

**BIODIVERSIDAD,
TAXONOMÍA Y BIOGEOGRAFÍA
DE ARTRÓPODOS DE MÉXICO:**
Hacia una síntesis de su conocimiento

VOLUMEN III



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GEOPHILOMORPHA

Donatella Foddai¹, Luis Alberto Pereira² & Alessandro Minelli¹

RESUMEN. En México se han registrado 69 especies de ciempiés Geophilomorpha, agrupadas en 30 géneros y ocho familias, de las 12 reconocidas en el mundo. La familia Eriphantidae, de Baja California, es endémica de México. Los Geophilomorpha mexicanos poseen un fuerte carácter endémico, con 12 géneros exclusivos del país; los restantes muestran una mayor afinidad con la región Neártica (siete géneros) que con la Neotropical (cinco géneros). Geophilidae, la familia del orden con mayor riqueza y de distribución mundial, posee ocho géneros y 35 especies en México. Schendylidae, la segunda familia del orden en riqueza y también con distribución mundial, está representada por siete géneros y 14 especies. Es interesante mencionar la ausencia o la presencia limitada de los géneros *Pectiniunguis* y *Schendylops* (Schendylidae), y *Ribautia* (Geophilidae), caracterizados por su abundancia en la región Neotropical al sur de México. La familia pantropical Ballophilidae solo posee dos especies. Se presenta un catálogo de las especies registradas para México hasta el momento. El conocimiento actual de la fauna mexicana de Geophilomorpha aún es muy incompleto: no se conocen especies de 13 de los 32 estados del país; en los restantes, el conocimiento no es homogéneo y en muchos casos es escaso, estando limitado a un solo taxón (con frecuencia un solo espécimen) registrado para una sola localidad.

INTRODUCTION

Geophilomorphs are multilegged arthropods (Fig. 20.1), easily distinguishable from other represen-

tatives of the class Chilopoda (centipedes) by their very elongated trunk, composed by 27 to 191 leg-bearing segments (this number is always odd). In Mexico, as well as in other Latin American countries, centipedes are commonly called 'ciempiés'. Geophilomorphs are known from all continents (except for the Antarctica), where they inhabit very different biotopes, from the sea level to very high elevations in the Andes and the Himalayas, from fairly dry biotopes to those periodically flooded as inundation forests in Amazonia. A number of species have adapted to life on the seashore, a habitat that has been generally difficult to colonize by terrestrial arthropods. Even so, these animals are generally little studied or understood and this is specially true for the taxa occurring in Mexico.

HISTORICAL ACCOUNT

The first author to describe a geophilomorph species from Mexico was Saussure (1858). In the following 42 years up to the turn of the century, five authors contributed by naming a total of 10 additional new species from the country, while one more species, originally described from Guatemala, was reported from Mexico (Table 20.1). Half of these new taxa were published by Pocock in the monumental series "Biologia Centrali-Americana". All the remaining species, together with some new genera and one new family, were originally described or reported from Mexico in a few papers by six authors only. Attems (1903, 1947) described two new species. Silvestri (1918) described two new species which he accommodated in two new genera, *Neogeophilus* and *Evallogeophilus*, and proposed for them the new family Neogeophilidae. Verhoeff (1926, 1934) described three new species, two of which were placed in the new genus *Aztekophilus* (1934). Crabill (1959a, b, 1961a, b, 1968, 1969a, b, 1970) described eight

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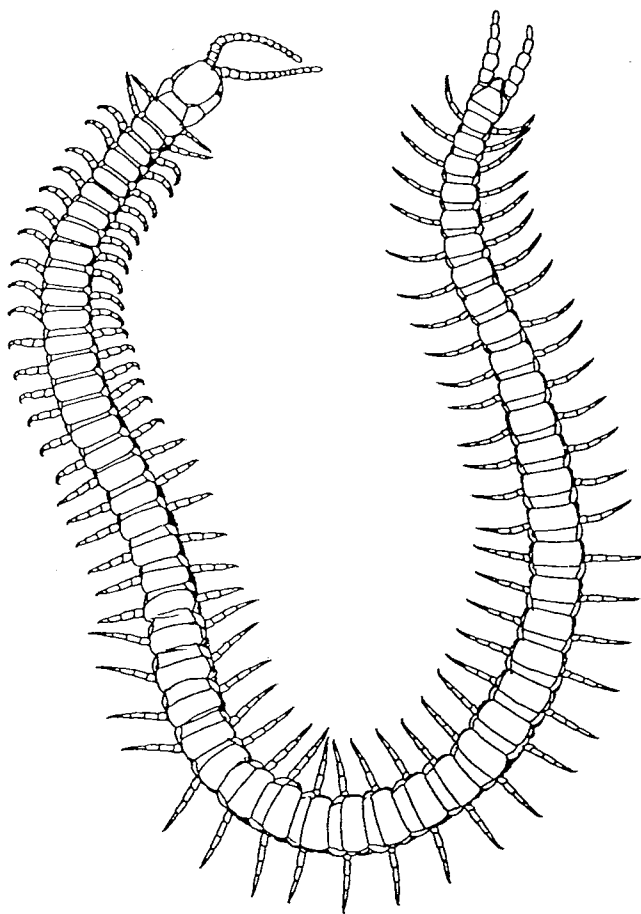


