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A Review of the Silverfish (Lepismatidae, Thysanura) of the United States and the Caribbean Area

BY PEDRO WYGODZINSKY¹

ABSTRACT

An analysis of the composition of the lepismatid fauna of the United States and the Caribbean area is made, with special emphasis on the geographic origin of the species. Among the 13 species found in the United States, only three are autochthonous; among the 13 species reported from the Caribbean area, six seem to be endemic. All other species probably have been introduced by man. Keys for the determination of the lepismatids of the United States and of the Caribbean area are followed by an enumeration of all species concerned, with distributional data and taxonomic comments. Four species are reported for the first time from the United States, viz., *Acrotelsa collaris*, *Ctenolepisma diversisquamis*, *C. targionii*, and *Stylifera gigantea*. *Lepisma mucronata* Packard is synonymized with *Acrotelsa collaris* (F.), and *Ctenolepisma reducta* Folsom with *C. diversisquamis* Silvestri; *Ctenolepisma campbelli* Barnhart is transferred to *Thermobia*. The female of *Ctenolepisma hummelincki* Wygodzinsky is described for the first time. *Peliolepisma calva*, until now only known from Ceylon, is reported from Guyana and Cuba, where it is supposedly a common house lepismatid.

RESUMEN

Este trabajo constituye una puesta al día de nuestros conocimientos sobre la fauna de lepismatidos (trazas) de los Estados Unidos de Norte América y de la región del Caribe. Se hace una análisis de la composición faunística de las dos áreas, con consideración especial de las orígenes geográficas de las especies. Entre

¹Curator, Department of Entomology, the American Museum of Natural History.

las 13 especies encontradas en los Estados Unidos, solamente tres son autóctonas; y de las 13 halladas en el area del Caribe, seis parecen ser endémicas. Todas las otras especies probablemente han sido introducidas por el hombre. Se presentan claves separadas para la determinación de todos los géneros y especies, seguidas de una enumeración comentada de las especies, con su sinonimia primaria y datos sobre su distribución. Se establece la sinonimia de *Lepisma mucronata* Packard con *Acrotelsa collaris* (F.), y la de *Ctenolepisma reducta* Folsom con *Ctenolepisma diversisquamis* Silvestri. La hembra de *Ctenolepisma hummelincki* se describe por la primera vez. *Ctenolepisma targionii*, conocida de la subregion mediterranea, se señala por primera vez del hemisferio occidental (Carolina del Sur). *Peliolepisma calva* Ritter, antes solamente conocida de Ceylan, se señala de la Guyana y de Cuba, donde se informe es comun en las habitaciones. *Ctenolepisma campbelli* Barnhart, especie sinántropa de Ohio y Pennsylvania, se transfiere al género *Thermobia*.

INTRODUCTION

Silverfish, firebrats, and related species are frequently commensals of man, in whose habitations and storage buildings they have established themselves, and where they may cause considerable damage. Several of these synanthropic species have been used in the laboratory in research on physiology. The literature on economic importance and physiology of these insects is voluminous and is not reviewed here.

The present paper is concerned with the classification, nomenclature, origin, and distribution of lepismatids found in North America and the Caribbean. The last key to synanthropic lepismatids of the United States, published by Slabaugh (1940) is out of date; a new key is now provided. No distinction is here being made between synanthropic and free-living species; the latter may locally invade human habitations, and synanthropic species may secondarily become free-living again.

A second key allows the determination of the lepismatids of the Caribbean area, including the Caribbean coast of Venezuela and Colombia. It is quite possible that certain species included in this key and not known from the United States will later be found in such regions as southern Florida and adjacent islands, a possibility that should be taken into account when identifying material from the extreme south.

ACKNOWLEDGMENTS

For the present study I have used the collections of the American Museum of Natural History (AMNH) as well as material received from other public institutions and individual scientists. I owe thanks to the following for loan of material and other assistance: Dr. J. N. Belkin, University of California at Los Angeles (UCLA); Dr. P. J. Darlington, Museum of Comparative Zoology, Harvard University; Dr. P. Hurd, formerly of the California Insect Survey (CIS), University of California,

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All photographs and drawings were made by the author.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution of Neotropical Thysanura has been analyzed by Wygodzinsky (1967); that paper should be consulted to supplement data contained in the present study.

Any interpretation of distribution patterns of lepismatids is encumbered by the frequency with which species of this family are introduced by man into areas and regions different from those where the species are native. This is facilitated by the ease with which domestic or peridomestic populations of silverfish originate from free-living ones, and, inversely, the frequent derivation of secondarily free-living populations from domestic ones. Not all free-living populations of lepismatids found in areas or regions that are not their original ones have necessarily arisen from domestic populations. *Lepisma wasmanni* Moniez, for instance, a circum-Mediterranean species also found in the coastal deserts of Peru has never been reported as associated with man; it probably was carried to Peru with soil or plant material.

Table 1 shows the species now known to occur in the United States and the Caribbean area. Species marked with an italic *a* are believed to be native, or at least have not been reported from anywhere else. All other species are considered to have been introduced.

It is remarkable that although the total number of species found in the United States and the Caribbean area is identical (13), the faunistic composition of these adjacent areas, which even slightly overlap in southern Florida, is quite different. Only five species share the two areas. Three of these (*A. collaris*, *C. longicaudata*, and *L. saccharina*) are common in households, and the two others (*C. diversisquamis* and *S. gigantea*) are common free-living, wide-ranging species reaching their northern limit in southern Florida.

The species not shared comprehend precinctive and introduced forms; the latter are examined first.

Ctenolepisma ciliata and *C. lineata pilifera*, originating from the Mediterranean area, may not be able to tolerate the comparatively hot and

humid conditions of the Caribbean area; the second species is very common in the Southwest.

The only record of *C. targionii* from the United States is based on a sample of what apparently is a localized population in South Carolina; its absence from the Caribbean is thus not surprising. On the other hand,

TABLE 1
DISTRIBUTION OF LEPISMATIDAE IN THE UNITED STATES AND CARIBBEAN AREA

United States	Caribbean Area
<i>Acrotelsa collaris</i>	<i>Acrotelsa collaris</i>
<i>Allacrotelsa spinulata</i> ^a	
<i>Ctenolepisma ciliata</i>	
<i>Ctenolepisma diversisquamis</i>	<i>Ctenolepisma diversisquamis</i>
	<i>Ctenolepisma dubitalis</i> ^a
	<i>Ctenolepisma hummelincki</i> ^a
<i>Ctenolepisma lineata pilifera</i>	
<i>Ctenolepisma longicaudata</i>	<i>Ctenolepisma longicaudata</i>
	<i>Ctenolepisma targioniana</i>
<i>Ctenolepisma targionii</i>	
	<i>Ctenolepisma versluysi</i> ^a
	<i>Heterolepisma horni</i> ^a
	<i>Heterolepisma</i> sp. (Bimini) ^a
<i>Lepisma saccharina</i>	<i>Lepisma saccharina</i>
<i>Leucolepisma arenaria</i> ^a	
<i>Mirolepisma deserticola</i> ^a	
	<i>Pelirolepisma calva</i>
<i>Stylifera gigantea</i>	<i>Stylifera gigantea</i>
	<i>Stylifera impudica</i> ^a
<i>Thermobia campbelli</i>	
<i>Thermobia domestica</i>	

