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DISTRIBUTION, GENERAL BIONOMICS, AND RECOGNITION
CHARACTERS OF TWO COCKROACHES RECENTLY ESTAB-
LISHED IN THE UNITED STATES

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Introduction

In contrast to the large numbers of cockroach species that occur in a great variety of natural habitats in most tropical countries, only about 55 are now recorded from the entire United States. With the exception of those occurring in a few localities, mainly in the Southwestern States, our roaches are well known to entomologists. In the northern third of the country there are few native roaches living in fields or woodlands, and most of the better-known species are established adventives which are rather closely associated with human habitations, having been brought there by artificial means. The recent establishment in the Northeastern States of two potentially important roaches new to this country is therefore of decided interest.

Beginning in 1948 and continuing each subsequent year, specimens of *Ectobius livens* (Turton), the spotted Mediterranean roach,² have been collected at Falmouth, Mass., under outdoor conditions, coming to houses at night and also occurring on fresh vegetables. Because of these habits and the wide natural occurrence of this roach in Europe and adjacent areas, it seems quite probable that a slow spread in the United States may take place, and that from time to time questions regarding its identity and importance will arise.

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²No generally accepted common name seems to be applied to *E. livens* in Europe, and this name is considered suitable for American use in view of the species' appearance and the region of its dominant Old World occurrence.

A second species not previously known to breed in the United States is *Leucophaea maderae* (Fabricius), the Madeira roach. Unlike the spotted Mediterranean roach, *L. maderae* is well known because it is frequently transported with articles of commerce in tropical countries. It has many times been intercepted by quarantine inspectors at United States ports and has occasionally been carried to inland cities, where it failed to survive. In the autumn of 1950 it was found to be established in the basements of New York City buildings occupied by people who had come from Puerto Rico. Although its native home is evidently West Africa, it apparently was introduced to the West Indies more than 100 years ago. The Madeira roach could probably live outdoors in tropical Florida and perhaps at the other southern extremities of the United States, but it is more likely to be important as a domestic pest in the well-heated buildings of our larger cities. One has only to recall the increasing importance of the brown-banded roach *Supella supellectilium* (Serville) in this country during comparatively recent years to realize the potential importance of *Leucophaea maderae*. Apparently a native of Africa that has been spread by commerce to most of the warmer parts of the world, *S. supellectilium* was first reported from the United States in 1903, based on specimens from Key West, Fla. It was not noted as a pest here until found in a private home in Nebraska in 1929, but since then has rapidly gained recognition as one of our principal pest roaches (see Back, 1937, and Gould and Deay, 1940).

This paper is intended to aid in the identification of these two roaches and to supply such available information on distribution and habits as is likely to be helpful to subsequent studies of these species in the United States. A third species, *Nauphoeta cinerea* (Olivier), was found to be established in Florida after this manuscript was prepared. It is briefly noted on page 46.

Genus *Ectobius* Stephens, 1835

Ectobius livens (Turton), 1800? (spotted Mediterranean roach)

FIGURE 10, *a-d*: PLATE 2, FIGURES 3-6

Blatta livida Fabricius, *Entomologia systematicae*, vol. 2, p. 10, 1793. (Pre-occupied by *Blatta livida* De Geer, *Memoirs pour servir à l'histoire des Insectes*, vol. 3, p. 538, pl. 44, fig. 6, 1773.)

Blatta livens Turton. *A general system of nature . . .*, vol. 2, p. 529, 1800? (New name for *Blatta livida* Fabricius.)

Ectobius lividus Fabricius, Stephens, *Illustrations of British entomology, Mandibulata*, vol. 6, p. 48, 1835.

Ectobius livens (Turton), Ramme, *Mitt. Zool. Mus. Berlin*, vol. 27, pp. 34-45, pl. 10, fig. 3, 1951.

Nomenclatural comments.—Until 1951 *Ectobius lividus* was usually applied to this species. The name *E. livens* has been resurrected by

Ramme (1951, p. 34) who says that Dr. K. Princis of Lund, Sweden, informed him that *livida* Fabricius was preoccupied and that Turton proposed *livens* on page 526, vol. 2, of his 1806 edition of Linné's *Systema Naturae*. Turton published two editions of an English translation of the thirteenth (Gmelin) edition of this work. These editions are listed in the 1903-1915 Catalogue of the Books, Manuscripts, Maps and Drawings in the British Museum (Natural History) (vol. 3, 1910, p. 1128). I have verified their dates and contents by an examination of the entire 7-volume 1806 edition in the Library of Congress and of volume 2 of the 4-volume first edition in the library of the U. S. National Museum. The first Turton edition appeared from 1800 to 1802. Volume 2, containing the genus *Blatta*, is dated 1800 and is reasonably sure to have appeared no later than 1802. The second Turton edition appeared in 1806, the first 4 volumes being re-issues of the former edition with slight changes of the title pages. On the page indicated by Ramme (p. 526) *Forficula livida*, an earwig, is treated.

Prior to Ramme's monograph, the identities of the British species of *Ectobius* were confused. Thus the species treated by Lucas (1920, p. 78) as *perspicillaris* Herbst is in reality *livens*. This has been clarified by Blair (1934, 1935). Princis (1936) has explained that a Lapland record of *lividus* (i. e., *livens*) actually was based on material of *lapponicus* (Linnaeus). Hebard (1943, p. 12) states that Australian records of *lividus* are incorrect. Taxonomists now differentiate the species of *Ectobius* on rather minute characters, especially on the basis of the dorsal abdominal gland and genitalia of males. Ramme (1949) has described *E. siculus* from Sicily, differing from *livens* in having black legs and antennae. *E. finoti* Chopard of Algeria (see Chopard, 1943, p. 21) is much like *livens*, having the small tegminal spots between the veins and with the dorsal gland bearing a rounded tubercle. The genus *Ectobius* (genotype: *lapponicus*) in a modern sense is much more restricted than formerly. In the older literature, species of *Ectobius* were reported from many parts of the world. Certain of these are now known to belong to other genera. For instance, many years ago several Nearctic roaches were referred to *Ectobius*. Rehn (1931, pp. 306-374) and Hebard (1943) have discussed the generic limits of *Ectobius*: Rehn (p. 308) has explained the nature of the toothed tarsal claws; the teeth were evidently overlooked by Hebard (p. 12).

Recognition features.—The most important features enabling recognition of *Ectobius livens* are: (1) Small size, over-all length about 8 to 9 millimeters; (2) small, dark spots on the veins of the front wing (tegmen); (3) conspicuous intercalated triangle at apex of wing (itr, fig. 10, *b*); (4) claws of unequal length, the posterior claw of each pair much longer than anterior one; (5) in males the characteristic shape of the dorsal abdominal glandular depression and the sub-

genital plate (fig. 10, *a, c*); (6) conspicuous spines on ventroposterior margin of each femur.

