International Journal for Parasitology: Parasites and Wildlife 31 (2026) 101312

Contents lists available at ScienceDirect

International Journal for Parasitology: Parasites and Wildlife

journal homepage: www.elsevier.com/locate/ijppaw

The hidden diversity of demodecid mites (Acariformes: Prostigmata) associated with the golden jackal *Canis aureus* (Carnivora: Canidae): descriptions of two new species

Joanna N. Izdebska [a], Leszek Rolbiecki [a,*], Karolina Cierocka [a], Maciej Szewczyk [b]

[a] Department of Invertebrate Zoology and Parasitology, Faculty of Biology, University of Gdańsk, Wita Stwosza 59, 80-308, Gdańsk, Poland
[b] Department of Vertebrate Ecology and Zoology, Faculty of Biology, University of Gdańsk, Wita Stwosza 59, 80-308, Gdańsk, Poland

ARTICLE INFO

Keywords:
New species
Demodex
Skin mites
Acariformes
Carnivoran
Canids

ABSTRACT

Existing data on the biodiversity and specific acarofauna of Demodecidae mites in the canids (Canidae) are based solely on information about the domestic dog *Canis lupus familiaris*, in which four demodecid species have been described. The present study describes two new species inhabiting the golden jackal *Canis aureus*, a wild representative of the Canidae, whose geographic range has expanded to include a number of European countries in response to climate change and "mesopredator release" effect. Both parasite species were found in two golden jackals from northern Poland. The parasite species described herein occurred as asymptomatic infestations. *Demodex ciacalis* sp. nov., the dominant species, was found in various regions of the haired skin of the body, whereas *D. thois* sp. nov. was recorded exclusively from the hairless or sparsely-haired skin of the head. These were accompanied by the ear mite *Otodectes cynotis* in the auditory canals of one jackal, and an asymptomatic infestation with the sarcoptic mite *Sarcoptes scabiei* in the other, where it was located in the posterior region of the body skin, including the tail. Our findings provide new insights into the parasite fauna of the golden jackal, which should be continuously monitored in view of its ongoing expansion.

1. Introduction

The family Demodecidae (Acariformes: Prostigmata) is a group of parasitic mites of mammals, where they lead a hidden lifestyle within the skin, organs or tissues of their hosts. In addition to a high degree of host specificity, most demonstrate topical specificity, with several demodecid species frequently inhabiting different microhabitats within a single mammalian host species (Izdebska and Rolbiecki, 2020). Although the biodiversity of these mites has been relatively well documented in carnivorans (Carnivora), in which 21 species from two genera have been described (Izdebska et al., 2022, 2023, 2024, 2025), only four species of the genus *Demodex* are currently known from the canids (Canidae), all of which are host-specific to the domestic dog *Canis lupus familiaris* Linnaeus, 1758 (Izdebska and Rolbiecki, 2018; Morita et al., 2018). Their presence in domestic dogs is typically associated with clinical manifestations of demodecosis, one of the most severe and troublesome parasitic skin diseases (Izdebska and Rolbiecki, 2018; Mueller et al., 2020). In contrast, information on the occurrence of demodecid mites in wild canids or their species diversity remains very limited and incomplete. The only published record concerns an unidentified *Demodex* sp. from the gray wolf *Canis lupus* Linnaeus, 1758 (Krzysiak et al., 2024). Demodecid mites have also been reported from the golden jackal *Canis aureus* Linnaeus, 1758, in Romania; these individuals were assigned to *D. injai* Desch et Hillier (2003) (Morariu et al., 2023), a species considered specific to the domestic dog (Desch and Hillier, 2003; Izdebska and Rolbiecki, 2020). Previously, unidentified *Demodex* mites had also been observed in a golden jackal from Israel, i.e. within the natural range of this host species; the mites were isolated from histopathological examinations of skin lesions caused by the co-occurrence of sarcoptic mites, probably *Sarcoptes scabiei* Linnaeus, 1758 (Berkovitz et al., 2009).

The golden jackal is the only Eurasian jackal species. Molecular evidence indicates that it is more closely related to members of the genus *Canis*, including the gray wolf and the coyote *Canis latrans* Say, 1823, than to the remaining jackal species inhabiting sub-Saharan Africa, assigned to the genus *Lupulella* (Hatlauf, 2026). It is also distinct from north-African jackal-like canids, historically classified as golden jackal subspecies, but recently recognized as a separate species, the African

* Corresponding author.
E-mail address: leszek.rolbiecki@ug.edu.pl (L. Rolbiecki).

https://doi.org/10.1016/j.ijppaw.2026.101312
Received 26 August 2026; Received in revised form 23 October 2026; Accepted 24 October 2026
Available online 27 October 2026
2213-2244/© 2026 The Authors. Published by Elsevier Ltd on behalf of Australian Society for Parasitology. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

golden wolf (Koepfli et al., 2015). The golden jackal was native to Asia and southeastern Europe; however, it is currently undergoing a rapid range expansion across Europe in response to the warming climate and historical intensive persecution of the apex predator, the gray wolf, causing „mesopredator release" effect (Rutkowski et al., 2015; Trouwborst et al., 2015; Krofel et al., 2017). In Poland, the first confirmed records of the golden jackal date back to 2015 (Kowalczyk et al., 2015, 2020).

Demodecid mites often accompany their typical hosts throughout their geographic range, which has been attributed their presence remaining asymptomatic despite maintaining a high prevalence of infestation (Izdebska and Rolbiecki, 2020; Kozina et al., 2023). Such infestations have been noted in the raccoon *Procyon lotor* (Linnaeus, 1758), a North American carnivoran that is invasive in Europe, in which the host-specific *Demodex procyonis* Izdebska, Rolbiecki, Faleńczyk-Koziróg et Gwiazdowicz, 2025 was recently described (Izdebska et al., 2025). Demodecidae typically exhibit a characteristic pattern of infestation, in which the host harbors several host-specific demodecid species occupying different skin microhabitats, structures or tissues. Usually, a host carries a dominant species that may be commonly observed throughout the host population. This species inhabits the hair follicles and is associated with various regions of the hairy skin of the body. The remaining species usually occupy more restricted microhabitats, such as sensory hair follicles, auditory canals, different types of glands (e.g., the Meibomian glands of the eyelids), and various regions of sparsely haired and hairless skin, including the lips, chin, nose, and the wing membranes of bats (Rolbiecki et al., 2026). This pattern has been documented in numerous rodent species, as well as in carnivoran animals such as the European polecat *Mustela putorius* Linnaeus, 1758, the domestic cat *Felis catus* Linnaeus, 1758, and the domestic dog (Izdebska and Rolbiecki, 2013, 2018; Izdebska et al., 2023, 2024). Therefore, a similar pattern of infestation, including the occurrence of a host-specific demodecid acarofauna, can also be expected in the golden jackal. The aim of this study is to understand the diversity of skin mites in golden jackals, with particular emphasis on the description of new Demodecidae species, as well as to determine their topographic distribution within the skin of their hosts in relation to previously known patterns of mite location.

2. Material and methods

Two specimens of *C. aureus* from Poland, collected in November 2023, were examined for skin mites. Both animals were obtained opportunistically and were not killed specifically for the purposes of this study. The first individual (from Jurata, 54°40′54″ N, 18°43′1″ E, ♂, 11.9 kg, 1–2 years old) was killed in a road traffic collision on a regional road, whereas the second (from Kosakowo, 54°35′21″ N, 18°29′8″ E, ♂, 11.5 kg, at least 8 years old) was legally shot by a licensed hunter at an airport as part of wildlife management measures aimed at reducing the risk of collisions with aircraft. The golden jackal is classified as a game species in Poland.

