

*Epiperipatus hilkae*, n. sp. from Costa Rica (Onychophora: Peripatidae)

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(Rec. 27-IV-1990. Acep. 16-VIII-1990)

**Abstract:** *Epiperipatus hilkae*, a new species discovered in tropical dry and moist forests (NW Costa Rica) has the following characteristics: in the fourth and fifth oncopods, the nephridial tubercle is free from the third sole, and only partially surrounded by the fourth arc. Each segment has 12 skin folds (seven folds reach the ventral side), which are divided only by the midline. The primary papillae are conical with rounded bases and two to three scale ranks in the apical section. The external jaw blade has two accessory teeth, the internal with one accessory tooth and 12 denticles. The diastema is monolobular. The dorsal part is dark brown with a pattern of hexagons conspicuous for their light reddish-brown papillae. The new species is closely related to *E. isthmicola* and *E. nicaraguensis*, also from Central America. It remains active during the dry season in isolated moist patches.

**Key words:** *Epiperipatus*, Onychophora, taxonomy, new species, morphology, peripatus.

The Peripatinae, a subfamily of Peripatidae, ranges throughout the American tropics and includes seven genera, three of which have been reported for Costa Rica: *Epiperipatus* Clark, *Macroperipatus* Clark and *Peripatus* Guilding.

Bouvier (1902 a,b, 1905) described two species from around the then sparsely populated capital city of San José, *Peripatus biolleyi* and *P. nicaraguensis isthmicola*, including them in the section *edwardsi*. Posteriorly, Clark (1913 a) erected a genus for this section: *Epiperipatus*, and established *E. isthmicola* as a species different from *E. nicaraguensis*.

During the first three quarters of this century, more onychophorans have been collected in the country, from Cordillera Volcánica Central and Cordillera de Talamanca (Brues 1911, 1925, Picado 1911, 1913, Calvert and Calvert 1917, Dunn 1943, Clark 1937, Clark and Zetek 1946, Peck 1975 and Young 1980). Previous to this report, two new species were described from Costa Rica: *P. ruber* from Rancho Redondo, San José, which was descri-

bed by Fuhrmann (1914) and *M. valerioi*, from Río Damitas, Quepos, described by Morera-Brenes and León (1986).

We describe herein a new species of *Epiperipatus*, for which parturition data were published in a recent review of onychophoran reproduction (Morera-Brenes *et al.* 1988).

## MATERIAL AND METHODS

Specimens were preserved in 70 % ethanol after distension in 20% ethanol. For Scanning Electron Microscopy (SEM) small pieces were treated in the following sequence: progressively rehydrated and re-distended in 50, 30, 15 and 5% ethanol and distilled water for 15 min each, in OsO<sub>4</sub> for two hours, distilled water for 15 min and tannic acid followed by two hours in OsO<sub>4</sub> and two rinses in distilled water (15 min each). After a 5, 15, 20, 50, 70, 80, 90, 95 and 100 % ethanol series (15 min each, the 100 % treatment repeated three times) and critical point drying, the pieces were gold-coated for 10-15 min (preparations were deposited with the type).

## RESULTS

**Species account:** *Epiperipatus hilkae*, n. sp.

**Holotype:** Female. Deposited as Nr. 11-19 Museo de Zoología, Universidad de Costa Rica.

**Locality:** Costa Rica. Bosque de las Cascadas, Parque Nacional Barra Honda, Península de Nicoya, Guanacaste (10 11' N, 85 20' W), 200 m above sea level. "Col. B. Morera-Brenes 6-IV-1985 en tronco podrido".

Other localities: Costa Rica. Reserva de Vida Silvestre Curú, Península de Nicoya, Guanacaste (9 47' N, 84 56' W), 20 m.a.s.l. "C.E. Valerio, potrero Marianos, Punta Curú, bajo un tronco podrido".

**Etimology:** *E. hilkae*, Morera & Monge 1991, is dedicated to the German zoologist Hilke Ruhberg, for her extensive work on the Onychophora.

**Diagnosis:** In fourth and fifth oncopods, nephridial tubercle free from third sole and only partially surrounded by the fourth arc. Each segment with 12 skin folds (seven reach ventral side) which are divided only by the dorsal midline. Primary papillae conical with rounded bases and apparently two (maximum three) "scale ranks" (=rows of scales) in the apical section. External jaw blade with two accessory teeth, the internal with one accessory tooth and 12 denticles. Diastema monolobular. Dorsal part of body dark brown with a pattern of hexagons conspicuous for their light reddish brown papillae.

