Parasitoids reared from galls of *Stefaniola* sp. (Diptera, Cecidomyiidae) on *Haloxylon* spp. in China, with redescription of *Mesopolobus quadrimaculatus* Dzhanokmen (Chalcidoidea, Pteromalidae)

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Abstract: *Mesopolobus quadrimaculatus* Dzhanokmen (Hymenoptera: Pteromalidae) is recorded for the first time from China and outside of Kazakhstan. It was reared from galls of *Stefaniola* sp. (Diptera: Cecidomyiidae) on black saxaul, *Haloxylon ammodendron* (C.A.Mey.) Bunge ex Fenzl and white saxaul, *H. persicum* (Bunge ex Boiss. & Buhs) (Chenopodiaceae) in Beishawo Desert in Fukang, Xinjiang Uyghur Autonomous Region, China. Provided are its illustrated redescription and diagnosis, which was not included in the original description, as well as data on the distribution and biology of this interesting, little known species. *Mesopolobus deserti* Dzhanokmen, which is also newly recorded from China, was swept on both *H. ammodendron* and *H. persicum* at the same site as *M. quadrimaculatus*. Besides *M. quadrimaculatus*, seven other parasitoids were also reared from stem-galls of *Stefaniola* sp. on both *Haloxylon ammodendron* and *H. persicum*. However, the relationships between these seven parasitoids and the gall inducer need further study.

Key words: Pteromalidae, *Mesopolobus deserti*, new record, Cecidomyiidae, *Haloxylon ammodendron*, *Haloxylon persicum*, Xinjiang

1. Introduction
The pteromalid (Hymenoptera, Chalcidoidea, Pteromalidae) wasp genus *Mesopolobus* Westwood was established by Westwood (1833) based on the type species *M. fasciiventris* Westwood. It is one of the largest genera of Pteromalidae with a worldwide distribution. It is an important group of entomophagous insects, some of which are known to be parasitoids of agricultural and forest pests, thus playing an important role in their natural control. Insects attacked by *Mesopolobus* species include dipterous (mainly cecidomyiids), hymenopterous, and coleopterous gall-makers as well as larvae developing in seeds of plants and stems of grasses (Bouček, 1988). There are also records of them parasitizing the eggs of Hemiptera (Delphacidae, Psyllidae) and the larvae and pupae of some genera of Lepidoptera. Some species can even parasitize species of the same genus, e.g., *M. aequus* (Walker) and *M. arcanus* Askew (Xiao et al., 2016). Insect hosts recorded for the genus include 5 orders, 43 genera, and more than 300 species (Xiao et al., 2016; Noyes, 2017). Presently, 132 valid species are described in *Mesopolobus*, but only 26 of them have been reported from China (Sun et al., 2005; Xiao et al., 2016; Noyes, 2017). *Mesopolobus quadrimaculatus* Dzhanokmen, reported here from Xinjiang Uyghur Autonomous Region, is a new record for China. Its illustrated redescription and an account of some biological traits are provided below. Its plant hosts in Xinjiang are two species of the genus *Haloxylon* Bunge ex Fenzl (Chenopodiaceae).

Both currently recognized species of *Haloxylon*, the black saxaul *H. ammodendron* (C.A.Mey.) Bunge ex Fenzl and the white saxaul *H. persicum* (Bunge ex Boiss. and Buhs), occur in China. Saxaul mainly grows in deserts and can resist drought, infertility, and extreme temperatures, and also has salt tolerance to some extent (Zhang, 2010; Xue et al., 2012). They are the largest plant individuals with the highest biomass production in the desert ecosystems of China, especially in Xinjiang. *Haloxylon* plants serve as shelter belts to impede wind erosion and stabilize sand dunes, which play a very important role in helping counter desertification. Xue et al. (2012) reported that *H. ammodendron* is also the host of the parasitic plant *Cistanche deserticola* Ma (Orobanchaceae), whose fleshy stems are of medicinal importance. Thus, both *H.
ammodendron and H. persicum are important both as ecological and economically valuable plants in the arid and semiarid regions of China. However, heavy infestations by gall inducers that occur repeatedly over several seasons slow growth and make the appearance of the affected plants unattractive. In H. ammodendron and H. persicum, the presence of dead branches is very likely to be due to the occurrence of galls, which eventually cause their breaking. When galls are present in low numbers on the host plants, they can usually be tolerated and may not even be noticed, but when the abundance of galls reaches a certain level, the vigor of the plants is obviously reduced (Saji et al., 2013). Based on our own investigations in Xinjiang and results of other researchers (Li et al., 2012; Xue et al., 2012; Sajiet al., 2013), there are many kinds of galls on saxaul and that is quite typical in arid environments; these can be induced by many insect species. Here we focus on Stefaniola sp. (Diptera, Cecidomyiidae).

