Acanoides gen. n., a new spider genus from China with a note on the taxonomic status of Acanthoneta Eskov & Marusik, 1992 (Araneae, Linyphiidae, Micronetinae)

Ning Sun¹‡, Yuri M. Marusik²³‡, Lihong Tu¹§

¹ College of Life Sciences, Capital Normal University, Xisanhuanbeilu Str. 105, Haidian Dist., Beijing, 100048, P. R. China ² Institute for Biological Problems of the North, FEB Russian Academy of Sciences, Portovaya Str. 18, Magadan, 685000, Russia ³ Zoological Museum, University of Turku, FI-20014 Turku, Finland

† http://zoobank.org/3EF5007C-4FF8-4642-B18F-57104A493701
‡ http://zoobank.org/F215BA2C-5072-4CBF-BA1A-5CCBE1626B08
§ http://zoobank.org/76D0E0A4-59E4-4087-8239-FBAC3A137AB1

Corresponding author: Lihong Tu (tulh@cnu.edu.cn)

Academic editor: D. Dimitrov | Received 17 August 2013 | Accepted 16 December 2013 | Published 30 January 2014

http://zoobank.org/319CFD1C-A795-4F2E-A20D-9284BCC2C3F7

Citation: 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. doi: 10.3897/zookeys.375.6116

Abstract

A new “micronetine” genus Acanoides gen. n. is erected to accommodate two species from China: Acanoides beijingensis sp. n. as the type species and Acanoides hengshanensis (Chen & Yin, 2000), comb. n., with the females described for the first time. The genital characters and somatic features of the new genus were studied by means of light microscopy and scanning electron microscopy (SEM). The monophyly of the new genus was tested by a phylogenetic analysis based on molecular data. Descriptions of the new genus, the new species and the new combination are presented; SEM images and microscopy pictures of somatic and genital characters are provided in detail. To distinguish from other genera with similar genital characters, we compare the new genus with the species of Acanthoneta Eskov & Marusik, 1992, Epibellowia Tanasevitch, 1996 and Wubanoides Eskov, 1986. Four putative synapomorphies for Acanoides gen. n. are suggested to support its monophyly that could be tested in the future. Furthermore, redescriptions of the epigynal morphology of Acanthoneta aggressa Chamberlin & Ivie, 1943 (Nearctic) and on the male of A. dokutchaevi Eskov & Marusik, 1993 (Far East Asia, firstly recorded from China) are provided. Based on comparison with Poeciloneta, from which Acanthoneta stat. n. was separated by Saaristo and Tanasevitch (1996), a revised diagnosis is proposed to support the generic status.
Keywords
Taxonomy, new species, new genus, genitalic morphology, movable epigynum

Introduction

Micronetinae Hull, 1920 is a fairly large subfamily of Linyphiidae Blackwall, 1859, including 1199 species placed in 90 genera (Tanasevitch 2014). It was redelimited by Saaristo and Tanasevitch (1996), who established eight new genera for 89 species, and raised three subgenera to generic status. Subsequently, a series of revisions were published (e.g. Saaristo and Tanasevitch 2002a, 2002b; Saaristo and Marusik 2004; Saaristo et al. 2006; Tu et al. 2006; Tu and Li 2006) that resulted in many new genera and a new subfamily Ipainae Saaristo, 2007. Results of these series of review works have not been tested in a phylogenetic context; neither Micronetinae nor Ipainae monophyly, as well as that of the genera included in the two subfamilies have been tested so far.

Poeciloneta hengshanensis (Chen & Yin, 2000) from China, originally placed in Lepthyphantes Menge, 1866, has its male palp very similar to that of Poeciloneta (Acanthoneta) aggressa (Chamberlin & Ivie, 1943). Acanthoneta Eskov & Marusik, 1992 is one of the three genera raised from subgeneric status by Saaristo and Tanasevitch (1996) with the type species Acanthoneta aggressa. Tu et al. (2006) transferred P. hengshanensis to Acanthoneta based on the similarity of the male palpal morphology. However, raising Acanthoneta to a generic status “was not accompanied by a diagnosis or justification”, and hence not accepted in The World Spider Catalog (Platnick 2014). All members of Acanthoneta are currently placed in Poeciloneta Kulczyński, 1894.

Females of P. hengshanensis (previously unknown) were found in new material from China. However, its epigynal conformation is neither congruent with that of P. aggressa, nor with any other species of Poeciloneta. Based on the presence of an extensible basal part, the movable epigynum accords with the diagnosis of the subfamily Ipainae Saaristo, 2007 (for example Ipa Saaristo, 2007 and Solenysa Simon, 1894). Additionally, we found another new species with genitalic morphology very similar to that of P. hengshanensis: the male palpal morphology similar to Acanthoneta and a movable epigynum in accordance with ipaine type.

A new genus Acanoides gen. n. is erected here for these two species. To test the placement of the new genus within Linyphiidae, a phylogenetic analysis based on newly sequenced molecular data of the two species and that of other linyphiids downloaded from NCBI was conducted. In the present study, the two species and the new genus are described. Characters of copulatory organs and somatic features of both species are illustrated by means of SEM and light microscopy. To distinguish the new genus from other “micronetine” genera with similar male palpal morphology and ipaine genera with a similar movable epigynum, the new genus is compared with the genera Acanthoneta (Micronetinae), Wubanoides Eskov, 1986 and Epibellowia Tanasevitch, 1996 (Ipainae). Due to limited material available for examination, comparisons are largely based on descrip-
Acanoides gen. n. from China

Totions and illustrations provided by Tanasevitch (1996), Saaristo and Tanasevitch (2000) and Saaristo (2007); images of the epigynum of Acanthoneta aggressa and the male of A. dokutchaevi Eskov and Marusik, 1994 are presented here. Four putative synapomorphies are suggested for Acanoides gen. n. that could be tested in future study. In addition, diagnoses for Acanthoneta stat. n. are provided based on comparison with illustrations of genitalic characters provided by Saaristo and Tanasevitch (2000), to support its generic status proposed by Saaristo and Tanasevitch (1996). The composition and monophyly of both Acanoides gen. n. and Acanthoneta stat. n. could be tested in future study.