Fig. 20.1. *Pectiniunguis halirrhytus* Crabill, 1959. Habitus. Male with 59 pairs of legs, body length 49 mm from Mexico, Quintana Roo, Ascension Bay.

new species and three new genera, the himantariid *Geoballus* and *Straberax* (1969b) and *Eriphantes*, for which the new family Eriphantidae was also described (1970). But it was Chamberlin who described the majority of the species (44) and 13 new genera, 10 of which have their type species in Mexico (Tab. 20.1; see also appendix 20.1). After 1970 no new species has been described from Mexico and no new record has been published from the country (Fig. 20.2).

HABITS AND HABITATS

Geophilomorphs are small to medium-sized arthropods, mostly measuring 3 to 5 cm, but with wide variation in size both interspecifically and intraspecifically. The minimum length ever recorded for an adult specimen is 4.5 millimetres in *Dinogeophilus oligopodus* Pereira, 1984, a geophilid species described from Argentina. The maximum length is 19.5 centimetres in *Himantarium gabrielis* (Linnaeus, 1767), an himantariid species of the Old World. In Mexico, the largest species is *Notiphilides maximiliani* Humbert & Saussure, 1870, a representative of the pantropical family Oryidae, known to reach up to 11.5 centimetres.

As to the number of pairs of legs, in the species thus far known, the extremes ever recorded for the whole order worldwide are a minimum of 27, hitherto recorded for a single specimen of *Schendyllops oligopus* (Pereira *et al.*, 1995) from Amazonia

Table 20.1. Authors of Geophilomorph descriptions of species occurring in Mexico. The species marked with an asterisk were originally described from Guatemala and later collected in Mexico.

Date(s) of publications	Author(s)	Nationality	Numbers of species
1858	Saussure	Swiss	1
1869-1870	Humbert - Saussure	Swiss	5
1889	Bollman	U.S.A.	1
1896	Pocock	English	4*
1899	Cook	U.S.A.	1
1903-1947	Attems	German	2
1912-1944	Chamberlin	U.S.A.	44
1918	Silvestri	Italian	2
1926-1934	Verhoeff	German	3
1959-1970	Crabill	U.S.A.	8

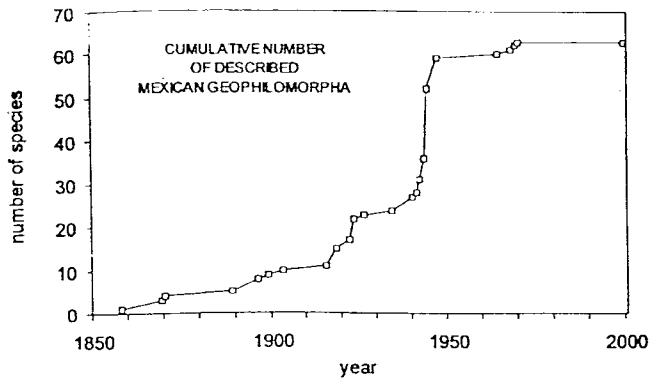


Fig. 20.2. Progress in the description of species of geophilomorph centipedes through time. The peak in the 1940's represents Chamberlin's production.

(Minelli *et al.*, 2000), and a maximum of 191 found in *Gonibregmatus plurimipes* Chamberlin, 1920 from the Fiji Islands. A number (29) slightly higher than the minimum is found in four species in the order, two of which are Neotropical: *Schendylops oligopus*, again, and *Dinogeophilus oligopodus* Pereira, 1984.

Most geophilomorphs live in the soil, under stones and roots, where enough humidity is guaranteed. In the Neotropics, they appear to occur both in forests and in open habitats, specially in litter and soil; some species have developed peculiar adaptations to periodically inundated forests. Some geophilomorph species have been found in caves, mostly in Central America, but usually as troglonexenes or troglophiles rather than as true troglobites. Only one troglomorphic geophilomorph species has been described up to day, *e.g.*, *Geophilus persephones* Foddai & Minelli, 1999, from a cave in southern France. With few exceptions, the main case being provided by females with their brood of eggs or juveniles, these centipedes are usually found in the field as isolated specimens.

