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A new solifuge of the genus *Gylippus* (*Paragylippus*) from Turkey (Solifugae: Gylippidae)

Новая сольпуга рода *Gylippus* (*Paragylippus*) из Турции (Solifugae: Gylippidae)

Melek Erdek
Мелек Эрдек

Hakkari University, Vocational School of Health Services, Department of Medical Services and Techniques, Hakkari, 30000, Turkey.
Melek Erdek E-mail: melekerdek@hakkari.edu.tr https://orcid.org/0000-0003-1060-4265

KEY WORDS: *Gylippus*, Gylippidae, camel spiders, new species, Cilo-Sat Mountains, Hakkari, Turkey.
КЛЮЧЕВЫЕ СЛОВА: *Gylippus*, Gylippidae, сольпуги, новый вид, горы Джило-Сат, Хаккяри, Турция.

ABSTRACT: A new solifuge species of Gylippinae Roewer, 1933, *Gylippus* (*Paragylippus*) *ozdinci* sp.n., is described and illustrated on the basis of both sexes from the Hakkari province, very close to the peak of the Cilo-Sat Mountains, the second highest mountain in Turkey. The detailed characteristics of both sexes are discussed and compared with related *Gylippus* (*Paragylippus*) species.

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РЕЗЮМЕ: Дано иллюстрированное описание самца и самки сольпуги подсемейства Gylippinae Roewer, 1933, *Gylippus* (*Paragylippus*) *ozdinci* sp.n. из провинции Хаккяри, поблизости от вершины гор Джило-Сат, второй по высоте в Турции. Признаки обоих полов нового вида обсуждаются в сравнении с близкими видами подрода *Gylippus* (*Paragylippus*).

Introduction

The arachnid order Solifugae, mostly known as camel spiders, solifuges, or sun spiders, is represented by 1122 species today belonging to 138 genera and 12 families [Botero-Trujillo *et al*., 2023; Cossois, 2023; Erdek, 2023; Fan *et al*., 2024; Garcia *et al*., 2024]. Gylippinae Roewer, 1933, a subfamily of Gylippidae Roewer, 1933 contains 24 species in two genera, *Acanthogylippus* Birula 1913 and *Gylippus* Simon 1879 [Harvey, 2013; Erdek, 2015, 2019, 2023; Koç, Erdek, 2019, 2021]. *Gylippus* is divided into four subgenera (*Anoplogylippus, Gylippus, Hemigylippus, Paragylippus*), based on the presence or absence of dental papilla, flagellar complex spiniform seta, retrolateral manus spiniform setae and flagellum shape [Bird *et al*., 2015; Erdek, 2019, 2023].

The subgenus *Gylippus* (*Paraylippus*) Simon, 1879 is represented by seven species, namely namely *G.* (*P.*) *afghanus* (Roewer, 1933), distributed in Afghanistan, *G.* (*P.*) *caucasicus* Birula, 1907 (with the subspecies *G.* (*P.*) *caucasicus caucasicus* Birula, 1907 and *G.* (*P.*) *caucasicus koenigi* Birula, 1913), in Armenia, Azerbaijan, Georgia, and Turkey, *G.* (*P.*) *hakkariensis* Erdek, 2019 and *G.* (*P.*) *monoceros* Werner, 1905, in Turkey, and *G.* (*P.*) *quaestiunculoides* Birula, 1907 and *G.* (*P.*) *spinimanus* Birula, 1905, both in Iran.

The current paper discusses the distinguishing traits of new species. With the current description in this study, Turkey now has ten species of the genus *Gylippus*: *Gylippus* (*Gylippus*) *erseni* Koç et Erdek, 2019, *G.* (*G.*) *merganus* Erdek, 2023, *Gylippus* (*G.*) *quaestiunculus* Karsch 1880, *Gylippus* (*G.*) *syriacus* (Simon, 1872), *Gylippus* (*Hemigylippus*) *bayrami* Erdek, 2015, *G.* (*P.*) *arikani* Koç et Erdek, 2021, *Gylippus* (*Paragylippus*) *caucasicus koenigi* Birula, 1913, *G.* (*P.*) *hakkaricus* Erdek, 2019, *Gylippus* (*P.*) *monoceros* Werner, 1905, and *Gylippus* (*P.*) *ozdinci* sp.n.

Material and Methods

Specimens were collected by hand collecting while moving on the ground at night and especially with pitfall traps in Hakkari Province, southeast Turkey. Specimens were examined and illustrated using images from a Leica DFC295 digital camera. Bird *et al*. [2015] was used for the terminology of cheliceral morphology, and Birula [1913] and Roewer [1933] were used for diagnosis. Measurements are given in millimeters. The parts of specimens were kept anovernight in absolute ethanol, for Scanning Electron Microscopy (SEM). After dehydration, specimens were gold-coated in a Quorum SC7620 sputter coater. Morphological structures were studied and photographed at an accelerating voltage of 10kV in a ZEISS Sigma 300 scanning electron microscope at the Science Application and Research Center at Van Yüzüncü Yıl University. Specimens are deposited in the solifuge collection at the Hakkari University Zoological Museum (HAKZM). The distribution map was produced using ArcGIS (version 10.3.1) (Fig. 1a).