Demodecidae and other mites were isolated using the digestion method developed for the detection of mammalian skin mites (Izdebska, 2004), with modification to suit the examined host. Skin fragments of 1 cm^2 were taken from several body regions, including the head, neck, thorax, abdomen, back, limbs, and genito-anal area. Skin samples were preserved in 70% ethanol and subjected to digestion in 10% potassium hydroxide solution. The digest material was decanted (examination of 1 cm^2 of the skin equal to the analysis of approximately 100 wet preparations), and examined using phase-contrast microscopy (Nikon Eclipse 50i). The mites were placed in polyvinyl-lactophenol solution. The images intended for publication were processed using graphics software (Corel PHOTO-PAINT) to improve contrast and colour balance and remove background debris. The following measurements were taken: total body length = length of gnathosoma, podosoma and opisthosoma; gnathosomal width (at base); podosomal and opisthosomal width (maximum width). All measurements are given in micrometers.

The specimen depositories are cited using the following abbreviation: UGDIZP, University of Gdańsk, Department of Invertebrate Zoology and Parasitology, Gdańsk, Poland (Zhang, 2018).

The description of the species adopted the conventional nomenclature of morphological structures commonly used for the family Demodecidae (Nutting, 1976), ensuring consistency with previously described taxa. To maintain consistency with the terminology used in descriptions of mites belonging to the superfamily Cheyletoidea (Acariformes: Prostigmata), the nomenclature was supplemented with terms proposed by Bochkov (2008), while also taking into account the additional taxonomic characters described by Izdebska and Rolbiecki (2016). Unfortunately, no molecular analyses have been possible, as the KOH used to digest mites from skin tissues for analysis degrades the genetic material.

The scientific and common names of the hosts follow Wilson and Reeder (2005) and the ITIS (2026).

3. Results

The study led to the discovery and description of two new species from the golden jackal: *Demodex ciacalis* sp. nov. and *Demodex thois* sp. nov., described from specimens of both sexes (see the descriptions below).

Furthermore, the ear mite *Otodectes cynotis* (Hering, 1838) (Acariformes: Astigmata: Psoroptidae; female – 1 individual, male – 1, larva – 1, nymph – 1, egg – 2; Fig. 1) was found in the auditory canals of one jackal, and the sarcoptic mite *S. scabiei* (Acariformes: Astigmata: Sarcoptidae; female – 2 individuals, nymph – 4; Fig. 1) was detected in the other, where it occurred asymptomatically in the posterior part of the body, including the abdomen, inguinal region, and middle part of the tail.

3.1. Taxonomy of *Demodex ciacalis* sp. nov. Izdebska, Rolbiecki, Cierocka et Szewczyk, 2026

3.1.1. Description

MALE (n = 1 holotype and 30 paratypes; Figs. 2 and 3, Table 1): Body oval and stocky; 172 (153–187) long and 51 (44–58) wide (holotype, 171 x 52). Gnathosoma oval, with length smaller than width at base; on dorsal side in middle part of basal (coxal) segment, pair of large, wedge-shaped supracoxal spines (setae *elc.p*) present, ca. 4 long (holotype, 4), directed medially. Palps 3-segmented, terminating in three spines (one small, knob-shaped, two larger, curved) on tibio-tarsus; also setae *I″G* present. On ventral part of gnathosoma, horseshoe-shaped pharyngeal bulb with pair of conical subgnathosomal setae (setae *n*) situated slightly posterior to anterior limit on both sides. Podosoma rectangular; four pairs of short legs, with coxa integrated into ventral idiosomal wall and five free, overlapping segments (trochanter-tarsus); two bifurcated claws, ca. 5 long (holotype, 5), with sharp subterminal spur and large bulge on each tarsus, and additionally a small tubercle at base of each claw. Epimeral plates (coxal fields) I–III distinctly sclerotized, trapezoidal, connect medially; pairs IV weakly sclerotized. On dorsal side of podosoma, podosomal shield present, reaching level of legs III. Opisthosoma oval, slightly tapering towards end, rounded at end; constitutes 47 (43–50%) of body length (holotype, 47%). Whole opisthosoma densely annulated; annuli clear, at ca. 2 μm. Opisthosomal organ present, in form of small tube; its posterior edge located 15−16 μm from end of opisthosoma. Aedeagus 24 (19–34) long (holotype, 22), on dorsal surface, located between epimeral plates I and III. Genital opening located on dorsal side, at level of middle part of epimeral plate I.

FEMALE (n = 32 paratypes; Figs. 2 and 3, Table 1): Body shape similar to male; 184 (162−202) long, 53 (48−58) wide. Gnathosoma oval, with length smaller than width at base. Pharyngeal bulb and morphological details of gnathosoma similar to those in male. Also shape of podosoma and legs similar to those in male: I−III epimeral plates connect medially, IV pair weakly sclerotized, almost invisible;

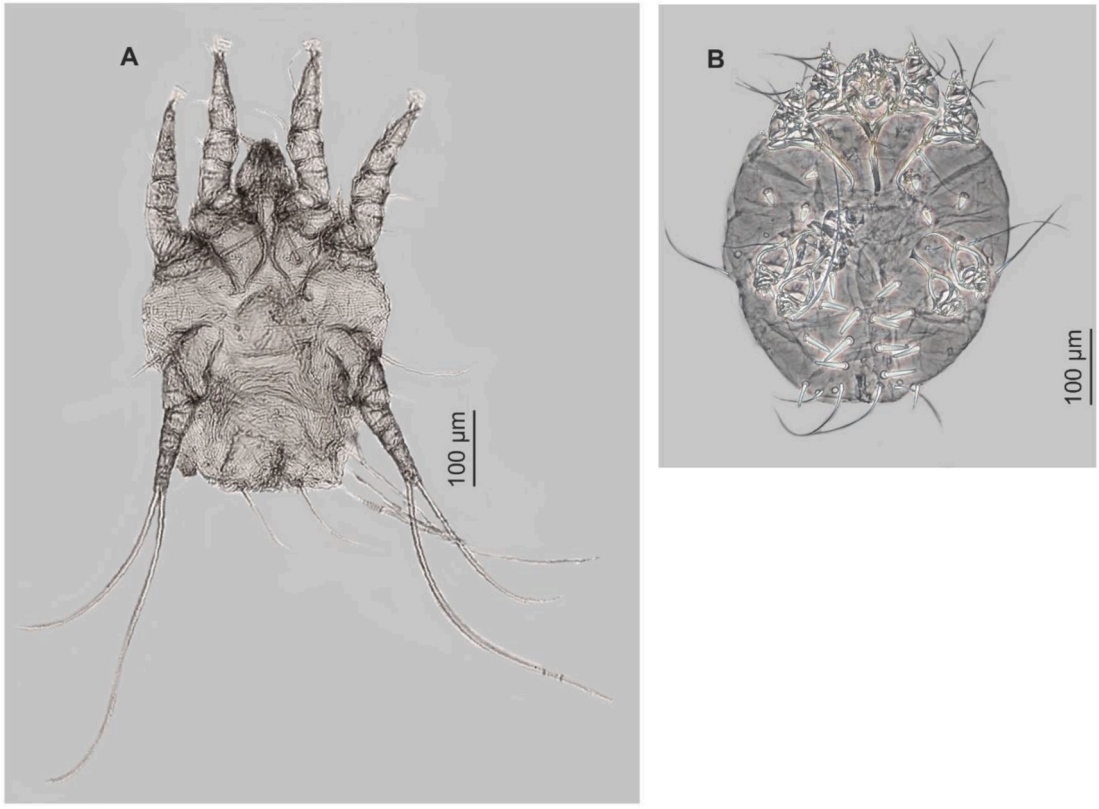


Fig. 1. *Otodectes cynotis* (A, female) and *Sarcoptes scabiei* (B, female).

posterior edges of pair IV form narrow incision. On the dorsal side of podosoma, podosomal shield present, reaching level of legs III. Opisthosoma oval, rounded at end; constitutes 47 (43−52%) of body length; distinctly annulated, annuli wide at ca. 1.5−2 µm. Opisthosomal organ present, in form of small, funnel-shaped vesicle; its posterior edge located 7−8 µm from end of opisthosoma. Vulva 8 (6−10) long, located between incision of IV epimeral plate.

