Callosa gen. n., a new troglobitic genus from southwest China (Araneae, Linyphiidae)

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Abstract

A new linyphiid genus Callosa gen. n., with two new species Callosa ciliata sp. n. (♀♂, type species) and Callosa baiseensis sp. n. (♀♂), from southwest China are described. Detailed description of genitalic characters and somatic features is provided, as well as light microscopy and SEM micrographs of each species. Callosa gen. n. was found in caves in Yunnan and Guangxi, and its copulatory organs are similar to those of Bathyphantes and Porrhomma, but differ greatly in details. The monophyly and placement of Callosa gen. n. are supported by the results of molecular analysis.

Keywords

Asia, cave spider, eyeless, Linyphiinae, morphology, photographs

Introduction

In previous collecting work conducted in caves in southwest China, a considerable number of troglobitic spider species belonging to Nesticidae, Leptonetidae, Telemidae, and Pholcidae were found, but Linyphiidae were seldom encountered. Due to insufficient efforts in taxonomy, no more than 100 linyphiid species have been reported from there, and only one of them was found in caves. Here a new linyphiid genus collected in caves from southwest China is described, whose copulatory organs identify it as a genus of Porrhommini. It has obvious somatic characters of real cave dwellers, indicating its long-term underground
evolutionary history. In order to test its placement in Porrhommini suggested by morphological characters, an additional molecular analysis based on newly sequenced DNA data of the two species and sequences available from GenBank was conducted.

**Materials and methods**

Specimens were studied using a LEICA M205 C stereomicroscope. Further details were examined under a BX51 compound microscope. Copulatory organs were examined after being dissected from the spiders’ bodies. Left male palps were used, except as otherwise indicated. Female epigynes and vulvae were removed and treated in warm potassium hydroxide (KOH) water solution before study. All embolic divisions, epigynes and vulvae were photographed after being embedded in gum arabic. Photos were taken with an Olympus c7070 wide zoom digital camera (7.1 megapixels) mounted on an Olympus BX51 compound microscope. Images from multiple focal planes were combined using Helicon Focus (version 3.10) image stacking software. All measurements are given in millimeters. Eye diameters were measured at their widest extent. Leg measurements are shown as: total length (femur, patella, tibia, metatarsus, tarsus). The terminology of copulatory organs follows Saaristo (1995), Tanasevitch (2014).

SEM images were taken using the FEI Quanta 450 at the Institute of Zoology, Chinese Academy of Sciences. Specimens for SEM examination were critical point dried and sputter coated with gold-palladium. Specimens were mounted on copper pedestals using double-sided adhesive tape.

The tibial spine formula, which expresses the number of dorsal tibial spines on each of legs I to IV, is given for species in which it differs from the type species of the genus. The patellar spine formula is given only if it differs from the most common one (1-1-1-1).

All type specimens are deposited in the Institute of Zoology, Chinese Academy of Sciences in Beijing (IZCAS), except as otherwise indicated.

Abbreviations used in the text and figures are given below. References to figures in cited papers are noted in lowercase type (fig.).

**Male palp**

| Abbreviation | Description             |
|--------------|-------------------------|
| CV           | convector               |
| DSA          | distal supratelular apophysis |
| E            | embolus                 |
| MM           | median membrane         |
| PC           | paracymbium             |
| PT           | protegulum              |
| ST           | subtegulum              |
| T            | tegulum                 |
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Epigynee

A atrium
CF copulatory furrows
CO copulatory opening
DP dorsal plate
P parmula
R receptacle
SO socket
VP ventral plate

Somatic morphology

ALE anterior lateral eye
ALS anterior lateral spinneret
AME anterior median eye
CY cylindrical gland spigot
PLE posterior lateral eye
PLS posterior lateral spinneret
PME posterior median eye
PMS posterior median spinneret

