FOLIA PARASITOLOGICA (PRAHA) 29: 343—349, 1982.

SORICIDEX DIMORPHUS G. N., SP. N. (ACARI: DEMODICIDAE) FROM THE COMMON SHREW, SOREX ARANEUS

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Abstract. A new genus, *Soricidex*, is erected and its type species, *S. dimorphus*, described from the hair follicles of the common shrew, *Sorex araneus*. Supposed adaptive nature of podosomal lamellar structures in female and phylogenetic affinities of opisthosomal organ are discussed.

Three currently accepted species of the family Demodicidae have been described from insectivore hosts to date*): *Demodex erinacei* Hirst, 1917 from the hedgehog, *Erinaceus europaeus*, *D. soricinus* Hirst, 1918 from the common shrew, *Sorex araneus castaneus*, and *D. talpae* Hirst, 1921 from the common mole, *Talpa europaea*. A new genus, *Soricidex*, is erected for unique demodicids from soricid insectivores discussed below, followed by a description of the type species, *S. dimorphus*, with some information on the incidence, sites and intensity of infestation, populations, and pathogenicity.

MATERIAL AND METHODS

One hundred and twenty (40 males, 80 females) common shrews captured in the field in May 1979 — February 1981 were examined for demodicids. Skin and mucosa of 58 animals were scraped and squeeze-plucked with watchmaker forceps in 11 body areas (muzzle, vibrissae area, eyelids, mouth, ear, vertex, dorsum of trunk, venter of trunk, genitals, anus, tail); 62 animals were examined on vertex, dorsum and venter of trunk only. The material obtained was mounted in Hoyer's medium. Skin sectors 5 × 5 mm large from various body areas of 5 infested shrews were excised, digested in 10% KOH and examined to obtain population counts. Sectors of dorsal trunk skin from heavily infested animals were hair-cropped, fixed in formalin, paraffin-embedded, cut at 8—10 μm and stained with hematoxylin-eosin. Light-and phase contrast optics and oil immersion were used studying Hoyer's mounts and skin sections. For the purpose of scanning electron microscopy the sectors of skin fixed in formalin were dehydrated in a graded series of ethanols, transferred to amyl acetate, critical point dried, coated with gold and examined with a Tesla BS—300 microscope.

RESULTS

Soricidex g. n.

Diagnosis. With characters of the family Demodicidae Nicolet, 1855 as given by Baker and Wharton (1952) and in part, emended by Desch et al. (1972). Medium-sized elongate body with annulated opisthosoma comprising about one half or more of total body length. Legs prominent and strong, their free parts three-segmented, with two claws which are bifid distally and spurred on shaft. Gnathosoma narrow, bearing palps with two free segments, terminal group of strong spines and supracoxal spines.

*) The author supports the doubts of validity of *Epimyodex talpae* Fain et Orts, 1969 within the family Demodicidae expressed by Lukoschus and Nutting (1979).

Soricidex g.n. is related to *Demodex* Owen, 1843 (for generic diagnosis see Desch et al. 1972, for detailed account of morphology see Desch and Nutting 1977) and *Pterodex* Lukoschus et al. 1980. *Soricidex* differs from these two genera in the following diagnostic characters: 1. striking sexual dimorphism in both body proportions and several special structures; 2. gnathosoma in male partly hidden under dorsal cover lamella (anterior part of podosomal "carapace" as in *Ophthalmodex* Lukoschus et Nutting, 1979), but incised anteriorly); 3. gnathosoma in female with conspicuous mushroom-shaped stylophore; 4. podosoma in female dorsally with shelf-like lamellae.

At present, the generic diagnosis of *Soricidex* is adequate for three hitherto undescribed demodicids found by the author in soricid insectivores; one of them has been collected in sufficient numbers for a full description given below.

Type species: ***Soricidex dimorphus*** sp. n.

Male (holotype) (Plate I, Fig. 1). Body length 207 μm with opisthosoma measuring two thirds of this value. Other measurements are given in Table 1.