IMMATURE STAGES: Mainly adults were found, as well as five deutonymphs and one larva. The specimens were in poor condition, making measurements and morphological descriptions impossible.

3.1.2. ZooBank registration

The Life Science Identifier for *Demodex ciacalis* sp. nov. is urn:lsid:zoobank.org:act:6A60837A-2487-4615-A046-764838CC405E.

3.1.3. Type material deposition

Holotype male (reg. no. UGDIZPCCaDDc01m), 30 male paratypes (reg. no. UGDIZPCCaDDc02m−31m), and 32 female paratypes (reg. no. UGDIZPCCaDDc01f−32f); host *Canis aureus* (reg. no. MCCCa1/2023, MCCCa2/2023); Jurata, Kosakowo, Poland; November 2023; hairy skin of the body (cheek, neck, vertex, arm, thorax, inguinal region, thigh); host coll. M. Szewczyk, parasite coll. J.N. Izdebska, L. Rolbiecki, K. Cierocka; the whole-type material (mounted microscope slides with the demodecid mites) deposited within the framework of the Collection of Extant Invertebrates in the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland.

3.1.4. Additional material

Five deutonymphs (reg. no. UGDIZPCCaDDc01d−5d), and one larva (reg. no. UGDIZPCCaDDc01l); host *Canis aureus* (reg. no. MCCCa2/2023); Kosakowo, Poland; November 2023; hairy skin of the body (cheek, arm, thigh); host coll. M. Szewczyk, parasite coll. J.N. Izdebska, L. Rolbiecki, K. Cierocka; the mounted microscope slides with the demodecid mites deposited within the framework of the Collection of Extant Invertebrates in the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland.

3.1.5. Etymology

The specific epithet *ciacalis* refers to the Latinized version of the Turkish vernacular name for the jackal, *çakal.*

3.1.6. Infestation and location in the host

Demodex ciacalis sp. nov. was detected in both examined jackals (MCCCa1/2023 – 4 mites, MCCCa2/2023 – 65) with a density (number of parasites per 1 cm^2 of the skin) of 4.9; 69 individuals (32 females, 31 males, 5 deutonymphs, 1 larva) in total were found. The mites were noted in various regions of the hairy skin of the body (cheek – 15 individuals, neck – 5, vertex – 14, arm – 17, thorax – 5, inguinal region – 3, thigh – 10). The observed mites did not cause any skin lesions in the examined jackals.

3.1.7. Differential diagnosis of Demodex ciacalis sp. nov

The species *Demodex ciacalis* sp. nov (Figs. 2 and 3, Table 2). is distinct from other Demodecidae with regard to certain taxonomically-important characteristics, as well as body shape and proportions. Morphologically, it is most similar to *D. foetorii* Izdebska, Rolbiecki et Rehbein, 2024, a species with an analogous localization in the European polecat (Izdebska et al., 2024). *Demodex ciacalis* sp. nov. is slightly larger than *D. foetorii* and exhibits a similarly pronounced sexual dimorphism, with males being shorter than females; however, it differs in body proportions. The gnathosoma of *D. ciacalis* sp. nov. is oval, with a distinctly shorter length than basal width; in contrast, in *D. foetorii*, it is smaller and trapezoidal, and slightly shorter than the width at the base. However, the main differences between these species concern the taxonomically-important structures of the gnathosoma. The supracoxal spines on the gnathosoma in *D. ciacalis* sp. nov. are wedge-shaped, smaller (ca. 4 µm in length), and pointed, whereas in *D. foetorii* they are also wedge-shaped but larger (5–6 µm in length), with a rounded end

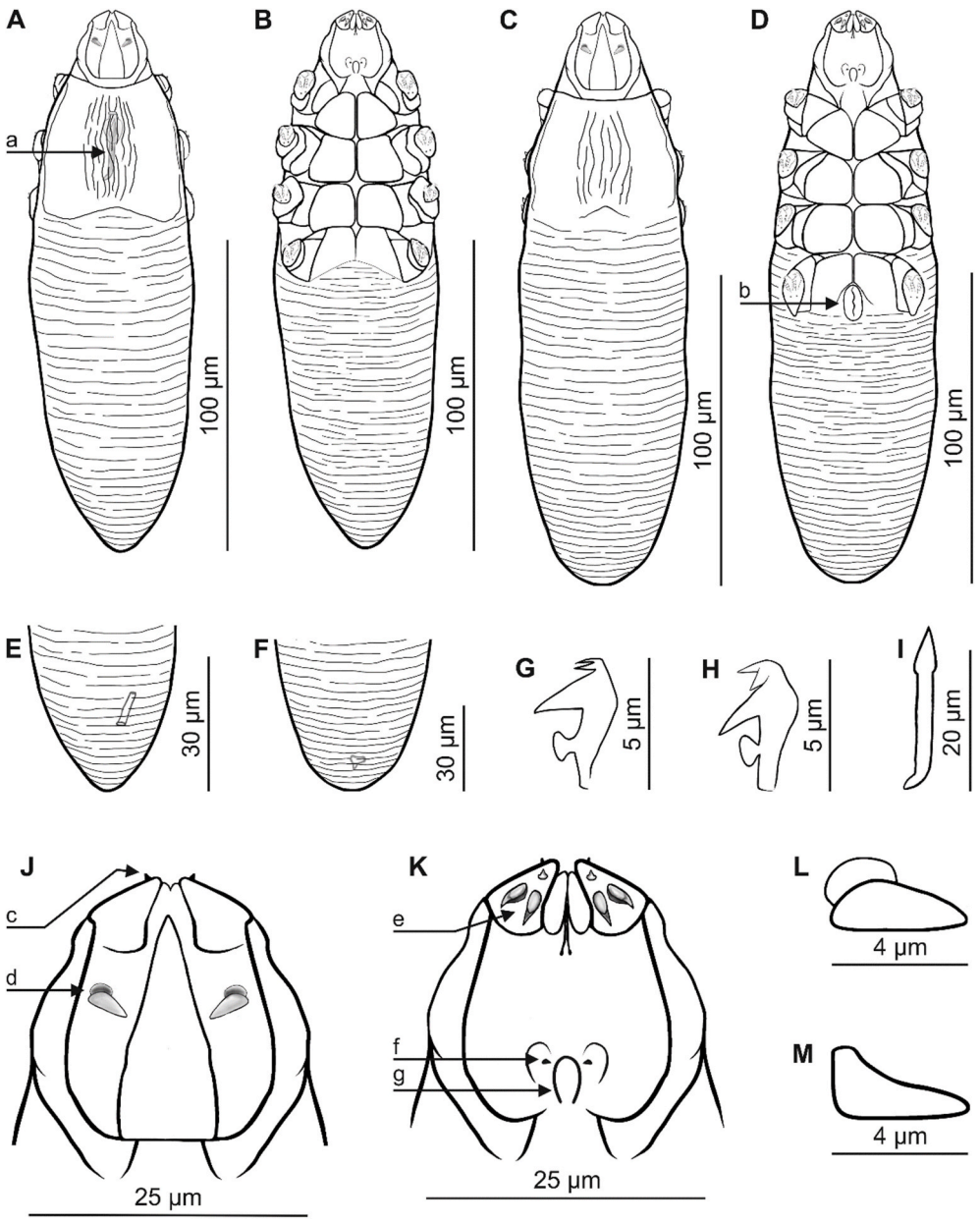


Fig. 2. *Demodex ciacalis* sp. nov. A, male, dorsal view, a – aedeagus; B, male, ventral view; C, female, dorsal view; D, female, ventral view, b – vulva; E, posterior part of the male opisthosoma with the opisthosomal organ visible; F, posterior part of the female opisthosoma with the opisthosomal organ visible; G, H, claw on the leg, various views; I, aedeagus; J, gnathosoma, male, dorsal view, c – seta *l″G*, d – supracoxal spine (seta *elc.p*); K, gnathosoma, male, ventral view, e – spines on palps, f – subgnathosomal seta (seta *n*), g – pharyngeal bulb; L, M, supracoxal spine (seta *elc.p*), various views.

