

## Article

# The Co-Occurrence of Demodecidae and Psorergatidae (Acariformes: Prostigmata) in the Yellow-Necked Field Mouse *Apodemus flavicollis* (Rodentia: Muridae) with a Description of Two New Species and a New Host Record

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**Abstract:** Mites from the Demodecidae and Psorergatidae can optimally use mammalian hosts by inhabiting a number of different microhabitats in their skin. Hence, in individual hosts, several species of parasites from these groups have been described in different microhabitats. There are few data on their co-occurrence either at the host species level or at the host individual level. Most research has addressed the co-occurrence of Demodecidae in carnivorans, ungulates, soricomorphs, and rodents, while the co-occurrence of both families was found in bats. The present study examines the possibility of their co-occurrence in a Eurasian rodent—*Apodemus flavicollis*. It is a suitable model for such analyses, because representatives of both families have been demonstrated here so far, and our findings extend the list of specific Demodecidae in *A. flavicollis* with two new species: *Demodex tenuis* sp. nov. from the lip region and *D. mediocris* sp. nov. from the chin region. The study also includes the first record of *Psorergates muricola* in this host, which occurred in the genital–anal region. Therefore, the findings confirm the possibility that different Demodecidae and Psorergatidae species can co-occur in the same host in different body regions. This paper also includes a checklist of Demodecidae and Psorergatidae in rodents around the world.

**Keywords:** *Apodemus flavicollis*; *Demodex mediocris*; *Demodex tenuis*; mammals; parasites; *Psorergates muricola*; Rodentia; skin mites



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## 1. Introduction

Skin mites (Acariformes: Trombidiformes: Prostigmata) parasitizing mammals constitute a species-rich assemblage with co-occurring species often specialized to different microhabitats (location) of the host skin, as well as other tissues and organs [1]. Such a model of parasitism, where several different mite species coexist on the host species, and the host individual levels, has been described for Demodecidae in carnivorous mammals. It has been described both in domestic animals, e.g., dog *Canis lupus familiaris* Linnaeus, 1758 and cat *Felis catus* Linnaeus, 1758 models, and in wild animals like the European polecat *Mustela putorius* Linnaeus, 1758 [2–4]. Similar observations have also been made in ungulates, e.g., European bison *Bison bonasus* (Linnaeus, 1758) [5,6], or soricomorphs [7–9]. Similarly, in rodents, such a co-occurrence has been reported in Muridae, including *Apodemus* spp. [10,11], the brown rat *Rattus norvegicus* (Berkenhout, 1769) [12,13], or the house mouse *Mus musculus* [14–16]. However, there are fewer data on the co-occurrence of Demodecidae and the closely related Psorergatidae, which has only been described to date in bats [17]. Most importantly, no similar studies have been conducted on rodents, despite the fact that they constitute the largest group of mammals in which the largest number of species from these mite families has been described so far. Previous research indicates that representatives of these groups may occur in the same host species [1,18].

However, this does not confirm their co-occurrence at the individual level, because certain mite species may have different geographical ranges or occur in different host populations. Additionally, there may be mechanisms that favor the colonization of the host by mites from one group/species, while excluding the presence of others in neighboring anatomic microhabitats. Unfortunately, such observations are limited by the lack of full recognition of the acarofauna of individual host species: Demodecidae and Psorergatidae are known only in some mammals, often from single records [1,19].

The present study examines the possibility that several mite species from these families may co-occur in the yellow-necked field mouse *Apodemus flavicollis* (Rodentia: Muridae). The yellow-necked field mouse is an appropriate model for such analyses, as it has been found to host several representatives of both mite families [1,18,20], and the occurrence of three *Demodex* species has been noted in hosts from the same region, Poland [11,21,22]. Our findings expand the list of Demodecidae inhabiting this mammal with the description of two new species. In addition, this paper compiles an updated list of Demodecidae and Psorergatidae in rodents around the world, which shows the possibility of co-occurrence at the species level.

## 2. Material and Methods

Twenty specimens of dead yellow-necked field mice *Apodemus flavicollis* (Poland, Pomeranian Voivodeship, Gdynia, 54°32'00'' N/18°28'30'' E, four mice; Kartuzy, 54°19'43'' N/18°21'31'' E, four mice; Tczew, 54°04'55'' N 18°47'05'' E, three mice; Ulkowy, 54°10'44'' N/18°38'01'' E, nine mice), collected from September 2019 to September 2022, were examined for the presence of skin mites.

The mites were isolated using the digestion method developed for the detection of mammalian skin mites [23], with a modification to suit the examined host. Fragments of the skin, 1 cm<sup>2</sup> each, were taken from various areas of the body, including the head (around the eyes, nose, area of vibrissae, lips, chin, cheeks, ear pinnae, and vertex), neck, abdomen, back, limbs, tail, and the genital–anal area. Skin samples were preserved in 70% ethanol and subjected to digestion in 10% potassium hydroxide solution. The digested material was decanted, mounted, and examined under phase-contrast microscopy (Nikon Eclipse 50i). The mites were placed in a polyvinyl-lactophenol solution and measured; 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 [24]. The description of the species adopted the nomenclature commonly used for the family Demodecidae [25] and was completed with the nomenclature proposed by Bochkov [26] for the superfamily Cheyletoidea (Acariformes: Prostigmata) and by Izdebska and Rolbiecki [16]. The scientific and common names of the hosts follow Wilson and Reeder [27] and the Integrated Taxonomic Information System [28].

To define the level of host infection, the following main parasitological parameters were measured: prevalence (percentage of hosts infected), mean intensity (mean number of parasites in infected hosts), and intensity range (minimum and maximum number of parasite individuals per host) [29].

The checklist has been compiled based on manuscripts published during the period 1842–2024. It also contains a new record, marked as the present study. The list includes all formally described mite species known to date and other functioning specific names. The study also includes information on the dates of host species, as well as the occurrence and microhabitats of mites. However, no host records related to unidentified *Demodex* spp. and *Psorergates* spp. are included.