A large portion of gnathosomal structures is hidden in dorsal and lateral views under cover lamella, which originates on dorsal and lateral sides of idiosoma and extends anteriorly. The following structures are freely visible from dorsal aspect, frontally to anterior V-shaped incision of the lamella: stylophore, diverging apices of large coxal endites and terminal parts of supracoxal spines (Figs. 1 A, D). In comparison to cover lamella, the gnathosoma proper is narrow, at apices of palps 19 μm wide, longer than wide, with V-shaped capsule. Palpal tarsus with 3 spines, two of which are strong, claw-like and 2-tined; one spine is slender and setiform (= solenidion?). Supracoxal spines strong, approximately 4 μm long, edged dorsally, directed towards midline. Pharyngeal bulb elongate, open posteriorly. Subgnathosomal setae absent.

Podosoma comprises approximately one fourth of total body length. Four pairs of strong legs arranged radially, approximately two thirds of each visible from dorsal aspect. Indistinct epimeral plates do not meet at midline. Teardrop-shaped segments 2 of legs I—IV with two spurs, a larger ventroposteral one (on leg I 7 μm long) and a smaller dorsoposteral one (on leg I 3 μm long), which differ little in size on legs I—IV. Claws bifid distally and with a large curved spur projecting from shaft. Legs I and II with a slightly curved solenidion on terminal segment near the dorsal-most claw.

Opisthosoma attached to podosoma without postpedal constriction, more or less tubular, terminating in a blunt point. Opisthosomal annuli distinct and wide (at mid-opisthosoma 3—4 μm). Opisthosomal organ mid-ventrally posterior to onehalf of opisthosoma (56 μm from the terminus), multiple, originating on body wall as a circular group (7 μm in diameter) of approximately 30 pores, each of which is extended to thin invagination 10 μm long. The invaginations are upright, on periphery of the group diverging slightly from dorsoventral axis (Fig. 1 H).

Genital orifice mid-dorsally over epimera I, a narrow slit in a small oval protuberance (Fig. 1 I). Penis sheathed, 18 μm long, with bulbous base. Dorsal podosomal tubercles oval-shaped, arranged to form subrectangular field 16 μm long and 14 μm wide.

Female (allotype) (Plate I, Fig. 2). Body length 210 μm with opisthosoma measuring one half of this value.

Gnathosoma not covered by unusually shaped cover structures: the compressed cylindrical sheath of loose creased material allows distal half of gnathosoma to be freely visible (Fig. 1 F). Gnathosoma with a mushroom-shaped stylophore conspicuous from dorsal aspect, its "cap" being 5 μm long and 13 μm wide, with protruding coxal

