

OBSERVATIONS ON THE SYSTEMATICS, DEVELOPMENT, AND HABITS OF *ERGINULUS CLAVOTIBIALIS* (OPILIONES: COSMETIDAE)¹

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GOODNIGHT, M. L. & GOODNIGHT, C. J. 1976. Observations on the systematics, development, and habits of *Erginulus clavotibialis* (Opiliones: Cosmetidae). *Trans. Amer. Micros. Soc.*, 95: 654-664. *Erginulus clavotibialis* (Cambridge, 1904) Goodnight & Goodnight, 1976 is a relatively large opilionid which is found in a wide variety of habitats in southern Mexico, Yucatan, Belize, and Guatemala. It is often found in small groups of 2-3 individuals under moist logs or rocks in suitable moist habitats. Because of its size and activity and omnivorous habits, it probably plays an important role in the ecology of the areas in which it is common. A study of the structures and characters used for its classification indicates that the number of tarsal segments, general spination of the dorsum and legs, the color pattern, and form of the penis are all important; the number of tarsal segments is least variable and that of the color pattern most variable. The female remains with the eggs after they are deposited in suitably moist spots. They hatched in 23-27 days at 20 C; the young remained with the female for ca. four days and then scattered. There were six nymphal stages, and the final molt was undergone 121 days after hatching.

The large (6-7.5 mm body length) opilionid *Erginulus clavotibialis* (Cambridge) is found in a wide variety of habitats in southern Mexico, Yucatan, Belize, and Guatemala. While this species is relatively more abundant in the lowlands, they have been collected at altitudes up to ca. 300 m in Chiapas. It is easily recognized in the field by the relatively large size, the spination of the tibiae of the fourth leg, and the conspicuous color pattern of the dorsum.

In suitable habitats, this species may be quite abundant. Like most opilionids, *E. clavotibialis* tends to be most active at night, remaining relatively quiescent during the daylight hours. Observations during the daytime have demonstrated that it is not evenly distributed throughout the habitat; rather it tends to be somewhat concentrated, often in small aggregations, in moist situations provided by rotting logs, rocks, or other protective materials. As a result, it is difficult to obtain an exact estimate of their abundance in any one habitat; however, as many as 15-20 individuals have been counted under a single log ca. one meter in length. Their relative abundance, general mobility, large size, and omnivorous habits indicate that *E. clavotibialis* may play an important role in the habitats in which they occur.

The members of the family Cosmetidae, subfamily Cosmetinae, are indigenous to the New World, achieving their greatest abundance and diversity in Central America. While they are found north of that area, only two valid species have been recorded from the southern portions of the United States.

Most species of cosmetids have complex white patterns and various combinations of tubercles and spines on the dorsal scute; in addition, they often have tubercles and spines on the legs. These latter tend to be most conspicuous on the third and fourth legs and are more prominent in the males than in the

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females. Variations of the characters are so marked and distinctive in different populations, that many workers have recognized a large number of genera and species. In 1953, we made an extensive study of the fauna of Chiapas, Mexico and redefined many of these generic and specific concepts; further studies have reaffirmed most of our decisions of that date. Until now a lack of favorable material has prevented an intensive study of a single, wide-ranging species.

Because of the large number of specimens of *E. clavotibialis* collected and observed over a period of years, it is now possible to present a more detailed study of their habits, structural variations, and distribution. Hopefully, such a study will be useful for defining taxonomic limits and ecological relationships of an important member of this family of opilionids.

Material used for this study was collected during several trips to Mexico, Belize, and Guatemala. Trips were made during the summers of 1947, 1948, 1949, and 1950 to Chiapas, Tabasco, Quintano Roo, and Yucatan. More recently, during the summers of 1971, 1972, and 1974, more material was obtained in Belize and Guatemala. A series of live specimens collected during the summer of 1974 were returned to Michigan for further observations. These latter specimens not only survived for ca. a year, but also reproduced.

TAXONOMY

The cosmetids of Central America and the southern portion of the United States have been observed for many years, but the first extensive work of significance for the Central American area was that of F. O. Pickard-Cambridge in Volume 2 of the Arachnida, Araneidea, and Opiliones section of *Biologia Centrali-Americana*, published in England in 1905. In this work he described and illustrated many new species. While he produced an excellent study, he apparently had a limited number of specimens from a number of different sites; thus individual variations and geographical distributions were not at all clear.

