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Source: Journal of Orthoptera Research, 15(2) : 241-249

Published By: Orthopterists' Society

URL: https://doi.org/10.1665/1082-6467(2006)15[241:FIOHEG]2.0.CO;2

Further Investigations of Hispaniolan Eumastacoid Grasshoppers (Espagnolinae: Episactidae: Orthoptera)

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Abstract

The new species *Espagnolopsis exaltata* Perez-Gelabert & Rowell is described from the mountains north of Ocoa, Cordillera Central, Dominican Republic. Also described is the hitherto unknown adult male of *Antillacris explicatrix* Rehn & Rehn 1939, a relatively rare high mountain species. The variation exhibited by the most widely distributed episactid species in the island, *Espagnola darlingtoni*, is investigated through a comparative analysis of male and female genital features in several populations. Usually the female subgenital plate of eumastacoids shows a species-specific morphology. We find that most of the apparent variation between populations is confined to the female subgenital plate, while the males are much more homogeneous. We conclude that our sample represents a single, somewhat variable species. Additionally, the transfer of *Tainacris divergentis* Perez *et al.* 1997 to the new genus *Neibamastax* Rowell & Perez-Gelabert (see paper this issue) prompted the need to review the evidence for the distinctiveness of the two other species included in *Tainacris*. Differences are found in both the female subgenital plate and the male internal genitalia. The earlier conclusion that these populations represent different species is supported.

Key words

Espagnolopsis exaltata, *Antillacris explicatrix*, *Espagnola darlingtoni*, *Tainacris nitaina*, *Tainacris quisqueiana*, intraspecific variation, Hispaniola, Dominican Republic

Introduction

The Hispaniolan eumastacoids were first revealed to science through the collections of Philip J. Darlington Jr. in the Cordillera Central of the Dominican Republic in 1938. Based on the four specimens he collected, Rehn & Rehn (1939) erected the two new genera *Espagnola* and *Antillacris*. A single subadult female was available for the description of *Antillacris*. No other Hispaniolan eumastacoid material was seen until the group was rediscovered by Perez, Hierro, Dominici, and Otte (1997a, b). Extensive collections covering a large portion of the Dominican Republic's territory, revealed a greater diversity for this group in the island. Besides the two species previously known, three new genera and six new species with distinctive external genitalic morphologies and varying degrees of wing reduction were reported. Also a fossil member of this group, the new genus and species *Paleomastacris ambarinus* from the Dominican amber, was reported in 1997 and later revisited in Perez-Gelabert (2002).

Although Perez *et al.* (1997a, b) classified these taxa as members of the family Eumastacidae, subfamily Episactinae [following Amedegnato (1993)], here we adhere to the classification scheme proposed in our accompanying paper (Rowell & Perez-Gelabert, 2006, this issue), which provides evidence for the validity of the family Episactidae *sensu* Descamps (1973), as a distinctive group. This group is composed of the Central American genera *Episactus* Burr, *Gymnotettix* Bruner, *Lethus* Rehn & Rehn (=*Mayamastax* Uvarov), and the new genus *Paralethus* Rowell & Perez-Gelabert as subfamily Episactinae Burr; the Hispaniolan genera *Espagnola* Rehn & Rehn, *Antillacris* Rehn & Rehn, *Tainacris* Perez *et al.*, *Espagnoleta* Perez et al., *Espagnolopsis* Perez et al., and the new genus *Neibamastax* Rowell & Perez-Gelabert comprise the subfamily Espagnolinae Rehn.

The current availability of material allows us to examine several issues bearing on the taxonomic identity of several Hispaniolan episactid species. In this paper we first describe the new species *Espagnolopsis exaltata* Perez-Gelabert & Rowell, from the mountain area northeast of the town of San José de Ocoa, Dominican Republic. Second, we describe the hitherto unknown adult male of *Antillacris explicatrix* Rehn & Rehn 1939, with special attention to its genital features. Third, we examine the variation among different populations of *Espagnola darlingtoni* (apparently the most widely distributed species of episactid in the island) through the analysis of the male and female genitalia. Fourth, after removal of one of its species to the new genus *Neibamastax* Rowell & Perez-Gelabert (2006, this issue) we review the evidence for the distinctiveness of the two other species included in *Tainacris*.

Material and methods

We used standard procedures for the preparation and study of the male and female genitalia of each species. Particularities of our techniques are described in detail in our accompanying paper (see Rowell & Perez-Gelabert, 2006, this issue). Identification numbers included with some of the specimens correspond to numbers in the Rowell collection.

The material examined is deposited in the following institutions:

ANSP Academy of Natural Sciences, Philadelphia, PA
NMNH U. S. National Museum of Natural History, Washington, DC
MHND Museo Nacional de Historia Natural, Santo Domingo, Dominican Republic