Of the foregoing features, the second and fifth are specific for the separation of this roach from other species occurring in the United States and the others are highly confirmatory when in combination.

The native Nearctic species most likely to be mistaken³ for *E. livens* are *Chorisonera texensis* Saussure and Zehntner, of Texas and the Southeast, and members of the genus *Cariblatta*. Both have claws of equal length, and *Cariblatta* lacks a well-developed, intercalated triangle. *C. texensis* has a large intercalated triangle, but has no conspicuous spines along the posterior margins of the femora. The best-known outdoor roaches of the Eastern States belong to the genus *Parcoblatta*; all are larger than *livens* and lack an intercalated triangle.

Identification of the Massachusetts specimens of *livens* was aided by comparisons made at the Academy of Natural Sciences of Philadelphia with authentic French and Swiss material, given to the Academy by the Swiss entomologist Henri de Saussure.

Description.—ADULTS: General form as in plate 2, figure 6; tegmina and wings covering abdomen; width between eyes on vertex about $1\frac{1}{2}$ times length of first antennal segment (female), slightly less in male; all femora with conspicuous spines on ventroposterior margins; ventroposterior margin of front femur with three or four well-spaced, strong spines along part slightly basad of middle, the more apical one often smaller than others, followed by 10 to 15 small, delicate spines (some of which are frequently broken) extending in a regular row nearly to apex, a long curved apical spine closely preceded by a straight subapical one about three-fourths as long; tarsal segments one to four each with a tiny, round pulvillus (membranous pad); segment 5 with large, broad apical arolium between conspicuously unequal tarsal claws, anterior claw about two-thirds length of posterior one, longer claw with about four spinelike inner teeth along basal half, teeth on smaller claw poorly developed. Tegmen with costal veins simple, cubital veins (discoidal sectors) strongly oblique, apex rather sharply rounded. Wing with distinctive intercalated triangle (itr, fig. 10, *b*).

General color pale yellowish; tegmina and marginal area of pronotum transparent, marked with reddish brown spots, on the tegmen these spots located on the veins; eyes dark brown to black; face yellow to reddish orange; vertex and upper part of face usually with several spots of darker orange; coxae and femora unspotted; tibiae with dark brown at bases of some spines; venter of abdomen with poorly

³ The standard taxonomic reference on Nearctic Blattaria is that of Hebard (1917). A recent key to genera is by John W. H. Rehn (1950). The European species of *Ectobius* were reviewed by Ramme (1923).

developed longitudinal rows of dark brown submarginal and median spots.

Measurements (in millimeters) of representative specimens: Overall length, including folded tegmina, female 9, male 8.5; pronotum, female 2.1, male 1.9; tegmen, female 7, male 7.2. Width of pronotum, female 3, male 2.9. No significant size variation has been noted.

NYMPHS: Nymphs (pl. 2, figs. 3, 4) ranging in body length from 2.5 to 4.5 millimeters have been examined. They are yellow, with conspicuous dark reddish brown spots on the dorsal surface and on the vertex and upper part of the face. Dark submarginal longitudinal streaks appear on the thorax. The venter of the abdomen is dark brown submarginally and medially.

OÖTHECAE: Two oöthecae have been examined (pl. 2, fig. 5). They are dark brown and measure 2.3 millimeters in length. The convex margin is weakly crenulate and there are faint transverse indications of the eggs contained.

Distribution.—Three American localities are known for *Ectobius livens*, all in Massachusetts: Falmouth, Manomet, and Plymouth. Falmouth, the first site discovered here, is situated near Woods Hole and the Cape Cod Canal, on the southern side of the base of Cape Cod. In October 1951, after this manuscript had been prepared, I examined 3 males and 4 females of *livens* collected at Manomet, Plymouth County, Mass., by Mrs. S. P. Graeff and submitted by Dr. Ellsworth H. Wheeler of the University of Massachusetts. Manomet is on the coast of Cape Cod, about 20 miles north of Falmouth. The specimens were collected before August 13, 1951, apparently just prior to that date. Mrs. Graeff wrote, "Our summer cottage is pretty well overrun with them. Painters told me they were even on the roof. The cottage is in the woods and the underbrush is close. I think this is the third summer we have had them. I suspect they like damp spots, they scurry under shingles."

An adult of *livens* was submitted July 28, 1952, by a Plymouth housewife who reported that her house and shrubbery were becoming infested.

This roach is widely distributed in the southern and central portions of western Europe, occurring in Germany, the Netherlands, Belgium, France, Switzerland, Italy, Portugal, Spain, and southern England. It has also been reported as far eastward in the Mediterranean area as Asia Minor, but the records I have seen were published prior to the modern work dating from Ramme's 1923 monograph of *Ectobius* and are not dependable. Chopard (1943, p. 21) has reported it from Algeria and Tunisia. I have found no records of its occurrence in the Azores. Fabricius originally described the species from France, and, in the absence of type material, Ramme in 1923 designated a male

neotype from Montpellier in southern France. Two varieties of *livens* have been recognized, *chopardi* Adelung described from France in 1916, and *minor* Ramme described from the Island of Elba in 1923. These varieties are based primarily on the amount of dark color on the lower surface of the abdomen, *minor* being quite dark except near the lateral margins, only the submarginal dark spots being well developed in *chopardi*, and the submarginal spots being poorly or moderately developed in typical *livens*. The species of *Ectobius* are well known for color variation, the color of tegmina and abdomen often being recessive (pale) or intensive (dark). In view of this situation, it remains to be proved whether *chopardi* and *minor* are valid subspecies or if they are forms without real significance. The center of distribution for the genus *Ectobius*, as outlined by Rehn (1931, pp. 314-318), was apparently the Mediterranean Basin, with a secondary center developed in Africa south of the Sahara Desert.

Biology.—The original Massachusetts specimens of *Ectobius livens* examined consist of 2 males, 16 females, 9 nymphs, and 2 oöthecae. The males were taken June 21, 1948, and the other specimens in late August and September 1950.⁴ It may be significant that males were found only in the spring and early summer. Lucas (1928) reported that in England males of *E. lapponicus* disappeared about midsummer, the females persisting longer than males, and nymphs appearing in late summer and fall preparatory to hibernation. No detailed life history studies of *livens* in Europe have come to my attention. Brown (1952) has reported observations on the related *E. panzeri* Stephens in England, which occurs there mainly on sand dunes near the coast. Adults die in the fall, the males disappearing first, but nymphs overwinter and do not reach full maturity until early August of the following year.