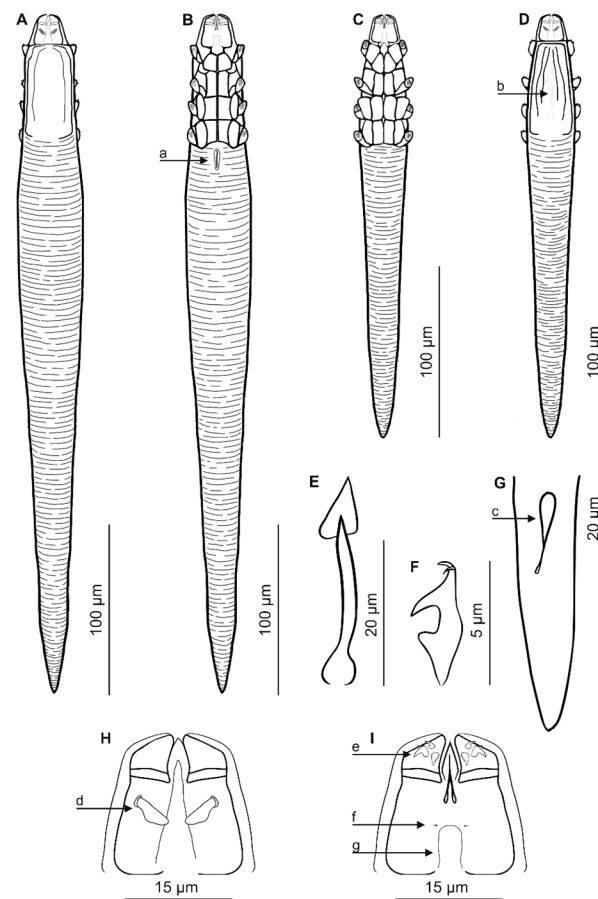
### 3. Results

#### 3.1. Systematics

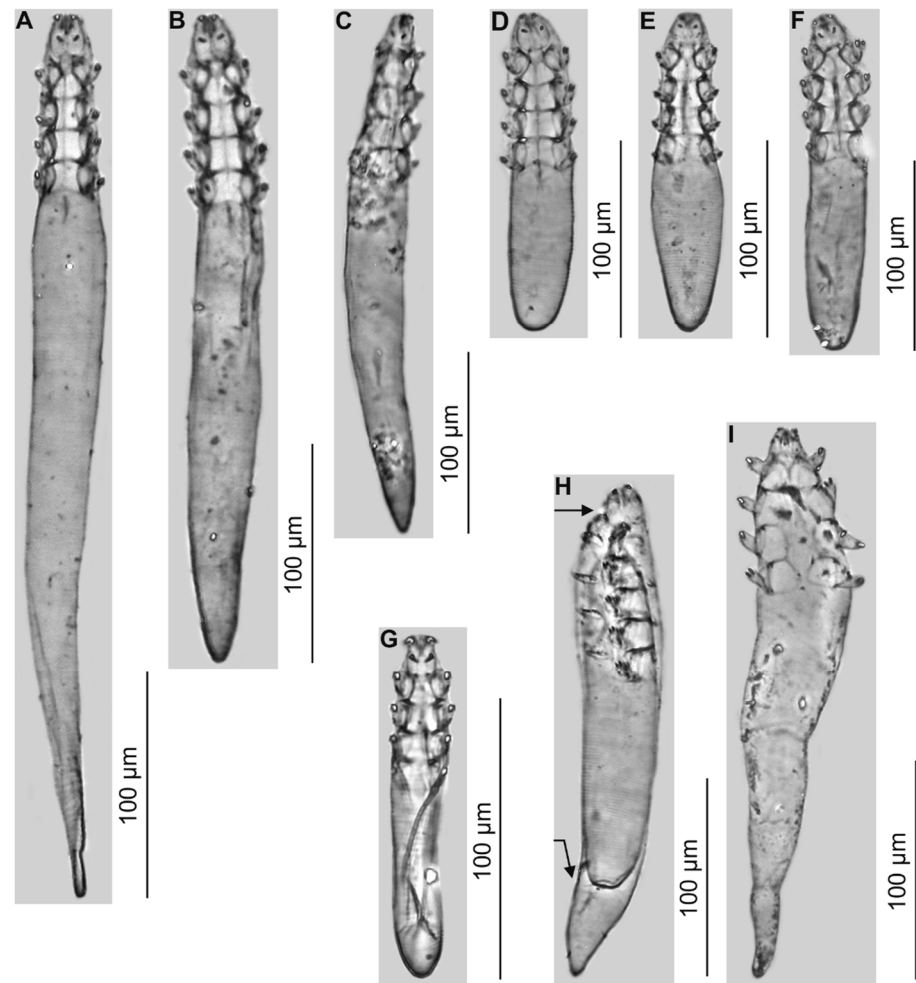
*Demodex tenuis* sp. nov. Izdebska, Cierocka et Rolbiecki  
(Table 1, Figures 1 and 2)

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

Morphologic Features	Males ( <i>n</i> = 14) Mean (Range) ± SD	Females ( <i>n</i> = 17) Mean (Range) ± SD
Length of gnathosoma	20 (18–22) ± 1	22 (20–23) ± 1
Width of gnathosoma (at base)	21 (19–23) ± 1	23 (22–24) ± 1
Length of podosoma	65 (60–68) ± 3	69 (65–71) ± 2
Width of podosoma	31 (30–32) ± 1	31 (28–33) ± 1
Length of opisthosoma	168 (138–190) ± 15	286 (202–347) ± 53
Width of opisthosoma	30 (28–33) ± 1	33 (29–35) ± 2
Aedeagus	29 (27–30) ± 1	–
Vulva	–	11 (10–13) ± 1
Total length of body	253 (218–280) ± 18	377 (293–434) ± 53



**Figure 1.** *Demodex tenuis* sp. nov.: female, dorsal view (A); female, ventral view (B); male, ventral view (C); male, dorsal view (D); aedeagus (E); claw on the leg (F); posterior part of opisthosoma with visible opisthosomal organ, male (G); gnathosoma, male, dorsal view (H); gnathosoma, male, ventral view (I). Abbreviations: a—vulva, b—aedeagus, c—opisthosomal organ, d—supracoxal spine (seta *elc.p*), e—spines on palps, f—subgnathosomal seta (seta *n*), g—pharyngeal bulb.



**Figure 2.** Demodecidae from *Apodemus flavicollis*. *Demodex tenuis* sp. nov.: female, various morphotypes (A,B); male (C); *Demodex mediocris* sp. nov.: female (D); males, various morphotypes (E,F); *Demodex corniculatus*: male (G); adult *Demodex mediocris* sp. nov. with visible remains of nymphal exuviae, arrow (H); *Demodex mollis*: male (I).

Male ( $n = 13$  and 1 holotype). Body elongated, narrow, slender, with distinctly separated gnathosoma; 253 (218–280) long and 31 (30–32) wide (holotype,  $264 \times 30$ ). Gnathosoma trapezoidal, with length equal to or slightly less than width at base; on dorsal side in central part of basal segments, pair of wedge-shaped supracoxal spines (setae *elc.p*) present, ca. 4–5 long (holotype, 4.0), directed obliquely, posteromedially. Palps 3-segmented, terminating in three hooked spines (one small and two larger) on tibio-tarsus. On ventral side, horseshoe-shaped pharyngeal bulb with pair of conical subgnathosomal setae (setae *n*), situated anterior on both sides. Podosoma trapezoidal, widening posterior end; four pairs of short legs, with coxa integrated into ventral idiosomal wall and five free, overlapping segments (trochanter–tarsus); conical spine on tibiae; two bifurcated claws, ca. 5 long (holotype, 5.0), with sharp, slightly curved downwards spur and triangular bulge on each tarsus. Epimeral plates (coxal fields) distinctly sclerotized, trapezoidal; all epimeral plates connect medially. On the dorsal side of podosoma, podosomal shield present, reaching level of legs IV. Opisthosoma strongly elongated, conical, tapered towards end, constitutes 66 (63–69%) of body length (holotype, 69%). Whole opisthosoma clearly, densely annulated; annuli relatively wide at ca. 1.5–2.0  $\mu\text{m}$ . Opisthosomal organ club-shaped, ca. 20 in length and is located in posterior part of opisthosoma. Aedeagus elongated, 29 (27–30) long (holotype, 29), on dorsal surface, located between epimeral plates II and III. Genital opening located on dorsal surface, at level of anterior margin of epimeral plate II.

Female ( $n = 17$ ). Distinctly longer than male, 377 (293–434) long, 33 (29–35) wide, with very long opisthosoma. Gnathosoma shape similar to male; usually length less 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 (coxal fields) I–III distinctly sclerotized, pair IV weakly sclerotized; all epimeral plates connect medially. On dorsal side of podosoma, podosomal shield, reaches level of legs IV. Opisthosoma relatively longer than males, narrow, conical, clearly narrows at end to sharp point; constitutes 75% (69–80%) of body length; distinctly annulated, annuli relatively wide at ca. 1.5–2.0  $\mu\text{m}$ . Opisthosomal organ not visible. Vulva 11 (10–13) long, located below posterior arched incision of epimeral plates IV.

Immature stages. Not found; only adults were found in the remains of nymphal exuviae.