Abbreviation: fcs — flagellar complex spiniform seta, flg — flagellum, rlms — retrolateral manus spiniform seta, sp — stridulatory plate, FD — fixed finger, distal tooth, FM — fixed finger, medial tooth, FP — fixed finger, proximal tooth, FSM — fixed finger, submedial tooth, PFM — profondal medial tooth, PFP — profondal proximal tooth PFSP — profondal

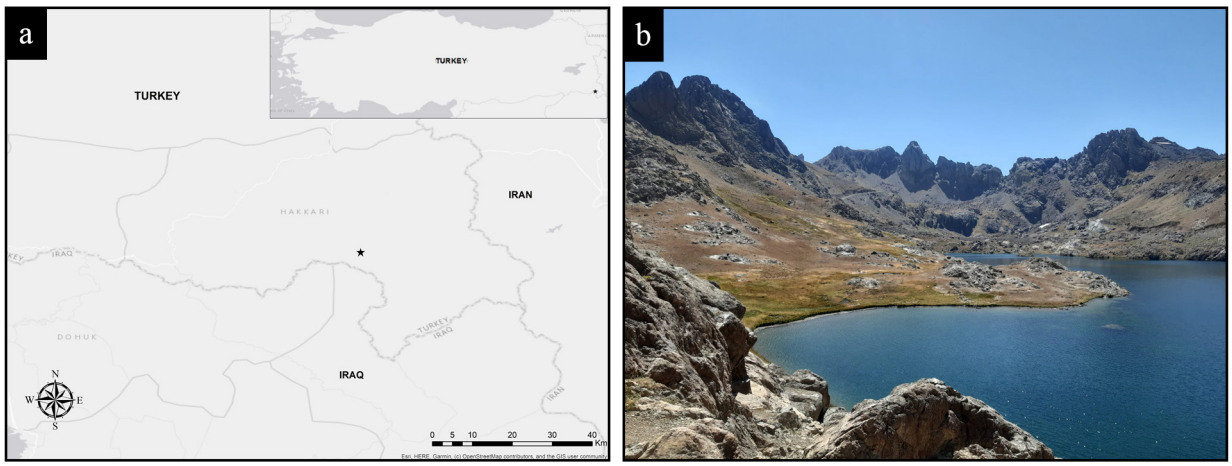

Fig. 1: a — type locality of *Gylippus* (*Paraylippus*) *ozdinci* sp.n., b — habitat of *Gylippus* (*Paragylippus*) *ozdinci* sp.n. in Cilo-Sat Mountains, Sat Lake.

Рис. 1: a — типовое местонахождение *Gylippus* (*Paraylippus*) *ozdinci* sp.n., b — биотоп *Gylippus* (*Paragylippus*) *ozdinci* sp.n. в горах Джило-Сат, озеро Сат.

subproximal tooth, RF — retrofondal teeth, RFM — retrofondal medial tooth, RFP — retrofondal proximal tooth, RFSM — retrofondal submedial tooth, MM — movable finger, medial tooth, MP — movable finger, proximal tooth, MSM — movable finger, submedial tooth.

Results

TAXONOMY

Family Gylippidae Roewer, 1933
Subfamily Gylippinae Roewer, 1933
Genus *Gylippus* Simon, 1879
Subgenus *Gylippus* (*Paragylippus*) Roewer, 1933

***Gylippus* (*Paragylippus*) *ozdinci* sp.n.**
Figs 1–5, Table 1.

TYPE MATERIAL**.** Holotype ♂ (HAKZM /Solfg-Gylp: 03-06); Turkey, Hakkari Prov., Cilo-Sat Mountains, The edge of Sat Lake, 37°21′28″ N, 44°11′ 22″ E, 2938 m, pitfall trap, 5.07.2023–6.09.2023, leg. M. Erdek & S. Özdinç.

Paratypes: ♂ (HAKZM /Solfg-Gylp: 03-07), same locality information, hand collecting, 2.07.2023, leg. S. Özdinç 3♂♂, 5♀♀, 7 subadult female, 42 juveniles (HAKZM /Solfg-Gylp: (03-08)–(03-11)) with same data of holotype.

ETYMOLOGY. The new species epithet is a patronym, dedicated to Serdar ÖZDİNÇ (Hakkari University), the close friend of the author and the first person to locate the species, for his help and support in this work.

DIAGNOSIS. The new species can be recognized from other known species of *Gylippus* (*Paragylippus*) by the presence of relatively "S" shaped flagellum, one dorsally situated retrolateral manus spiniform seta, one flagellar complex spiniform seta, and 4-6 dorsomedial spiniform setae on the dorsal fixed finger as retrolateral manus setae in males and posteriorly oval/rounded a significantly bulges on the genital segment in females.

