



# First record of *Procaeculus* (Acari: Caeculidae) in Miocene amber from Chiapas, Mexico

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## Abstract

The first *Procaeculus* Jacot 1936 (Acari: Trombidiformes: Caeculidae) is reported from the Miocene amber of Chiapas, Mexico. This is the third record for the genus in amber, the other two are from the Baltic (Eocene) and the Dominican Republic (Miocene).

Keywords: Crabs, Mite, Caeculidae, amber, lower Miocene, Mexico.

## Resumen

Se reporta por primera vez a *Procaeculus* Jacot 1936 (Acari: Trombidiformes: Caeculidae) en ámbar del Mioceno de Chiapas, México. Este constituye el tercer registro del género en ámbar, los otros dos corresponden a ámbar del Báltico (Eoceno) y de República Dominicana (Mioceno).

Palabras clave: Ácaro, Caeculidae, ámbar, Mioceno inferior, México.

## 1. Introduction

Approximately 55000 species of mites are described worldwide (Walter and Proctor, 1999), 2625 of which are known from Mexico (Pérez *et al.*, 2014). They demonstrate a wide range of habitats and habits in living chelicerate arthropods, being terrestrial and aquatic with predatory, phytophagous, saprophagous, phycophagous, and parasitic species (Krantz, 2009).

Mites are scarce in the fossil record because their usual size range is from 0.3 to 3 mm. Despite this, a relatively significant number of specimens from all mite orders are known from Eocene and Miocene amber deposits. The oldest fossil record is that of Hirst (1923), who described *Protacarus crani* from the Devonian of Scotland, and

313 species of the orders Ixodoidea, Mesostigmata, Trombidiformes and Sarcoptiformes Acari have been reported for posterior geologic periods (Dunlop *et al.*, 2015).

Ten species of mites have been recorded in Miocene amber from Chiapas (Norton and Poinar, 1993): *Dendrolaelaps fossilis* Hirschmann, 1971; *Amphicalvolia hurdi* Türk, 1963; *Neoliodes brevitarsus* (Woolley, 1971), *Mochloribatula smithi* (Woolley, 1971), *Oppia mexicana* (Woolley, 1971), *O. setigera* (Woolley, 1971), *Benoibates chiapasensis* (Woolley, 1971), *Parapirnodus denaius* (Woolley, 1971), *Scheloribates durhami* (Woolley, 1971) and *Arthrovertex hurdi* (Woolley, 1971), the first species belongs to the Mesostigmata and the rest to the Oribatida (Sarcoptiformes).

Caeculidae, commonly known as “rake-legged mites”,

due to the notorious rigid setae on the first pair of legs that are raptorial appendages, used to capture collembols and other mites, though one study demonstrated that they can feed on fungus (Crossley and Merchant, 1971). They move slowly and although they are relatively large in size, are cryptically colored mites and their brown and gray colors are ideal for camouflage (Walter *et al.*, 2009). Their hardened body is covered by eight dorsal sclerites, sometimes fused. Caeculids are often thermophilous and found in rocky habitats, some associated with vegetation. A species was noted associated with ant *Messor pergandei* in desert (Uppstrom and Klompen, 2011).

Worldwide, Caeculidae includes 99 described species (Taylor *et al.*, 2013) arranged in seven genera: *Allocaeculus* Franz, 1952; *Andocaeculus* Coineau, 1969; *Caeculus* Dufour, 1832; *Calocaeculus* Coineau, 1969; *Microcaeculus* Franz, 1952; *Neocaeculus* Coineau, 1969 and *Procaeculus* Jacot, 1936. Seven caeculid species have been reported from Mexico (Vázquez-Rojas and López-Campos, 2013): *Caeculus dorotheae* Mulaik, 1945; *C. hardyi* Mulaik and Allred, 1954; *C. tipus* Mulaik, 1945; *C. valverdius* Mulaik, 1945; *Procaeculus mexicanus* (Mulaik and Allred, 1954); *P. orchidicolis* (Mulaik and Allred, 1954) and *P. potosi* (Mulaik and Allred, 1954).

