



On *Putaoa*, a new genus of the spider family Pimoidae (Araneae) from China, with a cladistic test of its monophyly and phylogenetic placement

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Abstract

The spider genus *Putaoa* new genus (Araneae, Pimoidae) is described to place two species of pimoids from China, *Putaoa huaping* new species (the type species) and *P. megacantha* (Xu & Li, 2007) new combination. Parsimony analysis of morphological characters provides support for the monophyly of *Putaoa* and for its sister group relationship to the genus *Weintrauboa* Hormiga, 2003 and corroborates the monophyly of Pimoidae.

Key Words: Phylogeny, Taxonomy, Morphology, Araneoidea, Linyphiidae

Introduction

In a recent publication on Chinese spiders of the family Pimoidae Xu and Li (2007) described a new member of the genus *Weintrauboa* Hormiga, 2003 based on a single adult male specimen, *Weintrauboa megacanthus* Xu & Li, 2007. These authors expressed some reservations as to the correct generic placement of this new species, mainly because its pimoid embolic process (PEP) seemed to them quite different from the “typical PEP of *Weintrauboa* in morphology.” At the time of their description no females of *W. megacanthus* were known. We have recently collected both sexes of a similar species from the Guangxi Province in south China. Some of the shared morphological similarities between these two species seem to be apomorphic and suggest that this new species is a close relative of *W. megacanthus*. In this paper we describe and illustrate this new species, and along with *W. megacanthus*, we code it in a modified version of the cladistic matrix of Hormiga *et al.* (2005) for pimoid genera to test its phylogenetic placement. The results of our analysis suggest that the new species is sister to *W. megacanthus* and that this lineage is sister to a clade that includes the type species of *Weintrauboa*. We erect a new genus, *Putaoa*, for the lineage that includes the new species and *W. megacanthus*.

Materials and methods

Morphological methods are described in detail in Hormiga (2000, 2002). Taxonomic descriptions follow the format of Hormiga (1994a, 2002). Specimens were examined and illustrated using a Leica MZ16A stereoscopic microscope, with a camera lucida. Further details were studied using a Leica DMRM compound microscope with a drawing tube or an Olympus BX40 compound microscope. Digital images were taken with a Leica DFC 500 camera, except those of the tracheal system for which we used a Leica DFC 420C camera. The digital images depicting the habitus and general morphology are a composite of multiple images taken at

different focal lengths along the Z axis and assembled using the software package Leica Application Suite. A LEO 1430VP scanning electron microscope was also used to study and image morphological features. For SEM examination the specimens were prepared as described in Álvarez-Padilla and Hormiga (2008). Left structures (e.g., palps, legs, etc.) are depicted unless otherwise stated. Most hairs and macrosetae are usually not depicted in the final palp and epigynum drawings. All morphological measurements are in millimeters. Somatic morphology measurements were taken using a scale reticle in the dissecting microscope. The position of the metatarsal trichobothrium is expressed as in Denis (1949). Female genitalia were excised using carbon steel breakable blades or sharpened needles. Epigyna and palps were transferred to methyl salicylate (Holm 1979) for examination under the microscope, temporarily mounted as described in Grandjean (1949) and Coddington (1983). Tracheal morphology was studied by means of KOH digestion.

Anatomical abbreviations used in the text and figures

Male Palp

C	conductor
E	embolus
P	paracymbium
PCS	pimoid cymbial sclerite
PEP	pimoid embolic process
T	tegulum

Epigynum

CD	copulatory duct
FD	fertilization duct
S	spermatheca

Somatic morphology

AG	aggregate gland spigot(s)
ALE	anterior lateral eye(s)
ALS	anterior lateral spinneret
AME	anterior median eye(s)
CY	cylindrical gland spigot(s)
FL	flagelliform gland spigot(s)
PLE	posterior lateral eye(s)
PLS	posterior lateral spinneret
PME	posterior median eye(s)
PMS	posterior median spinneret

Cladistic analysis

Taxa. We have added the new species from the Guangxi Province, *W. megacanthus* and *W. yunnan* Yang, Zhu & Song 2006 to the character matrix of Hormiga *et al.* (2005), which included, in addition to the aforementioned species, two other *Weintrauboa* species, four species of *Pimoa*, *Nanoa enana* Hormiga, Buckle and Scharff, 2005 and 21 linyphiid species. We also scored representatives of three other araneoid families (Tetragnathidae, Theridiosomatidae, and Theridiidae) to root the “linyphioids.” The goal of this analysis is to study the placement of the new species and of *W. megacanthus* within the linyphioids. The Linyphiidae sample attempts to represent morphological diversity at the subfamilial level. The matrix includes a total of 34 taxa.

Characters. Most of the characters used in the current analysis are those used in Hormiga *et al.* (2005). A few additions and/or modifications of the aforementioned characters were introduced to accommodate the new taxonomic sample (see Appendix 1). Six of the 82 characters in the matrix are parsimony uninformative but are kept because they may be useful with a different taxonomic sample.

Analyses. The character matrix was edited and managed using the program Mesquite version 2.0 (Maddison & Maddison 2007). The parsimony analyses were performed using the computer program TNT version 1.1 (Goloboff *et al.* 2007) using both equal weights and implied weights (Goloboff 1993). Mesquite version 2.0 and WinClada version 1.00.08 (Nixon 1999) were used to study character optimizations on the cladograms. Ambiguous character optimizations were resolved so as to favor reversal or secondary loss over convergence (Farris optimization or ACCTRAN). The 18 multistate characters in the matrix were treated as non-additive (unordered or Fitch minimum mutation model; Fitch 1971). Bremer support indices (Bremer 1988) were calculated in TNT using the macro "bremer.run." Parsimony jackknife indices (Farris *et al.* 1996) were also calculated in TNT using 10,000 replicates (traditional search with TBR), a 0.36 removal probability and collapsing groups with a frequency below 50% (both clade support indices are reported in Fig. 12).

Results

Heuristic searches in TNT under equal weights, collapsing branches if the minimum length is 0 and performing 1000 replicates of TBR resulted in four minimal length trees of 205 steps (the best score was hit 1000 times), with ensemble consistency and retention indices of 0.52 and 0.75, respectively (after exclusion of the six uninformative characters the consistency index is 0.50). Two nodes are collapsed in the strict consensus cladogram (Fig. 12). In all minimal length cladograms the new species from the Gunagxi province is sister to *W. megacanthus*, and this lineage is sister to a clade composed of *W. contortipes* (Karsch, 1881), *W. chikunii* (Oi, 1979) and *W. yunnan*. The monophyly of *Putaoa* is supported by four unambiguous transformations: distinctively large and long macrosetae on cymbium and on male pedipalpal tibiae (characters 4 and 41, respectively), absence of a median apophysis (character 23) and the short length of its embolus (character 27). Implied weights analyses in TNT under $k = 3, 16$ and 12 resulted in the same topology for the internal relationships of Pimoidae (that is, identical to that found under equal weights).

Discussion

The results of the phylogenetic analysis suggest that the new species from the Guangxi province is the sister taxon of *W. megacanthus*. We have erected a new genus, *Putaoa*, for the lineage that includes these two species (*P. huaping* new species and *P. megacantha* new combination). Both species differ from the members of its sister clade (the genus *Weintrauboa*) in the details of the male genitalic morphology. Ranking the lineage that includes *P. huaping* and *P. megacantha* as a new genus should facilitate the diagnoses of these two genera. The palpal morphology of *Putaoa* (Figs. 3, 4, 5, 6, 8A, B) is indeed unique and different from other pimoids, although this genus is clearly a member of the family Pimoidae. As such it has a membrane on the tegulum that based on topology and special similarity we hypothesize homologous to the araneoid conductor (Figs. 6A-D). *Putaoa* also shares with other pimoids the presence of an ectal cymbial process (Fig. 8B). We could not find any evidence of an araneoid median apophysis, a tegular structure that among pimoids is found in *Nanoa enana*, many *Pimoida* species, and in *Weintrauboa*, although it is rather inconspicuous in the species of the latter genus (Hormiga *et al.* 2005; Hormiga 1994a; Hormiga 2003). The pimoid cymbial sclerite is large and continuous with the paracymbium, its distal end being scoop like (as in *Weintrauboa*) (Figs. 5D, F). The pimoid embolic process (PEP) is rather different in the two species of *Putaoa* and in both it differs from the

embolic processes in the rest of pimoids. In *P. huaping* the PEP is bifurcated (Fig. 3B, 6A-C, F); the branch that is continuous with the tegular margin being pointed and very sclerotized. The other branch of the PEP is smaller and is bifurcated at the tip. The PEP of *P. megacantha* is rather different, both in size and morphology (Xu & Li 2007: figs. 79-81) and again, unlike the PEP of any of the pimoids described so far. The embolus of both *Putaoa* species is short, especially when compared to that of *Weintrauboa*, and it has a basal enlargement that is connected to the basal bifurcation of the PEP (Figs. 3B, 6F). The ectal region of the tegulum that is prolonged into the base of the PEP resembles the suprategular region of some linyphiids (Fig. 3B). Topological correspondence and morphological similarity suggests that the base of the PEP may be homologous to the linyphiid suprategulum (it is essentially the same region of the tegulum). While sharing a number of common morphological features (both plesio- and apomorphic), the palps of pimoids have proven to be morphologically quite diverse across lineages.

SYSTEMATICS

Family Pimoidae Wunderlich, 1986

Putaoa New Genus

Type species: *Putaoa huaping* new species

Etymology: Derived from *pu tao*, grape in Chinese (using Pinyin as a system of representation of Standard Mandarin), analogous to how *Weintrauboa* is derived from the name Weintraub which in turn comes from the German word for grape (*weintraube*). The ending *-oa* follows that of other genera in the family Pimoidae. *Putaoa* is an undeclinable name and feminine in gender.

