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OTORHINOPHILA, A NEW GENUS OF CHIGGERS
(ACARINA, TROMBICULIDAE)
FROM WESTERN NORTH AMERICA

BY
William J. Wrenn and Richard B. Loomis.

ABSTRACT.

A new genus Otorhinophila, is proposed to include four species, three of them new. The species are: Otorhinophila intrasola sp. n. (type species), intranasal, type host Perognathus artus, other hosts Perognathus baileyi, P. goldmani, P. intermedius, P. penicillatus, P. pernix and Liomys pictus, type locality, 8 miles SSE Alamos, Sonora, Mexico, range from northern Sinaloa to northwestern Sonora, Mexico; Otorhinophila sinaloae, sp. n., intranasal, type host Perognathus pernix, other hosts Perognathus artus and Liomys pictus, type locality, 55 miles N Mazatlan, Sinaloa, Mexico, range in central Sinaloa, Mexico; Otorhinophila parvisola sp. n., type host Onychomys torridus, other hosts Perognathus (3 species), Dipodomys merriami, Citellus tereticaudus, Neotoma albicula and N. lepida, type locality, 9 miles NW Guaymas, Sonora, Mexico, range from Guaymas, central Sonora, northward through southern Arizona, southern California and northeastern Baja California Norte, Mexico; Otorhinophila sola (Gould), hosts Perognathus penicillatus and Neotoma lepida, range from northeastern Baja California Norte northward to southeastern California and southern Nevada. The larval and nymphal stages of each species are described and figured, and keys are provided. The distributions of the four species are illustrated.

INTRODUCTION

From 1960 through August 1965, approximately 5000 small mammals from western North America were examined for chiggers. The nasal passages of more than 3500 of these mammals also were examined for chiggers, after the discovery in December, 1961, of intranasal chiggers in rodents from California (Loomis, 1963). Among the many chiggers recovered were four closely related species, two from the

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nasal passages and two from the ears of rodents. One species is *Trombicula sola* Gould (1956), whereas the other three species are new. Although these species seem to be related to species in named genera, including *Euschoengastoides* Loomis, differences in several characteristics necessitate the proposal of a new genus *Oto­ rhinophila*. The genus is defined on the basis of characteristics exhibited by the larvae and correlated nymphs of all four species. The numerous recoveries of larvae provide information on the host preference, geographic distribution, and seasonal occurrence.

**Materials and Methods**

The majority of the mammalian hosts were obtained by means of kill or live traps, although some were shot, caught by hand, or were found dead on the road.

Each mammal was assigned a field number and all pertinent data including the exact locality, date of collecting, collector, and identification of the mammal were recorded. Each dead specimen was placed in a plastic bag and if not studied immediately, it was kept under refrigeration or preserved in 75 per cent ethyl alcohol until it could be examined for ectoparasites.

Several methods were used to recover larval chiggers. The host was inspected carefully with a dissecting microscope, and ectoparasitic trombiculids were removed with a small brush and fine needle. The intranasal species were found by cutting and lifting up the nasal bones, by flushing out the nasal passages with water (Yunker, 1961), or by pulling out the nasal mucosa for examination as the skin is separated from the skull.

The numbers, sites of recovery, color, and size of the larvae were recorded along with other data. Most of these chiggers were preserved and stored in 75 per cent ethyl alcohol. Representatives of each kind of larva were mounted for identification.

Whenever possible, well-engorged larvae were kept alive for rearing. Usually a single larva was placed in a small culture vial nearly filled with a hardened mixture of activated charcoal and plaster of Paris (Wharton, 1946). Upon emergence of a nymph the larval pelt was searched for and, if found, was mounted for identification. After 24 hours the nymph was preserved in 75 per cent ethyl alcohol. The preserved nymphs were usually cleared in warm lactophenol for approximately 24 hours before mounting. Both larvae and nymphs were mounted in polyvinyl alcohol lactophenol.

The nymphs were fed freshly laid collembolan eggs and upon emergence of adults, nymphal pels were recovered and prepared in the same way as larval pels. All 15 nymphs listed below were reared by one of us (W JW).

A phase contrast microscope was used to study the larvae and nymphs, and all drawings were made with the aid of a drawing tube.
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It would have been impossible to assemble the large numbers of mammals and examine them for chiggers without the help of many individuals. We are grateful to Dr. Elbert L. Sleeper and Dr. Dennis G. Rainey for mammals and for their helpful suggestions in the preparation of this paper.

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ACCOUNTS OF THE TAXA

The terminology used below usually follows Wharton, et al. (1951) for the larvae, and Crossley (1960) for the nymphs. All measurements are in microns. The description of each species is based upon the holotype, supplemented by additional information from the paratypes and referred specimens. Each nymph described below was identified by means of its recovered larval pelt. The characteristics of the larvae and nymphs shared by all four members of the genus are listed in the description of the genus. These characteristics usually are not repeated in the description of each species. The specimens listed below are in the collection of The Chigger Research Laboratory, Department of Biology, California State College at Long Beach, with the exception of four larvae: the holotype of O. sola, United States National Museum (USNM); one at Brigham Young University (BYU); and two at the Rocky Mountain Laboratory (RML). The holotype and one paratype of each species will be deposited in the collection of the Rocky
Mountain Laboratory, Hamilton, Montana and one paratype of each new species will be deposited in the following collections: United States National Museum; Snow Entomological Museum, The University of Kansas; The Hooper Foundation, University of California Medical Center, San Francisco; Los Angeles County Museum of Natural History; Brigham Young University; Dr. Anita Hoffmann, Mexico, D. F.; Institute of Acarology, Ohio State University; and to other appropriate institutions and individuals.