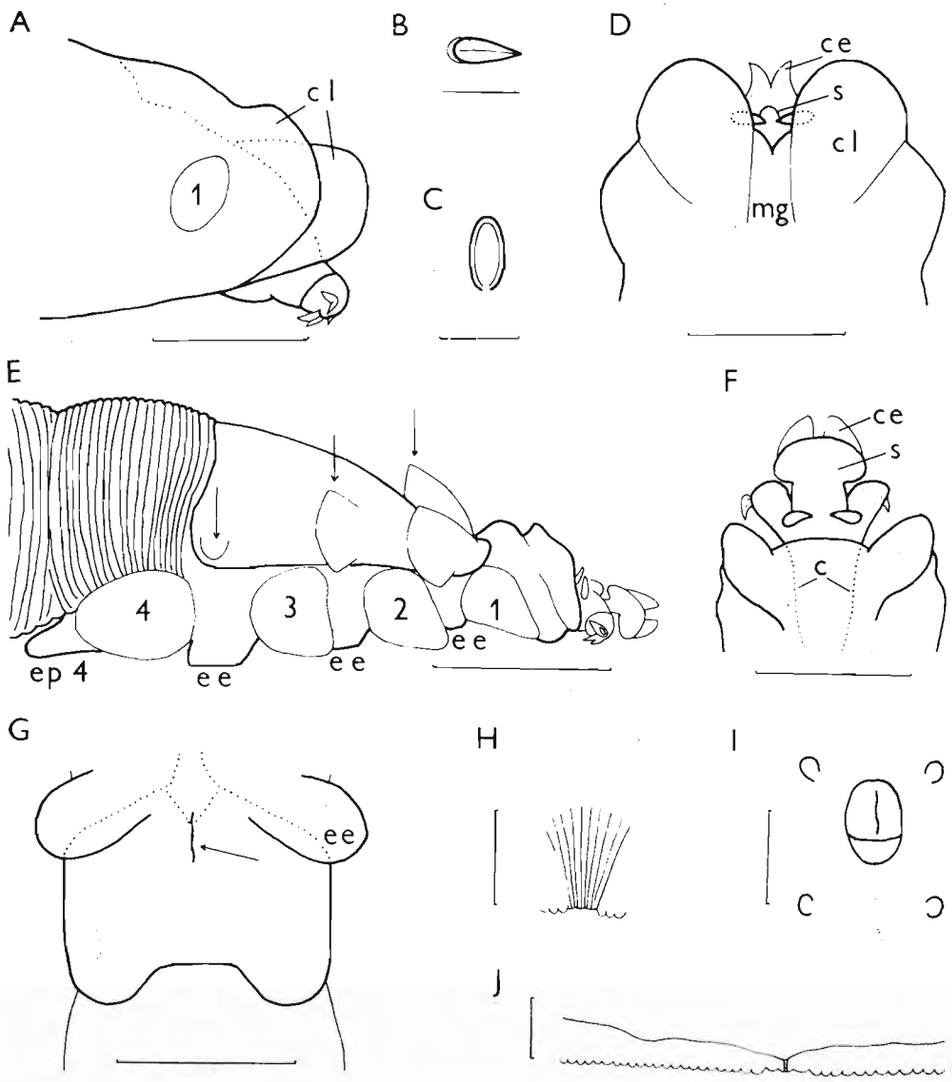

Fig. 1. *Soricidex dimorphus* g.n. sp. n., A — lateral view of anterior part of male; B — left supracoxal spine; C — pharyngeal bulb; D — dorsal view of male gnathosoma; E — dorsolateral view of anterior part of female, dorsal sclerotized structures (arrows); F — dorsal view of female gnathosoma; G — female external genitalia (arrow), epimeral extensions III, epimeral plate IV; H — lateral view of male opisthosomal organ (approx. one third of total number of invaginations drawn); I — male genitalia and dorsal tubercles; J — lateral view of female opisthosomal organ.
c — capsule of gnathosoma, ce — coxal endite, cl — cover lamella of gnathosoma, ee — epimeral extension, ep4 — epimeral plate IV, mg — medial groove, s — stylophore, 1, 2, 3, 4 — legs I, II, III, IV (Scales: A, D, F = 20 μm; B, C = 5 μm; E, G = 30 μm; H, I, J = 10 μm)

endites. Palps with stronger spines than in male. Other gnathosomal structures identical with male.

Podosoma measures slightly over one third of total body length. Four pairs of strong legs evenly spaced along podosoma, approximately four fifths of each visible from dorsal aspect. Distinct epimeral plates I—III meet at midline. Epimeral plates IV confluent, lacking middle and posterior sutures and extended posteriorly to form a free lamella covering base of opisthosoma. Similiar smaller extensions present over posterior epimeral sutures I—III (Figs. 1 E, G), protruding also laterally beyond outline of podosoma (mean maximum width of podosoma measured in 20 specimens at epimeral extensions is by 13.7 μm greater than that measured at lateral body wall). Segments 2 of legs I—IV with two spurs, which are shorter than in male (ventroposteral and dorsoposteral spurs on leg I are 5 μm and 2—3 μm long respectively) and decrease in length from legs I to IV. Claws stronger than in male. Legs II—IV near to claws with biscuit-shaped projection 6.5 μm long and 2.5 μm wide. Solenidia as in male.

Dorsum of podosoma laterally over gaps between leg pairs I—IV with three pairs of conspicuous sclerotized structures the first largest pair of which are triangular to oval lamellae 16 μm long and 9 μm wide, attached in anterior part and shelf-like extended from body in dorso-latero-posteral directions. The second smaller pair of lamellae has a similar appearance: the third pair are small sclerits embedded in integument (Fig. 1 E, Plate I, Fig. 8). Dorsal podosomal tubercles absent.