Diagnosis. Males of *Putaoa* species differ from other pimoids in having distinctively large macrosetae on the pedipalpal tibia and/or cymbium and by the absence of typical cuspules such as those found in *Pimoida* species. In addition, *Putaoa* species lack a median apophysis, have a relatively short embolus and the metatarsus I is unmodified (while sinuous in the males of most *Weintrauboa* species). Females are diagnosed by their relatively flat epigynum with lateral openings and medial fertilization ducts (the female of *P. megacantha* remains undescribed).

Description. Small to medium sized pimoid spiders, total length 3.70–4.27 in males, 3.15–4.25 in females (note that only the females of *P. huaping* are known). Carapace longer than wide, 1.95–2.35 long in males, 1.60–2.40 in females, with clearly discernable thoracic fovea (Figs. 1A, D). Sternum longer than wide, pointed in posterior region, slightly projecting between coxae IV (Fig. 1B). AME fairly close together, roughly similar in diameter to the rest (Fig. 1C); LE juxtaposed. Clypeus height 1.30–1.60 times an AME diameter. Chelicerae large (Fig. 1C, 7A), with three or four prolateral and three or four retrolateral teeth in males and with five prolateral and four retrolateral teeth in females; stridulatory striae absent (Figs. 8D, 9B). Legs slightly longer and slender in adult male; legs with dark annuli in both sexes. Femur I (male/female) 1.17–1.65/1.07 times the length of cephalothorax. Tibia I–IV with two dorsal spines. Trichobothrium metatarsus I 0.25–0.32; trichobothrium metatarsus IV present. Leg autospasy at patella-tibia junction. Abdomen ovoid, longer than wide, dark brown/gray with lighter marks and some guanine spots (Figs. 1A, 2B). Colulus large and fleshy, with setae. Spinnerets (studied in one male and one female of *P. huaping*) typical of a “linyphioid” (Hormiga 1994a, b)(Figs. 7F, 9C–F). ALS with ca. 30 piriform spigots. PMS with two aciniform spigots between the cylindrical and the minor ampullate spigot. PLS with four to six aciniform spigots between cylindrical spigots; base of the peripheral cylindrical spigot larger than base of distal one. Flagelliform and aggregate spigots (the so-called “araneoid triplet”) are well developed in females (Fig. 9F), reduced to nubbins in adult males. Epiandrous fusules arranged linearly along posterior margin of epigastric furrow,

most of them in groups of two to four fusules emerging from a common circular pit (Figs. 7C, E). Tracheal system morphology haplotracheate, consisting of two lateral tubes and two shorter medial ones (Fig. 10A, B). Female pedipalp with tarsal claw. Male pedipalp with large macrosetae on tibia and/or cymbium and without typical cusps. Cymbium with an ectal marginal process. Paracymbium heavily sclerotized, linguiform and continuous with distally concave pimoid cymbial sclerite and connected to base of the cymbium by means of a membrane. Conductor tongue-like and without papillae, in a relatively apical position on the tegulum, narrowly connected to tegular cuticle, (in *P. huaping* the conductor is located at the edge of an apical region that is relatively less sclerotized than the rest of the tegular cuticle; Figs. 3A-C, 6A-D). Median apophysis absent. Pimoid embolic process of varying morphology (see species descriptions and diagnoses for details). Embolus non filiform, relatively short, without embolic flap. Epigynum protruding less than its width, with lateral openings and medially oriented fertilization ducts (Figs. 4A-C).

Phylogenetics. The monophyly of *Putaoa* is supported by the following four unambiguous synapomorphies: large and long macrosetae on cymbium and on male pedipalpal tibiae (characters 4 and 41), absence of a median apophysis (character 23) and the relatively short embolus (character 27). The sister group of *Putaoa* is the genus *Weintrauboa*.

Natural History. See under *Putaoa huaping* new species.

Composition. Two species, *Putaoa huaping* new species and *P. megacantha* (Xu & Li, 2007) new combination.

Distribution. Known from the Guangxi and Sichuan provinces of China (see map in Fig. 11).

Putaoa huaping new species (Figs. 1-11)

Etymology. The species epithet is a noun in apposition, taken from the type locality.

Types. Male holotype, Cujiang Station, Huaping National Nature Reserve, Guangxi Prov., alt. 850 m, N25.60338°, E109.90554°, coll. L. Tu, 3 Nov. 2007 (#1386; Deposited in California Academy of Sciences, San Francisco, CAS). Paratypes: 1 female (same data as holotype, CAS); 1 male, 8 females, Longtangjie Village, Cujiang Station, Huaping National Nature Reserve, Guangxi Prov., alt. 802 m, N25.60405°, E109.90138°, coll. K. Liu, 6 Nov. 2007 (#1372; Deposited in Capital Normal University, Beijing); 1 male, 1 female, Xietangwan Village, Cujiang Station, Huaping National Nature Reserve, Guangxi Prov., alt. 804 m, N25.60235°, E109.90889°, coll. K. Liu, 4 Nov. 2007 (#1354; deposited at Museum of Comparative Zoology, Harvard University); 2 females, Xietangwan Village, Cujiang Station, Huaping National Nature Reserve, Guangxi Prov., alt. 804 m, N25.60235°, E109.90889°, coll. K. Liu, 4 Nov. 2007 (#1354; deposited at American Museum of Natural History, New York).

Diagnosis: Males of *P. huaping* can be most easily distinguished from other pimoid species by a series of extremely large and robust macrosetae on the pedipalpal tibia (Figs. 3A, 5B, C, E); these macrosetae are thicker and more numerous than those of its sister species, *P. megacanthus*. The unique shape of the PEP, highly bifurcated, is also diagnostic (Fig. 3B, 6A-C, F). Females of *P. huaping* are diagnosed by the rather flat epigynum with lateral openings (Figs. 4A-C).

Description.

Male (holotype; Figs. 1A-D; see also genus description). Total length 3.82. Cephalothorax 2.00 long, 1.7 wide, 1.15 high. Sternum 1.03 long, 1.00 wide. Abdomen 2.00 long, 1.68 wide. AME diameter 0.15. Clypeus height 1.48 times one AME diameter. Carapace with deep longitudinal fovea (Figs. 1A, D). Chelicerae with three prolateral and four retrolateral teeth; stridulatory striae absent (Fig. 8D). Legs annulated. Femur I 2.33 long, 1.17 times the length of cephalothorax. Metatarsus I trichobothrium 0.25. Metatarsus IV trichobothrium present. Pedipalp as in Figs. 3, 4, 5, 6, 8A, B. Pedipalpal tibia with one prolateral and two retrolateral trichobothria.

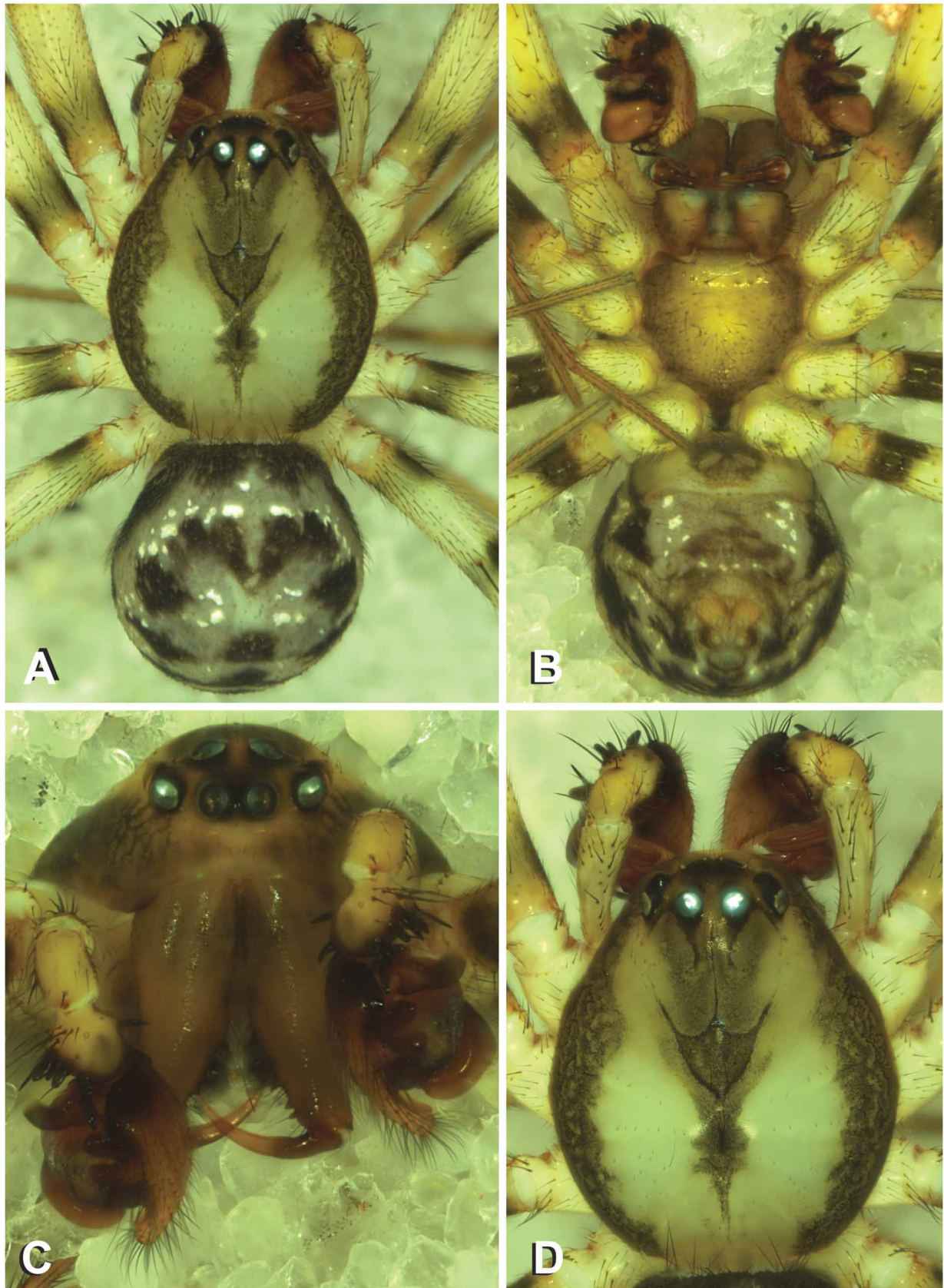


FIGURE 1. *Putaoa huaping* new species. Male from Huaping National Nature Reserve. A, dorsal; B, ventral; C, anterior; D, prosoma, dorsal.

