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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) *

BY

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Zoology Department, University of Massachusetts, Amherst, Mass., U.S.A.  
AND  
Fritz S. Lukoschus.  
Zoologisch Laboratorium, Katholieke Universiteit, Nijmegen, Netherlands.

Demodex longissimus and D. molossi n. sp., although from different chiropteran hosts, are described together in this paper since they show similar adaptations in the immature stages to a similar habitat, the Meibomian complex. A few of the adaptations are, however, remarkably different comparing more favorably with those of D. gapperi from the Meibomian complex of the red-backed vole, Clethrionomys gapperi (Nutting et al. in press). Descriptions of the two new species are followed by considerations of the life cycle, population dynamics, and pathology.

MATERIALS AND METHODS.

Mites were squeeze-plucked with watchmaker forceps from the eyelids of Carollia perspicillata and Molossus molossus, and mounted in Hoyer’s medium. For observation of the mites in situ, whole heads of both host species were fixed in Bouin’s solution. The entire ocular region was excised, embedded in paraffin-piccolyte mixture (Cloney, 1961), sectioned at 6 or 8 µm and stained with Ehrlich’s haematoxylin and eosin Y. Hoyer’s mounts and sections were studied with phase and light microscopy. All measurements in the descriptions, tables and discussion are in micrometers.

* This investigation was supported in part by NIH Grant 5-TOIAI-226-08 and Netherlands Foundation for the Advancement of Tropical Research Grant W 83-1.

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EXTENSION OF GENERIC CHARACTERISTICS.

Some minor extensions of generic characteristics are needed to include the species described below in the genus Demodex. These can be made without violating the original account by Owen (1843) or the intent of the basic diagnosis by Baker and Wharton (1952). These changes (see Baker and Wharton) include: length extended to 1 mm; capitulum may or may not cover palpi and chelicerae; distal palpal segment with forked or rodlike setae; subgnathosomal setae (not minute openings) present or absent; and male genital opening variously placed along midline on dorsal podosoma. Further, at least two of the diagnostic characteristics of Stomatodex (Fain, 1959), namely epimeral plates (coxae) broadly joined and leg claws with dorsal spur, should be abandoned since these are shared by the demodicids described below. It is apparent from these remarks and from a number of undescribed specimens in hand that a definitive differentiation of the genera of the family Demodicidae must await further study.

Demodex longissimus sp. nov.

DESCRIPTION (with characters of the genus and as extended above): Demodex longissimus is an extremely large member of the genus, the largest adult specimen, a female, measuring 955. Adults and immature stages highly variable with respect to total length.

Male (Pl. I, fig. 1): Mean body length $722.7 \pm 61.8$ (20 specimens) with opisthosoma comprising four-fifths this value. Other measurements given in Table I.

Gnathosoma trapezoidal; length less than basal width. Pharyngeal bulb oval shaped (Text-fig. 1). Subgnathosomal setae absent. Minute, conical supracoxal spines (Text-fig. 2). Three spines on terminal segment of palps; one of these forked and claw-like.

Four pairs of laterally extended legs evenly spaced along podosoma; prominent and strong. Femoral spurs large; solenidia on tarsi I and II; claws with several ventral points and without dorsal spur. Epimera II and III do not meet at mid-line.

Genital orifice non-operculate, opening as narrow slit in slightly raised chitinous protuberance on dorsal podosoma at level of legs I (Text-fig. 3). Dorsal podosomal tubercules round; all equidistant from mid-line. Penis $47.8 \pm 1.6$ long; approximately 3.0 wide.

Opisthosoma very long and narrow with fine transverse annuli. Proctodeum absent (see Desch et al., 1971).

Female (Pl. I, fig. 2): Total length $790.0 \pm 149.7$ (20 specimens) with body proportions as in male.

Gnathosoma and associated structures similar to male, but approximately 2 longer and wider.

Podosomal dimensions average about 10 percent larger than in male. Legs strong and evenly spaced along podosoma, but more ventrally situated than in the male. All epimera confluent at mid-line.

Anterior half of slit-like vulva covered by chitinous flap as a triangular-shaped chamber (Text-fig. 4). Most of chamber located beneath fourth pair of epimeral plates. Vulva length $25.2 \pm 1.4$.