The Falmouth collections were made on a farm located beside a small salt river about a mile from the shore. Mr. Flint found specimens in a large variety of situations, specimens occurring most consistently beneath loose lichens on oak trees, and crawling on trees and houses at night—the latter in the vicinity of lights. Some were found under baskets, in buckets, or on Swiss chard and other vegetables, or were taken by general sweeping (see Flint, 1951).

In England *E. livens* occurs only in the extreme southern counties—there found on trees, among bracken ferns, under dead leaves, and flying actively in hot sunshine (Lucas, 1920, p. 80; Burr, 1936, p. 44). Chopard (1947, p. 37) says *livens* is very common in the French woods, and he gives a colored illustration (pl. 2, fig. 28).

⁴ All of this material was collected by Oliver S. Flint, Jr., a student at the University of Massachusetts. I am much indebted to Mr. Flint for the enthusiasm with which he sought additional material once the character of his initial captures was pointed out to him, as well as for his diligence in seeking clues to the origin of the introduction.

Source of introduction.—The Massachusetts colony of *Ectobius livens* is probably the result of an accidental introduction from western Europe or the Mediterranean area. A good many people of Portuguese ancestry live in Falmouth and the vicinity, and visits to Portugal and the Azores are frequent. Seeds and occasional shipments of fruit are brought back, but quarantine regulations prevent widespread movements of plant products. Since *livens* occurs in Portugal, as reported by Seabra (1942, p. 19), the possibility of an introduction from that part of the Mediterranean seems the most likely.

Probable importance.—*Ectobius livens* is not likely to develop into a major pest or to live in buildings except occasionally. As a nuisance pest in the vicinity of gardens and dwellings, it may be expected to attract attention at intervals and to be submitted to entomologists for identification and advice, as is now true of male specimens of *Parcoblatta* which are attracted to lights and which occasionally remain in houses for short periods.

So far as known, species of *Ectobius* are not economically important in Europe. *E. lapponicus* has often been stated to be a pest of dried fish in Swedish Lapland, but Gaunitz (1935, 1936) found that *lapponicus* does not occur indoors and probably feeds on vegetable matter.

Genus *Leucophaea* Brunner, 1865

Leucophaea maderae (Fabricius), 1793 (Madeira roach)

FIGURE 10, e-h; PLATE 2, FIGURES 1, 2

Blatta maderae Fabricius, Entomologia systematicae, vol. 2, p. 6, 1793.

Leucophaea maderae (Fabricius), Rehn, Trans. Amer. Ent. Soc., vol. 29, p. 283, 1903.

Nomenclatural comments.—The name *Rhyparobia maderae* is currently used by certain workers, especially Europeans, as exemplified by Chopard (1943, p. 45) in his monograph of North African Orthoptera. *Leucophaea* was proposed by Brunner (1865, pp. 272, 278) as a subgenus of *Panchlora*, with four included species. One of the four, *maderae*, was designated type of *Leucophaea* by Rehn (1903, p. 282). *Rhyparobia* was proposed by Krauss (1892, p. 165), monotypic for *maderae*. Thus *Rhyparobia* is an isogenotypic synonym of *Leucophaea*. The use of *Rhyparobia* was doubtless encouraged by the action of Kirby (1904, pp. 150–151) who, evidently unaware of Rehn's 1903 designation, designated *Blatta surinamensis* Linnaeus type of *Leucophaea*. As explained by Hebard (1917, p. 309), Kirby also apparently objected to the name *Pycnoscelus* Scudder, 1862, to which *surinamensis* belongs, because it was originally based on an immature specimen. Kirby's latter view is not supported by the rules of nomen-

clature but, regardless of that aspect of the matter, the validity of *Leucophaea*, with *maderae* its type, is clear.

Recognition features.—The most important features in the recognition of *Leucophaea maderae* are: (1) Large size, overall length about 38 to 53 millimeters; (2) pronotal shape, and general color markings as illustrated (pl. 2, figs. 1, 2); (3) no strong spines along posterior margins of femora except one short apical spine on each hind and middle femur; (4) in males the characteristic shape of the specialized organ on the dorsal surface of the second abdominal segment and of the subgenital plate (fig. 10, *e, h.*).

Relatively few Nearctic roaches are as large as *L. maderae*, and none of them is likely to be confused with it. *Blaberus craniifer* Burmeister, illustrated by Hebard (1917, pl. 8, fig. 6), is the largest roach in the United States, being much larger than *maderae*. The species of *Periplaneta* are quite differently marked, and have numerous heavy spines on the posterior margins of the femora. Both *Eurycotis floridana* (Walker), of the Southeast, and *Hemiblabea tenebricosa* Rehn and Hebard,⁵ of the Florida Keys, have short, lobate tegmina and wings which are vestigial or lacking.

A relative of *L. maderae* recently established in Florida is *Nauphoeta cinerea* (Olivier). It superficially resembles *maderae*, though it is smaller, its average length being about 23 millimeters. The femora are proportionately stouter and the tegmina scarcely extend beyond the apex of the abdomen, while the posterior margin of the pronotum is transversely subtruncate, a median projection being scarcely evident. Zimmerman (1948, p. 94) and Rehn (1945, p. 274) have given photographs of *cinerea*. This species is apparently a native of East Africa now widely distributed in the Tropics by commerce and often intercepted at United States ports. Its potential importance is suggested by Illingworth (1942), who described its occurrence in alarming numbers about the feed room of the poultry plant at the University of Hawaii. He also mentioned its occurrence in heated buildings in England and Germany, though no records of permanent establishment in those countries have come to my attention.

In early December 1951 material of *cinerea* was received from Joseph Gross of Tampa, Fla., who stated that it was widely and thoroughly established about Tampa, especially in feed mills. Later, in August 1952, Mr. Gross contributed a series of 34 adults and 32 nymphs

⁵ *Hemiblabea tenebricosa* was described from the West Indies, including Nassau in the Bahamas, by Rehn and Hebard (1927, p. 271). Caudell (1931) recorded an adult pair collected at Key Largo, Fla., by E. A. Popenoe in 1896. Caudell's unpublished notes disclose subsequent discussions of this record with Mr. Popenoe's son, who explained that his father was collecting insects primarily for Kansas State College during the 1896 trip and that in view of conditions at Key Largo at that time this roach was probably an established species rather than an intercepted adventive. A number of roaches are now known to be native to the northern Bahamas and extreme tropical Florida, so the occurrence of *tenebricosa* in the Florida Keys is not illogical.