Roewer, in a series of publications (see Roewer, 1912, 1923), redescribed many of these species and attempted to understand better the generic and specific relationships; but he did not see examples of most of the species and worked chiefly from Cambridge's drawings and descriptions.

In 1940, we began studying the opilionids of North and Central America; but for several years we had to be content with museum collections. While these were often quite extensive, they tended to be from isolated areas, or else represented casual collecting by workers collecting other arthropods. Finally, we were able to do our own collecting in a more intensive manner and this resulted in better concepts of the distribution, variation, and ecological requirements of these abundant forms. With a series of visits to southern Mexico, Yucatan, Belize, and Guatemala, we have finally felt that we have gained some insight into some of the problems of taxonomy and distribution that have been so puzzling.

E. clavotibialis is a particularly abundant and vigorous form that lends itself well to further investigation. The taxonomy of this species, originally described by Cambridge (1905), has been subjected to a variety of interpretations from the time it was first described; more changes may occur as there is opportunity to study Cambridge's material in London. Cambridge (1905) described three species, which we (Goodnight & Goodnight, 1953) synonymized into the single species, *Erginulus clavotibialis*. These were *Erginus clavotibialis* from Atoyac, Vera Cruz (16 km east of Cordoba, 400 m altitude); *Erginus serratotibialis* from Teapa, Tabasco and Tikal, Cahabon, and Cubilguitz, Guatemala; and *Erginus cylindrotibialis* from Quirigua, Guatemala. Because the generic name, *Erginus*,

was preoccupied, Roewer (1912) changed it to *Euerginus* and placed many of Cambridge's species in it.

We (Goodnight & Goodnight, 1942, 1947) unfortunately contributed our own bit of confusion to the situation by describing in the genus *Acromares*: *A. vittatum* from Benque Biejo, Belize; *A. banski* from Palomares, Oaxaca and Jesus Carranza, Vera Cruz; and *A. roeweri* from Tekom, Yucatan. These species were all described before we had had the opportunity of doing our own collecting.

The study of our own more extensive collections made us realize that simplification was needed, that what we were regarding as separate species were actually variations of a single species. In 1953, we attempted to rectify the situation by considering all cosmetids possessing six segments in the tarsi of the first leg to be members of the genus *Cynorta*. In a recent study of the opilionids of the Yucatan Peninsula (Goodnight & Goodnight, 1976), additional collections of material from this area persuaded us that two groups were actually represented in the genus *Cynorta* as conceived by us in 1953. While both had six segments in the tarsi of the first leg, many forms had heavier third and fourth legs which were usually provided with spines and/or tubercles. To contain these forms, we revived the genus *Erginulus*. *Erginulus* had been originally proposed by Roewer (1912) to contain many of the forms described by Cambridge; Roewer again used it in 1923.

This complex of names can best be clarified by considering them in sequence, with descriptions of the forms to be included.

Genus *Erginulus* Roewer, 1912

Syns.: *Cynorta* Goodnight & Goodnight, 1953 *p.p.*; *Erginulus* Roewer, 1912; *Erginus* Cambridge, 1905 *p.p.*

Type-species: *Erginulus serratififer* (Cambridge) from Coban, Guatemala.

Cosmetids with simple, untoothed double claws on the third and fourth tarsi, with but six segments in the first tarsus. Distitarsi of both first and second tarsi with three segments. Dorsum with five areas, variously armed with tubercles and/or spines, third and fourth legs conspicuously heavier than the first and second. Males having more spinose fourth legs, heavier chelicerae, and usually an enlarged basitarsus on the first tarsus.

Erginulus clavotibialis (Cambridge, 1904) Goodnight & Goodnight, 1976

Syns.: *Acromares banksi* Goodnight & Goodnight, 1942; *A. roeweri* Goodnight & Goodnight, 1947; *A. vittatum* Goodnight & Goodnight, 1942; *Cynorta clavotibialis* Goodnight & Goodnight, 1953; *Erginulus clavotibialis* Goodnight & Goodnight, 1976; *Erginus clavotibialis* Cambridge, 1904; *E. cylindrotibialis* Cambridge, 1904; *E. serratobialis* Cambridge, 1904; *Euerginus clavotibialis* Roewer, 1912; *E. cylindrotibialis* Roewer, 1912; *E. serratotibialis* Roewer, 1912.

Male: Total length of body 7 mm; cephalothorax, 2.2 mm; width of body at widest portion, 6.1 mm.

