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A checklist of ants (Hymenoptera: Formicidae) in northern Shaanxi Province, China, with one new species of genus *Proformica* Ruzsky, 1902

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ABSTRACT

A preliminary checklist of the ants of northern Shaanxi is presented based on an evaluation from June 2018 to September 2020. Seven species are reported from Shaanxi for the first time: *Formica approximans* Wheeler, 1933; *Formica clara* Forel, 1886; *Messor aralocaspius* (Ruzsky, 1902); *Plagiolepis pygmaea* (Latreille, 1798); *Tapinoma rectinotum* Wheeler, 1927; *Tetramorium chefketi* Forel, 1911; *Tetramorium tsushimae* Emery, 1925 and *Temnothorax ruginosus* Zhou, Huang, Yu & Liu, 2010. A new species of genus *Proformica* Ruzsky, 1902, *Proformica muusensis* **sp. nov.**, is described based on the morphology and molecular method. In total, three subfamilies with 34 valid ant species in 15 genera are reported in our checklist.

Introduction

With 13,990 species and 1838 subspecies in 17 subfamilies and 340 genera, ants are among the most species-rich and ecologically diverse groups of social insects and are more sensitive than other insects to ecosystem change (Bolton, 2021; Guénard and Dunn, 2012; Andersen, 1995; Andersen and Majer, 2004; Kaspari and Majer, 2000; Paknia and Pfeiffer, 2011). As an important component of terrestrial ecosystems, ants crucial for soil aggregate formation, seed dispersal, and pest control (Chen et al., 2007; Pfeiffer et al., 2013). Until now, 1023 species and subspecies of ants belonging to 10 subfamilies and 117 genera are known from China, of which 115 species have been reported from Shaanxi Province (Xin, 2015; Gu et al., 2019; Bolton, 2021).

Northern Shaanxi is in the transition zone, between the warm temperate semi-humid continental monsoon climate to the temperate semi-arid climate. Several authors have studied the ant fauna part of Shaanxi. For instance, Liu et al. (1999) and Wei et al. (2001) studied the ant fauna of Shaanxi in the Taibai mountains as the main line. Tie and Xu (2004, 2005) have conducted further research on ants in Ningshan County and Chang'an District, Wang et al. (2008) in Xixiang County, and Ma and Xu (2018) in Foping County.

Proformica Ruzsky, 1902 is a genus in the formicid subfamily Formicinae. In this genus, a total of 29 species are reported worldwide, of which, only three species are reported from China: *P. buddhaensis* Ruzsky, 1915, *P. flavosetosa* (Viehmeyer, 1922), and *P. jacoti* (Wheeler, 1923). Additionally, 14 species have been identified in China, and only one species, *P. mongolica* (Emery, 1901), was recorded in Shaanxi Province (Guénard and Dunn, 2012, Bolton, 2021). Here, we present one new species collected in Northern Shaanxi, China, totaling the number of *Proformica* species to 30, Chinese *Proformica* fauna to 15, and Shaanxi *Proformica* fauna to two.

Materials and methods

Morphological observation

A total of 6160 ant specimens were collected from eight sites in northern Shaanxi (Fig. 1), between June 2018 and September 2020 in northern Shaanxi. The collection sites include Baota District (36°23′31.20″N, 109°14′33.36″E), Fu County (36°0′28.35′N, 109°22′30.15″E), Huangling County (35°34′54.98″N, 109°16′23.47″E), Huanglong County (35°34′52.19″N, 109°49′58.36″E), Qingjian County (37°4′30.06″N, 110°7′24.97″E), Suide County (37°30′6.47″N, 110°15′16.60″E), Shenmu County (38°53′50.84″N, 109°52′2.44″E), and Yuyang District (38°22′6.46″N, 109°40′28.92″E).