Materials and methods

Specimens were examined and measured using a Leica M205A stereomicroscope. Male palps and epigyna were examined after they were dissected from the body. Left structures (e.g. palps, legs, etc.) were depicted. Embolic divisions were excised by breaking the membranous column which connects the suprategulum and radix. Male palps and epigyna were cleared in methyl salicylate. Digital images were taken with a Leica DFC 500 camera, as composites of multiple focus images assembled using the software package LEICA APPLICATION SUITE. Scanning electron microscopy (SEM) images were taken using a S-3400N scanning electron microscope at the China Agricultural University. For SEM examination the specimens were prepared following Álvarez-Padilla and Hormiga (2008). SEM images of the embolic division taken from the right palp were mirrored to match those taken from the left palp. All measurements were taken with a micrometer and are expressed in millimeters. The leg measurements are given in the following sequence: total (femur, patella+tibia, metatarsus, tarsus). All specimens examined here are deposited in the College of Life Sciences, Capital Normal University, China (CNU) and in the College of Life Sciences, Hunan Normal University, China (HNU), except for the female material of A. aggressa, the epigynal pictures of which were provided by Don Buckle (Saskatoon, Canada). Distribution data for these species within China are presented at the provincial level. Terminology for the epigynal characters follows Tu and Hormiga (2010) and male palpal and somatic characters follows that of Saaristo and Tanasevitch (1996) and Hormiga (2000). Anatomical abbreviations used in the text and figures:

Somatic morphology

AER anterior eye row
ALE anterior lateral eye(s)
AME anterior median eye(s)
AMEd diameter of AME
PER posterior eye row
PLE posterior lateral eye(s)
Male palp

AX  apex of embolus
DM  distal membrane of terminal apophysis
DSA distal suprategular apophysis
EM  embolic membrane
EP  embolus proper
FiG Fickert’s gland
LC  lamella characteristica
P  paracymbium
PCA proximal cymbial apophysis
PH  pit hook
R  radix
SE  serrated area on embolus
SPT suprategulum
TA  terminal apophysis
TH  thumb of embolus

Epigynum

CO  copulatory opening
CG  copulatory groove
DP  dorsal plate
EA  extensible area of epigynal basal part
EB  epigynal basal part
FG  fertilization groove
MP  median plate
S  spermathecae
SC  scape
ST  stretcher
VP  ventral plate

Phylogenetic analysis

Based on the dataset of Arnedo et al. (2009) which includes 34 linyphiid taxa (Erigone dentipalpis was not included as it has only one of the five genes available), newly sequenced data of the two Acanoides and data of another 65 linyphiid taxa downloaded from NCBI were added. A total of 111 taxa were sampled in our matrix, ten outgroup taxa of other araneoid families as in that of Arnedo et al. (2009) and 101 ingroup taxa, which cover the representatives of all the seven subfamilies currently proposed; one Solenysa, as a representative of ipaine, and Acanthoneta were included to test the placement of Acanoides.
Five genes: cytochrome c oxidase subunit I (CO1) and 16S rRNA (16S) and three nuclear genes 18S rRNA (18S), 28S rRNA (28S) and Histone H3 (H3) were sequenced for *Acanoides beijingensis* sp. n. and *A. hengshanensis*. Molecular procedures for sequencing follow that of Arnedo et al. (2009), with the same molecular markers to maximize the overlap of dataset. Taxa sampled and sequence accession numbers are presented in Appendix - Table S1. Data were automatic multiple aligned using the computer program Clustal X version 1.81 (Thompson et al. 1997). Gaps were treated as missing data. Maximum Likelihood analysis was performed using RAxML v7.2.7 as implemented on the Cipres Gateway (Miller et al. 2010). Bootstrap support analysis was performed with the commands:raxmlHPC-HYBRID-7.3.1 -T 6 -s infile -n result -x 12345 -p 876 -f a -N 1000 -m GTRCAT -q part.

**Results**

All five genes were sequenced for *Acanoides beijingensis* sp. n. and *A. hengshanensis* (Appendix - Table S1). The monophyly of Linyphiidae and its sister relationship with Pimoidae were not recovered in the result of phylogenetic analysis as two outgroup taxa: cyatholipid *Alaranea* and theridiosomatid *Theridiosoma* are embedded within Linyphiidae (Appendix - Fig. S1). Besides some weakly supported deeper branches, four robustly supported clades are recognized: *Stemonyphantes* clade (clade S), “micronetines-erigonines” clade (clade ME), “linyphiines”-1 clade (clade L1) and “linyphiines”-2 (clade L2). For the seven subfamilies currently proposed, only *Stemonyphantinae* Wunderlich, 1986 (the *Stemonyphantes* clade) and *Mynogleninae* Lehtinen, 1967 are monophyletic, while the mynoglenines clade and the *Dubiariana* clade fall into clades L1 and L2 respectively that make Linyphiinae Blackwall, 1859 become a paraphyletic group; taxa of *Micronetinae* form a paraphyletic group, nested with taxa of *Ipainae* and *Erigoninae* within clade ME. The two *Acanoides* species form a robustly supported monophyly, distantly related to *Acanthoneta* and *Solenysa*.

**Discussion**

The result of the phylogenetic analysis based on molecular data suggests that the new species from Beijing is the sister taxon of *P. hengshanensis* which had ever been transferred to *Acanthoneta* by Tu et al. (2006). The lineage comprised by the two species is distantly related to *Acanthoneta* sp. (Appendix - Fig. S1). Accordingly, we erected here *Acanoides* gen. n. to accommodate the two species: *A. beijingensis* sp. n. and *A. hengshanensis* comb. n. The three known *Acanthoneta* species have very distinct male palpal morphology, only differ from that of the type species in small details (Eskov and Marusik 1992, 1993). Regardless the *Acanthoneta* taxon is congeneric with, or is the type species *Acanthoneta aggressus*, the new genus differs from all the three known species of *Acanthoneta* as well as all other “micronetines” in the females having a movable
epigynum (Figs 4G, 5G) and the males having a longer and sharper embolus proper (Figs 2D, 3D) which generally is pointed in “micronetes” (Fig. 6F); Fickert’s gland located in the membranous area outside the radix (Figs 2D, 3D), rather than embedded within the radix as usually the case in “micronetes” (Fig. 6G). This suggests that the two species are not congeneric with *Acanthoneta*.