Material deposition: Male holotype (reg. no. UGDIZPRAfDDt01m), 13 male paratypes (reg. no. UGDIZPRAfDDt02m–14m) and 17 female paratypes (reg. no. UGDIZPRAfDDt01f–17f); skin of the lips; host *Apodemus flavicollis* (reg. no. MRMAf11/2019a, MRMAf11/2019b, MRMAf05/2021, MRMAf07/2021a, MRMAf07/2021b, MRMAf08/2021, MRMAf08/2022, MRMAf09/2022a, MRMAf09/2022b); Gdynia, Kartuzy, Ulkowy, Poland; November 2019, May 2021, July 2021, August 2021, August 2022, and September 2022; coll. J.N. Izdebska, K. Cierocka and L. Rolbiecki; the whole-type material (mounted microscope slides) deposited within the framework of the Collection of Extant Invertebrates in Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland.

Infection and location in the host: *Demodex tenuis* sp. nov. was found in 45% of examined yellow-necked field mice, with a mean intensity of 2.4 and an intensity range 1–6; 31 (14 males and 17 females) individuals were noted. The demodecid mites were found in the lips of the examined yellow-necked field mice, and no lesions were observed in the examined hosts.

Etymology: The specific epithet *tenuis* (slender, slim, narrow) refers to the shape of the body.

Differential diagnosis: *Demodex tenuis* sp. nov. from the yellow-necked field mouse is morphologically similar to *D. gracilentus* from the striped field mouse *A. agrarius* (Pallas, 1771) and *D. longior* from the common field mouse *A. sylvaticus* (Linnaeus, 1758) [10]. *Demodex tenuis*, especially the female, is on average larger than other *Demodex* species, and has different body proportions (Table 2). Similarly to *D. longior*, it shows clear dimorphism, with the female being much longer than the male; in contrast, no such differences are found in *D. gracilentus*, in which individuals of both sexes are of similar length. The differences between these species concern the important structures of the gnathosoma. The supracoxal spines are wedge-shaped, directed obliquely, posteromedially in *D. tenuis* sp. nov., while they are conical, directed horizontally, medially in *D. gracilentus* and are club-like, directed obliquely, anterolaterally in *D. longior*. All mites possess three spines on the terminal segments of the palpi, but they are hook-shaped, one small and two large, in *D. tenuis* sp. nov., while they are large, overlapping and often visible as a single structure in *D. gracilentus*, and are small and three-armed in *D. longior*. The subgnathosomal setae in *D. tenuis* sp. nov. are located on both sides of the pharyngeal bulb, relatively higher than in *D. gracilentus* and *D. longior*. The opisthosomal organ is club-shaped in *D. tenuis* sp. nov., rhomboidal in *D. gracilentus* and fusiform in *D. longior*. The distinctiveness of the species is also confirmed by parasitological data regarding host specificity and location preferences: *D. gracilentus* is associated with the vibrissae region of the striped field mouse, *D. longior* in the analogous region of the head in the common field mouse, and *D. tenuis* sp. nov. exclusively around the lips in the yellow-necked field mouse.

**Table 2.** Morphometric comparison between *Demodex tenuis* sp. nov. and *Demodex gracilentus*, and *Demodex longior*.

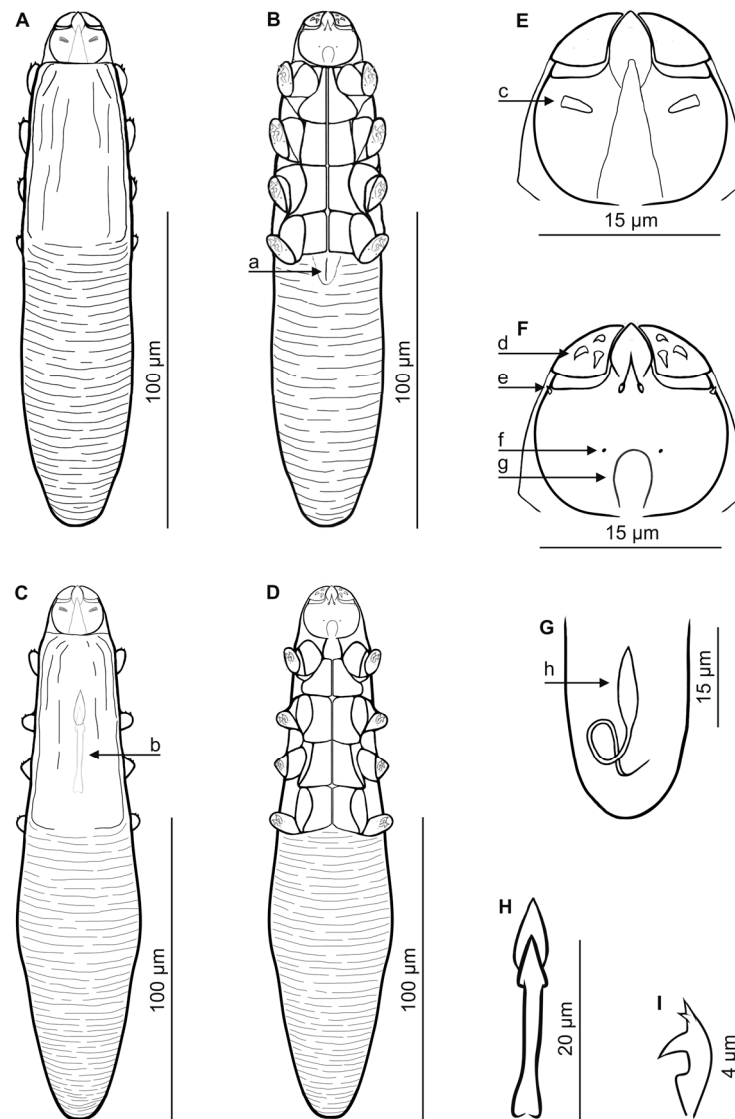
Feature/Species	<i>Demodex tenuis</i> sp. nov.		<i>Demodex gracilentus</i>		<i>Demodex longior</i>	
Source	Present Study		Izdebska and Rolbiecki [10]		Izdebska and Rolbiecki [10]	
Sex (Simple Size)	Males (n = 14)	Females (n = 17)	Males (n = 8)	Females (n = 16)	Males (n = 21)	Females (n = 24)
Body total length	253	377	296	289	219	308
Body total width	31	31	33	32	33	29
Body length to width ratio	8.1:1	11.5:1	9.0:1	9.3:1	6.6:1	10.6:1
Opisthosoma length to body length ratio (%)	66	75	70	67	65	73
Aedeagus length	29	–	32	–	29	–
Vulva length	–	11	–	12	–	12

*Demodex mediocris* sp. nov. Izdebska, Cierocka et Rolbiecki  
(Table 3, Figures 2 and 3)

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

Morphologic Features	Males (n = 17) Mean (Range) ± SD	Females (n = 12) Mean (Range) ± SD
Length of gnathosoma	17 (17–18) ± 0.4	18 (17–19) ± 1
Width of gnathosoma (at base)	20 (19–21) ± 1	20 (19–21) ± 1
Length of podosoma	59 (56–62) ± 2	59 (55–61) ± 2
Width of podosoma	30 (28–32) ± 1	30 (27–33) ± 1
Length of opisthosoma	96 (77–114) ± 10	90 (80–105) ± 9
Width of opisthosoma	33 (29–37) ± 3	31 (30–34) ± 1
Aedeagus	25 (24–27) ± 1	–
Vulva	–	7 (6–8) ± 1
Total length of body	172 (151–187) ± 10	166 (155–184) ± 10

Male ( $n = 16$  and 1 holotype). Body cylindrical, sometimes spindle-shaped, with distinctly separated gnathosoma; 172 (151–187) long and 33 (29–37) wide (holotype,  $184 \times 30$ ). Gnathosoma oval, length less than width at base; on dorsal side in central part of basal segments, pair of peg-like supracoxal spines (setae *elc.p*) present, ca. 3–3.5 long (holotype, 3.0), directed obliquely, medially. Palps 3-segmented, terminating in three spines (one small, two larger) on tibio-tarsus; also, small setae *v''F* present on middle segment (trochanter-femur-tarsus). On ventral surface of gnathosoma, horseshoe-shaped pharyngeal bulb with pair of small, conical subgnathosomal setae (setae *n*), situated anterior 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. 4.0 long (holotype, 4.0  $\mu\text{m}$ ) with sharp spur and triangular bulge on each tarsus; two small knobs at base of each claw. Epimeral plates (coxal fields) I–IV distinctly sclerotized, trapezoidal; all epimeral plates connect medially. On the dorsal side of podosoma, podosomal shield reaches level of legs IV. Opisthosoma fusiform or cylindrical, rounded at end, constitutes 56 (51–61%) of body length (holotype, 58%). Whole opisthosoma clearly, densely annulated; annuli relatively wide at ca. 1.5  $\mu\text{m}$ . Opisthosomal organ present; anterior part of opisthosomal organ, spindle-shaped and posterior part filamentous, spirally twisted; located in posterior part of opisthosoma. Aedeagus elongated, stocky, 25 (24–27) long (holotype, 26), on dorsal side, located between epimeral plates II and III. Genital opening located on dorsal side, at level of anterior edge of epimeral plate II.



