Morphology of the 1st Gonapophysis in the Genus Neoplea (Hemiptera: Heteroptera: Pleidae), including an Evaluation of Its Taxonomic Importance

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Morphology of the 1st gonapophysis in the genus Neoplea (Hemiptera: Heteroptera: Pleidae), including an evaluation of its taxonomic importance

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Abstract

The 1st gonapophysis of species in the genus Neoplea Esaki and China, 1928, includes a pattern of spurs that aids in depositing eggs into plant tissue. Within each species the pattern of spurs is relatively consistent, especially toward the apical end. Thus, there is taxonomic value in the morphology of this structure. Many of the currently known species of Neoplea can be identified using only the 1st gonapophysis, although intraspecific variation exists and characteristics may overlap in closely related species. All Neoplea species whose 1st gonapophyses are known are described and illustrated.

Key Words: external genitalia; classification; taxonomic character; pygmy backswimmer

Resumen

El ovipositor de las especies en el género Neoplea incluye un patrón de espinas que son utilizadas presumiblemente para ayudar en la deposición de huevos en el tejido vegetal. Dentro de cada especie, el patrón de estas espinas es relativamente consistente, especialmente hacia el extremo apical. Por lo tanto, hay valor taxonómico en la morfología de esta estructura. Muchas de las especies conocidas actualmente de Neoplea pueden identificarse utilizando únicamente el ovipositor, aunque existe variación en la especie y en las especies estrechamente relacionadas presenta cierta superposición en caracteres. Se describen e ilustran todas las especies de Neoplea cuyos ovipositor no conocidos.

Palabras Clave: genitales externos; clasificación; carácter taxonómico; notonectido pigmeo

External genitalia of insects are morphologically diverse and have considerable taxonomic value. Gullan & Cranston (2005) summarized that the male external genitalia often have characteristics that are widely used in distinguishing species, whereas the female external genitalia are often simpler and less varied. In the order Hemiptera, the female reproductive system often has substantial taxonomic value at the levels of superfamily, family, genus, and species (Pendergrast 1957; Scudder 1959; Papáček 2002, 2008; Cook 2011). At the levels of superfamily and family, the ovipositor has valuable taxonomic characters (Scudder 1959), and at the genus level, the spermatheca is taxonomically informative (Pendergrast 1957). In the family Helotrephidae, the sister family to Pleidae, Papáček (2002, 2008) showed that the 1st gonapophysis is taxonomically informative at the genus level. Cook (2011) showed that aspects of the 1st gonapophysis may be informative at both the species and genus level in pleids.

The morphology of the external genitalia of pleids has been treated in a general sense by several authors. Wefelscheid (1912) gave a general description of the ovipositor of Plea minutissima Leach, 1817. Scudder (1957) refined the terminology and Scudder (1959) illustrated the ovipositor of Plea atomaria (Pallas, 1771) (= P. minutissima). Of the female pleid external genitalic components, the 1st gonapophysis has the most modifications among species and is relatively large and distinct. This portion of the female external genitalia has been historically referred to as the ovipositor by pleid researchers. However, we will use the term 1st gonapophysis, because we are referencing a specific part of the ovipositor (see Snodgrass 1935).

Drake & Chapman (1953) noted that there was a large amount of overlap in the morphological characters being used to identify species in the family Pleidae. The first basis of species designation relied entirely on color and facial pattern (Fieber 1844), but these characters were later shown to be unreliable (Lundblad 1933). Drake & Chapman (1953) expanded the characters used to describe pleids, including comparing widths of the pronotum and scutellum, the state of body sculpturing, and the form of the clavus. In a subsequent paper, which was never published, they planned to illustrate pleid antennae, opercula (sternite VIII) of the male and female, sternal carinae, male parameres, and female 1st gonapophyses, all of which they thought had taxonomic significance. Several authors began incorporating some of these characters in descriptions of Neoplea (Bachmann 1968; Roback & Nieser 1974; Nieser 1975) but Benzie (1989) still found taxonomic character use to be inconsistent and confusing.

The 1st gonapophysis of species of Neoplea has been illustrated by several authors (Bachmann 1968; Roback & Nieser 1974; Nieser 1975) but none have discussed the taxonomic usefulness of the character. All

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simply stated that their new species had 1st gonapophyses as illustrated in the figures they provided. However, it is clear from these figures that 1st gonapophysis morphology differs between the species they described and that their intent was to illustrate this structure for its taxonomic usefulness. In this study, we compare the 1st gonapophysis of 12 of the 15 species of *Neoplea* as well as the morphological variation of this structure within 2 species, *Neoplea harnedi* (Drake 1922) and *N. striola* (Fieber 1844). Herein, we also expand on the description of the 1st gonapophysis of Pleidae given by Scudder (1959), with a concentration on the species of the genus *Neoplea*.