2. Materials and methods
All cecidomyiid galls were collected on H. ammodendron and H. persicum from 2014 to 2016 by Hong-ying Hu's group (Hong-ying Hu, Qin Li, Zhulidezi Aishan, Chao Wang, Wan Yin, Ya-jie Zhu, Feng Li, Dong-kang Zhang, Ling-ling Jiang, Jie Guo) in Beishawo Desert, Fukang (44°22′29″N to 44°22′49″N, 87°52′57″E to 87°52′58″E, 401–446 m), Xinjiang. All parasitoids (M. quadrimaculatus, Aprostocetus sp., Dzhanokmenia sp., Metaphycus sp., Psyllaephygas caillardiae Sugonjaev, Trichogramma sp., and some unidentified Eurytomiidae and Platygastriae) as well as Stefaniola sp. specimens were reared in the laboratory at room temperature (20–32 °C) and 22%–60% relative humidity, with natural and fluorescent lighting of approximately 13:11 L:D, at the College of Life Science and Technology, Xinjiang University, Urumqi, by Qin Li and preserved in 100% ethanol. They were subsequently air-dried, point-mounted, and examined with a Nikon SMZ25 system, and plates of illustrations were compiled using Adobe Photoshop. Morphological terminology follows that of Bouček (1988) and Gibson (1997). Body length excludes that of the exserted part of ovipositor and is measured in millimeters. The other measurements are given as ratios. Abbreviations of the morphological terms used are: $f_u$—funicular segment; POL—posterior ocellar distance; OOL—ocellocular distance; $G_t$—gastral tergum.

All voucher specimens are deposited in the Insect Collection of the College of Life Science and Technology, Xinjiang University, Urumqi, Xinjiang, China (ICXU).

3. Results
Mesopolobus Westwood, 1833
Mesopolobus Westwood, 1833: 443. Type species: M. fasciventris Westwood, by original designation and monotypy.

Mesopolobus Westwood: Graham, 1969: 638–681 (synonyms, key to European species); Dzhanokmen 2005: 71–79 (synonyms, annotated list of species from Kazakhstan); Sun et al., 2005: 14 (synonyms, key to Chinese species); Baur et al., 2007: 387–397 (discussion, host associations); Xiao et al., 2016: 65 (synonyms, diagnosis, biology, and distribution).

Diagnosis. Body green with luster; occiput not margined; antenna 13-segmented, inserted below middle of face; antennal formula 11353 or 11263; right mandible 4-toothed and left mandible 3-toothed; pronotum reticulate and its posterior edge with a conspicuous shiny strip, pronotal collar with an abrupt edge but not carinate; notauli incomplete; scutellum without frontal line; propodeum usually with median carina complete and plica developed, at least in posterior third, spiracles elongate; mesepisternum with upper triangular areas smooth; fore wing with speculum extending to marginal vein; costal cell on upper surface bare; gaster sessile.

Biology. The biology of the species in this genus is very diverse. Most species are parasitoids of gall-forming insects on a wide variety of plants including Chenopodiaceae, Salicaceae, Tamaricaeaceae, and Gramineae. It has been reported that cecidomyiids are common hosts for some species of this genus, with 65 such hosts in Kazakhstan alone (Dzhanokmen, 2005). Some species of Mesopolobus also parasitize pupae of various insect hosts, including other Diptera, sawflies (Hymenoptera, Symphyta), and Bucculatrix variabilis Braun (Lepidoptera: Bucculicridae) (Bouček, 1988).

Distribution. Cosmopolitan.

Mesopolobus quadrimaculatus Dzhanokmen, 1975
Mesopolobus quadrimaculatus Dzhanokmen, 1975: 629–631. Type locality: 20 km NE of Ajak-Kalkan, Ili River Valley, Almaty Region, Kazakhstan. Holotype male (Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia [ZIN]), examined (Dzhanokmen, 1975).