**Figure 3.** *Demodex mediocris* sp. nov.: female, dorsal view (A); female, ventral view (B); male, dorsal view (C); male, ventral view (D); gnathosoma, male, dorsal view (E); gnathosoma, male, ventral view (F); posterior part of opisthosoma with visible opisthosomal organ, male (G); aedeagus (H); claw on the leg (I). Abbreviations: a—vulva, b—aedeagus, c—supracoxal spine (seta *elc.p*), d—spines on palps, e—setae *v''F*, f—subgnathosomal seta (seta *n*), g—pharyngeal bulb, h—opisthosomal organ.

Female ( $n = 12$ ). Similar to male, cylindrical, 166 (155–184) long, 31 (30–34) wide. Gnathosoma oval, length usually less 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 distinctly sclerotized, trapezoidal; all epimeral plates connect medially. On the dorsal side of podosoma, podosomal shield reaches level of legs IV. Opisthosoma similar to male, usually cylindrical, rounded at end, constitutes 54 (51–58%) of body length. Whole opisthosoma distinctly annulated; annuli relatively wide at ca. 1.5–2.0 μm. Opisthosomal organ absent. Vulva 7 (6–8) long, located below posterior edges of epimeral plates IV.

Immature stages. Not found; only adults were found in the remains of nymphal exuviae.

Material deposition: Male holotype (reg. no. UGDIZPRAfDDm08m), 16 male paratypes (reg. no. UGDIZPRAfDDm01m–07m, UGDIZPRAfDDm09m–17m) and 12 female paratypes (reg. no. UGDIZPRAfDDt01f–12f); skin of the chin; host *Apodemus flavicollis* (reg. no. MRMAf09/2019, MRMAf11/2019, MRMAf07/2021a, MRMAf07/2021b, MRMAf08/2021, MRMAf08/2022a, MRMAf08/2022b); Gdynia, Kartuzy, Tczew, Ulkowy,

Poland; September 2019, November 2019, July 2021, August 2021, and August 2022; coll. J.N. Izdebska, K. Cierocka and L. Rolbiecki; the whole-type material (mounted microscope slides) is deposited within the framework of the Collection of Extant Invertebrates in Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland.

Infection and location in the host: *Demodex mediocris* sp. nov. was found in 35% of examined yellow-necked field mouse, with a mean intensity of 3.9 and an intensity range 1–11; 29 (17 males and 12 females) individuals were noted. The demodecid mites were found in the chin of the examined yellow-necked field mice. The observed mites did not cause any lesions in examined hosts.

Etymology: The specific epithet *mediocris* refers to metric features and morphological structures that are average for demodecid mites.

Differential diagnosis: *Demodex mediocris* sp. nov. from the yellow-necked field mouse resembles *D. corniculatus* from the same host in terms of size and shape [22]. However, *D. corniculatus* shows clear sexual dimorphism: males are smaller and cylindrical; also, females have a spindle-shaped opisthosoma. In *D. mediocris* sp. nov., the sizes of both sexes are similar, and spindle-shaped opisthosoma are sometimes observed in males (Table 4). The gnathosoma of *D. mediocris* sp. nov. is oval and shorter than the width at the base, while that of *D. corniculatus* is rectangular and longer than the width at the base. The supracoxal spines in *D. mediocris* sp. nov. are smaller (3–3.5 µm), peg-like, while in *D. corniculatus* they are massive, larger (5–6 µm), and wedge-shaped. Both species present three spines on the terminal segments of the palpi, but in *D. mediocris* sp. nov., the spines are smaller (one small, two slightly larger) and conical; in *D. corniculatus* they are larger, massive, as if forming a single bifurcated structure. The subgnathosomal setae in *D. mediocris* sp. nov. are located on both sides of the pharyngeal bulb at the level of its anterior edge, while in *D. corniculatus* they are slightly above its anterior edge. The opisthosomal organ in *D. mediocris* sp. nov. is very complex, i.e., composed of an upper spindle-shaped structure and a lower spirally twisted one, while in *D. corniculatus* it is arc-shaped. Furthermore, the aedeagus of the male *D. mediocris* sp. nov. is located at the level of epimeral plates II–III, while in *D. corniculatus* it is located at the level of epimeral plates III–IV. These species also demonstrate distinct location preferences: *D. mediocris* sp. nov. was found only in the less hairy region of the chin, while *D. corniculatus* occurs in the hairy skin of the entire body.

**Table 4.** Morphometric comparison between *Demodex mediocris* sp. nov. and *Demodex corniculatus*.

Feature/Species	<i>Demodex mediocris</i> sp. nov.		<i>Demodex corniculatus</i>	
	Present Study		Izdebska [22]	
Source				
Sex (Simple Size)	Males (n = 17)	Females (n = 12)	Males (n = 16)	Females (n = 12)
Body total length	172	166	124 *	156 *
Body total width	33	31	23 *	26 *
Body length to width ratio	5.3:1	5.3:1	5.4:1 **	6.0:1 **
Opisthosoma length to body length ratio (%)	56	54	56 **	59 **
Aedeagus length	25	–	22 *	–
Vulva length	–	7	–	12 *

\* Measurements were rounded to the nearest micrometer with respect to the original results [22]. \*\* Calculated from measurements by Izdebska [22].



### 3.2. New Record of Psorergatidae

*Psorergates muricola* was found in three out of the nine examined yellow-necked mouse (Table 5, Figure 4). A total of 291 mites were found (90 females, 28 males and 173 nymphs). The prevalence was 33%, with a mean intensity of 97.3. All individuals of *P. muricola* were recorded in the genital–anal area. No skin lesions were observed in infected hosts.

**Table 5.** Body size (mean, range and ±SD, in µm) for *Psorergates muricola*.

Feature/Source	Present Study		Fain [30], Fain et al. [31], Lukoschus et al. [32] *	Fain [30], Fain et al. [31], Lukoschus et al. [32] *	Giesen [19] **	Giesen [19] **
	Females (n = 90) Mean (Range) ± SD	Males (n = 28) Mean (Range) ± SD	Females (n = ***)	Males (n = ***)	Females (n = ***)	Males (n = ***)
Length of gnathosoma	24 (18–30) ± 3	24 (20–30) ± 2	No data	No data	No data	No data
Width of gnathosoma	28 (22–35) ± 2	27 (21–34) ± 2	No data	No data	No data	No data
Length of idiosoma	87 (66–107) ± 8	73 (61–84) ± 5	No data	No data	No data	No data
Width of idiosoma	91 (74–105) ± 6	82 (73–91) ± 5	(93–110) ****	(93–94) ****	(93–110) ****	(93–94) ****
Length of shield	81 (62–95) ± 6	74 (67–80) ± 3	(79–82)	(68–72)	84	76
Width of shield	76 (65–86) ± 5	70 (63–78) ± 3	(74–78)	(72–77)	75	72
Vulva length	12 (9–14) ± 1	–	No data	–	No data	–
Aedagus length	–	29 (21–35) ± 4	–	(34–38)	–	(34–38)
Aedagus sheath length	–	23 (16–33) ± 4	–	(24–30)	–	(24–30)
Length of shield setae	5 (3–6) ± 1	5 (4–6) ± 0	(5–7)	(5–7)	(5–6)	(6–7)
Gnathosomal setae	3 (2–5) ± 1	3 (2–5) ± 1	No data *****	No data *****	2	2
Length of palpal tibial setae	5 (2–7) ± 1	5 (2–7) ± 1	No more than 5	No more than 5	5	4
Length of ventral setae	6 (4–8) ± 1	5 (3–6) ± 1	6	(3–4)	6	(5–7)
Distance between ventral setae	9 (3–14) ± 2	9 (5–11) ± 2	(7–8)	6	12	13
Total length of body	110 (91–127) ± 8	97 (86–107) ± 5	(120–135)	(105–111)	(120–135)	(105–111)