**Materials and Methods**

Specimens were identified by JLC, and CAS performed dissections. Multiple specimens of *N. striola* and *N. harnedi* and 1 specimen each of the remaining available species were dissected. Genital dissections were based on the methods of Flowers (1999). Specimens were relaxed in warm water for approximately 10 min before dissecting the genitalia from under the overlying sclerites. Some specimens had the 8th abdominal sternite lifted and were soaked for an additional 5 min before they were sufficiently relaxed for dissection. Abdomens of some of the specimens were removed before dissecting the genitalia. To isolate the 1st gonapophysis, genitalia were further dissected in 70% ethanol. All dissections were performed using a Motic SMZ-168 stereomicroscope.

Genitalia were temporarily stored in 99.5% anhydrous glycerin for initial observations and photographed before being permanently mounted on slides. Slide mounts were based on the methods of Smith-Herron & Cook (2014). First gonapophyses were dehydrated in an ethanol series, cleared in xylene, and mounted in Damar balsam.

Observations were made using an Olympus B-Max 52 compound microscope with 10X and 20X universal objectives with differential interference contrast prisms, and 1st gonapophyses were photographed as temporary mounts with an Olympus DP-72 camera on the aforementioned microscope using cellSens Standard (Olympus Corporation 2010) and the stacking program Combine ZP (http://www.hadleyweb.pwp.blueyonder.co.uk/). Drawings were made directly from photographs or redrawn from published figures as noted.

**Results and Discussion**

**GENERAL PLEID FEMALE GENITAL MORPHOLOGY**

The sclerotized external genitalia of Pleidae are all part of abdominal segments VIII and IX (Fig. 1). At rest, the abdominal sterna conceal the external genitalia, although part of the 1st gonapophysis is sometimes visible. The 1st gonocoxa is subtriangular and fused through most of 1 side to the 1st gonapophysis. It is broadly attached, but not fused, to the 8th tergite. The 1st gonapophysis is rectangular, longer and narrower than 1st gonocoxa, and sclerotized. The apical half of the 1st gonapophysis has rows of spurs that are generally larger toward the apex. The 2nd gonocoxa is smaller and narrower than the 1st, ventrally connected to the 2nd gonapophysis and dorsally connected to the gonoplacs. The right and left 2nd gonapophyses are fused in the apical half. In lateral profile the fused 2nd gonapophyses are narrow and arched toward

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Fig. 1. General external female genital morphology in *Neoplea*, showing abdominal segments VIII and IX; T8 and T9 are tergal sclerites of abdominal segments VIII and IX, respectively; 1Gx and 2Gx are the 1st and 2nd left gonocoxae; 1Gpo and 2Gpo are the 1st and 2nd left gonapophyses; 2Gpl is the gonoplac, which is located on segment IX. Orientation of these structures is skewed to allow for viewing of all structures, but they overlap and tilt when attached to the abdomen.
the gonoplacs. The apex is acuminate and in ventral profile the apical end appears bulbous. The gonoplac is an elongated lobe with the apical half to two-thirds densely covered in long setae.

**FEMALE 1ST GONAPOPHYSIS MORPHOLOGY OF NEOPLEA**

The 1st gonapophysis in species of *Neoplea* is a rectangular structure with a generally species-specific pattern of rows of spurs that are directed posteriorly and slightly dorsally. On the dorsal apical edge, nearly all species of *Neoplea* have a lobe-like projection, here designated the dorsal lobe of the 1st gonapophysis (Fig. 2, dl), which is intraspecifically consistent in size. Only 1 described species, *Neoplea notana* (Drake & Chapman 1953), does not have a defined dorsal lobe, but instead has a crenate dorsoapical surface. Most species of *Neoplea* have a well-defined dorsal depression (Fig. 2, dd), which is provided with a small spine on the apical margin in some species. These small spines differ from the spurs in that the spurs emerge from sockets and are moveable. It is unknown if this movement is associated with independent muscles or if the socket simply allows them to be moved relative to the 1st gonapophysis and other spurs. Along the ventral edge there is a cuticular ridge (Fig. 2, vr) present in some species. At the ventrolateral corner some species have a small tooth (Fig. 2, vt). Setae are often associated with the 1st gonapophysis, and although they do not form species-specific patterns, the abundance of setae is consistently densely setose, sparsely setose, or glabrous.