Our results suggest an unknown *Lepthyphantes* species as a sister group to the *Acanoides* clade. *Lepthyphantes* Menge, 1866, which includes almost 500 species, is not a natural group (Saaristo and Tanasevitch 1996). All *Lepthyphantes* species, except five, have been transferred or are waiting to be transferred to other genera (e.g. Saaristo and Tanasevitch 1996, 2002a, b; Saaristo and Marusik 2004; Tu et al. 2006). The position of *Lepthyphantes* sp. on the tree indicates it is neither *Acanthoneta*, nor *Lepthyphantes*. Nevertheless, without morphological data, we fail to determine whether *Lepthyphantes* sp. is as a sister group of, or a number of *Acanoides* gen. n., so the close relative of *Acanoides* remains unresolved.

The genitalic characters of *Acanoides* make its subfamily placement problematic due to the epigynal character in accordance with Ipainae type, but the male palpal morphology of the “micronetine” type. Redelimitation of Mironetinae (Saaristo and Tanasevitch 1996) and the series of revisions of “micronetine” genera (e.g. Saaristo and Tanasevitch 2002a, 2002b; Saaristo and Marusik 2004; Saaristo et al. 2006; Tu et al. 2006; Tu and Li 2006) resulted in many new genera and even a new subfamily Ipainae (Saaristo 2007). However, none of them has been tested in a phylogenetic framework. Results of the first phylogenetic analysis for linyphiids based on molecular data indicate that neither Micronetinae nor Ipainae is a monophyletic group (Arnedo et al. 2009). Such a result was recovered in the present study too: “micronetine” taxa formed a paraphyletic group, and movable epigynum independently evolved in *Acanoides* and *Solenysa* (Appendix - Fig. S1). The extensible solenoid serving as a synapomorphy for *Solenysa* (Tu & Hormiga, 2011), the ventrally folded extensible epigynal basal part, together with long and sharp embolus proper, slender and unbranched lamella characteristica, and outside radix located Fickert’s gland are four putative synapomorphies for *Acanoides* gen. n.

With greatly increased ingroup sampling, the result of the present study produce a similar topology with that of Arnedo et al. (2009): four strongly supported clades S, L1, L2 and ME that correspond to the *Stemonyphantes* clade, clades C and D, and the “micronetines-erigonines” clade in the latter (Appendix - Fig. S1). Most newly added taxa fell into the clade ME that enriched the topology. However, the problems left by the previous study (Arnedo et al. 2009), such as the monophyly of Linyphiidae, placements of the weakly supported deeper branches, and taxa of different subfamilies placed together rendering most of the traditionally recognized subfamilies non-monophyletic, persist. Six of the seven subfamilies currently proposed are not monophyletic groups. The higher level relationships within linyphiids reflected by phylogenetic result are still far away from the classic subfamily system (see Millidge 1984, 1993; Saaristo and Tanasevitch 1996; Saaristo 2007). Nevertheless, revising the whole higher level linyphiid systematics is beyond the scope of the present study. In the text bellow we keep using Micronetinae and Ipainae following the current taxonomic system.
Although with ingroup sampling about two times increased, the sampling size of the current dataset seems not to be enough to resolve the placements of Acanoides and Acanthoneta, as well as Poeciloneta, from which Acanthoneta were separated (Eskov and Marusik 1992), their close relatives, and the relationships among them. To better understand the higher level phylogenetic relationships of linyphiid spiders, more information, such as morphology and behavior, and a comprehensive sampling design are necessary. Here, we provide four putative synapomorphies for the new genus Acanoides that could be tested in future phylogenetic studies.

**Taxonomy**

**Linyphiidae** Blackwall, 1859

*Acanoides* gen. n.

http://zoobank.org/4632240B-5228-4EB7-A1BC-CBD9176FEC2B

http://species-id.net/wiki/Acanoides

**Type species.** *Acanoides beijingensis* sp. n.

**Composition.** Two species, *Acanoides beijingensis* sp. n. and *Acanoides hengshanensis* (Chen & Yin, 2000) comb. n.

**Diagnosis.** The males of *Acanoides* gen. n. can be distinct from *Acanthoneta* by the sharp embolus proper, the slender lamella characteristica unbranched, and by the Fickert’s gland located in the membranous area outside the radix (Figs 2D, 3D). The females can be distinguished by the ventrally folded extensible epigynal basal part (Figs 2F, 3F).

**Description.** Male total length 2.34–2.73; female total length 2.10–2.42. Carapace yellowish-brown. Male carapace unmodified. AMEs smallest, others subequal; from the dorsal view AER recurved, PER straight, eyes separated by AMEd, ALE and PLE juxtaposed. Chelicerae medium-sized, with strong stridulatory ridges, female fang groove with three promarginal and three retromarginal teeth in *A. beijingensis* sp. n., and two promarginal and two retromarginal teeth in *A. hengshanensis*. Chaetotaxy: Ti I–IV: 2-2-2-2; Mt I–IV: 1-1-1-1; Mt I of males with two rows of ventral bristles, one prolateral, one retrolateral (Fig. 1C, 1D); Tm I about 0.25, Tm IV absent. Both species have a haplotracheate system.

**Male palp** (Figs 2A–E, 3A–E, 4A–B, 5A–B). Cymbium with proximal apophysis. Paracymbium medium to large-sized, with one tooth on lateral margin. Distal supratragular apophysis not modified as pit hook, or absent. Embolic division: radix long and narrow, Fickert’s gland located in the membranous area connecting radix and embolus; embolus wide and strongly sclerotized with serrated area, embolus proper sharp with a thumb and an apex at each side; lamella characteristica unbranched, long and narrow with sharp sclerotized apex, almost parallel to radix; terminal apophysis with distal membrane.

**Epigynum** (Figs 2F–H, 3F–G, 4G–H, 5G–H). Protruding, with deeply wrinkled basal part, extensible and ventrally folded in constricted state. Epigynum well scle-
rotized, epigynal cavity present (in *A. beijingensis* sp. n.) or absent (in *A. hengshanensis*), both scape and stretcher absent.