and a different orientation relative to the gnathosomal surface. While the terminal segments of the palpi have three spines (one small, two large) in both species, the small spine is knobbly in *D. ciacalis* sp. nov., but conical and pointed in *D. foetorii*. In addition, setae *l″G* are present on the palpi of *D. ciacalis* sp. nov. In both species, the subgnathosomal setae are located on both sides of the pharyngeal bulb, posterior to the anterior edge; however, in *D. ciacalis* sp. nov. they are relatively large and conical, while in *D. foetorii* they are smaller and barely visible. The structure of the legs, including the epimeral plates, also differs between the species. In *D. ciacalis* sp. nov., in both sexes, epimeral plates I–III connect medially, furthermore epimeral plates I–III are clearly sclerotized and the pair IV is poorly visible. In *D. foetorii*, only in the female, the epimeral plates connect medially; plates I–III are well sclerotized in both sexes, plate IV is less pronounced but more distinct than in *D. ciacalis* sp. nov. In addition, the legs differ in the shape of their claws. The vulva of the female *D. ciacalis* sp. nov. is located anteriorly, within a narrow incision of IV epimeral plates, in which it is entirely contained. In contrast, in *D. foetorii*, the vulva is located more posteriorly, within an arch-shaped incision between the IV epimeral plates, with most of it extending beyond the posterior margin of these epimers. Furthermore, in males of both species, the aedeagus is located at the level of epimeral plates I and III; however, in *D. ciacalis* sp. nov., the genital orifice is located at the level of the middle part of the epimeral plate I, with a pear-shaped opening; in *D. foetorii* the genital orifice is located at the border between epimeral plates I and II, with an ellipse-shaped opening.

3.2. Taxonomy of Demodex thois sp. nov. Izdebska, Rolbiecki, Cierocka et Szewczyk, 2026

3.2.1. Description

MALE (n = 1 holotype and 13 paratypes; Figs. 4 and 5, Table 3): Body elongated, slender, 327 (309–345) long and 45 (40–51) wide (holotype,

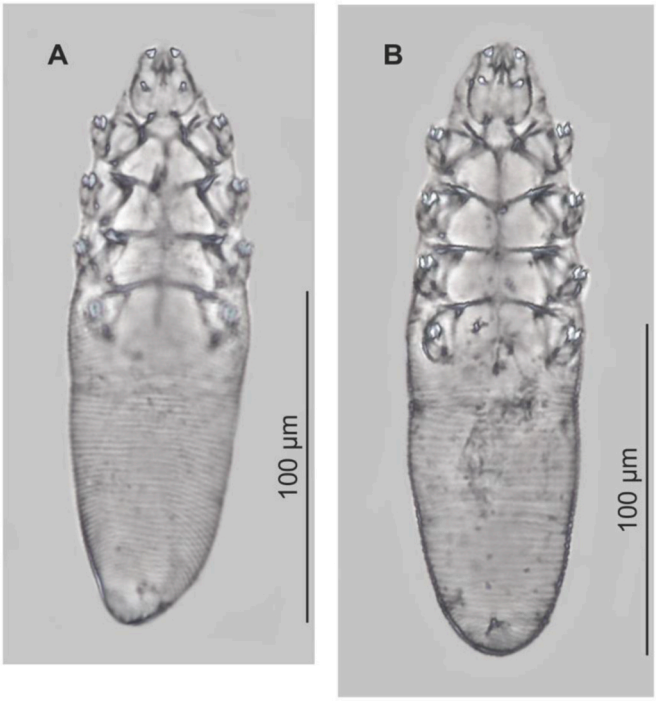


Fig. 3. *Demodex ciacalis* sp. nov. A, male, B, female.

Table 1
Body size (micrometers) for adults of *Demodex ciacalis* sp. nov.

Morphologic features	Males (n = 31)	Females (n = 32)
	Mean (range) ± SD	Mean (range) ± SD
Length of gnathosoma	21 (20–23) ±1	23 (20–25) ±1
Width of gnathosoma (at base)	25 (22–29) ±2	27 (24–29) ±2
Length of podosoma	70 (65–75) ±3	74 (68–81) ±3
Width of podosoma	51 (44–58) ±3	53 (48–58) ±2
Length of opisthosoma	81 (66–93) ±8	87 (72–101) ±9
Width of opisthosoma	48 (40–53) ±3	50 (44–55) ±2
Aedeagus	24 (19–34) ±3	–
Vulva	–	8 (6–10) ±1
Total length of body	172 (153–187) ±10	184 (162–202) ±11

Table 2
Morphometric comparison between *Demodex ciacalis* sp. nov. and *Demodex foetorii*.

Feature/Species	*Demodex ciacalis* sp. nov.		*Demodex foetorii*	
Source	Present study		Izdebska et al. (2024)	
Sex	Males	Females	Males	Females
Sample size	(n = 31)	(n = 32)	(n = 10)	(n = 14)
Body total length	172 (153–187) ±10	184 (162–202) ±11	151 (142–165) ± 6	161 (139–166) ±7
Body total width	51 (44–58) ±3	53 (48–58) ±2	38 (34–41) ±2	38 (38–40) ±1
Body length to width ratio	3.4 (2.9–3.8) ±0.2	3.5 (3.2–3.9) ±0.2	4.0 (3.7–4.5) ±0.3	4.2 (3.5–4.4) ±0.2
Opisthosoma length to body length ratio (%)	47 (43–50) ±2	47 (43–52) ±2	49 (45–53) ±2	47 (46–49) ±1
Aedeagus length	24 (19–34) ±3	–	24 (22–29) ±2	–
Vulva length	–	8 (6–10) ±1	–	8 (7–10) ±1

325 x 49). Gnathosoma clearly separated from podosoma; oval, with length smaller than width at base; on dorsal side in anterior part of basal (coxal) segment, a pair of small, conical supracoxal spines (setae *elc.p*) present, ca. 1 long (holotype, 1) and are directed anteriorly (upward). Palps 3-segmented, terminating in three spines (one small, curved, and two larger, one conical and other curved) on tibio-tarsus; also setae *v''F* present on middle segment (trochanter-femur-tarsus). On ventral surface of gnathosoma, horseshoe-shaped pharyngeal bulb with pair of large, conical subgnathosomal setae (setae *n*) situated clearly below anterior edge on both sides. Podosoma cylindrical; four pairs of short legs, with coxa integrated into ventral idiosomal wall and five free, overlapping segments (trochanter–tarsus); two bifurcated claws, ca. 5–6 long (holotype, 6.0), with narrow, subterminal sharp spur and small bulge on each tarsus; also one solenidion (*ω*) on each leg present. All epimeral plates (coxal fields) trapezoidal and connect medially; pairs I–III distinctly sclerotized, pair IV weakly sclerotized. On dorsal side of podosoma, podosomal shield with distinctly vertical striation present, reaching level of legs III. Opisthosoma slender, tapered towards the end, pointed at end; constitutes 67 (64−69%) of body length (holotype, 67%). Whole opisthosoma distinctly annulated; annuli wide at ca. 1 µm. Opisthosomal organ well-developed, tubular in shape, ca. 80 long; its posterior edge located 40−45 µm from end of opisthosoma. Aedeagus 29 (26−32) long (holotype, 26), on dorsal surface, located between epimeral plates II and III. Genital opening located on dorsal surface, at level of anterior part of epimeral plate I.