The type material is deposited in the Zoological and Botanical Museum, Shaanxi Normal University, Xi'an, China (ZBM). The specimens were examined, measured, and documented under a stereoscopic dissecting binocular microscope. The images of the new species were obtained using VHX-6000 super-high magnification lens zoom 3D microscope (Keyence, Japan). All measurements are given in millimeters. All specimens collected were preserved and further studied in a 75%

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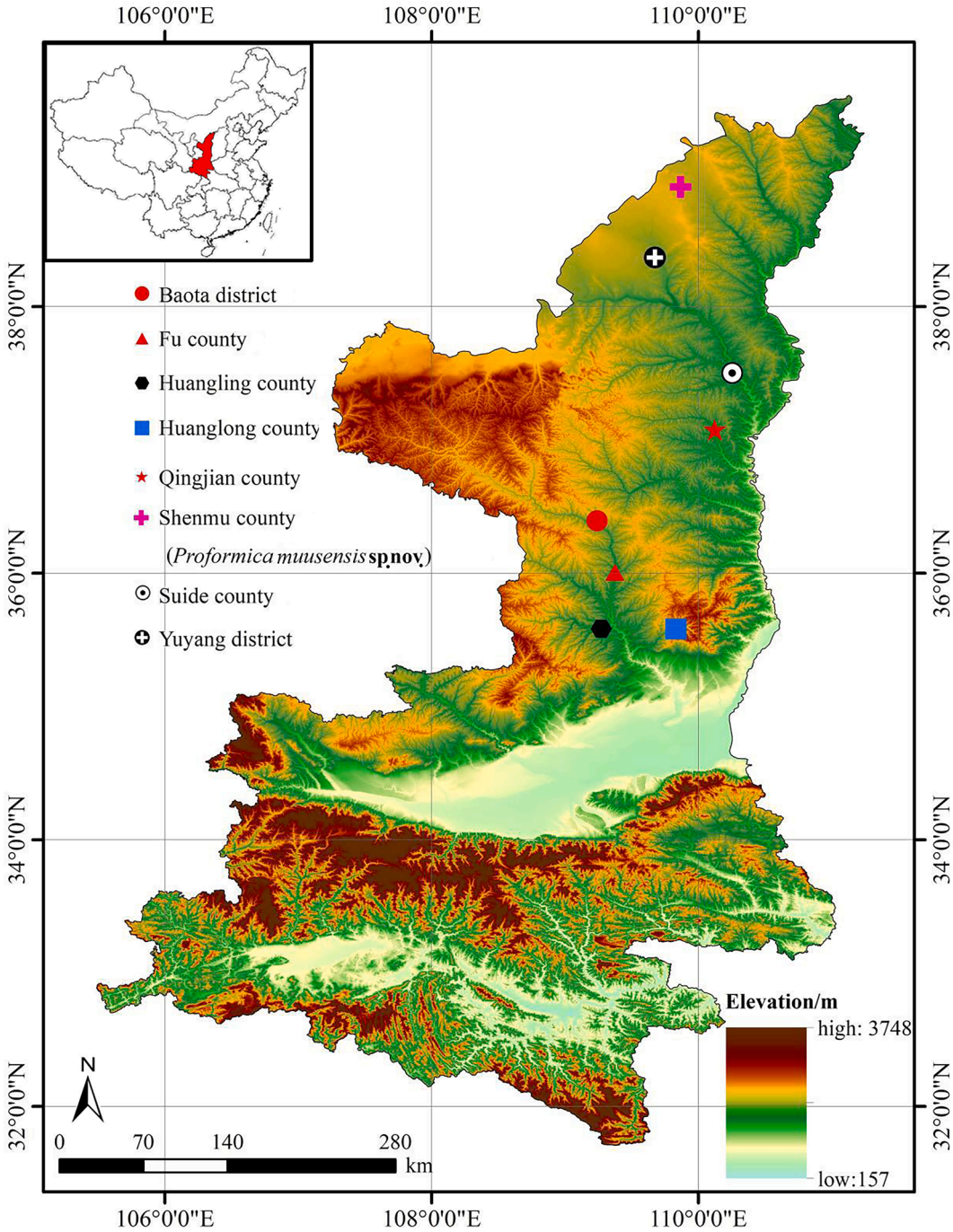

Fig. 1. Sampling sites in Northern Shaanxi.

ethanol solution. The terminologies follow Dlussky (1969), Lattke (2011), Bharti and Wachkoo (2013), and Xu and He (2015), and the taxonomy procedure follows Wu and Wang (1995).