Geophilomorphs prey on small invertebrates, mainly those inhabiting soil and litter. All members of the order are blind and are primarily adapted for life in dark environments, usually under ground. The antennae perform important sensorial functions, mostly tactile and chemical. The movements of geophilomorphs are generally slower than those of other centipedes, particularly when they move on a surface. They are in fact well

adapted to move more efficiently through interstitial spaces and some species have developed true fossorial abilities. Some species are able to react with short but quick movements when disturbed, or to move backwards, accompanying these movements by simultaneously lifting the anterior third of the body and opening the forcipules and actively moving the antennae.

The specialized appendages of the first trunk segment (the poison claws or forcipulae) (Fig. 20.3) reveal their ecological role. The forcipulae contain poison glands, whose secretion is used in the capture of prey and, occasionally, in defence. In geophilomorphs, however, forcipulae are relatively less powerful than in other centipedes as some lithobiomorphs and especially scolopendromorphs.

Geophilomorphs have separate sexes but, mostly, a poorly developed sexual dimorphism. The female lays a group of eggs (a few tens) in a cavity in the soil and remains coiled around them until the hatchlings are able to feed for themselves. The eggs are periodically groomed by the female until juveniles reach the I adolescens stage. The mother also protects them from predators; she probably produces substances able to protect the eggs from moulds. Suitable temperature and humidity are of special importance for the develop-

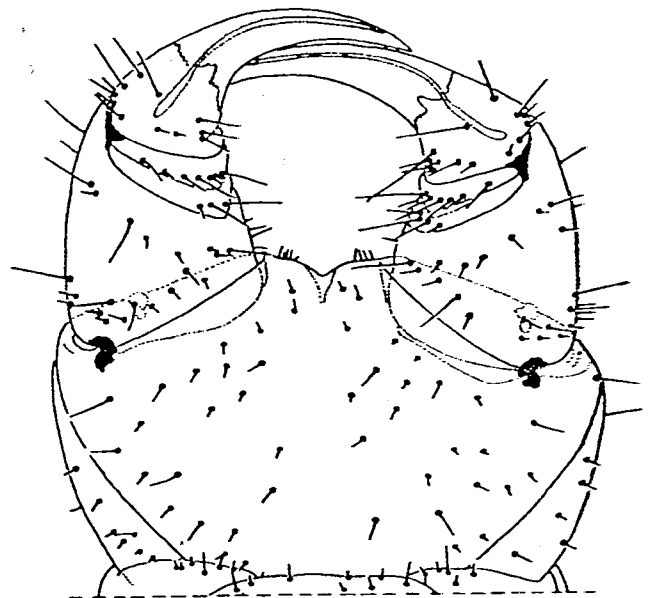


Fig. 20.3. *Pectiniunguis halirrhytus* Crabill, 1959. Forcipulae, ventral.

ment of the eggs. A disturbed female invariably eats or abandons her brood.

Juveniles, when hatching, are already provided with the definitive number of pairs of legs, but to reach sexual maturity they increase in size passing through several stages. Moults may occur even after sexual maturity has been reached. During the first stage, the *peripatoid*, the young centipede remains inactive inside the soil cavity together with the mother. The appendages are fully segmented whereas ventral pores, coxal organs, poison glands and anal organs are not yet developed. Also the setae ordinarily covering trunk and appendages are generally not yet developed. The young is still feeding on the yolk. During the following stages, the *foetus* and several *adolescens* stages, the animal is more advanced, but setae, ventral gland pores, coxal organs, etc. are not yet in the definitive asset, as to shape and number. Sexual maturity is shown by the presence of spermatecae full of spermatozoa in the female and vas deferens with mature spermatozoa in the male.

COLLECTION AND IDENTIFICATION

To get adequate collections of geophilomorphs representative of the local species diversity it is necessary to adopt several different techniques. The best ways of collecting geophilomorphs are by picking them by hand from under stones and tree trunks; by moving fallen leaves and logs, litter and mosses; and by sifting litter, leaves and debris using a sieve over a white towel. The specimens can be carefully picked up with a pair of stiff pincers or, for the smallest and delicate ones, with a moistened camel-hair brush. Due to their habits, their life in the soil, and their kind of locomotion, most geophilomorphs are not able to escape when they are on the free soil surface and, instead of running away, they rather try to go deeply into the ground. The size of the specimens is obviously relevant for the success of the catch with this technique, so usually the largest ones are most probably sighted and collected. For collecting the smallest ones, some technique of soil extraction (e.g. a Berlese apparatus) is particularly effective.

All these techniques are known to give good results while pitfall traps are generally not so efficient for collecting geophilomorphs, especially in

temperate habitats. This fact is probably due (at least for the representatives of some families) to their needs to be in physical contact with a stiff surface, both on the dorsal and the ventral side, whereas in order to fall down in a pitfall trap it is necessary to walk freely on the soil surface in the absence of dorsal contact. In addition to these more traditional techniques, geophilomorphs are collected also by means of additional devices such as ground photoelectors (also called emergence traps), arboreal photoelectors (also called trunk-traps or funnel traps) placed on the trunks and also fogging canopy with pyrethrum, as recently practised in forestal biotopes of Amazonia (see Foddai *et al.*, in press).