G. (*P.*) *ozdinci* sp.n. is differentiated with several prominent features, though having some affinities with morphologically similar species. This species is distinguished from all other gylippids by the fact that the number of femoral spines on pedipalps in males is seven. *G.* (*P.*) *ozdinci* sp.n. is similar in morphology to *Gylippus* (*P.*) *hakkaricus* and *Gylippus* (*P.*) *monoceros*. These species are distinguished by the following combination characteristics: coloration, body size, the shape of flagellum, retrolateral manus spiniform seta, flagellar complex spiniform seta and the number of retrolateral manus setae in males, and shape of genital sternites in females.

According to Birula's drawings [1913: Pl. VII, fig. 3] *G.* (*P.*) *monoceros* male has six retrolateral manus setae, Roewer's drawings [1933: figs 229B1–B2] have 2 more long and thin setae on anterior side of these six setae and *G.* (*P.*) *hakkaricus* male has four retrolateral manus setae with some shorter setae [Erdek, 2019: figs 3C, D, F; 5B, D; 7A–B]. This number is also six distinct, eleven visible setae in total in new species with long and dense setae antero- retrolaterally. According to abovementioned drawings by Birula and Roewer flagellum in *G.* (*P.*) *monoceros* is "S" shaped as in the new species, but it has more vertical position than in *G.* (*P.*) *monoceros*. The oval fold to which the distal end of the flagellum is attached is more reclined in *G.* (*P.*) *monoceros*. Unlike in *G.* (*P.*) *monoceros*, the flagellum does not curve towards the proximal chelicerae as it rises from the base. In *G.* (*P.*) *hakkaricus*, the flagellum is narrowing on cheliceral fingertip and rises upward expanding from lateral sides, tapering distally with a depression in the median section [Erdek, 2019: fig. 3C–F]. In the new species, unlike *G.* (*P.*) *hakkaricus*, the flagellum does not only rise upwards but also extends forwards. The flagellar complex spiniform seta in *G.* (*P.*) *monoceros* [Birula, 1913: Pl. VII, figs 1, 4; Roewer, 1933: fig. 229B1–B2] and *G.* (*P.*) *hakkaricus* is sickle-shaped and downwardly curved as in the new species, but the distally end of *G.* (*P.*) *hakkaricus* and new species is spicule-like, but in the new species it is longer and located closer to the chelicerae surface. Retrolateral manus spiniform seta/chelicera length ratio in *G.* (*P.*) *ozdinci* sp.n. is longer than *G.* (*P.*) *monoceros* [Birula 1913: Pl. VII, figs 1, 3; Roewer, 1933: fig. 229B1–B2] and *G.* (*P.*) *hakkaricus* [Erdek, 2019; fig. 3A, C). The pedipalpal tarsus in the new species is more swollen than in *G.* (*P.*) *monoceros* and *G.* (*P.*) *hakkaricus*; and the swollen part of pedipalp metatarsus in the new species is similar to *G.* (*P.*) *monoceros* [Birula, 1913: Pl. VII, fig. 3; Roewer, 1933: fig. 229B1], but more pointed than *G.* (*P.*) *hakkaricus* [Erdek, 2019: figs 3B, 6C].The indentations on genital lobes are different in all these three species (cf. Fig. 4e; Birula [1913: Pl. VII, fig. 4]; Erdek, [2019: fig. 4D]). Body length compared in all these three species, the new species (♂: 18.16 mm, ♀: 19.19 mm) is shorter than *G.* (*P.*) *hakkaricus* (♂: 31.44 mm, ♀: 34.15 mm in Erdek [2019] and *G.* (*P.*) *monoceros* (♂: 20 mm, ♀: 18 mm).