Molecular phylogenetic analyses

We analyzed data from eight *Proformica* individuals belonging to eight species (including seven taxa downloaded from GenBank; Table 1) and used one species of *Formica* (Formicidae: Formicinae) as the outgroup. In total, nine taxa were included in our molecular dataset.

Genomic DNA was extracted from the muscle tissue. It was extracted by a standard proteinase K and phenol/chloroform extraction method. After verification by gel electrophoresis, the DNA was stored at −20 ℃. Whole mitochondrial genome sequencing was performed by Genesky co. (Shanghai, China) using the Illumina platform according to a DNA library data. Raw reads were assembled using a baiting and iterative mapping approach (Hahn et al., 2013). Genome annotation was performed using the MITOS Web Server. The annotated COI gene sequence has been deposited in GenBank (Table 1).

The phylogenetic relationships of *Proformica muusensis* **sp. nov.** with other species were analyzed using all the currently available COI gene fragments of *Proformica* species. The Bayesian phylogenetic tree was constructed using mrbayes software (Huelsenbeck and Ronquist, 2001).

Table 1
Molecular information of specimen.

Species	Accession	Date	Sequence Length
Proformica buddhaensis Ruzsky, 1915	KJ499819	05-MAY-2014	548 bp
P. epinotalis Kuznetsov-Ugamsky, 1927	KX219962	28-DEC-2016	754 bp
P. ferreri Bondroit, 1918	AB010935	25-JUL-2016	974 bp
P. korbi (Emery, 1909)	KX219960	28-DEC-2016	754 bp
P. longiseta Collingwood, 1978	AB010934	25-JUL-2016	974 bp
P. mongolica (Emery, 1901)	KJ499820	05-MAY-2014	548 bp
P. muusensis **sp. nov.**	MW589257	15-FEB-2021	1530 bp
P. nasuta (Nylander, 1856)	DQ353311	05-MAR-2020	1035 bp
Formica fusca Linnaeus, 1758	FJ824419	24-JUL-2016	1377 bp

Abbreviations

HL	Head length. Maximum length of head capsule from anterior clypeal margin to mid-point of posterior head margin in full-face view.
HW	Head width. Maximum width of head in full-face view.
ML	Straight-line length of mandible. Measured from its insertion to head capsule to apex.
ED	Eye length. Maximum length of eye as measured in oblique view of head to show full surface of eye.
SL	Antennal scape length. Maximum length of antennal scape excluding basal constriction and condylar bulb.
PW	Maximum width of pronotum in dorsal view.
WL	Weber's length of mesosoma, measured in lateral view from anterior margin of pronotum (excluding the collar) to posterior margin of propodeal lobe.
PL	Petiole length. Maximum length of petiole from anterior process to posterior-most point of tergite, where it articulates with helcium.
DPW	Maximum width of petiole in dorsal view.
PH	Petiole height. Measured in lateral view from apex of ventral (subpetiolar) process vertically to a line intersecting dorsal-most point of node.
TL	Total length. Measured from anterior margin of head to tip of gaster in stretched specimens.
CI	Cephalic index (HW/HL × 100)
MI	Mandibular index (ML/HW × 100)
OI	Ocular index (ED/HW × 100)
SI	Scape index (SL/HW × 100)

Results

Taxonomy

The 6160 individuals of ants collected in Northern Shaanxi were identified to species. These include three subfamilies (Dolichoderinae Forel, 1878; Formicinae Latreille, 1809; Myrmicinae Lepeletier de Saint-Fargeau, 1835). A total of 34 species in 15 genera are listed below, including a new species *Proformica muusensis* **sp. nov.** and seven new records viz *Formica approximans* Wheeler, 1933; *Formica clara* Forel, 1886; *Messor aralocaspius* (Ruzsky, 1902); *Plagiolepis pygmaea* (Latreille, 1798); *Tapinoma rectinotum* Wheeler, 1927; *Tetramorium chefketi* Forel, 1911; *Tetramorium tsushimae* Emery, 1925 and *Temnothorax ruginosus* Zhou, Huang, Yu & Liu, 2010. The following section presents a checklist of ants in northern Shaanxi Province and the new species. Different symbols at the beginning of species names indicate: A circle (°) for new species, a plus (+) for newly recorded species, and an asterisk (*) for species collected during the present survey.