\* The authors provide measurements on the same individuals in three publications. \*\* Probably Giesen [19] took measurements of the specimens described by Fain [30]. \*\*\* Fain [30] provides data on holotype, allotype and paratypes (8 females and 2 males), and also mentions other individuals; Giesen [19] notes that the number of mites is unknown. \*\*\*\* Authors measured the width of the body. \*\*\*\*\* Authors describe the setae as very short and thick.

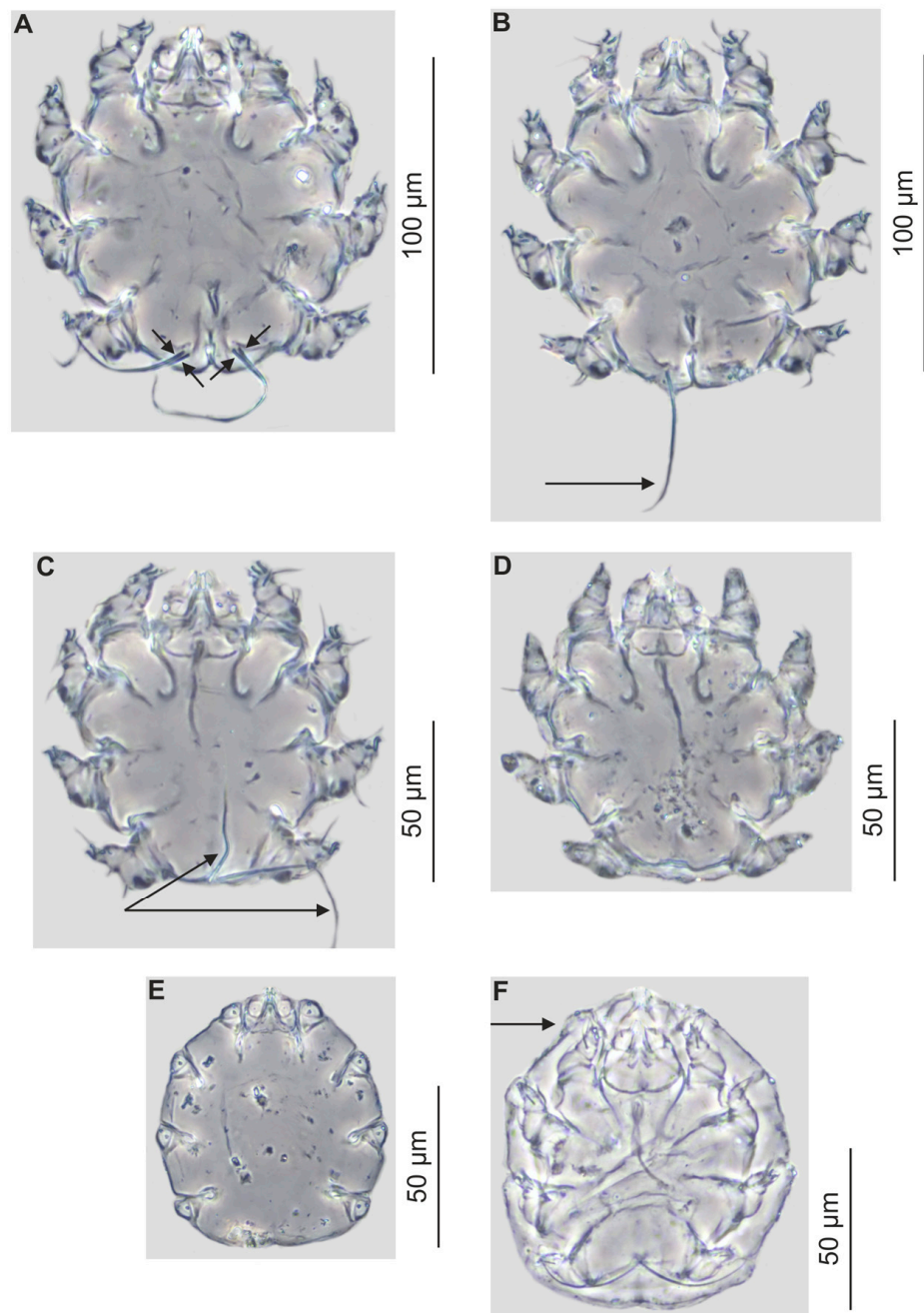
### 3.3. The Co-Occurrence of Demodecidae and Psorergatidae

In the 20 examined yellow-necked mice, 5 species of skin mites were found: *Demodex corniculatus* (prevalence 100%, mean intensity 18.5, intensity range 2–48), *D. tenuis* sp. nov. (45%, 2.4, 1–6), *D. mollis* (40%, 6.0, 2–16), *D. mediocris* sp. nov. (35%, 3.9, 1–11), and *Psorergates muricola* (15%, 97.0, 5–280). In 1 mouse, mites from 5 species co-occurred (a total of 351 specimens), in 3 mice—4 mite species co-occurred, in another 3 mice—3 mite species, in 7 mice—2 mite species, while in 5 mice, only 1 mite species was noted (Figures 5 and 6).

The dominant parasite was *D. corniculatus*, found in all mice, in various locations of the hairy skin of the body (a total of 371 specimens). However, the highest density was found for *P. muricola*—291 individuals were found only in the genital–anal areas in three mice. The level of infection with this mite was varied—in 1 mouse 280 specimens were found, and in the other 2 mice only 6 and 5 mites were found. No skin lesions were observed in the mice.

### 3.4. Biodiversity of Demodecidae and Psorergatidae in Rodentia

Of the 54 rodent species (from 8 families) studied so far, 46 Demodecidae and 34 Psorergatidae species were documented. The highest species richness (10) was found in the house mouse (Table 6).



**Figure 4.** *Psorergates muricola*: female with four terminal setae visible, arrows (A); female with one terminal seta, arrow (B); male with two terminal setae visible, arrows (C); male without terminal setae (D); nymph (E); adult with visible remains of nymphal exuvia, arrow (F).



Figure 5. The co-occurrence (number, %) of Demodecidae and Psorergatidae in the examined *Apodemus flavicollis*.

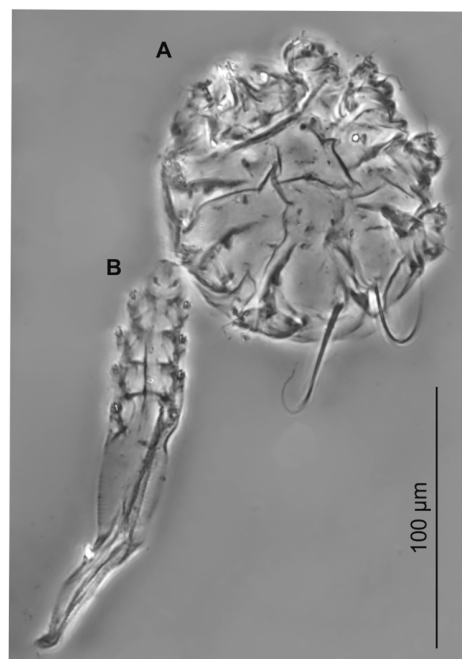


Figure 6. The co-occurrence of *Psorergates muricola* (A) and *Demodex corniculatus* (B) in the same skin fragment.