Otorhinophila gen. n.

Type species. — *Otorhinophila intrasola* sp. n.

Referred species. — *Trombicula sola* Gould, *O. sinaloae* sp. n. and *O. parvisola* sp. n.

**Diagnosis.** — Larva. Differs from all other genera in the subfamily Trombiculinae in having the following combination of characters: sensilla flagelliform with numerous branches and barbs; palpal tarsus with 5 branched setae; tibial claw trifurcate; cheliceral blade with tricuspid cap and prominent ventral tooth; legs I, II, and III each with 1 genuala; and leg III coxa with 3 setae and without tibiala and mastisetae. Seemingly closely related to *Euschoengastoides* Loomis, but differing from it in having genuala II and III (absent in *Euschoengastoides*), coxa III multisetose, usually with 3 setae (usually 1 seta in *Euschoengastoides*) and lacking tibiala III (usually present in *Euschoengastoides*); and to *Pseudoschoengastia* Lipovsky but differing from it in having flagelliform sensilla (clavate to capititate in *Pseudoschoengastia*), and lacking setae between coxae II and III (present in *Pseudoschoengastia*).

**Nymph.** Similar to *Euschoengastoides*, *Pseudoschoengastia* and *Gahrliepia* Womersley in having the hypostome short, blunt, with at least 20 short apical nude or nearly nude setae (usually a few more in *Otorhinophila*), pharynx with reticulate pattern, sensillary area with basal plate of well-separated halves; differing from *Euschoengastoides* in having a smooth tectal margin (margin with serrations in *Euschoengastoides*); and from *Euschoengastoides* and *Pseudoschoengastia* in having sensillary area narrow, ASL/SB, 2.0-3.0 (sensillary area wide, ASL/SB, 1.2-1.3 in *Euschoengastoides* and 1.7 in *Pseudoschoengastia*), ventral apodeme of basal plate present and conspicuous (seemingly absent in *Euschoengastoides* and *Pseudoschoengastia*); and from *Gahrliepia* in having 1 tectal seta (absent in *Gahrliepia*, and tarsus I without dorsoapical stumplike process (present in *Gahrliepia*).

**Description.** — Larva. Scutum roughly rectangular, AW less than PW, sensillary bases anterior to level of bases of PL's, sensilla flagelliform with distal two-thirds branched and proximal one-third with small barbs, AL's shorter than PL'S; tibial claw trifurcate, with prominent axial prong and 2 accessory prongs, palpal tarsus with 5 branched setae and tarsala, cheliceral blade with tricuspid cap and prominent ventral tooth, cheliceral base and capitular sternum moderately
punctate, galeal seta branched; eyes 2/2, subequal; dorsal body setae begin 2-6-6-6-6, resembling scutal setae; leg segments 7-7-7; leg I coxa, trochanter, and basifemur each with 1 branched setae, telofemur with 5 branched setae, genu with 4 branched setae, acuminate dorsal genuala and thick bladelike dorsal microgenuala, tibia with 8 branched setae, 2 short striated dorsal tibialae and short dorsal microtibialae, tarsus with 21 branched setae, tarsala, microtarsala, subterminala, and pretarsala; leg II coxa and trochanter each with 1 branched seta, basifemur with 2 branched setae, telofemur with 4 branched setae, genu with 3 branched setae and acuminate dorsal genuala, tibia with 6 branched setae and 2 short striated dorsal tibialae, tarsus with 15 branched setae, tarsala, microtarsala, and pretarsala; leg III coxa with 2-4 (usually 3) branched setae, trochanter with 1 branched seta, basifemur with 2 branched setae, telofemur with 3 branched setae, genu with 3 branched setae and acuminate dorsal genuala, tibia with 6 branched setae (tibialae lacking), tarsus with 15 branched setae and without mastisetae. All legs with segments punctate and ending in two stout claws without tenent hairs, and long slender empodium.

**Nymph.** Body, size medium to large (length 600 to 1000); body setae branched, not expanded, tips ending in 2-4 short attenuated branches; eyes absent. Sternal plate roughly pentagonal, closed behind. Tectum moderate in size, hyaline, without serrations on margin, with 1 tectal seta. Crista narrow but not rodlike. Two pairs parascutal setae adjacent to crista. Sensillary area narrow, mean ratio ASL/SB, 2.0-3.0, with sensillary bases placed well lateral and slightly anterior; bulla roughly triangular, moderate in size; ridges present; apodeme present and conspicuous; basal plate of well-separated halves; sensillary area without branched setae. Sensilla flagelliform with few branches to slightly expanded with numerous branches. Hypostome short, blunt with 20-30 short apical nude or nearly nude setae arranged in 2 rows, and 6-8 ventral branched setae. Pharynx with reticulate pattern. Basis capituli short, broad. Paalpal trochanter not elongated; palpus stout, not unusually large; distal portion of tibia not elongated, claw only slightly recurved, moderate in size, 2 accessory claws present; tarsus with 8 branched setae, 2 apical nude setae and tarsala. Cheliceral base slightly elongate; cheliceral blade shearlike. Precoxal plates absent. Tarsus I slightly elongated, without dorso-apical stumptlike process, claws undivided.

**Geographical distribution.** — Known from the deserts and thorn forests of western North America, from the states of Sinaloa, Sonora, and Baja California Norte, Mexico, northward into southern Arizona, southeastern California, and southern Nevada.