Checklist of ants in northern Shaanxi Province

Order Hymenoptera Linnaeus, 1758
Suborder Apocrita Gerstäcker, 1867
Family Formicidae Latreille, 1809
Subfamily Dolichoderinae Forel, 1878 (3 species)
Genus *Dolichoderus* Lund, 1831 (1 species)
1. **Dolichoderus sibiricus* Emery, 1889
Distribution: Qingjian County.
Type locality: Russian Federation (see Emery, 1889: 442).
Genus *Tapinoma* Foerster, 1850 (2 species)
2. **Tapinoma geei* Wheeler, 1927
Distribution: Shenmu County.
Type locality: China (see Wheeler, 1927: 8).
3. +*Tapinoma rectinotum* Wheeler, 1927
Distribution: Shenmu County.
Type locality: China (see Wheeler, 1927: 8).
Subfamily Formicinae Latreille, 1809 (20 species)
Genus *Camponotus* Mayr, 1861 (1 species)
4. **Camponotus japonicus* Mayr, 1866
Distribution: Baota District, Fu County, Huangling County, Huanglong County, Qingjian County, Suide County, Shenmu County and Yuyang District (Xin, 2015).
Type locality: Japan (see Mayr, 1866: 885).
Genus *Cataglyphis* Foerster, 1850 (1 species)
5. **Cataglyphis aenescens* (Nylander, 1849)
Distribution: Baota District, Dingbian County (Xin, 2015), Hengshan County (Xin, 2015), Jingbian County (Xin, 2015), Qingjian County, Suide County and Shenmu County.
Type locality: Russian Federation (see Nylander, 1849: 37).
Genus *Formica* Linnaeus, 1758 (8 species)
6. +*Formica approximans* Wheeler, 1933
Distribution: Shenmu County.
Type locality: China (see Wheeler, 1933: 65).
7. +*Formica clara* Forel, 1886
Distribution: Yuyang District.
Type locality: Russian Federation (see Forel, 1886: 206).
8. **Formica clara sinae* Emery, 1925
Distribution: Dingbian County (Xin, 2015), Suide County, Shenmu County and Yuyang District (Ran & Zhou, 2012, Xin, 2015).
Type locality: China (see Seifert and Schultz, 2009: 65).
9. **Formica cunicularia* Latreille, 1798
Distribution: Dingbian County (Xin, 2015), Baota District, Fu County, Hengshan County (Xin, 2015), Huangling County, Qingjian County, Suide County and Shenmu County.
Type locality: France (see Latreille, 1798: 40).
10. **Formica fukaii* Wheeler, 1914
Distribution: Shenmu County.
Type locality: Japan (see Wheeler, 1914: 26).
11. **Formica fusca* Linnaeus, 1758
Distriution: Baota District, Fu County, Huangling County, Huanglong County, Qingjian County, Suide County and Shenmu County.
Type locality: France (see Linnaeus, 1758: 580).
12. **Formica gagatoides* Ruzsky, 1904
Distribution: Fu County.
Type locality: Russian Federation (see Ruzsky, 1904: 289).
13. **Formica japonica* Motschoulsky, 1866
Distribution: Baota District, Fu County, Huanglong County, Qingjian County, Suide County and Shenmu County.
Type locality: Japan (see Motschoulsky, 1866: 183).
Genus *Lasius* Fabricius, 1804 (5 species)
14. **Lasius alienus* (Foerster, 1850)
Distribution: Suide County, Shenmu County and Yuyang District.
Type locality: Germany (see Foerster, 1850: 71).
15. **Lasius coloratus* Santschi, 1937