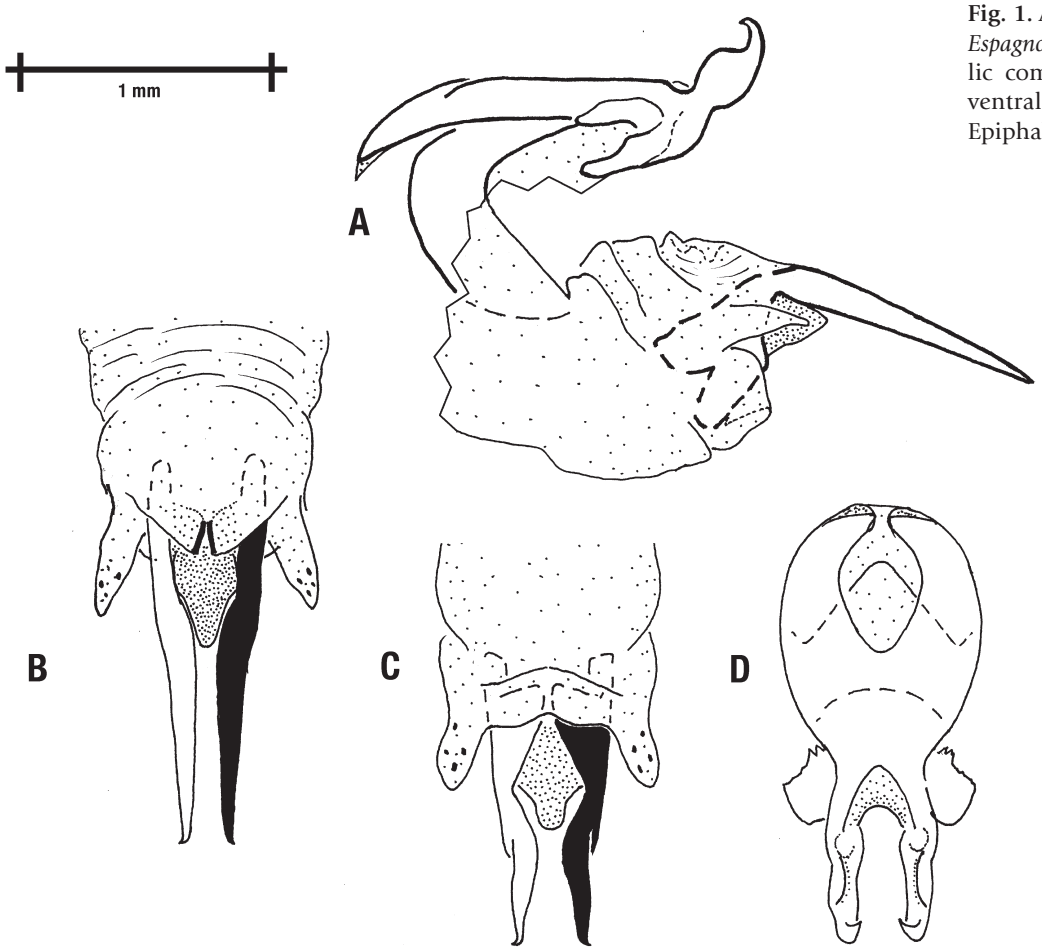

Fig. 1. A-D. Male internal genitalia of *Espagnolopsis exaltata* n. sp. A. Phallic complex, lateral; B. Ectophallus ventral; C. Ectophallus dorsal; D. Epiphallus, dorsal.

Taxonomy

1. A new species of *Espagnolopsis* Perez *et al.* 1997.

Diagnosis.— The genus *Espagnolopsis* is differentiated from its Hispaniolan relatives by having fully developed (although apparently nonfunctional) wings, which are shorter and narrower apically than in *Espagnola*, in which the wings are functional. Males differ from other genera most obviously in having two curved spiny ornaments dorsally on the last two abdominal tergites. The female subgenital plate has rounded lateral lobes with at most two teeth (five or more teeth in *Espagnola*).

Espagnolopsis exaltata Perez-Gelabert & Rowell, n. sp.
Figs 1A-D, 2A-B

Holotype.— Male. DOMINICAN REPUBLIC, RD-086 Hilltop on way to Palos Grandes, NE S. José de Ocoa, 1437 m, Ocoa Prov., lat 18°37.871'N, long 70°30.777'W, 8.xii.2002, D. Perez, R. Bastardo. Deposited at the ANSP. Rowell #2008185. [dissected]. *Paratypes*. Two males and two females, same data as holotype. Deposited at ANSP and NMNH.

Diagnosis.— Fully developed wings never surpassing abdominal end in both sexes of the five available individuals [most often surpassing in *E. breviptera* (next smallest wings) and *E. ornatipennis*]. Female subgenital plate with lateral lobes rounded, with rather smooth margins (one female lacks tooth ornamentations, while the other has two teeth positioned more anteriorly than in other species, which always have one or two finger-like teeth).

Description.— Small to medium sized grasshoppers (male ~11 mm). Fully winged in both sexes. Antennae shorter than the dorsoventral head length, made up of 12 cylindrical segments, the last two more markedly deplanate. Eyes large and oval-shaped, separated about the width of one eye by a protruding fastigium of vertex. Face in males generally colored a much lighter shade of brown than the rest of the head. Head bean-shaped, markedly shorter anteroposteriorly than dorsoventrally, its dorsal surface divided by a medial line. Pronotum only slightly longer than dorsal head length, its anterior margin nearly straight, while its posterior margin is only slightly elongated backwards. Dorsum of pronotum marked by weak medial carina and cut on its sides by only one sulcus. Pronotum markedly flattened laterally. Wings fully developed although apparently non-functional, extending to near tip of abdominal end but never surpassing it, broadening only slightly apically. Surface of wings with marked venation. Abdominal tergites cylindrical dorsally with a raised medial carina.