Phylogenetic analysis

Analysis conducted here is partially based on the data matrix of Arnedo et al. (2009). A few taxa were taken out, and more taxa of Linyphiinae downloaded from GenBank were added to reconstruct phylogeny. A total of 66 taxa were included for the final test. Partial fragments of the mitochondrial genes cytochrome c oxidase subunit I (COI), 16SrRNA (16S) and the nuclear genes Histone 3 (H3), 18SrRNA (18S) were amplified and sequenced for Callosa ciliata sp. n. and C. baiseensis sp. n. following the procedure in Arnedo et al. (2009). Sequences for each gene were edited in Bioedit (Hall 1999), and aligned in MAFFT (http://mafft.cbrc.jp/alignment/server/). Bayesian inference was performed in MrBayes 3.1.2 (Ronquist and Huelsenbeck 2003) using parameters selected by jModelTest (Posada 2008). The Markov chains were sampled every 1000 generations for 2 million generations, with the first 25% of sampled trees discarded as burn-in. Taxonomic and sequence information of the used taxa are presented in Table 1.

Bayesian inference based on four genes yielded a similar phylogenetic tree to Arnedo’s (Arnedo et al. 2009) and Sun’s (Sun et al. 2014). The Callosa gen. n. species belong to Porrhommini as indicated by the cladogram (Fig. 10).
### Table 1. DNA data information of species included in the phylogenetic analysis

| Family          | Genus      | Species            | 16S       | 18S       | COI       | H3        |
|-----------------|------------|--------------------|-----------|-----------|-----------|-----------|
| Pimoidae        | Pimoa      | sp. X131           | AY230940  | AY230893  | AY231025  | AY230985  |
|                 | Agyneta    | ramosa             | FJ838670  | FJ838694  | FJ838648  | FJ838740  |
|                 | Angeliphantes | nasus           | JN816483  | JN816703  | JN817115  |           |
|                 | Australolinphyra | remota          | FJ838671  | FJ838695  | FJ838649  | FJ838741  |
|                 | Bathyphonates   | floralis        | GU338604  | GU338645  | GU338659  |           |
|                 | Bathyphonates   | gracilis         | FJ838672  | FJ838696  | FJ838650  | FJ838742  |
|                 | Bolyphonates   | alticeps         | AY078660  | AY078667  | AY078691  | AY078700  |
|                 | Callosa gen. n. | baiseensis sp. n. | MF095861  | MF095862  | MF095863  | MF095864  |
|                 | Callosa gen. n. | ciliata sp. n.    | MF095865  | MF095866  | MF095867  |           |
|                 | Centromerus   | trilobus          | GU338599  | GU338468  | GU338656  |           |
|                 | Dicymbium     | sinofacetum       | GU338614  | GU338487  | GU338665  |           |
|                 | Diplocentria  | bidentata         | GU338629  | GU338494  | GU338688  |           |
|                 | Diplophephalus | cristatus        | GU338637  | GU338490  | GU338696  |           |
|                 | Diplostyla    | concolor          | FJ838673  | FJ838697  | FJ838651  | FJ838743  |
|                 | Doenitziuss   | pravus            | GU338632  | GU338474  | GU338691  |           |
|                 | Drapetica     | socialis          | FJ838674  | FJ838698  | FJ838652  | FJ838744  |
|                 | Dubiaranea    | ayenensis         | FJ838675  | FJ838699  | FJ838653  | FJ838745  |
|                 | Dubiaranea    | distincta         | GU338624  | GU338459  | GU338648  |           |
|                 | Dubiaranea    | propinquua        | GU338627  | GU338460  | GU338675  |           |
|                 | Erigone       | prominens         | GU338539  | GU338679  |           |           |
|                 | Eikovina      | clava             | JN816489  | JN816710  | JN817122  |           |
|                 | Frontinella   | communis          | GU338628  | GU338517  |           |           |
|                 | Gnathonarium  | dentatum          | GU338593  | GU338477  | GU338651  |           |
|                 | Haplinis      | diloris           | FJ838680  | FJ838704  | FJ838657  | FJ838750  |
|                 | Helophora     | insignis          | FJ838681  | FJ838705  | FJ838658  | FJ838751  |
|                 | Himalaphantes | azumiensis        | GU338522  | GU338677  |           |           |
|                 | Hlyphyantes   | sp. 'irellus'     | GU338618  | GU338481  | GU338668  |           |
|                 | Kaestneria    | pullata           | KT003126  | KT002937  | KT002739  | KT002838  |
|                 | Labulla       | thoracica         | AY078662  | AY078674  | AY078694  | AY078707  |
|                 | Laetesia      | sp. MAA-20099     | FJ838682  | FJ838706  | FJ838659  | FJ838752  |
|                 | Leptaphantes  | sp. 17 SL-2010    | GU338610  | GU338509  | GU338664  |           |
|                 | Linhya        | triangularis      | AY078664  | AY078668  | AY078693  | AY078702  |
|                 | Microlinyphia | dana              | AY078665  | AY078677  | AY078690  |           |
|                 | Microneta     | viaria            | FJ838684  | FJ838708  | FJ838661  | FJ838754  |
|                 | Moebelia      | rectangula        | GU338591  | GU338485  |           |           |
|                 | Neriene       | albolimbata       | JN816480  | JN816700  | JN817112  |           |
|                 | Neriene       | clathnata         | JN816478  | JN816698  | JN817110  |           |
|                 | Neriene       | emphana           | JN816474  | JN816694  | JN817106  |           |
|                 | Neriene       | japonica          | GU338633  | GU338462  | GU338692  |           |
|                 | Neriene       | longipedaella     | JN816476  | JN816696  | JN817108  |           |
|                 | Neriene       | nigrirceptoris    | JN816481  | JN816701  | JN817113  |           |
|                 | Neriene       | ooidedicata       | JN816479  | JN816699  | DQ396860  |           |