### Description:

**Oncopods:** Oncopod tips with three foot papillae, two anterior and one posterior (Fig. 1A). In fourth and fifth oncopods, nephridial tubercle free from third sole, only partially surrounded by the fourth arc (Figs. 1B and 1C). Oncopods with four soles ("walking pads") except for the last two pairs of oncopods which are rudimentary (see also Fig. 5A). First three arcs well developed, fourth rudimentary (Fig. 1B).

Regarding the position of the nephridial tubercle, *E. hilkae* appears closely related to *E. isthmicola* and *E. nicaraguensis* in which the fourth sole is absent or rudimentary (Bouvier

1905) (Fig. 2). In contrast, in *E. biolleyi* (Fig. 2), *E. brasiliensis* and *E. edwardsi* the fourth arc is complete and surrounds the urinary tubercle (Bouvier 1905). The number of oncopod pairs in *E. hilkae* ranges from 25 to 29. The type female has 29; paratypes include two males with 26 and one with 27, and one female with 29 pairs (specimens collected in Curú: two females with 28, one male with 26 and another with 25 pairs of oncopods).

**Integument:** Twelve dorsal skin folds in each body segment, seven of which reach ventral side, rest incomplete. Dorsal folds not divided transversely except for the antero-posterior midline channel (Fig. 3A).

Dorsal integument of a young male allotype (son of holotype female) clearly less dense in accessory papillae, possibly due to age (Fig. 3B) as was also found by Brues (1914) in Colombian *E. vespuccii* and *E. edwardsii*. The dense occurrence of accessory papillae in *E. hilkae* resembles the condition in the type of *E. brasiliensis* according to illustrations by Bouvier (1905) and Read (1988a).

No clear organs were seen, despite our efforts to find them.

All primary papillae conical with rounded bases (Figs. 3C and 3D).

Apparently two -maximum three- scale ranks in the apical part of the primary papillae; basal diameter about 12 ranks (Fig. 3D).

**Dentition of the jaws:** external blade of the jaw with two accessory teeth (Fig. 4), internal with one accessory tooth and 12 denticles (Figs. 4A and 4B). Labrum with five denticles.

Different from other *Epiperipatus* species from this region, *E. hilkae* has two accessory teeth in the mandibular outer blade (Fig. 4). A second accessory tooth in the outer blade is visible in a specimen from Mérida (Venezuela) identified by Bouvier (1908) as *E. brasiliensis*; the second accessory tooth in *E. biolleyi* is rudimentary (Fig. 4).

Regarding the inner blade, *E. hilkae* differs from *E. isthmicola*, which has two well developed accessory teeth (Fig. 4) and from *E. brasiliensis*, which has a rudimentary second accessory tooth.

The monolobular shape of the diastema in the inner blade of *E. hilkae* resembles those of *E. isthmicola* and *E. brasiliensis* from Mérida,

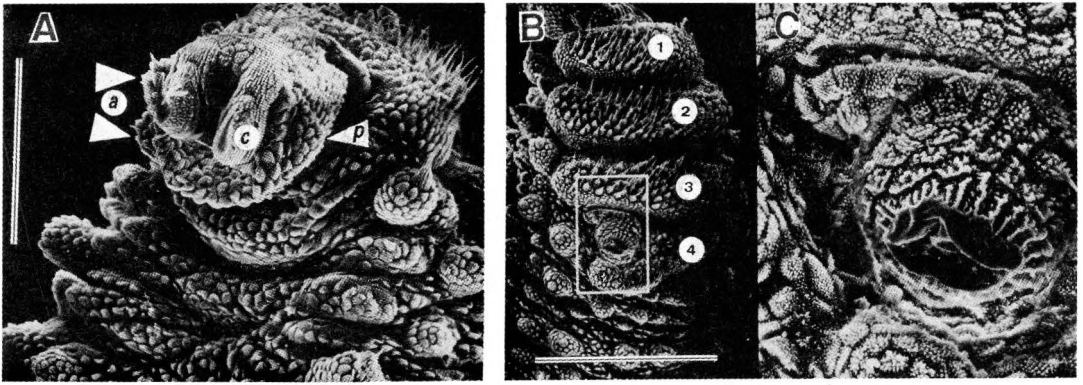


Fig. 1. A. Oncopod tip of *E. hilkae* in semi-apical view; arrows: foot papillae, two anterior (a) and one posterior (p); c: terminal claw. Scale bar = 150  $\mu$ m.