Males. Abdominal tergites nine and 10 bearing dorsally an ornamentation consisting of two pairs of thick spines, the most anterior pair roundly curving, with tips pointing straight up, the second pair with tips pointing backwards. Legs generally slender and cylindrical. Hind femora extending beyond end of abdomen; hind knees with only the dorsomedial spine somewhat developed. External genitalia (Fig. 2A,B) with cerci sharply pointed and curving forwards over a

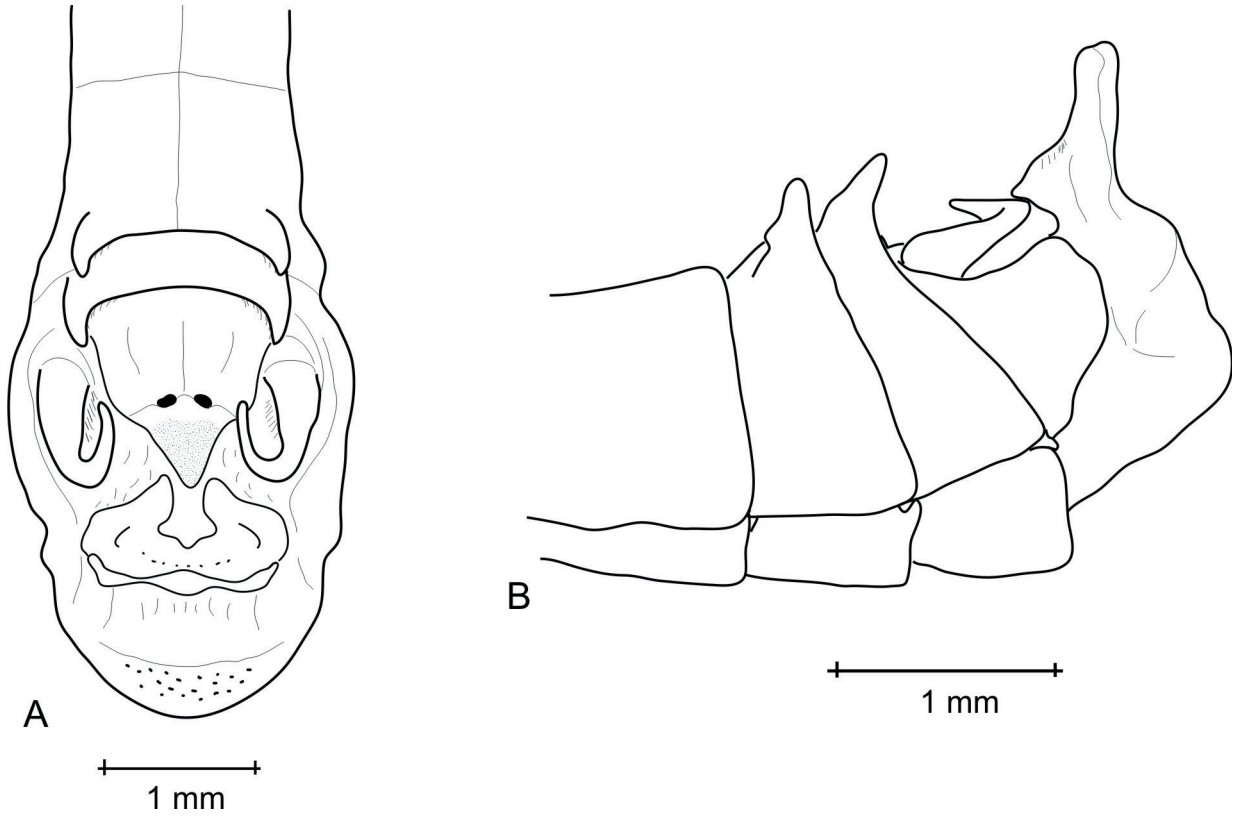

Fig. 2A-B. Male terminalia of *Espagnolopsis exaltata* n. sp. A. Dorsal view; B. Lateral view.

triangular supra-anal plate. Subgenital plate rounded, its posterior end dorsally elevated like a shield over the genital area.

Male internal genitalia (Figs 1A-D). The generic phallic characters are summarized in our accompanying article (Rowell & Perez-Gelabert 2006). *E. exaltata* is distinguished from its congenerics by the form of the processes of the apical shield, which are straight and pointed, blade-like in lateral view, and in dorsal view outwardly inflected at their extreme tips. Compare Fig. 1 with Figs 22, 23 of Rowell & Perez-Gelabert).

Female. Body length ~13 mm. Wings developed to same degree as in male. Female subgenital plate with lateral lobes rounded with rather smooth margins (one female completely lacks tooth ornamentations, while the other has two teeth positioned more anteriorly than in other species). Medial process thick, tapering smoothly to a thick point. Fig. 3 shows the subgenital plate of the female *E. exaltata* (3C) as compared with those of its congeneric species.

Etymology.— Meaning glorified and praised, because this new species had been much exalted after its finding, at least within our minds.

Habitat.— As do the other species of *Espagnolopsis*, *E. exaltata* inhabits the ground of wet and shaded areas of mountains of the Cordillera Central in the Dominican Republic. At Palos Grandes there was much open space covered by grasses and small shrubs. A large portion of the landscape had obviously been cleared for farming and ranching. So far this genus has only been collected in the provinces of La Vega, Ocoa and San Cristóbal, at elevations between 1000 and 2000 meters.