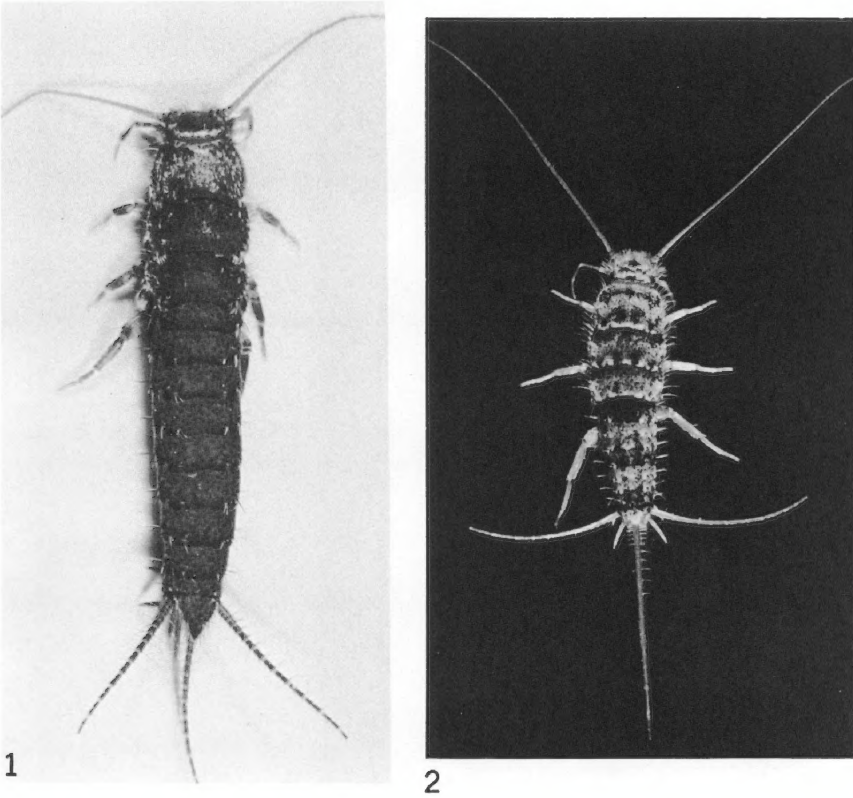
^aBelieved to be native.

C. targioniana ranges widely over the tropics, and might imaginably find a foothold in southern Florida.

Pelirolepisma calva is also a tropical species, free-living in Ceylon but apparently domestic in Guyana and Cuba; this adaptability makes the species a candidate for accidental introduction and possible establishment in the warmer parts of the United States.

Of the two species of *Thermobia*, *domestica* is well established in the United States, not only in human habitations but also with secondarily free-living populations in the West and Southwest. Its apparent absence from the Caribbean may be attributable, as in *Ctenolepisma ciliata* and *C.*

lineata pilifera, to the preference for a drier climate by the species. *Thermobia campbelli* is only known from two domestic populations in the eastern United States, and no domestic or free-living populations are known from anywhere else. The time of arrival and place of origin of the species are

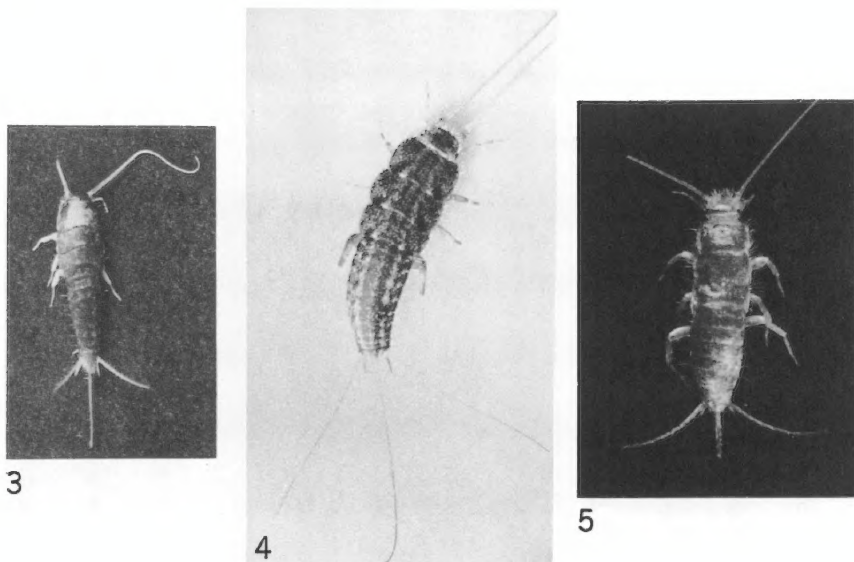


FIGS. 1, 2. 1. *Allacrotelsa spinulata*. 2. *Thermobia domestica*.

unknown, but as the remaining species of *Thermobia* occur naturally in the south of the Palearctic and in the Ethiopian region, it may be hypothesized that *T. campbelli* will eventually be found in that area.

The precinctives are of special interest; all are free-living.

Allacrotelsa spinulata is very common in the western and southern United States. The species has a considerable ecological range, but it does not occur in extremely hot and arid or hot and moist conditions. Significantly, it seems to be absent from southern Florida and has not been reported from the Caribbean. A second species of the genus is Mediter-



FIGS. 3-5. 3. *Lepisma saccharina*. 4. *Ctenolepisma lineata pilifera*. 5. *Thermobia campbelli*.

ranean in distribution, and the third is known only from Baltic amber (Wygodzinsky, 1961).

Leucolepisma arenaria and *Mirolepisma deserticola* are both desert forms found only in the Southwest. Both genera are monotypic, and probably are specialized derivatives, the first of *Ctenolepisma*-like, the second of *Prolepisma*-like ancestors.

None of the Caribbean precinctives belongs to an endemic genus, and as the world fauna of the Lepismatidae becomes better known, some of these species now considered precinctive may turn out not to be endemic at all.

The great majority of the species of the large genus *Ctenolepisma* are native to the Old World (Africa, southern Europe, and Asia), and the presence of three supposedly native species in the Caribbean is surprising. *Ctenolepisma hummelincki* and *C. verstuysi* are not different in any significant way from most other species of the genus; only *C. dubitalis* is highly aberrant morphologically compared with the rest of the genus. Wygodzinsky (1967) thought that the fact that *dubitalis* is marginal taxonomically as well as geographically in relation to the main stock of *Ctenolepisma* suggests the hypothesis that it or its ancestors arrived on the scene much earlier than the rest of the species of *Ctenolepisma*, viz., that it is truly autochthonous.

Heterolepisma is an old genus with a basically amphinotic distribution pattern, with several native species found in South America. Although there is no prima facie evidence to suggest that the Caribbean species are not autochthonous, it should be mentioned that at least one species of the genus, *trisetosa* (Escherich), is known to occur in the Brazilian state of Pernambuco, in East and West Africa, on Lombok, and in Japan; this clearly indicates that passive dispersal is a possibility in this genus.

The case of the two species of *Stylifera* is far from clear. *S. impudica*, listed as an endemic, seems to be basically restricted to the Caribbean. A record of a specimen caught on a boat in Oceania (Paclt, 1966) is highly doubtful (see Systematics, p. 22). Paclt (1966) also reported specimens from Hamburg (Germany), introduced from Venezuela or Colombia; even if correctly identified, these finds do not change the basic picture.

Stylifera gigantea is very common in the Caribbean area where it ranges from the mainland of South America to southern Florida, but it is also exceedingly common in the coastal desert of Peru; a closely related form of perhaps only subspecific difference occurs on the Galapagos Islands. It is possible that the areas mentioned represent the natural range of the species, a common distribution pattern in other animals and in plants. On the other hand, all the 13 remaining species of *Stylifera* are Pacific in distribution (Wygodzinsky, 1967), and it is possible that the two Caribbean species are not autochthonous.

SYSTEMATICS

KEY TO THE FAMILIES OF THYSANURA IN NORTH AMERICA
AND THE CARIBBEAN

- 1. Eyes and ocelli absent Nicoletiidae
- Eyes present 2
- 2. Ocelli present; scales absent Lepidotrichidae
- Ocelli absent; scales present Lepismatidae

Nicoletiidae are subterranean or cavernicolous, sometimes myrmecophilous or termitophilous; they are never pigmented, and their scales are colorless. The North American species are not well known.