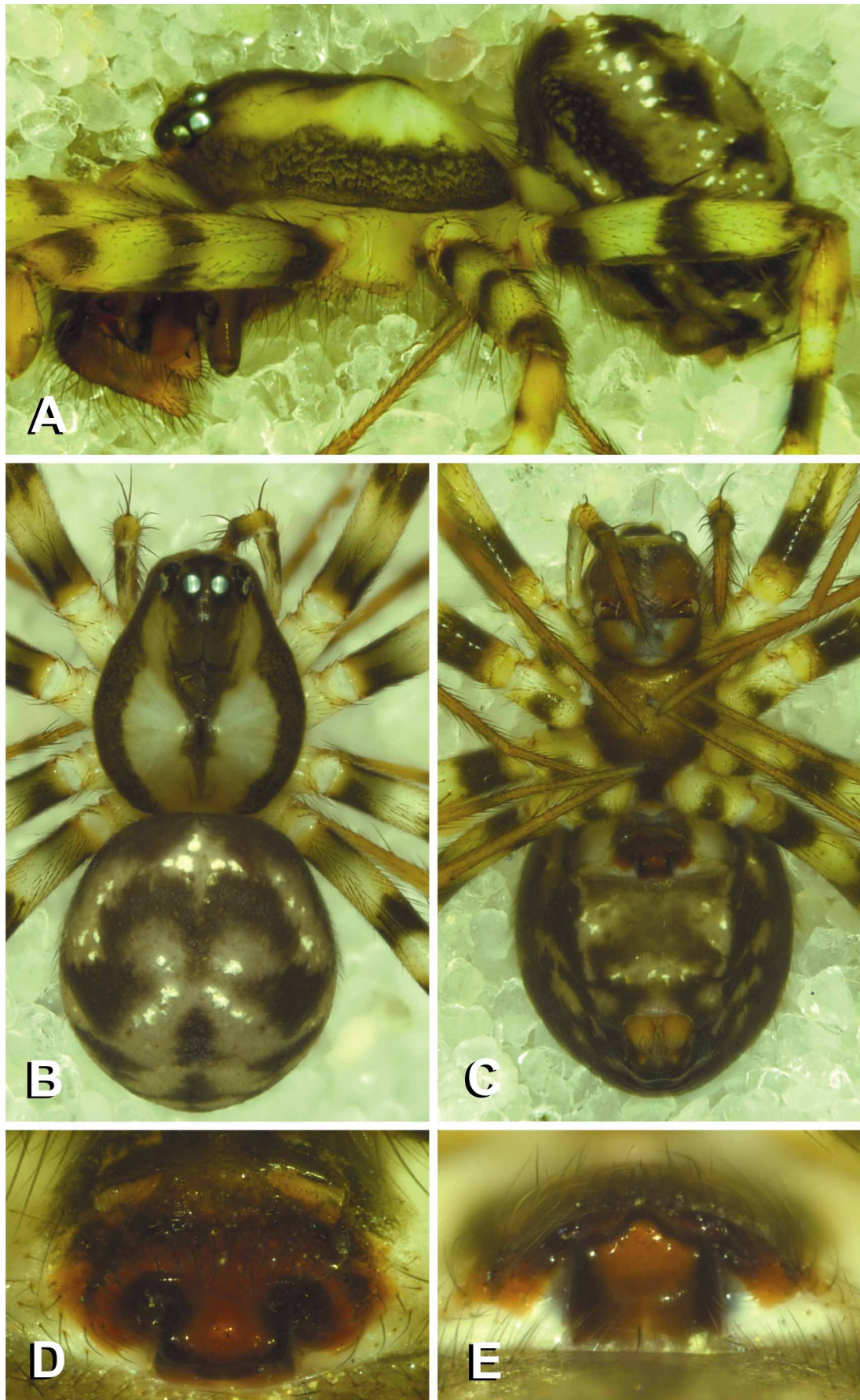


FIGURE 2. *Putaooa huaping* new species. Male (A) and female (B-E) from Huaping National Nature Reserve. A, lateral; B, dorsal; C, ventral; D, epigynum, ventral; E, caudal.

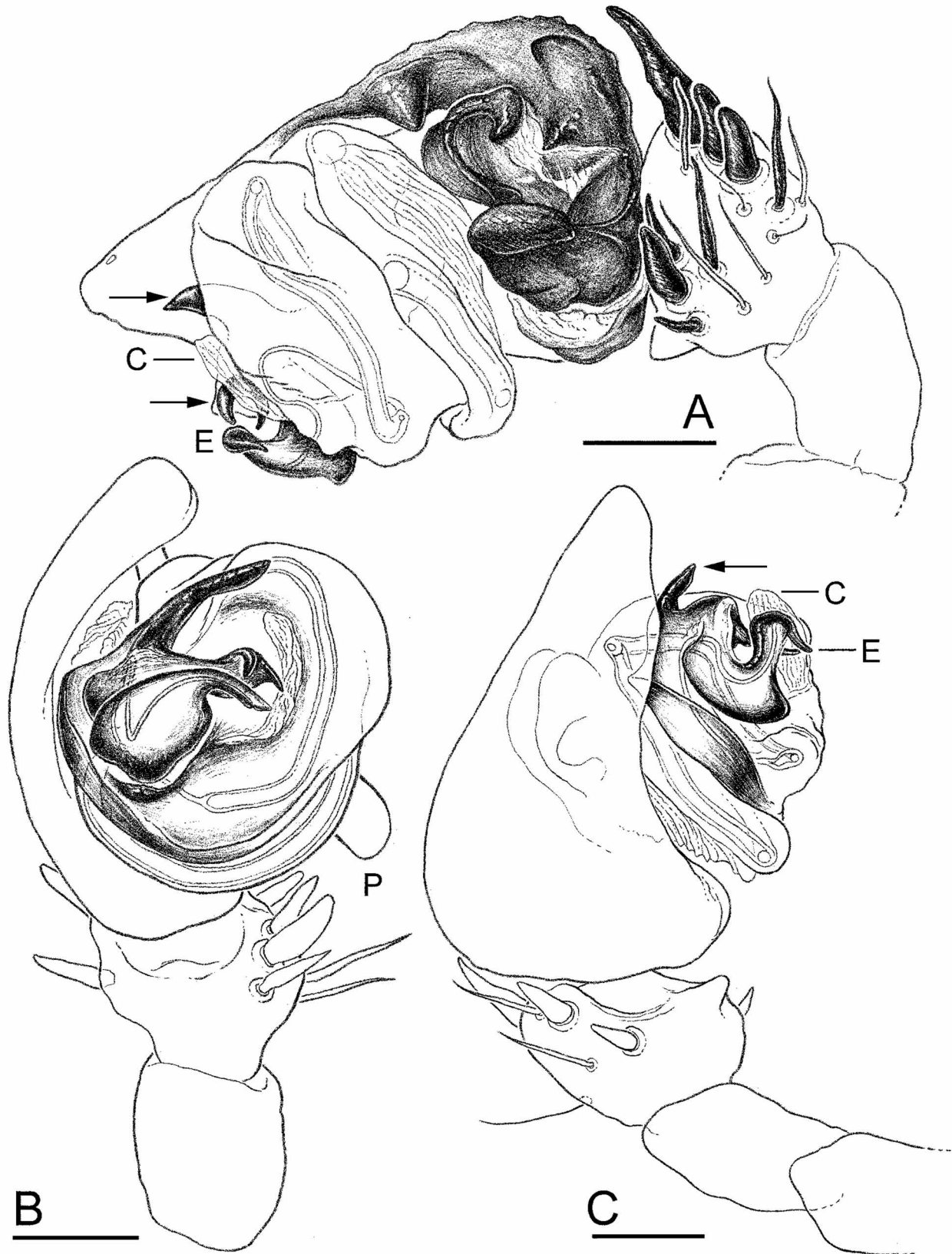


FIGURE 3. *Putaoa huaping* new species. Male pedipalp. A, ectal; B, ventral; C, dorsomesal (arrows point out to apical ends of pimoid embolic process). Scale bar, 0.2 mm.