**Table 6.** A checklist of Demodecidae and Psorergatidae reported in rodents.

Host Species	Mites	Microhabitat	Localities
<b>Family: Bathyergidae</b>			
<i>Cryptomys hottentotus</i> (Lesson, 1826)	<i>Psorobia zumpti</i> (Fain, 1965)	Most of the hairy skin	South Africa [33]
<b>Family: Castoridae</b>			
<i>Castor canadensis</i> Kuhl, 1820	<i>Psorobia castoris</i> (Kok, Lukoschus et Clulow, 1970)	Ears	Canada [34]
<i>Castor fiber</i> Linnaeus, 1758	<i>Demodex castoris</i> Izdebska, Fryderyk et Rolbiecki, 2016	Skin of the nose	Poland [35]
<b>Family: Caviidae</b>			
<i>Cavia porcellus</i> (Linnaeus, 1758)	<i>Demodex caviae</i> Bacigalupo et Roveda, 1954	No data	Laboratory animals, ex situ e.g., [36–38]
<b>Family: Cricetidae</b>			
<i>Arvicola amphibius</i> (Linnaeus, 1758)	<i>Demodex gliricolens</i> Hirst, 1921	No data	Great Britain [39]
<i>Cricetulus barabensis</i> (Pallas, 1773)	<i>Demodex sinocricetuli</i> Desch et Hurley, 1997	Hair follicles	Laboratory animals ex situ [40]
<i>Cricetulus migratorius</i> (Pallas, 1773)	<i>Demodex cricetuli</i> Hurley et Desch, 1994	Hair follicles of all body regions	Laboratory animals ex situ [41]
<i>Mesocricetus auratus</i> (Waterhouse, 1839)	<i>Demodex aurati</i> Nutting, 1961	Pilosebaceous unit	Laboratory animals, ex situ e.g., [42–48]
	<i>Demodex criceti</i> Nutting et Rauch, 1958	Epidermis	Laboratory animals, ex situ e.g., [44,45,47–50]
<i>Microtus agrestis</i> (Linnaeus, 1761)	<i>Demodex arvicolae</i> Zschokke, 1888	Hair follicles of skin from various body regions	Europe [51], Astrahan/Europe on the border with Asia [52]
	<i>Psorergates agrestis</i> Lukoschus, Fain et Beaujean, 1967	Ears	Netherlands [32]
	<i>Psorergates microti</i> Fain, Lukoschus et Hallmann 1966	Skin around the penis, hind legs	Netherlands [31]
	<i>Psorergates musculus</i> (Michael, 1889)	Ears	Great Britain [53], Russia [54]
	<i>Psorergates simplex</i> (Tyrrell, 1883)	No data	No data [19]
<i>Microtus (Arvicola) arvalis</i> (Pallas, 1778)	<i>Demodex arvicolae</i> Zschokke, 1888	No data	Astrahan/Europe on the border with Asia [52]
	<i>Demodex microti</i> Izdebska et Rolbiecki, 2013	Genital region	Poland [55]
	<i>Psorergates apodemi</i> Fain, Lukoschus et Hallmann 1966	Front and hind legs	Poland [56]
	<i>Psorergates arvalis</i> Lukoschus, Fain et Beaujean, 1967	Hind legs	Spain [32], Netherlands [19]
	<i>Psorergates dissimilis</i> Fain, Lukoschus et Hallmann 1966	Ears, abdomen	Russia [57], Ukraine [58], Poland [56]
	<i>Psorergates musculus</i>	No data	Russia [54]
	<i>Psorergates simplex</i>	Head, back, chest, abdomen, legs	France [59]

Table 6. Cont.

Host Species	Mites	Microhabitat	Localities
<i>Microtus (Arvicola) duodecimcostatus</i> (Selys-Longchamps, 1839)	<i>Psorergates auricola</i> Lukoschus, Fain et Beaujean, 1967	Ears	Spain [32]
	<i>Psorergates pitymydis</i> Lukoschus, Fain et Beaujean, 1967	Skin around the penis, hind legs	Spain [32]
<i>Microtus oeconomus</i> (Pallas, 1776)	<i>Psorergates neerlandicus</i> Lukoschus, De Cock et Driessen, 1971	Abdomen	Netherlands [60]
	<i>Psorergates oeconomii</i> Lukoschus, Fain et Beaujean, 1967	Ears	Netherlands [32]
<i>Microtus pennsylvanicus</i> (Ord, 1815)	<i>Psorergates canadensis</i> Kok, Lukoschus et Clulow, 1971	Ears	Canada [61]
<i>Microtus pinetorum</i> (Le Conte, 1830)	<i>Psorergates pinetorum</i> Giesen, Lukoschus, Whitaker et Gettinger, 1983	Abdomen	USA [62]
<i>Microtus (Pitymys) subterraneus</i> (de Selys-Longchamps, 1836)	<i>Psorergates polonicus</i> Haitlinger, 1986	Ears	Poland [63]
<i>Microtus townsendi</i> (Bachman, 1839)	<i>Psorergates townsendi</i> Giesen, Lukoschus, Whitaker et Gettinger, 1983	Ears	USA [62]
<i>Myodes (Clethrionomys) gapperi</i> (Vigors, 1830)	<i>Demodex gapperi</i> Nutting, Emejuaiwe et Tisolel, 1971	Ducts of Meibomian glands	USA [64]
<i>Myodes (Clethrionomys) glareolus</i> (Schreber, 1780)	<i>Demodex buccalis</i> Bukva, Vitovec et Vlček 1985	Tissues of the tongue and oral cavity	Czech Republic [65], Poland [66]
	<i>Demodex glareoli</i> Hirst, 1919	Various body areas, mainly skin of head	Great Britain [51], Poland [66]
	<i>Psorergates dissimilis</i>	Ears, anal region	Netherlands [31], Russia [67]
	<i>Psorergates microti</i>	Abdomen, hind legs, genital–anal region, vibrissae	Netherlands [31], Poland [20]
	<i>Psorergates musculus</i>	Ears	Netherlands [31] Poland [20]
<i>Ondatra zibethicus</i> (Linnaeus, 1766)	<i>Psorergates zibethicalis</i> Lukoschus, Fain et Beaujean, 1967	Ears	Germany [32]
<i>Onychomys leucogaster</i> (Wied-Neuwied, 1841)	<i>Demodex leucogasteri</i> Hughes et Nutting, 1981	Hair follicles, especially in the skin of the muzzle and eyelids	USA [68]
<i>Peromyscus leucopus</i> (Rafinesque, 1818)	<i>Demodex peromysci</i> Lombert, Lukoschus et Whitaker, 1983	Meibomian glands	USA [69]
	<i>Psorergates peromysci</i> Giesen, Lukoschus, Whitaker et Gettinger, 1983	Hind legs	Canada, USA [62]
<i>Peromyscus maniculatus</i> (Wagner, 1845)	<i>Psorergates peromysci</i>	Hind legs	Canada [62]
	<i>Psorergates watsoni</i> Kok, Lukoschus et Clulow, 1971	Ears	Canada [61]

Table 6. Cont.