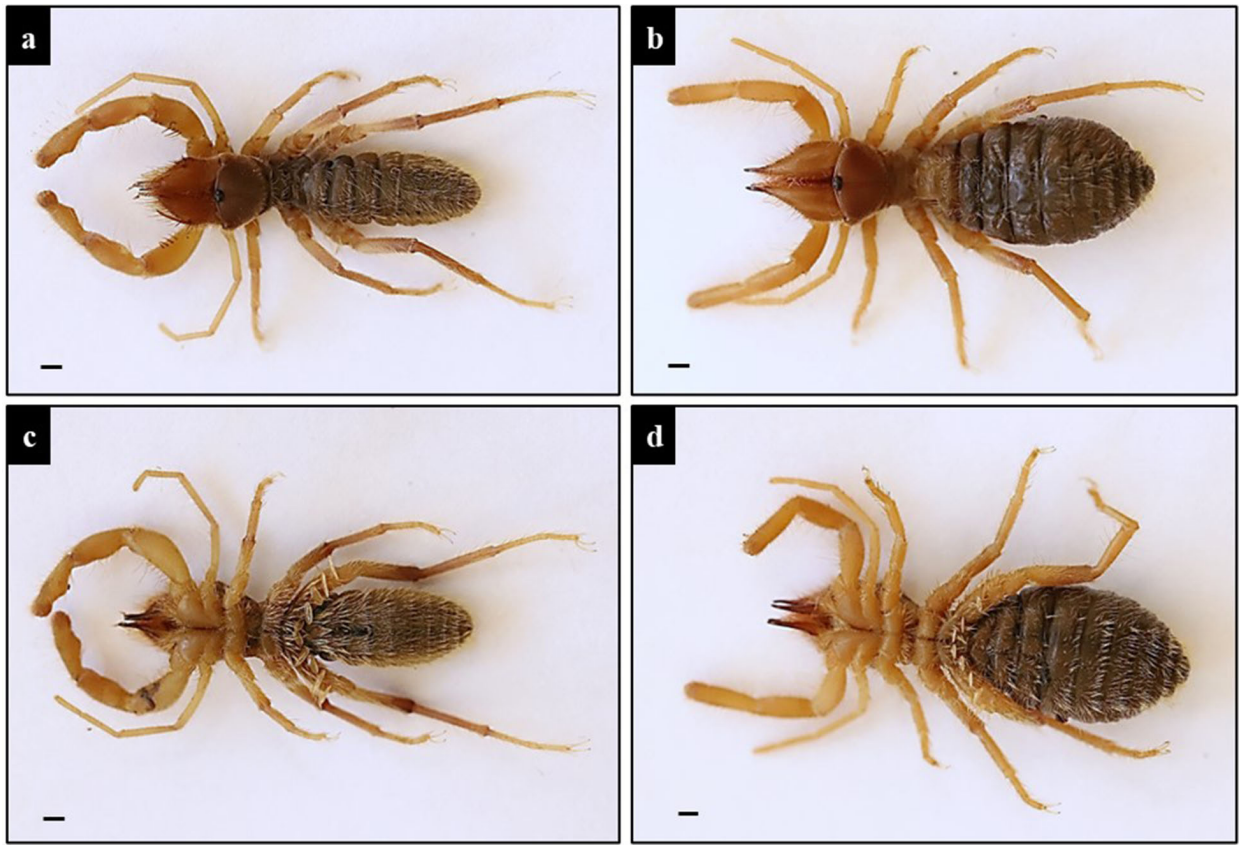

Fig. 2. *Gylippus* (*Paragylippus*) *ozdinci* sp.n.: a, c — male holotype, b, d — female paratype: a, b — habitus in dorsal view; c, d — habitus in ventral. Scale bars: 1 mm.

Рис. 2. *Gylippus* (*Paragylippus*) *ozdinci* sp.n.: a, c — голотип самец, b, d — паратип самка: a, b — внешний вид дорсально; c, d — то же. вентрально. Масштаб 1 мм.

DISTRIBUTION. Cilo-Sat Mountains, The edge of Sat Lake, Hakkari Province, Turkey (Fig. 1a, b).

DESCRIPTION.

MALE (HOLOTYPE)

COLORATION (Figs 2a, c; 3a–f). General background reddish yellow to reddish brown. Mesopeltidium and metapeltidium reddish brown to dark brown, dorsomedially and ventrally yellowish brown to dark brown. Abdomen surface with dense yellowish setae of different lengths. Propeltidium is pale reddish yellow with pale dark brown spots occurring at different pigment densities. Legs generally copper or pale reddish brown, ventrodistal portion of legs, and distal and dorsal portion of femur and tibia brownish, metatarsus, tarsus and claws yellow. Cheliceral fingers reddish dark brown; rlms, fcs, palp femoral setae, some setae on propeltidium yellowish brown and the tip of the cheliceral fingers dark brown. Ocular tubercle black. Malleoli is entirely pale dark yellow.

PROPELTIDIUM (Figs 2a; 3a). The entire surface is background pale dark yellow covered with blackish brown pigmentation in different densities. The short and thin setae in the anterior and anterolateral areas are denser than those in the posterior and posterolateral areas. Anterior edge of propeltidium is smooth and carries a pair of long setae on its mid-anterior edge. Ocular tubercle reniform, indented posteriorly.

CHELICERAE (Fig. 3a, c–f). Movable finger distally curved inward, on the dorsal side of the fixed finger, at the proximal part of the flagellum, where the membranous structure begins, the tip of the chelicerae makes a slight depression towards the ventral side (showed with an arrow in Fig.3f). Fixed finger not flattened and without tooth like protrude ventral side of fingertip. Dentition: Fixed finger with 1 FD- 1 FSD- 1 FM- 1 FSM- 1 FP- 1 RFM- 1 RFSM- 1 RFP- 8 RFSP (except for the 3 distal ones, the others are extremely reduced)- 1 PFM- 1 PFP- 1 PFSP. Movable finger with 1 MM- 1 MSM- 1 MP. Inverted “S” shaped flagellum membranous, tapering on cheliceral fingertip and extending dorsally without rounding and flattening anteriorly in the distal. On the upper curve of the S shape, there are protruding and curled ears on the lateral sides. The distance between cheliceral fingertip and flagellum is 0.44 mm. The rlms (2.34 mm) located dorsolaterally on the fixed finger and slightly distal end curved upwards. The fcs (0.9 mm) curved downward, needle-shaped, and thin like a spicule. Laterally on chelicera, 6 distinct retrolateral manus setae totally 11 visible with also some shorter and thinner setae around them. Numerous filiform and bifurcate setae cover the whole cheliceral surface. On the retrolateral and retrodorsal surfaces, these setae are denser and thicker. Stridulatory plates with 5 stridulatory ridges not very prominent on anterior edges and located proximally on the inner side of the chelicera. Five prodorsal distal setae dorsal to the stridulatory plate, prolateral surface of the chelicera with several long plumose setae and seven proventral subdistal setae (pvsd) behind the plumose setae.