Lepidotrichidae are found in leaf litter and under bark; their pigment is reddish. Only one genus and species is known, precinctive to a small area in northern California.

Lepismatidae comprehend the most commonly encountered species; they are found free-living, in birds' nests, or associated with humans; a few are myrmecophilous or termitophilous. They frequently possess hypodermal pigment, and the scales of the dorsal surface may form complex patterns (fig. 2) or not (fig. 1). Although most species are tropical or sub-

tropical, man has carried some to temperate climates where they survive in shelter provided by their host.

The taxonomy of lepismatids is based to a large extent on the structure and distribution of large, regularly arranged setae, the macrochaetae (figs. 7C, E; 10G). These may not be extant in poorly preserved specimens, but sockets indicate the place of their insertion (fig. 10D, F). Some experience and adequate optical equipment are necessary to analyze the arrangement of the macrochaetae; in case of doubt, a slide mount of the whole insect or of critical structures must be prepared.

I would like to point out that although the present survey includes all species now known from the areas under consideration, further species will probably be found in the future. Caution is thus required when determinations are made.

KEY TO THE LEPISMATIDAE OF THE UNITED STATES, EXCLUDING HAWAII

1. Last tergum triangular, sharply pointed and with more than 1+1 bristle-combs (fig. 6D) 2
 - Last tergum not sharply pointed (figs. 7F; 8C, E, H, K; 10F) or, when triangular, with only 1+1 bristle-combs (fig. 7D) 3
2. Submedian fields of macrochaetae of head capsule narrowly elongate, not attaining anterior border of head capsule (fig. 6A); prosternum covered by fore coxae from below, and with a tuft of macrochaetae centrally (fig. 6C); ovipositor with fossorial spines apically on posterior gonapophyses (fig. 6G); male with parameres *Acrotelsa collaris*
 - Submedian fields of macrochaetae on head capsule broadly triangular, attaining anterior border of head capsule (fig. 6B); prosternum covering fore coxae from below, without central tuft of macrochaetae (fig. 6E); ovipositor without fossorial spines *Stylifera gigantea*
3. Macrochaetae glabrous, often bifid or trifid apically (fig. 7E); males with parameres 4
 - Macrochaetae barbed or feathered (fig. 10G); males lacking parameres 5
4. Last tergum truncate or faintly rounded apically (fig. 7F); apical segment of labial palp wider than long (fig. 7H); dorsum of well-preserved living specimens uniformly slate gray (fig. 3) *Lepisma saccharina*
 - Last tergum triangular (fig. 7D); apical segment of labial palp longer than wide (fig. 7G); dorsum of well-preserved living specimens dark brown (fig. 1) *Allacrotelsa spinulata*
5. Insects golden yellow, not more than 6 mm. when mature, generally myrmecophilous; their shape as shown in figure 7A; caudal appendages very short, not longer than maximum width of abdomen (fig. 7A) *Mirolepisma deserticola*
 - Color different; when mature, length 6 mm. or more; shape more elongate (figs. 2, 4, 5); caudal appendages elongate, much longer than maximum width of abdomen (figs. 2, 4, 5) 6
6. Lateral claws at least as long as second tarsomere (fig. 9F, G); median claw with conspicuous cuticular projections (fig. 9E-G); ovipositor apically with

- fossorial spines (fig. 9H, I) *Leucolepisma arenaria*
 Claws shorter than second tarsomere (fig. 8D); median claw glabrous;
 ovipositor lacking fossorial spines 7
7. Several abdominal terga with 3+3 bristle-combs (fig. 8F); maxillary palps
 with five segments 8
 Abdominal terga at most with 2+2 bristle-combs; maxillary palps with five
 (fig. 10B) or six (fig. 10A) apparent segments 12
8. Abdominal sterna each with one median bristle-comb (similar to fig. 10D);
 3+3 bristle-combs on terga II-V *Ctenolepisma targionii*
 Abdominal sterna without median bristle-combs; 3+3 bristle-combs on
 abdominal terga II-V, II-VI or II-VII 9
9. Only abdominal terga II-V with 3+3 bristle-combs
Ctenolepisma diversisquamis
 Abdominal terga II-VI or II-VII with 3+3 bristle-combs 10
10. Only abdominal terga II-VI with 3+3 bristle-combs; tenth abdominal tergum
 truncate or faintly emarginate posteriorly (fig. 8E) 11
 Abdominal terga II-VII with 3+3 bristle-combs; tenth abdominal tergum
 subtriangular (fig. 8C) *Ctenolepisma lineata pilifera*
11. Maximum length about 10 mm.; antennae and caudal filaments not longer
 than body; distinct violaceous hypodermal pigment on head, body and
 appendages *Ctenolepisma ciliata*
 Length 13-15 mm.; antennae and caudal appendages longer than body; head,
 body, and appendages practically without hypodermal pigment
Ctenolepisma longicaudata
12. Maxillary palp with five segments (fig. 10B); only one pair of stylets present;
 scales of living specimen, when intact, uniformly gray dorsally (fig. 5) . . .
Thermobia campbelli
 Maxillary palp with six apparent segments (fig. 10A); two or three pairs of
 stylets present; scales of living specimen, when intact, forming complex
 pattern (fig. 2) *Thermobia domestica*

KEY TO THE LEPISMATIDAE OF THE CARIBBEAN AREA

1. Last abdominal tergum triangular, sharply pointed, and with more than 1+1
 bristle-combs (fig. 6D) 2
 Last tergum not sharply pointed; if triangular, then with only 1+1 bristle-
 combs (fig. 7D) 4
2. Submedian fields of macrochaetae on head capsule narrowly elongate, not
 attaining anterior border of head capsule (fig. 6A); prosternum covered
 below by fore coxae, and with tuft of macrochaetae centrally (fig. 6C);
 ovipositor with fossorial spines apically on posterior gonapophyses (fig. 6G);
 male with parameres *Acrotelsa collaris*
 Submedian fields of macrochaetae on head capsule broadly triangular, attain-
 ing anterior border of head capsule (fig. 6B); prosternum covering fore
 coxae from below, and without central tuft of macrochaetae (fig. 6E);
 ovipositor with or without fossorial spines; male without parameres . . 3
3. Abdominal sterna with 2+2 multiseriate bristle-combs at hind border, one at
 each side of insertion of stylets (fig. 6F), the latter present in more than two
 pairs; ovipositor of female lacking fossorial spines *Stylifera gigantea*

- Abdominal sterna with 1+1 uniseriate bristle-combs at hind border, mesad of insertion of stylets, the latter only in two pairs; ovipositor of female with fossorial spines *Stylifera impudica*
4. Large setae bare, often bifid or trifid apically (fig. 7E) 5
 Large setae feathered or barbed (fig. 7C) 7
5. Abdominal sterna with median bristle-combs in addition to sublateral ones (similar to fig. 10D); tenth abdominal tergum rather elongate, distinctly longer than wide (fig. 7F) *Lepisma saccharina*
- Abdominal sterna lacking median bristle-combs; tenth abdominal tergum rather short, subsemicircular, shorter than wide (similar to fig. 10F) 6
6. Stylets present in only one pair *Heterolepisma horni*
 Stylets present in two pairs *Heterolepisma* sp. (Bimini)
7. Thoracic nota at hind margin with only 1+1 single macrochaetae (fig. 7B) *Peliolopisma calva*
- Thoracic nota at hind margin with 1+1 bristle-combs composed each of at least two large setae (fig. 8A) 8
8. Last abdominal tergum subtriangular, strongly salient apically (fig. 8K) *Ctenolepisma hummelincki*
- Last abdominal tergum subtrapezoidal or broadly rounded apically (fig. 8E, H) 9
9. 3+3 bristle-combs present on abdominal terga II-VII (very rarely II-VIII); ovipositor of female with fossorial spines apically *Ctenolepisma dubitalis*
- 3+3 bristle-combs present on fewer abdominal terga; ovipositor of female lacking fossorial spines 10
10. 3+3 bristle-combs only present on abdominal terga II-V 11
 3+3 bristle-combs present on abdominal terga II-VI 12
11. Stylets present in only two pairs; size under 10 mm. *Ctenolepisma diversisquamis*
- Stylets present in three pairs; size over 10 mm. *Ctenolepisma targioniana*
12. Size over 10 mm.; last abdominal tergum distinctly truncate or slightly emarginate apically (fig. 8E); stylets present in two pairs *Ctenolepisma longicaudata*
- Size less than 10 mm.; last abdominal tergum subsemicircular (fig. 8H); stylets present in three pairs *Ctenolepisma versluysi*