Host Species	Mites	Microhabitat	Localities
<i>Phodopus sungorus</i> (Pallas, 1773)	<i>Demodex phodopi</i> Desch, Davis et Klompen, 2006	Hair follicles	Laboratory animals ex situ [70]
	<i>Demodex sungori</i> Desch, Davis et Klompen, 2006	Hair follicles	Laboratory animals ex situ [70]
<b>Family: Gliridae</b>			
<i>Eliomys quercinus</i> (Linnaeus, 1766)	<i>Psorergates eliomydis</i> Lukochus, Fain et Beaujean, 1967	Ears	Spain [60]
	<i>Psorergates quercinus</i> Lukoschus, de Cock et Driessen, 1971	Ears	Spain [32]
<i>Muscardinus avellanarius</i> (Linnaeus, 1758)	<i>Demodex muscardini</i> Hirst, 1917	No data	Great Britain [51,71], Armenia [52]
	<i>Psorergates muscardinus</i> Lukoschus, de Cock et Driessen, 1971	Ears	Germany [60]
<b>Family: Hystricidae</b>			
<i>Hystrix africae australis</i> Peters, 1852	<i>Psorobia hystrici</i> Till, 1957	Head	South Africa [72]
<b>Family: Muridae</b>			
<i>Apodemus agrarius</i> (Pallas, 1771)	<i>Demodex agrarii</i> Bukva, 1994	Glands in external auditory meatus	Slovak Republic [73], Poland [10,74]
	<i>Demodex apodemi</i> Hirst, 1918	Hairy skin of the body, especially skin of head	Russia [52], Poland [74]
	<i>Demodex gracilentus</i> Izdebska et Rolbiecki, 2013	Vibrissae area	Poland [10]
	<i>Demodex huttereri</i> Mertens, Lukoschus et Nutting, 1983	Eyelid area, Meibomian glands	Germany [75], Poland [76]
<i>Apodemus flavicollis</i> (= <i>Apodemus tauricus</i> ) (Melchior, 1834)	<i>Demodex corniculatus</i> Izdebska, 2012	Hairy skin of the head (eyelids, cheeks, ears, and chin), skin of the genital–anal region	Poland [22]
	<i>Demodex mediocris</i> Izdebska, Cierocka et Rolbiecki	Chin	Poland (present study)
	<i>Demodex mollis</i> Izdebska, Rolbiecki, Fryderyk et Mierzyński, 2017	Eyelid area	Poland [11]
	<i>Demodex rosus</i> Bukva, Vítovec et Vlček, 1985	Oral cavity, esophagus	Czech Republic [65], Poland [21]
	<i>Demodex tenuis</i> Izdebska, Cierocka et Rolbiecki	Lips	Poland (present study)
	<i>Psorergates apodemi</i>	Front and hind legs, regions of eyes, vibrissae, nose	Ukraine, Switzerland, Austria [57], Bulgaria [77], Poland [20,56]
	<i>Psorergates muricola</i> Fain, 1961	Genital–anal region	Poland (present study)

Table 6. Cont.

Host Species	Mites	Microhabitat	Localities
<i>Apodemus sylvaticus</i> Linnaeus, 1758	<i>Demodex apodemi</i>	Hairy skin of the body	Great Britain [52,78], Russia [52], Poland [79]
	<i>Demodex auricularis</i> Izdebska, Rolbiecki et Fryderyk, 2014	Ear canal	Poland [79]
	<i>Demodex lacrimalis</i> Lukoschus et Jongman, 1974	Meibomian glands	Italy, Netherlands [80], Poland [81]
	<i>Demodex longior</i> Hirst, 1918	Sensory hair follicles within the nose region	Great Britain [51,78], Russia [52], Poland [10]
	<i>Ophthalmodemodex apodemi</i> Bukva, Nutting et Desch, 1992	Ocular area	Czech Republic [82]
	<i>Psorergates apodemi</i>	Genital–anal region, front and back legs, regions of eyes, vibrissae, abdomen, sides of the body	Netherlands [31], Ukraine [57,58], Germany, Switzerland, Austria [57], Bulgaria [77], Poland [20]
	<i>Psorergates callipidis</i> Lukoschus, Fain et Beaujean, 1967	Skin on the chest, front and hind legs	Spain [32]
	<i>Psorergates muricola</i>	Ears, regions of eyes, vibrissae, nose	Netherlands [31], Poland [20]
	<i>Psorergates musculus</i>	Head, chest, abdomen, legs	France [83]
<i>Apodemus uralensis</i> (= <i>Apodemus microps</i> ) (Pallas, 1811)	<i>Psorergates apodemi</i>	Front and hind legs	Poland [56], Russia [67]
<i>Bandicota indica</i> (Beschstein, 1800)	<i>Demodex bandicotae</i> Izdebska, Rolbiecki, Morand et Ribas, 2017	Hairy skin of the body	Laos [84]
<i>Deomys ferrugineus</i> Thomas, 1888	<i>Psorergates deomydis</i> Lukoschus, Fain et Beaujean, 1967	Tail	Democratic Republic of the Congo [32]
<i>Hybomys univittatus</i> (Peters, 1876)	<i>Psorergates muricola</i>	No data	Democratic Republic of the Congo [31]
<i>Leopoldamys edwardsi</i> (Thomas, 1882)	<i>Demodex sabani</i> Desch, Lukoschus et Nadchatram, 1984	Meibomian glands	Malaysia [85]
<i>Leopoldamys sabanus</i> (Thomas, 1887)	<i>Demodex sabani</i>	Meibomian glands	Malaysia [85]
<i>Lophuromys aquilus</i> (True, 1892)	<i>Psorergates muricola</i>	Area behind the ear	Democratic Republic of the Congo [30]
<i>Lophuromys sikapusi</i> (Temminck, 1853)	<i>Psorergates muricola</i>	No data	Liberia [86]
<i>Mastomys coucha</i> (Smith, 1834)	<i>Psorergates simplex</i>	Abdomen	South Africa–laboratory animals [87]

Table 6. Cont.

Host Species	Mites	Microhabitat	Localities
<i>Mastomys natalensis</i> (Smith, 1834)	<i>Psorergates oettlei</i> (Till, 1960)	The skin in different parts of the body	South Africa [88]
<i>Micromys minutus</i> (Pallas, 1771)	<i>Psorergates micromydis</i> Lukoschus, Fain et Beaujean, 1967	Ears	Netherlands [32]
<i>Mus spretus</i> Lataste, 1883	<i>Psorergates hispanicus</i> Lukoschus, Fain et Beaujean, 1967	Front and hind legs	Spain [32]
<i>Mus musculus</i> Linnaeus, 1758	<i>Demodex conicus</i> Izdebska et Rolbiecki, 2015	Ear canal	Poland [14]
	<i>Demodex flagellurus</i> Bukva, 1985	Genital region	Czech Republic [89], Poland [15,90,91]
	<i>Demodex fusiformis</i> Izdebska et Rolbiecki, 2015	Abdomen, back, and limbs	Poland [15]
	<i>Demodex marculus</i> Izdebska et Rolbiecki, 2015	Abdomen, back, limbs, and anal region	Poland [15]
	<i>Demodex musculi</i> Oudemans, 1897 (redescription, Izdebska et Rolbiecki, 2015)	Skin of various, haired regions of the body	Europe [51,92], Russia [52], Poland [15,90], Spain [93], laboratory animals, ex situ e.g., [94–96]
	<i>Demodex vibrissae</i> Izdebska, Rolbiecki et Fryderyk, 2016	Vibrissae area	Poland [97]
	<i>Glossicodex musculi</i> Izdebska et Rolbiecki, 2016	Tissue of tongue	Poland [16]
	<i>Psorergates hispanicus</i>	No data	Philippines [19]
	<i>Psorergates muricola</i>	Ears, the skin all over the body	Netherlands [31], Belgium-laboratory animals [31], Russia [57], Bulgaria [98], Poland [99]
<i>Psorergates simplex</i>		Ears, legs, chest, abdomen, back, head, regions of eyes, chin, neck	Canada [100], Italy [101], France [59], Russia [52,57,102], Ukraine [52], Germany [52], USA-laboratory animals [103], USA [104], Great Britain-laboratory animals [105], Netherlands [31], Iran [106], Poland [20]
<i>Nivoiventer cremoriventer</i> (Miller, 1900)	<i>Demodex sabani</i>	Meibomian glands	Malaysia [85]
<i>Nivoiventer rapit</i> (Bonhote, 1903)	<i>Demodex sabani</i>	Meibomian glands	Malaysia [85]
<i>Otomys irroratus</i> (Brants, 1827)	<i>Psorergates muricola</i>	Ears	Democratic Republic of the Congo [30]



Table 6. Cont.