Linyphiidae
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### Taxonomy

**Family Linyphiidae Blackwall, 1859**

**Genus Callosa gen. n.**

http://zoobank.org/4EC11D86-CC7A-4467-8AB6-83356A928616

**Type species.** *Callosa ciliata* sp. n.

**Etymology.** The generic name is an arbitrary combination of letters. Gender is feminine.

**Diagnosis.** The copulatory organs in this genus clearly resemble those in *Porrhommini*, but differ from the similar genera by: embolus in *Callosa* gen. n. is long and forms one big loop (Figs 1A, 5A), neither a short and curved one as in *Porrhomma* Simon, 1884, *Diplostyla* Emerton, 1882, *Pacifiphantes* Eskov & Marusik, 1994 (Roberts 1987: figs 58a–e, 59a–e; Eskov and Marusik 1994: fig. 42), nor an apically coiled one as in most *Bathyphantes* Menge, 1866 (Roberts 1987: fig. 70a–e); the embolus in *Bathyphantes approximatus* (O. Pickard-Cambridge, 1871) is longer and slimmer, forming more than 2 loops (Ivie 1969: fig. 102); *Microbathyphantes* Helsdingen, 1985 has coiled, whip-like, and fully exposed embolus (Tu and Li 2006: fig. 2C), unlike the one enveloped in a membranous plate of the convector in *Callosa*...
Figure 1. Callosa ciliata sp. n., male holotype. A Palp, prolateral view B Palp, retrolateral view C Embolic division, retrolateral view D Distal suprategular apophysis, retrolateral view. Scale bars: B as A.
gen. n. The epigyne in Callosa gen. n. is distinguished by its long, spiraling copulatory furrows and the presence of a septum (Figs 3C, 7C); the receptacles are situated farther from atrium in most Bathyphantes species, furrows are not in double-helix; Kaestneria Wiehle, 1956 and Pacificiphantes have shorter copulatory furrows, which fold or curve (Slowik and Blagoev 2012: fig. 6); the copulatory furrows in Microbathyphantes make only half a turn.

**Description.** Median size, 2.5–2.8. Chelicerae with three promarginal, and four retromarginal teeth. AME completely lost, PME reduced to small unpigmented spots, ALE and PLE highly reduced (Figs 2C, 2E, 3D, 3F, 6C, 6E, 7D, 7F); ocular area with several rows of short setae (Figs 2C, 6C). Carapace length/leg I 0.13– 0.15. Coxae IV separated by their diameter. Chaetotaxy: 2-2-2-2. TmI 0.15–0.20, TmIV absent. Leg formula I-II-IV-III. Legs yellow without obvious patterns.