**Seasonal occurrence.** — Larvae have been found on hosts throughout the year.
Otorhinophila intrasola sp. n.

(Figures 1, 5N-S, 6J and 7)

Types. — Larvae, holotype and 53 paratypes as follows: Holotype and 6 paratypes from 8 miles south-southeast of Alamos (Rio Cuchujaqui), Sonora, Mexico, from the nasal passages of a Narrow-skulled Pocket Mouse, Perognathus artus Osgood, field number WJW630410-1, trapped 10 April 1963 by William J. WREN; 47 paratopotypes also from Perognathus artus, 10 April 1963 (19), 24 July 1960 (9), and 17 April 1962 (19 larvae).

Diagnosis. — Larva. Differing from other species in the genus in having axial and accessory prongs of tibial claw strongly recurved (straight in other species), and fewer branches on scutal, palpal, galeal, body and leg setae.

Nymph. — Differs from O. parvisola sp. n. in having TL longer, mean 95.3 (85.3 for O. parvisola), BL longer, mean 65.6 (58 for O. parvisola), and from O. sinaloae in having body longer, 775-964 (670 in O. sinaloae).

Description. — Larva (Fig. 1). Holotype (with differences among paratypes listed in parentheses).

Body: Slightly engorged, 150 by 265, color in life white; eyes 2/2, anterior slightly larger, ocular plate obscure, color in life red.

Dorsal setal formula 2-6-6-6-6-4-2, total 32; humeral seta 31, seta of first posthumeral row 24, posterior dorsal seta measuring 22.

Ventral setal formula 2-2+36, total 40; first sternal seta 24, posterior ventral seta measuring 23.

Scutum: Shape roughly rectangular with flared posterolateral margins, moderately punctate; sensilla flagelliform, with 15-18 branches on distal two-thirds, proximal one-third with small barbs. Scutal measurements of holotype (means and extremes of 12 paratypes in parentheses): AW, 41 (41.8, 39-43); PW, 53 (55, 52-60); SB, 22 (22.1, 22-23); ASB, 21 (21.2, 20-22); PSB, 16 (16, 15-17); AP, 26 (25, 23-28); AM, 18 (17.8, 16-21); AL, 19 (18.3, 17-19); PL, 25 (25.5, 24-27); S, 47 (46.7, 46-48). Scutal measurements for selected specimens from throughout the range with mean, ±SE, extremes (in parentheses), and number of specimens measured: AW, 40.8, ±.23 (36-45), 68; PW, 55, ±.30 (50-60), 67; SB, 22.6, ±.15 (19-25), 69; ASB, 21.1, ±.13 (19-23), 69; PSB, 16.2, ±.13 (14-18), 69; AP, 25.6, ±.19 (23-30), 69; AM, 16.7, ±.19 (14-20), 60; AL, 16.9, ±.25 (13-20), 65; PL, 25.6, ±.21 (22-29), 69; S, 45.5, ±.22 (42-48), 61.

Gnathosoma: Galeal seta, left nude, right forked (of 74 setae, 69 per cent nude, 19 per cent forked, and 12 per cent with 3-5 branches). Palpal formula N/N/BFF; palpal tarsus with 5 moderately branched setae and tarsala (5 μ); tibial claw trifurcate with axial and accessory prongs strongly recurved.
Legs (measurements and differences from other species): Leg I with tarsala 16 μ (16.8, 16-18); leg II with tarsala 21 μ (21.3, 21-22); leg III with 3 branched setae on coxa. Leg index (length of leg from coxa to tip of tarsus excluding claws) of holotype (with means and extremes of 6 paratypes in parentheses): I, 221 (202, 188-216); II, 179 (176, 168-185); III, 209 (204, 190-219); T, 609 (587, 561-619).

**Nymph** (Figs 5N-S, 6J). Based on 7 specimens unless otherwise noted. The measurements listed below include the mean (with the extremes in parentheses). Similar to other species except as follows:

- **Body**: About 900 long, color white. Posterior body setae short, length 14-15, ending in 2-4 short attenuated branches. Sternum with 6.8 (5-8) setae (5 specimens). Measurements of tarsus I (6 specimens): TL, 95.3 (80-109); TH, 42.7 (42-45); TL/TH, 2.2 (1.9-2.4).

- **Scutum**: Tectal seta short with few branches. Sensilla with distal two-thirds slightly expanded, with numerous small branches, proximal one-third with small barbs. Scutal measurements: ASL, 53.7 (45-58); SB, 19.4 (18-21); TS, 10.6 (9-12); S (6 specimens), 54 (47-59); ASL/SB, 2.8 (2.4-3.0).

- **Gnathosoma**: Hypostome with 26 nude or nearly nude apical setae. Pharynx with reticulate pattern covering about two-thirds its width. Cheliceral blade with 9-11 small teeth. Cheliceral measurements: BL, 65.6 (62-69); BH, 26.7 (24-28); CL, 31.4 (29-35); BL/BH, 2.5 (2.3-2.7); BL/CI, 2.1 (2.0-2.2). Palps punctate, stout, moderate in size; accessory claws thin, dorsal tibial setae large; tarsala (4 specimens), 7. Setal counts (6 specimens): femur, 6.4 (6-7); genu, 8.3 (7-10); tibia, 5.1 (5-6); tarsus (4 specimens), 8.

**Taxonomic remarks.** Larvae of *O. intrasola* from other localities agree with the type series in all important characters. However, they seem to exhibit a slight clinal variation from south to north in having a decrease in the average size of the scutum, a decrease in the number of branches on the setae and an increase in the average length of tarsala II. The recurved condition of the axial and accessory prongs of the palpal claw remains constant throughout the range of the species. The number of setae on coxa III (based on 118 counts) are: 5 per cent with two setae, 86 per cent with three setae, and 9 per cent with four setae. The means (extremes in parentheses) of the leg indices for 27 specimens from throughout the range are: I, 215 (191-232); II, 183 (161-198); III, 215 (188-232); T, 613 (547-654).