Geophilomorphs can be easily distinguished from other chilopods on the basis of their higher number of pairs of legs (at least 27 pairs of legs, see above, *vs.* 15, 21 or 23 pairs in all other chilopods) and the antennae composed by a fixed number of 14 articles (all other chilopods having a higher and often not fixed number of antennal articles).

Identification of Geophilomorpha mostly relies on traits of the external morphology to be analyzed on cleared specimens using a microscope. As the anatomy of the mouth parts (labrum, mandibles, first maxillae and second maxillae; Fig. 20.4) is important in the taxonomy of this group, it is often necessary to dissect them off. A detailed description of the procedure is given by Pereira (2000) and Foddai *et al.* (in press).

BIOGEOGRAPHY OF MEXICAN GEOPHILOMORPHA

Eight of the 12 families of Geophilomorpha known worldwide (Foddai *et al.*, 2000) have been collected in Mexico. One is endemic to the country, *i.e.*, Eriphantidae, and a further one, Neogeophilidae, has three of its four species endemic too. Twelve out of the 30 genera and 60 out of the 69 species cited for Mexico are endemic to the country. This very high level of endemism (>85%) makes it difficult to ascertain the relationships of the Mexican fauna when species are used as unit of comparison (Appendix 20.2). When genera are compared, this high proportion of endemics drops a little and more useful comparisons can be obtained (Appendix 20.3).

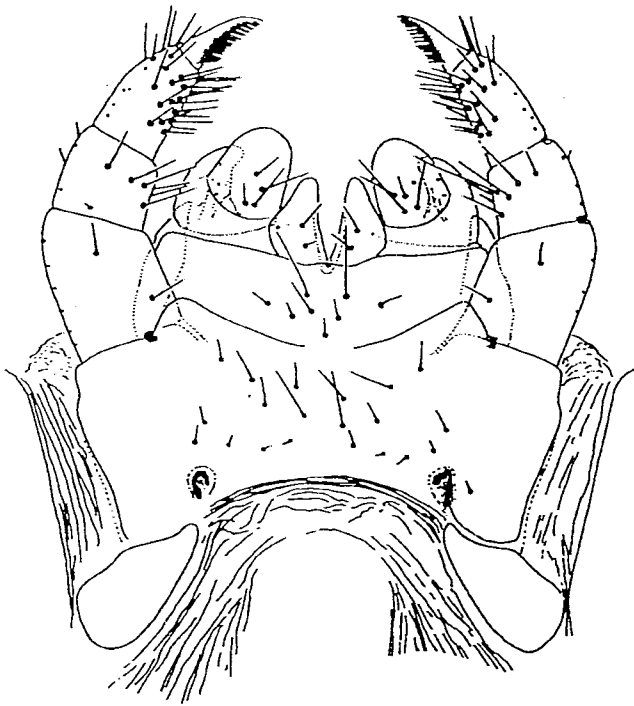


Fig. 20.4. *Pectiniunguis halirrhytus* Crabill, 1959. Maxillary complex, ventral.

At the generic level, three biogeographical elements are recognizable (besides a few elements with mixed affinities) *i.e.* endemic, Nearctic and Neotropical. The endemic elements are dominant, being 12 genera exclusive of this geographical area; they are followed by the Nearctic elements, here represented by six genera and by the Neotropical elements, represented by five genera. Some genera are most diverse in Mexico, extending south to Central and South America proper, and north into the Nearctic. The complete absence or very marginal presence of representatives of some large genera such as *Schendylops* and *Pectiniunguis* (Schendylidae) or *Ribautia* (Geophilidae), which taken together cover more than one third of the geophilomorph species described up to date from the Neotropical region, reinforces these Nearctic affinities.

The Mexican fauna is quite rich and diverse. The Neotropical range of predominantly Mexican genera is often restricted to the Caribbean area. No species (but some genera) are known to be shared between Mexico and the West Indies. Overall there is hardly any evidence of genera having crossed the Panama bridge in either direction. In-

terestingly, the southern limit of the range of the Holarctic family Himantariidae seems to run in Mexico. The likely absence of Himantariidae from South America could be explained by the difficulty of reaching this region, either because of formerly lacking land connections or because of barriers like the Sierras and in particular the Sistema Volcánico Transversal; *cf.* the Scarabaeid beetles studied by Halffter (1964).