FEMALE (n = 16 paratypes; Figs. 4 and 5, Table 3): Body shape similar to male; on average shorter than male, 301 (265−338) long, 43 (35−50) wide. Gnathosoma oval, with length smaller than width at base. Pharyngeal bulb and morphological details of gnathosoma similar to those in male. Also shape of podosoma and legs similar to those in male: epimeral plates I−IV connect medially; pair IV weakly sclerotized but visible, and posterior edges of pair IV form archwise incision. On dorsal side of podosoma, podosomal shield with distinctly vertical striation present, similar to that in male, and reaches level of legs III. Opisthosoma slender, elongated, tapered towards end, pointed at end; constitutes 65 (61−71%) of body length. Whole opisthosoma distinctly annulated; annuli wide at ca. 1 µm. Opisthosomal organ spindle-shape, elongated, ca. 65 long; its posterior edge located ca. 30 µm from end of opisthosoma. Vulva 9 (7−12) long, located between incision of IV epimeral plate.

IMMATURE STAGES: Mainly adults were found, as well as two deutonymphs. The poor condition of the specimens prevented reliable morphometric measurements and morphological descriptions.

3.2.2. ZooBank registration

The Life Science Identifier for *Demodex thois* sp. nov. is urn:lsid:zoobank.org:act:1E90907E-3412-4791-860A-56797BE3EC2D.

3.2.3. Type material deposition

Holotype male (reg. no. UGDIZPCCaDDt05m), 13 male paratypes (reg. no. UGDIZPCCaDDt01m−04m, UGDIZPCCaDDt06m−14m) and 16 female paratypes (reg. no. UGDIZPCCaDDt01f−16f); host *Canis aureus* (reg. no. MCCCa1/2023, MCCCa2/2023); Jurata, Kosakowo, Poland; November, 2023; hairless and sparsely-haired skin of the head (eyelid area, nose, region of vibrissae, vertex); host coll. M. Szewczyk, parasite coll. J. N. Izdebska, L. Rolbiecki, K. Cierocka; the whole-type material (mounted microscope slides with the demodecid mites) deposited within the framework of the Collection of Extant Invertebrates in the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland.

3.2.4. Additional material

Two deutonymphs (reg. no. UGDIZPCCaDDt01d−02d); host *Canis aureus* (reg. no. MCCCa1/2023); Jurata, Poland; November, 2023; hairless and sparsely-haired skin of the head (eyelid area, nose); host coll. M. Szewczyk, parasite coll. J. N. Izdebska; the mounted microscope

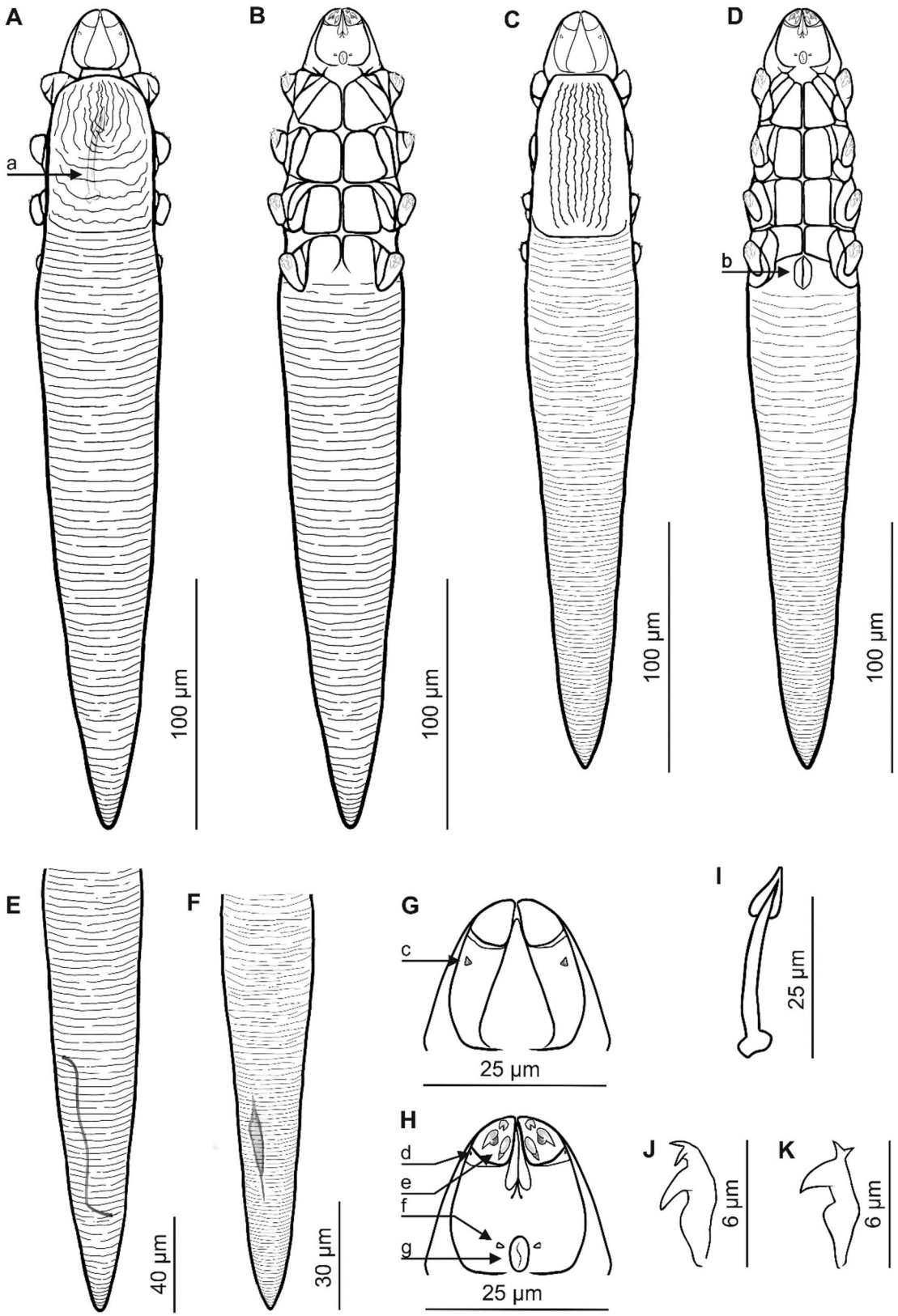


Fig. 4. *Demodex thois* sp. nov. A, male, dorsal view, a – aedeagus; B, male, ventral view; C, female, dorsal view; D, female, ventral view, b – vulva; E, posterior part of the male opisthosoma with the opisthosomal organ visible; F, posterior part of the female opisthosoma with the opisthosomal organ visible; G, gnathosoma, male, dorsal view, c – supracoxal spine (seta *elc.p*); H, gnathosoma, male, ventral view, d – seta *v''F*, e – spines on palps, f – subgnathosomal seta (seta *n*), g – pharyngeal bulb; I, aedeagus; J, K, claw on the leg, various views.