**Male palp:** femur about four times longer than patella; tibia with two trichobotria, one ventral and one retrolateral (Fig. 5B). Cymbium spindle-shaped at dorsal view (Figs 2A, 6A); Paracymbium ‘J’-shaped, stout at base, attenuated and curved at apex (Figs 1B, 5B). Bulb with an oblate subtegulum and a protruding protegulum (Figs 1B, 5B). Convector with a membranous plate enveloping the prolateral side of embolic division (Figs 1A, 5A), and a ribbon-like ventral process (Figs 1B, 2B, 5B, 6B); dorsal projection of convector situated near the base of cymbium in prolateral view (Figs 1A, 5A); distal suprategular apophysis pick-like, broad at base, hooked at apex (Figs 1D, 5D); median membrane with dense membranous short cilia (Figs 4B, 8B); embolus long and belt-like, with a tapering tip, making 1.5 loops along the exterior margin of convector plate (Figs 1A, 5A).

**Epigyne:** dome-shaped in lateral view, with atrium fully exposed in ventral view (Figs 3A, 4C–D, 7A, 8C–D); septum stretched along the axis of atrium; parmula short with a shallow socket near tip (Figs 4D, 8C); copulatory furrows making a spiral course (Figs 3C, 7C); receptacles oval, with short, tube-like processes (Figs 3C, 7C).

**Species composition.** Two species, Callosa ciliata sp. n. (type species) and Callosa baieseensis sp. n.

**Distribution.** Yunnan Province and Guangxi Zhuang Autonomous Region, China (Fig. 9).

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**Callosa ciliata sp. n.**

http://zoobank.org/2FF3B2E8-915E-487E-8F79-C5609A12D972
Figs 1–4, 9

**Types.** Holotype ♂: CHINA, Yunnan Province: Baoshan City: Tengchong County; Gudong Town; Jiangdong Village; 24°58.103’N, 98°52.104’E, ca 1900 m, Jiangdong Mountain, Luoshui Cave, 26.XI.2013, (Y.C. Li & J.C. Liu). Paratypes: 1 ♂ 2 ♀, same data as for holotype.

**Etymology.** This specific name is taken from the Latin word ‘ciliatus’, meaning ‘with cilia’, which refers to the median membrane with cilia; adjective.
Figure 2. *Callosa ciliata* sp. n., male holotype. A Palp, dorsal view  B Palp, ventral view  C Habitus, dorsal view  D Habitus, ventral view  E Habitus, lateral view. Scale bars: B as A; C as D.
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Figure 3. *Callosa ciliata* sp. n., female paratype. A Epigyne, ventral view B Epigyne, dorsal view C Vulva, dorsal view D Habitus, dorsal view E Habitus, ventral view F Habitus lateral view. Scale bars: C as B; D, F as E.
Figure 4. *Callosa ciliata* sp. n., SEM of a male paratype and a female paratype. A Palp of male paratype, ventral view B Detail showing embolus and embolic membrane of palp C Epigyne of female paratype, ventral view D Detail showing parmula of epigyne E Anterior lateral eye and posterior lateral eye of male paratype F Spinnerets of female paratype.
**Diagnosis.** It is characterised by the subdivided tip of distal suprategular apophysis (Fig. 1D) and in having three coils in copulatory furrows in epigyne (Fig. 3C). *Callosa ciliata* sp. n. also has a narrower atrium and shorter parmula.

**Description.** Male (holotype). Total length: 2.60. Carapace 1.25 long, 0.94 wide, brownish yellow (Fig. 2C, E), AME and PME entirely lost, ALE and PLE strongly reduced (Figs 2E, 4E). Sternum 0.68 long, 0.63 wide. Clypeus 0.50 high. Eye sizes: ALE 0.02, PLE 0.03. Leg length: I 8.06 (2.10, 0.40, 2.38, 2.05, 1.13), II 7.44 (2.00, 0.38, 2.13, 1.88, 1.05), III 5.74 (1.56, 0.30, 1.50, 1.55, 0.83), IV 6.98 (2.03, 0.31, 2.03, 1.75, 0.86). TmI 0.20. Abdomen pale, with irregular dark patterns (Fig. 2C–E). Palp: paracymbium large, with distal end strongly curved inward; tegulum broad at base, protegulum conical, crooked at tip; distal suprategular apophysis with a small indentation at apex (Fig. 1D); convector with a sharp projection at the 8 o’clock position at prolateral view (Fig. 1A); convector’s ventral process ribbon-like, with a slightly broadened tip (Fig. 1B); embolus coiling from 4 o’clock position in prolateral view (Fig. 1A).