Along the apical edge there is a vertical row of 5 to 6 spurs, usually relatively large, that are hereby designated as the apical spurs (Fig. 2, A1). Anterior to the apical spurs in all species of *Neoplea* is a 2nd vertical row of 4 to 6 spurs, designated as the primary spurs (Fig. 2, P1). In some species, such as *N. striola*, there is some variation in the number of primary spurs; however, in other species, such as *N. harnedi*, the number appears to be fixed. Anterior to the primary spurs is a 3rd vertical row of spurs, and in some cases this is followed by a partial 4th row of spurs, designated as the secondary and tertiary spurs (Fig. 2, S1; T1; L1; U), respectively. The primary, secondary, and tertiary rows of spurs are usually relatively straight, but may be slightly arched. Just ventral to the dorsal edge of the 1st gonapophysis is a horizontal line of spurs that extends toward the base of the 1st gonapophysis, designated as the lateral spurs (Fig. 2, L1). Often 1 each of the primary, secondary, and tertiary spurs are in line with the lateral spurs, but only those not designated as primary through tertiary are designated as lateral. Occasionally spurs do not fall into any of these categories and are designated as accessory spurs (Fig. 2, U).

Although many of the structures and patterns are relatively consistent for each species, there is some variability. The relative size and number of spurs tends to be most stable in the apical and primary rows and most variable in the lateral and tertiary rows. Therefore, it is not possible to use exact counts and sizes of spurs to identify species, but the general characteristics of the 1st gonapophysis, especially if more than 1 specimen of a species is available, can usually be used as a sound taxonomic character. Below are the general characteristics of the 1st gonapophysis of each species of *Neoplea*, except where the 1st gonapophysis is unknown. Intraspecific variation is documented for *N. striola* and *N. harnedi*.

*Neoplea absona* (Drake & Chapman, 1953) (Fig. 3)

Apical row: 5 spurs; A1 and A5 subequal, largest apical spurs; A1 and A5 subequal; series of A1 to A5 increase incrementally in size.

Primary row: 5 spurs; P1 longer and thinner than other primary spurs, located near apex and may be mistaken for an apical spur; series of P1 to P5 increases in length, P1 and P5 subequal; primary row weakly arched towards apex.

Secondary row: 2 spurs; S1 and S2 subequal; both near dorsal edge; S1 more posterior than S2.

Tertiary row: 1 spur; T1 very small, almost missing, just anterior to S2.

Additional features: small tooth-like projection of 1st gonapophysis ventral to P1; dorsal lobe thin, thinner than apical spurs; thin spur
on opposing side of 1st gonapophysis can sometimes be seen projecting above dorsal surface of 1st gonapophysis (not shown in Fig. 3); dorsal depression prominent and complete; ventral depression observable on about 80% of 1st gonapophysis.

Nieser (1975) included a figure of the 1st gonapophysis but made no comment on its structure. From his figure, the general 1st gonapophysis structure and size of spurs are consistent with the above description except for 2 minor differences. He figured 2 additional secondary spurs ventral to those in Fig. 3. One of these is likely the projection of the spur we noted on the opposing side of the 1st gonapophysis, thus leaving his specimen with 1 extra secondary spur. Nieser (1975) also showed 3 small lateral spurs. Because we did not examine his specimens, the accuracy of the drawings is unknown. Additional features: 1 thin spur on opposing side of 1st gonapophysis (not shown in Fig. 4); ventral tooth-like projection absent; dorsal lobe small, about as wide but less than half the length of A₁; dorsal depression complete but not prominent; broad, arched emargination between dorsal lobe and depression; ventral ridge present along most of ventral edge; distinct separation between the apical row and primary row, except near ventral edge.

A distinctive character of *N. apopkana* is the broad gap between the apical and primary spur rows. A gap is found between these rows in other species of *Neoplea*, but it is most pronounced in *N. apopkana*. This species inhabits the eastern Gulf Coast region of the United States and has been recorded from Florida and Mississippi; it has also been found in Hawaii, possibly as an introduced species (Polhemus, 1996).