Dorsum smooth, eye tubercle located approximately in the center of the cephalothorax, dorsum armed with low paired spines on the posterior portion of the third area. Small tubercles may or may not be present on the first and second areas. When present, they are located somewhat laterad to the median line. Venter, coxae, and genital operculum with some low granulations and scattered hairs; spiracles clearly visible.

Legs relatively slender, usually clothed with scattered hairs which tend to be more numerous on the tarsal segments (see Table I). Fourth femur often with a row of low tubercles at the distal third of the prolateral surface, patella

TABLE I
Male leg measurements

	I	II	III	IV
Trochanter	0.6 mm	0.8 mm	0.8 mm	0.9 mm
Femur	2.8	5.3	4.0	4.8
Patella	1.1	1.4	1.4	1.9
Tibia	1.9	4.2	2.5	3.6
Metatarsus	2.8	5.2	3.8	5.1
Tarsus	1.9	3.8	2.2	2.4
Total	11.1 mm	20.7 mm	14.7 mm	18.7 mm

with low spines which are usually most prominent on the retrolateral surfaces. Fourth tibia with conspicuous spines, varying somewhat in number but usually from 12 to 17 which are located on both prolateral and retrolateral surfaces. At times, the tibia is quite angular in appearance and a third row of low spines is present. Fourth metatarsus with rows of low hair-bearing tubercles, usually appearing quite smooth. Tarsi clothed only with hairs. Tarsal segments: 6 in first tarsus, remaining tarsal segments somewhat more variable in number, but tending to vary around 10 in the second tarsus, 7 in the third, and 8 in the fourth. Basitarsus of first tarsus enlarged.

Palpus—trochanter, 1.1 mm long; femur, 1.9; patella, 1.1, tibia, 1.9; and tarsus, 1.1. Total length, 7.1 mm. Palpus clothed with hairs; femur laterally compressed with low rounded teeth on the ventral surface; patella with an inner-distal spine; flattened tibia with small projections on either side of the distal portion. Chelicera somewhat enlarged; claws without teeth. Penis—a slender shaft, distal end somewhat inflated, surrounding a small claw-like structure. Total length: 3 mm.

Entire animal reddish brown, black mottling often present on the cephalothorax and on the outer border of the dorsal scute. Yellow white markings are present, but somewhat variable; in general, they are present on the lateral margins with a larger spot present just anterior to the junction of the cephalothorax and abdomen. White pencillings are usually present behind the spines of the third area; white spots are usually scattered over the entire dorsal surface. Venter somewhat lighter than the dorsum, free sternites darker, legs more or less concolorous with the dorsum, darker annulations often present on the metatarsi.

Female: Total length of body, 7.5 mm; cephalothorax, 1.6 mm; width of body at widest portion, 6.1 mm.

Female similar to male in general appearance, but lacking the enlarged chelicerae, the spines of the fourth tibia, and the enlarged basitarsus of the first tarsus. In some specimens studied, the white dorsal markings of the female were more conspicuous than those of the male. The above description was based chiefly on specimens from Teapa, Tabasco. Unless otherwise noted, all collections were made by C. and M. Goodnight; Charles Goodnight helped with the collections from Belize.

VARIATIONS OF TAXONOMIC CHARACTERS

For identification of cosmetids, dorsal color pattern, leg spination, number of tarsal segments, and dorsal spination have been utilized as taxonomic characters.

Dorsal color pattern. There is considerable variation in the dorsal color pattern of the various members of this species. The one most nearly resembling the illustration by Cambridge is the specimen from Lake Catemaco in southern