2. The unknown male sex of *Antillacris explicatrix*.

The original description of *A. explicatrix* by Rehn & Rehn (1939) was based on a juvenile female collected at an elevation of "5000-8000 feet" (roughly 1600-2600 m) at Loma Rucilla, Dominican Republic. Perez *et al.* (1997) reported four additional females and four very young males from the trail to Pico Duarte near Valle del Cruce and La Laguna (1980 to 2180m elevation), an area in the general vicinity of the type locality and with the same ecological characteristics: mountain pine forest with a lower stratum of dicotyledoneous herbaceous plants and ferns, and also in many areas predominantly covered by the tall grasses *Danthonia* and *Agrostis* (Poaceae). Several more adult females were later collected at La Nevera and Pinar Parejo, Valle Nuevo (about 2000 m elevation) in July 1998, but again the sample included no males. Adult males were finally collected in 2002 and 2003 at several points within the Reserva Cientifica Ebano Verde (about 30 km to the east of the type locality), which in general includes elevations lower than 2000 m and a much more diverse forest. The following description is based on the five adult males available at this time.

Antillacris explicatrix Rehn & Rehn, 1939
Rehn & Rehn, 1939: 202. Plate 8, Figs 19, 20. Perez *et. al*. 1997: 143. Fig. 19m. Perez-Gelabert, 1999: 53, 54.

Description of adult males.— Medium size grasshoppers (16 to 18 mm). Body color dark brown, apparently a cryptic coloration in their leaf-littered forest-floor habitat. Some individuals of both sexes can have small and varying patches of green color, mainly at the sides of pronotum, most of this color fading and disappearing after death. Head relatively small, widest across the eyes. Interocular space

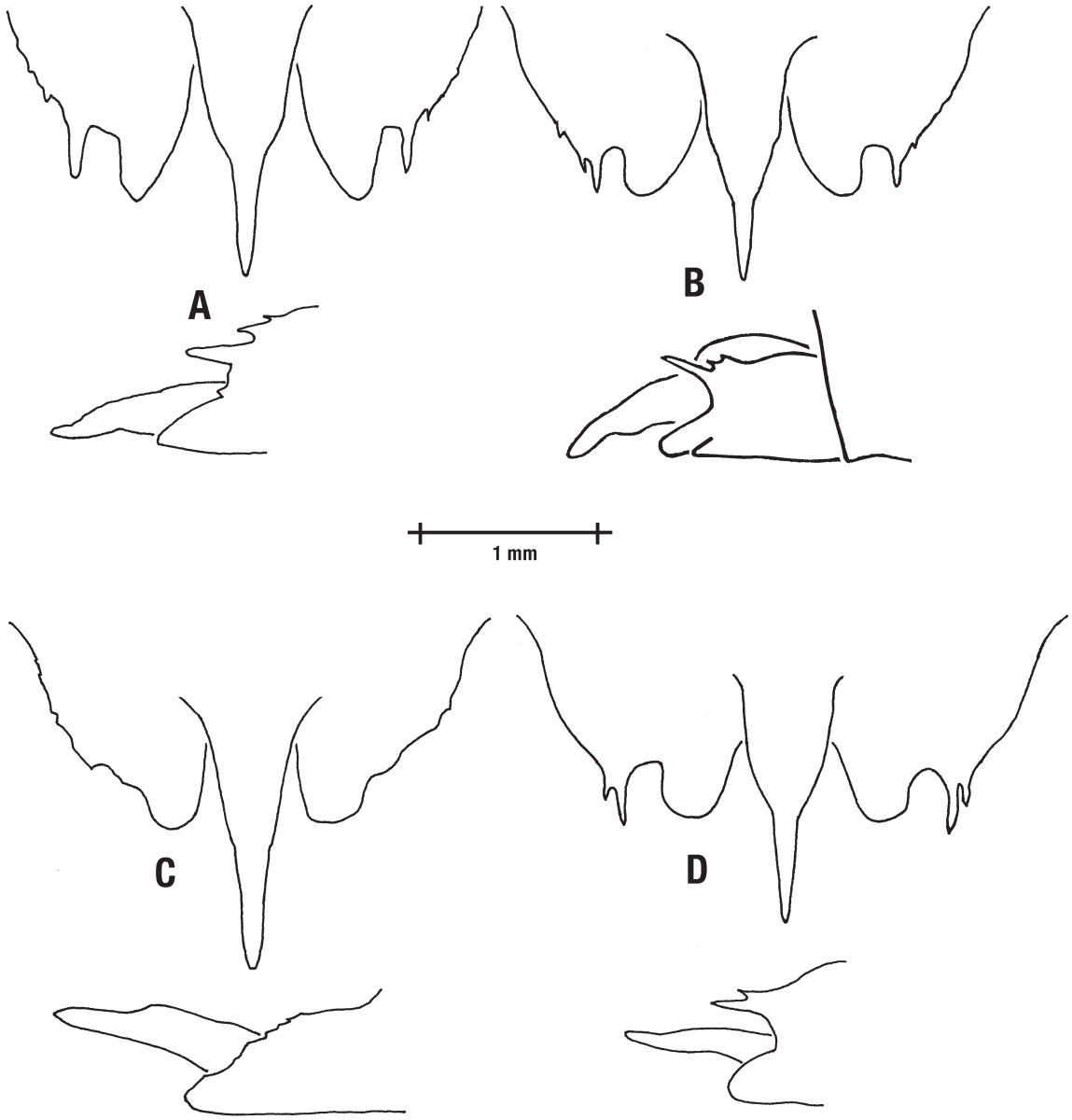

Fig. 3. A-D. Ventral and side views of the subgenital plates in females of the three *Espagnolopsis* species. A. *E. breviptera* from Los Tablones; B. *E. breviptera* from La Sal; C. *E. exaltata* n. sp. from Palos Grandes; D. *E. ornatipennis* from La Colonia.

approximately as wide as the width of one eye. Antennae slightly longer than head length, with 12 to 13 segments, of which 2 to 3 are not well defined, and 7 to 12 are more elongated and become wider and depressed distally; apical antennal segment smaller, tapering into a blunt point, apparently bearing a sensory organ. Fastigium of vertex protruding beyond eyes, with rounded margin divided medially by a small concavity. Surface of vertex very irregular, medially dissected by weakly defined carina and punctuated by lighter colored rugosities. Posterior margin of head emarginated, and with medial concavity.