Opisthosoma annulated as in male; proctodeum absent.
PLATE I, Figs. 1-3: Demodex longissimus.
(1) — male (x 220); (2) — female (x 220); (3) — ovum. Arrow indicates opercular crease (x 220).
TEXT-FIGS. 1-5: *Demodex longissimus*.

Ovum (Pl. I, fig. 3): Narrow and snake-like, 805.1 ± 84.1 long (20 specimens); greatest width 48.4 ± 4.3 at bulbous anterior end. One or two transverse grooves in swollen anterior operculum.

Larva (Pl. II, fig. 4): Very slender, 908.4 ± 116.4 (20 specimens); width 49.7 ± 5.6 (measured between Legs II and III). Long three-segmented palps with two trifid spines on the terminal segment; generally folded ventrad. A pair of chitinized spines, 5 long, on dorsal surface of epistome (Text-fig. 5). Anterodistal end of legs I with two slender trifid claws; a small solenidium either side of the pair. Position and structure of claws on legs II same as on legs I: single solenidium distal to claws. Legs III as a single long heavily chitinized claw-like arm; 96.5 ± 6.9 long. Terminal tip turned medially; a prominent subterminal thickening. Two pairs of large epimeral scutes on ventral surface at level of legs II and III; anterior pair smaller.

Protonymph (Pl. II, fig. 6): General features similar to larva. Total length 896.1 ± 131.4 (20 specimens); width 57.9 ± 6.5. Spines on epistome absent. Claws and solenidia of legs I and II, and epimeral scutes similar to larva (Text-fig. 6) although posterior scutes with tips more truncate. Legs III similar to larva, but significantly longer, 135.8 ± 12.4.

Nymph (Pl. III, fig. 5): General features similar to larva and protonymph. Total length 839.0 ± 96.4 (20 specimens); 67.5 ± 9.2 width. Legs I and II as in larva. Claw on legs III similar to larva but larger; 183.7 ± 12.1 long. Legs IV reduced to simple conical prominence; claws and solenidia absent. Three pairs of prominent epimeral scutes at level of legs II, III and IV (Text-fig. 7).

TABLE I: Means and standard deviations of 20 specimens of each stage and sex of *Demodex longissimus*. All measurements in micrometers.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gnathosoma</td>
<td>23.9 ± 0.7</td>
<td>25.2 ± 0.7</td>
</tr>
<tr>
<td>width</td>
<td>31.5 ± 1.7</td>
<td>33.4 ± 1.2</td>
</tr>
<tr>
<td>Podosoma</td>
<td>126.0 ± 5.6</td>
<td>138.6 ± 4.5</td>
</tr>
<tr>
<td>length</td>
<td>73.8 ± 4.0</td>
<td>80.1 ± 4.1</td>
</tr>
<tr>
<td>width</td>
<td>572.8 ± 63.1</td>
<td>586.5 ± 98.9</td>
</tr>
<tr>
<td>Opisthosoma</td>
<td>53.1 ± 3.0</td>
<td>65.1 ± 3.7</td>
</tr>
<tr>
<td>length</td>
<td>722.7 ± 61.8</td>
<td>790.0 ± 149.7</td>
</tr>
<tr>
<td>width</td>
<td>47.8 ± 1.6</td>
<td>25.2 ± 1.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Ovum</th>
<th>Larva</th>
<th>Protonymph</th>
<th>Nymph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>805.1 ± 84.1</td>
<td>908.4 ± 116.4</td>
<td>896.1 ± 131.4</td>
<td>839.0 ± 96.4</td>
</tr>
<tr>
<td>Width</td>
<td>48.4 ± 4.3</td>
<td>49.7 ± 5.6</td>
<td>57.9 ± 6.5</td>
<td>67.5 ± 9.2</td>
</tr>
<tr>
<td>Legs III claw</td>
<td>96.5 ± 6.9</td>
<td>135.8 ± 12.4</td>
<td>183.7 ± 12.1</td>
<td></td>
</tr>
</tbody>
</table>

Types: The following type specimens: a male (ringed in black) as holotype, a female (ringed in white) as allotype and several males and females as paratypes are deposited in the Rijksmuseum van Natuurlijke Historie, Leiden. Slides with paratype specimens will be sent to the British
PLATE II, Figs. 4-7: Demodex longissimus.