In Mexico we do not find any representative of Aphilodontidae, Gonibregmatidae, Macronicoophilidae and Mecistocephalidae, although at least two of them are well represented in the Neotropical region. The monotypic family Eriphantidae is endemic to the Mexico, together with two representatives of Linotaeniidae (*i.e.*, *Pagotaenia* and *Tomotaenia*) and the majority of remaining genera (see Appendix 20.3). Ballophilids are not represented by endemic genera but only by two endemic species (*Diplethmus mexicanus* Cook, 1899 and *Ityphilus savannus* Chamberlin, 1943). The pantropical family Oryidae is represented by one species, *Notiphilides maximiliani*, originally described from Mexico and later extensively collected in Central and South America. A sizeable part of the Mexican fauna of Geophilomorpha, however, comprises species belonging to genera whose range extends south (*e.g.*, *Polycricus* and *Pectiniunguis*), or north (*Gospipina* and *Sogona*): these are possibly recent immigrants to the Mexican area. This fauna is apparently young, nearly all endemic taxa belonging to the worldwide or at least pantropical families.

Thus the Mexican Geophilomorph fauna is a mix of both northern and southern affinities, but liaisons with Nearctic taxa are very conspicuous, with a species-rich fauna with boreal/temperate rather than tropical character, not too different from that of the southern United States. The northern (Nearctic) component prevails in 'temperate' middle and upper elevation localities along the sides of and upon the top of the Mexican Plateau. The geographical ranges of these species extends south either to the Isthmus of Tehuantepec, or even to high elevation sites in Central America (a pattern well described in other groups by Halffter, 1987). The southern (Neotropical) component is more frequent in lower elevation 'tropical' habitats. The genera only infrequently extend north-

wards into the United States, and those that do usually have only a few species in the southeastern USA.

STATE OF THE ART IN THE TAXONOMY

One or more species of geophilomorph centipedes are known from 19 Mexican states (Appendix 20.2). There are no records from the other 13 states, most of which are placed in the northern part of

the country and represent the largest ones. The distribution clearly reflects the bias of collectors. Highest diversity is found in VER (21 species) and DF (9), followed by Hidalgo (8), and Baja California Sur, MOR and SLP (7). Species richness in each state is summarized in Figure 20.5.

The background of the current knowledge of the geophilomorph fauna of Mexico is given by few papers, mostly dealing with occasional collections made in limited areas of the country (see list below). No comprehensive account has been



Fig. 20.5. Number of species of Geophilomorpha known, up to date, for each Mexican state.

published on the whole Mexican geophilomorph fauna. Apart from the original literature and the old worldwide monograph by Attems (1929), all Mexican species listed here (see appendices 20.1 and 20.2) have been treated in the recent regional catalogue by Foddai *et al.* (2000), together with the geophilomorph species known from the whole Neotropical region. Biogeographical considerations on the Mexican geophilomorphs fauna in the wider Neotropical context have been provided by Pereira *et al.* (1997). Keys for identifications of genera and species are not available, but Crabill (1959a) keys the Schendylid genera of North America including Mexico. Practical aspects on how to treat specimens and which traits to consider for the identification are found in Pereira (2000) and in Foddai *et al.* (in press). Adequate descriptions are available for few species only, while all other taxa need to be redescribed and adequately illustrated. The vast majority of the species recorded from Mexico (74%) is known from the type locality only and most of them from just one (50%) or a few specimens and little is known about morphological variation. Only for 16 species descriptions of both sexes are available. No genetic or ultrastructural data are available for any of the geophilomorph species from Mexico, not even SEM illustrations. No regional key is available for this geographical area and, in short, the only way most specimens of Geophilomorphs from Mexico can be identified with certainty is by comparison to either topotypes or type specimens, most of the original descriptions being largely useless.

By comparison with the geophilomorph fauna of other regions, we can expect that the species hitherto recorded from Mexico are perhaps one half of those actually existing in the country. Geophilomorphs are not known to have economic value in Mexico or in other part of the world. They are a small part of the vast biological patrimony of Mexico; obscure and poorly known, but a part of Mexico's biological heritage nevertheless.

SPECIALISTS AND COLLECTIONS IN MEXICO AND ELSEWHERE

Nobody in Mexico is apparently working on native or exotic geophilomorphs. At this time, all

over the world there are few taxonomists working on Geophilomorpha, most of current research focussing on South America, Europe and Oceania. Type-rich collections are those of the Muséum National d'Histoire Naturelle (Paris, France), the Natural History Museum (London, United Kingdom), the Zoological Museum of the Copenhagen University (Copenhagen, Denmark), the Natural History Museums of Berlin (Germany) and Vienna (Austria), the Museum of Comparative Zoology (Cambridge, Massachusetts, USA), the National Museum of Natural History (Wash., DC, USA), the California Academy of Sciences (San Francisco, California, USA), the Field Museum of Natural History (Chicago, USA), and the American Museum of Natural History (New York, USA).

The knowledge of Mexican Geophilomorpha deserves closer attention and it is reasonable to think that the current records of species underestimate actual diversity of the group.