OPISTHOSOMA. (Fig. 2a, c) Entire surface is covered with numerous, short and long bifurcated setae. Abdominal sternites without ctenidia.

PEDIPALPS. (Figs 2a, c; 3b) Metatarsus swollen. Metatarsus length/width = 1.49 mm\/ 0.84 mm. Pedipalps are covered with numerous short and long setae. The mesal surface of femur

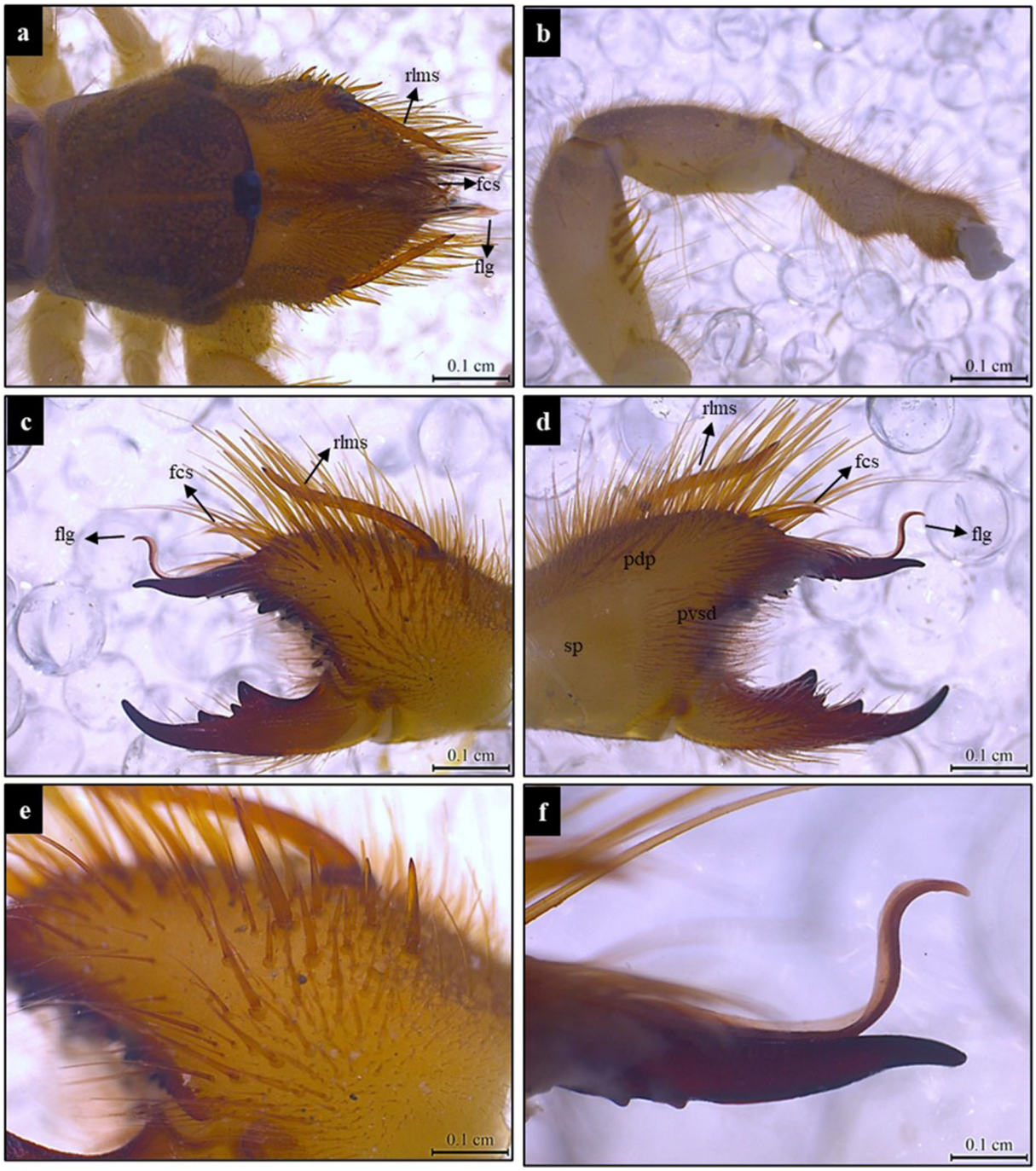

Fig. 3. *Gylippus* (*Paragylippus*) *ozdinci* sp.n. male holotype: a — chelicerae and propeltidium in dorsal view; b — sinistral pedipalp in dorsal view; c — sinistral chelicera in retrolateral view; d — sinistral chelicera in prolateral view; e — area of retrolateral manus setae; f — flagellum in prolateral view. Scale bars: 1 mm.