Extant species of *Procaeculus* are: *P. bryani* Jacot,

1936 from Hawaii; *P. brevis* (Mulaik, 1945) from Texas; *P. puertoricus* (Mulaik, 1945) from Puerto Rico; *P. mexicanus* (Mulaik and Allred, 1954) and *P. potosi* (Mulaik and Allred, 1945) from Mexico; *P. orchidicolis* (Mulaik and Allred, 1945) from Guatemala and Mexico; *P. willmanni* (Vitzthum, 1933) from Hawaii and *P. magnus* Coineau, 1969 from Texas.

There are only two known Caeculidae species preserved in amber: *Procaeculus eridanosae* Coineau and Poinar, 2001 from the Eocene of Poland and *P. dominicensis* Coineau and Magowski, 1994 from the Miocene of the Dominican Republic.

## 2. Locality and material

The amber from Simojovel, Chiapas is considered to be the result of leguminosae resin, deposited in an estuarine environment near to the ancient gulf coast, in early Miocene times (Poinar and Brown, 2002; Solórzano-Kraemer, 2010; Perrilliat *et al.*, 2010; Riquelme *et al.*, 2014; Serrano-Sánchez *et al.*, 2015). Two amber pieces (IHNFG-4924 and IHNFG-4982) include two adults and a molt of Caeculidae mites. Associated fauna includes ostracods, insect remains, sand grains and organic matter. The amber pieces were collected at Campo La Granja mines, north of the town