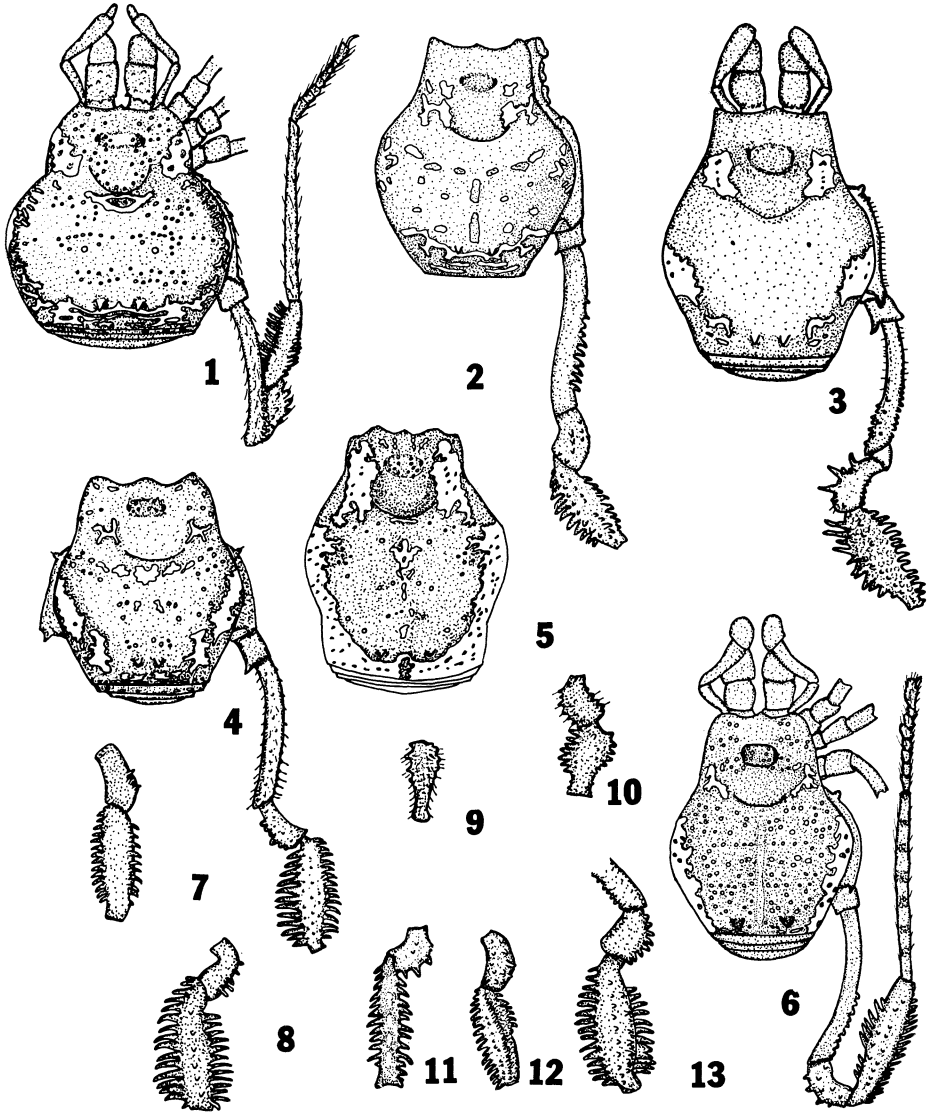


FIG. 1. Dorsal view of male from Teapa, Tabasco, Mexico. FIG. 2. Dorsal view of male from Lake Catemaco, Vera Cruz, Mexico. FIG. 3. Dorsal view of male from Campeche, Campeche, Mexico. FIG. 4. Dorsal view of male from Km 96, on highway between Flores and Guatemala City, Guatemala. FIG. 5. Dorsal view of female from Jesus Carranza, Vera Cruz, Mexico. FIG. 6. Dorsal view of male from 5 km north of Palenque, Chiapas, Mexico. FIG. 7. Ventral view of tibia of fourth leg of male from El Real, Chiapas, Mexico. FIG. 8. Ventral view of tibia of fourth leg of male from Jesus Carranza, Vera Cruz, Mexico. FIG. 9. Dorsal view of tibia of fourth leg of male from Jesus Carranza, Vera Cruz, Mexico. FIG. 10. Dorsal view of tibia of fourth leg of male from Palenque, Chiapas, Mexico. FIG. 11. Ventral view of tibia of fourth leg of male from Palenque, Chiapas, Mexico. FIG. 12. Ventral view of tibia of fourth leg of male from Teapa, Tabasco, Mexico. FIG. 13. Ventral view of tibia of fourth leg of male from Ciudad del Carmen, Campeche, Mexico.

Vera Cruz (Fig. 2). More typical of the majority of forms collected is the specimen illustrated from Teapa, Tabasco (Fig. 1), the type locality of *E. ser-ratotibialis*. The general pattern shows clearly in nearly all specimens, but it is variously reduced with the forms from the Yucatan Peninsula (Fig. 3) having four pronounced patches of white. The females, at times, appear to have more conspicuous white present than the males; the extreme example of this can be seen in a specimen from Jesus Carranza, Vera Cruz (Fig. 5).