Рис. 3. *Gylippus* (*Paragylippus*) *ozdinci* sp.n., голотип самец: a — хелицеры и пропельтидий дорсально; b — левая педипальпа дорсально; c — левая хелицера ретролатерально; d — левая хелицера пролатерально; e — область ретролатеральных щетинок основного членика хелицер; f — флагеллум пролатерально. Масштаб 1 мм.

with 7 orange red robust thick spiniform setae shorter than the diameter of femur and one short, thin, distinctive setae proximally basal the spiniform setae.

LEGS (Fig. 2a, c). Leg I without spiniform setae, with tarsal claws well-developed. Metatarsi II and III with two spiniform setae dorsally and five pairs of thin setae ventrally. Legs surface is covered with numerous, dense, thin setae some are sparse and long.

Some morphological details of males (chelicera and pedipalp) are pointed out on a paratype male in Fig. 5.

FEMALE (PARATYPE) (Figs 2b, d; 4). General body coloration is similar with males. The general background pale orange red. Mesopeltidium, metapeltidium pale yellowish brown and abdominal tergites laterally and ventrally pale brown, dorsomedially dark brown. Abdomen surface with dense yellowish setae. Propeltidium is pale yellowish red with dark purplish brown

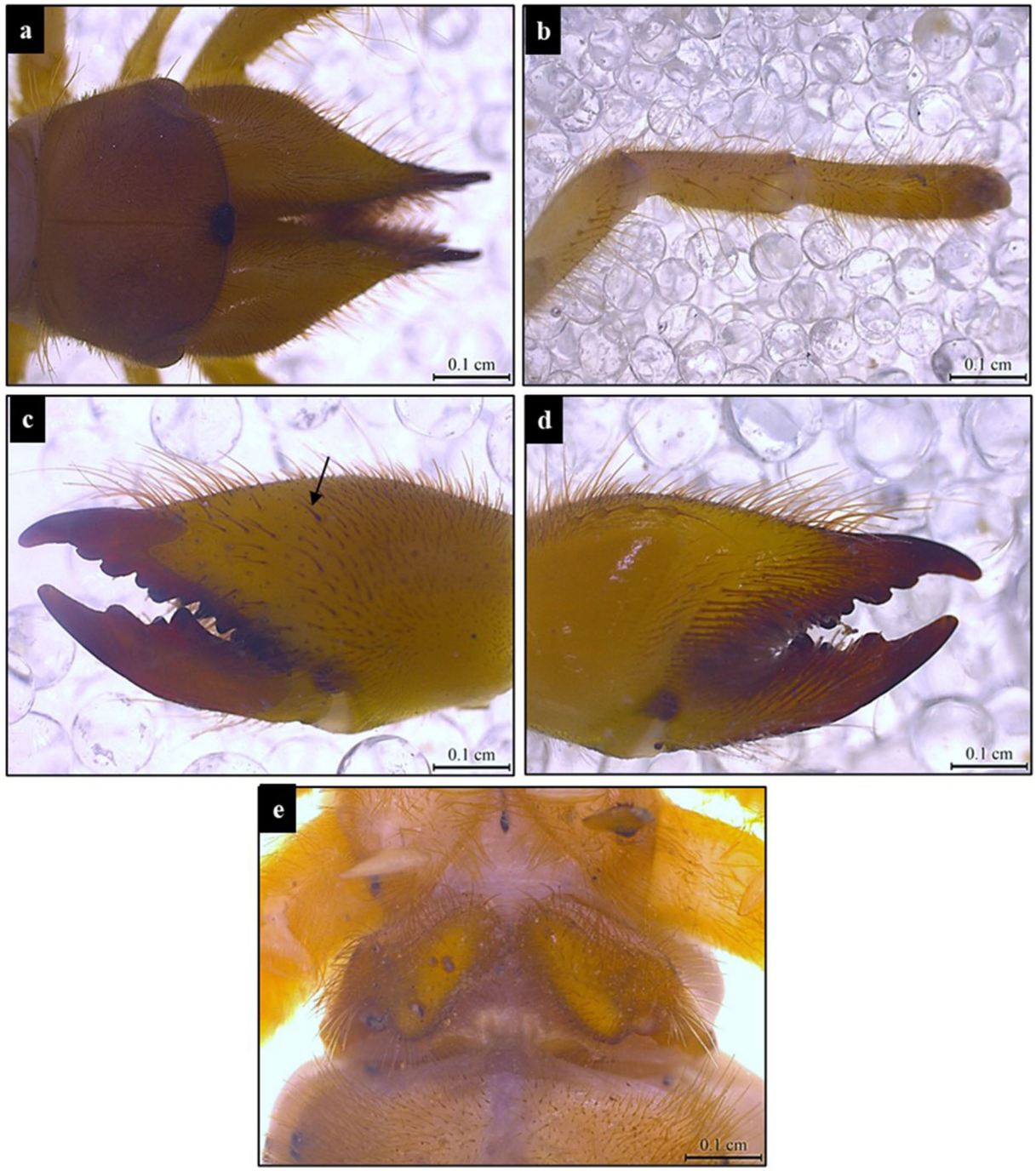

Fig. 4. *Gylippus* (*Paragylippus*) *ozdinci* sp.n. female paratype: a — chelicerae and propeltidium in dorsal view; b — sinistral pedipalp in dorsal view; dextral chelicera in prolateral view; c — sinistral chelicera in retrolateral view (Arrow indicates the setae in female homologous to retrolateral manus spiniform seta in male); d — sinistral chelicera in retrolateral view; e — genital sternite, ventral view. Scale bars: 1 mm.