(4). — larva (x 220); (5). — nymphal exoskeleton with female adult inside (x 220); (6). — protonymphal exoskeleton with nymph inside. Note position (arrow) of nymphal claw of Legs III (x 220). (7). — Gnatthosoma of larva within egg shell showing position (arrow) of egg teeth (x 1330).
Text-Figs. 6-7: *Demodex longissimus*. (6) — Protonymph. (7) — Nymph.
Museum (Natural History) in London; the National Collection of Surinam, Centraal Laboratorium, Paramaribo, Surinam; Zoologisches Staatsinstitut und Zoologisches Museum, Hamburg; Institut de Médecine Tropicale, Antwerpen; Institute of Parasitology, Prague; Museum National d’Histoire Naturelle, Paris; Zoological Institute of the Academy of Sciences, Leningrad; U. S. National Museum, Washington D. C.; University of Massachusetts Zoology Department, Amherst, Mass (W. B. Nutting) ; and the Acarology Institute, Columbus, Ohio.

**Diagnosis:** *Demodex longissimus* is most similar to *D. folliculorum* (see Hirst, 1919). The following characteristics serve to differentiate these two demodicids:

1. *Demodex longissimus* much larger (790.0) with opisthosoma c. three-fourths of total length (female); *D. folliculorum* (293.0) with opisthosoma c. two-thirds length (female).
2. *Demodex longissimus* with male genital orifice at level of legs I; in *D. folliculorum* at level of legs II.
3. Proctodeum absent in both sexes of *D. longissimus*; present as finger-like structure in female of *D. folliculorum* (absent in the male).
4. Subgnathosomal setae absent in *D. longissimus*; located slightly anterior and lateral to pharyngeal bulb in *D. folliculorum*.
5. Supracoxal spines simple and conical in *D. longissimus*; with small, medial flaring process in *D. folliculorum*.
6. Immatures of *D. longissimus* with enormous claw on legs III; claw not enlarged in immatures of *D. folliculorum*.

*Demodex carolliae* (Desch et al., 1971) is also found on *Carollia perspicillata* but is distinguished from *D. longissimus* as follows:

1. *Demodex longissimus* much larger (790.0) than *D. carolliae* (130.2).
2. *Demodex longissimus* site specific to Meibomian glands of host; *D. carolliae* inhabits only hair follicles of host.
3. Immature stages of *D. longissimus* with greatly enlarged claw as Legs III; no enlarged claw on immatures of *D. carolliae*.

**Host:** Material for this report was obtained from *Carollia perspicillata* taken at the following locations in Surinam by Dr. F. Lukoschus: Brokopondo (2/70), Brownsweg (1/70 and 2/70), Lelydorp (12/69 and 1/70), Onverwacht (2/70) and Zandery (1/70 and 2/70).

**Biology.**

**Life Cycle:** The eyelids of *Carollia perspicillata* contain only three Meibomian glands per eye. The two anterior glands, one of which opens onto the upper lid and the other onto the lower lid, are too small to accommodate *D. longissimus*. The mites are found in the two separate ducts of the large posterior Meibomian gland (Pl. III, fig. 8). Mites are situated such that when in situ a large portion of the opisthosoma extends from the gland opening onto the surface of the eye.

Females lay one non-embryonated egg at a time with the anterior end being extruded first. The first structures noted in the embryo are the larval palps. The gnathosoma develops in such a position that it is folded over onto itself. This flexed condition results in the placement of the strong spines on the epistome in direct contact with the egg shell (Pl. II, fig. 7). The position of these spines plus the fact that they are found only in the larval stage suggests they may be used as "egg teeth" during the hatching process.
The large claw-like third leg develops directed posteriorly and tightly compressed between the body wall and the egg shell. Claws III form in similar manner within the larva for the protonymphal and within the protonymphs for the nymphal stages (Pl. II, fig. 6). Although mite tissue occupies the central lumen of these claws it does not have the appearance of muscle but rather an epithelial layer possibly ectodermal in origin (Pl. III, fig. 9). Thus, it is presumed that the large claw is primarily a hold-fast structure. Tissue sections reveal that these “arm-like” claws are deeply embedded in the epithelium of the Meibomian duct and may even extend into the surrounding connective tissue (Pl. III, fig. 10). The prominent epimeral scutes also apparently act as hold-fasts. Since the gland probably produces large amounts of secretion all of these appendages are seemingly of adaptive advantage in preventing the immature mites from being flushed out of the Meibomian duct.