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**Fig. 1.** *Olorhinophila intrasola*. Larva.

Ecological notes. — All but one of the larvae were recovered from the nasal passages of heteromyid rodents. This single specimen was recovered from the nasal passage of the cricetid mouse, *Peromyscus eremicus*. Other known hosts include: *Perognathus artus*, *P. goldmani*, *P. intermedius*, *P. penicillatus*, *P. pernix*, and *Liomys pictus*. Larval *O. intrasola* and *O. parvisola* sp. n. were found together on two individuals of *Perognathus penicillatus* from near Guaymas, and on one *P. intermedius* from 0.5 miles west of Tajitos, Sonora, Mexico. Of 51 *Perognathus artus* examined from the type locality, 10 were found to harbor *O. intrasola*, and the number of larvae recovered varied from 1 to 34 with an average of 10 for each parasitized mouse. The maximum number of 50 larvae was recovered from one *Liomys pictus* taken in July, 12 miles northeast of El Fuerte, Sinaloa.

The larvae of *O. intrasola* were found in the anterior portions of the nasal passages and they were seen to move freely in the nasal mucous. In addition, they were not attached, and stylostomes were not seen.

*Audy* and *Nadchatram* (1957: 227) inferred that intranasal larvae remain in the nasal passages of their hosts for long periods of time, and *Harrison* (1957:391) observed three larvae of *Doloisia intermedia* (*Audy* and *Nadchatram*) leaving two wild rats at intervals of 9, 11, and 14 days. Four larvae of *O. intrasola* were recovered from the nasal passages of *Perognathus artus* 26 days after capture.

The nymphs of *O. intrasola* were active in the cultures and they fed successfully on freshly laid collembolan eggs. Adults have been reared, but no eggs were observed.

Geographical distribution. — Known only from northwestern Mexico, from northern Sinaloa, northward to northwestern Sonora.

Seasonal occurrence. — Larvae have been found in the months of April, June, August, and December. Since these were the only months (except March) in which mammals were obtained from the known range of *O. intrasola*, it seems reasonable to assume that more collecting will demonstrate their presence throughout the year.


Otorhinophila sinaloae sp. n.

Types. — Larvae, holotype and 81 paratypes as follows: Holotype and 15 paratypes from 55 miles north of Mazatlan (Rio Piaxtla), Sinaloa, Mexico, from the nasal passages of a Sinaloan Pocket Mouse, *Perognathus pernix* J. A. Allen, field number RBL621217-15, trapped 17 December 1962 by Alan R. HARDY and Gerald R. NOONAN; and, 66 paratypes, same host species and date.

Diagnosis. — Larva. Differing from *O. sola* and *O. parvisola* sp. n. in having scutum smaller, PW, mean 56.6 (71 for *O. sola*, 61.8 for *O. parvisola*), and an intranasal parasite; from *O. intrasola* in having axial and accessory prongs of palpal claw straight (strongly recurved in *O. parvisola*), and more branches on galeal seta and setae of palpal femur and genu (usually nude or forked in *O. intrasola*).

Nymph. Similar to *O. parvisola* and *O. intrasola*, but differing from *O. parvisola* in having TL longer, mean 98 (85.3 in *O. parvisola*), BL longer, mean 64 (58 in *O. parvisola*), ASL longer, mean 52.5 (48 in *O. parvisola*), and differing from *O. intrasola* in having body length smaller, 670 (775 to 964, 3 nymphs).

Description. — Larva. Holotype (with differences among paratypes listed in parentheses).

Body: Fully engorged, 412 by 811, color in life white; eyes 2/2, anterior larger, ocular plate lacking, color in life red.

Dorsal setal formula 2-6-6-6-6-4-2, total 32; humeral seta 32, seta of first posthumeral row 24, posterior dorsal seta measuring 22.

Ventral setal formula 2-2+4-0, total 44; first sternal seta 25, posterior ventral seta measuring 22.

Scutum: Shape roughly rectangular with flared posterolateral margins, moderately punctate, sensilla flagelliform with 13 to 14 branches on distal two-thirds, proximal one-third with small barbs.

Scutal measurements of holotype (with means and extremes of 14 paratypes in parentheses): AW, 43 (40.6, 39-44); PW, 59 (56.6, 53-60); SB, 28 (25.3, 24-28); ASB, 21 (20.9, 20-24); PSB, 17 (16.8, 15-18); AP, 29 (27.6, 26-30); AM, 17 (17-21);
AL, 21 (19.6, 19-21), PL, 26 (25.6, 25-26); S, 46 (43.8, 41-46). Scutal measurements for 18 selected specimens examined from throughout the range with means, ± SE and extremes (in parentheses): AW, 40.9, ±3.5 (39-44); PW, 56.3, ±4.2 (53-60); SB, 24.9, ±2.6 (23-28); ASB, 21.1, ±2.3 (20-24); PSB, 16.8, ±2.0 (15-18); AP, 27.4, ±2.7 (26-30); AM, 18.5, ±3.2 (17-21); AL, 19.5, ±2.0 (18-21); PL, 25.9, ±3.0 (24-29); S, 43.5, ±4.3 (40-46).

Gnathosoma: Galeal seta with 4-5 branches (4.3, 3-6). Palpal formula B/B/BBB; palpal tarsus with 5 branched setae and tarsala (5 p.); tibial claw trifurcate with axial and accessory prongs straight.