**Neoplea apopkana** (Drake & Chapman, 1953) (Fig. 4)

Apical row: 5 spurs; A₁ longest apical spur; A₁ and A₂ subequal, slightly shorter and thinner than A₃; distinct gap between A₁ and A₂; spurs progressively longer from A₁ to A₅; A₂ robust, subtriangular, shortest apical spur.

Primary row: 6 spurs; P₁, P₂, and P₃ subequal, longest primary spurs; P₁ and P₂, slightly shorter than P₃; primary row weakly arched apically. P₃ is almost on the apex and could be confused for an apical spur.

Secondary row: 4 spurs; S₁, S₂, and S₃ subequal in length, similar in size to P₁ and P₂; S₁, S₂, and S₃ in line with P₁, P₂, and P₃, respectively, form a straight line; S₄ in line with P₃, but offset from S₃, could be confused for a tertiary spur.

Tertiary row: 1 spur; slightly smaller than secondary spurs.

Lateral row and accessory spurs: 3 well-developed, short spurs; well-developed spurs followed by 3 short nub-like spurs; all spurs decrease in size from posterior to anterior end; spurs not in regular rows making it difficult to designate spurs as lateral or accessory.

**Neoplea argentina** (Drake & Chapman, 1953) (Fig. 5)

Apical row: 5 spurs; A₁ and A₂ subequal in length, longest apical spurs; A₁ and A₂ subequal in length, shortest apical spurs, A₁ more robust.

Primary row: 5 spurs; P₁, long, slender; P₂ and P₃ about 0.75' length of P₁; P₄ and P₅ subequal in length, shorter than P₁, P₂, conical.

Secondary row: 2 spurs; S₁, shorter, more robust than S₂, conical.

Tertiary row: 1 spur; T₁ subequal to S₁.

Additional features: dorsal lobe as broad but slightly shorter than A₁; ventral tooth short, between A₁ and P₃, apex rounded. Patch of setae near midline. Dorsal depression complete, beginning apically near P₁. Ventral ridge apparent.

**Neoplea argentina** has a unique combination of characters in having several small hairs along the midline and no lateral spurs. The dorsal lobe is relatively large, being almost as long as A₁. This species is known only from Argentina.
Neoplea borellii (Kirkaldy, 1899) (Fig. 6)

Apical row: 6 spurs; \( A_1 \) long, narrow, nearly straight; \( A_2, A_3, \) and \( A_4 \) subequal in length and shape; \( A_5 \) slightly more robust; \( A_6 \) and \( A_7 \) subequal in length; \( A_8 \) and \( A_9 \) contiguous.

Primary row: 4 spurs; spurs increase in size from \( P \) to \( P_2 \); \( P_3 \) and \( P_4 \) about equally robust, contiguous; distinct gap between \( P_5 \) and apical row.

Secondary row: 4 spurs; spurs increase in size from \( S_1 \) to \( S_2 \); \( S_3 \) and \( S_4 \) about equally robust; \( S_5 \) and \( S_6 \) about more so than \( S_7 \) and \( S_8 \).

Tertiary row: 4 spurs; \( T_3 \) longer, less robust than \( T_2 \); \( T_4 \) smaller than \( T_5 \) as robust as \( T_6 \); \( T_7 \) subequal to \( T_8 \).

Lateral row: 8 spurs; \( L_1 \) subequal to \( T_9 \), largest lateral spur; \( L_2 \) to \( L_8 \) subequal in size; \( L_9 \) to \( L_3 \) subequal in size, smaller than \( L_4 \) to \( L_7 \); \( L_8 \) and \( L_9 \) ventrally offset from lateral row.

Accessory spurs: 1 spur; \( U \) anterior to \( T_2 \), triangular, apex pointed.

Additional features: dorsal lobe short, less than 0.5 length of \( A_1 \), apex rounded; ventral tooth absent; primary, secondary, tertiary rows closely spaced; dorsal depression and ventral ridge observable but not prominent.

Rows of spurs of \( N. borellii \) are easily confused as they are closely packed and include full rows that go from the dorsal to ventral edge. These rows are relatively equally spaced except for a couple of pairs of contiguous or subcontiguous spurs. The dorsal lobe is small relative to those of most species of \( Neoplea \). Although not many samples have been examined, it is likely that there is substantial variation in the lateral spurs. The 1st gonapophysis of \( N. borellii \) is characterized as being generally covered with stout spurs. This species is currently known only from Argentina, but there are many other specimens that suggest it is either more widespread or part of a species complex. That determination is outside the scope of this study.