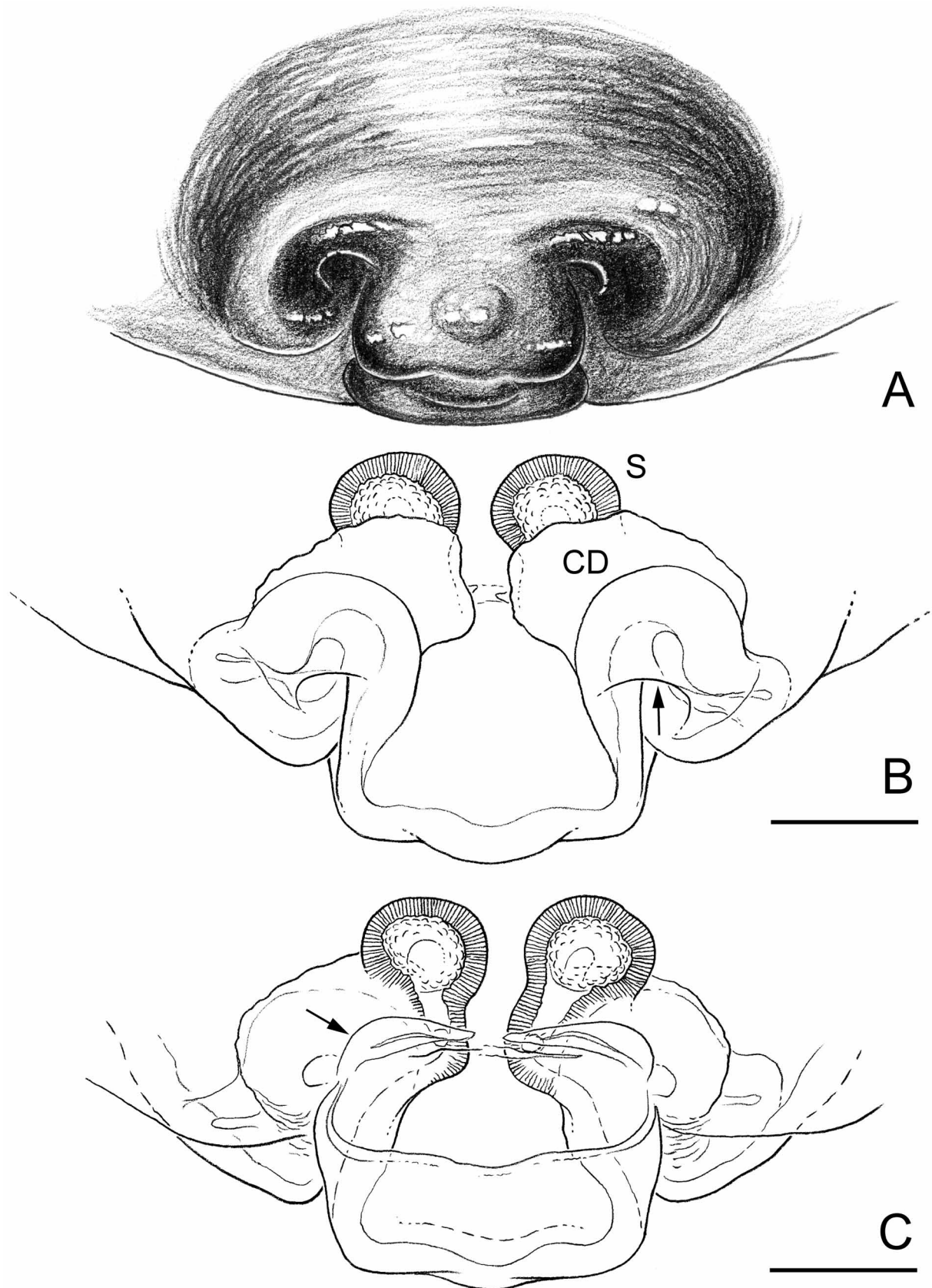


FIGURE 4. *Putaoa huaping* new species. Epigynum. A, ventral; B, dorsal (cleared); C, ventral (cleared). Scale bar, 0.1 mm.

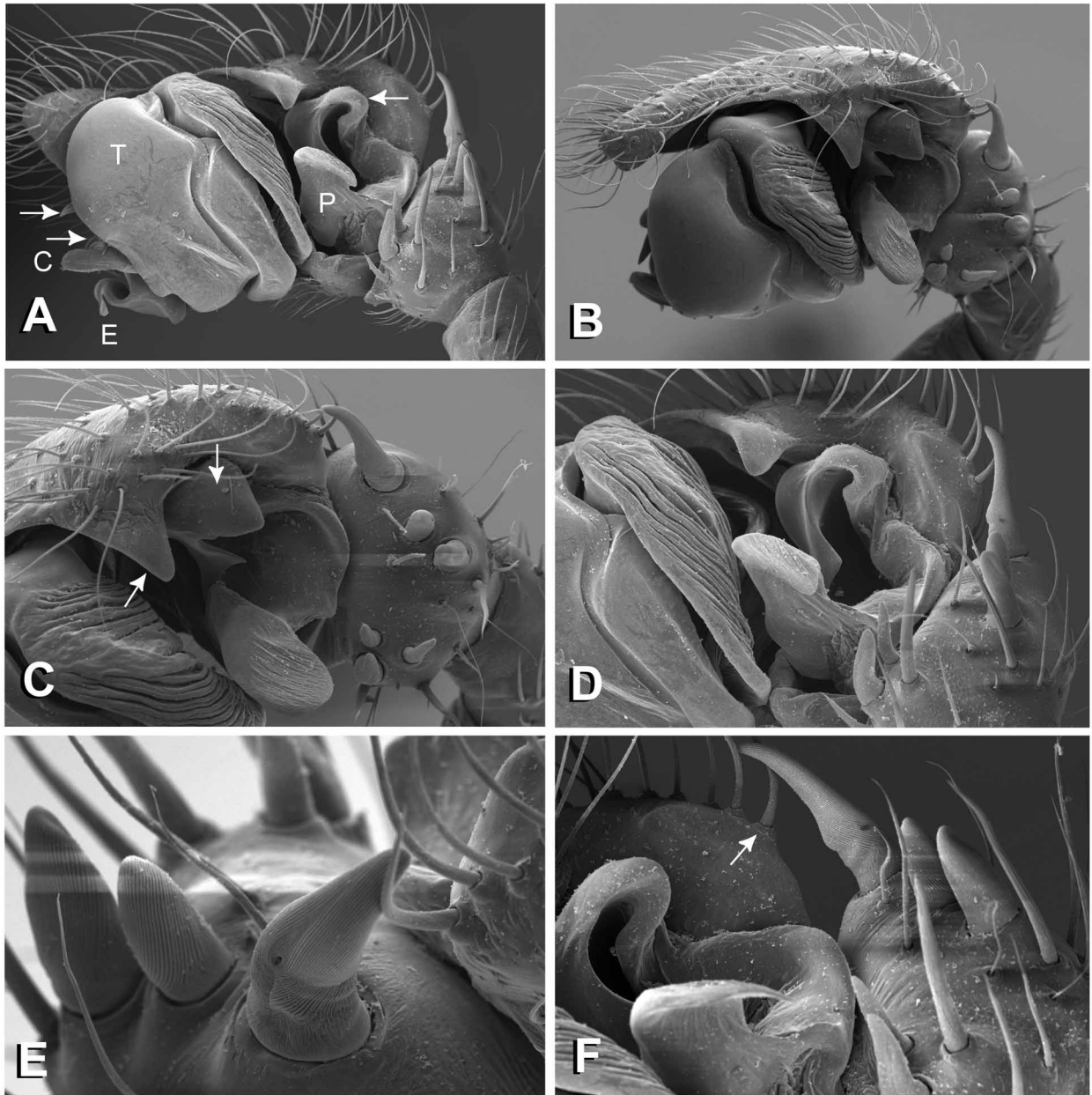


FIGURE 5. *Putaaoa huaping* new species. Male pedipalp. A, ectoventral (right point arrows indicate distal end of pimoid embolic process; left pointing arrow indicates pimoid cymbial sclerite); B, ectal; C, dorsoectal (left arrow points cymbial process; right arrow points pimoid cymbial sclerite); D, caudoventral; E, tibial macrosetae (note pore on macroseta at the center of image); F, paracymbium, pimoid cymbial sclerite and tibial macrosetae (arrow points to row of enlarged cymbial macrosetae).

Female (paratype, same locality as male; Figs. 2B, C). Total length 3.92. Cephalothorax 2.00 long, 1.43 wide, 1.13 high. Sternum 1.00 long, 0.93 wide. Abdomen 2.45 long, 1.90 wide. AME diameter 0.16. Clypeus height 1.30 times one AME diameter. Chelicerae with five prolateral and four retrolateral teeth; stridulatory striae absent (Fig. 9B). Legs annulated. Femur I 2.13 long, 1.07 times the length of cephalothorax. Metatarsus I trichobothrium 0.26. Epigynum as in Figs. 2D, E, 4A-C and 8E, F.

Variation. Male cephalothorax length ranges from 1.95 to 2.35 (n = 4). Female cephalothorax length ranges from 1.60 to 2.40 (n = 23). Male total length ranges from 3.70 to 4.25 (n = 4). Female total length ranges from 3.15 to 5.10 (n = 23).

Natural History. *Putaoa huaping* has been collected in native forests in China at altitudes between 700 and 1,000 m. Their webs are horizontal, thin and flat, built on the rock walls found on the side of mountain's roads, usually covered by mosses. During day time the spiders normally hide under the adjacent mosses.

Distribution. Known from the Guangxi province, in south China.

