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Immature stages of two *Pangaeus* Stål species (Hemiptera: Heteroptera: Cydnidae) inhabiting riparian vegetation of mesophilous forest in Veracruz, Mexico

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Abstract

The genus *Pangaeus* contains 23 species, eight have been registered in Mexico, and six of them in Veracruz. Immature stages of *P. docilis* and *P. piceatus* were found in remnants of riparian vegetation of the mesophilous forest in La Antigua river basin, Veracruz. Detailed descriptions and illustrations of the nymphal and adult stages of *Pangaeus* species are presented. Information about the biology of Cydnidae and ecological notes are included as well. *P. piceatus* is a new record for Veracruz and *P. docilis* is a new record for Mexico.

Keywords: Burrower bugs, leaf litter, nymphs, seasonality

Introduction

The Cydnidae family is distributed worldwide, and it is well represented in temperate and tropical regions [1]. It includes five subfamilies: Amnestinae, Cydninae, Garsauriinae, Scaptocorinae and Sehirinae [2]. The Cydninae subfamily contains approximately 90 genera and 300 species [3]. Mayorga noted that, all of these subfamilies are present in Mexico, except for Garsauriinae, and they are represented by 12 genera [3]. These hemipterans are characterized by their tricothoria arrangement on several posterior abdominal segments, the anterior wing venation with radial cells and the absence of hamus [2]; also the pronotum presents a lateral submarginal row of setigerous punctures [1].

Pangaeus Stål is distinguished for the presence of a sharply impressed row extending from one anterior angle to the other, having a distinctive transverse submedian impression with one row of punctures [2, 4]. *Pangaeus* is divided into two subgenera: *Pangaeus (Pangaeus)* Stål and *Pangaeus (Homaloporus)* Uhler. The first one contains 17 species distributed from southern Canada to southern Guatemala; three of these species are found in Mexico: *P. impressus* (Froeschner), *P. piceatus* Stål and *P. serripes* (Westwood). The *Pangaeus (Homaloporus)* subgenus includes six species distributed from west Texas and New Mexico to northern Guatemala; five of them are present in Mexico: *P. tuberculipes* (Froeschner), *P. congruus* (Uhler), *P. rugiceps* Horvath, *P. bilineatus* (Say) and *P. setosus* (Froeschner) [2].

According to Froeschner, the biology of Cydnidae has been well studied, but the information is fragmented and only a few complete life cycles have been described [2]. Mayorga and Cervantes described *Amnestus ficus* and their immature stages; they also described their association with fruits and seeds of *Ficus cotinifolia* Kunth (Moraceae), as food source [5]. The same authors described in detail the nymphs and adult stages of *Pangaeus (Pangaeus) serripes* (Westwood), adding notes about their biology and their interaction with several *Ficus* species [6]. Vivan *et al.* described the immature stages of *Scaptocoris carvalhoi* Becker, which feeds on host plants' roots [7].

In this study, the description and illustration of the nymphal stages of *P. piceatus* Stål and *P. docilis* (Walker) are presented in detail and some biological notes are added. Specimens were collected during a project conducted in riparian forests. Nymphs and adults were found in leaf litter in riparian vegetation, as part of the remnants of the mesophilous forest in central Veracruz, México. *P. docilis* is reported as a new record for Mexico.

Material and Methods

The sampling was conducted in the central portion of Veracruz in the mountain area of La Antigua river basin. The characteristic climate of the zone is humid weather with annual

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rainfall having variations from 1,500 to 2,000 mm and an annual average temperature of 18 °C [8]. Twelve sites in five localities were selected where first, second and third order rivers occur [9]: *Atzacán*: Matlalapa 19°28'01"N, 97°04'39"W, 1656 m; *Coatepec*: La Cortadura 19°29'39.5"N, 97°02'04.5"W, 2007 m; Antonio Guillen property 19°31'00"N, 97°00'25.4" W, 1635 m; *Ixhuacán de los Reyes*: Puente de Dios 19°23'13.1" N, 97°04'06.1" W, 1526 m; Tlalchi 19°23'14.5"N, 97°05'07.9"W, 1643 m; *Tlalnelhuayocan*: Piedra Parada, 19°30'58.6"N, 97°00'34.4"W, 1622 m; Pixquiac 19°32'04.9"N, 96°59'52.3"W, 1573 m; Trucha Feliz 19°31'01.8"N, 96°59'12.2"W, 1467 m; *Xico*: Buena Vista, 19°24'03.5"N, 97°05'24.9"W, 1854 m; Micoxtla 19°27'24"N, 97°01'48"W, 1678 m, Puente Buenavista 19°24'11.3"N, 97°05'26.1"W, 1733 m; Xico Viejo 19°27'07" N, 97°03'31"W, 1860 m.