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- G. michoacana* (Chamberlin, 1942) - MICH (e)
- G. monachus* Chamberlin, 1943 - DF (e)
- G. ochrus* Chamberlin, 1915 - HGO, DF, MOR (e)
- G. pedrigala* Chamberlin, 1943 - DF (e)
- G. pluripes* Chamberlin, 1943 - MOR (e)
- G. pujola* (Chamberlin, 1943) - SLP, NL (e)
- G. vera* (Chamberlin, 1943) - VER (e)
- G. vulcan* Chamberlin, 1943 - PUE (e)
- "*Geophilus*" *aztecus* Humbert & Saussure, 1869 - Mexico country (also: Guatemala)
- Gospipina dybasi* Chamberlin, 1944 - HGO (e)
- Oligna pueblana* Chamberlin, 1943 - PUE (e)
- Pachymerium salvini* (Pocock, 1896) - TAB (e)
- P. stolli* (Pocock, 1896) - VER (also: Guatemala)
- Polycricus brachyiceps* Chamberlin, 1944 - VER (e)
- P. cordobanensis* (Verhoeff, 1934) - VER (e)
- P. cruzanus* Chamberlin, 1944 - VER (e)
- P. didymus* (Chamberlin, 1915) - HGO, MOR (e)
- P. godmani* (Pocock, 1896) - GRO, SLP (also: Guatemala)
- P. jacalanus* Chamberlin, 1944 - HGO (e)
- P. nuevus* Chamberlin, 1941 - NL (e)
- P. paucipes* (Chamberlin, 1915) - HGO, VER (e)
- P. proximus* Chamberlin, 1943 - VER (e)
- P. toltecus* (Humbert & Saussure, 1869) - GRO, VER (also: El Salvador)
- P. verus* Chamberlin, 1944 - VER (e)
- Sogona anahua* Chamberlin, 1943 - DF (e)
- S. paucipes* Chamberlin, 1943 - DF (e)

Linotaeniidae

- Pagotaenia lestes* Chamberlin, 1915 - HGO (e)
- Tomotaenia fusata* (Attems, 1903) - Mexico (e)

Eriphantidae

- Eriphantus telluris* Crabill, 1970 - BCS (e)

Oryidae

- Notiphilides maximiliani* (Humbert & Saussure, 1870) - CAM, TAB, YUC (also: Costa Rica; Antilles; Trinidad; Colombia; Ecuador; Guatemala; Peru; Venezuela)

Schendylidae

- Marsikomerus koestneri* (Chamberlin, 1940) - NL (e)
- Mexiconyx hidalgoensis* Chamberlin, 1922 - HGO (e)
- Morunguis morelus* Chamberlin, 1943 - MOR (e)
- Nesonyx flagellans* Chamberlin, 1923 - BCS: Island of the Gulf of California (e)³
- Nyctunguis arcochilus* Chamberlin, 1941 - Mexico *s.l.* (state not specified) (e)
- N. dampfi* (Verhoeff, 1926) - DF (e)
- N. danzantinus* Chamberlin, 1923 - BCS: Island of the Gulf of California (e)¹
- Parunguis boneti* Chamberlin, 1943 - DF (e)
- P. cardenasi* Chamberlin, 1943 - DF (e)
- P. paucipes* Chamberlin, 1943 - VER (e)

³ This taxon is not listed in Foddai *et al.* (2000).

APPENDIX 20.1.

Taxonomic list of species of Geophilomorpha from Mexico and their distribution, compiled after Foddai *et al.*'s (2000) catalogue of Neotropical species. Endemic (e).

Neogeophilidae

- Evallogeophilus mexicanus* Silvestri, 1918 - VER, OAX (e)
- Neogeophilus ixion* Crabill, 1969 - VER (e)
- N. primus* Silvestri, 1918 - MOR, SLP, TAMPS, OAX (e)
- N. silvestri* (Crabill, 1961) - SLP, TAMPS, VER (also: Guatemala)

Geophilidae

- Aztekophilus* (*A.*) *storkani* Verhoeff, 1934 - VER (e)
- A. (Thylakiophilus) mexicanus* Verhoeff, 1934 - SIN (e)
- "*Brachygeophilus*" *dentifer* Chamberlin, 1943 - GRO (e)
- "*B.*" *hulenus* Chamberlin, 1943 - OAX (e)
- Chomatophilus aphanistes* Crabill, 1968 - OAX, SLP, TAMPS, VER (e)
- C. leonensis* (Chamberlin, 1941) - NL (e)
- C. smithi* Pocock, 1896 - NL, QRO, SLP, TAMPS (e)
- Garrina cruzana* (Chamberlin, 1942) - VER (e)
- G. leona* Chamberlin, 1943 - NL (e)