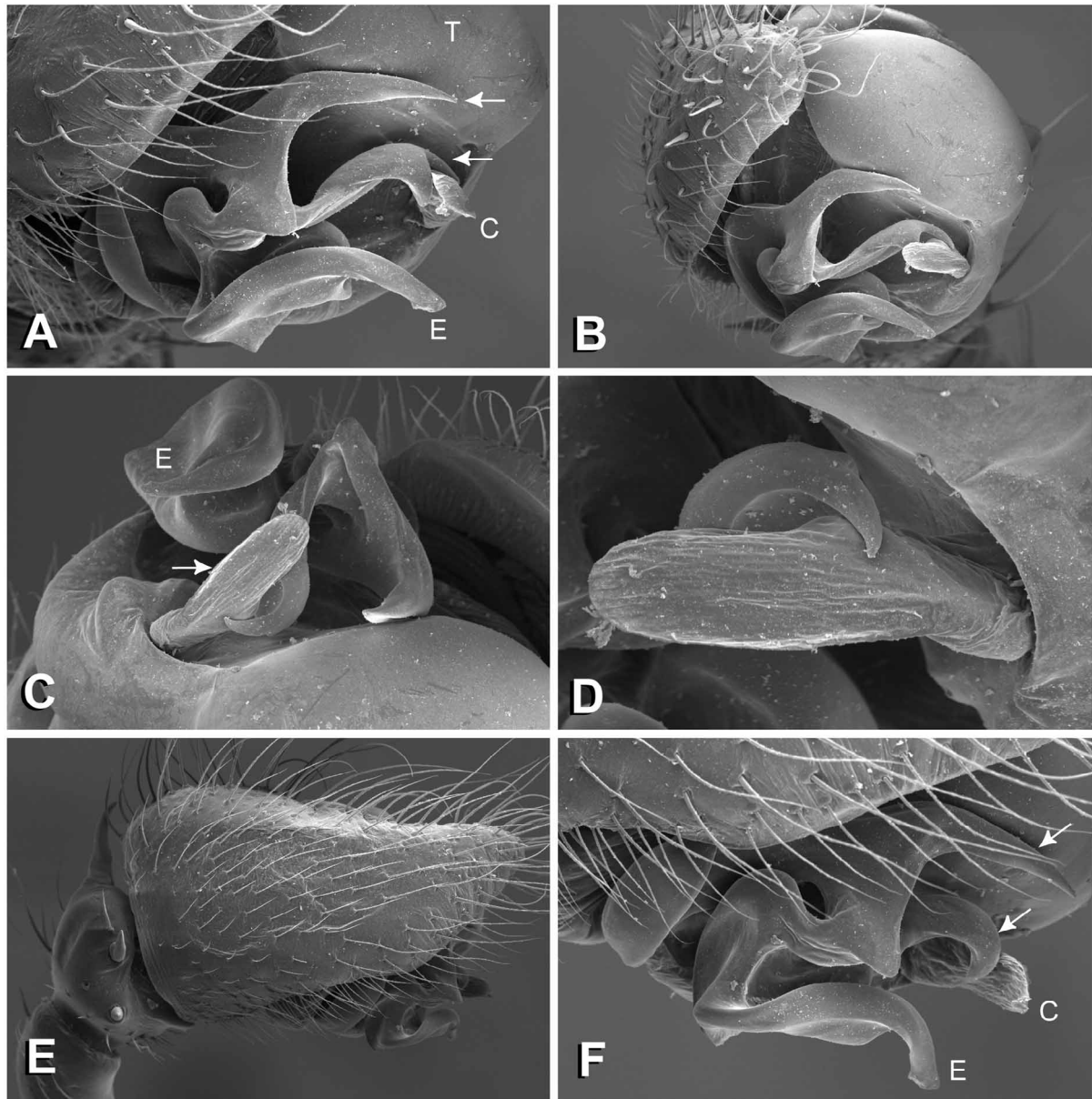


FIGURE 6. *Putaoa huaping* new species. Male pedipalp. A, mesoapical (right pointing arrows indicate pimoid embolic process); B, apical; C, apicoventral (arrow points out to conductor); D, conductor and part of pimoid embolic process; E, dorsal; F, mesal (arrows indicate embolic process).

Additional specimens studied (all deposited in Capital Normal University, Beijing): 2 females, Mt. Maozhusan, Fuping Station, Huaping National Nature Reserve, Guangxi Prov., alt. 942 m, N25.60328°, E109.95941°, coll. L. Tu, 30 Oct. 2007 (#1310); 1 male, 1 female, Square-bamboo Forest, Hongtan Station, Huaping National Nature Reserve, Guangxi Prov., alt. 828 m, N25.60760°, E109.94751°, coll. L. Tu, 31 Oct. 2007 (#1314); 2 females, Xiaojialu Village, Hongtan Station, Huaping National Nature Reserve, Guangxi Prov., alt. 936 m, N25.60931°, E109.95181°, coll. L. Tu, 1 Nov. 2007 (#1340); 1 male, 1 female, Bijiaye River, Hongtan Station, Huaping National Nature Reserve, Guangxi Prov., alt. 932 m, N25.60876°, E109.94865°, coll. L. Tu, 1 Nov. 2007 (#1345); 1 female, Hongmaochong Village, Cuijiang Station, Huaping

National Nature Reserve, Guangxi Prov., alt. 688 m, N25.59757°, E109.90448°, coll. K. Liu, 5 Nov. 2007 (#1361); 1 male, 6 females, *Cathaya argyrophylla* Forest, Cujiang Station, Huaping National Nature Reserve, Guangxi Prov., alt. 992 m, N25.60403°, E109.91103°, coll. K. Liu, 7 Nov. 2007 (#1382).

***Putaoa megacantha* (Xu & Li, 2007) new combination**

W. megacanthus Xu & Li, 2007: 499, figs. 75-81.

This species was recently described and illustrated, based on a single male specimen from the Sichuan Province (type specimen deposited at Institute of Zoology of the Chinese Academy of Sciences in Beijing; not examined). *Putaoa megacantha* is hypothesized to be sister to *P. huaping*. The female remains unknown. In this paper we provide a revised diagnosis in light of the description of *P. huaping* new species.

Diagnosis. Males of *P. megacantha* can be distinguished from other pimoids by the large and conspicuous macroseta at the base of the ectal cymbial margin (Xu & Li 2007: figs. 78 and 80-81). Both the embolus and the PEP are very different from those in *P. huaping* new species (compare Xu & Li 2007: figs. 79-81 to Figs. 3A-C). In *P. megacantha* the embolus is rather broad and forms a right angle with its base while in *P. huaping* the embolus is shorter and has a broad base. In *P. megacantha* the PEP is rather broad and forms a deep concavity while in *P. huaping* it is highly bifurcated and pointed.

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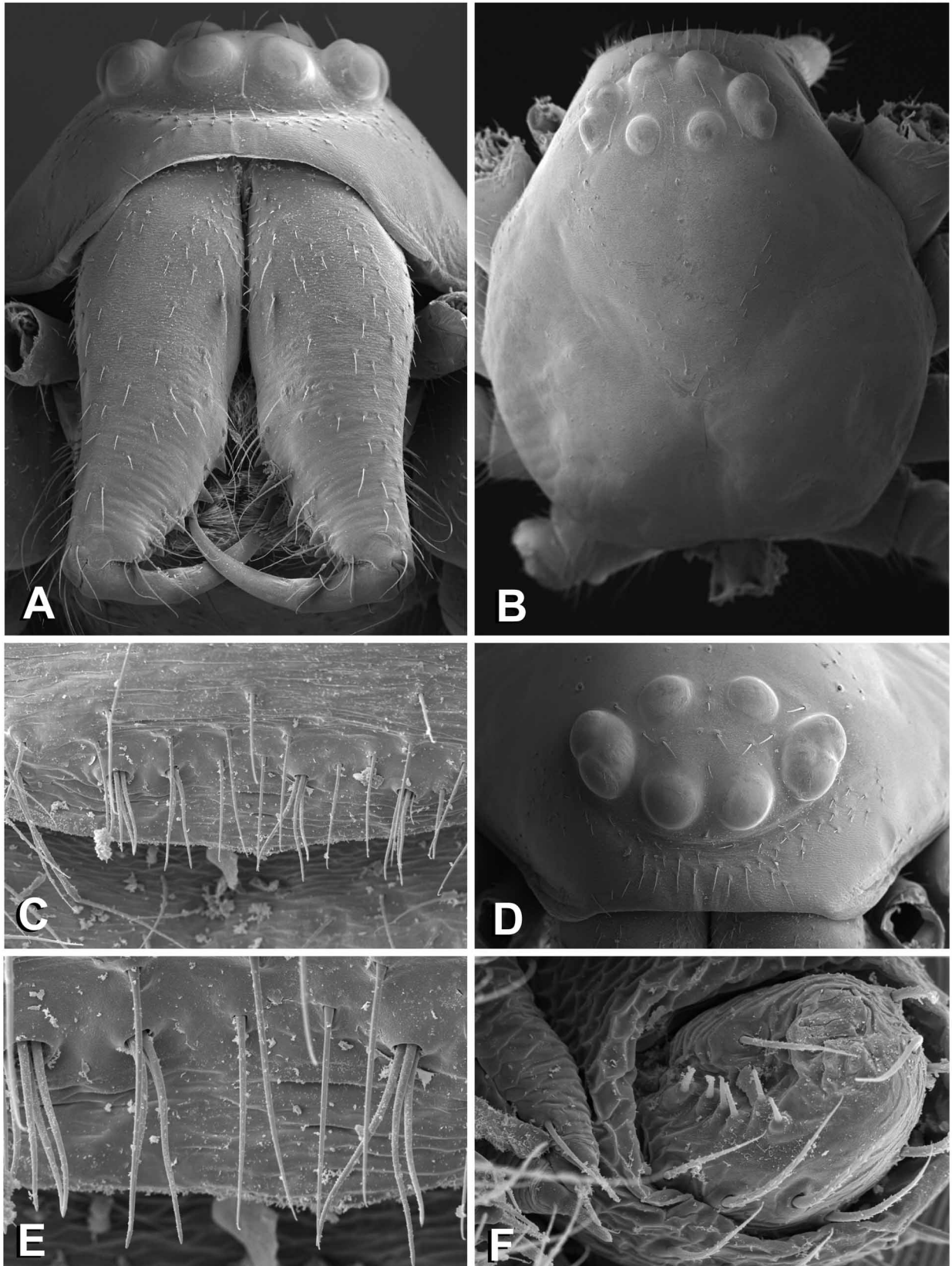


FIGURE 7. *Putaooa huaping* new species. Male. A, Prosoma, anterior; B, prosoma, dorsal; C, E, epiandrous fusules; D, eye region, anterodorsal; F, PLS with six aciniform spigots (right) and PMS with minor ampullate and two aciniform spigots (left).