The specimens were collected during both rainy (July) and dry (April) seasons in 2012. Transects of 100 meters were marked parallel to the river, collecting a leaf litter sample in each one, having by the end a total of ten samples separated in cloth bags. At the laboratory, five samples were processed in a Berlese-Tullgren funnel, with a 1 cm opening, and left exposed to a 40 watts lamp during 48 hours [10]; the other five were treated in Winkler sacks with sieved leaf litter from field [11]. The nymphs and adult stages of Cydnidae were separated and preserved in 70% alcohol. The specimens were identified to species level with the dichotomous keys from Cydnidae of the Western Hemisphere [2]. The following material was revised: 18 nymphs of stages I-IV and 39 adults for *Pangaeus piceatus*; and five adults and eight nymphs of II and IV instars for *P. docilis*. The measures: body length; head length, width between eyes, interocular distance; antennal segments: I, II, III, IV, rostral segments: I, II, III, IV, pronotum: length, width across frontal margin, width across humeral angles; fore leg: femur length, tibia length, and tarsi length were taken for nymphs and adults. Measurements are given in millimeters ± standard deviation.

The specimens were deposited in the Colección Entomologica, Instituto de Ecología, A.C. Xalapa, Veracruz (IEXA).

Results

Pangaeus piceatus Stål 1862

First instar (Figure 1). Slightly piriform body. Color variation from ochre to pale brown in head, pro-, meso-, metanotum, lateral and median dorsal plates and scent gland openings. Reddish eyes. Rostrum reaching metacoxal base. Clypeus as wide and long as juga, with three setigerous punctures and six in juga. Antennal segments with slight pubescence; I-III short, rounded and dark brown at the base with white apex; segment IV elongate and fusiform. Pale brown pronotum with four lateral setigerous punctures; round lateral margin, slightly extended humeral angles with the anterior margin concave. Meso- and metanotum with one setigerous puncture; mesonotum with an obscure row at basal margin. Pale yellow abdomen, tarsi and rostral segments. Dorsal median plates on segments II, III-IV, IV-V, V-VI and VII; hardly visible ventral plates. Visible spiracles. Pale brown femora and tibia with an obscured apex. Fore tibiae with five spines on dorsal margin and four shorts ventral spines.

Measurements in millimeters (n=1). Body length 1.8; head length 0.35; width between eyes 1.0; interocular distance 0.8; antennal segments: I 0.2, II 0.2, III 0.2, IV 0.3; rostral segments: I 0.25, II 0.25, III 0.25, IV 0.2; pronotum: length 0.35; width across frontal margin 0.6; width across humeral angles 0.8; fore leg: femur length 0.35; tibia length 0.3; tarsi length: I 0.1, II 0.15.

Second instar (Figure 2). Oval body. Dark brown colored head, pro-, meso-, metanotum, median, lateral dorsal plates and scent gland openings. Red eyes. Rostrum reaching mesocoxal base. Juga with seven or eight setigerous punctures. Antennal and tarsi segments with slight pubescence. Antennae, femora and tibiae darker than first instar. Pale yellow abdominal segments with a hardly visible submarginal pink-reddish spot; dark brown, rectangular scent gland openings; abdominal segment IV with a setigerous puncture. Dorsal median plates on segments II, III-IV, IV-V, V-VI and VII; pale brown ventral plates on segments VI-VII, plates with the same width as segments.