Fig. 5. *Demodex thois* sp. nov. A, male, B, female.

Table 3
Body size (micrometers) for adults of *Demodex thois* sp. nov.

Morphologic features	Males (n = 14)	Females (n = 16)
	Mean (range) ± SD	Mean (range) ± SD
Length of gnathosoma	24 (20–27) ±2	24 (20–26) ±2
Width of gnathosoma (at base)	26 (20–29) ±2	25 (20–30) ±3
Length of podosoma	84 (80–88) ±3	82 (67–92) ±7
Width of podosoma	45 (40–51) ±3	43 (35–50) ±5
Length of opisthosoma	219 (198–230) ±10	195 (170–226) ±16
Width of opisthosoma	41 (37–49) ±3	42 (35–48) ±4
Aedeagus	29 (26–32) ±2	–
Vulva	–	9 (7–12) ±1
Total length of body	327 (309–345) ±10	301 (265–338) ±18

slides with the demodecid mites deposited within the framework of the Collection of Extant Invertebrates in the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland.

3.2.5. Etymology

The specific epithet *thois* is derived from Greek and represents the Latinized form of a term "thos" referring to a canid smaller than the gray wolf, traditionally used for various species of jackals.

3.2.6. Infestation and location in the host

Demodex thois sp. nov. was detected in both examined jackals (MCCCa1/2023 – 25 mites, MCCCa2/2023 – 7) with a density of 4.0; 32 individuals (16 females, 14 males, 2 deutonymphs) in total were found. The mites were found on the hairless and sparsely-haired regions of the head (eyelid area – 8 individuals, nose – 18, region of vibrissae – 3, vertex – 3). The observed mites did not cause any skin lesions in the examined jackals.

3.2.7. Differential diagnosis of Demodex thois sp. nov

Demodex thois sp. nov (Figs. 4 and 5, Table 4). differs from other Demodecidae with regard to a number of taxonomically-important characters, including body shape and proportions. Among the known species, it is morphologically most similar to *D. injai* from the domestic dog (Desch and Hillier, 2003; Izdebska and Rolbiecki, 2018). *Demodex thois* sp. nov. is slightly shorter than *D. injai* but exhibits similarly pronounced sexual dimorphism, with males being longer than females, and differs in its body proportions. The primary differences between these species concern taxonomically-important structures of the gnathosoma. The supracoxal spines in *D. thois* sp. nov. are conical, small (1 µm in length), and clearly distant from the external edge of the gnathosoma, while those of *D. injai* are slightly larger (1–2 µm in length) and located at edge of the gnathosoma. Both species present three spines on the terminal segments of the palpi; however *D. thois* sp. nov. has one small (conical, curved) and two larger, single spines, while *D. injai* has one small and two large, bifurcated spines. In addition, setae *v''F* are present on the palpi of *D. thois* sp. nov. The subgnathosomal setae are relatively large and conical in both species, but in *D. thois* sp. nov., they are located on both sides of the pharyngeal bulb, clearly below the anterior edge, while in *D. injai*, they are at the level of the anterior edge of the pharyngeal bulb. The species also differ in the structure of the legs, including epimeral plates IV in females. In *D. thois* sp. nov., these plates form a deeper incision, within which the vulva is entirely contained. In *D. injai*, by contrast, only part of the vulva lies within the incision, with most of it extending beyond its posterior margin. The claws also differ in shape. In *D. thois* sp. nov., they are more delicate (5–6 µm long), with a

Table 4
Morphometric comparison between *Demodex thois* sp. nov. and *Demodex injai*.

Feature/Species	*Demodex thois* sp. nov.		*Demodex injai*	
Source	Present study		Desch and Hillier (2003)	
Sex	Males	Females	Males	Females
Sample size	(n = 14)	(n = 16)	(n = 20)	(n = 20)
Body total length	327 (309–345) ±10	301 (265–338) ±18	361 (306–451) ± 44[a]	334 (270–390) ±29[a]
Body total width	45 (40–51) ±3	43 (35–50) ±5	44 (41–47) ±3[a]	47 (28–31) ±1[a]
Body length to width ratio	7.3 (6.4–8.3) ±0.6	7.0 (6.3–8.5) ±0.6	8.2[b]	7.1[b]
Opisthosoma length to body length ratio (%)	67 (64–69) ±1	65 (61–71) ±3	70[b]	67[b]
Aedeagus length	29 (26–32) ±2	–	28 (24–29) ±1[a]	–
Vulva length	–	9 (7–12) ±1	–	7 (6–7) ±1[a]

[a] Measurements were rounded to the nearest micrometer with respect to the original results (Desch and Hillier, 2003).
[b] Calculated from mean measurements reported by Desch and Hillier (2003).

narrow, sharp spur and a slight bulge below it, whereas in *D. injai* they are more massive (6 μm long), with a broader spur and a more pronounced bulge. Solenidia are present on legs I–IV in *D. thois* sp. nov., whereas in *D. injai* they occur only on legs I–II. Both species possess an opisthosomal organ, with differences between females and males. However, in *D. thois* sp. nov., this organ is located closer to the posterior end of the opisthosoma, whereas in *D. injai* it is situated more centrally. Moreover, in the female *D. thois* sp. nov. it is elongated and spindle-shaped, while in the female *D. injai* it is short and finger-like.

4. Discussion

Our findings confirm the occurrence of Demodecidae parasitism in the golden jackal, which shared the characteristic pattern observed in various mammalian species, i.e. the co-occurrence of specific demodecid mite species within the same host species, each occupying distinct microhabitats (Rolbiecki et al., 2026). Typically, one dominant species occurs across different skin regions of a host, and is consistently recorded in individuals from different populations; additional species may be present, with these being confined to specific body regions and exhibiting more restricted distributions (Izdebska and Rolbiecki, 2020; Rolbiecki et al., 2026).

In the golden jackal, the dominant species is *D. ciacalis* sp. nov., which was detected in both examined jackals. The mites were identified in various regions of the hairy skin, including the head, neck, thorax, forelimbs and hindlimbs, although neither host exhibited clinical signs of demodecosis. Similarly, dominant species have been found to be distributed throughout the host skin in the domestic dog (*D. canis* Leydig, 1859), European badger *Meles meles* (Linnaeus, 1758) (*D. melesinus* Hirst, 1921), European otter *Lutra lutra* (Linnaeus, 1758) (*D. lutrae* Izdebska et Rolbiecki, 2014), and domestic cat (*D. cati* Mégnin, 1877). These dominant species are typically morphologically similar, being slender-bodied and characterized by an elongated opisthosoma (Izdebska et al., 2025). However, *D. ciacalis* sp. nov. is short-bodied and stocky, with a body shape and morphological features resembling those of *D. foetorii*, described from the hairy skin of the European polecat (Izdebska et al., 2024). The domestic dog also harbors a smaller *Demodex* species, *D. cornei* Izdebska et Rolbiecki (2018), with a more robust body shape, inhabiting the epidermis of various skin regions (Izdebska and Rolbiecki, 2018).

Demodex thois sp. nov., the less abundant of the two species identified in the golden jackal, was confined to specific regions of the head. It resembles *D. injai* from the domestic dog (Desch and Hillier, 2003; Izdebska and Rolbiecki, 2018). Similar microhabitat preferences have also been reported for *D. murilegi* Izdebska, Rolbiecki et Fryderyk, 2023, which was reported to inhabit the hairless and sparsely-haired regions of the head in the domestic cat, and *D. putorii* Izdebska, Rolbiecki et Rehbein, 2024, inhabiting the hairless skin of the head in the common polecat (Izdebska et al., 2023, 2024). This is in line with the repeated observation that demodecid mites inhabiting analogous microhabitats exhibit similar body shape, regardless of host species (Izdebska, 2009).