Pectiniunguis americanus Bollman, 1889 - BCS (e)⁴
P. amphibi Chamberlin, 1923 - Baja California Sur: Island of the Gulf of California (e)
P. halirrhytus Crabill, 1959 - QROO (also: United States: Florida: Monroe County: Big Pine Key and Flamingo; Honestead; Sugar Loaf Key)
P. nesiot Chamberlin 1923 - BCS (Islands of the Gulf of California) (e)

Ballophilidae

Diplothmus mexicanus Cook, 1899 - Mexico s.l. (state not specified) (also: Colombia; Antilles; Peru)
Ityphilus savannus Chamberlin, 1943 - VER (e)

Himantariidae

Arcophilus toltecus Chamberlin, 1943 - DF (e)
Californiphilus mexicanus (Attems, 1947) - Mexico country (e)
Causerium tuxtlanum Chamberlin 1964 - CHIS (e)
Chomatobius craterus (Chamberlin, 1944) - HGO (e)
C. mexicanus (Saussure, 1858) - VER, MOR, SLP (also: United States: Texas)
C. orizabae (Chamberlin, 1944) - VER (e)
Geoballus bebelus Crabill, 1969 - VER (e)
G. caputalbus Crabill, 1969 - OAX (e)
Gosothrix insulanus Chamberlin, 1923 - BCS: Island of the Gulf of California (e)¹
Straberax morelus (Chamberlin, 1943) - MOR, OAX, VER (e)
 Remark.- Two species are listed under "*Brachygeophilus*", and one more under "*Geophilus*", because the original descriptions, although poor, clearly show that none of these species belongs to the nominal genus to which they have been ascribed by their authors. However, no confident assignment to a correct genus within the family Geophilidae is possible at present.

APPENDIX 20.2.

List of species of Geophilomorpha from Mexico by state. Taxa are arranged in alphabetical order by family.

MEXICO s.l. (total species = 5) Geophilidae: "*Geophilus*" *aztecus*; Schendylidae: *Nyctunguis arcochilus*; *Diplothmus mexicanus*; Linotaeniidae: *Tomotaenia fusata*; Himantariidae: *Californiphilus mexicanus*

BAJA CALIFORNIA SUR (total species = 7) Eriphantidae: *Eriphant* *telluris*; Schendylidae: *Nesonyx flagellans*, *Pectiniunguis americanus*; *Pectiniunguis amphibius*, *Pectiniunguis nesiot*, *Nyctunguis danzantinus*; Himantariidae: *Gosothrix insulanus*
 CAMPECHE (total species = 1) Oryidae: *Notiphilus maximiliani*
 CHIAPAS (total species = 1) Himantariidae: *Causerium tuxtlanum*
 DISTRITO FEDERAL (total species = 9) Geophilidae: *Garrina*

⁴ The distribution for this species given in Foddai *et al.* (2000) includes countries other than Mexico, but see Crabill (1959a: 324, in Notes; 1961a: 74).

monachus; *G. ochrus*; *G. pedrigala*; *Sogona anahua*; *S. paucipes*; Schendylidae: *Nyctunguis dampfi*; *Parunguis boneti*; *P. cardenasi*; Himantariidae: *Arcophilus toltecus*.

GUERRERO (total species = 3) Geophilidae: "*Brachygeophilus*" *dentifer*; *Polycricus godmani*; *P. toltecus*

HIDALGO (total species = 8) Geophilidae: *Garrina ochrus*; *Gosipina dybasi*; *Polycricus didymus*; *P. jacalanus*; *P. paucipes*; Linotaeniidae: *Pagotaenia lestes*; Schendylidae: *Mexiconyx hidalgoensis*; Himantariidae: *Chomatobius craterus*

MICHOACÁN (total species = 1) Geophilidae: *Garrina michoacana*

MORELOS (total species = 7) Neogeophilidae: *Neogeophilus primus*; Geophilidae: *Garrina ochrus*; *G. pluripes*; *Polycricus didymus*; Schendylidae: *Morunguis morelus*; Himantariidae: *Chomatobius mexicanus*, *Straberax morelus*

NUEVO LEÓN (total species = 6) Geophilidae: *Chomatophilus leonensis*; *C. smithi*, *Garrina leona*, *G. pujola*, *Polycricus nuevus*; Schendylidae: *Marsikomermus koestneri*

OAXACA (total species = 6) Neogeophilidae: *Evallogeophilus mexicanus*, *Neogeophilus primus*; Geophilidae: "*Brachygeophilus*" *hulenus*, *Chomatophilus aphanistes*; Himantariidae: *Geoballus caputalbus*; *Straberax morelus*