Distribution: Shenmu County.
Type locality: China (see Santschi, 1937: 387).
16. **Lasius flavus* (Fabricius, 1782)
Distribution: Shenmu County.
Type locality: Germany (see Fabricius, 1782: 491).
17. **Lasius fuliginosus* (Latreille, 1798)
Distribution: Fu County.
Type locality: France (see Latreille, 1798: 36).
18. **Lasius niger* (Linnaeus, 1758)
Distribution: Fu County, Huanglong County, Qingjian County, Suide County, Shenmu County and Yuyang District (Xin, 2015).
Type locality: Europe (see Linnaeus, 1758: 580).
Genus *Plagiolepis* Mayr, 1861 (2 species)
19. **Plagiolepis manczshurica* Ruzsky, 1905
Distribution: Baota District and Suide County.
Type locality: Russian Federation (see Ruzsky, 1905: 467).
20. +*Plagiolepis pygmaea* (Latreille, 1798)
Distribution: Suide County.
Type locality: France (see Latreille, 1798: 45).
Genus *Polyergus* Latreille, 1804 (1 species)
21. **Polyergus samurai* Yano, 1911
Distribution: Shenmu County.
Type locality: China (see Yano, 1911: 110).
Genus *Proformica* Ruzsky, 1902 (2 species)
22. **Proformica mongolica* (Emery, 1901)
Distribution: Baota County, Suide County, Shenmu County and Yuyang District.
Type locality: Mongolia (see Emery, 1901: 159).
23. °*Proformica muusensis* **sp. nov.**
Distribution: Shenmu County.
III. Subfamily Myrmicinae Lepeletier de Saint-Fargeau, 1835 (11 species)
Genus *Messor* Forel, 1890 (2 species)
24. **Messor aciculatus* (Smith, 1874)
Distribution: Baota District, Dingbian County (Xin, 2015), Fu County, Huangling County, Qingjian County, Suide County and Shenmu County.
Type locality: Japan (see Smith, 1874: 405).
25. +*Messor aralocaspius* (Ruzsky, 1902)
Distribution: Qingjian County.
Type locality: Russian Federation (see Ruzsky, 1902: 20).
Genus *Myrmica* Latreille, 1804 (3 species)
26. *Myrmica koreana* Elmes, Radchenko & Kim, 2001
Distribution: Yangling County (Xin, 2015).
Type locality: Republic of Korea (see Elmes et al., 2001: 108).
27. *Myrmica kurokii* Forel, 1907
Distribution: Yangling County (Xin, 2015).
Type locality: Japan (see Forel, 1907: 18).
28. *Myrmica rubra* (Linnaeus, 1758)
Distribution: Yuyang District (Xin, 2015).
Type locality: Europe (see Linnaeus, 1758: 580).
Genus *Solenopsis* Westwood, 1840 (1 species)
29. **Solenopsis jacoti* Wheeler, 1923
Distribution: Suide County.
Type locality: China (see Wheeler, 1923: 2).
Genus *Strongylognathus* Mayr, 1853 (1 species)
30. *Strongylognathus koreanus* Pisarski, 1966
Distribution: Huangling County (Guénard and Dunn, 2012; Liu et al., 1999; Tie and Xu, 2004; Wu and Wang, 1995).
Type locality: Republic of Korea (see Pisarski, 1966: 519).
Genus *Temnothorax* Mayr, 1861 (1 species)
31. +*Temnothorax ruginosus* Zhou, Huang, Yu & Liu, 2010
Distribution: Fu County, Huangling County, Huanglong County, Qingjian County and Suide County.
Type locality: China (see Zhou et al., 2010: 18).
Genus *Tetramorium* Mayr, 1855 (3 species)
32. +*Tetramorium tsushimae* Emery, 1925
Distribution: Fu County, Huangling County, Huanglong County, Qingjian County, Suide County, Shenmu County and Yuyang District.
Type locality: Japan (see Emery, 1925: 187).
33. +*Tetramorium chefketi* Forel, 1911
Distribution: Fu County, Suide County, Shenmu County.
Type locality: Turkey (see Forel, 1911: 331-400).
34. *Tetramorium flavum* Chang & He, 2001
Distribution: Dingbian County (Xin, 2015).
Type locality: China (see Chang & He, 2001: 2).

