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On the synonymy between *Agistemus manjilicus* Khanjani, Hajizadeh & Zarei, 2015 and *A. mendozensis* Simons, 1967 (Acariformes: Stigmaeidae)

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Original research

ABSTRACT

The genus *Agistemus* Summers (Acari: Stigmaeidae) comprises predatory mites widely distributed in various agroecosystems. *Agistemus manjilicus* Khanjani, Hajizadeh & Zarei was described from Iran and differentiated from related species based on subtle morphological traits. However, a detailed comparison with *A. mendozensis* Simons reveals substantial overlap in diagnostic characters. In this study, we re-evaluated the taxonomic status of *A. manjilicus* through a comparative analysis of morphological characteristics, idiosomal dorsal setae measurements, diagnostic ratios, and leg chaetotaxy. Our results indicate that all distinguishing characters fall within the range of intraspecific variation of *A. mendozensis*. No consistent differences were found in key diagnostic traits such as dorsal setae morphology, diagnostic ratios, and leg chaetotaxy. Based on these findings, *Agistemus manjilicus* Khanjani, Hajizadeh & Zarei **n. syn.** is herein considered a junior subjective synonym of *A. mendozensis* Simons. This synonymy contributes to a more stable taxonomy within the genus and highlights the importance of comprehensive morphological comparisons in species delimitation.

Keywords ICZN ; morphology ; predatory mites ; synonymy

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Introduction

The family Stigmaeidae (Acariformes: Prostigmata) comprises a diverse group of mites occurring in soil, litter, mosses, and on plant surfaces. Most species are predatory and play an important role in the natural regulation of small arthropods, although some species have been reported to feed on plant-associated substrates such as mosses (Flechtman 1985; Fan & Zhang 2005; Fan & Flechtman 2015; Escobar-Garcia *et al.* 2023; Khaustov 2023). Within this family, the genus *Agistemus* Summers is one of the most species-rich and widely distributed, currently comprising 94 described species worldwide (Mirza *et al.* 2024). Species of *Agistemus* are primarily distinguished by morphological characters, including idiosomal ornamentation, length of dorsal setae, diagnostic ratios, and leg chaetotaxy.

Species delimitation in *Agistemus* has traditionally relied on subtle morphological differences, which can sometimes lead to taxonomic ambiguities, especially when based on limited material or geographically restricted populations. This has resulted in the description of species that may represent morphological variants of previously described taxa.

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Agistemus mendozensis was originally described by Simons (1967) from Argentina and later redescribed by Johann *et al.* (2013) based on material from Brazil, providing a more comprehensive characterization of the species. Subsequently, *Agistemus manjilicus* was described from Iran by Khanjani *et al.* (2015), based on a small number of specimens collected from *Olea europaea* L. (Oleaceae). The authors differentiated this species from related taxa using morphometric traits and setal measurements.

According to the principles of the International Code of Zoological Nomenclature (ICZN 1999), species names must be based on clear diagnostic differences, and synonymy should be established when two nominal species are shown to represent the same taxon. In this context, re-evaluation of previously described species using comparative approaches is essential to ensure taxonomic stability.

Species of the genus *Agistemus* are known to be important predatory mites in agricultural systems, where they contribute to the natural regulation of phytophagous arthropods (Fan & Flechtmann 2015). Therefore, accurate species delimitation is essential not only for taxonomic clarity but also for improving the reliability of ecological and biological control studies involving these mites.

The objective of this study was to critically compare *A. manjilicus* and *A. mendozensis* based on available morphological data and determine whether the former represents a valid species or a junior synonym of the latter.

Materials and methods

A comparative morphological analysis was conducted using published descriptions of *Agistemus manjilicus* Khanjani, Hajizadeh & Zarei (2015) and *Agistemus mendozensis* Simons (1967), including its redescription based on Brazilian specimens by Johann *et al.* (2013).

The morphological characters evaluated included idiosomal length and width, dorsal shield ornamentation, length and arrangement of dorsal idiosomal setae (vi , ve , sci , c_1 , c_2 , d_1 , d_2 , e_1 , e_2 , f , h_1 , h_2), distances between setae, diagnostic ratios (e.g., $vi/vi-vi$, c_1/c_1-c_1 , d_1/d_1-d_1 , e_1/e_1-e_1), and leg chaetotaxy (coxae, trochanters, femora, genua, tibiae, and tarsi). The distribution of barbed setae on leg segments (femora, genua, and tibiae of legs I–IV) was also evaluated as an additional diagnostic character. The terminology and interpretation of barbed setae follow González-Rodríguez (1963, 1965) and Escobar-García *et al.* (2023). Patterns of barbed setae distribution were extracted from the original descriptions and compared between species (Table 1).

All available measurement ranges reported in the literature were compiled and compared (Table 1). All measurements are given in micrometres (μm). Overlapping ranges were interpreted as evidence of intraspecific variation. Particular attention was given to characters typically used in stigmatid taxonomy, such as dorsal setae morphology, diagnostic ratios, and leg chaetotaxy.