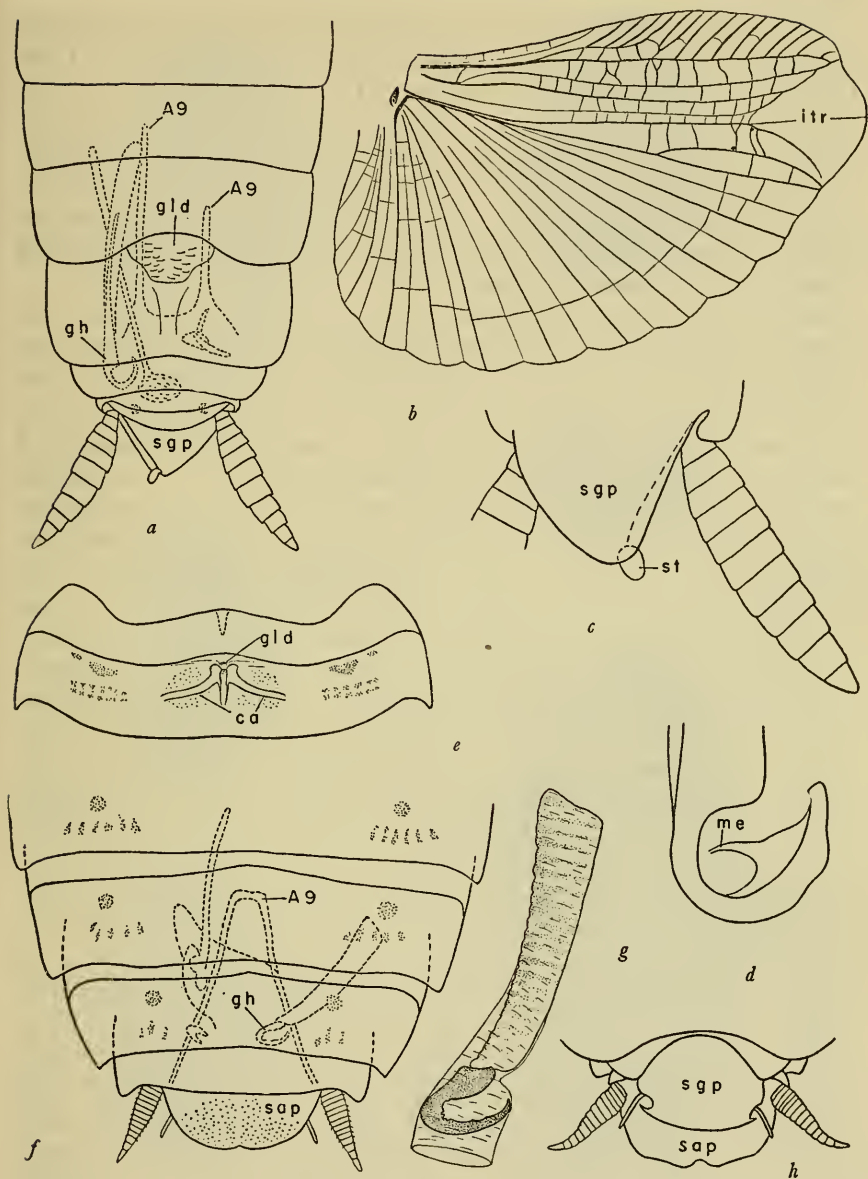
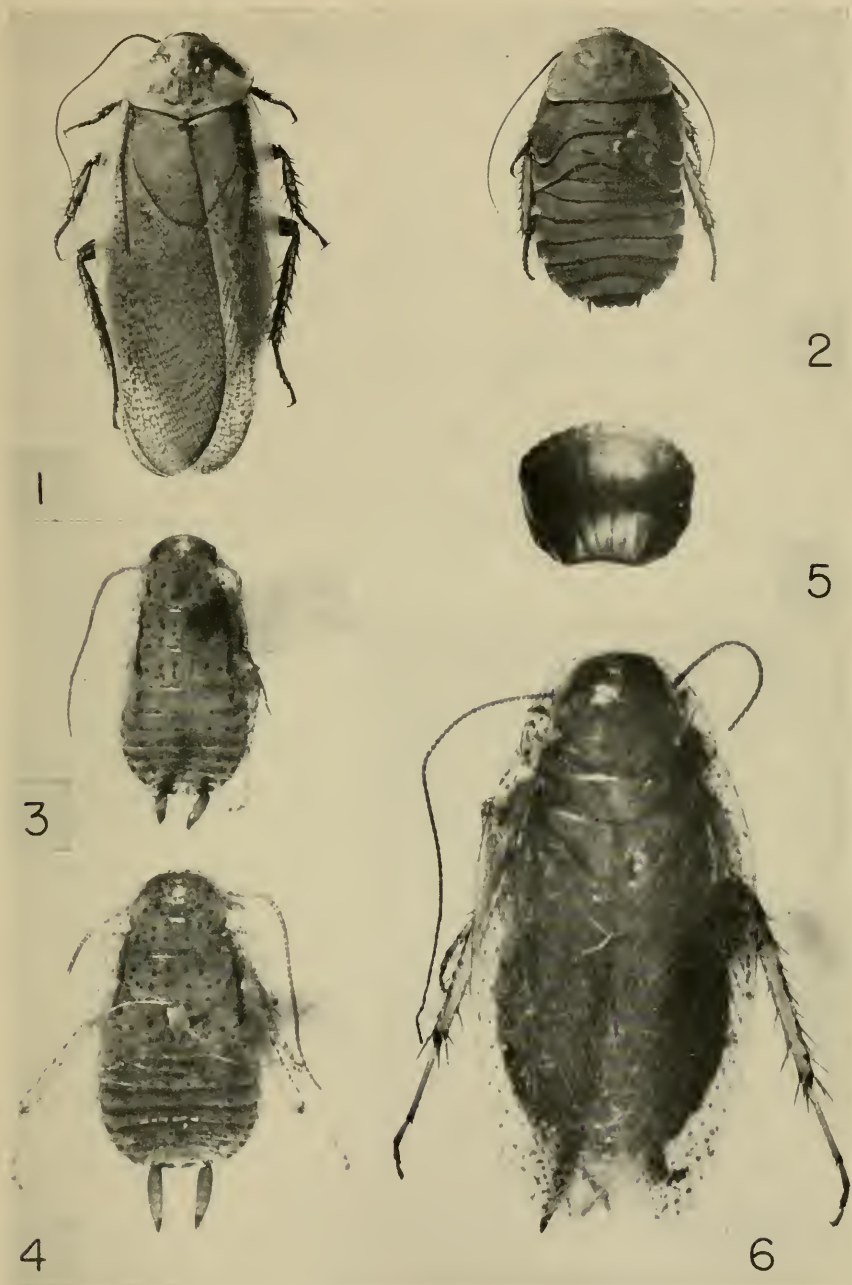


