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Apodemodex cornutus gen. n. et sp. n. (Acari: Demodecidae): new genus and new species of the hair follicle mite from the Mediterranean water shrew, *Neomys anomalus* (Insectivora: Soricidae)

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Abstract. A new hair follicle mite species, *Apodemodex cornutus*, is described from female and male specimens collected from the muzzle, lower jaw and vertex of Mediterranean water shrews, *Neomys anomalus* Cabrera taken in South Bohemia, Czech Republic. A new, at present monotypic genus *Apodemodex* is erected for this mite species. Diagnostic for the new genus are the morphology of the gnathosoma (the characters including conspicuous continuous arched antero-lateral contours of massive ventral face) and the morphology of the leg claws, which are deeply bifurcate and without spur.

At present the mite family Demodecidae consists of the following six genera: *Demodex* Owen, 1843, *Rhinodex* Fain, 1959, *Stomatodex* Fain, 1959, *Ophthalmodex* Lukoschus et Nutting, 1979, *Pterodex* Lukoschus, Woeltjes, Desch et Nutting, 1980, and *Soricidex* Bukva, 1982. Most of the approximately one–hundred demodecid species described to date have been classified as *Demodex*.

Among the mites collected from insectivores in South Bohemia, an undescribed, morphologically distinct demodecid was found which, in the author's opinion, could not be reasonably identified with anyone of the current demodecid genera. This form is described as a new species below, and a new genus is erected to accommodate it.

MATERIALS AND METHODS

Ten *Neomys anomalus* Cabrera, 1907 specimens snap-trapped in South Bohemia, Czech Republic were examined under a dissection microscope for presence of demodecid mites by scraping, squeezing with watchmaker forceps, and/or disintegrating pieces of tissues with needles in Hoyer's medium. The examined body areas were the eyelids, external auditory meatus, nasal and buccal cavities, muzzle, vertex, back, genital/anal area, and tail. Eleven specimens of the new mite species found were transferred into a clear drop of medium, mounted into permanent mounts, and later studied with phase contrast optics.

For comparison of generic characters the following materials including types deposited in the Natural History Museum, London (NHM) were studied: *Demodex folliculorum* (Simon, 1842) (the author's collection); *Rhinodex baeri* Fain, 1959 (female paratype, NHM No. 1961-10.25-5); *Stomatodex corneti* Fain, 1960 (male and female paratypes, NHM Nos. 1961-10.26-52 and 1961-10.25-3-4); *Soricidex dimorphus* Bukva, 1982 (male and female paratypes, the author's collection); *Ophthalmodex apodemi* Bukva, Nutting et Desch, 1992 (male and female paratypes, the author's collection).

RESULTS

Apodemodex cornutus sp. n. Figs. 1–3

A short-bodied plump mite remarkable for broad, unusually structured gnathosoma and spurless, deeply bifurcate leg claws.

Female (holotype) (Figs. 1A–E, 2). Holotype body length 137 μm, with opisthosoma making up 0.42 of this value. Corresponding averages in the type series were 129.4 μm (range 121–137) and 0.40. Other measurements are in Table 1.

Gnathosoma over twice as wide as long, in ventral view conspicuously massive with uniformly arched antero-lateral contours (Figs. 1C–D, 2). The outer-most layer of gnathosoma venter is cuticular duplicature which in anterior part of gnathosoma opens in 9–11 μm long, narrow (3 μm wide in holotype) to wider elliptical fenestra (6 μm wide in some paratypes). Rim of fenestra rather indistinct except anteriorly where more sclerotized. Internally, over anterior one-half of fenestra, a well defined, almost rectangular structure (considered to