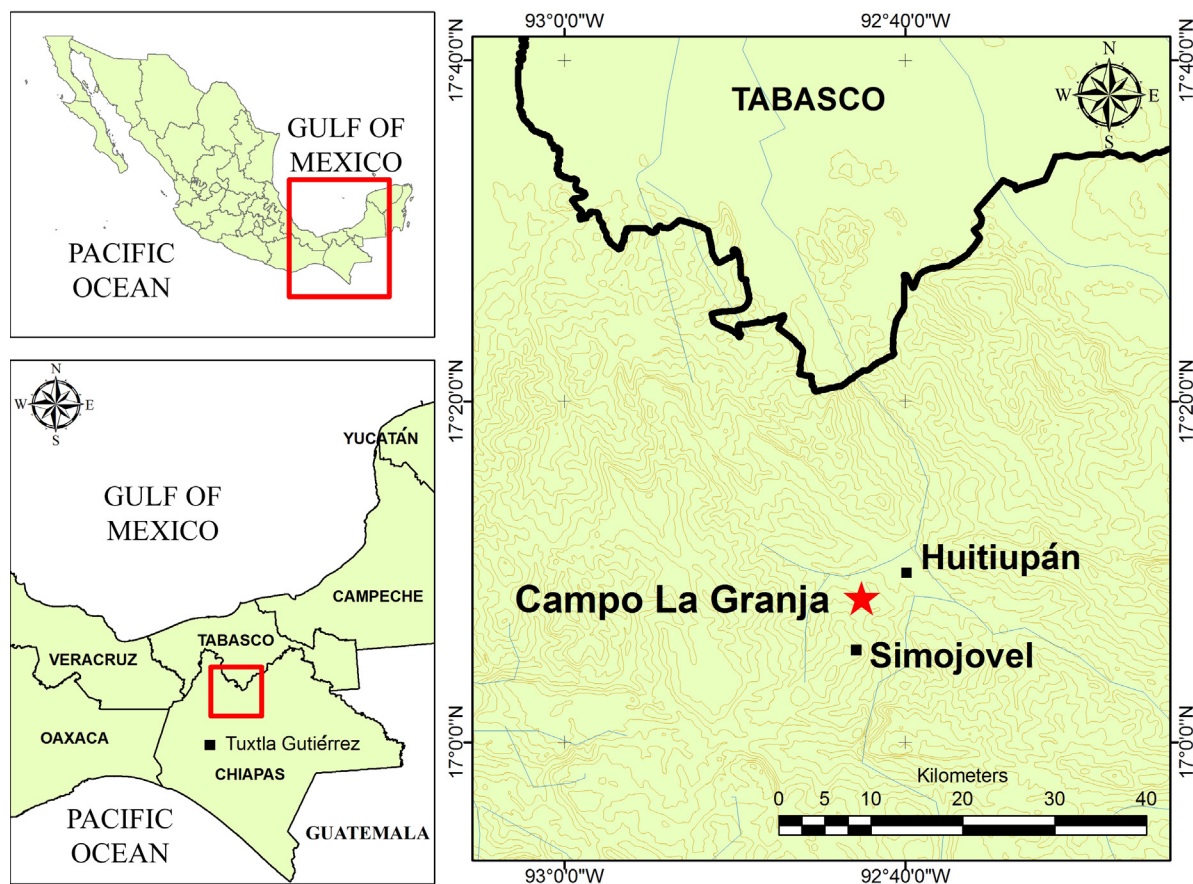


Figure 1. Location map of Campo La Granja mines, Chiapas, southeast Mexico. Modified after Serrano-Sánchez *et al.*, 2015

of Simojovel (Figure 1), in sediments that include mainly quartz sandstones of the upper portion (Finca Carmitto Member) of the lower Miocene La Quinta Formation (Frost and Langenheim, 1974; Serrano-Sánchez *et al.*, 2015). The peculiar contents (brackish water, freshwater and terrestrial organisms) and shape of amber pieces from Campo La Granja mines (mainly stratified amber with sandstone included into the ambar) suggest the resin was deposited in a tidal flat environment near the ancient Gulf of Mexico coastline (Serrano-Sánchez *et al.*, 2015).

The samples are deposited at the Museo de Paleontología “Eliseo Palacios Aguilera”, Calzada de los Hombres Ilustres s/n, Tuxtla Gutiérrez, Chiapas, under the acronym IHNFG.

### 3. Systematic Paleontology

Subclass Acari Sundevall, 1833  
 Superorder Acariformes Krantz, 1978  
 Order Trombidiformes Reuter, 1909  
 Suborder Prostigmata Kramer, 1877  
 Infraorder Anystina van der Hammen, 1872  
 Superfamily Caeculoidea Berlesse, 1883  
 Family Caeculidae Berlesse, 1883  
 Genus *Procaeculus* Jacot, 1936  
 Figures 2, 3, 4

**Description.** Idiosome slightly longer than wide, 358 µm from base of pedipalps to posterior end of body and 282 µm maximum width. No dorsal plates are evident (Figure 2a), only the posterior edge of aspidosomal plate is visible (Figure 3a), a pair of ocelli on each side is visible in this same region. From well-defined tubercles, two long and claviform trichobothria or bothridal setae are found at anterior edge of aspidosomal plate (Figures 2b, 3a); distally and beside each seta, an equally long trichobothrium arise from a corniculum-shaped projection. The chelicerae are clearly distinct from gnathosoma but not its segments. Pedipalps are visible in lateral view (Figure 2c), with a well-developed unguiform tibial setae. Tarsal chaetotaxia is unclear on the pedipalp. Legs folded ventrally between femur and tibia, making it difficult to observe tarsi and features of its claws. Rigid and spiniform setae, typical of caeculids can be observed on ventral side of first pair of legs: one on basifemur, two on genua and two on tibia (Figures 2d, 3b), one claviform setae on telofemur, as long these segments (Figure 3b). Leg trochanters robust with spatulate setae (Figures 2e, 3a). This kind of setae should also be found at the dorsal portion of idiosoma, but are not visible in the study specimens.

In the nearly complete specimen of piece IHNFG-4982, an exuvia was also preserved and it possibly belongs to the same mite. The exuvia preserves trochanter of legs I - III (Figure 2f), as well as rigid and spiniform setae on first leg. No idiosome or gnathosome is visible in this exuvia. A second specimen (IHNFG-4924) scarcely shows

a partial dorsal view (Figures 4a-4c). However, in this specimen, another view of the spinorms setae of legs and the lateral view of pedipalps can be seen (Figure 4d) and the aspidosomal plate has one pair of large trichobothria (Figure 4b).