Acrotelsa collaris (Fabricius)

Figure 6A, C, G

Lepisma collaris FABRICIUS, 1793, p. 64.

Lepisma mucronata PACKARD, 1873, p. 49 (new synonymy).

MATERIAL EXAMINED: USA: Florida: Levy County: Seahorse Key, Aug. 24, 1955 (C. H. Wharton; FSCA), one male. Monroe County: Loggerhead Key, Dry Tortugas Islands, in house, Jan. 9, 1962 (H. A. Denmark; FSCA), one male, one female. Bahamas: Nassau, summer 1945 (A. S. Vernay; AMNH), one male, one female.

I have examined the type of *Lepisma mucronata* Packard, kept in the Museum of Comparative Zoology, Harvard University, Cambridge. The

type is a moderately well-preserved male, which agrees fully with *Acrotelsa collaris*; hence the above synonymy, already suspected by Paclt (1966, 1967).

This is a tropicopolitan synanthropic species, often of economic importance; it has not been reported from the United States before.

In addition to the characters given in the key, this species can also be recognized by the macrochaetae arranged in distinct whirls on the legs and cerci; in other lepismatids, such setae are irregularly distributed on these appendages. The descriptions given by Escherich (1905) and Stach (1935) should be consulted for further taxonomic data.

Allacrotelsa spinulata (Packard)

Figures 1, 7D, G

Lepisma spinulata PACKARD, 1873, p. 48.

Stachisma mexicana WYGODZINSKY, 1949, p. 224.

MATERIAL EXAMINED: USA: Florida: Martin County: Hobe Sound, *Pinus clausa* debris, Feb. 1, 1959 (H. A. Denmark; FSCA), one female; 8 miles NNW of Stuart, Dec. 12, 1962 (W. Ivie; AMNH), one male, one female. Saint Lucie County: 9.4 mi. N of Saint Lucie River, *Pinus clausa* debris, Feb. 1, 1959 (H. A. Denmark; FSCA), one female. Highlands County: Sebring, in leaf litter in dry, sandy scrub oak-live oak association, Dec. 26, 1961 (H. V. Weems, Jr.; FSCA), several specimens; *ibid.*, under board in dry white sandy area, Feb. 1, 1960 (FSCA), one female; *ibid.*, between layers of weathered cardboard in dry white sandy field, March 1, 1960 (H. V. Weems, Jr.; FSCA), four males, four females; *ibid.*, in *Pinus clausa* association, Dec. 23, 1961 (H. V. Weems, Jr.; FSCA), several specimens. Orlando County: 3 miles NW of Maitland, Dec. 10, 1962 (W. Ivie; AMNH), one female. Putnam County: near Red Water Lake, under bark of dead *Quercus virginiana*, March 22, 1962 (H. V. Weems, Jr.; FSCA), two specimens. Alachua County: Gainesville, in sawdust mound, Dec. 20, 1959 (H. V. Weems, Jr.; AMNH, FSCA), numerous males and females; *ibid.*, in malt traps, Aug. 7, 1962 (R. E. Woodruff and B. Benesh; FSCA), one male, one female; *ibid.*, near Newman's Lake, Nov. 2, 1959 (R. E. Woodruff; FSCA); one female. South Carolina: Clemson, under pine bark, Jan. 9-10, 1966, June-July, 1966 (J. A. Payne; AMNH), 14 females, seven juveniles; Pendleton, in cardboard box (J. A. Payne; AMNH), two females; *ibid.*, under bark of elm, Sept. 26, 1961 (J. A. Payne; AMNH), two females. Tennessee: Oak Ridge, beneath pile of boards in old building, Feb. 9, 1965 (J. A. Payne; AMNH), five females. Arkansas: Lafayette County, Apr. 27, 1967 (I. Brown; AMNH), one fe-

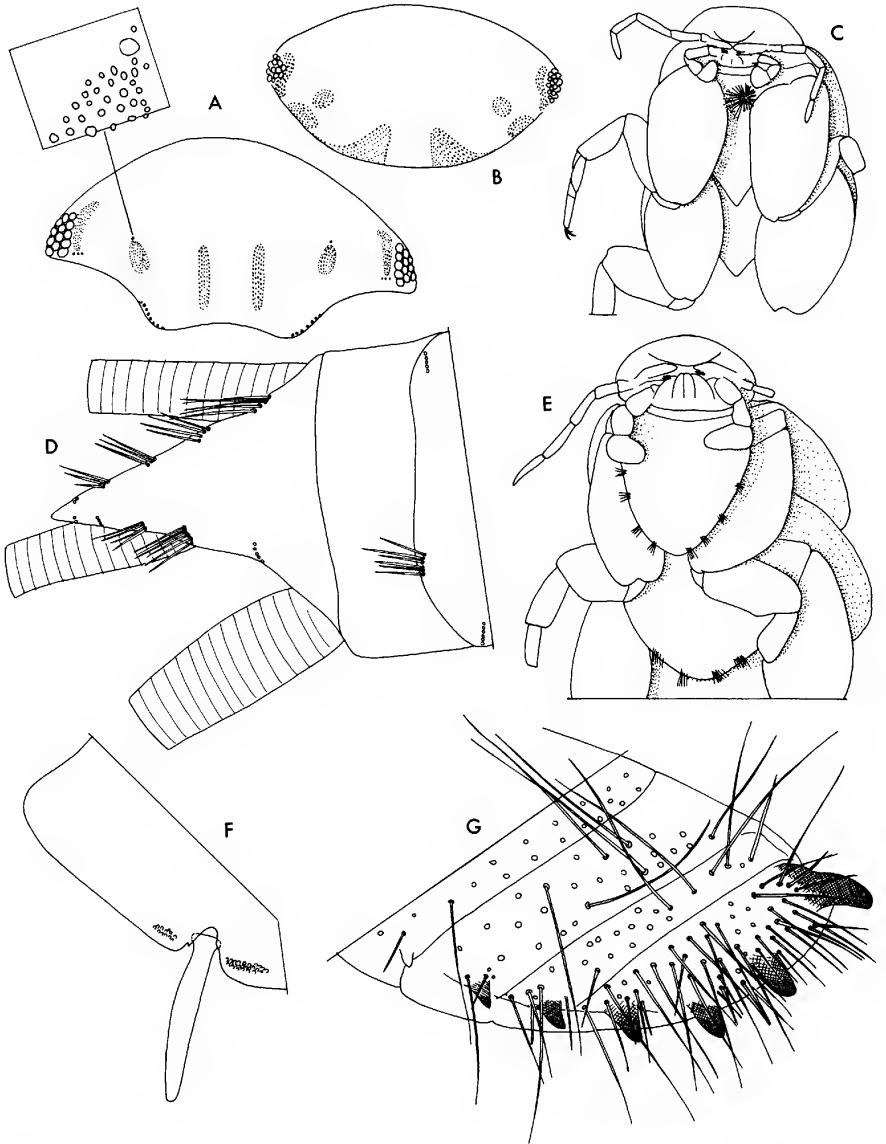


FIG. 6. A. *Acrotelsa collaris*, head capsule with fields of macrochaetae, schematic. B. *Stylifera gigantea*, head capsule with fields of macrochaetae, schematic. C. *Acrotelsa collaris*, anterior portion of body, seen from below. D-F. *Stylifera gigantea*. D. Apex of abdomen, seen from above and slightly lateral. E. Anterior portion of body, seen from below. F. Lateral portion of fifth abdominal sternum, with stylet and two multiserial bristle-combs. G. *Acrotelsa collaris*, apex of posterior gonapophysis.