Description of new species

Genus *Proformica* Ruzsky, 1902

Type species: *Proformica nasuta* (Nylander, 1856)
Generic diagnosis and description. See Wu and Wang (1995).
Key to the known extant Shaanxi province species of *Proformica* based on worker caste.
Body total length 1.5–2.5 mm. Head with rounded occipital margin in full face view. Clypeus with 4–6 erected setae, and dorsal of mesosoma with sparse setae…….....**P. muusensis sp. nov.**
Body total length greater than 2.5 mm. Head with quadrated occipital margin in full face view. Clypeus with 2–3 erected setae, and dorsal of mesosoma with dense setae…….....**P. mongolica (Emery, 1901)**

***Proformica muusensis* sp. nov.**

Fig. 2
Type material
Holotype worker (ZBM), Mu Us Desert (38°89′74″N, 109°86′73″E,

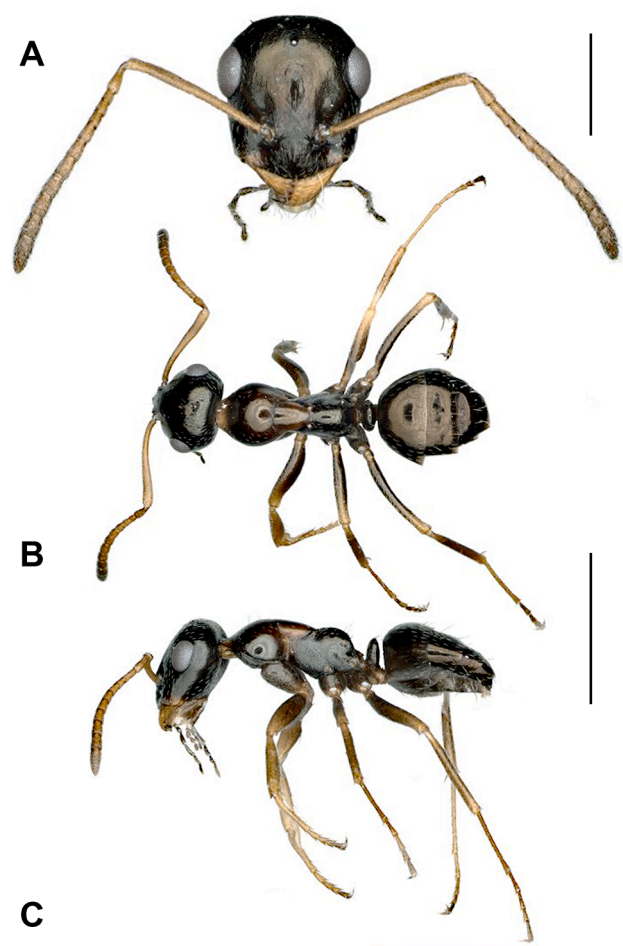

Fig. 2. *Proformica muusensis* **sp. nov.** holotype worker. A. Head in full-face view; B. body in dorsal view; C. body in lateral view. Scale bars: 0.40 (A), 1 (B, C).