Measurements (n=4). Body length 3.02 ± 0.05; head length 0.36 ± 0.05; width between eyes 0.8; interocular distance 0.6; antennal segments: I 0.2, II 0.24 ± 0.04, III 0.3, IV 0.42 ± 0.04; rostral segments: I 0.31 ± 0.03, II 0.4, III 0.32 ± 0.03, IV 0.28 ± 0.04; pronotum: length 0.49 ± 0.05; width across frontal margin 1.0; width across humeral angles 1.44 ± 0.05; fore leg: femur length 0.54 ± 0.05; tibia length 0.52 ± 0.04; tarsi length: I 0.1, II 0.15.

Third instar (Figure 3) Oval body. Variation in color from dark brown to copper in head, pro-, meso- and metanotum. Ochre pleura, median, lateral and ventral plates. Mesonotum with setigerous puncture. Wing pads hardly surpassing the abdominal apex in segment I. Pale ochre abdomen with a distinctive pink-reddish spot; dark brown scent gland openings on abdominal segments III-IV, IV-V and V-VI. Pale brown rostrum with white apex, surpassing mesocoxal apex. Fore tibiae with larger and darker spines than first instars.

Measurements (n=8). Body length 3.69 ± 0.2; head length 0.48 ± 0.06; width between eyes 0.99 ± 0.08; interocular distance 0.77 ± 0.05; antennal segments: I 0.23 ± 0.03, II 0.33 ± 0.05, III 0.39 ± 0.02, IV 0.46 ± 0.05; rostral segments: I 0.42 ± 0.04, II 0.48 ± 0.05, III 0.46 ± 0.05, IV 0.37 ± 0.05; pronotum: length 0.74 ± 0.05; width across frontal margin 1.14 ± 0.09; width across humeral angles 1.89 ± 0.17; fore leg: femur length 0.75 ± 0.08; tibia length 0.79 ± 0.02; tarsi length: I 0.15, II 0.25.

Fourth instar (Figure 4). Slightly elongate and oval body. Similar to third instar. Antennae, femora and tibiae darker than others instars; spines on tibiae longer and darker than previous instar; pale brown tarsi. Slender and slightly quadrangular antennal segment II. Rostrum reaching mesocoxal base. Pronotum and wing pads with barely visible punctuation; the latter reaching the base of abdominal segment II. Ochre to reddish abdomen; each abdominal segment with a small submarginal grayish spot.

Measurements (n=9). Body length 5.17 ± 0.48; head length 0.53 ± 0.05; width between eyes 1.3 ± 0.13; interocular distance 0.92 ± 0.07; antennal segments: I 0.22 ± 0.03, II 0.35 ± 0.05, III 0.49 ± 0.11, IV 0.49 ± 0.03; rostral segments: I 0.51 ± 0.08, II 0.64 ± 0.09, III 0.55 ± 0.09, IV 0.39 ± 0.06; pronotum: length 1.13 ± 0.23; width across frontal margin 1.5 ± 0.15; width across humeral angles 2.71 ± 0.35; fore leg: femur length 0.96 ± 0.05; tibia length 0.94 ± 0.1; tarsi length: I 0.19 ± 0.02, II 0.28 ± 0.03.

Adult (Figure 5). Body oval. Head: length than two-thirds width with surface shining, usually with weak, radiating rugae; juga little longer than clypeus; jugum with one setigerous puncture submarginally anterior to eye. Rostrum extended between mesocoxae. Pronotum larger than width, anterior margin shallowly, doubly emarginated; with submarginal row of four or five setigerous puncture; transverse impression distinct across full width, weaker at middle, marked by medially interrupted row of punctures; anterior lobe impunctate, occasionally small punctures laterally, median line impressed from subapical line to between calli; posterior lobe with few

scattered punctures on anterior half of middle area. Scutellum: length equal to or less than width; disc shining, with several scattered punctures. Clavus and corium polished; clavus with one row of punctures; corium not punctate, sometimes with one partial row paralleling claval suture; membrane longer than basal width, surpassing apex of abdomen. Posterior tibia without subbasal angulation ventrally, with four spines on posteroventral margin^[2].