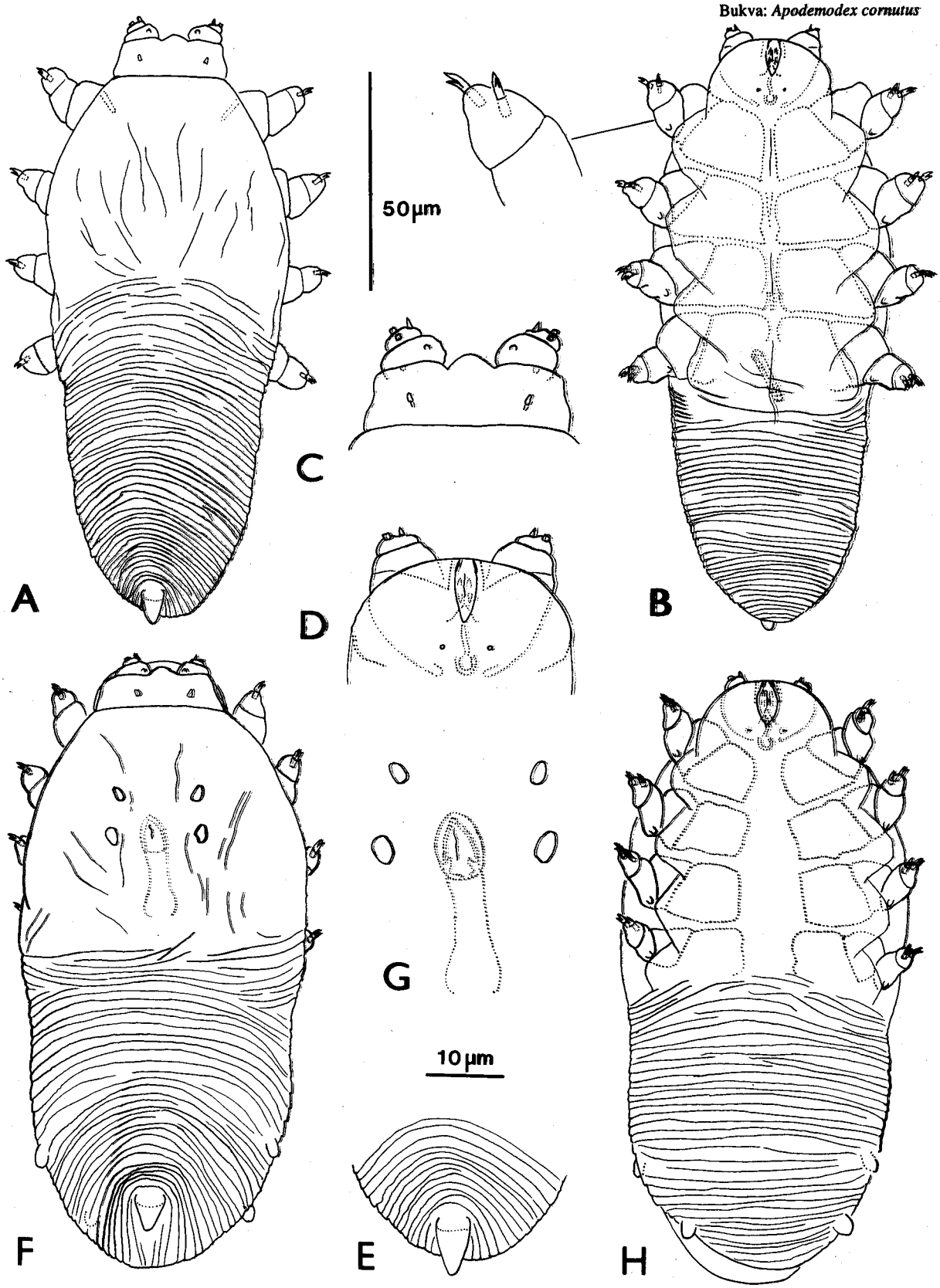

Fig. 1. *Apodemodex cornutus*. **A–E** – Female, holotype. **A** – Dorsal view. **B** – Ventral view. **C** – Gnathosoma, dorsal view. **D** – Gnathosoma, ventral view. **E** – Horn-like appendage on dorsum of opisthosoma. **F–H** – Male, allotype. **F** – Dorsal view. **G** – Genital orifice, aedeagus and dorsal podosomal tubercles. **H** – Ventral view. Scale bars: 50 µm (A–B, F, H) and 10 µm (C–E, G).