Neoplea gauchita Bachmann, 1968 (Fig. 7)

Apical row: 5 spurs; \( A_1 \) large, at least 2 size of \( A_2 \) curved dorsally; \( A_3 \) shorter, narrower than other apical spurs; \( A_4 \) and \( A_5 \) subequal in length, slightly shorter than \( A_1 \); \( A_6 \) more arched, broader laterally than \( A_1 \); \( A_7 \) slightly shorter than \( A_8 \), as broad laterally as \( A_9 \).

Primary row: 5 spurs; \( P_1 \) about 2 length of \( P_2 \), nearly straight; \( P_3 \), \( P_4 \), and \( P_5 \) subequal in length; \( P_6 \) and \( P_7 \) similar shape; \( P_8 \) shorter, as robust as \( P_9 \); primary row weakly arched towards apex.

Secondary row: 3 spurs; \( S_2 \) and \( S_3 \) subequal in size, triangular; \( S_4 \) slightly shorter, much narrower than \( S_5 \) or \( S_6 \).

Tertiary row: 2 spurs; \( T_3 \) small, triangular; \( T_4 \) more than 2 length of \( T_5 \); \( T_6 \) and \( T_7 \) widely spaced.

Additional features: dorsal lobe short, about 0.25 length of \( A_1 \), prominently observable, apex rounded; ventral tooth absent; spur on opposing face of 1st gonapophysis. The figure of the 1st gonapophysis of \( N. gauchita \) is taken from the figure provided by Bachman (1968), who commented only that the structure was armed with robust spurs. Thus, it is unclear as to the degree of accuracy of this drawing and description. In the apical and primary rows, the most ventral spur of \( N. gauchita \) appears to be much larger than other spurs, and these are found on a ventral edge that curves dramatically toward the base. This 1st gonapophysis has relatively large apical spurs but

Figs. 7–10. Outer lateral surface of the right 1st gonapophysis of species of Neoplea. Neoplea gauchita (7), re-drawn from Bachmann (1968); Neoplea harnedi (8); Neoplea lingula (9), re-drawn from Roback & Nieser (1974); Neoplea maculosura (10); op: spur on opposing face of 1st gonapophysis.
much smaller spurs in the remaining rows. *Neoplea gauchita* is known only from the type locality in Argentina and the original description.

**Neoplea globoides** Nieser, 1975

*Neoplea globoides* was described from a single male, and therefore there is no knowledge of the 1st gonapophysis. Nieser (1975) reported that the holotype would be deposited in the Zoological Museum at Utrecht, but this had not happened by 2013 (Yvonne van Nierop, personal communication). The species is known only from Suriname.

**Neoplea harnedi** (Drake, 1922) (Fig. 8)

Apical row: 5 spurs; A1 and A2 subequal in length, A3 more robust; A4 and A5 subequal in length, A6 more robust; A7 shorter, more robust than A6.

Primary row: 5 spurs; P1 longer, most robust primary spur; P2 and P3 subequal in length; P4 about 0.75’ length P3; P5 slightly shorter than P4, triangular; primary row weakly arched towards apex.

Secondary row: 4 spurs; S1 and S2 nearly straight, triangular; S3 and S4 subequal in length; distinct gap between S3 and S4; secondary row starts slightly below P4.

Tertiary row: 2 spurs; T1 and T2 subequal in size, in line with P1 and P2, respectively.

Lateral row: 4 spurs; L1 through L4 subequal, row nearly parallel to dorsal edge.

Additional features: dorsal lobe less than 0.5’ length A1, apex bluntly rounded; ventral tooth absent; dorsal depression present, prominent, incomplete, clearly observable anterior to tertiary row of spurs; dorsal edge broadly, shallowly emarginate between apical and primary rows; ventral ridge small, parallel to dorsal depression.

The apical spurs of *N. harnedi* are all relatively large and there is a distinct gap between the dorsal apical spurs and dorsal primary spurs. There is intraspecific variation in the vestiture and number of lateral spurs. Many specimens have a few long hairs on the 1st gonapophysis, especially along the ventral edge. The number of lateral spurs varies from 2 to 5. All other characters are stable for the species.