Host Species	Mites	Microhabitat	Localities
<i>Rattus annandalei</i> (Bonhote, 1903)	<i>Demodex sabani</i>	Meibomian glands	Malaysia [85]
<i>Rattus norvegicus</i> (Berkenhout, 1769)	<i>Demodex nanus</i> Hirst, 1918 (redescription Desch, 1987)	Sebaceous glands, skin of genital–anal region	Great Britain [78], Russia [52], laboratory animals, ex situ [107], Poland [13,23,108]
	<i>Demodex norvegicus</i> Bukva, 1995	Genital–anal region	Czech Republic [12], Poland [13,23,108]
	<i>Demodex ponderosus</i> Izdebska et Rolbiecki, 2014	Thinly haired regions (tail and paws)	Poland [13]
	<i>Demodex ratti</i> Hirst, 1917 (redescription Bukva, 1995)	Hairy skin of the body, generally head	Europe [51,71], Russia [52], Czech Republic [12], Poland [13,23,108–110]
	<i>Demodex ratticola</i> Bukva, 1995	Skin of head (nose, lips, and chin)	Czech Republic [12], Poland [13,109,110]
	<i>Psorergates rattus</i> Fain et Goff, 1986	The base of the tail, back, ears	USA [111], Poland [112]
<i>Rattus rattus</i> (Linnaeus, 1758)	<i>Demodex nanus</i>	Sebaceous glands	Great Britain [78], Russia [52], New Zealand [107]
<i>Rattus tiomanicus</i> (Miller, 1900)	<i>Demodex sabani</i>	Meibomian glands	Malaysia [85]
<i>Sundamys muelleri</i> (Jentink, 1879)	<i>Demodex sabani</i>	Meibomian glands	Malaysia [85]
<b>Family: Sciuridae</b>			
<i>Dremomys rufigenis</i> (Blanford, 1878)	<i>Psorergates dremomydis</i> Giesen, Lukoschus et Nadchatram, 1982	Front legs	Malaysia [113]
<i>Glaucomys volans</i> (Linnaeus, 1758)	<i>Psorergates glaucomys</i> Ah, Peckham et Atyeo, 1973	Area behind the ear	USA [114]
<i>Paraxerus cepapi</i> (A. Smith, 1836)	<i>Psorergates paraxeri</i> Giesen et Lukoschus, 1982	Front and hind legs	South Africa, Botswana [115]
<i>Sciurus vulgaris</i> Linnaeus, 1758	<i>Demodex sciurinus</i> Hirst, 1923	Penis	Great Britain [116], Poland [1]

#### 4. Discussion

The biodiversity of mammalian skin mites remains poorly understood, with most species described from rodents [1,18,19].

In the case of Demodecidae, the co-occurrence of several host-specific (monoxenic) species in different host microhabitats is commonly observed, with the largest number of synhospital species being identified in the Muridae: seven in *M. musculus*, five each in *A. sylvaticus* and *R. norvegicus*, and four in *A. agrarii* [1]. Until now, three species have been identified in *A. flavicollis*, including *D. rosus* from the tongue, *D. corniculatus* from the hairy skin of the body, and *D. mollis* from the eyelid region [11,21,22,65]. A large number of species from various microhabitats in other murids indicated the likely occurrence of further, unknown mite species in *A. flavicollis*. However, their discovery was complicated by the low levels of infection intensity, asymptomatic infection, the microscopic size and hidden lifestyle of these mites, as well as their spatially limited microhabitat within the host and low prevalences of infection. The two new species described in the present study, *D. tenuis* sp. nov. and *D. mediocris* sp. nov., have very narrow microhabitats, similarly to the previously identified *D. rosus* or *D. mollis*. Hence, they probably show much lower infection

parameters than *D. corniculatus* [11,22]. In turn, their narrow spectrum of microhabitats and low intensity of infection limits the possibility of co-occurrence; as such, the co-occurrence of various species with *D. corniculatus* was most often observed, the most numerous and most widely distributed in the skin of this host.

In turn, the parasites of the family Psorergatidae often are oligoxenic: among the 72 known species, the largest number (34 species) has been shown in rodents, with most being found in Cricetidae and Muridae, and 5 species, the largest number, observed in the common vole *Microtus arvalis* [117].

In the present study, *P. muricola* obtained from the yellow-necked field mouse was described based on individuals obtained from the abscess behind the ear in the dark-colored brush-furred rat *Lophuromys aquilus* and in the ear pinna of a Southern African vlei rat *Otomys irroratus* from the Democratic Republic of the Congo [30]. It was subsequently found in other representatives of Muridae, both from Africa and Europe: Peters's hybomys *Hybomys univittatus*, house mouse, laboratory mouse, common field mouse, and the rusty-bellied brush-furred rat *Lophuromys sikapusi*. The parasite was detected mainly in the ears or their vicinity, but also in the inter alia regions of the eyes, vibrissae, nose, and in the skin all over the body [20,31].

The occurrence of *P. muricola* was often correlated with the appearance of skin lesions in the form of skin nodules [31], which is quite a characteristic symptom of occurrence in the case of the family Psorergatidae [33,57,59,83,87,88,101–105,115]. Most species of Psorergatidae have been found and described in hosts in which skin lesions have been observed. Conversely, cases of asymptomatic Psorergatidae infections have been reported only rarely [17,20,112]. This may be related to their small size and difficulties in preparation, or the lack of data on their preferences for location in the host body, frequency of occurrence, and level of infection. Identification of these mites may also be problematic. Certain features merit particular consideration in the diagnosis, differentiating *P. muricola* from other representatives of the genus. For example, for females of *P. muricola* and *P. oettlei*, it is only a difference in dimensions (e.g., the length and width of the body). In turn, for males of these species, the criterion is the lack of terminal setae in *P. oettlei*. Intact terminal setae, located at the end of the adult idiosoma, are characterized by considerable length [19] and may be subject to damage. During the current studies on Psorergatidae, damaged setae, or their complete absence, were repeatedly observed, which is also confirmed by earlier observations [17,19,112].

The current literature data confirm that Psorergatidae are characterized by different ranges of host specificity: they can be monoxenic or oligoxenic (Table 6) [19,26]. However, most species are known from a few records, without parasitological analyses based on larger numbers of hosts. Therefore, the degree of specificity and the host range require verification. The last time the Psorergatidae were subjected to meticulous analyses was over 30 years ago [19], and as such, the taxonomy and biology of the group are very poorly known. For example, it is also questionable whether *Psorergates simplex*, *P. apodemi* and *P. musculus* possess a wide range of host specificity, although the species have been recorded in several members of the Cricetidae and Muridae families. Importantly, the wide host range of *Psorergates muricola*, including Eurasian, cosmopolitan and African species, is also relatively uncertain. It is possible that this taxon may represent two species with different geographical ranges, but to confirm this requires further criteria for differentiation. It is possible that different species exhibit different parasitism strategies, with different levels of association with the host, showing conservatism or plasticity in establishing host–parasite relationships with rodent species.

Regardless of the taxonomic doubts related to the species identification of Psorergatidae, our data confirm the co-occurrence of these mites with representatives of Demodecidae. Although the parasites sometimes occupy neighboring microhabitats, they are always characterized by a low infection intensity/density, and hence do not have a significant impact on the host, i.e., no disease symptoms were observed.

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