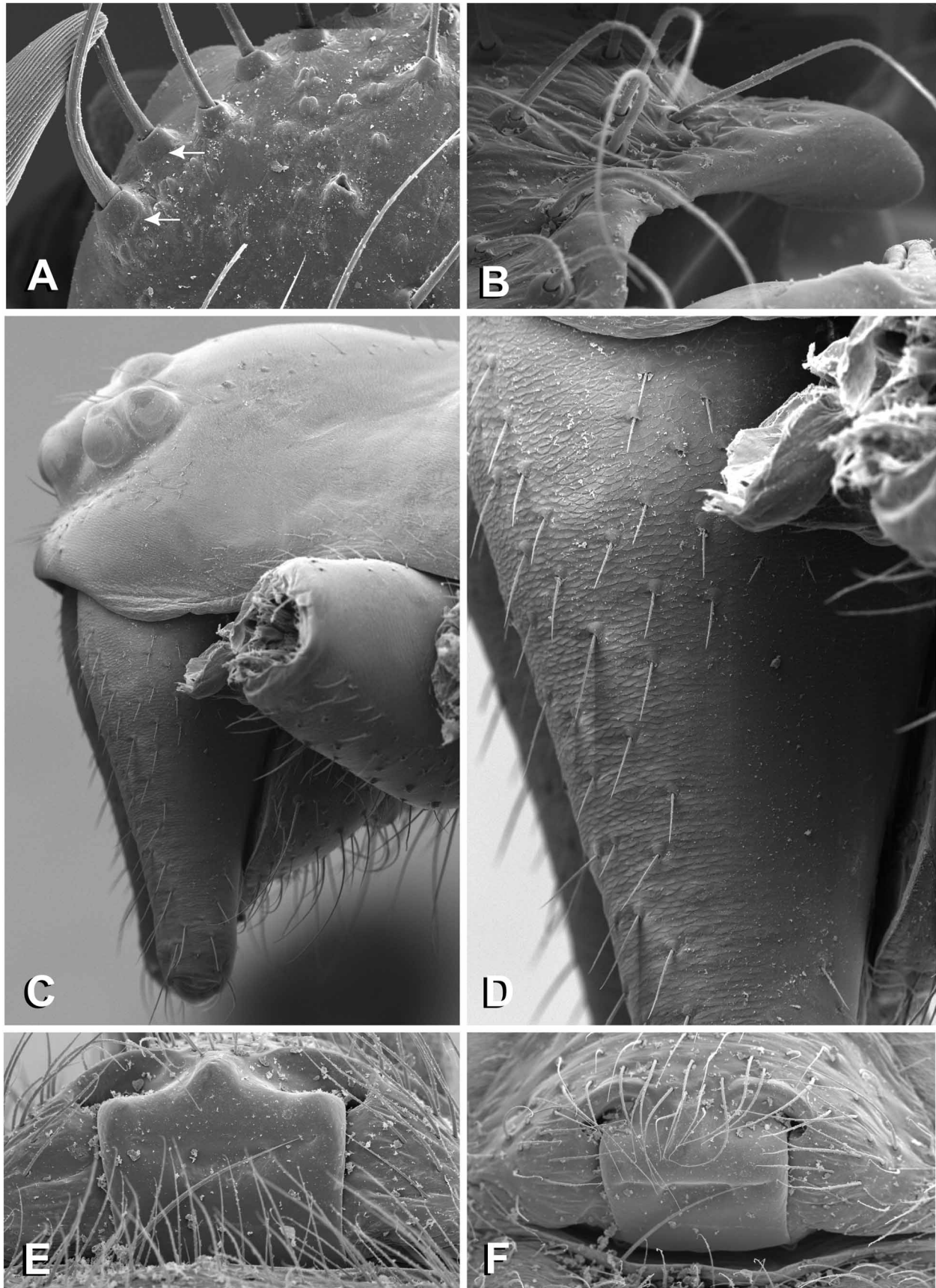


FIGURE 8. *Putaoba huaping* new species. Male (A-D) and female (E-F). A, basoectal cymbial margin macrosetae (arrows point out to enlarged macrosetae basis); B, ectal cymbial process; C, cephalic region, lateral; D, chelicera, ectal; E, epigynum, caudal; F, epigynum, ventral.

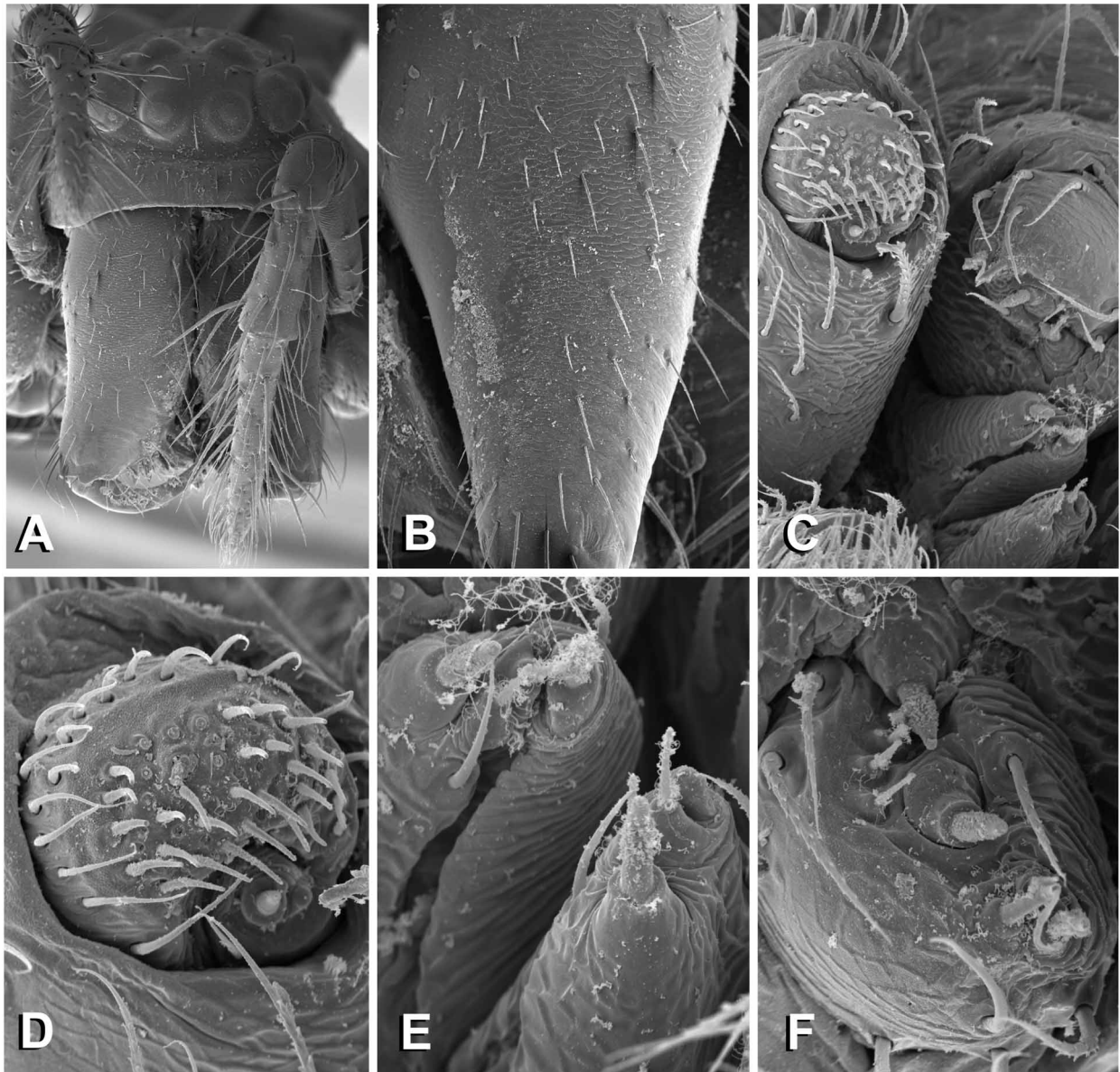


FIGURE 9. *Putaoa huaping* new species. Female. A, prosoma, anterior; B, chelicera, ectal; C, left spinnerets; D, ALS; E, PMS; F, PLS.