B. Position of nephridial tubercle in fourth and fifth oncopods (ventral view). The soles of the pad are numbered 1-4. Rectangle: nephridial tubercle (mid-position). Scale bar = 0.30 mm.

C. Detail of area marked by rectangle in B. The nephridial tubercle is free from the third sole (10 X of B).

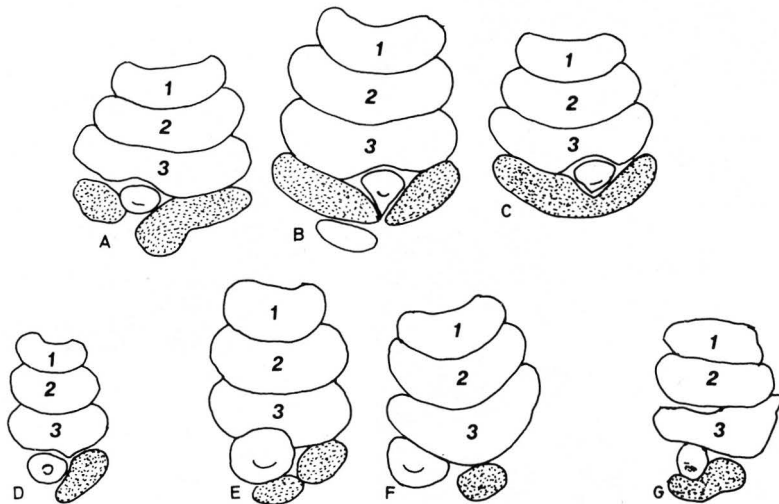


Fig. 2. Position of the nephridial tubercle in fourth and fifth oncopods of four Central American species of *Epiperipatus*. Notice that despite the variability in *E. biolleyi* (A-C), it is possible to distinguish among species (D: *E. nicaraguensis*; E-F: *E. isthmicola*; G: *E. hilkae*). The fourth sole is dotted for clarity's sake. A through F redrawn from Bouvier (1905, p. 323, 324 and 331) and G from our observations on six specimens. We also corroborated Bouvier's illustrations by personal examination of five *E. isthmicola* and 15 *E. biolleyi*.

and differs from the elongated shape in *E. nicaraguensis* and the bilobulate shape in the type of *E. brasiliensis* from the Amazon. Such mandibular differences in *E. brasiliensis* may represent intraspecific variability or may simply be the result of an erroneous identification.

The general shape of both mandibular blades in *E. hilkae* is similar to those of *E. isthmicola* and *E. nicaraguensis* (Fig. 4).

At least in the Peripatidae, jaw dentition may vary intraspecifically (Read 1988a) and although we have found it useful to distinguish among closely related species, dentition can be identical in distant taxa.

**Color (life):** dorsal part of body dark brown with a pattern of hexagons conspicuous due to the presence of light reddish brown papillae. Cephalic region yellow with marked dark