To ensure consistency in the comparison, the nomenclature and positional homology of dorsal setae were standardized following Escobar-García *et al.* (2023). This standardization was necessary because the original descriptions and subsequent studies used slightly different terminologies and arrangements for setal notation. All setae were interpreted and aligned under a unified system prior to comparison.

No new specimens were examined; the analysis was based entirely on published data and comparative morphology.

Overlapping ranges are evident across most diagnostic characters, supporting the proposed synonymy.

Results

Agistemus mendozensis Simons, 1967

= *Agistemus manjilicus* Khanjani, Hajizadeh & Zarei, 2015, **n. syn.**

The comparative analysis showed a high degree of overlap between *A. manjilicus* and *A. mendozensis* across all evaluated characters (Table 1). The dorsal shields of both taxa are described as reticulated, with no qualitative differences in ornamentation.

Measurements of dorsal setae (vi , ve , sci , c_1 , c_2 , d_1 , d_2 , e_1 , e_2 , f , h_1 , h_2) show considerable overlap in their ranges. Similarly, distances between setae and diagnostic ratios (e.g., $vi/vi-vi$, c_1/c_1-c_1 , d_1/d_1-d_1 , e_1/e_1-e_1) fall within comparable intervals, with no consistent differences that would support species separation.

No differences were detected in key diagnostic characters, including the morphology of dorsal setae, leg chaetotaxy across all segments, and overall body morphology. These characters are considered among the most reliable for species delimitation within Stigmaeidae.

The distribution of barbed setae on leg segments was identical in both species. In all legs (I–IV), the number and position of barbed setae on femora, genua, and tibiae showed the same pattern, with no observable differences between *A. manjilicus* and *A. mendozensis* (Table 1). This character further supports the morphological congruence between the two nominal species.

Additionally, published descriptions indicate that males of both nominal species are morphologically similar, with no distinguishing features reported that would allow separation.

Discussion

The present study provides strong morphological evidence supporting the synonymy of *Agistemus manjilicus* with *Agistemus mendozensis*. All diagnostic characters traditionally used in stigmaeid taxonomy, including dorsal shield ornamentation, diagnostic ratios, and leg chaetotaxy, showed complete overlap between the two nominal species. No consistent qualitative or quantitative differences were identified that would justify their separation.

In particular, the absence of differences in dorsal setae morphology and leg chaetotaxy is highly relevant, as these characters are considered among the most reliable for species delimitation within Stigmaeidae. Furthermore, the observed variation in morphometric measurements falls within the expected range of intraspecific variability, which has been previously reported in other species of *Agistemus* (Johann *et al.* 2013). Such variation may be influenced by environmental conditions, host plants, or differences in measurement techniques among authors.

The identical distribution of barbed setae on leg segments provides additional support for the proposed subjective synonymy. The presence and arrangement of barbed setae have been previously recognized as informative characters in stigmaeid taxonomy (González-Rodríguez 1963, 1965; Escobar-García *et al.* 2023). In this context, the complete correspondence observed between *A. manjilicus* and *A. mendozensis* in this character further reinforces the absence of diagnostic differences and supports their conspecificity.

Although both species were described from different geographic regions and host plants (*Olea europaea* in Iran and *Vitis vinifera* in Brazil), these differences are not sufficient to support species separation. *Agistemus mendozensis* was originally described from Argentina (Simons 1967) and later reported from Brazil on *Vitis vinifera* (Johann *et al.* 2013). Host association in stigmaeid mites is often not species-specific, and wide geographic distributions have been documented for several species within the genus (Fan *et al.* 2016).

The present comparison also revealed considerable morphological similarity between *Agistemus mendozensis* and two other species currently recognized within the genus, *A. duzgunesae* Koç, Çobanoğlu & Madanlar, 2005 (Koç *et al.* 2005) and *A. neocollyerae* Kamran, Mirza, Elgoni & Alatawi, 2023 (Kamran *et al.* 2023). In particular, these species share similar idiosomal ornamentation, dorsal setae morphology, diagnostic ratios, and leg chaetotaxy. However, the published information available for these taxa includes some inconsistencies, particularly regarding the distribution of barbed setae on the legs in *A. duzgunesae*, and apparent differences in the length of certain dorsal setae in *A. neocollyerae*. Therefore, a formal assessment of their taxonomic status would require a broader comparative study, ideally including type material and additional sources of evidence. This topic merits further investigation.

Table 1 Comparative morphological characters of *Agistemus manjilicus* and *A. mendozensis* *.