Mesopolobus quadrimaculatus Dzhanokmen: Dzhanokmen, 2005: 76 (habitat, distribution, and host associations in Kazakhstan).

Redescription (specimens from Xinjiang). FEMALE. Body length 2.6–4.2 mm (n = 15). Body (Figure 1a) metallic blue-green with shine, eye bare; antenna dark brown except scape, pedicel and anelli brown; fore wing hyaline, marginal and postmarginal veins brown, stigmal vein pale yellow; two infuscate transverse maculae below base of marginal vein and apex of postmarginal vein;
coxae identical with body color, femora dark brown, tibiae brown, telotarsi dark brown.

Head in frontal view (Figure 1b) about 1.2× as wide as high, face with metallic reflections and regular raised reticulations; antennal scrobe broad but not deep, with raised reticulations in its lower part; clypeal margin truncate to slightly emarginate. Antennae inserted below middle of face, at lower ocular line, antennal formula 11353; scape short, not reaching lower margin of anterior ocellus; pedicel about 1.8× as long as broad, about 1.8× as long as fu₁; proportions of length of anelli 13:19:33; funicular segments connected tightly to each other and each with 1 whorl of sensilla; fu₁ to fu₃ each about 1.2× as long as funicular segments connected tightly to each other and 

some metallic tints.

segments yellow and clava dark brown, or even black, with 

(Figure 1f) different from that of female in having pedicel margin medially rounded and projecting, about 0.3× as long as head plus mesosoma; Gt₁ smooth, with posterior margin medially rounded and projecting, about 0.3× as long as head plus mesosoma; Gt, smooth, with posterior margin medially rounded and projecting, about 0.3× as long as gaster.

MALE. Body length 2.5–2.7 mm (n = 5). Antenna (Figure 1f) different from that of female in having pedicel and flagellum about 0.8× as long as head width, funicular segments yellow and clava dark brown, or even black, with some metallic tints.

Diagnosis. Mesopolobus quadriraculatus is unique among the described species of the genus in having two infuscate transverse maculae on the fore wing disc, one below the base of marginal vein and the other below the apex of postmarginal vein and just beyond the apex of stigmatic vein in both sexes.

Both females and males of M. quadriraculatus from Xinjiang are larger than those from Kazakhstan as described by Dzhanokmen (1975), the body length of which was, respectively, 2.25 mm and 1.3–1.7 mm.

A key to M. quadriraculatus and M. deserti Dzhanokmen, another taxon newly recorded from China (see Section 4), is provided here.

Fore wing disc with two infuscate transverse maculae, one below base of marginal vein and the other below apex of postmarginal vein and just beyond apex of stigmatic vein in both sexes; fu₁ broader than long (about 1.2×); propodeum shorter than half of scutellum (0.33×)……………………

M. quadriraculatus Dzhanokmen

– Fore wing disc hyaline, without maculae in both sexes; fu₄ longer than broad (about 1.3×); propodeum more than half of scutellum (0.64×)……………………

M. deserti Dzhanokmen


Biology. Dzhanokmen (2005) reported that this species is a parasitoid of various Cecidomyiidae. It was reared from galls of various cecidomyiid species on different host plants: from stem-galls of Stefaniola ilisiensis Fedotova on Haloxylon persicum, from stem-galls of Stefaniola fragosa Mamaev and S. gigas (Marikovskij) on Haloxylon ammodendron, from bud-galls of Halodiplosis meridianus (Marikovskij) on the same host plant, and also from Halodiplosis nanophytonis Fedotova on Nanophyton erinaceum (Pallas) Bunge. Dzhanokmen (2005) also reported adults of this pteromalid species collected on blooming Tamarix spp. (Tamaricaceae).

