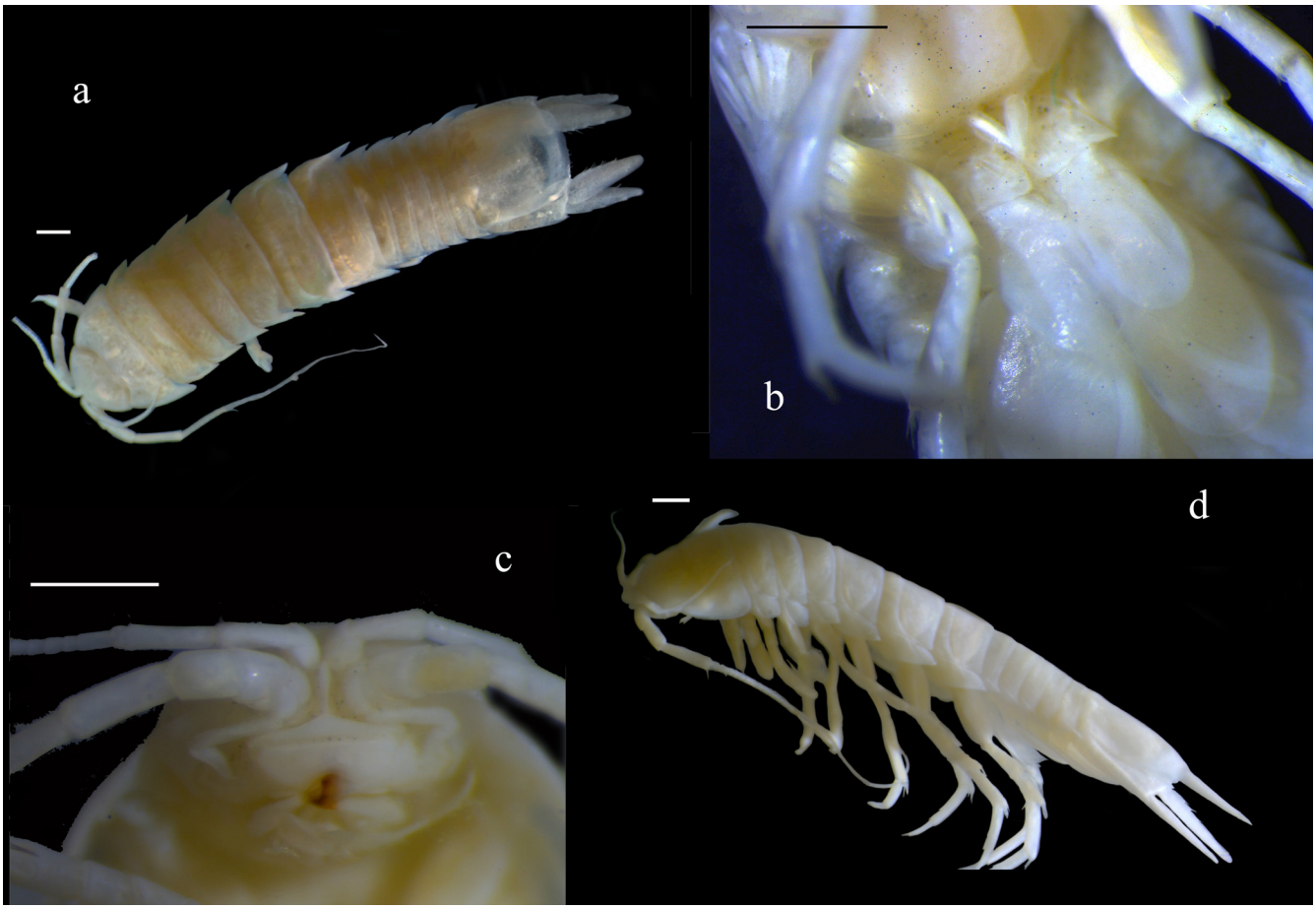


Fig. 1. *Catailana whitteni*, new species. Holotype male: a, body dorsal view; b, penes; c, head ventral view; d, body lateral view. Scale bars = 1 mm.