Measurements (n=10). Male. Body length 5.91 ± 0.6 ; head length 0.71 ± 0.07 ; width between eyes 1.47 ± 0.09 ; interocular distance 1.02 ± 0.1 ; interocelar distance 0.52 ± 0.04 ; antennal segments: I 0.31 ± 0.03 , II 0.32 ± 0.02 , III 0.39 ± 0.02 , IV 0.49 ± 0.03 , V 0.59 ± 0.06 ; rostral segments: I 0.64 ± 0.05 , II 0.56 ± 0.06 , III 0.59 ± 0.06 , IV 0.49 ± 0.06 ; pronotum: length 1.7 ± 0.08 ; width across frontal margin 1.7 ± 0.14 ; width across humeral angles 3.19 ± 0.15 ; scutellum: length 2.04 ± 0.15 ; width 2 ± 0.11 ; fore leg: femur length 1.09 ± 0.12 ; tibia length 1.03 ± 0.13 ; tarsi length: I 0.23 ± 0.05 , II 0.14 ± 0.02 , III 0.2 ± 0.01 .

Distribution. Brazil, Colombia, Costa Rica, Guatemala, Peru, Puerto Rico. Mexico: Oaxaca^[2, 4], *Veracruz. *New record.

Pangaesus (Pangaesus) docilis Walker (1867)

Third instar (Figure 6). Oval body. Dark brown head, pro-, meso-, metanotum, lateral, dorsal and ventral plates. Tylus with rounded margins and as long as juga; the latter with six setigerous punctures, three median and three lateral. Red eyes. Pronotum with eight setigerous punctures; mesonotum with two on lateral margin. Pale brown rostrum and antennal segments I-III with an ochre apex; rostrum reaching the mesocoxae. Pale brown pleura, femora and tibiae. Fore tibia with seven spines on lateral margin, reducing its size at base and the apice whit five thick spines. Wing pad reaching the base of abdominal segment I. Pale yellow abdomen; its respective segments with a grayish row parallel to basal margin; dorsal median plates on segments II, III-IV, IV-V, V-VI and VII; ventral plates on segments VI-IX. Dark brown scent gland openings on the segments III-IV, IV-V and V-VI. Abdominal segment III with a lateral setigerous punctation; dorsal median plates on segments I, II, III, VII and VIII; slightly rounded lateral plates.

Measurements (n=1). Body length 0.36; head length 0.4; width between eyes 0.1 interocular distance 0.7; antennal segments: I 0.2, II 0.4 ± 0.03 , III 0.3, IV 0.4; rostral segments: I 0.4, II 0.5, III 0.5, IV 0.3; pronotum: length 0.8; width across frontal margin 1.2; width across humeral angles 1.8; fore leg: femur length 0.72; tibia length 0.7; tarsi length: I 0.1, II 0.2.

Fourth instar (Figure 7). Slightly elongate and oval body. Darker coloration than in third instar. Dark brown head, pronotum, scutellum, wing pad, pleura, median, lateral and ventral plates and scent gland openings. Rostrum reaching mesocoxal base. Antennae with slight pubescence; short segment I, elongate segment II with straight angles, pale fusiform segment IV. Pronotum with six lateral setigerous punctures; basal margin, apex scutellum and wing pads with thin, dark brown to black, strip. Wing pads reaching the base of abdominal segment II. Ochre abdomen with hardly visible grayish spots. Amber femora and tibiae; pale brown tarsi with slight pubescence. Fore tibiae with eight spines on lateral margin. Measurements (n=6). Body length 4.82 ± 0.46 ; head length 0.56 ± 0.09 ; width between eyes 1.25 ± 0.05 ; interocular distance 0.87 ± 0.08 ; antennal segments: I 0.28 ± 0.03 , II 0.53 ± 0.05 , III 0.46 ± 0.05 , IV 0.52 ± 0.04 ; rostral segments: I 0.53 ± 0.03 , II 0.64 ± 0.05 , III 0.5 ± 0.03 , IV 0.4 ± 0.03 ; pronotum: length 1.13 ± 0.23 ; width across frontal margin 1.5 ± 0.15 ; width across humeral angles 2.71 ± 0.35 ; fore leg: femur length

0.93 ± 0.1 ; tibia length 0.88 ± 0.04 ; tarsi length: I 0.1, II 0.2.

