

New Record of *Tamarixia* (Hymenoptera: Eulophidae) from Transcaucasia with Some Taxonomic and Biogeographical Notes

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ABSTRACT

Genus *Tamarixia* Mercet, 1924, was recorded from Transcaucasia and particularly from Georgia for the first time, therefore all 12 European species recorded from this genus are new for above mentioned geographic locations. A diagnosis for distinguishing this genus from other genera belonging to subfamily Tetrastichinae is provided.

Key words: Georgia, Tetrastichinae, diagnosis, Malaise trap.

INTRODUCTION

Tamarixia Mercet, was described by Mercet (1924) based on the material collected in Spain as a singleton type specimen *Tamarixia bicolor* Mercet. Later Domenichini (1966a, b) synonymized this genus with *Tetrastichus* Haliday. However Kostjukov (1977) treated *Tamarixia* as a subgenus under genus *Tetrastichus*, with one included species. Graham (1987) and Bouček (1988) raised *Tamarixia* to generic level and Graham (1991) added several more species, previously placed in other genera *Tetrastichus*, *Cirrospilus*, *Eulophus* (Eulophidae), *Pteroptrix* (Aphelinidae), *Gastrancistrus* (Pteromalidae). According to Noyes (2015) fifty one described species of *Tamarixia* are known; twenty-nine species were recorded from Palaearctic; ten species from Oriental; six, five and two species from Nearctic, Australasia and Caribbean respectively; Twenty-four species were recorded from Russia and 9 from Kazakhstan; there were no records from Transcaucasia.

Species of belonging to genus *Tamarixia* are endoparasitoids of psyllids belonging to *Trioza* (Triozidae) and rarely to *Strophingia* (Hemiptera: Psylloidea). Several species of *Tamarixia* are considered as a biological control agents for some psyllid pests (Burckhardt *et al.*, 2015; Pena-Carrillo *et al.*, 2015).

Lagodekhi reserve was established in 1912. Lagodekhi Protected Areas is one of the world's best-preserved, primitive area with diversity of natural landscapes is

located in Lagodekhi, in the extreme north-eastern part of the southern slopes of the Caucasus and extends at an altitude of 590-3500 m. Lagodekhi Protected Areas includes Lagodekhi Nature Reserve (19749 ha) and Managed Reserve (4702 ha) (APA 2016).

MATERIAL AND METHODS

This study represents part of the material collected in Lagodekhi protected areas, using Malaise traps, during the entire growing season of 2014. Malaise traps in Lagodekhi protected areas were set in the following vertical zonal sites: 1. Low zone of forest (450-750m), 2. Middle zone of forest (750-1250m), 3. High zone of forest (1250-1800m), 4. Subalpine forest (1800-2000m), 5. Subalpine fields and shrublands (2000-2500m), 6. Alpine zone (Above 2500m).

As the material was vast we had to concentrate at first on the alpine and subalpine areas, as the chance to have a novelty was higher. The subalpine site was located at 41° 53.883' N, 46° 20.033' E, elevation 2225m; the alpine site was at 41° 54.371' N, 46° 20.004' E, elevation 2558m.

General collecting was started in 02.04.2014 and lasted until 07.11.2014, although in alpine and subalpine areas collecting was started later (subalpine 5.05.2014; alpine 23.05.2014) and completed earlier (6.10.2014), due to climate conditions and altitude. Material was collected every 10 (± 2) days and placed at first in 96% Ethanol, then it was sorted, dried, mounted and labeled according Noyes (2015). Identification was done by the second and third authors, using modern keys and papers of original description, and the collections of the Zoological Institute of the Russian Academy of Sciences (St. Petersburg) and All-Russian Research Institute of Biological Plant Protection (Krasnodar).

Malaise traps were obtained from BandN Entomological services (<http://www.entomology.org.uk/>). Containers were filled with 80% ethanol and were checked and replaced every ten days. Material then was transferred to the laboratory and was critical point dried, following Noyes (1998) and mounted on cards.

All voucher specimens are deposited to the Entomological collection of Agricultural University of Georgia, Tbilisi, Georgia.

Information about synonymy and biology is given in Graham (1991) and the Universal Chalcidoidea Database (Noyes, 2015), therefore we did not put this data in our paper, unless there were no additional data from authors side.