Legs (measurements and differences): Leg I with tarsala 16 (15.8, 15-16); leg II with tarsala 19 (19.4, 19-20), leg III with 3 (3-4) branched setae on coxa. Leg index of holotype (with means and extremes of 4 paratypes in parentheses): I, 226 (216, 213-219); II, 190 (183, 176-190); III, 226 (221, 212-237); T, 642 (620, 606-631).

NYMPH (Figs 6A-F, K). Based on 2 specimens unless otherwise noted. Resembling other species except as follows:


Scutum: Tectal seta short with few branches. Sensilla with distal two-thirds slightly expanded, with numerous small branches, proximal one-third with small barbs. Scutal measurements: ASL, 52, 53; SB, 19, 20; TS, 13, 12; S, 56, 58; ASL/SB, 2.7, 2.7.

Gnathosoma: Hypostome with 24 nude or nearly nude apical setae. Cheliceral blade with 9-11 small teeth. Cheliceral measurements: BL, 63, 65; BH, 29, 28; CL, 29, 31; BL/BH, 2.2, 2.3; BL/CL, 2.2, 2.1. Palpal tarsala 7, 7. Setal counts: femur 6-7, 7-7; genu, 7-8, 7-8; tibia 5-5, 5-5; tarsus 8-8, 8-8.

Taxonomic remarks. Larvae of O. sinaloae examined from other localities agree with the type series in all characters. Of 36 coxae III examined, 97 per cent had three setae, while only 3 per cent had four setae. The means (extremes in parentheses) of the leg indices for 9 specimens from throughout the range are: I, 215 (197-226); II, 184 (176-193); III, 212 (209-237); T, 619 (581-642).

Ecological notes. This species was found in the anterior portions of the nasal passages of heteromyid rodents. The larvae were not attached and no stylostomes were observed. Of 38 Perognathus pernix examined from the localities below,
II harbored *O. sinaloae* and the number of larvae varied from 1 to 30, average 11. Two of 13 *Liomys pictus* had 4 and 26 larvae.

**Geographical distribution.** — Known only from the Tropical Thorn Forest in central coastal Sinaloa, Mexico.

**Seasonal occurrence.** — The incidence of this species in the three known host species was 6 percent in June, 13 percent in August, and 44 percent in December, and it is reasonable to assume that it occurs in the nasal passages throughout the year.

**Specimens examined.** — Total, 105 larvae and 2 nymphs:


*Otorhinophila parvisola* sp. n.  
(Figures 3, 5G-M, 6H and 7)

**Types.** — Larvae, holotype and 78 paratypes as follows: Holotype and 19 paratypes from 9 miles northwest of Guaymas (near Bahia San Carlos), Sonora, Mexico, from deep in the ears of a Southern Grasshopper Mouse, *Onychomys torridus* (Coues), field number RBL600766-6, trapped 6 July 1960, by Richard B. Loomis; 59 paratopotypes taken 26 June 1962, from *Perognathus penicillatus* (39) and *Dipodomys merriami* (20 larvae).

**Diagnosis.** — **LARVA.** Differing from *O. sola* in having tarsala II shorter, 18-19, mean 18.9 (21-26, mean 23.8 for *O. sola*), tibialae II not in tandem (tibialae II in tandem in *O. sola*); from *O. sinaloae* in having scutal plate longer, mean of AW, 54 (41 for *O. sinaloae*), scutal setae longer, PL, 31-36, mean 34.5 (25-26, mean 25.6 for *O. sinaloae*), tarsala I shorter, 12-13, mean 12.1 (15-16, mean 15.8 for *O. sinaloae*); and from *O. intrasola* in having axial and accessory prongs of palpal claw straight (strongly recurved in *O. intrasola*).

**NYMPH.** Smaller in size than other known nymphs in the genus with mean ASL, 48 (63.3 for sola, 53.7 for *O. intrasola*, 52.5 for *O. sinaloae*).

**Description.** — **LARVA** (Fig. 3). Holotype (with differences among paratypes listed in parentheses).

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**Fig. 3.** — *Otorhinophila parvisola*. Larva.
Body: Slightly engorged, 225 by 367, color in life white; eyes 2/2, anterior slightly larger, ocular plate seemingly present, color in life red.

Dorsal setal formula 2-6-6-6-2-6-2. total 36; humeral seta 35, seta of first posthumeral row 29, posterior dorsal seta measuring 24.

Ventral setal formula 2-2+47, total 45; first sternal seta 24, posterior ventral seta measuring 24.

Scutum: Shape roughly rectangular with flared posterolateral margins, moderately punctate, sensilla flagelliform with 17-21 branches on distal two-thirds, short barbs on proximal one-third.

Scutal measurements of holotype (with means and extremes of 19 paratypes in parentheses): A_W, 54 (51.9, 50-55); PW, 65 (61.8, 58-65); SB, 29 (28.6, 26-31); ASB, 22 (22.1, 21-24); PSB, 18 (17.4, 15-19); AP, 29 (28.5, 26-30); AM, 22 (21.3, 19-24); AL, 24 (23.5, 21-25); PL, 35 (34.5, 31-36); S, 49 (46.2, 44-49). Scutal measurements for selected specimens from throughout the range with mean ±SE, extremes (in parentheses), and number of specimens measured: A_W, 53.9, ±3.3 (48-61), 92; PW, 63, ±3.3 (56-72), 96; SB, 29.9, ±2.6 (25-36), 99; ASB, 23.2, ±1.3 (21-28), 98; PSB, 17.7, ±1.3 (15-22), 98; AP, 28.8, ±1.3 (25-32), 100; AM, 23.3, ±3.0 (19-28), 59; AL, 23.8, ±1.5 (20-28), 89; PL, 34.8, ±1.9 (30-39), 86; S, 49.8, ±3.8 (42-56), 81.