Distinct postpedal constriction between podosoma and opisthosoma; maximum width of opisthosoma is at the middle; terminus blunt. Annuli faint and narrow (at mid-opisthosoma 1—2 μm wide). Opisthosomal organ of the same relative position as in male (52 μm from the terminus), a single pore with a short tubular invagination, from the apex of which several very indistinct filamentous branches run anteriorly and posteriorly (Fig. 1 J).

Vulva 11 μm long, irregular longitudinal slit opening behind anterior suture of fused epimeral plates IV (Fig. 1 G). **Ovum** (Plate I, Fig. 3). Oval-shaped to slightly reniform, on the average 37.6 μm long and 16,3 μm wide, non-operculate, usually

Table 1. Means and standard deviations of 20 specimens of each stage and sex of *Soricidex dimorphus* (All measurements in μm)

			Male	Female
Gnathosoma	length	gnathosoma proper	25.8 ± 2.5	30.6 ± 1.3
		to apex of cover lamella	29.2 ± 1.9	—
	width	at apices of palps	19.0 ± 0.8	19.6 ± 0.8
		cover structures	43.1 ± 3.0	31.7 ± 1.6
Podosoma	length		43.5 ± 2.6	68.2 ± 2.3
	width	at lateral body wall	48.0 ± 4.8	43.2 ± 3.4
Opisthosoma	length		132.1 ± 11.3	99.0 ± 9.1
	width		50.2 ± 4.0	50.3 ± 3.9
Total length			204.8 ± 13.2	197.8 ± 10.5
Penis			18.1 ± 1.2	—
Vulva			—	11.0 ± 0.8
	Ovum	Larva	Protonymph	Nymph
Length	37.6 ± 9.1	45.9 ± 4.4	74.8 ± 7.4	155.0 ± 29.3
Width	16.3 ± 2.9	19.8 ± 1.9	34.6 ± 4.1	67.9 ± 12.8

with a filamentous appendage on each end. **Larva** (Plate I, Fig. 4). Body oval-shaped, with rounded posterior part and prominent gnathosoma; on the average 45.9 μm long and 19.8 μm wide. Gnathosoma simple, without unusual cover structures. Palps with terminal group of spines (one 2-tined spine + one simple spine?), dorsal sclerotized excrescence of obliquely transverse orientation, and small supracoxal spines. Horseshoe-shaped pharyngeal bulb open posteriorly. Subgnathosomal setae absent. Three pairs of short stubby legs, each ending with a single three-pointed claw. Solenidia and epimeral scutes absent.

Protonymph (Plate I, Fig. 5). In general body outline similar to larva, except for posterior part of body elongated to a blunt terminus; on the average 74.8 μm long and 34.6 μm wide. Gnathosoma and related structures similar to larva; palps with two 2-tined spines and one simple spine. Legs as in larva, except for each with two four-pointed claws. Solenidia and epimeral scutes absent.

Nymph (Plate I, Fig. 6). The dorsally high arched body has inflated appearance; attenuated posterior part terminates in acute point; on the average 155.0 μm long and 67.9 μm wide. Body with faint transverse striation. Gnathosoma and related structures similar to protonymph; palps with two 2-tined spines and one simple spine. Four pairs of legs, each with two four-pointed claws. Solenidia and epimeral scutes absent.

Host and locality: *Sorex araneus araneus* Linnaeus, 1766, the common shrew. Type material is from host specimens collected at České Budějovice, Czechoslovakia, 15. 8. 1979 (holotype No. PaÚ ČSAV 1926, allotype, typical series — part), 10. 10. 1979 and 17. 9. 1980 (typical series — part).

Type material is deposited in the collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague; several specimens are deposited in the collection at the University of Massachusetts, Amherst, USA.

Incidence, sites and intensity of infestation. Using routine scrape-squeeze-pluck techniques 14 animals (11.7 %) of the total 120 examined were found infested with *Soricidex dimorphus*. Of these 7 were males and 7 females, indicating a significantly higher incidence of mites ($p = 0.05$) in males (17.5 %) than in females (8.8 %).

The mites were recovered from vibrissae area, vertex, dorsum of trunk, venter of trunk; 13—7—3 animals were found infested on head (vibrissae area and/or vertex) — dorsum of trunk — venter of trunk, respectively.