pereonite 1, anterior margin scarcely concave. Lamina frontalis narrow, strongly tridimensional, anteriorly moderately expanded, separating base of antennae, not separating antennulae, not visible in dorsal view. Pereonites 2–4 subequal, pereonites 5–7 about 2 times longer than previous ones, with groove running through lateral and anterior margins. Pereopods 1–3 haptorial; pereopods 4–7 slender, ambulatory. Propodial organ absent in both sexes. Coxae articulate and moderately carinate. Five free pleonites, subequal, fully visible, moderately posteriorly produced, larger than pleotelson; lateral margin of pleonite 5 not overlapped by pleonite 4. Pleotelson subquadrangular, partially covering uropods, lateral margins slightly convex posterior margin truncate, crenate.

Description. Head 2.5 times wider than longer, about 60% as wide as pereionite 1. Clypeus flatly triangular. Peduncles of antennulae and antennae, 4 and 5-segmented, respectively. Antennae long, reaching second pleonite. First maxilla with 3 PS and 2 smaller GS. Right mandible, with 3 strongly chitinised teeth, lacinia mobilis with 20 lifting spines, pars molaris with 21 teeth. Left mandible with 4 strongly chitinised teeth, lacinia mobilis with 15/16 lifting spines, pars molaris with 18/22 teeth. Pereonites II–IV subequal about 3 times wider than longer, V 1.3 times, and VI and VII 1.5 times wider than previous ones. Pleonites I–V subequal about 10 times wider than longer, ventrally extended to cover 1/4 of ventral surface. Sympodite of pleopods 1–5 subrectangular. Endopods of pleopods 1 and 2 and all exopods with numerous marginal plumose setae. Exopodite of pleopods 3–5 with a partial transverse suture, laterally strongly incised, endopodite naked, strongly bifid. Appendix masculina proximally inserted, curved with rounded apex almost reaching exopodite distal margin. Sympodite of uropods subtriangular, strongly tridimensional, partially covered by pleotelson, as long as endopodite; exopodite shorter (1.2 times) and narrower (1.3 times) than endopodite. Pleotelson posterior margin with about 25 tiny setae.

Etymology. The name is derived from an arbitrary combination of two words: Catai, the Chinese empire, as recorded in the book *Il Milione* by Marco Polo, a XIII century Venetian traveller, merchant and writer who spent several years in China as counsellor and ambassador of Kublai Khan; and the genus name *Cirolana*. Gender feminine.

Remarks. *Catailana*, new genus, is characterised by the possession of five subequal free pleonites, by the first three pairs of haptorial pereiopods, by the narrow and strongly tridimensional frontal lamina, by the endopodite of pleopods 3 to 5 being bifid, and the subquadrangular pleotelson.

Within the subterranean genera of Bowman's (1975) 'group a', *Catailana* is closest to the peri-Mediterranean genus *Sphaeromides* Dollfus, 1897, and to the western

atlantic genera *Cirolanides* Benedict, 1896, and *Bahalana* Carpenter, 1981. It shares with *Sphaeromides* an almost identical lamina frontalis, pereiopods 1–3 haptorial and the endopodite of pleopods 3–5 deeply incised; they differ in pleonal morphology because in *Sphaeromides* pleonite 4 somehow overlaps pleonite 5, and pleonite 2 and 3 have different widths in some species (i.e., *S. bureschi* Strouhal, 1963 and *S. polateni* Angelov, 1968). This particular aspect, the pleonal morphology, should be discussed in a deeper revision of the Taxonomy and Biogeography of all the genera of the *Sphaeromides* group, because apparently not many of them fit into the scheme proposed by Bowman (1975). *Cirolanides* can be distinguished by: head more encapsulated in pereonite 1; only pereiopod 1 haptorial; first pleonite shorter than the others and partially hidden by the seventh pereonite (all subequal and well visible in *Catailana*); endopodite of pleopod 1 smaller than exopodite; endopodite of pleopods 3–5 2-segmented and much smaller than exopodite which has a complete suture (incomplete in *Catailana*); and the exopodite of uropods much thinner than the endopodite. *Bahalana* has a more rounded head; a thinner lamina frontalis; pereopods 3–5 with projections on merus and/or carpus; endopodite of pleopods 3–5 entire, with marginal setae; appendix masculina inserted at base and longer of endopodite, tapering distally (inserted near base, reaching distal margin of endopodite and with rounded apex in *Catailana*) and a wider uropod endopodite.