Pronotum saddle-shaped with very irregular surface, dorsally delimited by strong lateral secondary carinae that run diagonally downwards cephalad, their anterior ends marking the widest point of the anterior margin. Pronotum traversed by medial carina, well-defined only at the central region of the pronotum. Lateral lobes of pronotum smoother, flaring to a width slightly larger than the anterior margin.

Legs rather slender, total length of a hind leg (femur + tibia) larger than body length. Surface of legs mostly smooth, anterior and middle femora bearing a small spine at the distal end of each dorsal carina. Hind femora elongated beyond abdominal end, distally armed with five strong spines, the dorso-medial one being largest, the dorsolateral pair next largest and the dorsoventral pair the smallest. Hind tibiae approximately as long as femora, armed with 14 internal and 16 to 17 external spines, of which the internal ones are distinctly larger. Tarsi elongated, together with claws nearly one third as long as hind tibiae.

Mesonotum and metanotum excavated dorsally at the sides of a strong medial carina that continues more weakly on the abdominal segments. Thoracic epimera large and well-differentiated, flaring on

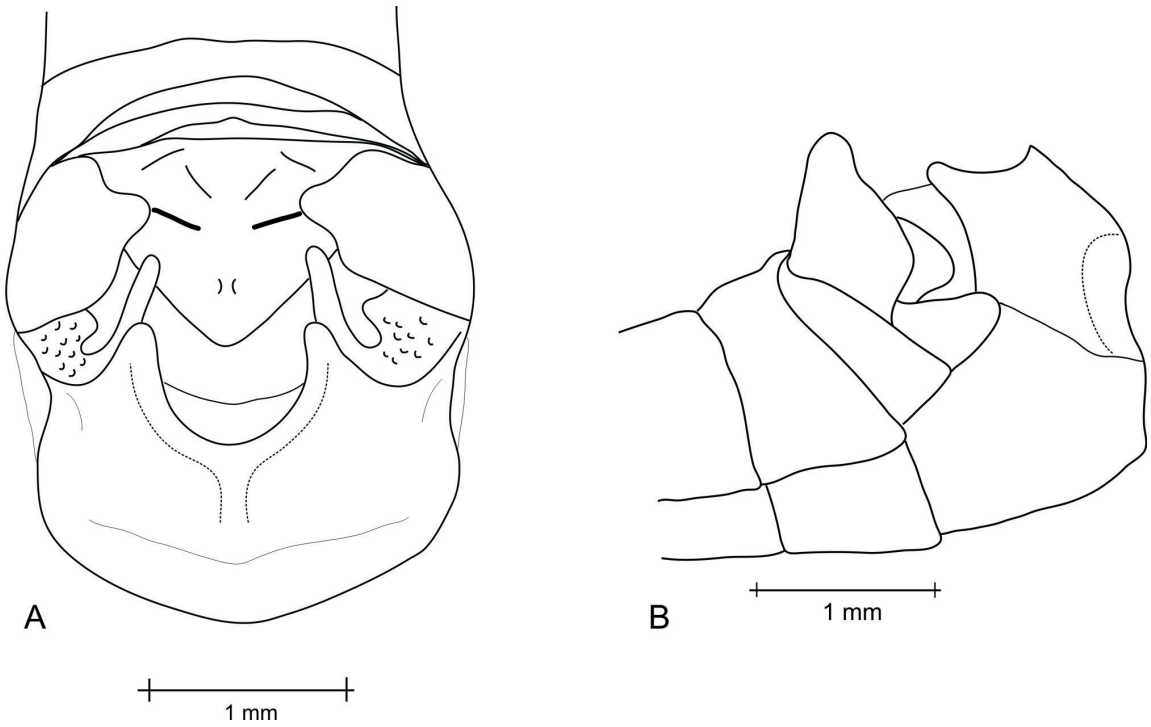

Fig. 4. A, B. Male terminalia of an adult male *Antillacris explicatrix* Rehn & Rehn. A. Dorsal view; B. Lateral view.

their distal portions to produce a width nearly double that of the abdomen. Abdomen shorter than in female, with segments markedly cylindrical. Anterior margin of 10th tergum slightly elevated over the level of subtriangular supra-anal plate. Cerci very robust, thickened at their base into a globose triangle, bluntly pointed and somewhat turned inwards at its anterior extremity; the shorter, but also thickened, posterior portion of the cercus armed with a strong, and smooth spine that curves sharply inward over the supra-anal plate (Fig. 4A-B). Subgenital plate globose, posteriorly rugose with a medial carina, its top portion smoother, curving over the genital area, with its upper corners blunt pointed.

Phallic complex (Fig. 5A-G). The general genital features of *Antillacris* are examined in more detail in our accompanying paper (Rowell & Perez-Gelabert, this issue). The main characteristics are the hypertrophy and sclerotization of the lateral lobes, the very reduced, almost obsolete, processes of the apical shields, and the dorsoventrally compressed and highly modified subepiphallic sclerite. *A. explicatrix* possesses a rounded phallus in which lateral lobes are very large and completely surround the genital area. The epiphallus is a somewhat flattened disk with hooked lophi vertically disposed, their separation being somewhat intermediate between that of *Antillacris inflaticercus* (Perez *et al.* 1997, Fig. 16d) and *Antillacris eumenes* (Perez *et al.* 1997, Fig. 17c). Unusually, the lophi lack sensory plaques at their base. The processes of the apical shield are short and blunt.