There has been discussion in the literature as to whether *N. harnedi* should be synonymized with *N. striola* (Ellis 1950, 1965; Drake & Chapman 1953). These arguments were based on characters that are mostly highly variable, and the conclusion of Drake & Chapman (1953) was that Ellis (1950) based his argument on observations of only 1 species instead of a comparison using both species. The 1st gonapophyses of *N. harnedi* and *N. striola* are very similar, although careful observation suggests that there are distinct and consistent differences between the species. Based on all current evidence, including the 1st gonapophyses, both species should be considered valid until a more thorough study that includes molecular data can be undertaken.

Because of the uncertainty of the status of *N. harnedi* and *N. striola*, the distribution is also unclear. *Neoplea harnedi* was reported from the United States (Florida, Louisiana, Mississippi, Oklahoma, and Texas [specimens for the present study were mostly from Texas]), Mexico, and Panama (Drake 1922; Blatchley 1926; Hungerford 1936; Ellis 1950, 1965; Drake & Chapman 1953; Wilson 1958; Schaefer & Drew 1964). It is most likely that the distribution of *N. harnedi* is restricted to the Gulf Coast region of the United States.
Neoplea mexicana (Drake & Chapman, 1953)

*Neoplea mexicana* was described from a type specimen whose sex was undetermined because the operculum was not clearly visible and the genitalia were not exposed. We examined the holotype and concluded it is not possible to observe the genitalia except by dissection. Because the species is known only from the holotype, we refrained from dissecting it. The species was described from Veracruz, Mexico.

**Neoplea notana** (Drake & Chapman, 1953) (Fig. 11)

Apical row: 6 spurs; A subequal, longest apical spurs; A and A subequal; A slightly shorter than A; A, shortest apical spur.

Primary row: 4 spurs; P, longest primary spur; P, and P, subequal in length; P, triangular, shortest primary spur; P, P, and P, widely spaced, oriented dorsoapically.

Secondary row: 2 spurs; S, about P size S; row begins in ventral half of 1st gonapophysis

Additional features: dorsal lobe absent, dorsoapical edge crenate; single specimen available for this study appears to have a ventral tooth anterior to S, with apex broadly rounded but this could be an empty spur socket, which would constitute S; 1st gonapophysis apex truncate; dorsal depression easily observed and large but only extending forward to about the level of the secondary spurs; ventral depression present. The 1st gonapophysis of *N. notana* is simple, with relatively fewer and smaller spurs than those of other species of *Neoplea*. The crenate dorsoapical edge distinguishes *N. notana* from other species of *Neoplea*. This species is known from the United States (Florida and Mississippi).

**Neoplea punctifer** (Barber, 1923) (Fig. 12)

Apical row: 6 spurs; A, and A subequal; A and A subequal, shorter than A; A, slightly shorter than A; A, shortest apical spur.

Primary row: 5 spurs; spurs increase in size from P, to P,; P, subequal to P,, most slender primary spur.

Secondary row: 3 spurs; S, S, and S, subequal; distinct gap between S, and S; secondary row in a vertical line that is nearly dorsal to P,, Tertiary row: 4 spurs; T, T, and T, subequal; T, about P, size of T; tertiary spurs in a nearly straight line except T, is slightly closer to the apex.

Lateral row: 2 spurs; L, and L, subequal; almost in line horizontally with T.

Additional features: dorsal lobe more than P, length of A, apex rounded; ventral tooth absent; setae moderately long, 2 patches along ventral edge; patch 1 small, in line with L; patch 2 larger, more dense, ending at base of ventral ridge; 2 weak ridges flanking T, nearly parallel to midline; dorsal depression present but not well defined; ventral ridge present.

The 1st gonapophysis of *N. punctifer* is heavily spurred, somewhat like that of *N. maculosa*. The dorsal lobe is distinctive for its relatively large size and shape, similar to, but more exaggerated than, the state found in *N. striola*. It has several stout setae like *N. maculosa*, but the setae are less dense in *N. punctifer*. The species is known only from Puerto Rico.
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**Neoplea semipicta** (Horváth, 1918)

*Neoplea semipicta* is described from a type specimen whose sex was undetermined. Syntypes of *N. semipicta* are now deposited in the US National Museum, as part of the J. T. Polhemus collection, and will soon be available for study. The species is known from Columbia and Paraguay.

**Neoplea striola** (Fieber, 1844) (Fig. 13)

Apical row: 6 spurs; A₁ and A₂ subequal; A₁ longest apical spur; A₄ and A₅ subequal.

Primary row: 6 spurs; spurs increase in length from P₁ to P₅ and P₆; almost equal in length, P₂; robust; P₃ slender, straight; distinct gap between bases of P₃ and P₆.