Leg spination. The only constant character here is the fact that the fourth tibia of the male always has spines. It can be noted that there is considerable variation, with the most extreme being found in the specimens from Jesus Carranza (Figs. 9, 10). In many cases, notably the specimens from Burrell Boom, Belize (Fig. 7), the fourth tibia is nearly triangular in cross-section. The spination of the fourth femur and patella is somewhat variable, but in most cases, there are spines on the fourth femur and patella. The female lacks spination on the legs.

Tarsal segments. The tarsal segments of 40 specimens from several different localities were counted. The results show remarkable consistency; for example, the first tarsus had 6 segments in all specimens; the second tarsus varied from eight to 11, with most having either nine or 10; the third tarsus, with but only a few exceptions had seven segments; the fourth had from seven to nine, with most specimens having either eight or nine.

Body size. The body measurements of a representative group of specimens from a number of localities was made. These consisted of three measurements: total body length, length of cephalothorax from the anterior margin of the carapace to the groove separating the cephalothorax and abdomen, and the width of the widest portion of the body, usually in the region of the fourth coxa. Such measurements are subject to considerable variation, particularly among the females where gravid specimens have swollen abdomens.

Among males, the smallest individuals were from Jesus Carranza, Vera Cruz where one male was only 5.6 mm long; the largest male measured was 7.7 mm, a specimen from Ciudad del Carmen, Tabasco. The average body length of 15 males from various localities was 6.18 mm.

Among females, the body size tended to be somewhat larger, averaging 7.57 mm for 18 individuals. A comparison of the average length of the cephalothorax (2.6 for males, 2.5 for females) indicates that the difference was actually in the abdomen and was probably related to the condition of the females at the time of capture. Indications are that breeding tends to occur most frequently during the rainy season (May through December) and most of the material was collected during that period; thus it is reasonable to conclude that the females were probably in various stages of egg production. In general, the width of the body of the males was only slightly smaller (6.2 mm) than that of the females (6.3 mm).

Genitalia. The male genitalia of opilionids have been used as taxonomic characters. This has been the case particularly among the members of the genus *Leiobunum* of North America (see Davis, 1934). In order better to determine the possible utility of using the genitalia of the cosmetids, a number of penes and ovipositors of *E. clavotibialis* were studied. Except for minor details, the penes of members of this species showed little variation. In all those studied, a chitinous jaw was closely associated with a softer portion. Both were enclosed in the expanded distal end of the penis. In one case, that from Guatemala (Fig. 16), a portion of the jaw appears to be absent. Possibly it was broken off; otherwise, the resemblance to the others is quite clear. Differences in appearance and orientation of parts are due to the angle at which the tip of the penis

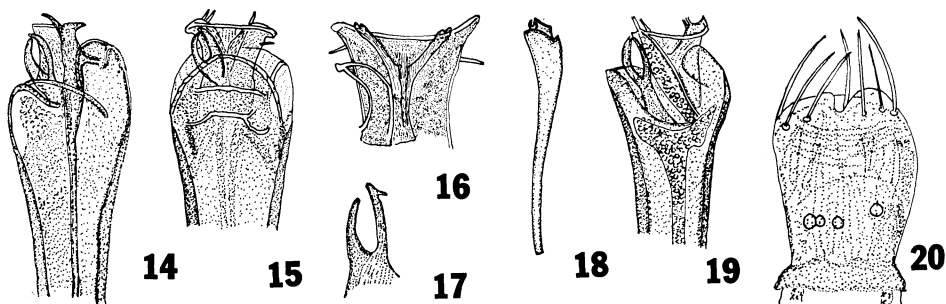


FIG. 14. Distal portion of penis of male from Teapa, Tabasco, Mexico. Fig. 15. Distal portion of penis of male from Lake Catemaco, Vera Cruz, Mexico. Fig. 16. Distal portion of penis of male from Km 96 on highway between Flores and Guatemala City, Guatemala. Fig. 17. Claw from distal portion of penis of male from Jesus Carranza, Vera Cruz, Mexico. Fig. 18. Entire penis from male from Lake Catemaco, Vera Cruz, Mexico. Fig. 19. Distal portion of penis from male from San Antonio, Campeche, Mexico. Fig. 20. Ovipositor from female from Lerma, Campeche, Mexico.

was mounted. An examination of the genitalia of other species indicates that the details of the structure are quite specific for each form. Less variation among species is apparent in the structure of the ovipositor. All examined ovipositors were similar to that illustrated in Figure 20.