**Discussion.** The mite of our study is the first fossil record for the Trombidiformes order in Mexico. This represents an important contribution to the fossil record from the Chiapas Miocene and also for the knowledge of acarologist diversity from Mexico.

The caeculid mite found in Miocene amber belongs to *Procaeculus*, a genus with two known fossil species. The spiniform setae on first pair of legs and location of trichobothria on antero-dorsal (aspidosomal) plate, are all diagnostic features to place the specimen within the Caeculidae.

*Procaeculus* is characterized by having relatively narrow aspidomal (antero-dorsal) plate (Coineau, 1967) as the case of our Mexican specimen. The concave shape of anterior margin of the aspidosomal plate and the possibility to observe pedipalps and chelicerae in dorsal view (this plate not projected anteriorly), are the two main features that allow to place the specimen within the genus *Procaeculus* Jacot, 1936.

For the moment, it is not possible to identify the specimen at species level, since details of pedipalps are difficult to observe, particularly the claw-tibia-tarsus complex, tarsus of legs (the distal portions are folded) and the chaetotaxia and shape of idiosoma plates in dorsal view.

Only two fossil species for the genus have been reported so far. *Procaeculus eridanosae* from the Eocene amber of Poland has a narrow and not so acute anterior portion of the aspidosomal plate. *P. dominicensis* from the Miocene Dominican amber is similar to our specimen in the shape of the anterior margin of antero-dorsal plate, but trichobothria (bo) in the Mexican specimen are larger and the antero-dorsal plates wider than long.

Although caeculid mites are typical in terrestrial environments (mountains and arid regions), associated with fallen leaves and bark, some extant species *i.e.* *Microcaeculus* Franz, 1952 are found in littoral zones (Coineau, 1969; Otto, 1993). Thus, this range of tolerance and ecophysiological plasticity may explain the presence of a caeculid mite in estuarine environments, such as the one where the studied piece of amber was deposited.

### Acknowledgements

We are grateful to Christopher Taylor, José Palacios, Ignacio Vázquez and Griselda Montiel for their valuable support with bibliographic references. Support during the postgraduate studies of M.L. Serrano from Posgrado en Ciencias de la Tierra, Instituto de Geología, UNAM and CONACYT is highly appreciated. We appreciate valuable corrections of two anonymous reviewers.