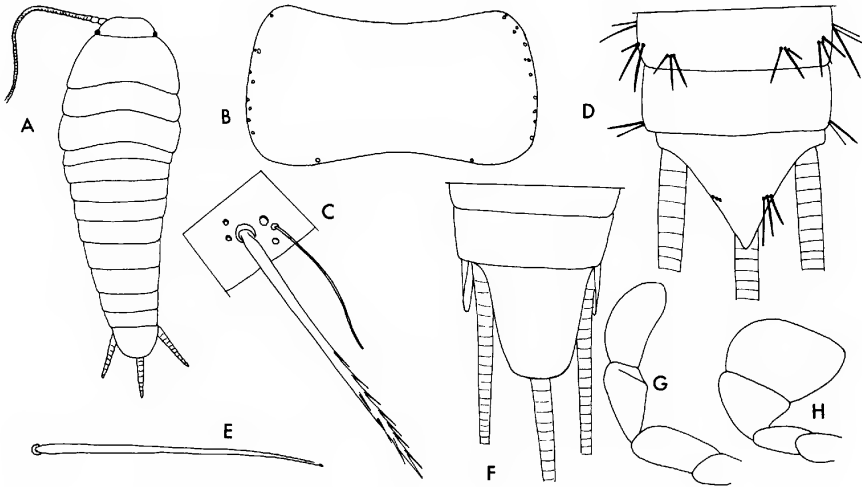


FIG. 7. A. *Mirolepisma deserticola*, general aspect. B, C. *Peliolepisma calva*. B. Pronotum. C. Macrochaeta of posterior border of pronotum, with sensory seta and sockets of additional smaller hairs. D. *Allacrotelsa spinulata*, apex of abdomen, seen from above. E, F. *Lepisma saccharina*. E. Macrochaeta. F. Apex of abdomen, seen from above. G. *Allacrotelsa spinulata*, labial palp. H. *Lepisma saccharina*, labial palp.

male; Ashley County (I. Brown; AMNH), one female. Oklahoma: Arrowhead State Park, July 17, 1966 (J. and W. Ivie; AMNH), one female. Texas: Montopolis, near Austin, in sand, June 5, 1903 (AMNH), one male, three females; Somerset, Nov. 15, 1942 (E. S. Ross; CAS), one female, identified by Wall; Lockhurst State Park, April 13, 1963 (W. J. Gertsch and W. Ivie; AMNH), four males, one female.

This is a free-living species, originally described from Texas. It is very common in the western United States, from the state of Washington to Arizona; it has also been found in Mexico. The above records widen its known range considerably.

The best description of the species (as *Acrotelsa spinulata*) is given by Silvestri (1948).

Ctenolepisma ciliata (Dufour)

Lepisma ciliata DUFOR, 1831, p. 420.

MATERIAL EXAMINED: USA: California: Contra Costa County: Lafayette, July 6, 1952 (R. A. Stirton; CIS), one male. Los Angeles County: Pasadena, April 1, 1953 (UCLA), one male. Mexico: Chihuahua:

Salaices, Cueva del Diablo, mouth of cave, July 23, 1947 (W. J. Gertsch; AMNH), one female.

This species apparently is not common in North America; the above are all the specimens I have seen, as opposed to hundreds of specimens of the very successful *Ctenolepisma lineata pilifera*.

The best descriptions of this species are given by Escherich (1905) and Stach (1935).

Ctenolepisma diversisquamis Silvestri

Figure 8B

Ctenolepisma diversisquamis SILVESTRI, 1908b, p. 153.

Ctenolepisma reducta FOLSOM, 1923, p. 170 (new synonymy).

MATERIAL EXAMINED: USA: Florida: Monroe County: Loggerhead Key, Dry Tortugas Islands, in leaf litter of *Casuarina* sp., Sept. 2-3, 1961 (H. V. Weems, Jr.; FSCA, AMNH), very numerous males and females; Garden Key, Dry Tortugas Islands, in sand and debris back of beach, May 9, 1961 (H. V. Weems, Jr.; FSCA), two females.

The above synonymy was tentatively suggested by Paclt (1967), and is here formally established. The main difference between *diversisquamis* and *reducta* was supposed to be the presence in the first species of scales of two different kinds, those with numerous and those with few rays, and the absence of this scale polymorphism in *reducta*. I have now examined specimens of *reducta* from Florida, and have found the dorsal scales to be of two types, just as illustrated in the original description of *diversisquamis* by Silvestri (1908). Another difference seemed to reside in the shape of the terminal segment of the labial palp; according to the original descriptions, this segment is wider than long in *diversisquamis* but longer than wide in *reducta*. In immature specimens from Florida now examined, the terminal segment of the labial palp (fig. 8B) is about as wide as long, but in mature specimens it is slightly wider than long, as in *diversisquamis*. Paclt (1967) also synonymized *Ctenolepisma brachyura* Silvestri under *diversisquamis*.

The species has been reported from the Cape Verde Islands from where it was described originally, from East Africa (as *brachyura*) and from Puerto Rico, Aruba, the Caribbean coast of Colombia, and the Marquesas (as *reducta*); it is now also known from the United States. This is obviously a species dispersed by man, although it is not necessarily synanthropic.

Ctenolepisma dubitalis Wygodzinsky

Ctenolepisma dubitalis WYGODZINSKY, 1959, p. 35.

This species has been collected only on the Leeward Group of the Lesser Antilles.

Ctenolepisma hummelincki Wygodzinsky

Figure 8G, I-N

Ctenolepisma hummelincki WYGODZINSKY, 1959, p. 31.

MATERIAL EXAMINED: Bahamas: Leaf Cay, Allen Cays, Exuma Island, Jan. 6, 1953 (Hayden and Giovannoli; AMNH), one female.

This species was described from Barbuda and St. Kitts, in the Windward Group; only males were known. The female now examined agrees with the males in such characters as shape, pigmentation, structure of mouthparts, abdominal chaetotaxy, chaetotaxy of stylets, and shape of last tergum. The size of the female examined is 8.5 mm.; the maximum size of the males was 9 mm. The main difference between the males and the female is the number of bristle-combs on the prosternum: 5-6+5-6 bristle-combs in the males, and only 2+2 in the female (fig. 8I).

The eighth and ninth coxites are as illustrated (fig. 8J, L). Each coxite VIII bears a bristle-comb composed of approximately 14 macrochaetae. The inner projections of coxites IX are unusually long and slender, viz., slightly more than three times as long as wide at their base. The ovipositor is long and slender, surpassing the apex of the process of coxite IX by about twice the length of the latter. The gonapophyses consist of approximately 35 articles. The terminal article of the anterior gonapophyses (fig. 8N) is pointed, that of the posterior gonapophyses (fig. 8M) strongly flattened dorsoventrally and somewhat scoop-shaped. The chaetotaxy of the apical segments of the gonapophyses is as illustrated (fig. 8M, N).