Secondary row: 5 spurs; S₁ about 0.5’’ length S₂, S₃, and S₄ subequal, all slightly longer than S₅; S₆ slender; distinct gap between S₅ and S₆; secondary row nearly straight vertically.

Tertiary row: 2 spurs; short, robust, triangular; T₁ shorter than T₂.

Additional features: dorsal lobe almost 0.5’’ length A₁; apex broadly rounded; dorsal tooth short, blunt, aligned vertically with P₆; dorsal depression broad; ventral ridge present but weak; patch of setae along ventral margin, setae moderately long.

*Neoplea striola* has a 1st gonapophysis similar to that of *N. harnedi* (see discussion of *N. harnedi*). The dorsal lobe is consistently larger in *N. striola*, but this is only discernible if a series of each species is observed together, and it is not easily quantified. A distinct dorsal tooth above the primary row was present in all specimens of *N. striola*, but we only saw 1 specimen of *N. harnedi* that had a weakly developed dorsal tooth. Spurs are generally more robust, especially in the primary and secondary rows, in *N. striola*, but there is some overlap in this characteristic. These 2 species are probably sister species, and there are only minor differences in the 1st gonapophysis that suggest they are distinct.

Variation is found in several 1st gonapophysis characters of *N. striola*. Some specimens have 1 fewer primary spur and/or 1 fewer secondary spur. One tertiary spur is missing in some specimens. Lateral spurs are found in some specimens, and the number is almost always either 0 or 4. Some spurs appear blunt; environmental factors may blunt spurs, so sharpness of spurs may not be a good taxonomic character.

The reported distribution of *N. striola* is almost certainly incorrect and confused with that of *N. harnedi*, because authors have sometimes viewed them as the same species and left no vouchers. Additionally, since the 1950s when *N. harnedi* was synonymized with *N. striola* (Ellis, 1950) and when it was suggested they remain synonymized (Wilson 1958; Ellis 1965), most New World pleids were all reported as *N. striola*, again with no vouchers to sort out correct identifications. The reported distribution from the literature includes the United States (California, Colorado, Florida, Illinois, Indiana, Iowa, Kansas, Maryland, Michigan, Mississippi, Nebraska, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Virginia, and West Virginia), Canada, Mexico, Guatemala, the Antilles, Cuba, St. Vincent, and Granada (Fieber 1844; Champion 1901; Torre-Bueno 1912, 1924; Drake 1922; Clark 1925; Bare 1926; Blatchley 1926; Rice 1942; Wilson 1958; Schaef er & Drew 1964; Gittleman 1974, 1975, 1977, 1978; Takahashi et al. 1979; McPherson 1986; Dufree et al. 1999).

**Neoplea tenuistyla** Roback & Nieser, 1974 (Fig. 14)

Apical row: 6 spurs; A₁ and A₂ subequal, slightly shorter than A₃; A₄ and A₅ subequal; A₆ longest apical spur; A₇, A₈, and A₉ nearly straight, triangular.

Primary row: 6 spurs; P₁ and P₂ subequal; P₃ and P₆ subequal; P₄ and P₅ can be subequal, similar in shape, less robust than P₆; P₂ row curves basally toward ventral edge starting at P₆.

Secondary row: 6 spurs; S₁, S₃, and S₄ subequal; S₅ and S₆ subequal; S₇, S₈, S₉, and S₁₀ triangular; S₁₁ slightly shorter than S₁₀; less robust; S₁₂ longest secondary spur, very slender; row curves basally toward ventral edge S₁₂ to S₆.

Tertiary row: 2 spurs; T₁ and T₂ subequal, triangular.

Lateral row: 5 spurs; L₁, L₂, L₃, and L₄ subequal; distinct gap between L₅ and L₆; lateral spurs in nearly straight line except L₅, ventral to L₆.

Accessory spurs: 8 spurs; 3 distinct groups separated by gaps: U₁, U₂, U₃, and U₄, U₅, U₆, and U₇, U₈, U₉, and U₁₀ subequal; U₁ about 2.5’’ length U₂, directly below U₁; U₃, U₄, and U₁₀ subequal; U₁, directly below U₄; U₁₀ subequal to U₁; all accessory spurs very slender.

Additional features: dorsal lobe almost 0.5’’ length of A₁, apex rounded; dorsal depression broad, extending from L₁ to P₆, with weak medial ridge.