Adult male specimens examined.— Three males, DOMINICAN REPUBLIC, RD-023 31.i.02, Loma Casabito, Reserva Científica Ebano Verde, La Vega Prov., 1390 m, 340-522mE 2106-146mN, R. Bastardo, B. Hierro, D. Perez [ANSP]. 1 male, DOMINICAN REPUBLIC, RD-042, Arroyazo, Reserva Científica Ebano Verde, La Vega Prov., lat 19°01.945'N, long 70°32.593'W, 9-10.vii.2002, 3,500 ft., D. Perez, B. Hierro, R. Bastardo [NMNH]. 1 adult male, DOMINICAN REPUBLIC, RD-149, Loma La Golondrina, Reserva Científica Ebano Verde, La Vega Prov., lat 19°03.498'N, long 70°32.670'W, 11.vii.2003, D. Perez, R. Bastardo, B. Hierro (day/night) [NMNH].

3. Variation among populations of *Espagnola darlingtoni* Rehn & Rehn, 1939.

E. darlingtoni was originally described from a male specimen taken at Jarabacoa in the Dominican Cordillera Central and two male paratypes from Monte Diego de Ocampo (Rehn & Rehn, 1939), a peak located some 40 km to the north (and separated by the Valley of Cibao) in the Cordillera Septentrional. Some variation among individuals was noted by these authors, although only in body characters that usually are not very important in species separation, such as small details of the antennae, lateral pronotal carinae, and wing veins.

However, the physical separation between the localities and the observation that other episactid species in the island have a rather restricted range, led us to consider the possibility of there being more than a single species in this genus. Over the years we have gathered over 200 specimens with the general characteristics of *E. darlingtoni*, from over 30 different localities distributed over medium elevations (200 to 1000 m) of the Cordillera Central, Cordillera Septentrional and the Cordillera Oriental. Showing the relatively wide distribution of this species in the northern half of the Dominican Republic, the following provinces are represented in the material studied: Monseñor Nouel, La Vega, Sánchez Ramírez, Duarte, María Trinidad Sánchez, Santiago, Puerto Plata, El Seibo, and Elías Piña. We considered the possibility that the observed morphological variation represented the existence of more than one species. This morphological variation was assessed through the analysis of the external and internal genitalic features of nine males from eight different populations and four females, each from a different population of *E. darlingtoni*.