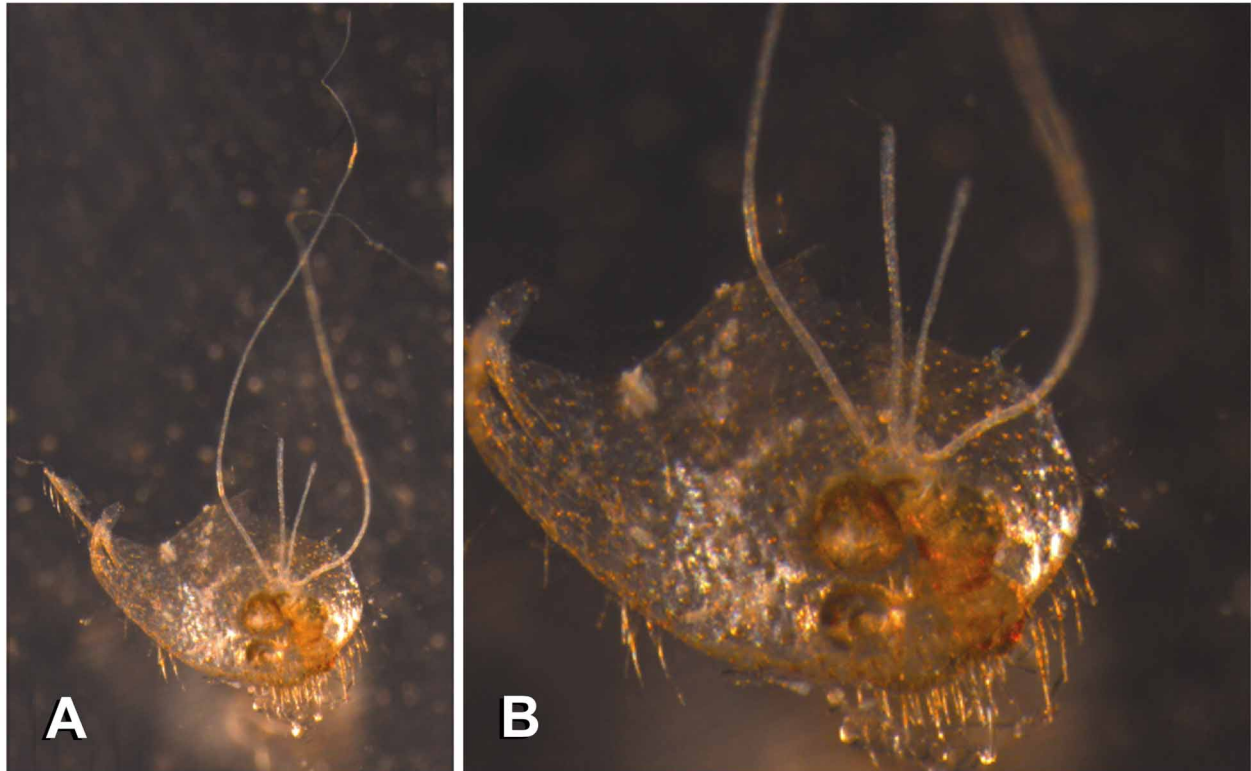


FIGURE 10. Tracheal system of *Putaoa huaping* new species (female) after dissection and digestion with potassium hydroxide. A, general view; B, detail.

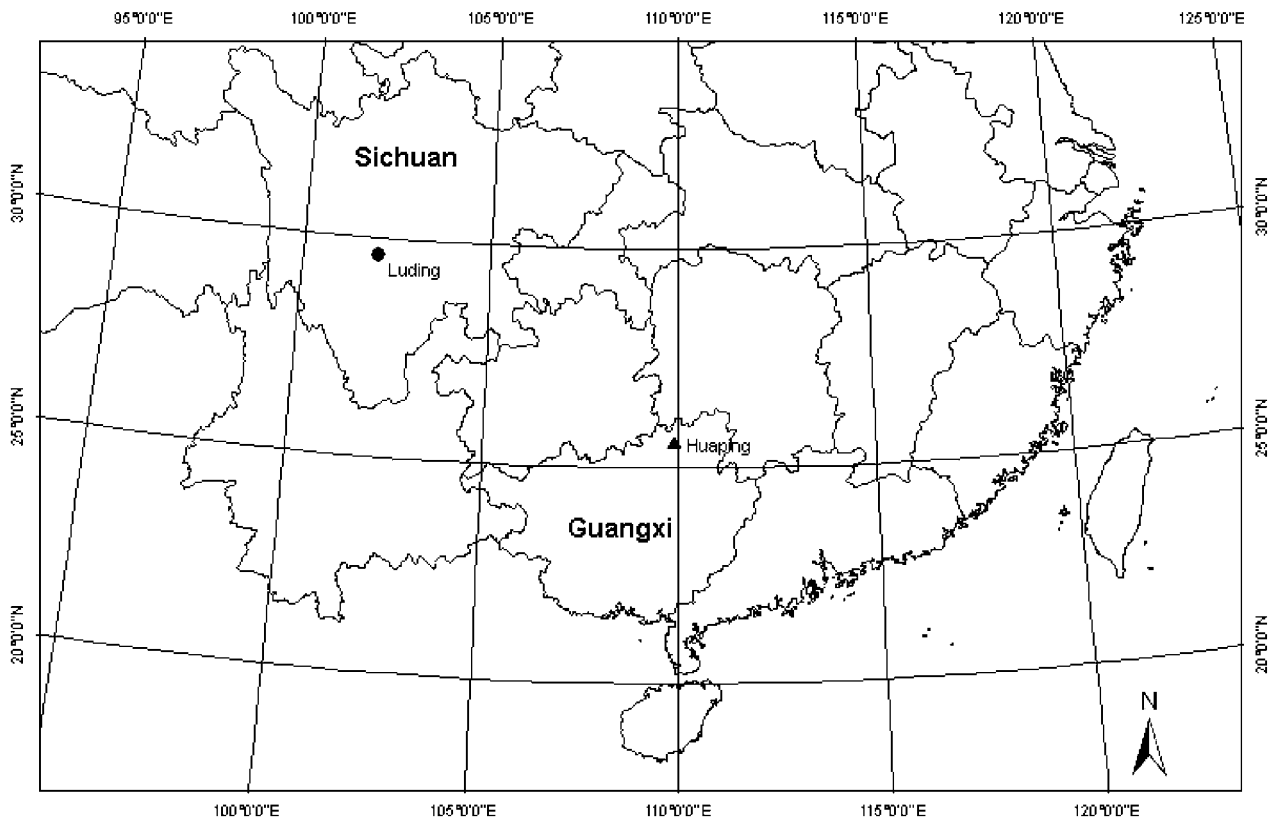


FIGURE 11. Collecting localities in China of *Putaoa huaping* new species (triangle; Guangxi Province) and *Putaoa megacantha* (circle; Sichuan Province).

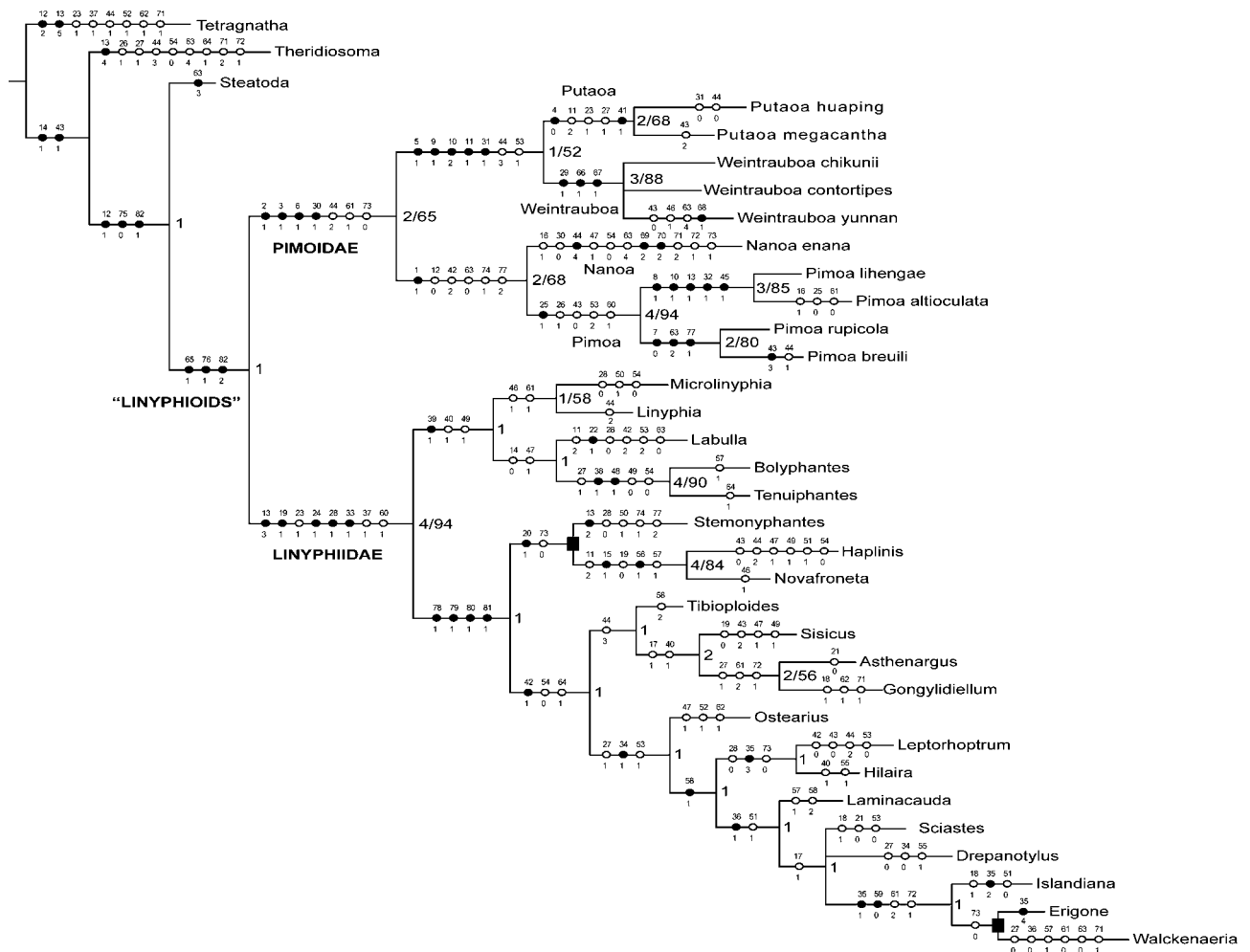


FIGURE 12. One of the four minimal length trees of 205 steps that result from the analysis of the data matrix presented in Appendix 1 (CI = 0.52, RI = 0.75). Exclusion of the six parsimony uninformative characters decreases the tree length to 196 steps and the ensemble consistency index to 0.5. Ambiguous character changes are resolved under “Farris optimization.” Closed circles represent non-homoplasious character changes. The two nodes that collapse in the strict consensus cladogram of the four most parsimonious trees are marked with a closed rectangle. Numbers at nodes indicate Bremer support / parsimony jackknife frequency (only those above 50% are reported). The basal trichotomy has been resolved according to the araneoid topology presented in Griswold *et al.* (1998); see text for additional details.