FIGURE 10.—Structural details of *Ectobius livens* (Turton) and *Leucophaea maderae* (Fabricius). *a-d*, *E. livens*: *a*, Dorsal view of apical half of cleared male abdomen; *b*, wing; *c*, ventral view of subgenital plate and associated cerci, male; *d*, apical portion of genital hook, male. *e-h*, *L. maderae*: *e*, Dorsal view of second abdominal segment, male, cleared and in alcohol; *f*, dorsal view of apical half of cleared male abdomen; *g*, genital hook of male, enlarged; *h*, ventral view of subgenital plate and associated structures, male, dry preparation. Drawn from specimens as follows: *a-d*, from Massachusetts specimen; *e*, from Puerto Rico specimen; *f* and *g*, from specimen collected in a Tampa, Fla., warehouse; *h*, from New York City specimen. (A-9, apodemes of sternum 9; *ca*, oblique carinae of glandular specialization; *gh*, genital hook; *gld*, glandular depression; *itr*, intercalated triangle; *me*, mesal extension; *st*, stylus; *sap*, supra-anal plate; *sgp*, subgenital plate.)

to the U. S. National Museum. I inquired especially as to the apparent permanence of the infestation, and on June 24, 1952, a colleague of Mr. Gross', W. B. Gresham, Jr., replied, "It seems evident to us that *Nauphoeta* is in Florida to stay. They appear to be well adapted and quite numerous in the locations where we have noted them. All infestations noted have been within commercial buildings engaged in the manufacture of animal feeds. I myself have not noted any out of doors." Notes on the Florida infestations by Ratcliffe (1952) and Gresham (1952) have appeared.

Description.—ADULTS: General form as in plate 2, figure 1; tegmina and wings extending beyond apex of abdomen about one-fifth their length; width between eyes on vertex about two-thirds length of first antennal segment; a shallow, scarcely wrinkled transverse depression in interocular area where eyes are closest; ventroposterior margin of middle and hind femur each with short, apical spine; conspicuous spines on posterior femoral margins otherwise lacking; ventroposterior margin of front femur with continuous row of delicate, seta-like spines, these slightly shorter toward apex of femur and a few noticeably longer ones near base; front tibia with two elongate groups of setae along margins; pulvillus on each tarsal segment, elongate on segments 1 and 5; claws equal, unarmed ventrally, with sparse setae dorsally; pronotum obtusely angulate laterally, posterior margin with rounded median production; tegmen with cubital veins (discoidal sectors) oblique; wing (see J. W. H. Rehn, 1951, pl. 9, fig. 102) with well-developed axillary and cubital fields, intercalated triangle lacking. Dorsal surface of abdomen simple in female, specialized in male; second tergum of male (fig. 10, *e*) with median glandular development consisting of paired oblique carinae (ca) and a brief longitudinal carina centered on a trifold papilla which largely covers a small glandular depression (gld); supra-anal plate transverse, with median emargination of posterior margin, general shape more quadrate when dry (fig. 10, *h*) than when preserved in alcohol (fig. 10, *f*); subgenital plate unspecialized in female, slightly asymmetrical in male, with recurved lateral hooks near styli; cleared male abdomen with apodemes of sternum 9 (subgenital plate) (A9) united anteriorly, genital hook (gh) and additional sclerotized elongate rod associated with an irregular genital mass; genital hook (fig. 10, *g*) enclosed in a membranous sheath.

General color pale brown, the tegmen and pronotum marked with dark brown as illustrated (pl. 2, fig. 1); remainder of body and appendages largely dark brown; clypeus and most of labrum pale; abdominal sterna with oblique submarginal marks of brownish-black; terga with more heavily pigmented areas as shown (fig. 10, *f*). Base of genital hook with pigmented transverse lines, the apical portion much darker.



1, 2, *Leucophaea maderae* (Fabricius); 1, Adult female, collected in Manila, Philippine Islands (length, 47 mm.); 2, last nymphal stage, intercepted at Washington, D. C.
 3-6, *Ectobius livens* (Turton), all from Falmouth, Massachusetts: 3, 4, Nymphal stages; 5, oötheca; 6, adult female (length, 9 mm.).

Measurements (in millimeters): Overall body length, including folded tegmina, female 45 to 53, male 38 to 45; pronotum, female 9 to 10.3, male 7.5 to 8.5; tegmen, female 37 to 46, male 32 to 38.5. Width of pronotum, female 13.3 to 16, male 11.5 to 14.

Nymphs: Nymphs (pl. 2, fig. 2) ranging from 7.5 to 32 millimeters in body length have been examined. The dorsal surface of the thorax and abdomen is sharply rugose, with short, microscopic spines, these especially conspicuous along the posterior margins of segments; much smaller and less evident spines on ventral surface of abdomen. General color reddish brown; each tergum with a submarginal dark spot near the base, the basal half of the exposed lateral margin blackish and the apical third yellowish.

Distribution.—In the United States *Leucophaea maderae* is known to be established only in the Harlem section of New York City.⁶ Many times each year inspections made at shipping centers detect the species with plant products and other articles coming both from the American Tropics and the Old World. The distribution of *maderae* in warm countries is very wide, but somewhat irregular, depending upon the vagaries of commerce. The specific and the common names are derived from the fact that this roach was first described from Madeira, a small island now belonging to Portugal and located in the Atlantic Ocean about 400 miles west of Morocco. Rehn (1937, pp. 56–58; 1945, p. 273) has reasoned (by a detailed analysis of the present occurrence of *maderae* and its congeners) that West Africa is the native home, from which commerce (in early centuries—that of the slave trade in particular) has carried it to Madeira, the West Indies, Brazil, and elsewhere. Ecuador, Colombia, Venezuela, the Guianas, Brazil, and Argentina are known to have established colonies of *maderae*, as well as Panamá, Costa Rica, and most of the West Indian islands. Old World distribution outside of Africa is more spotty and, to my knowledge, the species is not yet recorded from India or Australia—even though it is known from Java, the Philippines, Hawaii, and Fiji. Doubtless, *maderae* now breeds in many coastal areas from which there are no records and it will continue to spread as conditions permit.