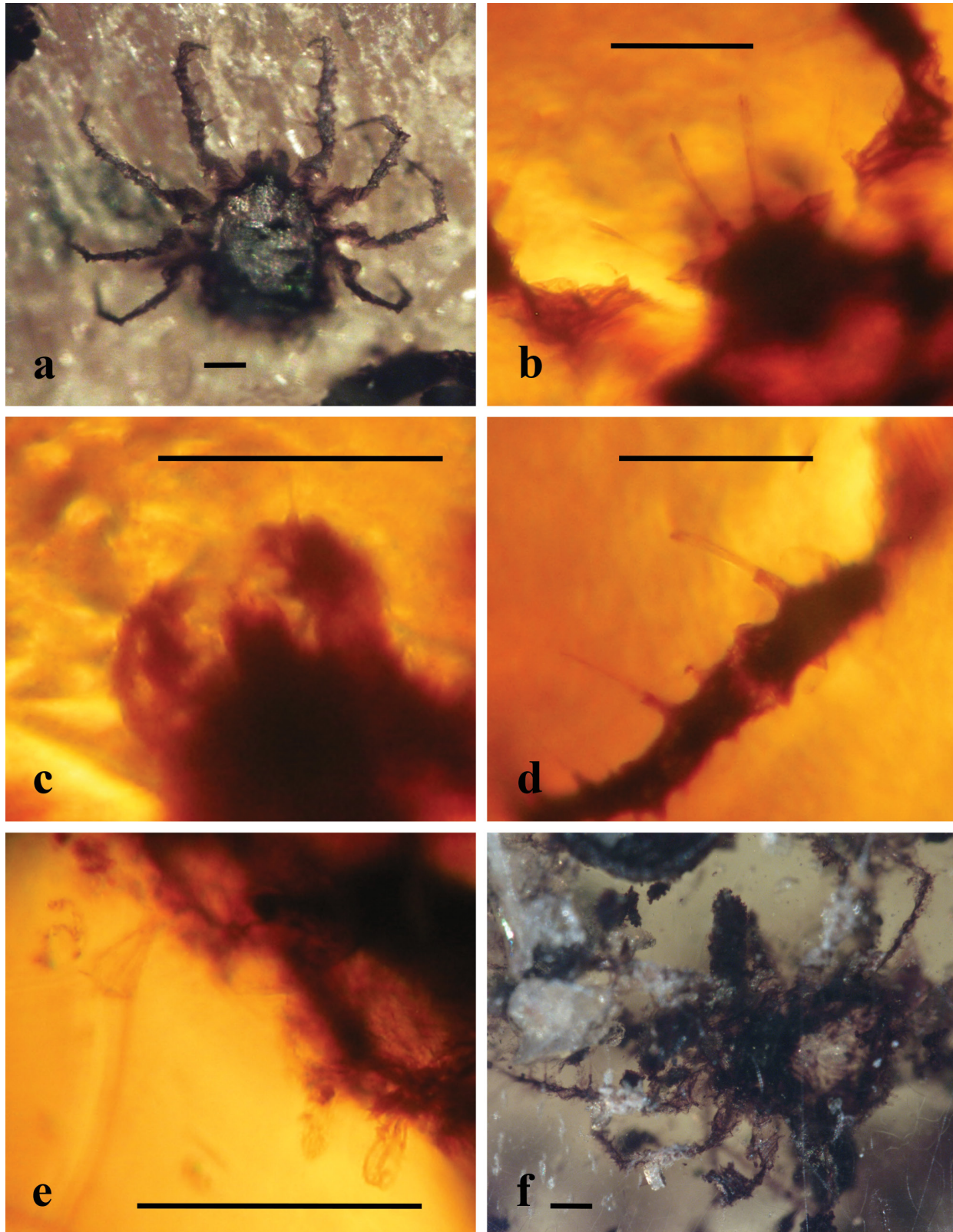


Figure 2. *Procaeculus* (Acari: Trombidiformes) in lower Miocene amber of Chiapas, Mexico, IHNFG-4982). a) Complete specimen in dorsal view. b) Trichobothria setae on anterior portion of the aspidosomal plate. c) Gnathosoma: pedipalp and chelicerae in central portion. d) Spiniform setae of first pair of legs. e) Spatulate setae in trochanter of first pair of legs. f) Spiniform setae in exuvia. Scale bar = 100 microns.

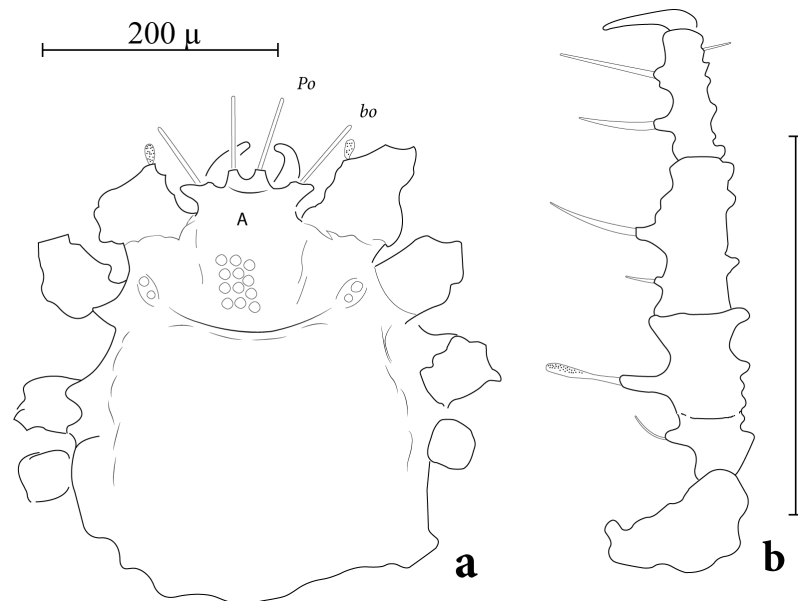


Figure 3. *Procaeculus* (Acari: Trombidiformes) in lower Miocene amber of Chiapas, Mexico, IHNFG-4982). a) Idiosoma in dorsal view. A = aspidosomal plate, Po = proximal trichobothria, bo = distal trichobothria. b) First leg. Scale bars = 200 microns.