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Appendix 1

The characters used in this study have been largely taken from those presented in Hormiga (2003) with the modifications introduced in Hormiga *et al.* (2005). Most of the characters are discussed in detail in those publications as well as in Hormiga (1994a, b, 2000) and Miller and Hormiga (2004). Only new characters, recoded characters or modifications from previous state delimitations are discussed here (and those are marked with an asterisk in front of the character number). An example of a taxon exhibiting the new or edited described character states with reference to an illustration is given after the description. All multistate characters were treated as non-additive.

1. Alveolar sclerite: (0) absent; (1) present.
2. Ectal region of cymbium: (0) smooth (no process); (1) with ectal cymbial process.
- *3. Cymbial macrosetae: (0) all about the same size; (1) at least some modified (distinctively larger, bigger socket/base; Fig. 8A).
- *4. Larger cymbial macrosetae length: (0) long (many times its diameter; Fig. 8A); (1) short, cuspule type (*Pimoid breuili* (Fage), Hormiga 1994a: figs. 68-70).
- *5. Larger cymbial macrosetae location: (0) on cymbial process itself (*Pimoid breuili* (Fage), Hormiga 1994a: fig. 68); (1) on dorsal surface of cymbium, not on process (*Weintrauboa contortipes*, Hormiga 2003: fig. 1E, 5E). Characters 3-5 have been re delimited to accommodate the pedipalpal setae found in *Putaoa*.
6. Pimoid cymbial sclerite (PCS): (0) absent; (1) present.
7. Pimoid cymbial sclerite (PCS): (0) with membranous flap; (1) without membranous flap.
8. Pimoid cymbial sclerite (PCS): (0) attached/fused to paracymbium; (1) separate from paracymbium.
9. End of PCS: (0) scoop or concave (*Weintrauboa contortipes*, Hormiga 2003: fig. 1B, 5E); (1) "solid" (*Pimoid breuili*, Hormiga 1994a: fig. 44).
- *10. PCS-cymbium connection: (0) sclerotized and rigid; (1) membranous; (2) of intermediate degree of sclerotization.
- *11. Distal end of cymbium: (0) rounded (*Pimoid breuili*, Hormiga 1994a: fig. 53); (1) elongated (*Weintrauboa contortipes*, Hormiga 2003: fig. 1E); (2) conical (*Putaoa huaping*, Fig. 3A, 6E).
12. Paracymbium attachment: (0) integral; (1) intersegmental; (2) articulated.
13. Paracymbium morphology: (0) linguiform; (1) triangular; (2) *Stemonyphantes* type; (3) U or J shaped; (4) hook; (5) straight and narrow.
14. Paracymbium apophyses: (0) present; (1) absent.
15. Mynoglenine tegular apophyses: (0) absent; (1) present.
16. Tegular suture: (0) conspicuous; (1) subtle or absent.
17. Protegulum: (0) absent; (1) present.
18. Protegular papillae: (0) absent; (1) present.
19. Suprategulum: (0) absent; (1) present.
20. Suprategulum: (0) continuous with tegulum; (1) articulated.
21. Suprategular distal apophysis: (0) absent; (1) present.
22. Suprategular marginal apophysis: (0) absent; (1) present.
23. Median apophysis: (0) present; (1) absent.
24. Conductor: (0) present; (1) absent.
- *25. Conductor papillae: (0) absent (*Putaoa huaping*, Fig. 6D); (1) present (*Pimoid breuili*, Hormiga 1994a: fig. 66).
26. Conductor base: (0) narrowly connected to tegulum, tongue-like (*Putaoa huaping*, Fig. 6D); (1) broadly connected to tegulum (*Pimoid breuili*, Hormiga 1994a: fig. 66).
27. Embolus length: (0) long; (1) short.
28. Embolic membrane: (0) absent; (1) present.
29. Embolic flap: (0) absent; (1) present.
30. Pimoid embolic process (PEP): (0) absent; (1) present.
31. Pimoid embolic process (PEP): (0) elongated; (1) compact.
32. Shape of elongated PEP: (0) bifurcated; (1) simple (one branch).
33. Radix: (0) absent; (1) present.
34. Radical tail piece: (0) absent; (1) present.
35. Radical tail piece morphology: (0) straight; (1) spiraled; (2) curved ectally; (3) curved mesally; (4) anteriorly directed.
36. Anterior radical process: (0) absent; (1) present.
37. Column: (0) absent; (1) present.
38. Fickert's gland: (0) absent; (1) present.
39. Terminal apophysis: (0) absent; (1) present.
40. Lamella characteristic: (0) absent; (1) present.

- *41. Male pedipalpal tibia macrosetae size: (0) ca. as the rest of pedipalp setae (*Pimoida lihengae*, Griswold *et al.* 1999: plate III); (1) very thick, clearly larger in diameter and/or length (*Putaoa huaping* new species, Figs. 3A, 5A-F).
42. Male pedipalpal tibial apophysis: (0) absent; (1) retrolateral; (2) dorsal.
43. Prolateral trichobothria in male pedipalpal tibia: (0) 2; (1) 1; (2) 0; (3) 3.
44. Retrolateral trichobothria in male pedipalpal tibia: (0) 2; (1) 4; (2) 3; (3) 1; (4) 0.
45. Epigynum protrusion: (0) protruding less than its width; (1) protruding more than its width.
46. Dorsal plate scape: (0) absent; (1) present.
47. Ventral plate scape: (0) absent; (1) present.
48. Ventral plate scape: (0) straight; (1) sigmoid.
49. Atrium: (0) absent; (1) present.
50. Copulatory duct: (0) separate from fertilization duct; (1) spirals fertilization duct.
51. Copulatory duct encapsulation: (0) absent; (1) present.
52. Spermathecae: (0) 2; (1) 4.
53. Fertilization duct orientation: (0) posterior; (1) mesal; (2) anterior.
54. Thoracic furrow: (0) nearly smooth, often recognizable only from pigment, not invagination; (1) thoracic furrow a distinct invagination.
55. Male post-PME lobe: (0) absent; (1) present
56. Subocular clypeal sulci: (0) absent; (1) present
57. Male cephalothoracic cuticular pores: (0) absent; (1) present
58. Tracheal system: (0) haplotracheate; (1) desmitracheate; (2) intermediate
59. Taenidia in tracheoles: (0) absent; (1) present.
60. Male chelicerae: (0) smooth; (1) stridulatory striae.
61. Cheliceral stridulatory striae: (0) ridged; (1) scaly; (2) imbricated.
62. Dorsal spur on male chelicerae: (0) absent; (1) present.
63. Retrolateral teeth female chelicera: (0) 3; (1) 4 or more; (2) 2; (3) 0; (4) 1.
64. Female pedipalpal tarsus: (0) with claw; (1) without claw.
65. Patella-tibia leg autospasy: (0) absent; (1) present.
66. Male Metatarsus I: (0) straight; (1) sinuous.
- *67. Male Metatarsus I proximal base: (0) diameter ca. as in Mt II; (1) diameter larger than Mt II (*Weintrauboa contortipes*, Hormiga 2003: fig. 7A-C).
68. Male Metatarsus I proximal apophysis: (0) subtly sinuous; (1) very sinuous.
69. Dorsal spines tibia I: (0) 2 or more; (1) 1; (2) 0.
70. Dorsal spines tibia II: (0) 2 or more; (1) 1; (2) 0.
71. Dorsal spines tibia III: (0) 2 or more; (1) 1; (2) 0.
72. Dorsal spines tibia IV: (0) 2 or more; (1) 1; (2) 0.
73. Trichobothrium metatarsus IV: (0) present; (1) absent.
74. Aciniform spigots in female PMS: (0) 1 or more; (1) absent.
75. PMS minor ampullate nubbins: (0) absent; (1) 1.
76. PLS mesal CY base: (0) same size as other CY; (1) enlarged.
77. Aciniform spigots in female PLS: (0) 2 or more; (1) 1; (2) absent.
78. PLS aggregate in male: (0) absent; (1) present.
79. PLS flagelliform in male: (0) absent; (1) present.
80. Male position during construction of sperm web: (0) above sperm web; (1) below sperm web.
81. Male position during ejaculation: (0) above sperm web; (1) below sperm web.
82. Web architecture: (0) orb; (1) tangle; (2) sheet.