Conclusions. A study of the variability of the traits commonly used for separating species of opilionids tends to validate current practices. The number of segments of the tarsi, general spination of the dorsum and legs, color pattern, and form of the penis, all appear significant. Of these, the tarsal segments seem to be least variable, and the color pattern most variable. The structure and general appearance of the penis can be utilized to verify specific identifications. Females are more difficult to determine accurately due to their lack of secondary sexual traits; fortunately, they are usually associated with the males.

DEVELOPMENT AND BEHAVIOR

The reports on the habits, development, and habitat requirements of tropical cosemetids is much more limited than that on their taxonomy. Roewer, a voluminous writer on opilionids, confined his studies to their taxonomy, relying almost entirely upon preserved materials. Various studies of oviposition, development (both embryonic and postembryonic) have been confined mainly to European species of the suborder Palpatores (Juberthie, 1964; Silhavy, 1956; among others).

More recently there have been studies of New World forms relating to their development and behavior. Munoz-Cuevas (1971a,b) published two papers on *Pachylus quinamavidensis* Munoz-Cuevas (Gonyleptidae), a large form from Chile. The first of these studies is concerned with the development of the tarsi and the formation of the claws during postembryonic development; the second is a study of the embryonic development. A third paper (Munoz-Cuevas, 1971c) describes the post-embryonic development of this gonyleptid. Juberthie (1972) studied the reproduction and development of *Cynorta cubana* (Banks) from Cuba.

In both cases, the animals were observed under laboratory conditions. Rodriguez & Guerrero (1976) have described in detail the mating and nesting behavior of *Zygopachylus albomarginis* (Chamberlain) in Barro Colorado Island,