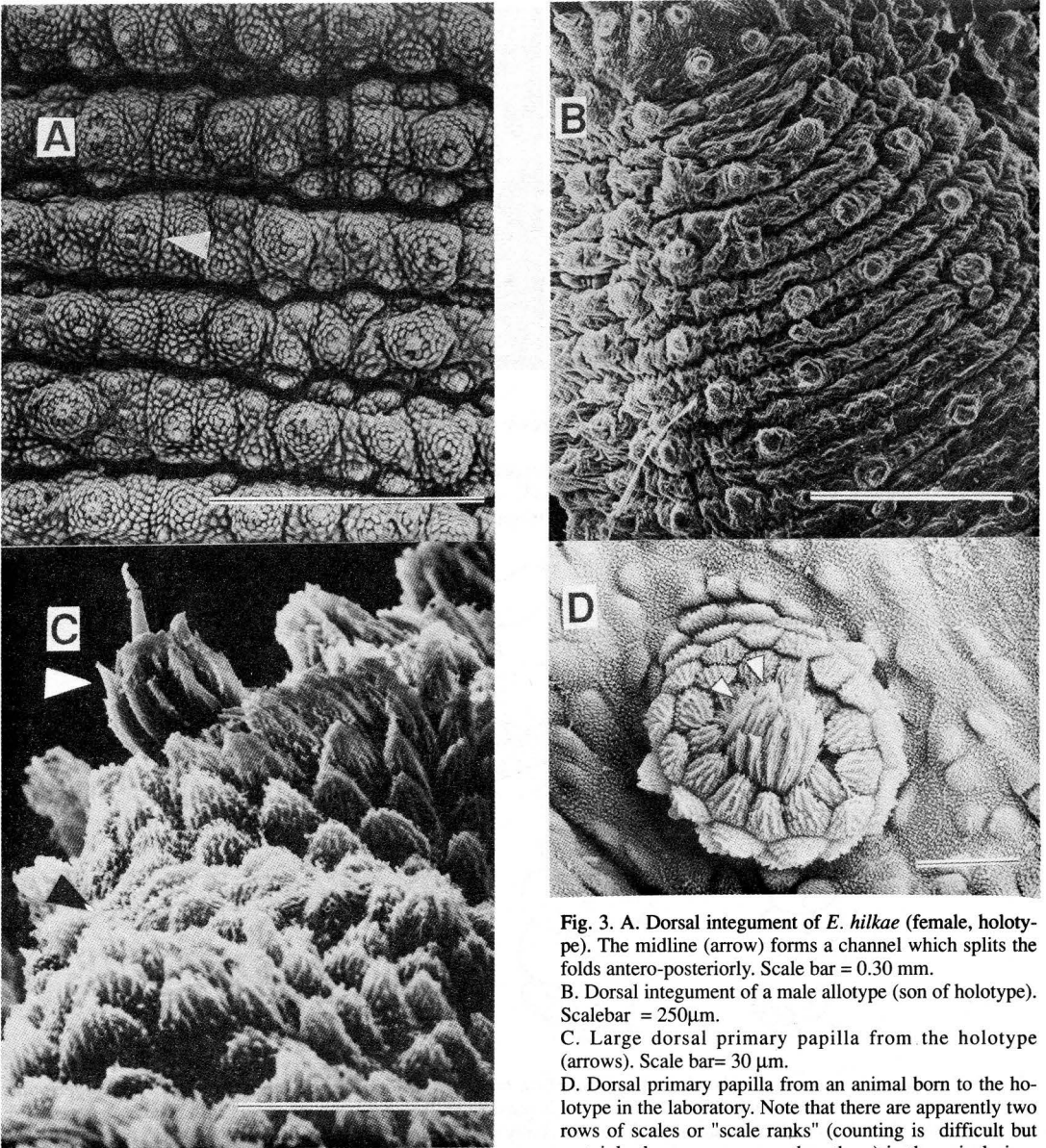


Fig. 3. A. Dorsal integument of *E. hilkae* (female, holotype). The midline (arrow) forms a channel which splits the folds antero-posteriorly. Scale bar = 0.30 mm.

B. Dorsal integument of a male allotype (son of holotype). Scalebar = 250 $\mu$ m.

C. Large dorsal primary papilla from the holotype (arrows). Scale bar= 30  $\mu$ m.

D. Dorsal primary papilla from an animal born to the holotype in the laboratory. Note that there are apparently two rows of scales or "scale ranks" (counting is difficult but certainly there are no more than three) in the apical piece of the primary papilla. Scale bar = 30  $\mu$ m (photograph: Hilke Ruhberg).

brown papillae which become reddish brown at the level of the third pair of oncopods; ventral part of body pink until the sixth pair of oncopods where it becomes dark brown with conspicuous pink papillae and pit. Mid dorsal and mid ventral lines brown, slightly darker than rest of body; antennae dark brown with cream

yellow background, eyes black. Generally, this coloration resembles that of *E. isthmicola* (photograph in Young 1980) but is easily distinguished from that of *E. biolleyi*, which is crimson red with blackish midline (200 specimens observed by B.M.B.). In 70 % alcohol whole body decolorized to whitish brown.

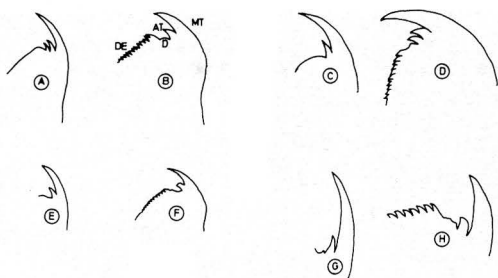


Fig. 4. Jaw dentition of four species of *Epiperipatus*. A-B: *E. hilkae*; C-D: *E. isthmicola*; E-F: *E. nicaraguensis* and G-H: *E. biolleyi*. Left: inner blade, right: outer blade; MT main tooth, AT accessory teeth, D diastema, DE denticles. Redrawn after Bouvier (1905). We also prepared ten jaws of *E. biolleyi* and five of *E. isthmicola* for corroboration.