**Etymology.** The genus name, *Acanoides*, is a combination of the first four letters of “Acanthoneta” and the last five letters of “Wubanoides”. “-oides” itself in Latin means “similar to”, masculine in gender.

**Phylogenetics.** Due to limitations of the current dataset the monophyly of *Acanoides* could not be tested explicitly in our phylogenetic analyses, however it is supported by the following four putative synapomorphies: sharp embolus proper, slender and unbranched lamella characteristica, outside radix located Fickert’s gland and ventrally folded extensible epigynal basal part.

**Distribution.** China (Beijing, Hunan, Hebei) (Fig. 7).
Remarks. The males of *Acanoides* gen. n. have the palp of a “micronetine” type: presence of the Fickert’s gland, the boat-shaped radix, the trunk-like embolus with a pointed proper and a thumb, as well as the well developed terminal apophysis and lamella caracteristica (Saaristo and Tanasevitch 1996). However, these sclerites in *Acanoides* (Fig. 2D) have some features different from the normal “micronetine” type (Fig. 6F, Saaristo and Tanasevitch 1996): Fickert’s gland is not embedded within the radix, but located in the membranous area connecting the radix and the embolus; and the embolus has a wide, strongly sclerotized body, with a longer and sharper embolus proper, whereas in most “micronetines” the embolus is usually trunk-like with a pointed embolus proper. The male palp of both *Acanoides* and *Acanthoneta*, have a long and slender lamella caracteristica parallel to the long radix, but with an additional long and thin branch in *Acanthoneta* (Fig. 6F), unbranched in *Acanoides* (Figs 2D, 3D). The epigynum of *Acanthoneta* is in a normal “micronetine” type, with a sigmoid scape surrounded by an epigynal cavity (Fig. 6H), but with an extensible basal part in *Acanoides*.

The result of phylogenetic analysis based on molecular data indicates that Ipainae is not a monophyletic group as the movable epigynum independently evolved in *Acanoides* and *Solenysa* (Appendix - Fig. S1). This is also supported by the tracheal characters: haplotracheate type in *Acanoides*, but intermediate type in *Solenysa*, with the median pair extending into the prosoma (Tu and Hormiga 2011). We infer that the extensible basal part of the epigynum may have also evolved convergently with that in other ipaines. In *Acanoides* it differs by being ventrally folded, while it forms a solenoid in *Solenysa* (Tu & Hormiga, 2011), and folds inwards in other ipaines, e.g *Ipa* (Saaristo 2007: fig. 29), *Wubanoides* and *Epibellowia* (Tanasevitch 1996: figs 7–9). Furthermore, the male palp of typical ipaines has filiform embolus proper (Saaristo 2007: fig. 7; Tanasevitch 1996: figs 1, 4) much longer than that of *Acanoides* (Fig. 2D).

*Acanoides beijingensis* sp. n.
http://zoobank.org/CE596A12-9C21-4B8F-97FC-F31C61CD7E
http://species-id.net/wiki/Acanoides_beijingensis
Figs 1A–C, 2, 4

**Type-locality.** China, Beijing: Mt. Yangtaishan, 39°20.15’N; 115°34.52’E, alt. ca 320 m, 15 Oct. 2007, L. Tu leg.

**Type-specimens.** Holotype, ♀ (CNU), China, Beijing, Mt. Yangtaishan, 39°20.15’N; 115°34.52’E, alt. ca 320 m, 15 Oct. 2007, L. Tu leg. Paratypes, 2 ♂♂ and 3 ♀♀ (CNU), same data as holotype.

**Additional material examined.** 1 ♂ and 2 ♀♀ (CNU), China, Hebei Province, Mt. Wulingshan, 40°33.61’N; 117°29.69’E, alt. ca 1100 m, 12 Aug. 2009, L. Tu leg.

**Diagnosis.** The male of *A. beijingensis* sp. n. can be distinguished from *A. hengshanensis* by the spine-shaped lamella characteristic (Figs 2D, 4C), ribbon-like in the latter (Figs 3D, 5C); by the hook-shaped terminal apophysis (Fig. 4C), straight in the latter (Fig. 5D); and by the presence of a distal suprategular apophysis (Fig. 4A), absent in
Figure 2. Acanoides beijingensis sp. n. A male palp, prolateral B male palp, prolateral, with embolic division removed C male palp, retrolateral D embolic division, ventral E embolic division, dorsal F epigynum, ventral G epigynum, dorsal H epigynum, lateral. CG copulatory groove; CO copulatory opening; DP dorsal plate; EA extensible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; FiG Fickert’s gland; LC lamella characteristica; MP median plate; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermathecae; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].
the latter. The female is distinct by having the epigynum two times longer than wide (Fig. 2F), shorter than wide in *A. hengshanensis* (Fig. 3F); and by the presence of a remnant epigynal cavity (Fig. 2G), totally absent in *A. hengshanensis* (Fig. 3G).
**Description.** Male holotype (Fig. 1A, C): Total length 2.69. Carapace 1.22 long, 1.01 wide. Abdomen 1.39 long, 0.88 wide. Lengths of legs: I 3.88 (1.05 + 1.18 + 0.99 + 0.66); II 3.02 (1.03 + 0.73 + 0.69 + 0.57); III 2.66 (0.87 + 0.88 + 0.51 + 0.40); IV 3.78 (1.12 + 1.09 + 0.93 + 0.64). Female (Fig. 1B): Total length 2.12. Carapace 0.93 long, 0.78 wide. Abdomen 1.25 long, 0.83 wide. Lengths of legs: I 6.10 (1.68 + 2.04 + 1.43 + 0.95); II 5.43 (1.56 + 1.74 + 1.24 + 0.89); III 4.39 (1.24 + 1.13 + 1.10 + 0.75); IV 5.88 (1.79 + 1.78 + 1.46 + 0.83). Tm I: 0.20. For other somatic features see description of the genus.

**Male palp** (Figs 2A–C, 4A–B). Cymbium with proximal apophysis. Paracymbium narrow, half rounded lateral tooth strongly sclerotized. Distal supratregular apophysis blunt, not modified as pit hook. Embolic division: radix long and narrow; Fickert’s gland located in the membranous area connecting radix and embolus; embolus main body short and wide, strongly sclerotized, with serrated area on ventral surface; embolus proper sharp with pointed thumb and tail-like apex at each side; unbranched lamella characteristica long and slender, with sharp and strongly sclerotized apex; terminal apophysis hook-shaped with distal membrane.