Counts in 5×5 mm skin sectors from vertex — dorsum of trunk — venter of trunk of two heavily infested animals (male and female) revealed the following numbers of mites (all stages): 922—649—345 and 236—364—288, respectively. Total *S. dimorphus* load on a heavily infested host animal can be estimated from these data: if on the average 300 mites per 25 mm² (chosen arbitrarily) infest whole head-and-trunk area estimated to be over 4,500 mm², the total parasite load on a host animal amounts to over 5×10^4 mites.

Populations. Three population counts in skin sectors from head, dorsum of trunk, and venter of trunk of a single male shrew (KOH digestion) yielded a total of 1916 mites in the following proportions: males 348 (18.2%), females 452 (23.6%), ova 146 (7.6%), larvae and protonymphs 342 (17.8%), nymphs 628 (32.8%). Thus the following ratios from this total count were obtained: male to female, 1 : 1.3; immature to mature, 1.2 : 1; female to ova, 3.1 : 1.

Habitat and histopathology. In a heavily infested host numerous adult mites were discerned in skin from outside, with their anterior parts embedded in skin and posteriors extending from skin (Plate II, Figs. 1, 2). No gross signs of infestation were noted on skin from outside.

In histological sections adult mites were found in follicles of general body hairs

(no sections from vibrissae area studied), penetrating gradually inside, with their mouthparts oriented downwards and opposed to walls of follicles. Mites were found in follicles in low numbers: from 200 infested follicles single mites were found in 81.0%, two mites in 17.0%, three mites in 1.5%, four mites in 0.5%. Adult and nymphal stages, always found in follicles, were discerned frequently, whereas the efforts to locate pre-nymphal stages failed.

Soricidex dimorphus is a low-grade pathogen. The presence of mites is primarily associated with undercutting of follicular epithelium (Plate II, Figs. 2, 3). No inflammatory response was observed.

DISCUSSION

At least one of the unusual morphological features of *Soricidex*, viz. dorsal podosomal lamellae in female, can be interpreted as adaptation for life in follicular habitat. These interesting structures could facilitate anchoring of mites in the follicles and their penetrating deeper inwards. Analogous holdfast structures, e.g. epimeral scutes, have been described in immature stages of most *Demodex* species; in immatures they seem to compensate for weak holdfast properties of their usually weak legs (Nutting 1973). In contrast to this condition, special holdfast structures in adults appear to be an exceptional feature in morphology of demodicids. A tail-like appendage in *Demodex bicaudatus* to maintain adult mites in the Meibomian glands against the secretion flow has been described recently (Kniest and Lukoschus 1981).

With regard to recognized importance of demodicid opisthosomal organs for marking of phylogenetic relationships in joint mammal-mite evolution (Nutting and Desch 1979), a closer attention must be given to morphological affinities of the unusual male opistho-organ in *S. dimorphus*. Organs of identical type with that of *S. dimorphus*, viz. multiple upright thin invaginations, have also been found by the author in males of two other undescribed *Soricidex* spp. and in a male of an undescribed *Demodex* sp., all from soricid hosts. Compared to described opistho-organs (in *Demodex*) which have been classified by Nutting and Desch (1979), the male opistho-organs in these four demodicids from soricid hosts are of special position: while entirely dissimilar from organs in demodicids from other eutherian mammals, they greatly approximate male opistho-organs in demodicids from metatherian mammals. The latter have been characterized as organs quadruple or sextuple, upright i.e. perpendicularly from the exoskeleton oriented, and stamen-like (Nutting and Sweatman 1970, Nutting and Desch 1979, Nutting et al. 1980). The three following minor differences from this type can be noted in *Soricidex* and *Demodex* species from soricids: a) origin of invaginations not from a common base, each invagination having its own external pore; b) number of invaginations higher (the lowest number observed: 12 invaginations); c) invaginations appearently without expanded tips (observation of this minute detail not decisive).

This disclosed case of distinct affinity in demodicid opistho-organs at the infraclass level of mammalian phylogeny is probably exceptional (cf. Nutting and Desch 1979). Noteworthily, it is fully consistent with the mammaliologists' conception of close phylogenetic proximity of Metatheria and Insectivora: a fact which exemplifies utility of opistho-organs in assaying host phylogeny.