PUEBLA (total species = 2) Geophilidae: *Garrina vulcan*; *Oligona pueblana*

QUERÉTARO (total species = 1) Geophilidae: *Chomatophilus smithi*

QUINTANA ROO (total species = 1) Schendylidae: *Pectiniunguis halirrhytus*

SAN LUIS POTOSÍ (total species = 7) Neogeophilidae: *Neogeophilus primus*; *N. silvestri*; Himantariidae: *Chomatobius mexicanus*; Geophilidae: *Chomatophilus aphanistes*, *C. smithi*, *Garrina pujola*; *Polycricus godmani*

SINALOA (total species = 1) Geophilidae: *Aztekophilus (Thylakio-*

philus) mexicanus
 TABASCO (total species = 2) Geophilidae: *Pachymerium salvini*; Oryidae: *Notiphilus maximiliani*

TAMAULIPAS (total species = 4) Neogeophilidae: *Neogeophilus primus*; *N. silvestri*; Geophilidae: *Chomatophilus aphanistes*; *C. smithi*

VERACRUZ (total species = 21) Neogeophilidae: *Evallogeophilus mexicanus*; *Neogeophilus ixion*; *N. silvestri*; Geophilidae: *Aztekophilus (A.) storkani*; *Garrina cruzana*; *G. vera*; *Pachymerium stoll*; *Polycricus brachycephus*; *P. cordobanensis*; *P. cruzanus*; *P. paucipes*; *P. proximus*; *P. toltecus*; *P. verus*; *Chomatophilus aphanistes*; Schendylidae: *Parunguis paucipes*; Ballophilidae: *Ityphilus savannus*; Himantariidae: *Chomatobius mexicanus*; *C. orizabae*; *Geoballus bebelus*; *Straberax morelus*

YUCATÁN (total species = 1) Oryidae: *Notiphilus maximiliani*

APPENDIX 20.3.

Biogeographical affinities of the genera. The regional and faunal association are defined as: endemic (e) = endemic to state(s), not occurring outside of Mexico (state(s) listed); Nearctic affinities (Nea) = occurring in Mexico and further north in countries and states listed; Neotropical affinities (Neo) = occurring in Mexico and fur-

ther south in countries and states listed; Mixed affinities (Mix) = occurring in Mexico and further north and south in the Americas as well as out of the Americas in countries and states listed.

Neogeophilidae

Evallogeophilus Silvestri, 1918 (e)
Neogeophilus Silvestri, 1918 (Neo: Guatemala)

Geophilidae

Aztekophilus Verhoeff, 1934 subg. *Aztekophilus* Verhoeff, 1934 (e)
Aztekophilus Verhoeff, 1934 subg. *Thylakiophilus* Verhoeff, 1934 (e)
Chomatophilus Pocock, 1896 (e)
Garrina Chamberlin, 1915 (Mix: Central America; southeastern United States)
Gosipina Chamberlin, 1940 (Nea: south-eastern United States)
Oligna Chamberlin, 1943 (e)
Pachymerium C.L. Koch, 1847 (Mix: Central America; Holarctic Region)
Polycricus Saussure & Humbert, 1872 (Neo: Central and South America)
Sogona Chamberlin, 1912 (Nea: southeastern United States)

Linotaeniidae

Pagotaenia Chamberlin, 1915 (e, but family has Holarctic affinities)
Tomotaenia Cook, 1895 (Nea: North America)

Eriphantidae

Eriphantus Crabill, 1970 (e, as it is the family)

Oryidae

Notiphilides Latzel, 1880 (Neo: Central and South America)

Schendylidae

Marsikomerus Attems, 1938¹ (Mix: southeastern United States; Hawaii)
Mexiconyx Chamberlin, 1922⁵ (e)
Morunguis Chamberlin, 1943⁵ (e)
Nesonyx Chamberlin, 1923⁵ (e)
Nyctunguis Chamberlin, 1914 (Mix: southern United States and South America)
Parunguis Chamberlin, 1941 (Nea: southwestern United States)
Pectiniunguis Bollman, 1889 (Mix: Central and South America; southern United States; Africa; Fiji Is.)

Ballophilidae

Diplethmus Cook, 1899 (Neo: Central and South America)
Ityphilus Cook, 1899 (Mix: Central and South America; southern United States; China; Japan; Seychelles; Marianne Id.)

Himantariidae

Arcophilus Chamberlin, 1943 (Neo: Central America)
Californiphilus Verhoeff, 1938 (Nea: southwestern United States)
Causerium Chamberlin, 1964 (e)
Chomatobius Humbert & Saussure, 1870 (Nea: southern United States)
Geoballus Crabill, 1969 (e)
Gosothrix Chamberlin, 1923 (e)
Straberax Crabill, 1969 (e)

⁵ According to Hoffman & Pereira (1991: 45), *Marsikomerus* Attems, 1938 and *Morunguis* Chamberlin, 1943 are possibly synonyms of *Mexiconyx* Chamberlin, 1922. If confirmed, this would decrease both the diversity of genera and their degree of endemism.