Female. Total length: 2.80. Carapace 1.25 long, 0.59 wide, same coloration as in male, AME vanished, ALE, PLE and PME reduced to white spots (Fig. 3D, F). Sternum 0.63 long, 0.69 wide. Clypeus 0.34 high. Eye sizes: ALE 0.03, PME 0.02, PLE 0.02. Leg length: I 8.21 (2.25, 0.40, 2.43, 2.00, 1.13), II 7.52 (2.18, 0.40, 2.19, 1.75, 1.00), III 5.79 (1.70, 0.38, 1.55, 1.38, 0.78), IV 7.07 (2.13, 0.35, 2.00, 1.75, 0.84). TmI 0.15. Abdomen with same coloration as in male (Fig. 3D, F). Epigyne: atrium roughly triangular in form, broad at posterior, narrowing towards anterior (Fig. 3A); fovea large, with ridged inner walls; parmula small; receptacles suboval, with digit-like outgrowth, separated by 3 diameters (Fig. 3C); copulatory furrows making 3 coils.

*Callosa baiseensis* sp. n.
http://zoobank.org/2433C26A-75D0-4B76-9720-1AA133CA168D
Figs 5–9

**Types.** Holotype ♂: CHINA, Guangxi Zhuang Autonomous Region: Baise City; Longlin County; De’e Town; Yakou Village; 24°39.130’N, 105°09.557’E, ca 1500 m, Da Cave, 14–15.XII.2012, (Z.G. Chen & Z. Zhao). Paratypes: 1♂ 2♀, same data as for holotype; 1♀, Yumigan Cave, 24°39.145’N, 105°09.430’E, ca 1549 m, 14–15. XII.2012, (Z.G. Chen & Z. Zhao).

**Etymology.** This specific name is derived from Chinese Pinyin ‘bǎi sè’ (白色), referring to its type locality; adjective.

**Diagnosis.** Non-indented apex of distal suprategular apophysis (Fig. 5D), and the broad tip of convector ventral process in male palp (Figs 5B, 6B); it differs from the type species *C. ciliata* sp. n. by the relatively longer parmula (Figs 7B, 8C) and wider atrium (Fig. 7C).

**Description.** Male (holotype). Total length: 2.60. Carapace 1.20 long, 1.00 wide, beige, ocular area brownish yellow (Fig. 6C), AME completely lost, ALE, PLE and PME strongly reduced (Fig. 6C, E). Sternum 0.68 long, 0.66 wide. Clypeus 0.44 high.
Figure 5. *Callosa baiseensis* sp. n., male holotype. **A** Palp, prolateral view **B** Palp, retrolateral view **C** Embolic division, retrolateral view **D** Distal suprategular apophysis, retrolateral view. Scale bars: **B** as **A**.
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Figure 6. *Callosa baiseensis* sp. n., male holotype. A Palp, dorsal view B Palp, ventral view C Habitus, dorsal view D Habitus, ventral view E Habitus, lateral view. Scale bars: B as A; D as C.
Figure 7. *Callosa baiseensis* sp. n., female paratype. A Epigyne, ventral view B Epigyne, dorsal view C Vulva, dorsal view D Habitus, dorsal view E Habitus, ventral view F Habitus lateral view. Scale bars: C as B; D, F as E.
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Figure 8. Callosa baiseensis sp. n., SEM of a male paratype and a female paratype. A Palp of male paratype, ventral view B Detail showing embolus and embolic membrane C Detail showing scape of epigyne D Epigyne of female paratype, ventral view E Anterior lateral eye, anterior median eye and posterior lateral eye of male paratype F Spinnerets of female paratype.
Eye sizes: ALE 0.03, PME 0.02, PLE 0.04. Leg length: I 9.25 (2.50, 0.38, 2.80, 2.41, 1.16), II 8.27 (2.28, 0.38, 2.38, 2.23, 1.00), III 6.33 (1.84, 0.40, 1.68, 1.56, 0.85), IV 8.05 (2.38, 0.38, 2.33, 2.03, 0.93). TmI 0.16. Abdomen pale, with dark yellow markings (Fig. 6C–E). Male palp: protegulum medially expanded, then attenuated at tip (Fig. 5B); distal suprategular apophysis with a small, hooked apex (Fig. 5D); embolus coiling from 8 o’clock position in prolateral view (Fig. 5C).