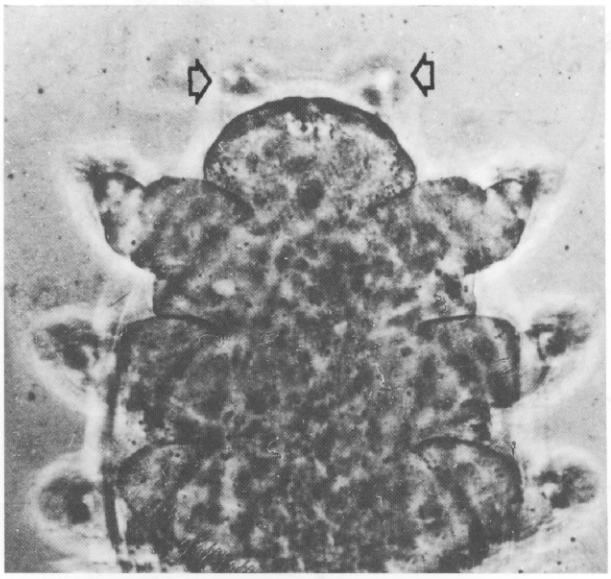

Fig. 2. *Apodemodex cornutus*, female, holotype, ventral view. Note the conspicuous arched contour of the gnathosoma with the palps (arrows) in a dorsal (out-of-focus) position. (× 1000).

Table 1. Means with standard deviations, and/or ranges of measurements of *Apodemodex cornutus* (in µm).

		Male (n = 3)	Female (n = 8)
Gnathosoma	Length	14	13.6 ± 1.4 (11–15)
	Width	32	28.9 ± 2.4 (26–33)
Podosoma	Length	60–65	64.2 ± 4.4 (58–71)
	Width	68	57.0 ± 5.6 (47–66)
Opisthosoma	Length	62–70	52.1 ± 3.8 (45–58)
	Width	57–64	44.4 ± 6.1 (35–51)
Total length		137–148	129.4 ± 5.5 (121–137)
Aedeagus		20–23	–
Vulva		–	12.9 ± 0.6 (12–14)

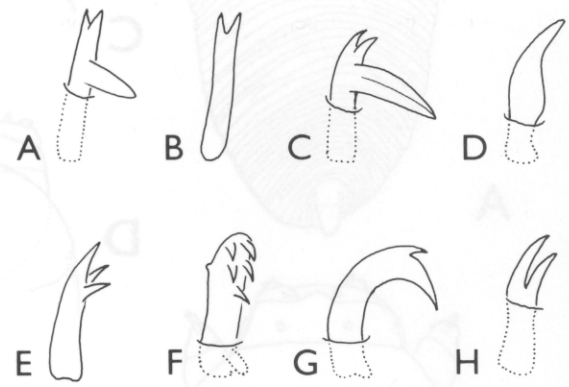

Fig. 3. The leg claw morphology of Demodecidae. **A** – *Demodex folliculorum*. **B** – *D. caviae*. **C** – *Soricidex dimorphus*. **D** – *Rhinodex baeri* (of the heteromorphic claws only one shape is shown here). **E** – *Pterodex carolliae*. **F** – *Ophthalmodex apodemi*. **G** – *Stomatodex galagoensis*. **H** – *Apodemodex cornutus*. (A, original; B, after Bacigalupo and Roveda 1954; C–D, original; E, after Lukoschus et al. 1980; F, after Bukva et al. 1992; G, after Fain 1959; H, male paratype; A–H, sketches not in scale).

be the receded hypostome) whose apex is level and apparently, confluent with arched general edge of gnathosoma. Subgnathosomal setae distinct, situated anterior to horseshoe-shaped, anteriorly open pharyngeal bulb. Base of palps dorsad to arched edge of gnathosoma (Fig. 2); of two free palpal segments the proximal one is bulbous, with a minute round protuberance dorsally; the terminal palpal segment with three spines of which one positioned antero-mediad is slender and pointed, while two spines positioned more laterally are strong, spatule-shaped and heavily sclerotized. Stylophore broadly rounded terminally. Supracoxal spines 1 µm long, poorly sclerotized pegs.

Podosoma broad, with regularly arched lateral outlines; greatest width between legs II–III. Four pairs of legs evenly spaced along podosoma. Coxal plates distinct, with parallel, almost touching median margins; posterior three-quarters of coxal plates IV confluent. Each leg with three movable segments. Movable segment 2 of all legs with minute postero-ventral triangular spur. Terminal segment of each leg distally with a pair of identical claws. Each claw almost straight, terminally with two large, slightly recurved tines; tines positioned one over another, and subequal (dorsal tine slightly longer than ventral tine); basal half of claw embedded nearly to bifurcation point in the terminal leg segment[1]. Solenidion on terminal segments of legs I and II (existence suspected in some observations) not conclusively verified. Dorsum of podosoma over legs I–III smooth except for irregular longitudinal cuticular furrows; over legs IV with transverse cuticular striae as on opisthosoma.