Gnathosoma: Galeal seta with 9 branches. Palpal formula B/B/BBB; palpal tarsus with 5 branched setae and tarsala (4); tibial claw trifurcate with axial and accessory prongs straight.

Legs (measurements and differences): Leg I with tarsala 12 (12.1, 12-13); leg II with tarsala 19 (18.9, 18-19); leg III with 3 (2-4) branched setae on coxa. Leg index of holotype (with means and extremes of 9 paratypes in parentheses): I, 218 (224, 206-238); II, 189 (187, 178-194); III, 225 (218, 213-231); T, 632 (628, 597-637).

Nymph (Figs 5G-M, 6H). Based on 3 specimens unless otherwise noted. Similar to other species except as follows:

Body: Smaller, about 600 long. Posterior body setae length 12-15. Sternum with 5-8 setae. Measurements of tarsus I: TL, 85.3 (78-90); TH, 40.6 (39-42); TL/TH, 2.1 (2.0-2.2).

Scutum: Smaller. Sensilla shorter, distal two-thirds slightly expanded, with numerous short, stout branches and proximal one-third with small barbs. Scutal measurements: ASL, 48 (44-51); SB, 18.7 (17-20); TS, 11 (2 specimens); S, 54 (2 specimens); ASL/SB, 2.6.

Gnathosoma: Hypostome with 22-24 nude or nearly nude apical setae. Cheliceral blade with 9-11 teeth. Cheliceral measurements: BL, 58 (54-62); BH, 26.7 (24-29); CL, 27.7 (25-29); BL/BH, 2.2 (2.1-2.3); BL/CL, 2.1 (2.0-2.2). Palpal tarsala length, 5-6. Setal counts (2 specimens): femur, 5.9 (5-7); genu, 6 (5-8); tibia, 4.9 (4-5); tarsus, 8.
Taxonomic remarks. — Larvae of *O. parvisola* examined from other localities agree with the type series except for 25 specimens from 3 miles north of Puertecitos, Baja California Norte. This is approximately 2.5 miles north of the locality where *O. sola* and other *O. parvisola* have been found on the same host. These 25 specimens have certain structures which were larger than those of the type series. For example, the means and ±SE of the AW of the type series and of this series are 51.9 ± 3.2 and 58.2 ± 3.7, respectively; and the means and ±SE of tarsala I are 12.1 ± 0.7 and 14.9 ± 1.1, respectively. However, this population agrees with the type series in other characters.

The number of setae on coxa III (196 counts) is: 2 per cent with two setae, 84 per cent with three setae, and 14 per cent with four setae. The means (with extremes in parentheses) of leg indices for 32 specimens from throughout the range are: I, 230 (206-244); II, 194 (171-209); III, 228 (208-246); T, 649 (595-708).

Ecological notes. — In California, *O. parvisola* has been found almost exclusively on *Neotoma lepida*. Ten of 48 wood rats examined from localities where *O. parvisola* has been taken were parasitized by this chigger. In addition, larvae were found on 2 *Perognathus formosus*. Other mammals examined from the same localities were not found to be parasitized by this trombiculid. Both *O. parvisola* and *O. sola* were recovered from deep in the ears of the same individual of *Neotoma lepida* from Lost Palms Canyon in Joshua Tree National Monument.

In Baja California Norte, *O. parvisola* was found on 11 of 15 *Perognathus formosus* from near Puertecitos. Also, *O. sola* and *O. parvisola* were found together on the same individual of *Perognathus penicillatus*, taken in December.

In Sonora, *O. parvisola* has been found on more kinds of hosts and has been taken twice from *Perognathus penicillatus* and once from *P. intermedius* that also harbored *O. intrasola*.

Mold seemed to be the limiting factor in rearing the nymphs of this species, and those which were successfully cultured were not observed to feed upon collembo lan eggs.

Geographical distribution. — Known from Mexico in Sonora (north of Guaymas) and Baja California Norte (Puertecitos), north to southern Arizona and southeastern California (San Bernardino County, Joshua Tree National Monument).

Seasonal occurrence. — In California and Arizona this species can be found from May through October, and in Mexico it has been taken in the months of April through July, November and December.


Otorhinophila sola (Gould) New Combination
(Figures 4, 5A-F, 6G and 17)


Diagnosis. — Larva. Differing from other species in the genus in having scutum larger; galeal seta usually with more branches; and bases of tibialae I in tandem, with proximal tibia slightly posterolateral to distal tibia, and base

![Image of Otorhinophila sola Larva](Fig. 4)
of microtibiala posterad to both tibialae (bases of tibialae I not in tandem in other species).

**NYMPH.** Differing from other known nymphs in the genus in having sensilla flagelliform with few branches (sensilla slightly expanded with numerous branches in other species); TL longer, mean 113.3.

**Description.** — **LARVA (Fig. 4).**

Body: Fully engorged, 335 by 632 (1 specimen), color in life pale yellow to white; eyes 2/2, anterior larger, ocular plate lacking, color in life, red.

Dorsal setal formula 2-6-6-6-2-4-2, total 34; humeral seta 47, seta of first posthumeral row 39, posterior dorsal seta measuring 26.

Ventral setal formula 2-2+32 to 50, total 36 to 54; first sternal seta 35, posterior ventral seta measuring 29.