Female. Total length: 2.50. Carapace 1.19 long, 0.94 wide, same coloration as in male. Sternum 0.55 long, 0.63 wide. Clypeus 0.34 high. Eye sizes: ALE 0.05, PME 0.04, PLE 0.05. Leg length I 8.91 (2.48, 0.40, 2.56, 2.34, 1.13), II 8.30 (2.28, 0.40, 2.34, 2.19, 1.09), III 6.29 (1.88, 0.38, 1.63, 1.59, 0.81), IV 7.91 (2.30, 0.38, 2.15, 2.08, 1.00). TmI 0.18. Abdomen with same coloration as in male (Fig. 7D–E). Epigyne: atrium nearly semicircular, partitioned by a septum along the long axis (Fig. 8C–D); copulatory furrows forming 2 coils; receptacles oval separated by 2 diameters, with curved outgrowths (Fig. 7C–D).

Remarks. To confirm the species delimitation, the p-distance of COI sequences of *C. baiseensis* sp. n. and *C. ciliata* sp. n. was calculated using MEGA 6 (Tamura et al. 2017).
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2013), and the result is 0.12, which falls within the genetic distance interval of 0.07 to 0.16 among Bathyphantes species and 0.07 to 0.17 in Porrhomma based on data from NCBI (The National Center for Biotechnology Information https://www.ncbi.nlm.nih.gov/).

**Discussion**

Linyphiidae Blackwall, 1859 is not commonly found in caves. In China, in contrast to more than 370 terrestrial linyphiids, only two species have been reported from caves so far (Song and Li 2009), but none of them exhibited traits of cave adaptation, such as depigmentation, reduction or complete loss of eyes, or elongation of legs (Sket 2008). *Callosa* gen. n. is the first true troglobiont linyphiid genus discovered in southwest China, encompassing two new species found in caves almost 600 kilometers apart, and they display apparent characters of true cave dwellers. It is assumed their ancestors were widely distributed in the montane area in southwest China, and almost certainly extrinsic forces (e.g. geological events, climatic changes) drove them to colonize the caves, which are considered to be a relatively stable environment.

*Callosa* gen. n. belongs to Porrhommini as suggested by both molecular analysis (Fig. 10) and morphological characteristics. It is obviously monophyletic, and its distinctive traits in both body and copulatory organs might be a result of long-term solitary evolution. Despite its morphological similarities to Bathyphantes (especially *B. approximatus*), *Callosa* gen. n. is situated relatively farther from Bathyphantes in the cladogram (Fig. 10). The taxonomical history of *Bathyphantes* is long and complicated, and several of its subgenera have now been validated as separate genera (e.g. *Kaestneria*, *Diplostyla*, *Pacifiphantes*) based on the conformation of copulatory organs, and some related genera were also established with species transferred from *Bathyphantes* (e.g. *Cresmatoneta* Simon, 1929, *Microbathypabntes* Helsdingen, 1985). A better-sampled phylogenetic analysis of Porrhommini was presented by Wang et al. (2015), in which Bathyphantes appeared as polyphyletic, with Pacifiphantes zakharovi Eskov & Marusik, 1994 grouped with *Bathyphantes eumenis* (L. Koch, 1879). The split between *Porrhomma* + *Diplostyla* and Bathyphantes is not well supported. A similar relationship is recovered in our analysis, where Pacifiphantes zakharovi is clustered with Bathyphantes floralis Tu & Li, 2006 (Fig. 10). It also has been previously pointed out that *Pacifiphantes magnificus* (Chamberlin & Ivie, 1943) could be a misplacement, and probably grouped with *Porrhomma* + *Diplostyla* as indicated by both morphology and DNA barcoding (Slowik and Blagoev 2012). As the type species, Pacifiphantes zakharovi was identified with a super short embolus (Eskov and Marusik 1994: fig. 42), the unique trait supposedly distinguishing it from other similar Bathyphantes, however, the discrepancy between morphology and molecular analysis results demands a more comprehensive analysis on the delimitation of Bathyphantes and its close relatives.
Figure 10. Phylogenetic tree reconstructed using Bayesian inference based on concatenated data. Numbers besides each node are posterior possibilities. Outgroup: *Pimoa* sp. X131 (dark blue) **DU** Dubiaraneinae (purple) **LI** Linyphiinae (blue) **MY** Mynogleninae (red) **PO** Porrhommini (blue) **ST** Stemonlyphantinae (dark blue). “Micronetines-erigonines” clade is presented in green, the “distal erigonines” clade is colored in orange. Taxa with sequences downloaded from NCBI are listed at the end of each branch in black accordingly, and *Callosa* gen. n. species are marked in red.
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References