Рис. 4. *Gylippus* (*Paragylippus*) *ozdinci* sp.n., паратип самка: a — хелицеры и пропельтидий дорсально; b — левая педипальпа дорсально; правая хелицера пролатерально; c — левая хелицера ретролатерально (Стрелка показывает щетинки самки, гомологичные шиповидным ретролатеральным щетинкам основного членика хелицер самца); d — левая хелицера ретролатерально; e — генитальный стернит, вентрально. Масштаб 1 мм.

scattered spots occurring at different pigment densities, and short and sparse reddish brown setae. Ocular tubercle reniform shape less distinctly than male, indented posteriorly. Legs generally orange red. Unlike males, pedipalps are not swollen and four slightly modified setae are present on femur with some sparse long and dense short thin hairs. Chelicerae with thin, short and less abundant setae. Dentition: Fixed finger with 1 FD- 1 FM- 1 FSM- 1 FP- 1 RFM- 1 RFSM- 1 RFP- 9 RFSP- 1 PFM- 1 PFP. Movable finger with 1 MM- 1 MSM- 1 MP. The tips of distal and medial teeth on the fixed finger flattened and the tips of other teeth rounded. Almost all of the teeth are the same size. Malleoli is entirely pale yellow. Genital sternites are sclerotized; covered with long and dense bifurcate setae and forming two distinct, protuberant lobes with abundant setae on both sides