***Catailana whitteni*, new species**
(Figs. 1–5)

Material examined. Holotype male 17.8 x 4.6 mm (at V pereonite) (SCAU), China: Guangxi: Nandan Xian: Xiaochang Zhen: Encun village: Bacuanhe Dong [=cave] (25°05'28.12"N 107°35'13.86"E, 652 m asl), coll. Zhihong Xue, Lei Gao & Lin Wei, 27 December 2008.

Paratypes: 1 male (dissected and mounted on 7 slides) and 1 female (dissected and mounted on 7 slides), same locality (ZMUF5001); 2 females (1 ovigerous, 15.4 x 4.6mm, bearing 9 eggs in brood pouch) (ZMUF5002), 1 female (SCAU), China, Guangxi: Hechi: Nandan Xian: Chengguan: Encun village: Encun Dong [=cave] (25°03'00"N 107°35'59"E, 600 m asl), in a pool of the cave, coll. Xue Zhihong, Gao Lei & Lin Wei, 26 December 2008.

Comparative material. One specimen of *S. raymondi* from the Ressel cave on River Cele (Region du Lot, Massif Central, France) (Collection Messana, N° 0380).

Diagnosis. Maximum observed length 19.5 x 5.2 mm (at pereonite 5), head suboval. Lamina frontalis thin, slightly expanded anteriorly, not separating antennulae. Antennae long, reaching anterior margin of first pleonite, antennulae reaching midpoint of pereonite 2. Palp of maxilliped with 3/4 coupling hooks on the right and left maxillipeds, respectively. Pereon with slightly carinate coxae (II–VII), second and the third posteriorly rounded, remaining (IV–VII) moderately produced. Pereopods 4–7 slender, ambulatory, dactyl organ composed of 10–3 setae (PI–PVII),