Opisthosoma shorter and narrower than podosoma; opisthosoma terminus broadly rounded. Cuticle with faint, transverse striae which curve strongly on dorsum near terminus. At dorsal midline near terminus a conical, smooth, 5–8 µm long horn-like appendage. Opisthosomal organ absent.

Vulva a prominent longitudinal slit (displaced from the longitudinal axis in holotype) positioned mid-ventrally at podosoma-opisthosoma border.

[1] Measurements of the leg claws in a male specimen favourably oriented for exact examination were as follows: total length 5 µm; basal one-half embedded in the terminal leg segment; dorsal tine 2–2.5 µm long; ventral tine approx. 1.5 µm long (Fig. 3H). The leg claws in female appeared to be very similar to male.

Male (allotype) (Fig. 1F–H). Allotype body length 143 μm (type series range 137–148), with opisthosoma making up 0.49 of this value (type series range 0.45–0.49). Other measurements are in Table 1.

Gnathosoma similar to female. Width of podosoma and opisthosoma greater than in female[2]. Coxal plates distinct inclusive of widely separated median margins. Movable leg segments as in female. Dorsum of podosoma smooth (except for occasional irregular longitudinal cuticular furrows) over legs I–III; with transverse cuticular striae as on opisthosoma over legs IV. Mediodorsal appendage on opisthosoma similar to female; another two pairs of small, button-shaped appendages dorso-laterally (anterior pair) and ventro-laterally (posterior pair). Opisthosomal organ absent.

Genital orifice a simple longitudinal slit at dorsal midline over gap between legs II–III. Aedeagus strong (20–23 μm long; at base 7.5 μm, in middle 4 μm wide). Dorsal podosomal tubercles oval (approx. 4 μm long to 2.5 μm wide); posterior pair level with genital orifice, 22–23 μm apart; anterior pair 9–12 μm anterior to this, 18–19 μm apart (n = 3).

Immature stages. Not known.

Host: The Mediterranean water shrew, *Neomys anomalus* Cabrera, 1907.

Locality: The type series is from three host specimens taken in České Budějovice, South Bohemia, Czech Republic, 28 April 1981, 14 May 1981, and 21 June 1982.

Sites: Muzzle (two host specimens; in one specimen the same site concurrently infested with *Demodex neomydis* Bukva, 1995); lower jaw and vertex (two host specimens; both specimens and both sites concurrently infested with *Soricidex* sp. undet.). Microhabitat (histological level) unknown.

Deposition of materials: Type collection in the Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice. Holotype, allotype and another male paratype, Coll. No. 1969. A slide containing one female paratype has been deposited in the Natural History Museum, London (accession No. BMNH[E] 1996.268). Another six slides containing paratypes are in the author's collection in the Institute of Parasitology, ASCR, České Budějovice.

Etymology: The genus name indicates relationships (*apo-* [Greek] = "separate", "away from"). The species name refers to the horn-like opisthosomal appendage in both sexes (*cornutus* [Latin] = "horned").

Apodemodex gen. n.

Type species: *Apodemodex cornutus* sp. n. At the present time, *Apodemodex* is a monotypic genus.

Genus diagnosis. The genus *Apodemodex* displays basic characters of the family Demodecidae Nicolet, 1855 as present in the currently recognized demodecid genera. The following characters serve to differentiate this new genus from these genera.

Gnathosoma very wide, with massive ventral face which is conspicuously contoured anteriorly and laterally as a wide, regular, uninterrupted arch. Hypostome receded. Base of palps dorsad to the arched edge of gnathosoma. The mouthparts communicate with the exterior through a fenestra in ventral cuticle.

The leg claws moderately recurved, spurless, terminally with two large, superposed tines.