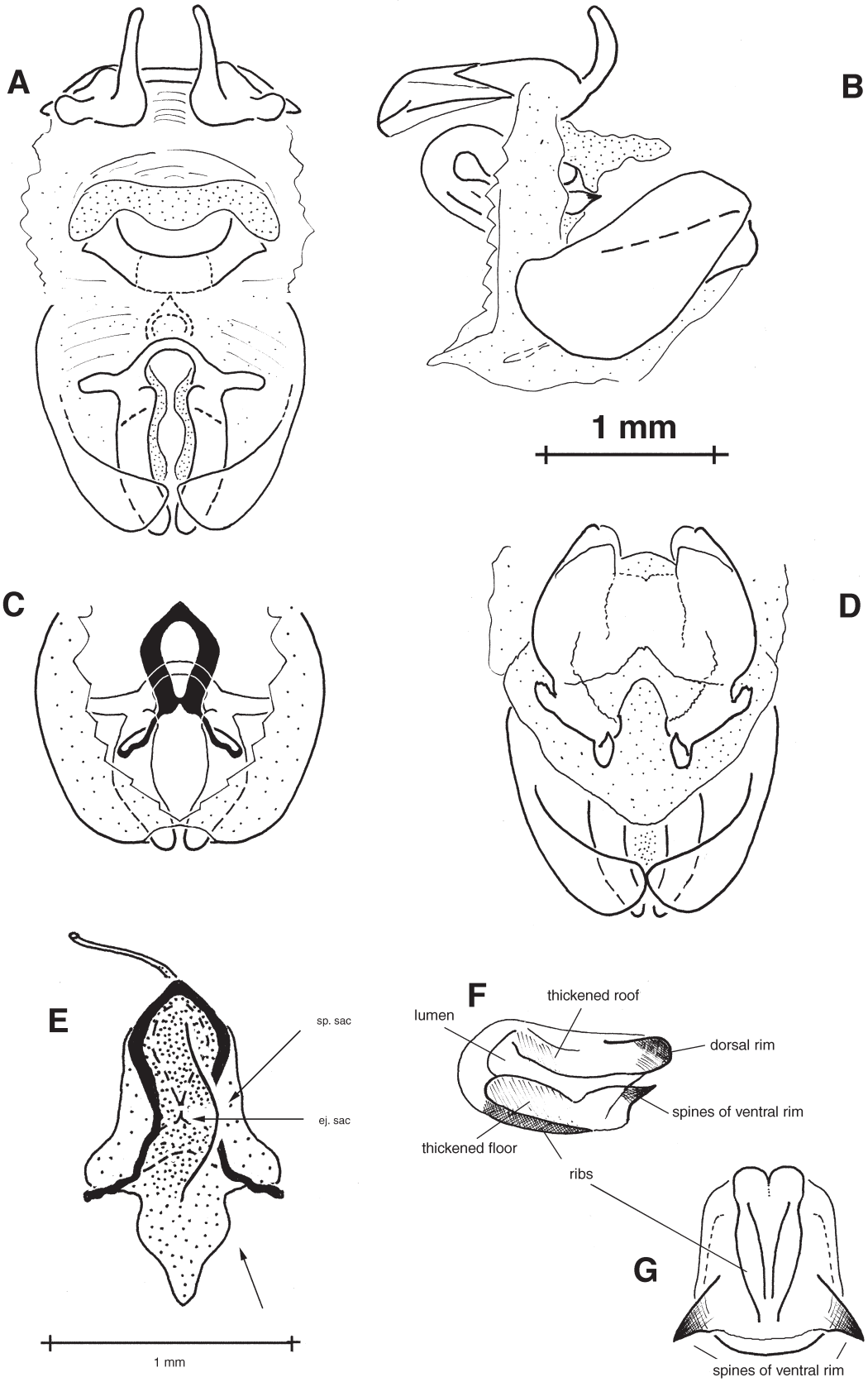

Fig. 5A-G. Male internal genitalia of *Antillacris explicatrix* Rehn & Rehn. A. Complete phallic complex, dorsal; B. Phallic complex lateral; C. Endophallus; D. Epiphallus, dorsal; E. Endophallus and associated sac, ventral view; F. Subepiphallic sclerite, lateral view; G. Subepiphallic sclerite, ventral view.

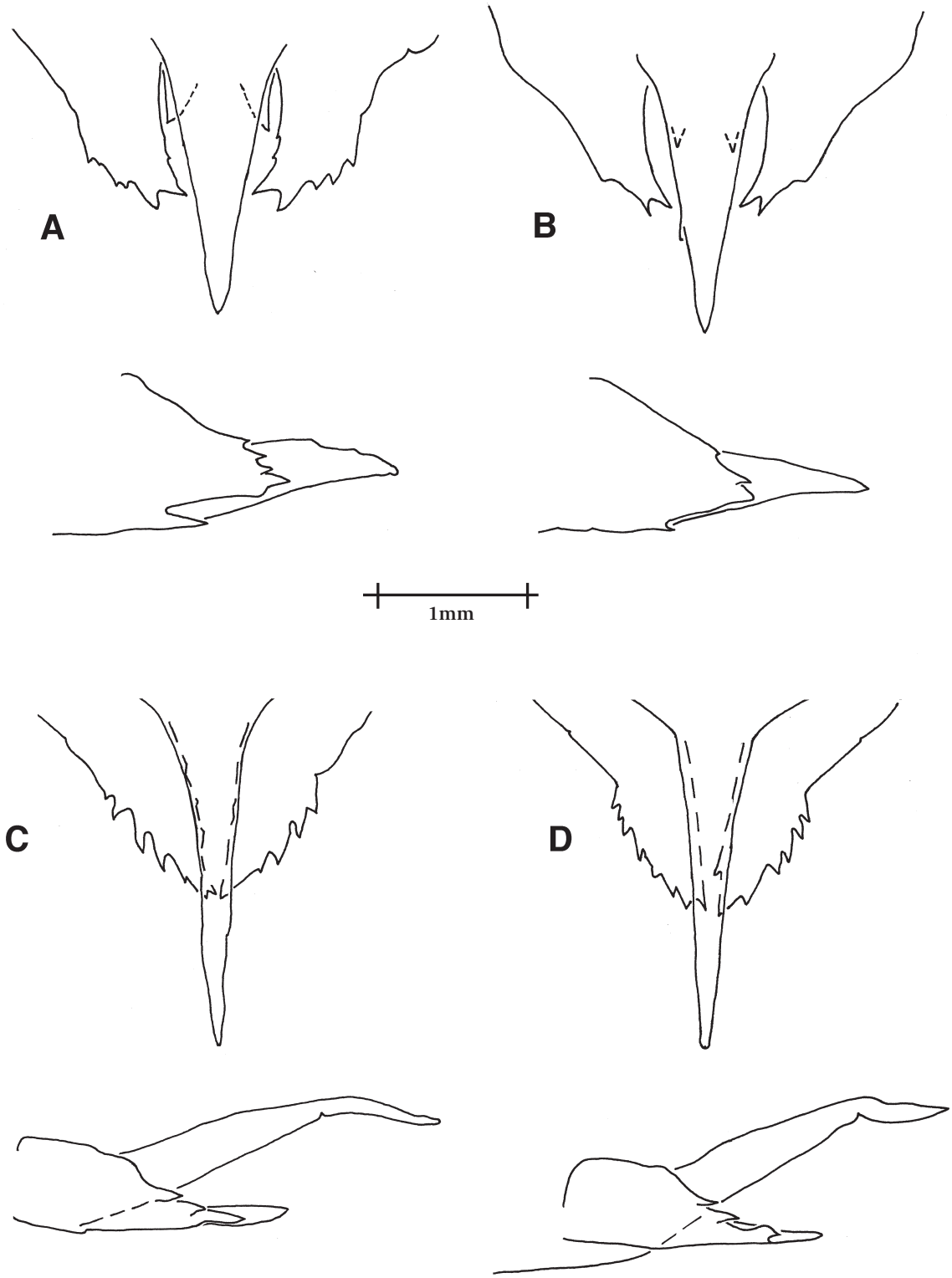

Fig. 6A-D. Ventral and side views of the subgenital plates in *Espagnola darlingtoni* females from several populations. A. Loma Guaconejo; B. Loma La Herradura; C. Arroyo Toro; D. Jarabacoa.