Biology.—In New York City *Leucophaea maderae* has been “found in some abundance in the basement of an apartment of the Harlem section,” and an observer also writes⁷ “From their abundance and the presence of all stages of the insect . . . I would conclude that they

⁶ Davis (1940) reported at a meeting held December 15, 1938, that a specimen of *L. maderae* taken in the Bird House of Bronx Park, New York City, was the first record of this species in New York State. In the absence of further information, there is a strong likelihood that the specimen in question was an escaped adventive.

⁷ Specimens from the described infestation were submitted by Ralph E. Heal, Technical Director of the National Pest Control Association. Grateful acknowledgment is made of Dr. Heal's cooperation in obtaining information on the Harlem infestation.

are breeding in this house." It was also noted that the Harlem roaches appeared rather sluggish in their movements.

In the absence of biological studies of *L. maderae* in this country it is instructive to review the observations of life history and habits that have been made elsewhere, particularly the papers of Illingworth (1915), Sein (1923), and Pessoa and Correa (1928).

As is true of species of *Periplaneta*, growth in the Madeira roach is slow. The first molt may occur 1 to 4 months after birth. Pinned nymphs reared by Illingworth in Hawaii and now deposited in the U. S. National Museum suggest that there are six nymphal stages, though the number is likely to vary, and in cultures it may sometimes be difficult to observe because exuviae reportedly are eaten immediately after each molt. Pessoa and Correa report only four "metamorphoses," but that number of molts is almost certainly too small for a normal growth cycle. The body length in millimeters of specimens of various ages collected by Illingworth is as follows: 1 day, 7.5; 1 month, 7.5; 4 months, 16; 5 months, 18.5; 6 months, 24.5; 7 months, 29; 8 months, 30.7; 9 months, 32. Food and environmental conditions are doubtless important influences on growth. Sein notes maturity being attained in 220 days, but that a year is often required, while Pessoa and Correa indicate that adults are obtained in a year with 16 to 18 months the longest observed time. In Sein's cultures the first nymphs appeared 4 months after their parents matured. Immediately following birth, nymphs usually hide beneath the mother during the day. According to Pessoa and Correa, this makes the adult restless and active in contrast to its usual slow gait.

In a general paper emphasizing the adaptability and value of *Leucophaea maderae* as an experimental animal, Scharrer (1951) comments that it thrives on a diet of apples, carrots, and dogfood. She reports that there are 30 to 35 young every 3 months, that there is an average of 8 molts, and that life expectancy is up to 2½ years. Dr. Scharrer has observed that tumors which resemble malignant cancer of higher animals develop in various parts of the roach body following the removal of the corpora allata and the corpora cardiaca. That such an injury to the nervous system has produced tumors has very interesting and practical implications for further research. The name "woodroach" that Dr. Scharrer applied to *maderae* is a questionable choice, since the name is most often used for native Nearctic species of *Parcoblatta*.

Leucophaea is one of several roach genera which are viviparous; that is, the eggs are enclosed in a delicate membranous sac which normally ruptures before extrusion from the mother's body, or immediately thereafter, so that, in effect, the young are born alive. This is in contrast to the habit of most roaches which form a heavily-sclerotized, dark-colored capsule or oötheca, usually of characteristic shape,

which may be carried protruding from the body for some time prior to hatching, or be deposited loosely or surrounded with a matrix.

The viviparity exhibited generally takes a special form known as ovoviviparity. This occurs in several well-known genera, especially *Panchlora*, *Pycnoscelus*, *Nauphoeta*, and *Leucophaea*, and Chopard (1938, p. 218) notes six subfamilies of roaches (according to the long-used classification) in which viviparity occurs. J. W. H. Rehn (1951) has recently proposed a new classification, based on wings, and it is significant that many of the viviparous genera fall in what he terms the epilamproid complex. In addition to Chopard, Shelford (1907), Karny (1924, pp. 3-10), and Rau (1941) have discussed viviparity among roaches. Hagan (1941; 1951) has described the female reproductive system of the viviparous *Diploptera*, and Chopard (1950), that of *Gromphadorhina*.

Illingworth and Sein both recognized that *Leucophaea maderae* is viviparous, but it appears that Pessoa and Correa observed unusual or abnormal instances of the egg sac being deposited, as they wrote of a capsule being placed in the darkest corner of a rearing box and the first young appearing 20 days later. In the following paragraphs I have attempted to explain this apparent lack of agreement.

Several preserved adult females of *L. maderae* received for identification during recent years have exhibited an elongate sac about 20 millimeters long protruding from the end of the abdomen. In certain cases the eggs (varying up to about 40 in number), directed transversely with respect to the mother's body and arranged in two rows, were undeveloped, but in others nymphs ready for hatching were visible—in fact, rupturing of the sac had sometimes occurred. Rehn (1937, p. 62) has described his experience in the Belgian Congo with the related *L. grandis* (Saussure). A female confined in a bottle gave birth to 20 living young. The number of young of *maderae* produced at one time, according to published records, ranges from 25 to 32.

The related *Pycnoscelus surinamensis* (Linnaeus) is known to be viviparous, but the literature concerning its habits suggests a lack of uniformity in birth or hatching. Watson (1929, p. 58) commented on an egg capsule being deposited but the eggs failing to hatch. Caudell (1925) also maintained cultures of *P. surinamensis*, and mentioned young born alive and oöthecae seldom if ever protruding from the female abdomen. In a somewhat fuller account, Zappe (1918) gave the opinion that young of *surinamensis* are either born alive or hatch from eggs within 24 hours. Eggs were often laid in soil, but were not observed to hatch. When females were injured or excited, they often deposited poorly developed egg masses that did not hatch. Similarly, Illingworth (1942) reported that the eggs of *Nauphoeta cinerea* were usually kept in the body until living young appeared, but that confined individuals sometimes produced aborted egg masses that were ex-

truded but which dried up without hatching when the delicate enclosing membrane was exposed to the air. These experiences suggest that some of the protruding eggs of *L. maderae* that I have noted are the result of handling when the specimens were collected and that occasional egg masses may be deposited under certain conditions by this ordinarily viviparous species.

In his important recent paper, Chopard (1950) has discussed the anatomy and development of *Gromphadorhina laevigata* Saussure and Zehntner, of Madagascar. He observed, in the course of rearings conducted in Paris, that the female of this viviparous species extrudes the soft oötheca nearly to its full extent, then it is drawn into an incubating pouch where the eggs undergo incubation for approximately 70 days prior to the appearance of the young. Occasionally the oötheca is completely extruded, with the result that desiccation occurs and no hatching takes place. I am indebted to my colleague R. E. Snodgrass for pointing out the significance of Chopard's observations. They explain how the oötheca is transferred from the uterus to the incubating chamber in the case of *Gromphadorhina*. Possibly the same habit occurs in certain other viviparous genera, and some protruding oöthecae that have been seen may represent a stage in this normal act. In discussing the transfer of the developing eggs in the viviparous *Diploptera*, Hagan (1951, p. 299) states that the oöcytes pass from the ovarioles to the lower end of the common oviduct, where "they are directed by the ovipositor from the genital chamber ventrally into the open end of the uterus."