Scutum: Shape roughly rectangular with flared posterolateral margins, moderately punctate, sensilla flagelliform with 10-12 branches on distal two-thirds, proximal one-third with small barbs.

Our scutal measurements of holotype (with mean ± SE and extremes of 13 specimens in parentheses): AW, 56 (59. ± 66, 56-63); PW, 71 (71, ± 45, 69-74); SB, 34 (33.9, ± 42, 31-36); ASB, 24 (25.5, ± 89, 22-28); PSB, 18 (18.8, ± 40, 17-21); AP, 29 (31.8 ± 85, 27-35); AM, ? (33.6, ± 87, 29-38); AL, 29 (27.2, ± 37, 26-29); PL, 40 (43-5. ± 65, 39-46); S, 55 (58.7, ± 1.72, 49-65).

Gnathosoma: Galeal seta with 2 branches. Palpal formula B/B/BBB; palpal tarsus with 5 branched setae, and tarsala (5 μ); tibial claw trifurcate with axial and accessory prongs straight.

Legs (measurements and differences): Leg I with tarsala 14 (15-3, 14-16); leg II with tarsala 21 (23.8, 21-26); leg III with 2.2 (2-4, usually 3) branched setae on coxa. Leg index, holotype, (mean and extremes of 10 specimens): I, 247 (272, 259-302); II, 216 (235, 216-237); III, 253 (263, 238-294); T, 716 (770, 718-853).

**NYMPH (Figs 5A-F, 6G).** Based on 3 specimens unless otherwise noted. Similar to other nymphs except as follows:

Body: Larger, about 900 to 1000 long; posterior body setae length about 18.

Sternum with 11 (8-13) setae. Measurements of tarsus I: TL, 113.3 (75-133); TH, 52 (49-55); TL/TH, 2.2 (1.5-2.6).

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**Fig. 5.** — Features of nymphs (to same scale).

*Otorhinophila sola*: A. Scutum; B. Palpal tibiotarsus; C. Chelicera and cheliceral apodeme; D. Sternum; E. Hypostome; F. Posterior body setae.

*O. parvisola*: G. Scutum; H. Palpal tibiotarsus; J. Chelicera and cheliceral apodeme; K. Sternum; L. Hypostome; M. Posterior body setae.

*O. intrasola*: N. Scutum; O. Palpal tibiotarsus; P. Chelicera and cheliceral apodeme; Q. Sternum; R. Hypostome; S. Posterior body setae.
Scutum: Sensilla flagelliform with branches on distal two-thirds, small barbs on proximal one-third. Scutal measurements: ASL, 63.3 (54-68); SB, 27.7 (24-32); TS (2 specimens), 10 (9-11); S (2 specimens), 67.5 (67-68); ASL/SB, 2.3 (2.0-2.8).

Gnathosoma: Hypostome with about 30 nude or nearly nude apical setae and 8 ventral branched setae. Cheliceral blade with 12.6 (12-15) small teeth; apodeme narrow and elongate. Cheliceral measurements: BL, 73.3 (63-79); BH, 38 (32-45); CL, 38.7 (32-43); BL/BH, 1.95 (1.8-2.1); BL/CL, 1.9 (1.8-2.0). Palpal tarsala length 7 (6-8). Setal counts: femur, 6.2 (5-7); genu, 8.3 (7-9); tibia, 5; tarsus, 8.

Taxonomic remarks. — We examined the holotype of Trombicula sola Gould, and found it in good condition, with nearly all features discernable. We obtained pertinent measurements and verified the presence and position of all nude setae on the legs, as described above. The specimens of O. sola from southern Nevada and southeastern California closely resemble the holotype in all characters evaluated. Although Gould (1956 : 46) did not mention the subterminalai, or the number of setae on the palpal tarsus, we were able to verify the presence of a subterminalai and five branched setae on the palpal tarsus in the holotype. Five larvae examined from California and Nevada and one larva from Baja California Norte have two branched setae on coxa III and the lengths of tarsala I and II are 14-15 and 21-23, respectively. The remaining eight larvae from Baja California Norte have three branched setae on coxa III (except for one coxa which has four setae) and the lengths of tarsala I and II are 16 and 24-26, respectively. In addition, the scutal measurements and leg indices of the larvae from California and Nevada seem to be slightly smaller and they have fewer ventral body setae.

Ecological notes. — In California and Nevada O. sola has been taken only from Neotoma lepida and in Baja California Norte from both Neotoma lepida and Pergnathus penicillatus. As previously mentioned, this species of chigger has been recovered with O. parvisola from the same individuals of Neotoma lepida and Pergnathus penicillatus.

It seems reasonable to assume that the free-living stages of this and the other species inhabit the burrows and nest area of the host. The nymphs were moderately active in cultures and seemed to feed upon freshly laid collembolan eggs.

Geographical distribution. — Known from Mexico, in Baja California Norte (Puertecitos), northward to southeastern California and southern Nevada (Nye County).

Seasonal occurrence. — Larvae of O. sola have been found in the months of January, August, October and December.