Ctenolepisma lineata pilifera (Lucas)

Figures 4, 8C

Lepisma pilifera LUCAS, 1840, p. 560.

Lepisma quadriseriata PACKARD, 1873, p. 47.

Lepisma rubro-violacea SCHÖTT, 1897, p. 190.

Lepisma reticulata SCHÖTT, 1897, p. 192.

MATERIAL EXAMINED: USA: South Carolina: Clemson, on desk, Dec. 15, 1965 (AMNH), one female. Pennsylvania: Glenside, in house, April 14, 1969 (E. H. Slifer; AMNH), numerous males and females.

This introduced, often synanthropic, species is exceedingly common in the western states of Oregon, Nevada, California, and Arizona and also in Mexico; *lineata pilifera* is generally secondarily free-living in the southern

portion of this area. In the East, the species is also common, according to Sweetman and Kulash (1944) who listed it as *Ctenolepisma quadriseriata*. These authors report the species ranging from south-central Canada in the north to Georgia and Tennessee in the south, and at least to Missouri westward.

This species is very variable, especially as to pigment distribution, although individual populations tend to be rather uniform. This variability might explain the large synonymy of this species.

Acceptable descriptions of *lineata pilifera* may be found in Escherich (1905), Stach (1935) and, as *Ctenolepisma rubroviolacea*, in Wall (1954).

Ctenolepisma longicaudata Escherich

Figure 8A, D-F

Ctenolepisma longicaudata ESCHERICH, 1905, p. 83.

Ctenolepisma urbana SLABAUGH, 1940, p. 95.

MATERIAL EXAMINED: USA: Florida: Putnam County: near Red Water Lake, July 18, 1959 (Pam Weems; FSCA), one female. Alachua County: Gainesville, in buildings, various dates (H. V. Weems, Jr., H. A. Denmark, and others; FSCA), numerous males and females. South Carolina: Clemson, under old book, Sept. 22, 1965 (H. G. Young; AMNH), one male. Louisiana: Baton Rouge, June 23, 1960, in bookcase (H. Daly; AMNH), one male.

This species is common in the warmer parts of the world. In the United States it is strictly synanthropic and has been reported, generally as *Ctenolepisma urbana*, from North Carolina, Missouri, Louisiana, Illinois, and southern California (Mallis, 1941; Slabaugh, 1940; and Sweetman and Kulash, 1944). *Ctenolepisma urbana* has been correctly synonymized with *longicaudata* by Paclt (1966).

The original description is sufficient to recognize the species.

Ctenolepisma targionii (Grassi and Rovelli)

Lepisma targionii GRASSI AND ROVELLI, 1889, p. 7.

MATERIAL EXAMINED: USA: South Carolina: Anderson, Nov. 12, 1965 (R. M. O'Neal; AMNH), two males.

This is the first record of the species from the Western Hemisphere; the original range is circum-Mediterranean.

Acceptable descriptions of this species can be found in Escherich (1905) and Stach (1935).

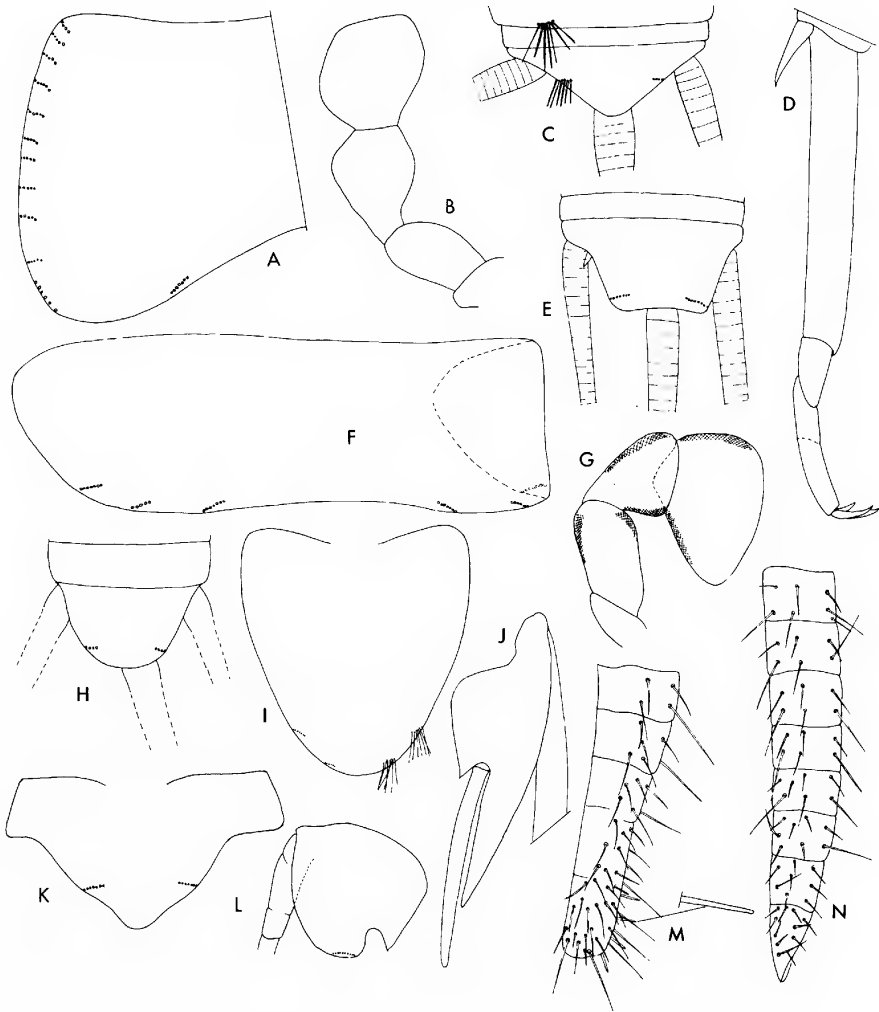


FIG. 8. Species of *Ctenolepisma*. A. *C. longicaudata*, left half of pronotum. B. *C. diversisquamis*, immature female from Florida, labial palp. C. *C. lineata pilifera*, apex of abdomen, dorsal view. D-F. *C. longicaudata*. D. Tarsus of hind leg. E. Apex of abdomen, dorsal view. F. Abdominal tergum V, right lobe folded under. G. *C. hummelincki*, labial palp. H. *C. versluysi*, apex of abdomen, dorsal aspect. I-N. *C. hummelincki*, female from Leaf Cay, Bahamas. I. Prosternum. J. Coxite IX, with stylet and base of posterior gonapophysis. K. Tergum X. L. Coxite VIII, with base of anterior gonapophysis. M. Apical article of posterior gonapophysis; one sensory rod with high magnification. N. Apical articles of anterior gonapophysis.

Ctenolepisma targioniana Silvestri

Ctenolepisma targioniana SILVESTRI, 1908a, p. 11.

This species, originally described from East Africa, was later reported from Brazil, the Caribbean coast of Venezuela, and the Leeward Group of the Lesser Antilles.

The original description is the only one available.

Ctenolepisma ver sluysi Escherich

Figure 8H

Ctenolepisma ver sluysi ESCHERICH, 1905, p. 84.

This species is known from the Lesser Antilles, the Caribbean coast of Colombia, and Acapulco, on the Pacific coast of Mexico.

Escherich's description is the only one available.

Heterolepisma horni Stach

Heterolepisma horni STACH, 1933, p. 341.

This species, originally described from the coast of Ecuador, was later found in Jamaica and the Leeward Group of the Lesser Antilles.

The original description is sufficient to identify this species.

Heterolepisma sp.