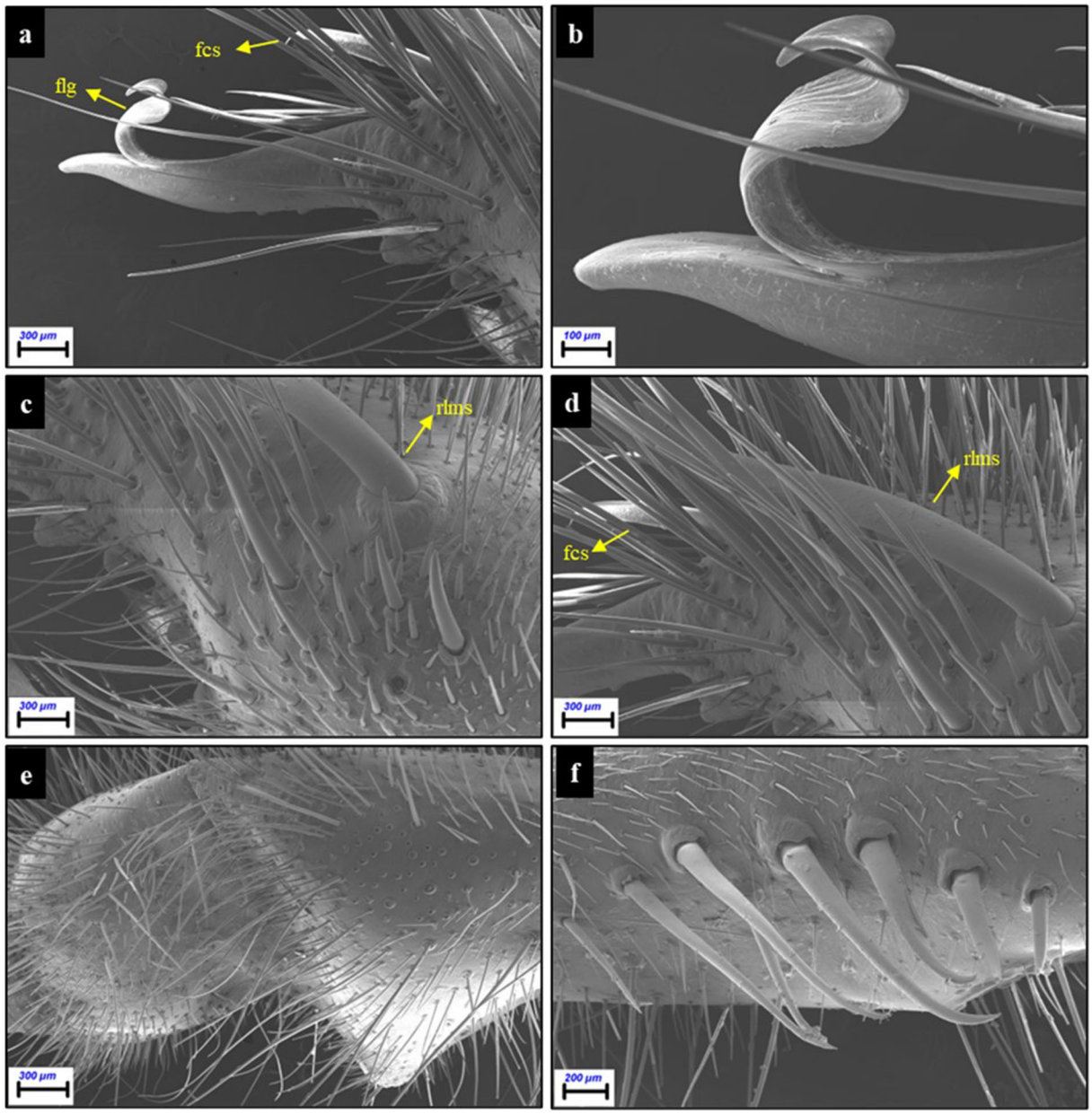

Fig. 5. SEM images of *Gylippus* (*Paragylippus*) *ozdinci* sp.n. male paratype: a — sinistral chelicera in retrolateral view; b — sinistral flagellum in retrolateral view; c — retrolateral manus setae in detail; d — flagellar complex spiniform seta and retrolateral manus spiniform seta in detail; e — dextral pedipalp, tarsus and metatarsus in dorso-prolateral view; f — dextral pedipalp, modified setae on femur in dorso-prolateral view.

Рис. 5. *Gylippus* (*Paragylippus*) *ozdinci* sp.n., паратип самец, СЭМ: a — левая хелицера ретролатерально; b — правый флагеллум ретролатерально; c — ретролатеральные щетинки основного членика хелицер, детально; d — шиповидные щетинки флагеллярного комплекса и шиповидные основного членика хелицер, детально; e — правая педипальпа, лапка и предлапка дорсо-пролатерально; f — правая педипальпа, видоизмененные щетинки бедра дорсо-пролатерально.

of genital opening (0.63mm). Each lobe expands from anterior to posterior. The anterior part of each lobe is 0.47 mm, while the posteriorly expanded form is 1.58 mm. The inner length of each genital lobe is 1.42 mm, and the outer length is 1.98 mm, while the distance between the two lobes is 2.45 mm posteriorly. There is one depression, 0.28 mm deep, like a lobal notch in the posterior part of each lobe.

ECOLOGY. Cilo-Sat Mountain Range is the second highest mountain in Turkey after Mount Ararat. It is the first gylippid recorded from such a high-altitude of 2938 m a.s.l. and collected from the edge of Lake Sat, a glacial lake. The specimens were found in alpine meadow and alpine steppe vegetation (Fig. 1b). Adults most likely occur in the end of June to early August.

Discussion

Gylippids are the solifuges with well-defined character traits and distinctions, unlike rhagodids, solpugids and galeodids. The gylippids belonging to subgenus *Gylippus* (*Paragylippus*) are relict species as single mountain endemics preferring special microhabitats, having own

Table 1. Measurements of *Gylippus* (*Paragylippus*) *ozdinci* sp.n. (male holotype and female paratype, in mm).
Таблица 1. Промеры *Gylippus* (*Paragylippus*) *ozdinci* sp.n. (голотип самец и паратип самка, мм).

	Holotype (♂)	Paratype (♀)
Total length	18.16	19.19
Chelicerae		
Dorsal width	1.36	1.67
Lateral width	2.84	3.33
Lateral lenght	5.06	6.51
Propeltidium		
Anterior width	3.28	3.72
Posterior width	2.46	2.44
Length	2.72	2.46
Palp		
Tarsus	0.68	0.72
Metatarsus	1.49	1.76
Tibia	2.65	2.06
Femur	2.73	1.36
Total	10.38	7.59
1st leg		
Claw	0.14	0.11
Tarsus	1.22	0.96
Metatarsus	1.59	1.50
Tibia	2.68	1.69
Femur	2.06	1.38
Total	10.18	8.07
2nd leg		
Claw	0.71	0.56
Tarsus	0.78	0.39
Metatarsus	1.00	0.68
Tibia	1.72	1.50
Femur	1.34	1.19
Total	7.71	7.23
3rd leg		
Claw	0.78	0.56
Tarsus	0.94	0.62
Metatarsus	1.13	1.19
Tibia	2.65	2.03
Femur	1.47	1.30
Total	10.26	8.16
4th leg		
Claw	1.22	0.59
Tarsus	1.31	0.59
Metatarsus	2.19	1.38
Tibia	3.75	1.81
Femur	2.78	2.60
Total	15.21	9.71

specific vegetation and microclimatic conditions. When the geographical features evaluated under the heading of ecology are taken into consideration, it is thought that the species retreated to this region/altitude, especially during glacial periods, and speciated as small populations there. Based on both male and female specimens, a new species of subgenus *Gylippus* (*Paragylippus*) is presented in this contribution. The specificity of the number of femoral setae (seven spine-like setae) on the pedipalp of males leads us to the new species. In addition, considering the evaluation of *Gylippus* species in the reviewed literature, the new species described in this contribution is the one that lives in the highest region and has the smallest body size.

With this new species, the number of gylippids in Turkey increased to 10 species and the number of updated solifuges worldwide increased to 54 species.

Disclosure Statement
No potential conflict of interest was reported by the author.

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