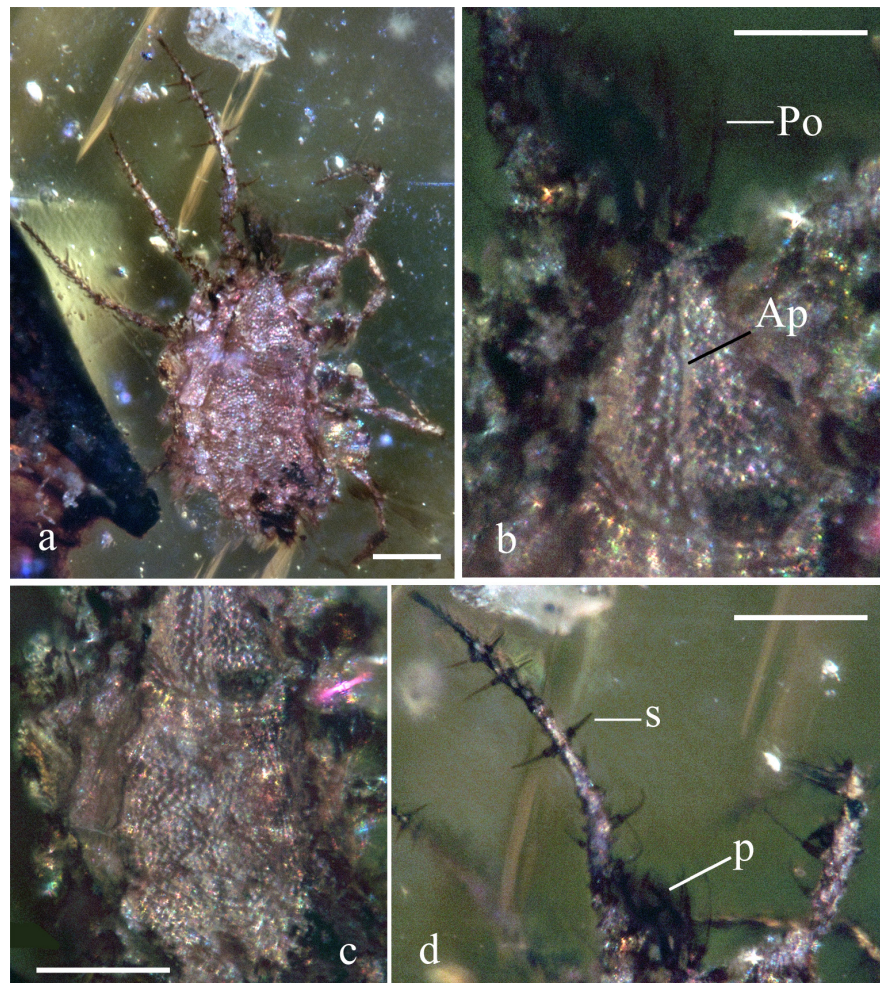


Figure 4. *Procaeculus* (Acari: Trombidiformes) in lower Miocene amber of Chiapas, Mexico, IHNFG-4924). a) Second specimen in partial dorsal view. b) Proximal trichobothria (Po) setae on anterior portion of the aspidosomal plate (Ap). c) Close up to dorsal surface. d) Spiniform setae (s) on first leg and pedipalp (p) in lateral view. Scale bars = 100 microns.



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Manuscript received: January 18, 2015

Corrected manuscript received: March 23, 2015

Manuscript accepted: March 30, 2015