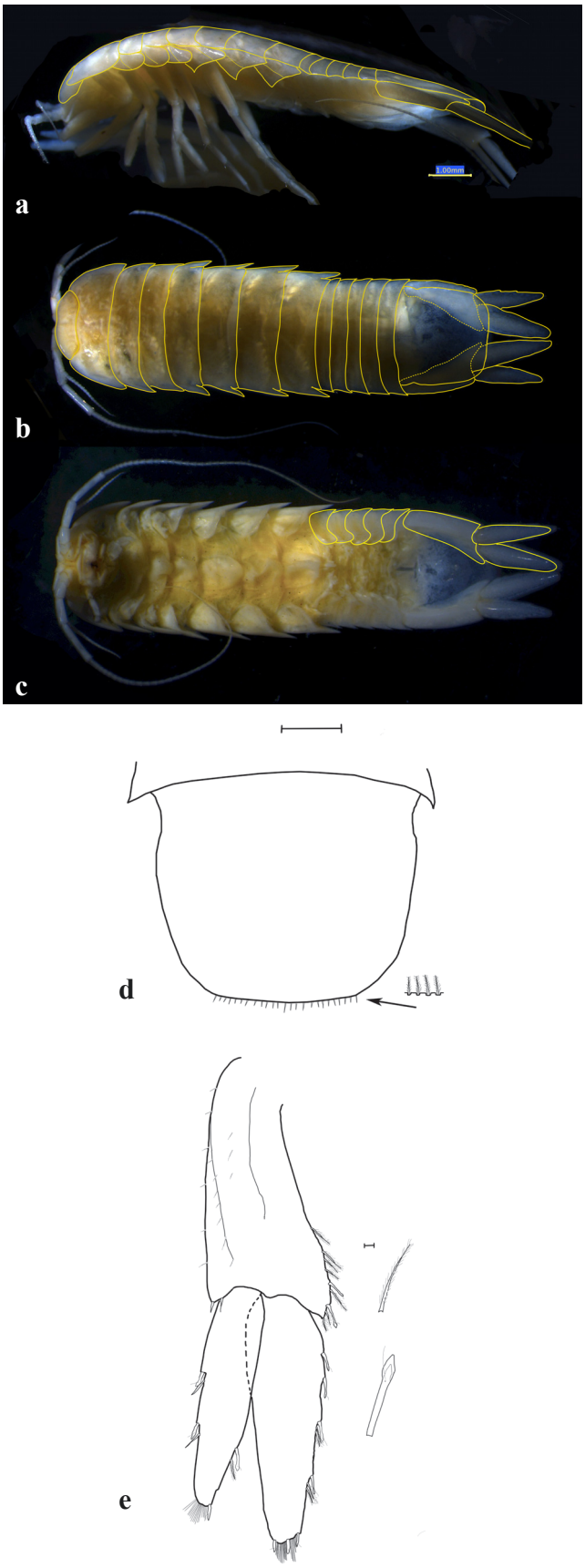
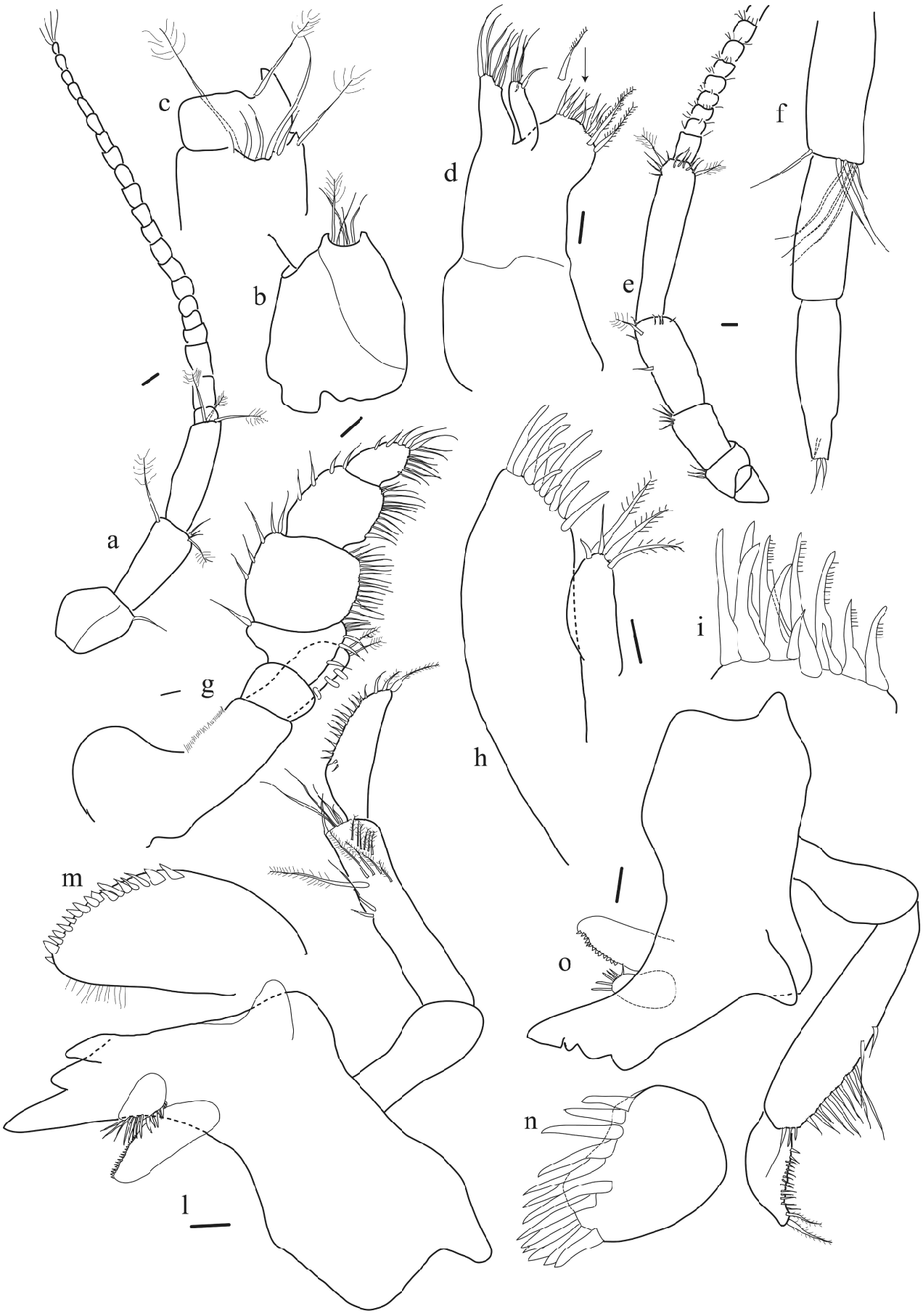