RESULTS

Genus *Tamarixia* Mercet, 1924

Female.

Length. 0.6-1.9 mm

Malar sulcus straight, not foveate. Anterior margin of clypeus truncate with two

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minute tubercles. Antenna with one transverse anellus, sometimes with rudimentary laminate anellus; funicle with 3 segments; clava with 3 segments (rarely solid). Thorax short and squat, pronotum short; Midlobe of mesoscutum without median line, with 2 setae on each side, these equal or subequal in length and tending to be erect or suberect; scutellum strongly transverse with submedian lines; sublateral lines neither broad nor deep.

Propodeum with median carina thin, expanded only near hind end, usually sharp; plicae and paraspiracular carinae absent; spiracles small or moderate-sized, subcircular, close to metanotum. Forewing with costal cell from very slightly to much longer than marginal vein; submarginal vein with 1 dorsal seta; marginal vein sometimes thick, with 3-7 frontal setae; postmarginal vein absent; stigmal from very short to moderately long. Hind wing acute. Hind coxa without dorsal carina or rugulose sculpture; first segment of mid and hind tarsi as long as second; gaster subcircular to ovate; ovipositor sheaths not or hardly projecting; ovipositor relatively short; one setae of each cercus 1.5x or more the length of the next longest setae.

Body black or partly yellow (head and/or gaster), non-metallic or weakly metallic.

Male:

Length. 0.5-0.9mm.

Differs from female as follows. Antenna with a very small or minute ventral plaque on the scape, placed near the middle; funicle with 4 segments; clava with 3 segments; genital armature 4-8x as long as broad; digitus extended as a curved hook or spine which is not articulated.

Differential diagnosis between *Tamarixia* and other Tetrastichinae is given in the Table 1.

Species list of *Tamarixia* distributed in Lagodekhi reserve (Georgia)

***Tamarixia actis* (Walker, 1839)**

Material examined: 1 Female, Lagdekhi reserve, Mt Kudigora, 41° 53.883' N, 46° 20.033' E, 2225 m asl (above sea level), malaise trap, 25.07-5.08.2014, G. Japoshvili and G. Kirkitadze; 1 Female and 1 Male, Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15.07-25.08.2014, G. Japoshvili and G. Kirkitadze.

Distribution: Czech Republic, France, Germany, Hungary, Ireland, Netherland, Portugal (Azores), Russia (Dagestan), Spain (Canary), Sweden (Graham, 1991; Gunasheva, 2004; Kostjukov and Gunasheva, 2004; Noyes, 2015).

***Tamarixia arboreae* (Graham, 1979)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 5-15.08.2014, 2 ♀♀, G. Japoshvili and G. Kirkitadze; Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.08.2014, 1 ♀, 1 ♂, G. Japoshvili and G. Kirkitadze.

Distribution: Portugal (Madeira) (Graham, 1991; Noyes, 2015), Russia (Dagestan) (Gunasheva, 2004; Kostjukov and Gunasheva, 2004).

Table 1. Differential diagnosis of *Tamarixia* and other Tetrastichinae.