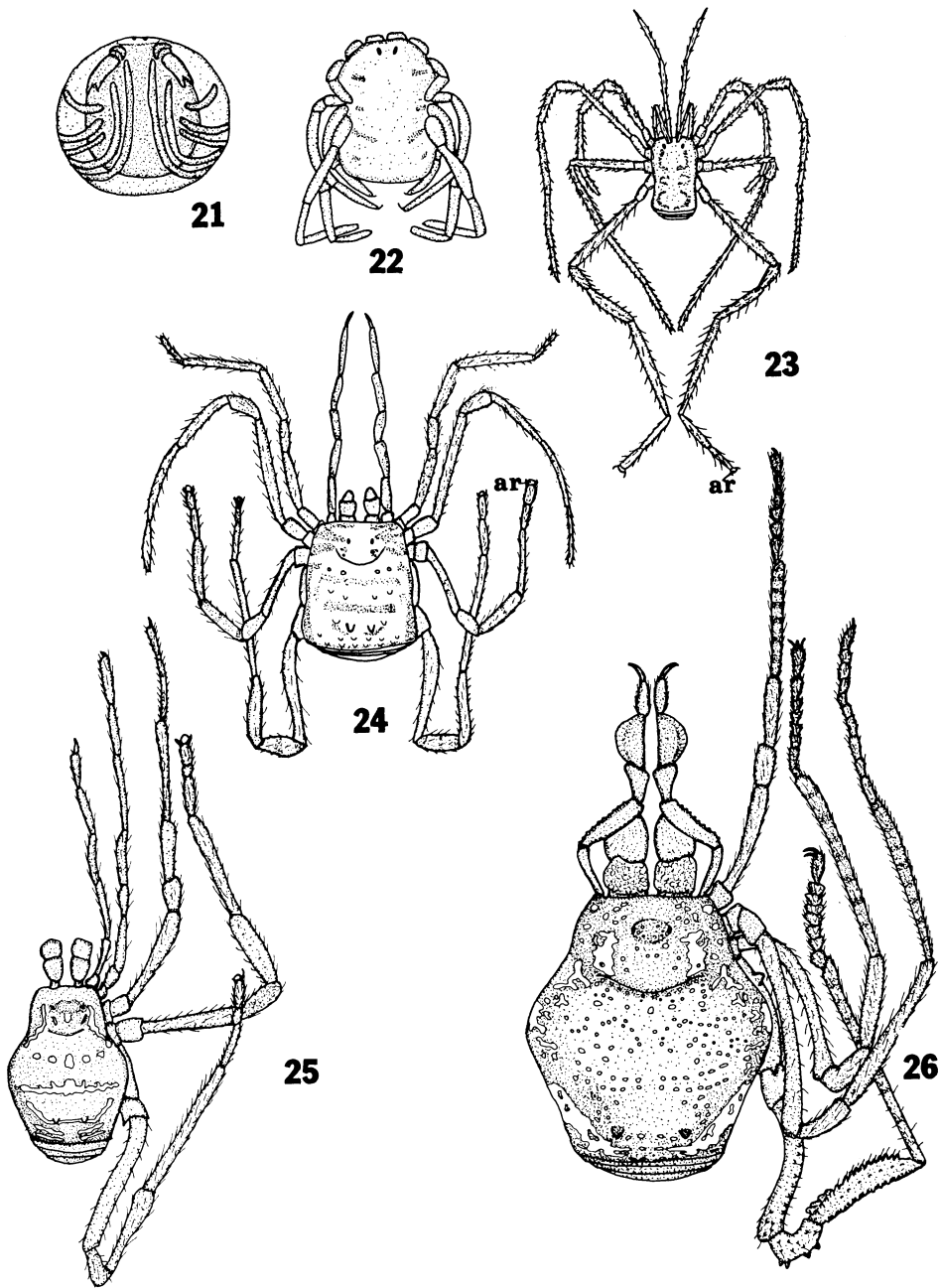


FIG. 21. Egg previous to hatching, showing embryo. FIG. 22. Newly emerged nymph, 1.1 mm long. FIG. 23. Fully developed first nymphal stage, 1.2 mm long. Ar = arolium. FIG. 24. Third nymphal stage, 4 mm long. FIG. 25. Fourth nymphal stage, 6 mm long. FIG. 26. Adult male from Burrell Boom, Belize, 7.5 mm long.

Panama. This large species (family Gonyleptidae) builds a nest of mud, the male remains with the eggs and guards them against predation.

Our own observations were made on several living specimens of *E. clavotibialis* which were collected in Belize and then brought to Michigan for further study. They were housed in large aquaria, the bottoms of which were covered with a mixture of soil and sand. Moist leaves, bark, and twigs were placed on this substratum. Small insects normally present in the twigs were available as food; and, in addition, "Formula 4-24" Instant Drosophila Medium was available. They were maintained at room temperature (20-22 C).

Observations reported were made over a period of ca. one year; several of the animals deposited eggs, and hatching was successful in most cases. Possibly due to predation by adults or small insects in the containers, only a few of the hatchlings survived to adulthood.

During daylight hours, the opilionids were found on the undersides of the twigs or flat pieces of bark. At times, they were in groups of two or three, but no significant interaction among them was observed. They rested with their bodies against the substratum, usually with the fourth pair of legs extended backwards and crossed twice, once at the femora, then again at the proximal portion of the tibia. The remaining legs were held against the dorsum with the femora more or less projecting posterior, and the remainder of the leg somewhat more forward in position, but still close to the body. Juberthie (1972) describes a similar resting position for *C. cubana* (Banks).

In the early evening hours, the individuals became active, moving about the surface of the soil and among the debris, presumably in search of food. At times, an individual could be observed resting on a protruding twig or piece of bark. The body would be lifted high upon the first, third, and fourth legs. The second pair of legs was extended high above the body and moving slowly. The assumption was that such a pose would facilitate chance encounters with small arthropods which could then be consumed. Similar behavior in a few other species, namely, *Vonones compressus* (Cambridge) and *Paecilaema variegatus* Goodnight & Goodnight was observed. Neither Munoz-Cuevas nor Juberthie comments on such behavior in the forms that they studied.

Courtship patterns have not been noted among most opilionids, but our observations would tend to indicate that there is at least a limited amount. At times, a male and female were observed to be facing one another with the second legs of each extended forward, stroking the partner. Unfortunately, they tend to move rapidly when disturbed, and it was difficult to make extended observations.

No nest building was observed. The female deposited the eggs in a cluster on the underside of bark or in crevices. The 90-100 eggs were deposited over a period of a few days. The female then remained with the eggs, protecting them with her body. Similar behavior was observed by Robert W. Mitchell (1971) for *Hoplobunus boneti* Goodnight & Goodnight (Phalangodidae: Phalangodinae). Field observations indicate that this may be a common phenomenon among tropical opilionids; however, neither Juberthie (1972) nor Munoz-Cuevas (1971) made note of this. This behavior probably serves to prevent predation and the development of mold. The eggs thus protected did develop and hatch.