**Epigynum** (Figs 2F–H, 4G–H). Two times longer than wide, wrinkled basal part extensible and ventrally folded in constricted state. Median plate and epigynal cavity present, without scape and stretcher. Copulatory openings opened dorsally.

**Etymology.** The species name refers to the type locality.

**Variation.** Males (n = 3). Total length 2.61–2.73. Carapace: 1.13–1.27 long, 0.95–1.05 wide. Abdomen 1.34–1.45 long, 0.71–0.99 wide.

Females (n = 3). Total length 2.10–2.23. Carapace: 0.90–0.96 long, 0.74–0.78 wide. Abdomen: 1.10–1.38 long, 0.79–0.88 wide.

**Distribution.** China (Beijing, Hebei) (Fig. 7).

**Remarks.** Although *A. beijingensis* sp. n. looks quite different from *A. hengshanensis* in the shape of the male paracymbium and in terms of female epigynal morphology, the strongly sclerotized embolus main body and the sharp embolus proper, the location of Fickert’s gland, the presence of a ventrally folded extensive area of the epigynal basal part and the absence of a scape and stretcher, shared by the two species suggest they are closely related. A close relationship between the two species is additionally supported by the phylogenetic analysis (Appendix - Fig. S1).

*Acanoides hengshanensis* (Chen & Yin, 2000), comb. n.
http://species-id.net/wiki/Acanoides_hengshanensis
Figs 1D–F, 3, 5

*Leptophyantes hengshanensis* Chen & Yin, 2000: 87, figs 12–16 (♂)
*Acanthoneta hengshanensis*: Tu et al. 2006: 412, figs 24–27 (♂).

**Type-specimen.** Holotype of *L. hengshanensis* Chen & Yin, 2000, ♂ (HNU), China, Hunan Province, Mt. Hengshan, 27°18’N; 112°42’E, 1–7 Aug. 1995, C. Yin leg. (examined).
Figure 4. Acanoides beijingensis sp. n. A palp (embolic division removed), prolateral B palp, retrolateral, arrow indicates half rounded lateral tooth on paracymbium C embolic division, ventral D embolic division, dorsal E detail of D F detail of G epigynum, ventral H epigynum, dorsal. AX apex of embolus; CG copulatory groove; CO copulatory opening; DM distal membrane of terminal apophysis; DSA distal suprategular apophysis; EA extensible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; LC lamella characteristica; MP median plate; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermatheca; SE serrated area on embolus; SPT suprategulum; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].
Additional material examined. 3 ♂♂ and 4 ♀♀, China, Beijing, Mt. Yangtaishan, Dajue Temple, 40°03.06'N; 116°05.97'E, alt. 50 m, 15 Oct. 2007, L. Tu leg.

**Diagnosis.** See diagnosis for *A. beijingensis* sp. n.

**Description.** Male (Fig. 1D–E): Total length 2.39. Carapace 1.02 long, 0.78 wide. Abdomen 1.37 long, 0.78 wide. Lengths of legs: I 5.03 (1.37 + 1.56 + 1.32 + 0.78), II 3.33 (0.98 + 0.98 + 0.83 + 0.54), III 3.47 (0.98 + 1.07 + 0.88 + 0.54), IV 4.63 (1.27 + 1.41 + 1.22 + 0.73). Tm I: 0.24. Female (Fig. 1F): Total length 2.42. Carapace 0.96 long, 0.78 wide. Abdomen 1.80 long, 1.25 wide. Lengths of legs: I 4.21 (1.18 + 1.42 + 0.96 + 0.65), II 3.19 (0.98 + 1.06 + 0.66 + 0.49), III 2.81 (0.84 + 0.85 + 0.68 + 0.44), IV 3.70 (1.08 + 1.19 + 0.89 + 0.54). Tm I: 0.23. For other somatic characters see description of the genus.

**Male palp** (Figs 3A–C; 5A–B). Cymbium with distinct proximal apophysis pointing backwards. Paracymbium wide and U-shaped, with triangular tooth on posterolateral margin. Distal supratelapophysis apophysis absent. Embolic division: radix long and narrow; Fickert’s gland located in the membranous area connecting radix and embolus; embolus main body large and strongly sclerotized with serrated area; embolus proper sharp with large thumb and pointed apex; lamella characteristica long and slender with bifurcated ends, one sharp and sclerotized, one membranous; terminal apophysis straight, with distal membrane.

**Epigynum** (Figs 3F–G, 5G–H). Short and wide, box-shaped, strongly sclerotized; wrinkled basal part extensible and ventrally folded in constricted state. Neither median plate nor epigynal cavity present. Copulatory openings located on ventral surface, slits of epigynal grooves extending laterally, passing from ventral to dorsal surface, then convergent mesally. No scape, no stretcher.

**Variation.** *Males* (n = 3). Total length 2.34–2.41. Carapace: 1.09–1.12 long, 0.72–0.93 wide. Abdomen 1.14–1.42 long, 0.68–0.83 wide.

*Males* (n = 4). Total length 2.32–2.42. Carapace: 0.87–1.01 long, 0.75–0.81 wide. Abdomen: 1.63–1.82 long, 0.76–1.22 wide.

**Distribution.** China (Beijing, Hunan) (Fig. 7).

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**Genus Acanthoneta Eskov & Marusik, 1992 stat. n.**

*Acanthoneta* Eskov & Marusik, 1992: 34. Described as a subgenus of *Poeciloneta.*

*Acanthoneta: Saaristo and Tanasevitch 1996: 175. Raised to generic status without any comments or argumentation.

**Type species.** *Poeciloneta aggressus* (Chamberlin & Ivie, 1943).

**Composition.** Three species: *A. aggressa* Chamberlin & Ivie, 1943 (Nearctic), *A. dokutchaevi* Eskov & Marusik, 1993 (Far East Asia) and *A. furcata* Emerton, 1913 (Nearctic).