The adults are considered the stage of intra- and interhost transference since they are the only stage capable of locomotion.

Examination of a total of 599 mites from a number of Carollia perspicillata reveals the following population structure: 117 eggs, 45 larvae, 33 protonymphs, 59 nymphs, 210 females and 135 males. Thus, there is a 3:4 ratio of immatures to adults. The adults exhibit a 2:3 (male to female) sex ratio. Because of the method of collecting these figures may underrate the early stages in the life cycle.

Pathology: The primary pathologic reaction of the host to the mites appears to be a trans-epithelial migration of leucocytes into the lumen of the Meibomian gland from the adjacent connective tissue. The free leucocytes in the gland lumen loosely surround the mites (Pl. III, fig. 10, 11). The mites do not appear to be harmed by these cells. There is little or no cellular response to the claws on legs III of immatures which have broken through the epithelial lining of the gland lumen and have become embedded in the surrounding connective tissue (Pl. III, fig. 9, 10). Unlike some demodicid infestations (e.g., D. caprae (Nutting, 1950) and D. carolliae (Desch et al., 1971)), the gland in this case retains its structural integrity (Pl. III, fig. 8).

Apposition of larval, nymphal and adult mouthparts to the duct epithelium indicates that this species feeds, at least in part, on epithelial cells. Lukoschus noted in collecting that the eyelids were often markedly swollen, which in the absence of cellular changes may indicate duct plugging by the mites. In all respects, however, D. longissimus is apparently a low grade pathogen.

**Demodex molossi**, sp. nov.

Description (with characters of the genus and as extended above): *Demodex molossi* is a large member of the genus, the largest adult specimen, a female, measuring 847.0. Adults and immature stages highly variable with respect to total length.

*Male* (Pl. IV, fig. 12): Meany body length 451.8 ± 37.2 (20 specimens) with opisthosoma comprising three-fourths this value. Other measurements given in Table II.

Gnathosoma trapezoidal, length less than basal width. Pharyngeal bulb horseshoe-shaped opening posteriorly (Text-fig. 8). Minute subgnathosomal setae anterior to pharyngeal bulb. Conical-shaped supracoxal spines, very small (Text-fig. 9). Five spines on terminal segment of palp.

Four pairs of laterally extended legs evenly spaced along podosoma; prominent and strong. Solenidia on tarsi I and II; claws with small dorsal spurs; large femoral spurs; epimera I, II, III do not meet at mid-line.
PLATE III, Figs. 8-11: Demodex longissimus.

(8). mites (M) seen in transverse section of Meibomian gland. Arrow indicates cornea of host (× 80).

(9). Legs III of immature mite lies embedded in Meibomian gland epithelium (ME). Note the nuclei (arrow) which occupy the lumen of the claw. (10). Leucocytes (L) cluster around body of immature mite (M) lying in gland lumen. Arrows show position of claws of Legs III. Epimeral scute (ES). (× 435).

TEXT-FIGS. 8-12: Demodex molossi.

Genital orifice non-operculate, opening as narrow slit immediately flanked on each side by a triangular chitinous plate at the level of legs II on dorsal podosoma (Text-fig. 10). Dorsal podosomal tubercles round, each with a small central protuberance. All equidistant from median body axis. Penis 40.6 ± 1.7 long.

Opisthosoma long with fine transverse annuli. Proctodeum absent.

Female (Pl. IV, fig. 13) : Total length 582.8 ± 126.4 (20 specimens) with body proportions as in male.

Gnathosoma and associated structures similar to male, but approximately 1 longer and wider.

Podosomal dimensions average about 20 to 23 percent larger than in male. Legs strong and evenly spaced along podosoma, but more ventrally situated than in male. All epimera confluent at mid-line.

Vulva posterior to fourth epimeral plate on ventral surface of opisthosoma (Text-fig. 11). Anterior quarter of slit-like vulva (18.9 ± 1.4 long) covered by chitinous flap as a triangular-shaped chamber.