Fig. 2. *Catailana whitteni*, new species. Paratype male: a, body lateral view; b, body dorsal view; c, body ventral view; d, pleotelson; e, uropod. Scale bars: a–c, 1 mm; d–e, 100 µm.



Fg. 3. *Catailana whitteni*, new species. Paratype male: a, antennula (setation and aestetascs omitted); b, first article of antennula; c, fourth article of antennula; d, maxilla; e, antenna peduncle and proximal part of flagellum (setation omitted); f, distal articles of antenna; g, maxilliped; h, maxillula; i, maxillula, particular of exite; l, right mandibule, palp setation of second article partially omitted; m, pars molaris; n, lacinia mobilis; o, left mandible, palp setation of second article partially omitted. Scale bars = 100 µm.

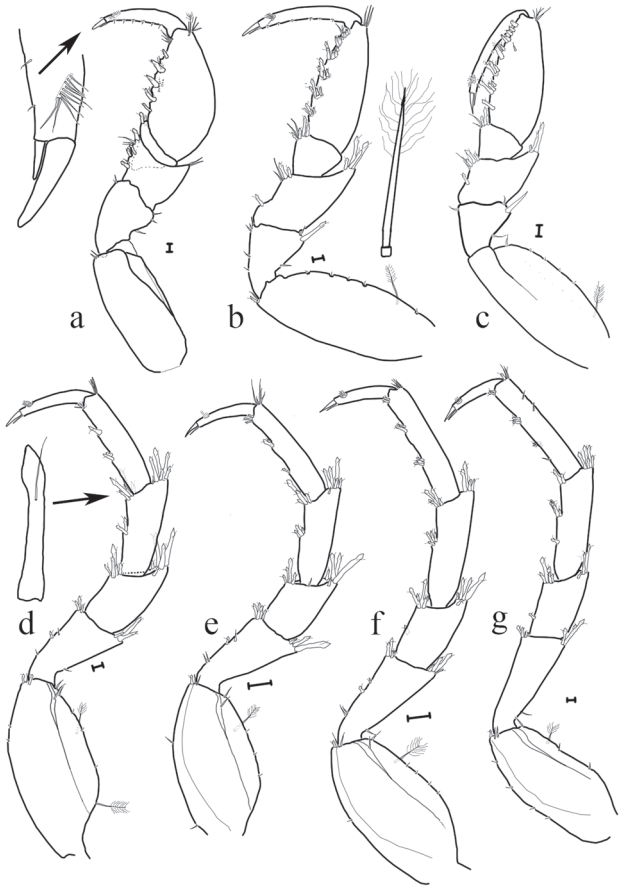


Fig. 4. *Catailana whitteni*, new species. Paratype male: a, pereopod 1; b, pereopod 2; c, pereopod 3; d, pereopod 4; e, pereopod 5; f, pereopod 6; g, pereopod 7. Scale bars = 100μm.