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KEY TO THE LARVAE OF Otorhinophila

1. Tibia I with bases of tibialae in tandem, proximal tibiala slightly posterolateral to distal tibiala, and base of microtibiala posterad to both tibialae (see Fig. 4F); galeal seta with numerous branches....O. sola
1'. Tibia I with bases of tibialae not in tandem, proximal tibiala posterolateral and slightly proximal to distal tibiala, with base of microtibiala between tibialae (see Figs. 1F, 2F, 3F); galeal seta nude or branched.........................2

2. Galeal seta branched; palpal claw with axial and accessory prongs straight..3
2'. Galeal seta usually nude or forked; palpal claw with axial and accessory prongs strongly recurved; in nasal passages of heteromyid rodents (Perognathus and Liomys)....O. intrasola

3. Galeal seta with 8 or more branches; scutum larger, with AW 48-61, PL 30-39; deep in ears of various rodents.................................O. parvisola
3'. Galeal seta with 3 to 6 branches; scutum smaller, with AW 39-44, PL 24-29; in nasal passages of heteromyid rodents (Perognathus and Liomys)....O. sinaloae

KEY TO THE NYMPHS OF Otorhinophila

1. Sensilla flagelliform with few branches.............................O. sola
1'. Sensilla slightly expanded with numerous branches..............2

2. Body larger (750-1000 in length)..................................O. intrasola
2'. Body smaller (600-700 in length).................................3

3. Cheliceral base length (BL) longer, mean 64 (63-65); ASL longer, mean 52.5; TL longer, mean 98 (97-99).........................O. sinaloae
3'. BL shorter, mean 58 (54-62); ASL shorter, mean 48 (44-51); TL shorter, mean 85.3 (78-90)..........................O. parvisola

DISCUSSION

Based on consideration of both the larval and nymphal stages of all four species, the following relationships are proposed.

Fig. 7. — Distribution of the four species of Otorhinophila.
The shading shows the estimated range for each species. The following symbols represent localities listed under specimens examined: Triangle, O. sola, open triangle is the type locality; solid circle, O. parvisola; open circle, O. sinaloae; and solid square, O. intrasola.
Although the larvae are similar morphologically, *Otorhinophila* can be divided into two groups on the basis of nymphal characteristics 1) *O. sola* and 2) the other three species. The several differences exhibited by the nymphal stage of *O. sola* suggests an early separation from an ancestral form. The species *O. sola* seems to be most closely related to *O. parvisola*, as shown by larval morphology, the choice of similar hosts and the same parasitope deep within the ears. Although they are sympatric over a considerable area in southeastern California and northeastern Baja California, *O. parvisola* also occurs throughout much of the Sonoran Desert in southern Arizona and Sonora, Mexico.

The other two species, *O. sinaloae* and *O. intrasola*, share the preference of an intranasal parasitope and along with *O. parvisola* have nymphs which are extremely close morphologically. In larval characteristics, the allopatric southern intranasal species *O. sinaloae* is closer to *O. parvisola* rather than to the other intranasal species *O. intrasola*, which has been taken within 50 miles of *O. sinaloae*. Larvae of *O. intrasola* have been found with *O. parvisola* where their ranges overlap in Sonora. The larva of *O. intrasola* seems to have the greatest number of modifications in response to the intranasal parasitope. Similar changes also can be seen in the larvae of other intranasal species in such distantly related genera as *Microtrombicula* and *Doloisia*. When intranasal chiggers are compared to closely related species which do not invade the nasal passages, larvae of the former group usually show these modifications. The palpal claw frequently is strongly recurved, and there is a reduction in the branching, lengths, and total numbers of setae on the body, palps, and legs, as well as having a smaller scutal plate.

**SUMMARY AND CONCLUSIONS**

Taxonomic studies of 934 larval and 15 nymphal chiggers recovered from more than 155 hosts have resulted in the recognition of four species, three of which are new. They are placed in a new genus, *Otorhinophila*, which is closely related to *Euschoengastoides* and *Pseudoschoengastia*.

The genus *Otorhinophila* is found in the Mojave and Sonoran deserts and the adjacent Tropical Thorn Forest of southwestern United States and northwestern Mexico. The four species exhibit few morphological differences either as larvae or nymphs. Larvae of *O. sola* and *O. parvisola* regularly attach to an external site, usually within the ears, on a variety of small rodents, whereas *O. intrasola* and *O. sinaloae* are intranasal chiggers of heteromyid rodents only.

The larvae of *O. sola*, *O. parvisola*, and *O. sinaloae* seem closer morphologically to each other than any one of these is to *O. intrasola*. The species *O. sola* and *O. parvisola* are partially sympatric, have a similar external parasitope, and are found on a variety of hosts, whereas *O. sinaloae* is allopatric and has an intranasal parasitope. The species *O. intrasola*, although sympatric with *O. parvisola* at three localities, exhibits several larval differences, including the recurved palpal claw.
Similar characteristics shared by *O. intrasola* and *O. sinaloae*, including the smaller body and scutal size and relatively fewer branches on many setae, probably are due to the influence of the same parasitope. The species *O. parvisola* seems to be intermediate between the intranasal forms and *O. sola* in the larval features.

As nymphs, *O. parvisola*, *O. intrasola*, and *O. sinaloae* are almost indistinguishable from each other and they differ from *O. sola* in several prominent characters.

The morphology of the nymph seems to be conservative, and the characteristics probably change at a different and slower rate than those of the larvae due to different environmental factors. The nymphs of all four species probably live in similar niches, whereas two different parasitopes are occupied by the larvae. Thus among these four species the nymphs seem to show the relationships, and the larvae exhibit the specific differences.

Therefore, our conclusions are (1) the three species *O. parvisola*, *O. sinaloae*, and *O. intrasola* are more closely related to each other than any one is to *O. sola*, (2) based on the differences in the nymphs, *O. sola* seemingly became a species prior to the separation and development of the other three species, and (3) the similarity of the nymphs of *O. parvisola* and the intranasal species seems to indicate that while the larvae of *O. intrasola* and to a lesser extent *O. sinaloae*, have responded morphologically to an intranasal parasitope, the nymphal stage has remained relatively unchanged.

**LITERATURE CITED**

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