Transverse opisthosomal annuli more prominent than in male. Proctodeum absent.

Ovum (Pl. IV, fig. 14) : Y-shaped with bifurcation anterior. Rounded protuberance in crotch of anterior "arms" with ventral inscription (operculate). Length from this point to posterior end 238.1 ± 9.5; greatest width 66.7 ± 3.8

Larva (Text-fig. 12) : Slender, 580.3 ± 93.0 long (20 specimens); width 64.8 ± 8.7 (measured between legs II and III). Palps three-segmented with a three-tined and a two-tined claw on terminal segment; generally folded ventrolaterally. Pair of chitinized spines, 5 long, on dorsum of epistome. Minute, conical supracoxal setae. Pharyngeal bulb shaped as in adults, but setae absent.

Anterodistal end of legs I with two slender club-shaped, non-denticulate claws. A small solenidium proximal and one distal to claws. Claws of legs II same as legs I with single solenidium distal to claws. Legs III as a long, slender "arm-like" claw; 68.2 ± 4.8 long. Claw terminated by two recurving, hook-like processes; prominent, subterminal thickening medially directed. Two pairs of large, elongate epimeral scutes on ventral surface at level of legs II and III. Dorsum with pair very large chitinized wing-like structures; 69.7 ± 18.6.

Protonymph (Text-fig. 13) : General features similar to larva. Total length 625.7 ± 99.5 (17 specimens); width 74.4 ± 8.7. Two small tubercles on epistome. Two claws trifid on legs I and II. Solenidia of legs I and II as in larva. Legs III similar to larva, but significantly larger, 100.0 ± 12.2. Dorsal "wings" absent. Epimeral scutes as in larva.

Nymph (Text-fig. 14) : General features similar to larva and protonymph. Total length 667.3 ± 95.0 (20 specimens); width 83.2 ± 9.5 (as measured in larva). Legs I and II as in larva. Claw as legs III similar to larva; 127.4 ± 15.2 long. Legs IV small and short with two non-dentate fingers; solenidia absent. Three pairs of prominent epimeral scutes at level of legs II, III and slightly anterior to IV.

Types : The following type specimens : a male (ringed in black) as holotype, a female (ringed in white) as allotype and several males and females as paratypes are deposited in the Rijksmuseum van Natuurlijke Historie, Leiden. Slides with paratype specimens will be sent to the British Museum (Natural History) in London; the National Collection of Surinam, Centraal Laboratorium, Paramaribo, Surinam; Zoologisches Staatsinstitut und Zoologisches Museum, Hamburg; Institut de Médecine Tropicale, Antwerpen; Institute of Parasitology, Prague; Museum National
PLATE IV, Figs. 12-16: *Demodex molossi*.

(12).—male (× 220); (13).—female (× 220); (14).—ovum (× 220); (15).—mites (M) in transverse section of Meibomian gland. Arrow indicates cornea of host (× 80). (16).—Embryonated egg (E) in duct (D) of gland (× 435).
TEXT-FIGS. 13-14: *Demodex molossi.* (13) — Protonymph. (14) — Nymph.
d'Histoire Naturelle, Paris; Zoological Institute of the Academy of Sciences, Leningrad; U. S. National Museum, Washington D. C.; University of Massachusetts Zoology Department, Amherst, Mass. (W. B. Nutting); and the Acarology Institute, Columbus, Ohio.