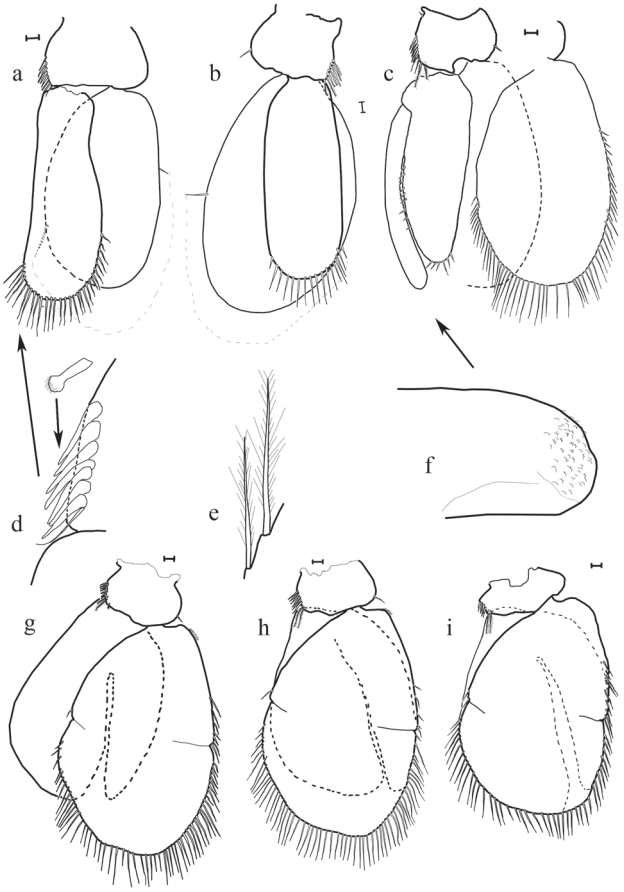


Fig. 5. *Catailana whitteni*, new species. Paratype male: a, pleopod 1, setation of endopodite omitted, only first and last setae drawn and limits of others delineated; b, pleopod 2 female, setation of endopodite omitted, only first and last setae drawn and limits of others delineated; c, pleopod 2 male, endopodite and exopodite set-apart; d, coupling hooks of pleopod 1 particular; e, setation of exopodites; f, apex of appendix masculina particular; g–i, pleopods 3–5. Plumosity of all exopodite's setae omitted. Scale bars = 100 μm.

propodial organ absent in both sexes. Genital papillae, about 4 times longer than larger (about 300 μm in length in examined specimen), reaching half of sympodite of pleopod 1. Endopodite of pleopods 3–5 bifid. Pleotelson bearing about 25 tiny plumose setae. Uropod sympodite external margin flat, externally protruding from lateral margins of pleotelson, endopodite slightly larger, longer than exopodite, both bearing short setae at apex.

Description. Antennula, first article of peduncle subquadrangular with 1 plumose seta (PS) on antero-distal corner, second twice length of first one and with 2 PS on antero- and postero-distal corners, anterior corner bearing 2 simple setae, third article 1.2 times longer than second one and bears on distal margin 2 PS 1 medial and 1 on anterior corner, 4 simple setae between them, fourth article very short bearing 2 distal paramedial PS. Flagellum first article naked, following articles with varied number of aestetascs (a) and simple setae (s) on distal margin flagellar formula of one of specimens examined as follows: 1a2s, 3a, 1a, 3a3s, 4a, 4a3s, 3a1s, 1a3s, 2a3s, 3a, 3a3s, 3a1s, 2a3s, 2a, 1a2s, 1a2s, 1a2s, 1a, last article bears 4 simple apical setae.