A distinguishing characteristic of the 1st gonapophysis of *N. tenuistylo* is the presence of several narrow spurs along the ventral edge, which is not seen in other species. The apical spurs are much larger than all other spurs, which also occurs in *N. gauchita* and *N. lingual*; however, *N. tenuistylo* has substantially more spurs than these other species. *Neoplea tenuistylo* is known only from Colombia.

**KEY TO SPECIES OF NEOPLEA BASED ON 1ST GONAPOPHYSIS MORPHOLOGY**

Many species of *Neoplea* can be identified reliably using characters of the 1st gonapophysis. Although there is some intraspecific variability in these structures, 1st gonapophysis morphology is still a valuable taxonomic character and is adequate by itself for distinguishing most species. Given here is a key to the species of *Neoplea* based on 1st gonapophysis morphology. Note that *N. globoidea*, *N. mexicana*, and *N. semipicta* are not included, because the morphology of their 1st gonapophyses is not known.

**Provisional Key to Species of Neoplea**

1.— Apical lobe present and apical dorsal edge smooth (Fig. 8); dorsal depression limited to complete; ventral tooth present or absent, P₁, P₂, and P₃ not all widely spaced .......................................................... 2

1’.— Apical lobe absent and apical dorsal edge crenate (Fig. 11); dorsal depression limited, terminating at level of secondary row; ventral tooth present between A₁ and P₃, P₄ short, broadly rounded; P₅, P₆, and P₇ widely spaced .................................................. *N. notana*

2.— Lateral row of spurs absent (Fig. 3) .......................................................................................... 3

2’.— Lateral row of spurs present (Fig. 8) .................................................................................... 7
3.— Tertiary row with 2 spurs (Fig. 13) ........................................................................ 4
3'.— Tertiary row with 1 spur (Fig. 5) ......................................................................... 5
4.— Apical and primary rows with 5 spurs; dorsal lobe about 0.25’ length of A1 (Fig. 7); dorsal depression broad, without medial ridge and without marginal tooth; emargination between dorsal depression and dorsal lobe moderately deep, arcuate .. N. guachita

4'.— Apical and primary rows with 6 spurs; dorsal lobe about 0.5’ length of A1 (Fig. 13); dorsal depression with medial ridge, margined apically with short, rounded tooth; ventral ridge ending in apical half, margined with setae subequal to A1 in length; emargination between dorsal depression and dorsal lobe broad, truncate .................................. N. striola

5.— Primary row well defined and linear, no spurs offset from row (Fig. 3); dorsal lobe more than 0.25’ length of A1 .................................................. 6

5'.— Primary row not well defined as linear, at least 1 spur offset from row (Fig. 9); dorsal lobe less than 0.25’ length of A1; apical spurs about 1.5’ length of non-apical spurs ........................................................................ N. lingula

6.— Tertiary spur much smaller than secondary spurs; dorsal lobe narrow, about half the width of A1 (Fig. 3); ventral tooth below P1; glabrous ........................................................................................................ N. abscona

6'.— Tertiary spur the same size as secondary spurs; dorsal lobe about as wide as A1 (Fig. 5); ventral tooth between A1 and P1; with several short hairs medially and a series of longer hairs along the ventral edge .......................................................... N. argentina

7.— Without several relatively long slender accessory spurs along ventral edge (Fig. 14); all apical spurs longer than any other spurs .............................................. 8

8.— Dorsal lobe rounded at apex (Fig. 4); no tooth on dorsal edge; hairs on 1st gonapophysis variable but not consisting of a large number on the basal and ventral half .......................................................... 9

8'.— Dorsal lobe truncate at apex (Fig. 10); tooth on dorsal edge, above secondary row of spurs; dense patch of long hairs in basal and ventral half of 1st gonapophysis ................................ N. maculosa

9.— With 6 apical spurs (Fig. 6) ................................................................................. 10

9'.— With 5 apical spurs (Fig. 4) ................................................................................. 11

10.— Dorsal lobe at least 0.66’ length of A1 (Fig. 12); A1 clearly longer than A5 ........................................................................................................ N. punctifer

10'.— Dorsal lobe less than 0.5’ length of A1 (Fig. 6); A1 and A5 about equal in size ........................................................................................................ N. borellii

11.— Distinct gap between P1–P2 and apical spurs (Fig. 8); A1 offset behind apex .................................................. N. harnedi

11'.— Distinct gap between P1–P2 and apical spurs (Fig. 4); A1 on apex ........................................................................................................ N. apopkana

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