**Table II**: Means standard deviations of 20 specimens (except where noted) of each stage and sex of *Demodex molossi.*

All measurements in micrometers.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Male</th>
<th>Female</th>
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<tr>
<td><strong>Gnathosoma</strong></td>
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<tr>
<td>length</td>
<td>26.6 ± 0.8</td>
<td>28.9 ± 0.9</td>
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<td>width</td>
<td>32.6 ± 2.2</td>
<td>34.7 ± 1.9</td>
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<tr>
<td><strong>Podosoma</strong></td>
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</tr>
<tr>
<td>length</td>
<td>105.5 ± 18.6</td>
<td>134.6 ± 3.9</td>
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<tr>
<td>width</td>
<td>82.5 ± 5.6</td>
<td>91.0 ± 5.4</td>
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<tr>
<td><strong>Opisthosoma</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>length</td>
<td>373.3 ± 34.8</td>
<td>419.2 ± 125.1</td>
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<tr>
<td>width</td>
<td>64.6 ± 5.5</td>
<td>73.5 ± 3.9</td>
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<tr>
<td><strong>Total length</strong></td>
<td>451.8 ± 37.2</td>
<td>582.8 ± 126.4</td>
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<tr>
<td><strong>Penis</strong></td>
<td>45.7 ± 313.3</td>
<td>64.6 ± 5.5</td>
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<td><strong>Vulva</strong></td>
<td>40.6 ± 64.6</td>
<td>18.9 ± 1.4</td>
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<table>
<thead>
<tr>
<th>Stage</th>
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<th>Larva</th>
<th>Protonymph *</th>
<th>Nymph</th>
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</thead>
<tbody>
<tr>
<td>Length</td>
<td>238.1 ± 9.5</td>
<td>580.3 ± 93.0</td>
<td>625.7 ± 99.5</td>
<td>667.3 ± 95.0</td>
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<tr>
<td>Width</td>
<td>66.7 ± 3.8</td>
<td>64.8 ± 8.7</td>
<td>74.4 ± 8.7</td>
<td>83.2 ± 9.5</td>
</tr>
<tr>
<td>Length of Claw-like Legs III</td>
<td>68.2 ± 4.8</td>
<td>100.0 ± 12.7</td>
<td>127.4 ± 15.2</td>
<td></td>
</tr>
<tr>
<td>Length of &quot;arms&quot; of Ovum</td>
<td>53.4 ± 1.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of dorsal prominences</td>
<td>69.7 ± 18.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* only 17 specimens.

**Diagnosis**: *Demodex molossi* is most similar to *D. folliculorum* (see Hirst, 1919). The following characteristics serve to differentiate these two demodicids:

1. *Demodex molossi* much larger (582.8) with opisthosoma c. three-fourths of total length (female); *D. folliculorum* (293.0) with opisthosoma c. two-thirds total length (female).
2. Posterior pair of dorsal podosomal tubercles of male *D. molossi* at level of genital orifice; in *D. folliculorum* the anterior pair lies at this level.
3. Proctodeum absent in both sexes of *D. molossi*; present as finger-like structure in female of *D. folliculorum* (absent in male).
4. Vulva of *D. molossi* posterior to and not in contact with the fourth epimeral plate; in *D. folliculorum* vulva posterior to and abutting this plate.
5. Supracoaxal spines simple and conical in *D. molossi*; with small, medial flaring process in *D. folliculorum*.
6. Immatures of *D. molossi* with enormous claw as legs III; claw not enlarged in immatures of *D. folliculorum*.

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Demodex molossi differs from D. longissimus with respect to the following characteristics:

1. Demodex longissimus averages about 210 longer than D. molossi (females).
2. Subgnathosomal setae not apparent in D. longissimus; are distinct in D. molossi.
3. Male genital orifice at level of legs I in D. longissimus; at level of legs II in D. molossi.
4. Vulva partly beneath epimeral plate IV in D. longissimus; entirely posterior to this plate in D. molossi.
5. Ovum long and snake-like in D. longissimus; Y-shaped in D. molossi.
7. Large claw-like legs III single-tined in D. longissimus; double-tined in D. molossi.

Host: Material for this report was obtained from Molossus molossus taken at the following locations in Surinam by Dr. F. Lukoschus: Lelydorp (2/70) and Paramaribo (12/69, 1/70 and 2/70).

Biology.

Life Cycle: As for Demodex longissimus, D. molossi is specific to the ducts of the Meibomian glands of its host, Molossus molossus. Each pair of eyelids possess only a single large gland with its orifice near the posterior corner of the ventral lid. The normal position of the mites in the gland is such that a portion of the opisthosoma extends from the duct onto the eyeball.

The unusual shaped egg of this species is layed one at a time in a non-embryonated condition. The larval gnathosoma develops in the rounded protuberance between the two "arms" with the palps flexed ventrally. This places the "egg teeth" on the dorsum of the epistome so they are appressed to the inner surface of the egg shell. The egg lies in the gland duct with its anterior end toward the flow of secretion product (Pl. IV, fig. 16). The pressure of the flow may force the "arms" to extend laterally, thereby anchoring the egg to the duct walls. A similar hold-fast adaptation occurs in the egg of D. gapperi (Nutting et al., 1968; and in press). Embryonic tissue within the "arms" of the egg gives rise to the "humps" of the larva. The enormous claw-like legs III of the larva, protonymph and nymph develops as in D. longissimus (see above).