The species of genus <i>Tamarixia</i>	The other species of subfamily Tetrastichinae
Female	Female
1. Length 0.6-1.9mm	1. Length 0.5-4.5mm
2. Mid lobe of mesoscutum with two virtually equal in length and suberect, relatively strong adnotaular setae on each sides, placed before and behind the middle of mesoscutum	2. Mid lobe of mesoscutum with 1 or 3-6 adnotaular setae on each side; if with 2 then the anterior seta of each side is shorter than the posterior seta, or is not situated before middle of mesoscutum or both setae are reclinate.
3. Anterior margin of clypeus truncate, usually without teeth, rarely with two minute tubercles.	3. Anterior margin of clypeus distinctly bidentate.
4. Forewing with marginal vein slightly to much shorter than costal cell, submarginal vein with 1 dorsal setae.	4. Forewing with marginal vein often as long as costal cell or longer than costal cell; submarginal vein with 1-5 dorsal setae.
5. Thorax at most 1.3x as long as broad. Body black, occasionally with weak metallic reflection; gaster sometimes partly to fully yellow, rarely the head more or less yellow.	5. Thorax often more elongate; body often with distinct metallic reflection or with some parts of head or thorax yellow.
Male	Male
1. Length 0.5-1.1 mm	1. Length 0.5-4.0mm
2. Ventral plaque of scape extremely short, its length at most 0.2x that of scape, placed near the middle of scape.	2. Ventral plaque of scape at least 0.35x length of scape.
3. The first funicular segment is not or hardly longer than broad.	3. The first funicular segment distinctly longer than broad.
4. Anterior margin of clypeus truncate, without teeth or rarely with two minute tubercles.	4. Anterior margin of clypeus distinctly bidentate (except some <i>Quadrastichus</i> and <i>Oomyzus</i>).
5. Marginal vein slightly to much shorter than costal cell; submarginal vein with 1 dorsal setae.	5. Marginal vein often as long as costal cell or longer than costal cell; submarginal vein with 1-6 dorsal setae.
6. Thorax 1.1-1.3x as long as broad.	6. Thorax often more elongate.
7. Body black, occasionally with weak metallic reflection; gaster sometimes partly to fully yellow, rarely the head more or less yellow.	7. Body often with strong metallic reflection or with some parts of head, thorax and gaster yellow.
8. Parasites of forming gall species of <i>Trioza</i> , sometimes <i>Strophingia</i> (Hemiptera: Psylloidea).	8. Parasites of gall forming species of <i>Trioza</i> and <i>Strophingia</i> (Hemiptera: Psylloidea) and other insects.

***Tamarixia bicolor* Mercet, 1924**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 53.883' N, 46° 20.033', 2225 m asl, malaise trap, 25.07-5.08.2014, 1 ♀, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, China (Guangxi), Pakistan, Spain (Graham, 1991; Noyes, 2015).

***Tamarixia flaviventris* (Kostjukov, 1978)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 53.883' N, 46° 20.033', 2225 m asl, malaise trap, 25.07-5.08.2014, 1 ♀, G. Japoshvili and G. Kirkitadze.

Distribution: Kazakhstan (Janibek, Uralsk, Ak-Kumy), Russia (Stavropolskii Krai, Astrakhanskaia obl.) (Kostjukov, 1978; 1995; Noyes, 2015).

Comments: Zuparko *et al.* (2011) in distribution gives also Tajikistan, according publication this data comes based on Kostjukov's (1977; 1978; 1995; 2000) publication however this information is erroneous and according to second author (Kostjukov), it must be omitted from the distributional list.

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***Tamarixia leptothris* Graham, 1991**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 5-15.08.2014, 1 ♀, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Czech Republic, Slovakia, Hungary, Italy, Netherlands, Sweden, UK (Noyes, 2015); Ireland, Slovenia, Montenegro, Croatia, Serbia (Graham, 1991).

***Tamarixia monesus* (Walker, 1839)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 53.883' N, 46° 20.033' E, 2225 m asl, malaise trap, 5-15.07.2014, 1 ♀, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Czech Republic, Slovakia, Hungary, Italy, Netherlands, Sweden, UK (Noyes, 2015), Germany, Moldova, Slovenia, Montenegro, Croatia, Serbia, Kazakhstan, Russia, (Dagestan, Stavropolskii Krai, Astrakhanskii obl., Khabarovskiy Krai, Primorskiy Krai) (Graham, 1991; Gunasheva, 2004; Kostjukov, 1978; 1995; 2000; Kostjukov *et al.*, 2004).

***Tamarixia poddubnyi* (Kostjukov, 1978)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.08.2014, 1 ♀ 1 ♂, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Moldova, China (Ningxia), Russia (Stavropolskiy Kray, Astrakhanskaia obl.), Uzbekistan Kazakhstan (Graham, 1991; Gunasheva, 2004; Kostjukov, 1978; 1995; 2000; Kostjukov *et al.*, 2004; Noyes, 2015).

***Tamarixia pronomus* (Walker, 1839)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 5-15.08.2014, 1 ♀, G. Japoshvili and G. Kirkitadze; Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.08.2014, 1 ♀ 1 ♂, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Spain (Canary), Czech Republic, France, Slovakia, Germany, Greece, Hungary, Ireland, Italy, Portugal (Madeira), Sweden, UK (Noyes 2015), Russia (Dagestan, Stavropolskiy Kray) (Gunasheva, 2004; Kostjukov and Gunasheva, 2004; Kostjukov *et al.*, 2004). Russia (Ulianovsk Obl) (Noyes, 2015) based on Yegorenkova *et al.* (2007), however in the paper the territory of distribution is as Middle Volga River Area, therefore is must be as in original publication and should not be as Ulyanovsk oblast as in Noyes (2015).