Arnedo MA, Hormiga G, Scharff N (2009) Higher-level phylogenetics of linyphiid spiders (Araneae, Linyphiidae) based on morphological and molecular evidence. Cladistics 25: 231–262. https://doi.org/10.1111/j.1096-0031.2009.00249.x

Eskov KY, Marusik YM (1994) New data on the taxonomy and faunistics of North Asian linyphiid spiders (Aranei Linyphiidae). Arthropoda Selecta 2(4): 41–79.

Hall TA (1999) Bioedit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic Acids Symposium Series 41: 95–98.

Ivie W (1969) North American spiders of the genus Bathyphantes (Araneae, Linyphiidae). American Museum Novitates 2364: 1–70.

Posada D (2008) jModelTest: phylogenetic model averaging. Molecular Biology and Evolution 25: 1253–1256. https://doi.org/10.1093/molbev/msn083

Roberts MJ (1987) The spiders of great Britain and Ireland. Volume 2. Harley Books, England, 204 pp.

Ronquist F, Huelsenbeck JP (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19(12): 1572–1574. https://doi.org/10.1093/bioinformatics/btg180

Saaristo MI (1995) Linyphiid spiders of the granitic islands of Seychelles (Araneae, Linyphiidae). Phelsuma 3: 41–52.

Sket B (2008) Can we agree on an ecological classification of subterranean animals? Journal of Natural History 42: 1549–1563. https://doi.org/10.3956/2007-55.1

Slowik J, Blagoev GA (2012) First description of the male spider Paciphantes magnificus (Chamberlin & Ivie) (Araneae: Linyphiidae). Zootaxa 3481: 73–81.

Song YJ, Li SQ (2009) Two new erigonine species (Araneae: Linyphiidae) from caves in China. The Pan-pacific Entomologist 85(2): 58–69. https://doi.org/10.3956/2007-55.1

Sun N, Marusik YM, Tu L (2014) Acanoides gen. n., a new spider genus from China with a note on the taxonomic status of Acanthoneta Eskov & Marusik, 1992 (Araneae, Linyphiidae, Micronetinae). ZooKeys 375: 75–99. https://doi.org/10.3897/zookeys.375.6116

Tamura K, Stecher G, Peterson D, Filipski A, Kumar S (2013) MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. Molecular Biology and Evolution 30: 2725–2729. https://doi.org/10.1093/molbev/ms197

Tanasevitch AV (2014) New species and records of linyphiid spiders from Laos (Araneae, Linyphiidae). Zootaxa 3841(1): 67–89. https://doi.org/10.11646/zootaxa.3841.1.3
Tu LH, Li SQ (2006) Three new and four newly recorded species of Linyphiinae and Micronetinae spiders (Araneae: Linyphiidae) from northern Vietnam. The Raffles Bulletin of Zoology 54: 103–117.
Wang F, Ballesteros JA, Hormiga G, Chesters D, Zhang YJ, Sun N, Zhu CD, Chen W, Tu LH (2015). Resolving the phylogeny of a speciose spider group, the family Linyphiidae (Araneae). Molecular Phylogenetics and Evolution 91: 135–149. https://doi.org/10.1016/j.ympev.2015.05.005