Acknowledgement. The author thanks the following colleagues from the Institute of Parasitology, Prague: Dr. M. Vlček who provided most of the host specimens for this study; Dr. J. Vítovec who revised some histological sections and manuscript on habitat and histopathology; Dr. P. Berkovský who helped with the scanning electron microscopy and the photography; Mrs. V. Richterová who rendered technical assistance.

SORICIDEX DIMORPHUS G. N., SP. N. (ACARI: DEMODICIDAE) ОТ ЗЕМЛЕРОЙКИ *SOREX ARANEUS*

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Резюме. Создан новый род *Soricidex* и описан его типовой вид *S. dimorphus* с волосяных фолликулов землеройки *Sorex araneus*. В работе обсуждается приспособляемость подосомальных пластинчатых структур у самки и филогенетические сходства органа задней части тела.

REFERENCES

BAKER E. W., WHARTON G. W., An introduction to acarology. McMillan Co., New York, 465 pp., 1952.

DESCH C. D., NUTTING W. B., Morphology and functional anatomy of *Demodex folliculorum* (Simon) of man. Acarologia 19: 422—462, 1977.

—, —, LUKOSCHUS F. S., Parasitic mites of Surinam VII: *Demodex longissimus* n. sp. from *Carollia perspicillata* and *D. molossi* n. sp. from *Molossus molossus* (Demodicidae: Trombidiformes); Meibomian complex inhabitants of Neotropical bats (Chiroptera). Acarologia 14: 36—53, 1972.

HIRST S., On three new parasitic Acari. Ann. Mag. nat. Hist. 8. s. (120), 20: 431—434, 1917.

—, On four new species of the genus *Demodex*, Owen. Ann. Mag. nat. Hist. 9. s. 2 (8): 145—146, 1918.

—, On some new or little-known Acari, mostly parasitic in habit. Proc. Zool. Soc. London Pt. 2: 357—378, 1921.

KNIEST F. M., LUKOSCHUS F. S., Parasites of Western Australia XIII. A new species of demodicid mite from the Meibomian glands of the bat *Macroglossus minimus*. Rec. West. Aust. Mus. 9: 111—118, 1981.

LUKOSCHUS F. S., NUTTING W. B., Parasitic mites of Surinam XIII. *Ophthalmodex artibei* gen. nov., spec. nov. (Prostigmata: Demodicidae) from *Artibeus lituratus* with notes on pathogenesis. Intl. J. Acar. 5: 299—304, 1979.

—, WOELTJES A. G. W., DESCH C. E., NUTTING W. B., Parasitic mites of Surinam XX: *Pterodex carolliae* gen. nov., spec. nov. (Demodicidae) from the fruit bat, *Carollia perspicillata*. Intl. J. Acar. 6: 9—14, 1980.

NUTTING W. B., Adaptations in demodicids (Trombidiformes: Demodicidae) for utilization of the mammalian skin complex. Proc. 3rd Internat. Congr. Acarology, Prague 1971: 531—535, 1973.

—, DESCH C. E., Relationships between mammalian and demodicid phylogeny. In: J. G. Rodriguez (Ed.), Recent advances in acarology, Vol. II, Academic Press, New York — San Francisco — London: 339—345, 1979.

—, LUKOSCHUS F. S., DESCH C. E., Parasitic mites of Surinam XXXVII. *Demodex marsupiali* sp. nov. from *Didelphis marsupialis*: Adaptation to glandular habitat. Zool. Mededel. (Leiden) 56: 83—90, 1980.

—, SWEATMAN G. K., *Demodex antechini* sp. nov. (Acari, Demodicidae) parasitic on *Antechinus stuartii* (Marsupialia). Parasitology 60: 425—429, 1970.

Received 21 October 1981.