In Brazil, mating of *Leucophaea maderae* occurs mainly during the warm and rainy season, according to Pessoa and Correa, who say that copulation may occupy 20 to 30 minutes and takes place with the pair end to end facing in opposite directions. Prior to mating, the female is described as opening her wings and drawing them along the ground, at the same time producing a sound by vibrating them. The scent gland on the dorsum of the male presumably is attractive to the female at mating time, but its function is not definitely known.

Illingworth stated that when disturbed the Madeira roach stridulates very noticeably, and he believed the sound is produced by rubbing the posterior margin of the pronotum over the mesonotum. According to Chopard (1938, p. 286), several roaches stridulate delicately by rubbing the border of the pronotum upon the mesonotum or upon the strongly denticulate base of the costal vein of the tegmen. To test the possibilities of stridulation, I have relaxed dry specimens of both sexes of *L. maderae*, then manipulated the body parts with my fingers. A low, squeaking sound is consistently obtained in either sex by rubbing the lateroposterior margin of the pronotum on the basal costal margin of the tegmen. Both surfaces are heavily sclerotized, turned to oppose

each other, nonpubescent, and are finely rugose so as to make stridulation possible.

In tropical regions where it is established, *L. maderae* is definitely a domiciliary species, though, like certain other roaches often associated with man, it is capable of living apart from him in a purely wild state. From available records, however, it is not clear how frequently it has been collected entirely unassociated with man-made surroundings. According to Alfken (1904, p. 565) more than 50 years ago a German collector, H. Schauinsland, in 1896 or 1897 found *maderae* in native huts on the Hawaiian Island of Molokai, commerce already having carried it to certain Pacific areas. However, in spite of this long establishment in the Hawaiian group, no mention of its occurrence in fields is made by Williams (1931). In July 1950, in the Venezuelan State of Aragua, Dr. Ernst Schwarz³ collected it coming to lights in fair numbers, but whether it was breeding in the adjacent forest or associated with nearby habitations is not known. Likewise, specimens collected by the late C. F. Baker in the Philippines before 1927 bear the collecting label "Mt. Maquiling," and they may have bred under entirely natural surroundings. However, as I saw during my visit to Mt. Maquiling in 1945, at the base and on the lower slopes there are ample opportunities for this roach to remain associated with man. The species frequently flies actively and has often been taken at lights, including those on porches, in field camps, or of automobiles. On the other hand, Sein states that *Leucophaea maderae* does not fly much when indoors at night as part of an infestation. *L. puerilis* Rehn, considered its closest relative, is a strictly endemic, forest type in West Africa.

Source of introduction.—The New York City infestation is reported to be localized in apartment buildings occupied by people from Puerto Rico and, since there has been a good deal of movement—much of it by air—from that island in the past few years, there is little doubt that Puerto Rico is the source of the infestation.

Probable importance.—In Puerto Rico the Madeira roach most often occurs in fruit stores and markets. It is especially fond of grapes. It is considered very gregarious and develops large, localized colonies. Wolcott (1950, p. 43) records about a bushel having been swept from one store. Warehouses and other buildings are often infested. When handled or otherwise disturbed, *Leucophaea maderae* produces an odor described as especially offensive. Houses infested by the species usually do not contain *Periplaneta* or *Blattella*. There is a strong possibility that *maderae*, if allowed to spread, will gradually develop into a serious pest in our larger cities. In the light of its wide occurrence in the Bahamas and other West Indian islands, tropical Florida would probably be a suitable habitat, either outdoors or in buildings without central heating.

³ Associated with the Venezuela Plague Mission (Commander J. M. Amberson, U.S.N., Dr. Ernst Schwarz, and Mrs. Schwarz).

References

ALFKEN, JOHANN D.

1904. Beitrag zur Insectenfanna der Hawaiischen und Neuseelandischen Inseln. Zool. Jahrb., System., vol. 19, pp. 561-628, 1 pl.

BACK, ERNEST A.

1937. The increasing importance of the cockroach, *Supella supellectilium* Serv., as a pest in the United States. Proc. Ent. Soc. Washington, vol. 39, pp. 205-213, 2 pls., 2 figs.

BLAIR, KENNETH G.

1934. A note on the British species of *Ectobius* Steph. Ent. Monthly Mag., vol. 70, pp. 157-159.
1935. [British species of *Ectobius*.] Proc. South London Ent. Nat. Hist. Soc., 1934-35, p. 5.

BROWN, E. B.

1952. Observations of the life-history of the cockroach *Ectobius panzeri* Stephens (Orth., Blattidae). Ent. Monthly Mag., vol. 88, pp. 209-212.

BRUNNER DE WATTENWYL, CHARLES

1865. Nouveau système des Blattaires. 426 pp., 13 pls., Vienna.

BURR, MALCOLM

1936. British grasshoppers and their allies. 164 pp., 6 pls., 56 figs., 40 maps, London.

CAUDELL, ANDREW N.

1925. *Pycnoscelus surinamensis* Linnaeus (Orthoptera); on its nymphs and the damage it does to rose bushes. Proc. Ent. Soc. Washington, vol. 27, pp. 154-157, 2 figs.
1931. Notes on Blattidae, adventive to the United States. Ent. News, vol. 42, p. 204.

CHOPARD, LUCIEN

1938. La biologie des Orthoptères. Encyclopedie entomologique, ser. A, vol. 20, pp. 1-541, 4 pls., 453 figs. Paris.
1943. Orthoptéroïdes de l'Afrique du Nord. Faune Empire Français, vol. 1, pp. 1-450, 658 figs., Paris.
1947. Atlas des Aptérygotes et Orthoptéroïdes de France. Nouvel atlas d'entomologie, vol. 2, pp. 1-111, 12 pls., 12 figs. Paris.
1950. Sur l'anatomie et le développement d'une blatte vivipare. Proc. 8th Int. Cong. Ent., Stockholm, 1948, pp. 218-222, 6 figs.

DAVIS, WILLIAM T.

1940. [*Leucophaea* recorded.] Bull. Brooklyn Ent. Soc., vol. 35, p. 35.

FLINT, OLIVER S.