Interestingly, *D. injai*, another species typically associated with, and possibly even specific to, the domestic dog has been reported in a jackal from Romania showing clinical signs of demodecosis (Morariu et al., 2023); this cosmopolitan mite has been recorded in dogs from various regions of the world (Izdebska and Rolbiecki, 2020). While no confirmed, well-documented evidence of the transfer of these generally monoxenous parasites to other host species currently exists, such transmission cannot be excluded. However, as these mites are difficult to detect and identify at the species level, any presumed records of the same species in different hosts may have arisen from misidentification (Izdebska and Rolbiecki, 2020). Consequently, it would be worthwhile to verify the occurrence of *D. injai* in the golden jackal, particularly in view of the rarity of demodecosis in wild mammals.

It should be noted that, in the study by Morariu et al. (2023), taxonomic verification was not carried out according to the criteria essential for Demodecidae taxonomy. Most importantly, the identification was not based on morphological features described by the authors of the species description (Desch and Hillier, 2003); it was instead based solely on morphometric data, which cannot serve as a primary taxonomic criterion in this group (Izdebska and Rolbiecki, 2018). Furthermore, while the identification was supported by molecular analyses, these are not currently considered reliable criteria for Demodecidae identification (Izdebska and Rolbiecki, 2020; Izdebska et al., 2023). Species-level genetic distances are unknown in this group, as previous molecular studies have been based on material that has not been sufficiently taxonomically verified. As such, many of the sequences deposited in genetic databases originate from mites whose identity has not been fully verified (Izdebska and Rolbiecki, 2020).

It is not surprising that the specimens obtained from the jackal and *D. injai* appear to share a relatively close relationship, given the close phylogenetic relationship between their hosts; however, this does not necessarily indicate that they belong to the same species, particularly considering the limited understanding of their intraspecific variability. Furthermore, it is not possible to compare the molecular data with the materials being present studied, because the genetic material is effectively degraded by the etching and decantation method used to detect asymptomatic skin infestations.

Based on the published data, it is possible that the one of the present species, *D. thois* sp. nov., which resembles *D. injai* in body shape, may correspond to *Demodex* specimens found by Morariu et al. (2023); however, the latter material cannot be verified, as it was not deposited in any museum collection. More importantly, the specimens described (e.g. body total length: 239 μm) by Morariu et al. (2023) significantly differed morphometrically from those of both *D. injai* and the newly-described *D. thois* sp. nov. (Table 4) (Desch and Hillier, 2003; Izdebska and Rolbiecki, 2018). Instead, these specimens showed greater similarity to another demodecid species, *D. canis* (Izdebska and Rolbiecki, 2018). By contrast, *D. injai*, known from the domestic dog, exhibits not only different morphological characteristics (important for Demodecidae taxonomy) to those of *D. thois* sp. nov., but also a distinct topographical pattern, i.e. distribution across the host body, and different topical preferences, i.e. its relationship with a specific microhabitat, being recorded in various regions of hairy skin. It should be noted, however, that the data on *D. thois* sp. nov. refer to asymptomatic infestations, reflecting the natural localization of mites within skin structures. In contrast, observations of *D. injai* in both the domestic dog (e.g. Desch and Hillier, 2003) and the jackal from Romania (Morariu et al., 2023) have both been associated with clinical signs of disease. During such infestations, proliferation of demodecid mites is often associated with colonization of atypical body regions and may differ from their localization in typical asymptomatic infestations.

In summary, the parasite species described herein in the golden jackal exhibit low density (4.0-4.9 individuals per 1 cm^2) on the skin and occupy distinct body regions. The co-occurrence of several species and demonstrate separation of microhabitats appears to represent a common pattern among Demodecidae inhabiting mammal hosts from different groups, reflecting efficient use of the host body as a habitat and food source with limited effects on the host (Rolbiecki et al., 2026).

Due to its rapid geographic expansion, the golden jackal may contribute to the spread of parasites by increasing the risk of transmission to other hosts, particularly other carnivoran mammals (Gherman and Mihalca, 2017). While the transmission of host-specific monoxenous parasites, which have limited potential to colonize other host species, is of relatively minor importance. Our findings also indicate the presence of the polyxenous sarcoptic mite *S. scabiei*, previously reported in golden jackals in Israel (Berkovitz et al., 2009). This parasite is known to cause sarcoptosis, including severe and potentially fatal infections, in various carnivoran mammals (Fuchs et al., 2016; Perrucci et al., 2016; Villalba-Briones et al., 2022; Barroso and Palencia, 2024). Additionally, the parasite was found to be accompanied by the ear mite *O. cynotis*, an oligoxenous parasite inhabiting the ear canals. It is

commonly associated with various carnivoran mammals; it also occurs in jackals within their native range and was previously reported in one of 56 examined golden jackals in Iran, where it was considered a rare parasite (Razmjoo et al., 2013). The results obtained suggest that golden jackals may potentially act as a reservoir of these parasites in areas newly colonized by them. The possibility of their involvement in the spread of ear mites and sarcoptic mites indicates the need for further research and parasitological monitoring to assess the scale and significance of this phenomenon.

CRediT authorship contribution statement

Joanna N. Izdebska: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Leszek Rolbiecki:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Karolina Cierocka:** Writing – review & editing, Investigation. **Maciej Szewczyk:** Writing – review & editing, Investigation.

Declaration of competing interest

Authors have no conflict of interest to declare.

Acknowledgments

We thank Martyna Jankowska-Jarek for technical assistance with the animal dissections.