**Comments.** Originally *Acanthoneta* was described as a subgenus of *Poeciloneta,* including two species: *Poeciloneta (A.) aggressa* and *Poeciloneta (A.) furcata.* One ad-
Figure 5. Acanoides hengshanensis. A palp (embolic division removed), prolateral B palp, retrolateral, arrow indicates pointed tooth on posterolateral margin C embolic division, ventral D embolic division, dorsal E detail of D F detail of C G epigynum, ventral H epigynum, dorsal. AX apex of embolus; CG copulatory groove; CO copulatory opening; DM distal membrane of terminal apophysis; EA extend- sible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; LC lamella characteristica; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermatheca; SPT suprategulum; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].
ditional species *A. dokutchaevi* was assigned to the subgenus by Eskov and Marusik (1993). Saaristo and Tanasevitch (1996) raised *Acanthoneta* to genus status without any argumentations and hence the new status was not accepted by Platnick (2014). Here we provide a diagnosis for *Acanthoneta* and a comparison with *Poeciloneta*.

**Diagnosis.** Males of *Acanthoneta* differ from *Poeciloneta* by the long radix almost parallel with the long lamella characteristica (Fig. 6F), in the latter the radix is normal boat-shaped, lamella characteristica large and ribbon-like (Saaristo and Tanasevitch 2000: fig. 11). Females of the two genera differ by the epigynum in *Acanthoneta* having a sigmoid scape surrounded by an epigynal cavity, the lateral wall of which is posteriorly extended (Fig. 6H), whereas in *Poeciloneta* the scape is exposed, enlarged and strongly sclerotized (Saaristo and Tanasevitch 2000: fig. 18).

*Acanthoneta aggressa* (Chamberlin & Ivie, 1943)
http://species-id.net/wiki/Acanthoneta_aggressa
Fig. 6H–J

*Leptywaćphantes aggressus* Chamberlin & Ivie, 1943: 14, figs 19–20.
*Poeciloneta aggressa*: Crawford 1988: 19.
*Acanthoneta aggressa*: Saaristo and Tanasevitch 1996: 175.
*Poeciloneta aggressa*: Paquin and Dupérré 2003: 147, figs 1623–1625.

**Material examined.** No material examined, epigynum pictures were provided by Don Buckle (Saskatoon, Canada): 1 ♀, Canada, Alberta, Chinook Lake, under log in spruce or fir woods, 49°40’N; 114°30’W, 25 Jul. 1988, D. J. Buckle leg.

**Description.** Epigynum (Fig. 6H–J). Slightly protruding, without extensible area at basal part. Epigynal cavity, with posteriorly extended lateral wall, surrounding sigmoid folded scape; scape long and narrow, with well developed lateral lobes hosting copulatory openings and distal stretcher.

**Distribution.** Across North America from Washington State to Québec (Buckle et al. 2001; Paquin and Dupérré 2003).

*Acanthoneta dokutchaevi* Eskov & Marusik, 1993
http://species-id.net/wiki/Acanthoneta_dokutchaevi
Fig. 6A–G

*Poeciloneta (Acanthoneta) aggressa* non Chamberlin & Ivie, 1943: Eskov and Marusik 1992: 34–35, figs 11–13 (♂).
*Poeciloneta (Acanthoneta) dokutchaevi*: Eskov and Marusik 1993: 52, figs 49–51 (♀).

**Material examined.** 1 ♂, China, Jilin Province, Mt. Changbaishan, Ski. 42°01.54’N; 128°04.25’E, alt. ca 1260 m, 31 July 1971.
Figure 6. Acanthoneta dokutchaevi (A–G) and Acanthoneta aggressa (H–J). A male, dorsal B male, lateral C male palp, prolateral D male palp, ventral E male palp, retrolateral F embolic division, ventral G embolic division, dorsal H epigynum, ventral I epigynum, posterior J epigynum, lateral (H–J photos provided by Don Buckle). EB epigynal basal part; EM embolic membrane; EP embolus proper; FiG Fickert’s gland; LC lamella characteristica; P paracymbium; PCA proximal cymbial apophysis; PH pit hook; R radix; SC scape; ST stretcher; TA terminal apophysis; TH thumb of embolus. [Scale bars: mm].
**Description.** Male (Fig. 6A–B). Chelicera long, with strong stridulatory ridges. Chaetotaxy: Ti I–IV: 2-2-2-2; Mt I–IV: 1-0-0-1; Tm I about 0.80, Tm IV present. For other somatic characters see description by Eskov and Marusik (1993).

*Male palp* (Fig. 6C–E). Cymbium with proximal apophysis erected. Paracymbium wide, with two pointed teeth on lateral margin. Distal suprategular apophysis modified as pit hook. Embolic division: radix long and narrow; Fickert’s gland located within radix; embolus main body trunk-like with serrated area, pointed embolus proper and well developed thumb; lamella characteristica fork-like branched, long and slender, almost parallel to radix; terminal apophysis with distal membrane and two strongly sclerotized teeth on ventral side.

Female. Unknown.

**Remarks.** The male of this species is similar to the type species *Acanthoneta aggressa*. It differs only by the shape of the paracymbium. For a detailed comparison see Eskov and Marusik (1993).

**Distribution.** Far East Asia: Magadan Area (Eskov and Marusik 1993) and China (Fig. 7) (new record).
Acanoides gen. n. from China

Acknowledgements

We would like to thank Lyubomir Penev, Dimitar Dimitrov, Nikolaj Scharff, Gustavo Hormiga and Jeremy Miller for their comments on an earlier version of this paper. We would like to thank Don Buckle for providing the epigynum pictures of *Acanthoneta aggressa*, Fang Wang for helping molecular analysis and Chen Wei for field assistance. English of the final draft was kindly checked by David Penney. The study was supported by Natural Sciences Foundation, China (NSFC-30670244, NSFC-30970314, and NSFC-30911120070) and Russian Foundation for Basic Research grants (No.11-0401716 and 12-04-01548).