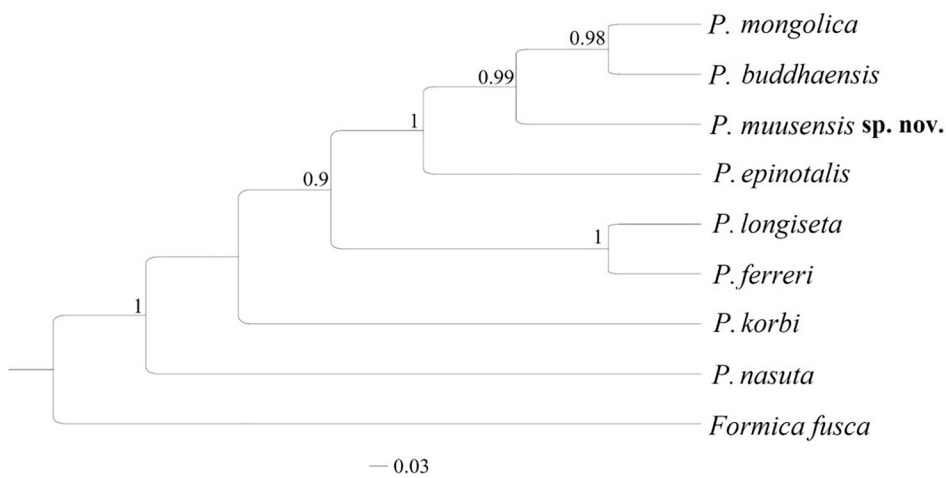

Fig. 3. Bayesian phylogenetic tree of eight taxa of *Proformica*. *Formica* is used as the outgroup. Posterior probabilities <0.95 are not shown.

elevation 1300 m), Shenmu County, Yulin, China, 3 July 2020, L. Wu leg. **Paratypes** 2 workers (ZBM), same data as the holotype; three workers (ZBM), Mu Us Desert (38°89′53″N, 109°86′74″E, elevation 1285 m), Shenmu County, Yulin, China, 3 July 2020, L. Wu leg.

Description

Worker (holotype): Head in full-face view longer than the broad, with convex sides, and rounded occipital margin. Anterior clypeal margin broadly rounded. Antennae 12-segmented, antennal scape relatively long, surpassing posterior head corner by one third of its length. Eye moderately large, occupying approximately one third of lateral cephalic margin, and located in front of midpoint of lateral margin.

In lateral view, the promesonotum is moderately convex and indistinctly higher than the propodeum. Metanotal groove slightly angularly impressed. Dorsum of propodeum weakly convex. Petiolar node roughly triangle, approximately two times higher than long in lateral view, and lateral margins convex, anterior margin and posterior margin straight and nearly oval in dorsal view. Gaster nearly oval in dorsal view, with distinct constriction.

Mandible smooth and shiny. Antennal scape with dense pubescence, and without setosity. Head dorsum with abundant subdecumbent pubescence, and without setae. Dorsal of mesosoma, petiolar node and gaster with short and sparse decumbent pubescence. Pronotum and mesonotum with two setae, petiole with three setae, and dorsal of gaster with four setae. Femur with dense decumbent pubescence and tibia with setae on external face close to apex. Body and appendages black, antennae, trochanters, femora, tibiae, and tarsi yellowish red.

Measurement: HL 0.96, HW 0.67, ML 0.20, ED 0.22, SL 0.70, PW 0.58, WL 0.99, PL 0.13, DPW 0.24, PH 0.25, TL 1.91, CI 69.99, MI 25.89, OI 30.07, SI 107.65.

Variation in paratype workers: HL 0.76–1.17, HW 0.53–0.78, ML 0.12–0.28, ED 0.18–0.25, SL 0.52–0.83, PW 0.45–0.66, WL 0.86–1.09, PL 0.10–0.16, DPW 0.20–0.29, PH 0.19–0.34, TL 1.59–2.39, CI 66.67–72.84, MI 15.38–35.90, OI 27.94–35.59, SI 94.55–120.75 (n = 5 workers).

Etymology

The specific name is a noun in apposition and refers to the type locality.

Distribution

China (Shaanxi).

Remarks

This new species resembles *P. mongolica* (Emery, 1901) (see Ruzsky, 1915: 432; Xin, 2015: 116) with antennal scape without setosity but can be distinguished by a smaller body total length, by having different shapes of the head occipital margin (rounded in *P. muusensis* sp. nov. *vs* quadrated in *P. mongolica*), fewer setae in the pronotum and mesonotum longer than wide, much narrower than the pronotum.

Molecular analysis

A total of nine COI sequences from eight ingroup members and one outgroup member were generated. The alignment did not include any gaps, and the sequence accession numbers are listed in Table 1.

The topology of BI (Fig. 3) trees supported that *P. muusensis* **sp. nov.** is the sister clade to the *P. mongolica* and *P. buddhaensis.*

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.aspen.2022.101875.

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