References

Barroso, P., Palencia, P., 2024. Camera traps reveal a high prevalence of sarcoptic mange in red foxes from northern Spain. Res. Vet. Sci. 166, 105098.
Berkovitz, A., Waner, T., King, R., Perl, S., 2009. Concurrent parasitation with *Sarcoptes* and *Demodex* in a golden jackal. Isr. J. Vet. Med. 64, 10–11.
Bochkov, A.V., 2008. New observations on phylogeny of cheyletoid mites (Acari: Prostigmata: Cheyletoidea). Proc. Zool. Inst. RAS 312, 54–73.
Desch, C.E., Hillier, A., 2003. *Demodex injai*: a new species of hair follicle mite (Acari: Demodecidae) from the domestic dog (Canidae). J. Med. Entomol. 40, 146–149.
Fuchs, B., Zimmermann, B., Wabakken, P., Bornstein, S., Månsson, J., Evans, A.L., Liberg, O., Sand, H., Kindberg, J., Ågren, O., Arnemo, J.M., 2016. Sarcoptic mange in the Scandinavian wolf *Canis lupus* population. BMC Vet. Res. 12, 156.
Gherman, C.M., Mihalca, A.D., 2017. A synoptic overview of golden jackal parasites reveals high diversity of species. Parasit. Vectors 10, 419.
Hatlauf, J., 2026. Golden jackal *Canis aureus* Linnaeus, 1758. In: Loy, A., Ciucci, P. (Eds.), Carnivora. Handbook of the Mammals of Europe. Springer, Cham, pp. 343–372.
ITIS, 2026. Integrated Taxonomic Information System. Retrieved August, 2026, from. http://www.itis.gov.
Izdebska, J.N., 2004. *Demodex* spp. (Acari: Demodecidae) in brown rat (Rodentia: Muridae) in Poland. Wiad. Parazytol. 50, 333–335.
Izdebska, J.N., 2009. Selected aspects of adaptations to the parasitism of hair follicle mites (Acari: Demodecidae) from hoofed mammals. Eur. Bison Conserv. Newsletter. 2, 80–88.
Izdebska, J.N., Rolbiecki, L., 2013. A new species of *Demodex* (Acari, Demodecidae) with data on topical specificity and topography of demodectic mites in the striped field mouse *Apodemus agrarius* (Rodentia, Muridae). J. Med. Entomol. 50, 1202–1207.
Izdebska, J.N., Rolbiecki, L., 2016. A new genus and species of demodecid mites from the tongue of a house mouse *Mus musculus*: description of adult and immature stages with data on parasitism. Med. Vet. Entomol. 30, 135–143.
Izdebska, J.N., Rolbiecki, L., 2018. The status of *Demodex cornei*: description of the species and developmental stages, and data on demodecid mites in the domestic dog *Canis lupus familiaris*. Med. Vet. Entomol. 32, 346–357.
Izdebska, J.N., Rolbiecki, L., 2020. The biodiversity of demodecid mites (Acariformes: Prostigmata), specific parasites of mammals with a global checklist and a new finding for *Demodex sciurinus*. Diversity 12, 261.
Izdebska, J.N., Rolbiecki, L., Faleńczyk-Koziróg, K., Gwiazdowicz, D.J., 2025. A new Demodecidae mite (Acariformes: Prostigmata) parasitizing the raccoon *Procyon lotor* (Carnivora: Procyonidae), an invasive species in Europe. Insects 16, 1218.
Izdebska, J.N., Rolbiecki, L., Fryderyk, S., 2023. *Demodex murilegi* and *Demodex obliquus*, two new specific skin mites from domestic cat *Felis catus*, with notes on parasitism. Med. Vet. Entomol. 37, 263–274.
Izdebska, J.N., Rolbiecki, L., Rehbein, S., 2022. Morphological and ontogenetic characteristics of *Miridex putorii* (Acariformes: Demodecidae), a new genus and species of skin mite specific to the European polecat *Mustela putorius*. Int. J. Parasitol.: Parasites Wildl. 18, 225–231.
Izdebska, J.N., Rolbiecki, L., Rehbein, S., 2024. Two new species of parasitic demodecid mites in the European polecat *Mustela putorius* and their co-infestation with *Miridex putorii* (Acariformes: Demodecidae). Eur. Zool. J. 91, 568–589.
Koepfli, K.P., Pollinger, J., Godinho, R., Robinson, J., Lea, A., Hendricks, S., Schweizer, R.M., Thalmann, O., Silva, P., Fan, Z., Yurchenko, A.A., Dobrynin, P., Makunin, A., Cahill, J.A., Shapiro, B., Álvares, F., Brito, J.C., Geffen, E., Leonard, J. A., Helgen, K.M., Johnson, W.E., O'Brien, S.J., Van Valkenburgh, B., Wayne, R.K., 2015. Genome-wide evidence reveals that African and Eurasian golden jackals are distinct species. Curr. Biol. 25, 2158–2165.
Kowalczyk, R., Kołodziej-Sobocińska, M., Ruczyńska, I., Wójcik, J.M., 2015. Range expansion of the golden jackal (*Canis aureus*) into Poland: first records. Mamm. Res. 60, 411–414.
Kowalczyk, R., Wudarczyk, M., Wójcik, J.M., Okarma, H., 2020. Northernmost record of reproduction of the expanding golden jackal population. Mamm. Biol. 100, 107–111.
Kozina, P., Izdebska, J.N., Rolbiecki, L., 2023. A new species of *Demodex* (Acariformes: Prostigmata) observed in the mouflon, *Ovis aries musimon* (Artiodactyla: Bovidae) with data on the parasitism and occurrence of other ectoparasites. Animals 13, 2619.
Krofel, M., Giannatos, G., Ćirović, D., Stoyanov, S., Newsome, T.M., 2017. Golden jackal expansion in Europe: a case of mesopredator release triggered by continent-wide wolf persecution? Hystrix. It. J. Mamm. 28, 9–15.
Krzysiak, M.K., Świątalska, A., Plis-Kuprianowicz, E., Konieczny, A., Bakier, S., Tomczuk, K., Larska, M., 2024. Fatal *Sarcoptes scabiei* and *Demodex* sp. co-infestation in wolves (*Canis lupus*) at the Białowieża National Park, Poland – is it a consequence of climate change? J. Vet. Res. 68, 551–562.
Morariu, S., Morariu, F., Marin, A.-M., Moraru, M.M.F., Popovici, D.C., Imre, M., Igna, V., Mederle, N., 2023. First Morphological and molecular identification of *Demodex injai* in golden jackal (*Canis aureus* Linnaeus, 1758) in Romania. Pathogens 12, 412.
Morita, T., Ohmi, A., Kiwaki, A., Ike, K., Nagata, K., 2018. A new stubby species of demodectic mite (Acari: Demodicidae) from the domestic dog (Canidae). J. Med. Entomol. 55, 323–328.
Mueller, R.S., Rosenkrantz, W., Bensignor, E., Karaś-Tęcza, J., Paterson, T., Shipstone, M. A., 2020. Diagnosis and treatment of demodicosis in dogs and cats. Clinical consensus guidelines of the World Association for Veterinary Dermatology. Vet. Dermatol. 31, 4-e2.
Nutting, W.B., 1976. Hair follicle mites (*Demodex* spp.) of medical and veterinary concern. Cornell Vet. 66, 214–231.
Perrucci, S., Verina, R., Mancianti, F., Poli, A., 2016. Sarcoptic mange and other ectoparasitic infections in a red fox (*Vulpes vulpes*) population from central Italy. Parasite Epidemiol. Control 1, 66–71.
Razmjoo, M., Bahrami, A.M., Hosseini, E., 2013. Ectoparasitic species from red fox and jackal in Western of Iran. Glob. Vet. 10, 626–629.
Rolbiecki, L., Izdebska, J.N., Cierocka, K., Ribas, A., Morand, S., 2026. A search for a universal pattern of infestation of Demodecidae skin mites in murid hosts, exemplified by the description of a new species of the genus *Demodex* (Acariformes: Demodecidae) in the Polynesian rat *Rattus exulans*. Eur. Zool. J. 93, 375–389.
Rutkowski, R., Krofel, M., Giannatos, G., Ćirović, D., Männil, P., Volokh, A.M., Lanszki, J., Heltai, M., Szabó, L., Banea, O.C., Yavruyan, E., Hayrapetyan, V., Miliou, N.K.A., Tryfonopoulos, G.A., Lymberakis, P., Penezić, A., Pakeltytė, G., Suchecka, E., Bogdanowicz, W., 2015. A European concern? Genetic structure and expansion of golden jackals (*Canis aureus*) in Europe and the Caucasus. PLoS One 10 (11), e0141236.
Trouwborst, A., Krofel, M., Linnell, J.D.C., 2015. Legal implications of range expansions in a terrestrial carnivore: the case of the golden jackal (*Canis aureus*) in Europe. Biodivers. Conserv. 24, 2593–2610.
Villalba-Briones, R., Molineros, E.B., Monrós, J.S., 2022. First report of *Sarcoptes scabiei* parasitism (Sarcoptiformes: Sarcoptidae) in *Lycalopes sechurae* (Mammalia: Carnivora). Braz. J. Vet. Parasitol. 31, e005022.
Wilson, D.E., Reeder, D.M. (Eds.), 2005. Mammals Species of the World. A Taxonomic and Geographic Reference, third ed. The Johns Hopkins University Press, Baltimore and Maryland. Available online. http://www.departments.bucknell.edu/biology/resources/msw3/.
Zhang, Z.Q., 2018. Repositories for mite and tick specimens: acronyms and their nomenclature. Syst. Appl. Acarol. 23, 2432–2446.