Apodemodex is most clearly separate from *Rhinodex*, *Stomatodex*, *Ophthalmodex*, *Pterodex* and *Soricidex*, the monotypic or homogeneous genera containing only a few known species. Less distinct might prove to be the division between *Apodemodex* and some representatives of the heterogeneous, species-rich genus *Demodex* which presently comprises dozens described species, while, seemingly, hundreds to thousands of species are yet to be described. The type species *Demodex folliculorum* as well as numerous other *Demodex* species, however, are dissimilar from *Apodemodex* in both the aforementioned differential characters. (For details see below.)

DISCUSSION

The present classification of the family Demodecidae as outlined above is far from being conclusive: there are estimated thousands (5000+) of demodecid-mammalian species associations (Nutting 1985) which await examination and taxonomic evaluation. Hence possibly hundreds to thousands of taxonomically separate demodecid forms should be morphologically characterized, described as new species, and classified in a (greater than current?) number of genera. This may not be easy, since the structural modifications to parasitic life of demodecids include a drastic reduction of taxonomically applicable characters (see in Bukva 1991). In view of all this, it is legitimate and advantageous to tentatively classify newly discovered divergent forms in new genera based on even a limited number of differential characters, rather than contribute to the heterogeneity of existing genera. A comparison of the two differential characters of the new genus versus other demodecid genera follows.

Leg claws[3]. In the genus *Demodex* the typical leg claws present in both the type *D. folliculorum* and in most other species, have a straight shaft terminating in two small lateral tines; a large, more or less

[2] The males studied certainly were not distorted by cover slip compression, since they were mounted in slides containing also undistorted female *A. cornutus* and/or other demodecid specimens.

[3] Morphology of the leg claws in adult specimens only is considered for all the genera. Two claws, equal or unequal, are present on each leg.

perpendicular spur projects posteriorly from the midregion of the shaft (Fig. 3A). Minor to major modifications of this type have been mentioned in descriptions of approximately a dozen *Demodex* species; unfortunately, some of these descriptions of divergent leg claw morphology did not figure the leg claws and thus they are difficult to interpret. A modification which should be noted here was shown in the rather perplexing and apparently, not very careful description of *D. caviae* Roveda et Bacigalupo, 1954: the leg claws with spurless shaft terminating in two tines (Bacigalupo and Roveda 1954)[4]. To the best of the author's knowledge, the leg claws in no other *Demodex* species resemble *Apodemodex cornutus* more closely (Fig. 3B). In *Soricidex* (one species described; at least another one species undescribed in the author's collection) the spur on the shaft of otherwise *Demodex*-like leg claws is very large (Fig. 3C). In *Rhinodex* (one species described) the spurless leg claws are heteromorphic, each terminating in a single point (Fig. 3D). In *Pterodex* (one species described) the leg claws terminate in three equal minute tines, of which one is median dorsal and two ventrolateral (Fig. 3E). The leg claws in *Ophthalmodex* (seven species described) are provided with five to six tines in the distal part of recurved claw shaft (Fig. 3F). *Stomatodex* (four species described) and *Apodemodex* are somewhat similar to one another in that their spurless leg claws terminate in two superposed tines (Fig. 3G, H). The principal differences in the leg claw morphology of these two genera are as follows: the undivided claw shaft in *Stomatodex* relatively much longer than in *Apodemodex*; both the shaft and the tines conspicuously recurved in *Stomatodex* vs. moderately recurved in *Apodemodex*; the tines distinctly unequal, the dorsal one being much shorter in *Stomatodex* vs. subequal, the dorsal one being slightly longer in *Apodemodex*. It should be noted here that no substantial intrageneric variability in the leg claw morphology has so far been described for the demodecid genera other than *Demodex*.

Gnathosoma. No arrangement of gnathosomal structures similar to that presently described for *Apodemodex* has either been mentioned for the demodecids described to date or noticed by the author in dozens of undescribed forms on hand. Interestingly enough, some similarity to *Apodemodex*, again, can be seen in *Demodex caviae* as figured by Bacigalupo and Roveda (1954).

[4] The text of the *D. caviae* description in Spanish mentioned that each leg consisted of five segments, the ultimate one of which terminated in two 2.3–3.6 μm long claws ("uñas") whose shape ("la forma de anzuelo, pero lisas" [meaning not clear to the present author]) could be clearly seen. A terminal leg structure believed to be a claw (Bacigalupo and Roveda 1954, Fig. 4) has been redrawn here, although the latter figure was not consistent with the text.

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