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Appendix

Figure S1. Linyphiid phylogeny resulting from Maximum Likelihood analysis based on molecular data. Numbers at the nodes are bootstrap value. Branches in color indicate the four robustly supported clades within linyphiids: **S Stemonyphantes clade (blue)** **L1 “linyphiines”-1 clade (pale green)** **L2 “linyphiines-2” clade (dark blue)** **ME “micronetines-erigonines” clade (red)** with “Distal erigonines” clade in green. Taxa in different colors sampled from different groups: grey, outgroup; blue, Stemonyphantinae; pale green, Linyphiinae; dark blue, Mynogleninae; pink, Dubiaraneinae; black, Micronetinae; red, Ipainae, Acanthoneta and Acanoides gen. n.; green, Erigoninae. Red stars indicate the two out-group taxa: cyatholipid Alaranea and theridiosomatid Theridiosoma embedded within Linyphiidae.
**Table S1.** GenBank accession numbers. Data of the taxa labeled with “#” are newly sequenced; the taxa labeled with “*” come from Arnedo et al. 2009.

| Family            | Genus       | Species          | 16s   | 18s   | 28s   | COI   | H3    |
|-------------------|-------------|------------------|-------|-------|-------|-------|-------|
| Araneidae         | *Argiope*   | trifasciata      | FJ525386 | FJ525368 | FJ525316 | FJ525335 |
| Cyatholipidae     | *Alaranea*  | merina           | AY230942 | AY230890 | AY231074 | AY231022 | AY230982 |
| Mysmenidae        | *Maymena*   | ambita           | GU456746 | GU456765 | GU456824 | GU456876 | GU456921 |
| Nesticidae        | *Nesticus*  | cellulans        | EU746444 | AF005447 | AF124961 | EU746435 |
| Pimoidae          | *Pimoa*     | haden            | GU338640 | GU338524 | EF128112 | EF128155 |
| Pimoidae          | *Pimoa*     | sp.              | AY230940 | AY230893 | AY231072 | AY231025 | AY230985 |
| Syncixidae        | *Synotaxus* | sp.              | AY230943 | AY230894 | AY231076 | AY231026 | AY230986 |
| Theridiidae       | *Steatoda*  | bipunctata*      | AY230951 | AY230926 | AY231084 | AY231057 | AY231014 |
| Theridionidae     | *Theridion* | varians*         | AY230976 | AY230932 | AY231111 | AY231063 | AY231017 |
| Theridiosomatidae | *Theridiosoma* | gemmosum       | HM030408 | HM030417 | HM030428 | HM030436 | HM030443 |
| Linyphiidae       | *Acanoides* | bijengensis*     | KJ027589 | KJ027587 | KJ027580 | KJ027582 | KJ027583 |
| Acanthopheta      | sp.         |                 | GU338479 | GU338560 | GU338678 |
| Agyneta           | sp.         | GU338621         | GU338529 |
| Agyneta           | ramosa*     | FJ838670         | FJ838694 | FJ838717 | FJ838648 | FJ838740 |
| Anguliphantes     | karipinskii | GU338516         | GU338566 | GU338680 |
| Asperthorax       | communis    | GU338482         | GU338545 | GU338684 |
| Ashenargus        | sp.         | GU338493         | GU338661 |
| Australolinyphia  | remotu*     | FJ838671         | FJ838695 | FJ838718 | FJ838649 | FJ838741 |
| Bathyphantes      | florals     | GU338604         | GU338645 | GU338583 | GU338659 |
| Bathyphantes      | gracilis*   | FJ838672         | FJ838696 | FJ838719 | FJ838650 | FJ838742 |
| Bolyphantes       | alticeps*   | AY078660         | AY078667 | AY078678 | AY078691 | AY078700 |
| Capsulina         | sp.         | GU338470         | GU338586 |
| Centrometerus     | trilobus    | GU338599         | GU338468 | GU338571 | GU338656 |
| Collinsia         | inernans    | GU338601         | GU338518 | GU338645 |
| Collinsia         | plumosae    | GU338638         | GU338499 | GU338543 |
| Denisiphantes     | sp.         | GU338619         | GU338508 | GU338563 | GU338669 |
| Dicymbium         | sinofacatum | GU338614         | GU338487 | EF128119 | GU338665 |
| Family            | Genus          | Species         | 16s          | 18s          | 28s          | COI          | H3           |
|-------------------|----------------|-----------------|--------------|--------------|--------------|--------------|--------------|
| Diplocentria      | bidentata      | GU338629        | GU338494     | GU338542     | GU338688     |              |              |
| Diplocephalus     | crispatus      | GU338637        | GU338490     |              |              |              |              |
| Diplostyla        | concolor*      | FJ838673        | FJ838697     | FJ838720     | FJ838651     | FJ838743     |              |
| Diplostyla        | concolor       | GU338639        | GU338467     | GU338585     | GU338697     |              |              |
| Doenitzius        | peniculus      | GU338631        | GU338469     |              |              |              |              |
| Doenitzius        | pruus          | GU338632        | GU338474     |              |              |              |              |
| Drapetica         | socialis*      | FJ838674        | FJ838698     | FJ838721     | FJ838652     | FJ838744     |              |
| Dubianaea         | aysenensis     | FJ838675        | FJ838699     | FJ838722     | FJ838653     | FJ838745     |              |
| Dubianaea         | distincta      | GU338624        | GU338459     | GU338579     | GU338648     |              |              |
| Dubianaea         | propinquia     | GU338627        | GU338460     | GU338580     | GU338675     |              |              |
| Dubianaea         | similis        | GU338521        | GU338581     | GU338681     |              |              |              |
| Erigone           | edentate       | GU338486        | GU338540     | GU338686     |              |              |              |
| Erigone           | prominens      | GU338498        | GU338539     | GU338679     |              |              |              |
| Floronia          | bucculenta*    | FJ838676        | FJ838700     | FJ838723     | FJ838654     | FJ838746     |              |
| Frontinella       | communis       | GU338628        | GU338517     | GU338573     |              |              |              |
| Frontinella       | communis*      | FJ838677        | FJ838701     | FJ838724     | FJ838655     | FJ838747     |              |
| Fusciphantes      | hibamus        | GU338512        | GU338570     | GU338683     |              |              |              |
| Gnathonarium      | dentatum       | GU338593        | GU338477     | EF128120     | GU338651     |              |              |