***Tamarixia pubescens* (Nees, 1834)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.08.2014, 2 ♀♀, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Czech Republic, France, Germany, Hungary, Ireland, Italy, China (Guangxi), Croatia, Serbia, Slovakia, Sweden, UK (Graham, 1991; Noyes, 2015).

***Tamarixia pygmaeola* (Erdos, 1954)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 5-15.08.2014, 1 ♀, G. Japoshvili and G. Kirkitadze; Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.08.2014, 1 ♀, 2 ♂♂, G. Japoshvili and G. Kirkitadze.

Distribution: Croatia, France, Hungary, Sweden (Noyes, 2015), Russia (Dagestan) (Gunasheva, 2004; Kostjukov and Gunasheva, 2004).

***Tamarixia tremblayi* (Domenichini, 1966)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.08.2014, 1 ♀, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Czech Republic, Italy, Slovakia, Sweden, UK (Graham 1991, Noyes, 2015), Russia (Dagestan) (Gunasheva, 2004; Kostjukov and Gunasheva, 2004).

***Tamarixia upis* (Walker, 1839)**

Material examined: Lagdekhi reserve, Mt Kudigora, 41° 53.883' N, 46° 20.033' E, 2225 m asl, malaise trap, 5-15.07.2014, 1 ♀, G. Japoshvili and G. Kirkitadze; Lagdekhi reserve, Mt Kudigora, 41° 54.371' N, 46° 20.004' E, 2558m asl, malaise trap, 15-25.07.2014, 1 ♀ 1 ♂, G. Japoshvili and G. Kirkitadze.

Distribution: Bulgaria, Czech Republic, France, Germany, Iran, Italy, Portugal (Madeira), Moldova, Netherlands, Russia (Moscow obl., Leningradskaia obl., Ulianovsk obl.), Serbia, Slovakia, Sweden, UK (Noyes, 2015), Russia (Stavropolskiy kray, Dagestan, Primorskiy Kray) (Gunasheva, 2004; Kostjukov, 1978; 1995; 2000; Kostjukov *et al.*, 2004; Kostjukov and Gunasheva, 2004).

DISCUSSION

Tamarixia is a first record for Transcaucasia, therefore all species recorded from this genus are new for the fauna of Transcaucasia. From the species recorded from Europe according to Graham (1991) only one species *T. pallicornis* (Walker, 1872) was not recorded during our study. It must be noted that this species was described based on single specimen from Madeira and thereafter has not been recorded from anywhere. Herting (1972) recorded *T. triozae* (Burks, 1943) species Italy, but because this species is known only from the Nearctic region, we suspect these records are misidentifications, and therefore we don't discuss this species as European.

The fauna of *Tamarixia* recorded in Lagodekhi reserve is most close to the fauna of *Tamarixia* recorded from Dagestan (North-East Caucasus, 8 species), which borders the Lagodekhi Reserve from the north.

The current distribution of land cover shaped after completion of the Last Glacial Maximum (LGM). Paleobotanists suggest that 15-20 Ty (thousands of years) ago forests covered much smaller area than now. Although an ice shield in the Caucasus during the Ice Age covered mountains of the Greater Caucasus at the elevation above 1400-1900 m in the west and 2400-2900 m in the east, the dominating landscape was grassland and scrubland throughout the region (Tarkhnishvili, 2014). Based

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on above given information it can be hypothesized that species of *Tamarixia* may have survived in Caucasus refugia during the glaciation and later spread to northern areas. To confirm this expectation and to assess the extent of recolonization events, molecular-genetic studies are needed.

According to our study Malaise traps are good devices for collecting *Tamarixia*. However, based on data samples of *Aprostocetus*, *Baryscapus* and *Neotrichoporoides* from the same trapping does not give complete information about diversity of these genera, which we suppose to be dependent on biological, ethological and morphological characters of these taxa.

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