Adult (Figure 8). Body oval. Head: clypeus as long tan juga and strongly narrowed apically; surface shining, impunctate, with weak rugae; Jugum with one submarginal setigerous puncture anterior to eye. Rostrum reaching the mesocoxae. Pronotum: length little more than half width; lateral margin straight on basal half, with five setigerous punctures submarginally; transverse impression across full width: anterior lobe impunctate with few punctures medially. Scutellum: disc shining with few to numerous scattered punctures. Clavus and corium alutaceous; clavus with one row of punctures; corium with basal part of second row paralleling claval suture. Costa with one setigerous puncture; membrane longer than basal width, surpassing apex of abdomen. Posterior tibiae with subbasal angulation and two subapical spines on posteroventral margin^[2].

Measurements (n=2). Male. Body length 5.3 ± 0.42 ; head length 1.1; width between eyes 1.2 ± 0.14 ; interocular distance 0.85 ± 0.07 ; interocelar distance 0.5; antennal segments: I 0.25, II 0.3, III 0.35 ± 0.07 , IV 0.45 ± 0.07 , V 0.55 ± 0.07 ; rostral segments: I 0.55, II 0.68 ± 0.11 , III 0.53 ± 0.04 , IV 0.38 ± 0.04 ; pronotum: length 1.55 ± 0.21 ; width across frontal margin 1.5 ± 0.14 ; width across humeral angles 2.85 ± 0.35 ; scutellum: length 1.7 ± 0.28 ; width 0.75 ± 0.35 ; fore leg: femur length 0.9 ± 0.14 ; tibiae length 0.88 ± 0.18 ; tarsi length: I 0.23 ± 0.04 , II 0.13 ± 0.04 , III 0.17 ± 0.02 .

Distribution. Brazil, Colombia, Ecuador, Guatemala, Panama, Peru, Venezuela^[2]. *Mexico: Veracruz. *New record *Biology* Nymphs and adults of *Pangaesus piceatus* and *P. docilis* were found inhabiting leaf litter of riparian vegetation in mesophilous forests. We believe that they feed from the abundant herbaceous vegetation roots belonging to the Piperaceae family. Individuals were found in leaf litter from the following tree species: *Carpinus caroliniana* Walter (Betulaceae), *Clethra mexicana* A. DC. (Clethraceae), *Ilex toluicana* Hemsl. (Aquifoliaceae), *Liquidambar macrophylla* Oerst. (Hamamelidaceae), *Meliosma alba* (Schltdl.) (Sabiaceae) and *Ulmus mexicana* (Liebm.) (Ulmaceae) and other shrubs in the Rubiaceae family. The abundance of leaf litter, fruits and seeds produced by trees predominant in the area provide shelter and food for these organisms.

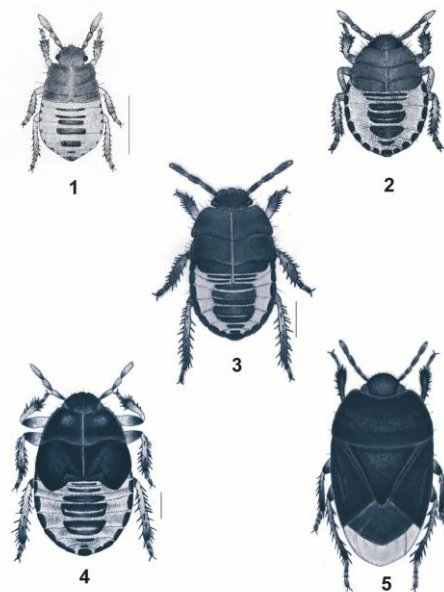


Fig 1-5: Immature stages of *Pangaesus (Pangaesus) piceatus*. 1. First instar. 2. Second instar. 3. Third instar. 4. Fourth instar. 5. Adult (Scale = 1 mm).