| Gnathonarium      | taczanowskii   | GU338620        | GU338480     | GU338547     | GU338670     |              |              |
| Gonatium          | japonicum      | GU338613        | GU338492     |              |              |              |              |
| Gonatium          | rubellum*      | FJ838679        | FJ838703     | FJ838726     | FJ838656     | FJ838749     |              |
| Gongylidiellum    | vivum*         | FJ838678        | FJ838702     | FJ838725     | FJ838748     |              |              |
| Grammonota        | sp.            | GU338491        |              |              |              |              |              |
| Hapliniis         | diloris*       | FJ838680        | FJ838704     | FJ838727     | FJ838657     | FJ838750     |              |
| Helophora         | insignis*      | FJ838681        | FJ838705     | FJ838728     | FJ838658     | FJ838751     |              |
| Himalaphantes     | azumiensis     | GU338522        | GU338564     | GU338677     |              |              |              |
| Hylyphantes       | graminicola    | GU338595        | GU338478     | GU338550     | GU338653     |              |              |
| Hylyphantes       | sp.            | GU338618        | GU338481     | GU338549     | GU338668     |              |              |
| Labella           | thoracica*     | AY078662        | AY078674     | AY078680     | AY078694     | AY078707     |              |
| Laetesia          | sp.*           | FJ838682        | FJ838706     | FJ838729     | FJ838659     | FJ838752     |              |
| Leptolyphantes    | minutus*       | AY078663        | AY078673     | AY078681     | AY078689     | AY078705     |              |
| Family     | Genus          | Species   | 16s        | 18s        | 28s        | COI        | H3        |
|------------|---------------|-----------|------------|------------|------------|------------|-----------|
| Lepthyphantes | leprosus     | GU338488  | GU338565   | GU33862   |
| Lepthyphantes | sp.          | GU338610  | GU338509   | GU33862   |
| Linyphia    | triangularis* | AY078664  | AY078668   | AY07862   |
| Linyphia    | sp.          | GU338597  | GU338461   | GU33872   |
| Macargus    | alpinus      | GU338505  | GU338559   |            |
| Agyneta     | nigra        | GU338608  | GU338504   | GU33877   |
| Agyneta     | rurestris*   | FJ838683  | FJ838707   | FJ83860   |
| Microlinyphia | dana*        | AY078665  | AY078677   | AY07863   |
| Microneta   | sp.          | GU338609  | GU338472   | GU33853   |
| Microneta   | viaria*      | FJ838684  | FJ838708   | FJ83861   |
| Microneta   | viaria       | GU338598  | GU338502   | GU33857   |
| Moebelia    | rectangular  | GU338591  | GU338485   | GU33857   |
| Mughiphantes | nigromaculans | GU338600  | GU338510   | GU33827   |
| Nematogmus  | sanguinolentus | GU338635  | GU338489   | GU33854   |
| Neomaso     | patagonicus  | GU338626  | GU338473   | GU33878   |
| Neriene     | japonica     | GU338633  | GU338462   | GU33857   |
| Neriene     | radiata*     | AY078710  | AY078670   | AY07868   |
| Neriene     | radiate      | GU338623  | GU338463   | GU33854   |
| Neriene     | variabilis*  | AY078711  | AY078669   | AY07868   |
| Nesioceta   | elipoidalis  | GU338519  | GU338532   | GU33867   |
| Nippononeta | kantonis     | GU338634  | GU338471   | GU33850   |
| Nippononeta | sp.          | GU338602  | GU338520   | GU33853   |
| Notholephyphantes | australis* | FJ838685  | FJ838709   | FJ83862   |
| Novafroneta | vulgaris*    | FJ838686  | FJ838710   | FJ83863   |
| Oeoetobenus | apicatus*    | FJ838687  | FJ838711   | FJ83864   |
| Orsonwelles* | malus        | AY078737  | AY078676   | AY07879   |
| Orsonwelles* | polites      | AY078725  | AY078671   | AY07886   |
| Ostariae    | melampygus*  | FJ838688  | FJ838712   | FJ83875   |
| Paikiniana  | sp.          | GU338617  | GU338495   | GU33855   |
| Parameioneta | biloba      | GU338605  | GU338503   | GU33853   |
| Parasisis   | sp.          | GU338592  | GU338500   | GU33854   |
| Family       | Genus                 | Species     | 16s     | 18s     | 28s     | COI     | H3       |
|--------------|-----------------------|-------------|---------|---------|---------|---------|----------|
|              | Pityohyphantes        | costatus*   | AY078666| AY078675|         |         |          |
|              | Pocoblethus           | sp.*        | FJ838689| FJ838713| FJ838736| FJ838665| FJ838759 |
|              | Porrhomma             | sp.         | GU338607| GU338466| GU338584| GU338661|          |
|              | Prosoponoides         | sinensis    | GU338606| GU338576| GU338649|         |          |
|              | Pseudafroneta         | incerta*    | FJ838690| FJ838714| FJ838737| FJ838666| FJ838760 |
|              | Ryojius               | sp.         | GU338611|         |         |         |          |
|              | Siscottus             | montanus    | GU338625| GU338497| GU338541| GU338673|          |
|              | Solenysa              | sp.         | GU338616| GU338506| GU338528| GU338667|          |
|              | Sphecozone            | bicolor     | GU338622| GU338496| GU338553| GU338671|          |
|              | Stemonyphantes        | lineatus*   | FJ838691| FJ838715| FJ838738| FJ838667| FJ838761 |
|              | Stemonyphantes        | sibiricus*  | FJ838692|         |         |         |          |
|              | Syedra                | oii         | GU338615| GU338513| GU338569| GU338666|          |
|              | Tapinopa              | guttata     | GU338511|         |         |         |          |
|              | Temiphantes           | ancatus     | GU338515|         |         |         |          |
|              | Temiphantes           | sp.         | GU338612| GU338514| GU338568| GU338646|          |
|              | Temiphantes           | tenuis*     | FJ838693| FJ838716| FJ838739| FJ838669| FJ838763 |
|              | Ummeliata             | feminea     | GU338594| GU338475| GU338551| GU338652|          |
|              | Ummeliata             | insecticeps| GU338476|         |         |         |          |
|              | Walckenaeria          | clavicornis | GU338596| GU338483| GU338554|         |          |
|              | Walckenaeria          | keikoae     | GU338636| GU338484| GU338556| GU338695|          |