During 2014–2016, we reared M. quadriraculatus in Beishawo Desert in Fukang, Xinjiang, from stem-galls of Stefaniola sp. on both H. ammodendron and H. persicum. Galls of this Cecidomyiidae are generally located at the bases of newly grown stems or small branches. At the early infesting stage, the protuberant galls are small. The color of the galls changes from green or yellow to yellowish-brown during the growing season. Finally, the galls desiccate and both ends of the stem turn yellow and also desiccate, as stated by Xue et al. (2012). Both individuals of Stefaniola sp. and M. quadriraculatus were found in the two cells within the same gall when dissected (Figures 2a and 2b). However, generally, only one adult (Figures 2c–2f) of M. quadriraculatus was reared from each stem-gall on both H. ammodendron and H. persicum. The trophic relationship between M. quadriraculatus and the gall of Stefaniola sp. (and the gall-maker itself) still needs further study as it remains unclear whether the parasitoids feed externally on eggs, larvae, or pupae of this gall-inducer.
Figure 1. a–f: *Mesopolobus quadrimaculatus* Dzhanokmen: a–e (♀), f (♂). a: Body, dorsal view; b: head, frontal view; c: head and mesosoma, dorsal view; d: scutellum and propodeum, dorsal view; e: fore wing; f: head, frontal view, and antennae.
**Distribution.** China (Xinjiang) [new record] and Kazakhstan (Dzhanokmen, 1975, 2005).

**4. Discussion**

Here we redescribe and illustrate *M. quadrimaculatus* in detail, including providing digital images of the female habitus, because its original description was accompanied only by line drawings of some body parts. This species was described by Dzhanokmen (1975) from the male holotype and a series of both male and female paratypes collected by the second author in June 1971 in Ili River Valley, northeast of Ajak-Kalkan, Almaty Region of Kazakhstan, on blooming *Atraphaxis* sp. (Polygonaceae) and *Tamarix* sp. The information on its type locality in Noyes (2017) is thus incorrect: it is not in Tselinograd Oblast’, which is now the Akmola Region of Kazakhstan. We also provide a diagnosis of this species since that in its original description was only a short statement that would not key in Graham (1969). That was not an adequate diagnosis nor even an appropriate statement because Graham’s key was compiled for northwestern Europe and is not really applicable for the fauna of Central Asia. Unfortunately, there were no

**Figure 2.** a–f: Development of *Mesopolobus quadrimaculatus* Dzhanokmen. a–b: Pupa found in the same gall with a larva of *Stefaniola* sp.; c: pupa; d–f: adult female (d: frontal view, e: lateral view, f: dorsal view).
keys provided for separation of the Central Asian species of *Mesopolobus* in Dzhanokmen’s earlier work (1975, 2005).

Besides *M. quadrimaculatus*, we also reared *Aprostocetus* sp. (Eulophidae), *Dzhanokmenia* sp. (Eulophidae), *Metaphycus* sp. (Encyrtidae), *Psyllaephagus caullardisi* Sugonjaev (Encyrtidae), *Trichogramma* sp. (Trichogrammatidae), and some unidentified Eurytomidae and Platygastroidea in Fukang (44°22′29″N to 44°22′49″N, 87°52′57″E to 87°52′58″E, 401–446 m), Xinjiang, from stem-galls of *Stefaniola* sp. on both *Haloxylon ammodendron* and *H. persicum*. However, the relationships between these species and this particular gall inducer are not clear. We believe that further thorough studies are needed to identify which insects are gall inducers and which are parasitoids associated with galls on *Haloxylon* spp., and their effects on these plant species. Currently, the taxonomy of the Palearctic species of the genus *Stefaniola* is in flux according to Dr Jiao (Institute of Entomology, College of Life Science, Naikai University, Tianjin, China), who identified *Stefaniola* sp., so *Stefaniola* sp. cannot be positively identified to the species level.

Another new species record for China in the same pteromalid genus is that of *Mesopolobus deserti*. It was collected by sweeping on both *H. ammodendron* and *H. persicum* at the same site as *M. quadrimaculatus* (Beishawo Desert in Fukang (44°22′49″N, 87°52′58″E, 446 m), Xinjiang, on 26–IV–2015 by the same collectors, 4 females and 5 males), but no specimens of it were reared there from galls of *Stefaniola* sp. on *Haloxylon* spp. However, Dzhanokmen (2005) reported that this species was reared in Kazakhstan from *Halodiplosis vernalis* (Marikovskij), as well as from *H. saxauli* Kaplin and *Baldratia kozlovi* Marikovskij on *H. persicum*. At the same site in Fukang we also collected *M. deserti* by sweeping on *Tamarix* sp., which is a new host plant record for this pteromalid species.

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**References**