Antenna, peduncle first article small, naked, second with few tiny setae on anterior margin, third one with 3 simple setae on antero-distal corner, fourth article as long as sum of 2 previous ones with 5 simple setae on distal antero-distal corner, fifth article as long as sum of 3 previous ones, with 1 PS and 9 simple setae on antero-distal corner, 3 and 1 simple setae present on distal margin and posterior corner, respectively. Flagellum with about 50 subequal articles bearing distally 1/2 groups of 3/4 simple setae, last article with 3 distal simple setae.

Lamina frontalis, narrow, about 5 times longer than larger, strongly tridimensional, slightly inflated in rostral part which is about 2 times larger than proximal one, separating base of antennae, not separating antennulae.

First maxilla, exite with 12 strong setae, in 2 rows, 5 of which DS, endite with 3 long PS and 2 thin, simple setae.

Second maxilla, external and medial lobes with 6 (4 in female) and 5 simple setae, respectively, endite with 15 SS and 2 PS on inner corner.

Left mandible, with 4 strongly chitinised teeth, lacinia mobilis with 15/16 lifting spines, pars molaris with 18/22 teeth and tuft of hairy setae on posterior margin. Mandibular

palp with long medial seta on internal margin of second article and 26 setae in medial to distal margin of which proximal 3 simple and remainder SS, 3 long simple setae on distal margin. Third article curved with 15 marginal setae and 2 strong distal SS.

Right mandible, with 3 strongly chitinised teeth, lacinia mobilis with 20 lifting spines, pars molaris with 21 teeth.

Maxilliped, endite with 3 and 4 CH on the right and left, respectively, and 4 PS, 2 medial and 2 distal; palp articles with numerous simple setae on inner margin and a few on outer one.

Pereopods 1–3 haptorial, pereopods 4–7 ambulatory, growing in length posteriad. Basis of pereopod 1 with 4 simple setae on ventral margin and 1/2 on distal ventral corner, pereopods 2–7 bearing 1/2 PS and series (3–6) of tiny setae on dorsal margin and 1/2 simple setae on distal corner, 2 simple setae and 1/2 SAS present on distal ventral corner; basis of pereopods 1–7 strongly tridimensional.

Ischium of pereopod 1 with 3 simple setae on dorsal margin and 2 on distal ventral corner, 1 of which SAS; pereopod 2 and 3 with 2 SAS on distal dorsal corner and 2 simple ones on ventral corner; pereopods 4–7 with 3 SAS on both distal dorsal and ventral corners, ventral margin bearing 2 SAS and 2 simple setae (none on pereopod 7), dorsal margin bearing only proximal simple seta.

Merus of pereopod 1 with 3 SAS and 3 simple setae on ventral margin and 1 SAS and 2 simple setae on distal ventral corner, 2 simple setae on distal dorsal corner; pereopods 2–7 with 1 SAS on ventral margin (none on pereopods 4 and 5) and 2–4 SAS and 2 or no simple setae on ventral distal corner, 2–5 SAS present on distal dorsal corner.

Carpus of P1 with 1 SAS and 3 simple setae on distal ventral corner; pereopods 2 and 3 with 4 and 3 SAS, respectively, and 2 simple setae on distal ventral corner; pereopods 4–7 with 2–4 SAS on ventral margin and 2–4 SAS on distal ventral corner, 4–6 SAS present on distal dorsal corner.

Propodus of pereopod 1 with 5 SAS and 7 simple setae on ventral margin, 4 simple setae on distal ventral corner and 5 simple setae and 1 PS on distal dorsal corner; pereopods 2 and 3 with 23 and 16 SAS, respectively, on ventral margin and 3 simple setae on distal ventral corner and 3 simple (5 on pereopod 3) and 1 PS are on distal dorsal corner; pereopods 4–7 with 3 or 4 SAS on ventral margin and 2 or 3 on distal ventral corner, distal dorsal corner with 3/4 simple setae and one SAS.

Dactylus of pereopods 1–3 with 6 simple setae on ventral margin and a dactyl organ of 10 (pereopod 1) and 7 (pereopods 2 and 3) simple setae; pereopods 4–7 dactyl organ of 4 simple setae.