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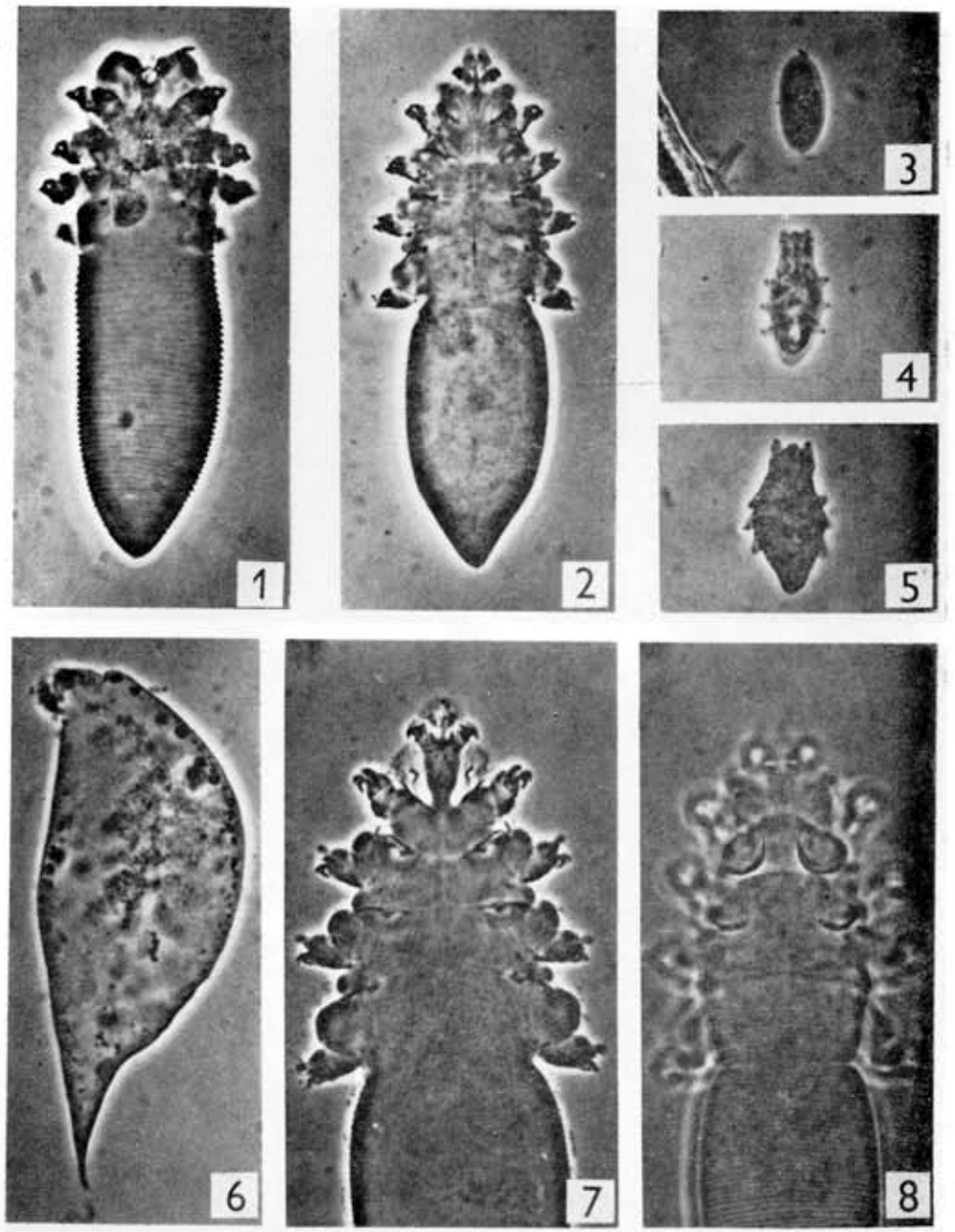
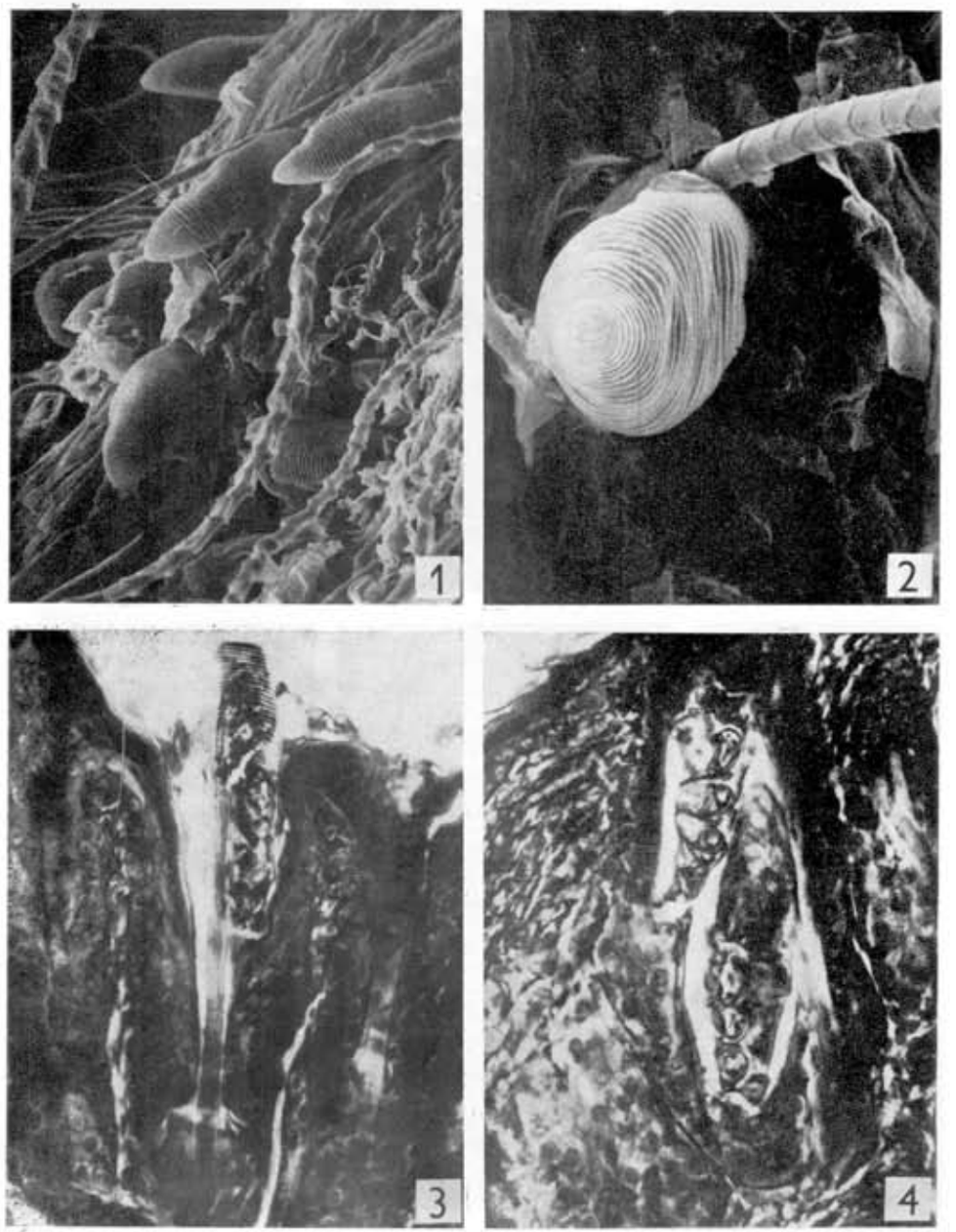


Soricidex dimorphus g. n. sp. n. Figs. 1—6. Developmental stages (× 150), **Fig. 1.** Male. **Fig. 2.** Female. **Fig. 3.** Ovum. **Fig. 4.** Larva. **Fig. 5.** Protonymph. **Fig. 6.** Nymph. Figs. 7—8. Female, anterior part of body (× 2 600). **Fig. 7.** Ventral view, note V-shaped capsule of gnathosoma and terminal projections on legs II—IV. **Fig. 8.** Dorsal view, note podosomal sclerotized structures.



Figs. 1—4. Habitat of *Soricidex dimorphus* in skin of *Sorex araneus*. **Eig. 1**. Posteriors of half-extending adult mites (× 90). **Fig. 2.** An adult mite penetrating into a hair follicle with a hair (× 235). **Fig. 3.** Section through a hair follicle with a male in entrance (× 115). **Fig. 4.** Section through a hair follicle with a male (left) and a female (right). Note evidence of undercutting of follicular epithelium by the male (× 115).