Taxonomic character	<i>Agistemus manjilicus</i> Khanjani, Hajizadeh & Zarei (Khanjani <i>et al.</i> 2015)	<i>Agistemus mendozensis</i> Simons (Simons 1967)	<i>Agistemus mendozensis</i> Simons (Johann <i>et al.</i> 2013)
Host	<i>Olea europaea</i> L.	<i>Malus domestica</i> Borkh	<i>Vitis vinifera</i> L.
Material examined (n)	Holotype + 4	Holotype + 2	2
Idiosoma length	250 (255–270)	218.5 (228–237.5)	298–325
Idiosoma width	170 (180–195)	142.5 (152–161.5)	210–240
Hysterosomal shields	reticulated	reticulated	reticulated
vi	16 (16–17)	10.7 (12.8–17.1)	16–17
ve	22 (23–27)	21.4 (21.4–23.5)	24–26
sci	23 (22–24)	21.4–25.6 (23.5–27.8)	27–28
c ₁	21 (21–23)	19.2–20.3 (22.4–23.5)	23–26
c ₂	24 (23–27)	22.4–23.5 (21.4–25.6)	27
d ₁	21 (21–25)	21.4 (20.3–27.8)	24–25
d ₂	22 (24–26)	23.5 (21.4–27.8)	25–26
e ₁	29 (31–32)	29.9 (27.8–32.1)	31–32
e ₂	29 (31–36)	29.9 (29.9)	31–42
f	34 (33–37)	29.9–31 (29.9–34.2)	32–36
h ₁	35 (36–39)	34.2 (27.8–31.2)	34–36
h ₂	33 (34–36)	34.2 (21.4–34.2)	31–34
vi–vi	28 (25–30)	32.1 (28.8–32.1)	26–27
ve–ve	53 (55–60)	57.7 (53.5–55.6)	-
sci–sci	-	99.5 (85.6–96.3)	-
ve–sci	24 (22–25)	27.8 (23.5–29.9)	-
c ₁ –c ₁	26 (25–27)	33.1 (32.1–34.2)	31
c ₂ –c ₂	135 (133–145)	135.8 (124.1–139.1)	-
d ₁ –d ₁	56 (58–60)	59.9 (55.6–64.2)	58–62
d ₂ –d ₂	105 (106–110)	-	-
e ₁ –e ₁	27 (25–29)	28.8 (25.6–32.1)	28–29
e ₂ –e ₂	83 (82–85)	-	-
f–f	54 (55–58)	62 (53.5–62)	67–70
h ₁ –h ₁	15 (18)	21.4 (17.1)	17–19
h ₂ –h ₂	52 (52–54)	55.6 (40.6–53.5)	-
vi/vi–vi	0.57 (0.56–0.64)	0.3 (0.44–0.53)	0.6–0.7
ve/ve–sci	0.91 (1.04–1.08)	0.77 (0.78–0.91)	-
c ₁ /c ₁ –c ₁	0.80 (0.84–0.85)	0.58 (0.68–0.70)	0.7–0.8
d ₁ /d ₁ –d ₁	0.37 (0.36–0.38)	0.35 (0.36–0.43)	0.4
e ₁ /e ₁ –e ₁	1.07 (1.1–1.24)	1.03 (1–1.08)	1.1
Coxae I–IV	2(+1)–1–2–1	-	2(1)–1–2–1
Trochanters I–IV	1–1–1–1	-	1–1–1–1
Femora I–IV	4–4–2–2	4–4–2–2	4–4–2–2
Genua I–IV	2(+1)–0–0–0	3–0–0–0	3–0–0–0
Tibiae I–IV	5 (+1) –5(+1)–5(+1)–4	6–6–6–4	5(1)–5(1)–5(1)–4
Tarsi I–IV	11(+1)–9(+1)–7(+1)–7	12–10–8–7	11(1)–9(1)–7(1)–7
Femur–tibia I (barbed setae)	1–1–0	1–1–0	Genu with 1
Femur–tibia II (barbed setae)	1–0–1	1–0–1	Tibia with 1
Femur–tibia III (barbed setae)	1–0–1	1–0–1	-
Femur–tibia IV (barbed setae)	1–0–1	1–0–1	-

*Values correspond to measurements of the holotype followed by the range in parentheses when available. For *A. manjilicus*, data are taken from Khanjani *et al.* (2015: 2–4). For *A. mendozensis* (Simons, 1967: 57–62), measurements correspond to the holotype with ranges as reported in the original description. For *A. mendozensis* (Johann *et al.*, 2013: 245–246), measurements correspond to the Brazilian specimens, based on additional material examined during the redescription.

From an applied perspective, this synonymy has additional relevance. Species of *Agistemus* are widely recognized as predatory mites associated with agricultural systems (Fan & Zhang 2005; Fan & Flechtmann 2015). *Agistemus mendozensis* has been reported from cultivated apple and grape systems in Argentina and Brazil (Simons 1967; Johann *et al.* 2013). Clarifying its taxonomic status is therefore important not only for systematics but also for future studies on biological control and biodiversity assessments.

Based on the available evidence, *Agistemus manjilicus* Khanjani, Hajizadeh & Zarei, 2015 is herein considered a junior subjective synonym of *A. mendozensis* Simons, 1967. This decision contributes to improving taxonomic clarity within *Agistemus* and highlights the importance of comprehensive comparative analyses in avoiding unnecessary species proliferation.

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