Unguis and accessory unguis smooth, simple in all pereopods.

Pleopod 1, sympodite with 7 coupling hooks, 1 simple seta on medial distal corner and 1 simple seta on lateral one. Endopodite elliptically narrow, about 3 times longer than larger, with 30 marginal plumose setae, exopodite ovoidal with about 50 marginal plumose setae.

Pleopod 2 males, sympodite with 5 coupling hooks, 4 setae, 2 of which PS on medial distal corner and 1 simple seta on lateral one**,** endopodite with about 23–24 PS on lateral to distal margin, exopodite with 63–67 similar marginal setae. Appendix masculina not exceeding exopodite in length, curved, with subparallel margins slightly depressed on lateral half, this depressed area covered by scale spines, and rounded apex bearing several scale spines on entire surface.

Pleopod 2 females, sympodite with 5 coupling hooks and 2 PS on medial distal corner and 1 simple seta on lateral one**,** endopodite with about 14 or 15 PS on distal margin, exopodite with about 60 similar marginal setae.

Pleopods 3–5, sympodite with 4/6 CH and 2/3 PS, exopodite suboval with partial transverse suture, laterally strongly incised, not evident medially, endopods naked, strongly bifid.

Uropods, sympodite triangular, somewhat longer than exopodite, laterally protruding from pleotelson, bearing 7 PS and 2 SAS paradistally on medial margin and 2 simple setae on lateral distal corner, about 15 tiny simple setae present laterally on dorsal surface and lateral margin. Exopodite narrower (about 2/3) and shorter (about 8/9) than endopodite, bearing 2 groups of setae, 1 simple seta and 1 SAS medially on lateral margin, a PS and 1 SAS are present on medial margin, several setae are present apically together with 1 SAS. Endopodite bears 3 SAS and several simple setae at apex, and 2 groups, 1 paradistal and 1 medial, of 2 PS, 1 SAS, and 2 paraproximal SAS on medial margin.

Etymology. *Catailana whitteni* is dedicated to the memory of the distinguished speleologist and former Chair of the IUCN Cave Invertebrates Specialist Group, Tony Whitten.

DISCUSSION

The occurrence of *C. whitteni*, new species, in the subterranean waters of a karst in China, situated far away from its potentially closest relatives, raises interesting questions about its origin and evolutionary history, and strengthens the hypothesis of ancient marine ancestors widely distributed in the Tethys Sea which have colonised continental groundwaters through littoral freshwater habitats (Baratti et al., 2010). In the Early to Late Jurassic and Early Cretaceous several transgressions led to the connection of the Mesotethys Ocean to the west up to the South China Sea. In this period, as stated by Zhou (2008): "Large quantities of Tethyan water carrying Tethyan organisms entered the area". This new taxon thus appears to be so far another example of stygobiont crustacean that has evolved from a widespread ancestor, inhabiting an ancient Tethyan Seaway during the Cretaceous period. Among stygobiotic

crustaceans, *Catailana* is not the only genus having the same kind of affinities. A similar situation has been documented and discussed also for other crustacean groups with closely related stygobiotic species that are recorded from anchialine and/or freshwater caves and other subterranean waters in southern North America, West Indies, Mediterranean, Asia Minor, eastern Africa, and Australia. These groundwater habitats developed in areas that were previously covered by or bordered the Tethyan Seaway. Stygobiotic crustacean groups with Tethyan ancestors, include remipedes, ostracods, thermosbaenaceans, isopods (anthurids, cirolanids, stenasellids), hadziid amphipods, and atyid shrimps (Magniez, 1981; Yager & Humphreys, 1996; Danielopol et al., 2000; Holsinger & Ruffo, 2002; Argano & Messana, 2019).

Hopefully the first stygobiont isopod and Tethyan relict from Chinese groundwter will not be the only one. Its geographical position and the extensive karst ecosystems, so far not well explored biologically, will result in more interesting and biogeographically significant discoveries of stygobiotic Isopoda.

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