### Other characters

**Body size:** holotype 5.6 cm long, 0.3 cm maximum height, 0.4 mm maximum breadth, weight 0.404 gr. Allotype and paratype measurements, from Morera-Brenes *et al.* 1988: "Both young measured, at birth, 1.8 mm in length and weighed 0.0178 and 0.0155 g ... [in] two posterior births.

The young measured 1.2 and 1.4 mm and weighed 0.0130 and 0.0108 g respectively".

Two crural tubercles each at base of the two pregenital pairs of legs of the male (Figs. 5A and 5B).

**Natural history:** holotype found about ten cm deep inside a tunnel, in the moist side of a fallen rotten trunk, approximately 25 cm in diameter. This trunk was at a distance of three meters from a creek, apparently the last dry season reduct of water in that patch of forest. The evergreen forest, which is surrounded by deciduous forest, has annual means of 28 Celsius, 1800 mm of precipitation and 10.5 daily hours of solar radiation. The dry season lasts from October through April (Mora-Castro 1981). The other specimens were collected under rotten trunks in Punta Curú (Fig. 6).

## DISCUSSION

**Systematics:** Clark (1913a) raised the four sections of *Peripatus* to genera: *Plicato peripatus*, *Macroperipatus*, *Peripatus* and *Epiperipatus*. This large group is uniform in having

two anterior and one posterior foot papillae (Read 1988a), as observed also in *E. hilkae*.

We compared *E. hilkae* with specimens of *E. biolleyi*, *E. isthmicola* and *P. ruber* and found that it fits the following description of *Epiperipatus* (according to Bouvier 1905 and Peck 1975): plication usually undivided, primary papillae of dorsal surface with more or less rounded bases (all of the same type) passing through all intermediate stages from large to small; papillae closely set, though with occasional accessory papillae between them; in small individuals some papillae predominate (Clark 1913a, Clark and Zetek 1946).

Here (Figs. 3 and 5) we followed the advice of Read (1988 a, 1988b) who emphasized the convenience of using SEM for the systematics of Peripatidae, particularly regarding the morphology and distribution of papillae. The latter is an important taxonomic character difficult to interpret under the light microscope. Nevertheless, Read (1988a) also found that some of the characters used in several descriptions to distinguish between *Peripatus* and *Epiperipatus* are to some extent subjective. He concluded that these genera differ clearly by the number of scale ranks in the apical part of the primary papillae, with *Epiperipatus* having 2-3 ranks and *Peripatus* always more than three. Additionally, *Peripatus* usually has a lower number of basal scales than *Peripatus*.

According to any of the above criteria, the new species described here is an *Epiperipatus*: it fits the traditional integument description and also has 2-3 ranks of about 12 scales each (Figs. 1 and 3).

At this stage, any further analysis would not be justified. Other species of *Epiperipatus* are known from few of even only one specimen; even the easily observed coloration is a rather dubious character for systematic inference (*e.g.* the white "collar" reappears in *Macroperipatus*, *Epiperipatus* and *Peripatus* and may even be absent in some individuals within a population).

**Ecology:** Onychophorans require high humidity levels (Watt 1961) and those from dry and even periodically burned habitats can survive by migrating vertically to deeper ground layers (Endrödy-Younga and Peck 1983). The sites, where all the specimens of *E. hilkae* were found, are classified as Tropical Dry Forest, Moist Province Transition and Tropical Moist