Examination of a total of 190 mites from a number of M. molossus revealed the following population structure: 36 eggs, 25 larva, 17 protonymphs, 36 nymphs, 50 females and 26 males. Thus, there is a ratio of 3:2 (immatures:adults). The adults exhibit a 1:2 male to female sex ratio. As in D. longissimus these figures may be somewhat inexact due to the method of collection.

Pathology: Relative to Demodex longissimus, D. molossi elicits a more pronounced response in its host. The epithelial lining of the Meibomian gland duct and certain regions of the gland proper become hypertrophied and the cells form an irregular (deranged?) pattern (Pl. IV, fig. 15). Few leucocytes are seen in the lumen of the gland whereas many are found in the adjacent duct connective tissue. In addition to the mites, the lumen contains eosinophilic cellular debris from the gland itself. Mite activities appear to reduce considerably the secretory capacity of the gland (Pl. IV, fig. 15).

As in D. longissimus apposition of larval, nymphal and adult mouthparts to the duct epithelium indicates that this species feeds, at least in part, on epithelial cells. Demodex molossi is, therefore, apparently a low grade pathogen. This statement is made with some reservation since the material for examination was in short supply.
TABLE III. Characteristics of ova and immature stages of three demodicids
(D. gapperi, D. longissimus, D. molossi) restricted to the host Meibomian complex.
All measurements represent means and standard deviations in micrometers for 20 specimens of each.

<table>
<thead>
<tr>
<th>Rodentia</th>
<th>D. gapperi</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Larval mouth-parts in one arm. No egg teeth, non-operculate</td>
<td>293.8 ± 23.6 x 39.9 ± 4.7</td>
<td>284.9 ± 36.1 x 34.5 ± 7.7</td>
</tr>
<tr>
<td>Chiroptera</td>
<td>D. longissimus</td>
<td>Snake-like, Larval mouth-parts in head, egg teeth, operculate</td>
<td>Elongate, claw-like legs III, palps reflexed, solenidia.</td>
</tr>
<tr>
<td>Carollia picillata</td>
<td></td>
<td>805.1 ± 84.1 x 48.4 ± 4.3</td>
<td>908.4 ± 116.4 x 49.7 ± 5.6</td>
</tr>
<tr>
<td></td>
<td>Larval measurements</td>
<td>896.1 ± 131.4 x 37.9 ± 5.5</td>
<td>839.0 ± 96.4 x 67.5 ± 9.2</td>
</tr>
<tr>
<td>Molossus molossus</td>
<td>D. molossi</td>
<td>Y-shaped, larval mouth-parts in crotch, egg teeth, operculate</td>
<td>Elongate, dorsal wings, claw-like legs III with recurved tip.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>238.1 ± 9.5 x 66.7 ± 3.8</td>
<td>580.3 ± 93.0 x 625.7 ± 99.5</td>
</tr>
<tr>
<td></td>
<td>Protonymph measurements</td>
<td>625.7 ± 99.5 x 74.4 ± 8.7</td>
<td>667.3 ± 93.0 x 83.2 ± 9.5</td>
</tr>
</tbody>
</table>

Data for D. gapperi from Nutting et al. (in press).
* Only 17 specimens.

DISCUSSION.

These two new species show remarkable similarities in larval, protonymphal, nympha! and adult stages. They are, furthermore, found in markedly similar habitats (Meibomian ducts) and in hosts which share the same geographic area although different habitats. If little else were known it would seem plausible that these two demodicids are not as host species specific as are other members of this mite genus (see Nutting, 1968). The ova are, however, remarkably different and, in D. molossi, the "arms" of the ovum persist in the larval stage as dorsal wing-like extensions. We can also compare and contrast morphological details of these demodicids with
another species, *D. gapperi*, restricted to the Meibomian complex of a microtine rodent *Clethrionomys gapperi* (Nutting et al., in press). Included in Table III are most of the distinguishing features of these three species.