MATERIAL EXAMINED: Bahamas: Bimini, East Bimini, Jan. 31, 1964 (K. Krishna; AMNH), one female; Bimini, South Bimini, Jan. 30, 1964 (K. Krishna; AMNH), two males, one female.

All specimens were collected on the beach under dead vegetation.

This species keys out to *Heterolepisma pampaneae* Silvestri, found in the colder areas of Argentina, but is not identical. Not enough material is available to describe this species, member of a notoriously difficult genus.

Lepisma saccharina L.

Figures 3, 7E, F, H

Lepisma saccharina LINNÉ, 1758, p. 608.

MATERIAL EXAMINED: USA: Florida: Monroe County: Loggerhead Key, Dry Tortugas Island, in leaf litter of *Casuarina* sp., with large numbers of *Ctenolepisma reducta*, Sept. 3, 1961 (H. V. Weems, Jr.; FSCA), one male.

The above is the only record of free-living *Lepisma saccharina* in the United States. The species is normally domestic and probably widely

distributed over the country, although older identifications must be open to doubt.

This is the only *Lepisma* recorded from North America, but other species may well be found in the future; as mentioned above, *Lepisma wasmanni* is commonly found free-living in coastal deserts of Peru, and I have seen a further, as yet unidentified, species from Cuba.

Good illustrated redescriptions of *Lepisma saccharina* are found in Uchida (1943) and Wygodzinsky (1941).

Leucolepisma arenaria Wall

Figure 9

Leucolepisma arenaria WALL, 1954, p. 74.

MATERIAL EXAMINED: USA: California: San Diego County: Borrego Valley, on sand dunes at night, April 1955 (P. Wygodzinsky; AMNH), numerous males and females; Borrego Valley, sand dune area, April 28, 1961 (J. Rozen, Jr. and R. Schrammel; AMNH), several males and females. Riverside County: 3 mi. W of Indio, June 10 and 16, 1956 (M. Wasbauer; CIS), several males and females; Hopkins Well, 18 mi. W of Blythe, sand dunes, April 12, 1958 (J. Powell; CIS), several specimens; Palm Desert, June 23, 1956 (M. Wasbauer; CIS), several specimens. San Bernardino County: Cronise Station, April 28, 1956 (P. D. Hurd and J. Powell; CIS), several males and females; Saratoga Springs, Death Valley, May 30, 1953 (MacDonald; UCLA), one male, one female. Arizona: Ocotillo, Maricopa County, April 26, 1961 (W. J. Gertsch; AMNH), one female. Nevada: Nelson, Clark County, April 27, 1952 (H. Washburn; UCLA), four males, one female.

Leucolepisma arenaria was described from San Diego and Riverside counties in southern California; additional records from California and the finding of the species in Arizona and Nevada widen its range considerably.

A few illustrations of the coxites IX and genital appendages of the female supplement those given by the author of the species (Wall, 1954). Figure 9E shows the microtrichia of the median claw, a character mentioned by Paclt (1967) as characteristic for the species. Illustrations of the mouthparts and hind tarsi of specimens from Borrego, southern California, and from Nelson, Nevada show certain features distinguishing the Nevada population from all other material seen. In the Nevada specimens, the maxillary palp (fig. 9C) is comparatively more elongate, the distal segment of the labial palp (fig. 9D) is less strongly widened, the tarsi (fig. 9F) are relatively more slender, and the claws comparatively much shorter, than

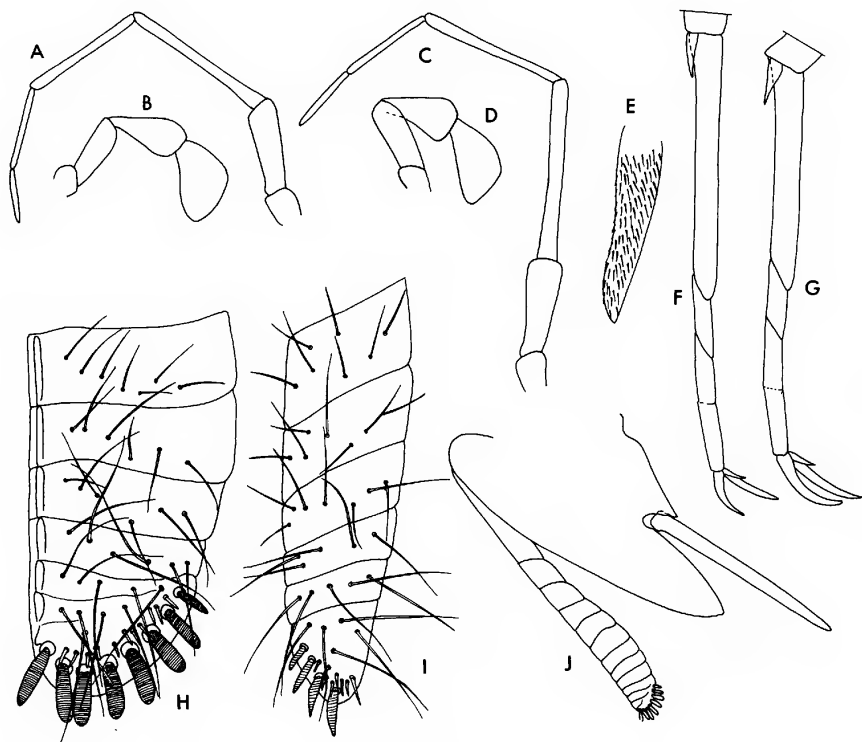


FIG. 9. *Leucolepisma arenaria*. A, B. Specimen from Borrego, California. A. Maxillary palp. B. Labial palp. C, D. Specimen from Nelson, Nevada. C. Maxillary palp. D. Labial palp. E. Median claw of hind leg, California specimen. F. Hind tarsus, Nevada specimen. G–J. California specimen. G. Hind tarsus. H. Apex of anterior gonapophysis. I. Apex of posterior gonapophysis. J. Coxite X, with stylet and posterior gonapophysis.

in other specimens. These meristic differences are constant for all specimens observed, but as the populations examined agree in all other structural characters, they are considered to be conspecific.

Mirolepisma deserticola Silvestri

Figure 7A

Mirolepisma deserticola SILVESTRI, 1938, p. 353.

This is the only myrmecophilous lepismatid found in North America. It is known only from Arizona and California.

The original description is very detailed.

Peliolepisma calva Ritter

Figure 7B, C

Peliolepisma calva RITTER, 1910, p. 380.

MATERIAL EXAMINED: Guyana [former British Guiana]: Demerara, in book in library, 1964 (C. P. Kennard; CIE, AMNH), three males, one female. Cuba: La Habana (F. de Zayas; AMNH), one male, two females.

Paclt (1967) synonymized *Peliolepisma* Ritter with *Ctenolepisma* Escherich, and listed the present species under *Ctenolepisma*. No reasons were given for this synonymy.

Peliolepisma calva was described from Ceylon and had not been reported from anywhere else. Its discovery in the Western Hemisphere adds to the considerable list of introduced lepismatids already discovered. The collector of the Cuban specimens considers the species to be the "common household silverfish" in La Habana.

The original and only description is quite short; a redescription is desirable.

Stylifera gigantea (Escherich)

Figure 6B, D-F

Acrotelsa gigantea ESCHERICH, 1905, p. 109.