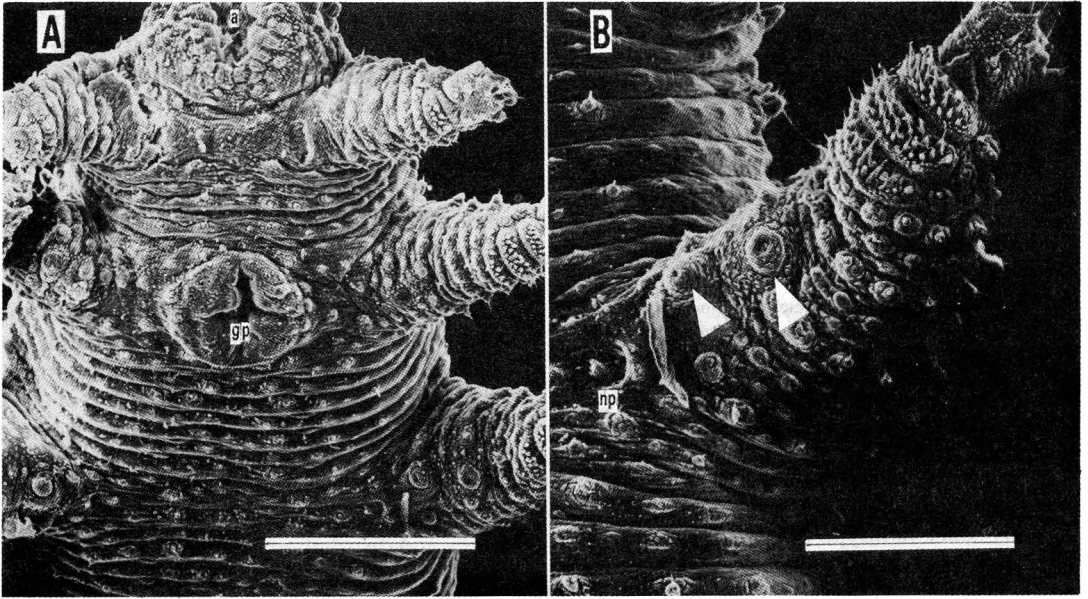


Fig. 5. Ventral surface of a male *E. hilkae*.

A. Anus (a) and genital pore (gp). Scale bar = 0.38 mm.

B. Crural tubercles (arrows) at base of pregenital oncopod and nephridial pore (np). Scale bar = 150  $\mu$ m.

Forest, in the Holdridge system. There, the marked rainfall differences between both seasons (Fig. 6) produce a strong seasonality of the vegetation (Janzen 1983). *E. hilkae* was found above ground (inside a rotten log), which indicates that activity continues during the dry season in these moist habitat patches. If the species does not survive in drier habitats by vertical migrations, it probably is isolated in the southwest area of the Nicoya Peninsula, which limits with Tropical Dry Forest habitats in the Tempisque River Basin (Fig. 6).

## RESUMEN

*Epiperipatus hilkae*, una nueva especie de onicóforo descubierta en los bosques tropical seco y tropical húmedo del noroeste de Costa Rica, tiene las siguientes características: en los oncopodios cuarto y quinto, el tubérculo nefridial está libre de la tercera almohadilla ambulatoria y rodeado solo parcialmente por el cuarto arco. Cada segmento tiene 12 pliegues cutáneos (siete llegan hasta el lado ventral) divididos únicamente por la línea media. Las papilas primarias son cónicas con bases redondeadas y dos a tres hileras de escamas en la sección apical. La lámina externa de la mandíbula tiene

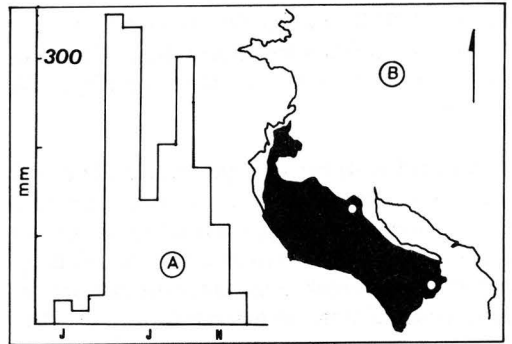


Fig. 6. A. Rainfall pattern in the habitat of *E. hilkae* (1980-1984). B. Collection sites (white circles; above: Barra Honda, type locality; below: Punta Curú) and currently known habitat range (black) of *E. hilkae* (Nicoya Peninsula in NW Costa Rica). The area shown in the map at right (fig. 6B) corresponds to 84°40'-85°00'W and 10°30'-11°00'N.

dos dientes accesorios y la interna tiene uno accesorio y 12 dentículos; la diastema es monolobular. El dorso es pardo oscuro con un patrón de exágonos conspicuos por sus papilas rojo-pardo claro. Esta especie nueva está cercanamente emparentada con *E. isthmicola* y *E. nicaraguensis* (también de América Central) y permanece activa en áreas húmedas aisladas en la estación seca.

## ACKNOWLEDGEMENTS

We thank H. Levi, E. Orozco, N.I. Platnick, D. Quintero, A. Wille and A.M. Young for loan of specimens; R. Rojas and J. Ballesterro assisted field work and Jollyanna Malavassi and Francisco Hernández helped greatly with the SEM. H. Ruhberg provided one excellent photograph and very patiently waited for the completion of this work.

Field work was partially financed by the Tinker Foundation through the Fundación de Parques Nacionales de Costa Rica, CONICIT and Vicerrectoría de Investigación, Universidad de Costa Rica.

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