Eggs were first observed in July, then again in November, December, and the following July of 1975. Though these represent limited observations, egg laying appears to be most prevalent during the rainy season (May-December). Juberthie observed that egg laying occurred through the year in *C. cubana*. Further observations of *E. clavotibialis* will be needed to clarify this point.

The individual egg was a white sphere, 1.1 mm in diameter. Rate of develop-

ment varied with the ambient temperature. At 20 C, it took ca. 23–27 days to hatch; at a slightly higher temperature (26 C) hatching occurred in only 13 days.

Pigmentation of the egg was first noted in those that took 23 days to hatch on the 17th day. The development of the embryo within the egg appeared to resemble closely that observed by Munoz-Cuevas for *Pachylus quinamavidensis*. Just before hatching, the young could be observed in the egg (Fig. 21).

These developmental periods correlate well with those noted by Juberthie: at 20 C, *C. cubana* took 27.5 days to hatch; at 25 C, it took 16 days.

At hatching, the nymph was 1.2 mm long and 0.17 mm wide. The tarsal segments were not developed, and the arolium was clearly visible on the third and fourth legs (Fig. 21). Immediately after hatching, the nymph molted; the exuvia was seen at that time, but not later. Possibly it was consumed. Juberthie (1972) reports that it was consumed by the nymphs of *C. cubana*. He postulates that the arolium is a nymphal structure which is useful during molting.

Nymphs from one clutch of eggs laid on 23–24 January 1975, hatched on 16–17 February. The female remained with the young which remained crowded together until 21 February. At that time, the female left the young and they scattered. Later that evening (ca. 7:40 PM) several of the young were observed molting on the sides of the container. On 19–23 March, when they were ca. 2 mm long, several were again noted on the sides of the container molting. A third molt occurred on 2 April, when they were ca. 4 mm long; and another molt occurred on 27 April when the few remaining individuals attained a length of 6 mm.

The young could be seen moving about the surface of the debris in the evening, and at times they assumed the typical adult posture, that is, resting in a raised position on small twigs or bark. The palpi, somewhat elongate in the nymphs, are carried with the femur projecting backwards and the remaining segments pointing forward.

As only a few nymphs survived to adulthood, it was not possible to observe in detail the anatomy of all stages. A few nymphs did attain adulthood, making the final molt 121 days after hatching. Juberthie (1972) observed that the time to attain maturity for *C. cubana* varied from 4½ to 7 months at temperatures ranging from 20 to 25 C. He also noted that there were six nymphal stages; our observations of *E. clavotibialis* also demonstrated six nymphal stages. Secondary sexual characters were not attained until the final molt; and the arolium was not present in adults.

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CHARACTERIZATION OF THE SPECIES OF THE *TETRAHYMENA PYRIFORMIS* COMPLEX¹

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NANNEY, D. L. & McCOY, J. W. 1976. Characterization of the species of the *Tetrahymena pyriformis* complex. *Trans. Amer. Micros. Soc.*, 95: 664-682. The ability to distinguish different species among members of this complex, combined with increasing evidence of their ancient divergence and large molecular distances, requires that they be assigned Latin binomials. We propose that the breeding strains be assigned species designations corresponding, insofar as present evidence permits, to natural populations sharing common gene pools. On this basis we recommend recognition of *Tetrahymena americanis*, *T. australis*, *T. borealis*, *T. canadensis*, *T. capricornis*, *T. cosmopolitanis*, *T. hyperangularis*, *T. pigmentosa*, *T. thermophila*, and *T. tropicalis* as new species. For amiconucleate strains we recommend species designations for sets of strains agreeing in at least 67% of their electrophoretic mobilities, thus making the amiconucleate species taxa approximately equivalent to the genetic species in terms of molecular diversification. The species designation *T. pyriformis* (Ehrenberg) is reserved for the amiconucleate kindred descended primarily from Lwoff's original laboratory strain GL. Three additional amiconucleate species are proposed as new: *Tetrahymena ellioti*, *T. furgasoni*, and *T. lwoffi*.

The existence of cryptic species among the ciliates has long been recognized (Sonneborn, 1939), but the assignment of Latin binomials to the species was at first resisted (Sonneborn, 1957), chiefly on the pragmatic grounds that species identification would require living reference strains with which to conduct mat-

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