MATERIAL EXAMINED: Mexico: Perez Island, Yucatán, Sept. 2, 1952 (J. Pallister; AMNH), one female. Cuba: Oriente: Moa, May, 1954 (F. de Zayas; AMNH), one male; Matanzas: Itabo, Apr. 1962 (AMNH), two males, two females. Bahamas: Long Cay, Feb. 10 and 25, 1953 (E. B. Hayden; AMNH), one male, four females; New Portsmouth, Eleuthera Island, March 29, 1953 (G. Rabb; AMNH), one female; South Bimini, June, 1951 (M. A. Cazier, C. and P. Vaurie; AMNH), one female. USA: Florida: Monroe County: Garden Key, Dry Tortugas Islands, collected by beating a dead sea-purslane (*Suriana maritima*), Jan. 12, 1962 (H. A. Denmark; FSCA); *ibid.*, under fallen coconuts, May 8, 1965 (H. A. Denmark; FSCA), numerous males and females; *ibid.*, under bark of *Casuarina* sp., Sept. 2-3, 1961 (H. V. Weems, Jr.; FSCA), several males and females; Big Pine Key, Nov. 20, 1958 (R. E. Woodruff; FSCA), one male; Key Largo, under bark of dead tree, Aug. 29, 1961 (H. V. Weems, Jr.; FSCA), one male; South Matecumbe Key, Nov. 30, 1961 (W. J. Gertsch; AMNH), one female; Little Torch Key, under bark of dead tree, May 7, 1961 (H. V. Weems, Jr.; FSCA), numerous males and females; Middle Torch Key, May 7, 1961 (R. E. Woodruff; FSCA), one male,

one female; Torch Key, June 8, 1960, under bark of small dead trees (H. V. Weems, Jr.; FSCA), numerous males and females. Dade County: Homestead, under bark of *Casuarina equisetifolia*, May 7, 1962 (J. Knowles; FSCA), one female; Miami, Feb. 10, 1961 (R. E. Woodruff; FSCA), two males, three juveniles.

This species was originally described from the Antilles, but was later collected also in the coastal deserts of Peru, and in arid regions of Colombia and Venezuela, on the shores of the Caribbean.

The original description is sufficient to identify this species, the largest of all lepismatids of the area under consideration.

Stylifera impudica (Escherich)

Acrotelsa impudica ESCHERICH, 1905, p. 112.

This species is known from the Caribbean coastal regions of Colombia and Venezuela, and from various islands of the Leeward Group of the Lesser Antilles.

The rather summary original description (Escherich, 1905) was recently supplemented by a detailed redescription (Wygodzinsky, 1959).

The chaetotaxy of the posterior gonapophyses of a female from Oceania as shown by Paclt (1966) is very different from that illustrated in Wygodzinsky's (1959) redescription and obviously does not represent conditions found in *impudica* as understood by Wygodzinsky (*loc. cit.*).

Thermobia campbelli (Barnhart), new combination

Figures 5, 10B-J

Ctenolepisma campbelli BARNHART, 1951, p. 184.

MATERIAL EXAMINED: USA: Pennsylvania: University Park, campus of Pennsylvania State University, in buildings (J. F. Luke; AMNH) numerous males and females.

The above specimens agree well with the data given in the description of *Ctenolepisma campbelli* by Barnhart (1961), who found specimens in buildings in Ohio. Barnhart (*loc. cit.*) described his specimens as not having more than 2+2 bristle-combs on any abdominal tergum, which places the species in *Thermobia* and not in *Ctenolepisma*, but none of the authors who have published on this species (Barnhart, 1961; Theron, 1963; and Paclt, 1967) placed *campbelli* correctly. An examination of the types of *Ctenolepisma campbelli* confirmed this identification.

Barnhart's description and drawings are here supplemented by some additional illustrations. Although Barnhart mentioned that the terminal

segment of the labial palp bears five sensory papillae, his figure shows a larger number, obviously in error; the five sensory papillae are shown here (fig. 10E) in detail. The chaetotaxy of the apical articles of the ovipositor, of some importance in the taxonomy of the Lepismatidae, is also illustrated here (fig. 10I, J).

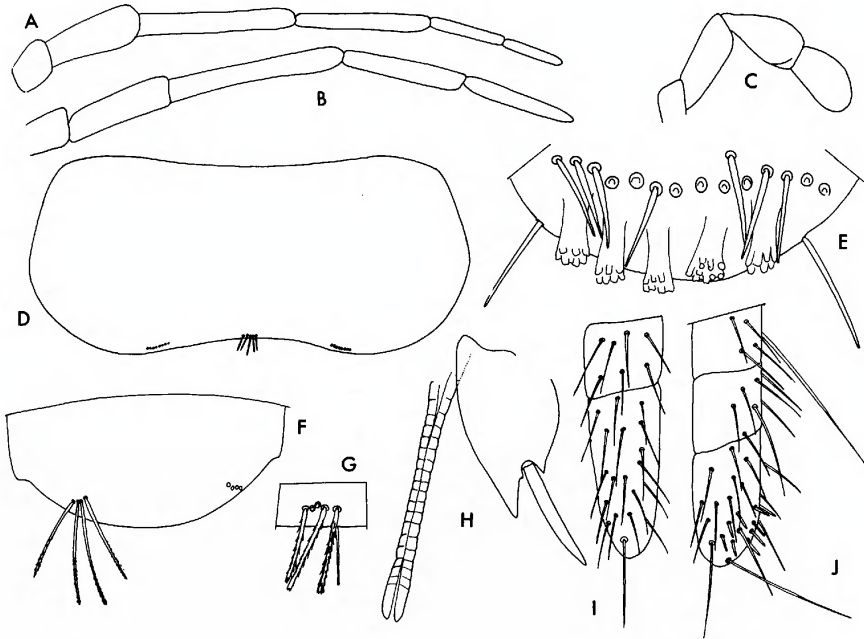


FIG. 10. Species of *Thermobia*. A. *T. domestica*, maxillary palp. B-J. *T. campbelli*. B. Maxillary palp. C. Labial palp. D. Abdominal sternum V. E. Apex of labial palp, high magnification. F. Tergum X, macrochaetae shown only on one side. G. Bristle-comb of abdominal tergum, high magnification. H. Coxite IX of female, with stylet and posterior gonapophyses. I. Apex of anterior gonapophysis. J. Apex of posterior gonapophysis.

The description of the chaetotaxy of the abdomen as given by Barnhart (1961) is somewhat confusing and not quite correct. *Thermobia campbelli* has abdominal terga I-VIII and X with 1+1 lateral bristle-combs, and terga II-VII with 1+1 sublateral bristle-combs. Ventrally, sterna I and II lack bristle-combs; there are 1+1 sublateral bristle-combs on sterna IV-VIII, and median bristle-combs on sterna III-IV.

Thermobia campbelli adults especially when preserved in alcohol, can easily be mistaken for juvenile *Thermobia domestica*. I am indebted to Mr. J. F. Luke for having called my attention to the fact that living

campbelli can easily be distinguished from *domestica* by their dorsal scales, which are uniformly gray (fig. 5); in *domestica*, the dorsal scales form a complex color pattern (fig. 2). *Thermobia campbelli* differs from *domestica* and the three other named species of *Thermobia*, *aegyptiaca* (Lucas), *infelix* Silvestri, and *longimana* Escherich by the presence of only one pair of stylets; there are two or three pairs in the remaining species. *Thermobia campbelli* differs, furthermore, from *aegyptiaca* by its smaller size, and the comparatively short and stout inner processes of the coxite IX in the female; *longimana* is distinguished by its extremely elongate appendages, and *infelix* by the strongly widened apical segment of its labial palp.

Thermobia campbelli is only known from two domestic populations in the eastern United States; it is probably Mediterranean or northern Ethiopian in origin, to judge from the distribution of the other species of the genus.

Thermobia domestica (Packard)

Figures 2, 10A

Lepisma domestica PACKARD, 1873, p. 48.

The firebrat, a normally synanthropic insect and introduced in the Western Hemisphere, is rare in South America but rather common in the United States. In colder climates the species is generally restricted to basements where permanent heat sources, such as boilers, exist, whereas in warmer areas it is found in any part of a given building. In the west and southwest of the United States secondarily free-living populations have become established in semiarid areas.

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