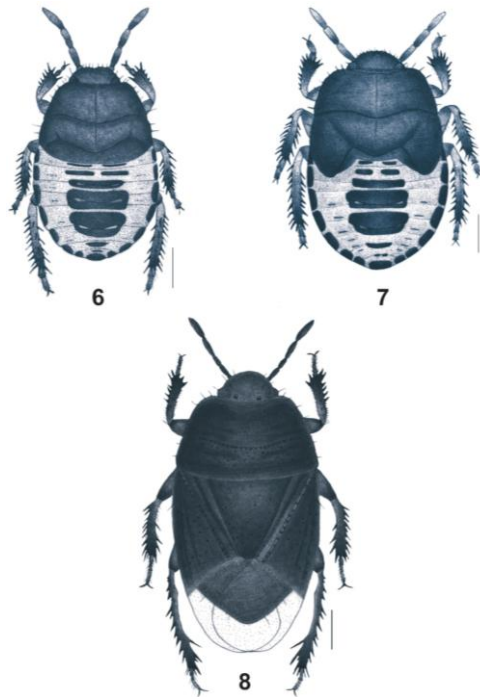


Fig 6-8: Immature stages of *Pangaeus (Pangaeus) docilis*. 6. Third instar. 7. Fourth instar. 8. Adult (Scale= 1 mm).

Discussion

Most Cydnidae species spend most of their life cycles buried several meters below ground feeding from roots, making this group difficult to study. According to Southwood and Southwood and Hine, most nymphal instars feeding in *Sehirus cinctus* L. and *S. bicolor* L. focus on the floral or frutal parts of the Labiate plants [12, 13]. Since several plants in the Piperaceae family were observed in the area of study, we believe that nymphs and adults may feed on this herbaceous plant. Also, several tree species were abundant in the area and their fruits and seeds could possibly be an excellent food source for bugs. While mesophilous forests have high vegetation cover and offer ideal habitat for animal species, riparian plant communities offer abundant and diversified food resources for terrestrial wildlife. In regions with seasonal climates, riparian forest provides shelter for animals during dry periods [14]. Several species of Heteroptera inhabit leaf litter, because it provides optimal conditions and abundant resources for completing their life cycles. Brailovsky and Cervantes described a new genus and three new species of the Ozophorini tribe (Rhyparochromidae) associated with leaf litter in mesophilous forest at southeastern México and Central America [15]. In tropical climates, some *Ficus* species offer food resources to several Cydnidae such as seeds present in the soil [16].

All species listed were collected inhabiting leaf litter, under the shade of *Ficus* spp. trees, feeding from their fruits and seeds. Due to *Ficus* spp., flowering is asynchronous and their food sources remain all year round, these species could also be present almost all year; *P. docilis* and *P. piceatus* were more abundant in July (summer), when the rainy season begins and food and refuge resources increase. In this period, leaf litter levels are high and offer optimal conditions for oviposition and survival for nymphs, promoting the abundance of the species. On the other hand, only a few individuals were collected in April (spring) corresponding to the dry season. Mayorga and Cervantes previously recorded Cydnidae species in La Mancha, Actopan, including *P. serripes*, *P. bilineatus* and *P. rugiceps* that were collected mainly during the rainy season

(May-November) [16]. Also, they described the immature stages of *P. serripes* in the same time of the year as well [6].

In this study, the immature stages from the first to fourth instar of *Pangaeus piceatus* and the third and fourth instar of *P. docilis* were described. The most noticeable morphological difference between these species and *P. serripes* while in nymph stage is their body size. *P. serripes* is the largest (5.6 ± 0.4) followed by *P. piceatus* (5.17 ± 0.48) and *P. docilis* is the smallest one (4.82 ± 0.46). The three species have dark brown dorsal median plates on the abdominal segments II, III-IV, IV-V, V-VI and VII. In *P. piceatus* and *P. docilis*, there is also a dorsal plate present on segment VII. Both species have lateral setigerous punctures on segment III, while *P. serripes* does not. The general coloration of *P. docilis* is lighter and the abdomen has a small grayish spot which is hardly visible; *P. serripes* and *P. piceatus* are darker and have light reddish-pink spots.

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