From examination of this table we note that convergence has occurred between *D. molossi* and *D. gapperi* in the egg stage with the egg arms held over at least to the larval stages in both species. Differences here are also readily apparent namely that larval mouthparts develop in one arm with the other arm becoming the dorsal finger in both larval and nympha stages in *D. gapperi* whereas larval mouthparts in *D. molossi* develop in the operculate crotch prominence with both arms remaining as dorsal podosomal "wings" in only the larval stage.

Certainly the similarities between the two bat demodicids far outweigh the differences. Special mention here should be made of the operculate ova and the egg teeth, the first reports for demodicids. Fain (1962) has shown epistomal setae in the Ereynetidae but these are apparently typical branched setae quite different from the simple shelf-like "egg tooth" extensions of larval *D. molossi* and *D. longissimus*. The massive larval, protonymphal and nympha legs III are very similar in and unique to both species; so also the remarkably flexible palps and the solenidia on legs I and II.

At first glance it would seem difficult to even attempt to explain the remarkable differences between *D. longissimus* and *D. molossi*. Examination of sectioned material, however, reveals that the habitat of *D. longissimus* is a narrow (120 μm) duct with side branches to cell clusters of the Meibomian gland whereas for *D. molossi* one large (220 μm) duct houses the species. It seems plausible that habitat dimension has been the major environmental factor to which these species have become adapted in the evolutionary process. Such adaptive differences as the following seem linked to this space difference.

1. *Demodex longissimus* thinner and more elongate in all stages (width range 48.4 to 80.1 μm; length range 722.7 to 908.4 μm) as compared to *D. molossi* (width range 64.8 to 91.0 μm; length range 238.1 to 667.2 μm) — all ranges expressed as average values (Tables, I, II).
2. Claws of immature legs III are embedded deep in the epithelium in *D. longissimus* whereas claws of *D. molossi* have not been found so embedded.
3. Reduction of legs IV in both species but most markedly in *D. longissimus*.
4. Presence of wing-like projections in larval *D. molossi* as compared to no such projections in *D. longissimus*.

In a more purely speculative vein it would seem possible that (1) solenidia are adaptations to provide information on duct conditions (monitor glandular secretions; assess duct dimensions) and (2) operculate ova combined with egg teeth are adaptations for more rapid eclosion from the ovum. Both of these would be of survival value to a species resident in a Meibomian complex.

It seems apparent that the development of a Y-shaped egg in both *D. molossi* and *D. gapperi* represents an evolutionary convergence. Despite some major differences the remarkable number of similarities between *D. longissimus* and *D. molossi* which reside in similar habitats in their hosts would seem to indicate a common derivation for these two rather than independent (synhospitatic) species formation as postulated elsewhere for members of the genus *Demodex* (Nutting, 1968).
In summary two new species of demodicids, *D. longissimus* and *D. molossi*, have been described for all life cycle stages. They are unusually large, remarkably modified species both of which are restricted to the Meibomian ducts of their respective hosts, *Carollia perspicillata* and *Molossus molossus*. Both are also low grade pathogens subsisting primarily on epithelial cells of the ducts. The major adaptations are apparently primarily related, as holdfast mechanisms, for maintenance of position in ducts which are sluiceways for the Meibomian secretions. Both species also possess operculate ova, and larval egg teeth — the first report of such structures for the genus. The differences between the two species, such as larger girth and more prominent holdfast structures in *D. molossi*, are thought to be directly related to the difference in physical dimensions of the ducts of the two hosts, that of *Molossus molossus* being nearly two times the diameter of the Meibomian duct of *Carollia perspicillata*.

Some information is also provided on the population structure of *D. longissimus* and *D. molossi*. The ratio of immatures to adults is very similar in both (3:2 : 4:3) as is also the sex ratio (1:2 vs 2:3).

**BIBLIOGRAPHY**


**Nutting (W. B.), 1968.** — Host specificity in parasitic acarines. — *Acarologia*, 10 : 165-180.

**Nutting (W. B.), Tisdel (M. O.) & Emejiaiwe (S.), 1968.** — Y-shaped ovum of a demodicid from *Clethrionomys gapperi*. — *J. Parasit.*, 54 : 393-394.


**Owen (R.), 1843.** — Lectures on the comparative anatomy and physiology of the invertebrate animals. — Royal College of Surgeons London.