1951. A new cockroach record from the United States. Bull. Brooklyn Ent. Soc., vol. 46, p. 53.

GAUNITZ, C. B.

1935. Till frågan om *Ectobius lapponicus* L. förmente skadegörelse inomhus i Lappland. Ent. Tidskr., vol. 56, pp. 138-150.
1936. *Ectobius lapponicus* L. als Vorratsschadling in Lappland, eine alte sicher unrichtige Vermutung in neuer Beleuchtung. Konowia, vol. 15, pp. 162-166.

GOULD, GEORGE E., and DEAY, H. O.

1940. The biology of six species of cockroaches which inhabit buildings. Purdue Agr. Exp. Stat. Bull. 451, pp. 1-31, 13 figs.

GRESHAM, WILLIAM B.

1952. [Note on *Nauphoeta* in Florida.] Florida Ent., vol. 35, p. 77.

HAGAN, HAROLD R.

1941. The general morphology of the female reproductive system of a viviparous roach, *Diploptera dytiscoides*. Psyche, vol. 48, pp. 1-9, 1 pl., 2 figs.

1951. Embryology of the viviparous insects. 472 pp., 160 figs., New York.

HEBARD, MORGAN

1917. The Blattidae of North America north of the Mexican boundary. Mem. Amer. Ent. Soc., No. 2, pp. 1-284, 10 pls., 1 fig.

1943. Australian Blattidae of the subfamilies Chorisonaurinae and Ectobiinae. Monogr. Acad. Nat. Sci. Philadelphia, No. 4, pp. 1-129, 14 pls.

ILLINGWORTH, JAMES F.

1915. Notes on Hawaiian roaches. Proc. Ent. Soc. Hawaii, vol. 3, pp. 136-140.

1942. An outbreak of cockroaches, *Nauphocta cinerea* (Olivier), in Hawaii. Proc. Ent. Soc. Hawaii, vol. 11, pp. 169-170.

KARNY, HEINRICH H.

1924. Beiträge zur malayischen Orthopterenfauna. Treubia, vol. 5, pp. 1-234, 1 pl., 85 figs.

KRAUSS, HERMANN

1892. Systematische Verzeichnis der Canarischen Dermapteren und Orthopteren mit Diagnosen der neuen Gattungen und Arten. Zool. Anz., vol. 15, pp. 163-171.

LUCAS, WILLIAM J.

1920. A monograph of the British Orthoptera. Ray Soc., Monogr. 104, 264 pp., 25 pls., 25 figs., London.

1928. Notes on British Orthoptera, including Dermaptera, in 1927. Entomologist, vol. 61, pp. 78-81.

PESSOA, SAMUEL B., and CORREA, CLOVIS

1928. Notas sobre a biologie de *Rhyparobia maderae*, Fabr. Rev. Biol. Hyg., São Paulo, vol. 1, pp. 83-87, 1 pl., 3 figs.

PRINCIS, K.

1936. Ergänzungen und Berichtigungen zur Orthopterenfauna Lettlands, I. Folia Zool. Hydrobiol., vol. 9, pp. 90-92.

RAMME, WILLY

1923. Vorarbeiten zu einer Monographie des Blattidengenus *Ectobius* Steph. Arch. Naturg., Berlin, ser. A, vol. 89, pp. 97-145, 2 pls, 55 figs.

1949. Ein neuer *Ectobius* vor Sizilien (Blatt.) Opuscula Ent., vol. 14, p. 158, 1 fig.

1951. Zur systematik faunistik und biologie der Orthopteren von Südost-Europa und Vorderasien. Mitt. Zool. Mus. Berlin, vol. 27, pp. 1-431, 39 pls., 134 figs.

RATCLIFFE, JACK

1952. Lobster roach. Pest Control, vol. 20, pp. 44, 54.

RAU, PHIL

1941. Cockroaches: The forerunners of termites. Ent. News, vol. 52, pp. 256-259.

REHN, JAMES A. G.

1903. Studies in American Blattidae. Trans. Amer. Ent. Soc., vol. 29, pp. 259-290.

1931. African and Malagasy Blattidae, Part I. Proc. Acad. Nat. Sci. Philadelphia, vol. 83, pp. 305-387, 5 pls.

1937. African and Malagasy Blattidae, Part III. Proc. Acad. Nat. Sci. Philadelphia, vol. 89, pp. 17-123, 4 pls.

REHN, JAMES A. G.—Continued

1945. Man's uninvited fellow traveler—the cockroach. *Sci. Monthly*, vol. 61, pp. 265-276, 11 figs.

REHN, JAMES A. G., and HEBARD, MORGAN

1927. The Orthoptera of the West Indies, No. 1. Blattidae. *Bull. Amer. Mus. Nat. Hist.*, vol. 54 (Art. 1), pp. 1-320, 25 pls.

REHN, JOHN W. H.

1950. A key to the genera of North American Blattaria, including established adventives. *Ent. News*, vol. 61, pp. 64-67.

1951. Classification of the Blattaria as indicated by their wings. *Mem. Amer. Ent. Soc.* No. 14, pp. 1-134, 13 pls., 5 figs.

SCHARER, BERTA

1951. The woodroach. *Sci. American*, vol. 185, no. 6, pp. 59-62, 5 figs.

SEABRA, A. F. DE

1942. Contribuicoes par o inventario da fauna lusitânica. *Insecta Orthoptera*. *Mem. Mus. Zool. Univ. Coimbra, Portugal*, vol. 127, pp. 1-26.

SEIN, FRANCISCO

1923. Cucarachas. *Puerto Rico Estac. Exp. Insul.*, Circ. 64, pp. 1-12, 9 figs.

SHELFORD, ROBERT W. C.

1907. Viviparity amongst the Blattidae. *Trans. Ent. Soc. London*, 1906, pp. 509-514.

WATSON, JOHN R.

1929. [Rearing of *Pycnoscelus*.] *Univ. Florida Agr. Exp. Stat.*, Ann. Rep. 1929, p. 58.

WILLIAMS, FRANCIS X.

1931. Handbook of the insects and other invertebrates of Hawaiian sugar cane fields. 400 pp., 41 pls., 190 figs., Honolulu.

WOLCOTT, GEORGE N.

1950. The insects of Puerto Rico. *Journ. Agric.*, Univ. Puerto Rico, vol. 32 (1948), pp. 1-224, illus.

ZAPPE, MAX P.

1918. A cockroach pest of greenhouses. *Connecticut Exp. Stat. Bull.* 203, pp. 302-313.

ZIMMERMAN, ELWOOD C.

1948. *Insects of Hawaii*, vol. 2, pp. 1-475, 228 figs., Honolulu