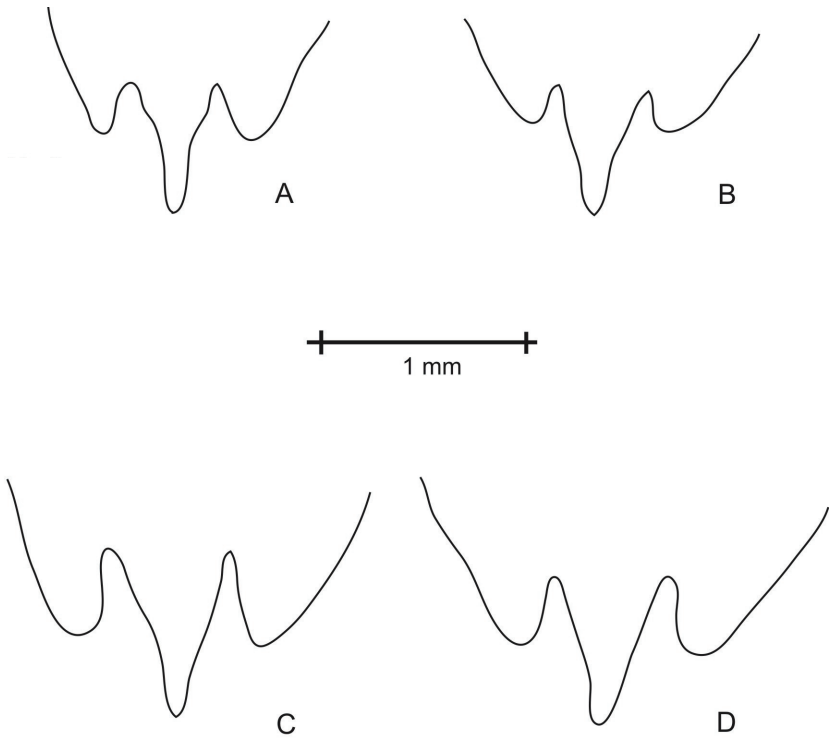

Fig. 7A-D. Ventral views of the female subgenital plates in *Tainacris* species from the type localities. A, B. *T. nitaina* from Las Yayitas and C, D. *T. quisqueiana* from Rd to Los Martinez.

Specimens dissected.— **Males:** Male 2003175, DOMINICAN REPUBLIC, RD-077, Escuela Nacional Forestal, Jarabacoa, La Vega Prov., lat 19°11.099'N, long 70°34.889'W, 29.xi.2002, D. Perez, B. Hierro. (night). Male 2003168, DOMINICAN REPUBLIC, Loma La Herradura, El Seibo Prov., 500-700 m, 23.ii.1991, G. Dominici. Male 2003172, DOMINICAN REPUBLIC, Parque Nac. A. Bermúdez, Mata Grande, 910, night, bosque ribereño, 21.iv.1999, R. Bastardo. Male 2003177, DOMINICAN REPUBLIC, RD-051, Alto del Rancho, Loma Guaconejo, M. T. Sánchez Prov., 170 m, 24-25.vii.2002, lat 19°18.752'N, long 69°56.663'W, D. Perez, B. Hierro, R. Bastardo. Male 20031165, DOMINICAN REPUBLIC, Arroyo Blanco, Loma La Canela, Res. L. Quita Espuela, Duarte Prov., 24.ix.1995, S. Navarro. Male 2003170, DOMINICAN REPUBLIC, RD-044, La Sal, Reserva Científica Ebano Verde, la Vega Prov., 11-12.vii.2002, lat 19°04.101'N, long 70°34.089'W, 1043 m, D. Perez, B. Hierro, R. Bastardo. Male 2003166. DOMINICAN REPUBLIC, RD-128, Around caseta La Sierrecita, PNAB, Santiago Prov., 752 m, lat 19°14.889'N, long 71°04.735'W, 9.iv.2003, D. Perez, R. Bastardo, B. Hierro. Male 2003170, DOMINICAN REPUBLIC, RD-044, La Sal, Reserva Científica Ebano Verde, la Vega Prov., 11-12.vii.2002, lat 19°04.101'N, long 70°34.089'W, 1043 m, D. Perez, B. Hierro, R. Bastardo. Male 2003173, DOMINICAN REPUBLIC, RD-126, Caseta parques, Diferencia, PNAB, Santiago Prov., 740 m, lat 19°16.313'N, long 71°03.132'W, 8.iv.2003, D. Perez, R. Bastardo, B. Hierro.

Females: Female 2003169, DOMINICAN REPUBLIC, Loma La Herradura, El Seibo Prov., 500-700 m, 23.ii.1991, G. Dominici. Female 2003176, DOMINICAN REPUBLIC, Arroyo Toro, Bonao, Monseñor Nouel Prov., 24.iii.1990, G. Dominici, B. Hierro. Female 2003174, DOMINICAN REPUBLIC, RD-051, Alto del Rancho, Loma Guaconejo, M. T. Sánchez Prov., 170 m, 24-25.vii.2002, lat 19°18.752'N, long 69°56.663'W, D. Perez, B. Hierro, R. Bastardo. Female 2003167, DOMINICAN REPUBLIC, RD-077, Escuela Nacional Forestal, Jarabacoa, La Vega Prov., lat 19°11.099'N, long 70°34.889'W, 29.xi.2002, D. Perez, B. Hierro. (night).

Results.— The dissected males did not reveal detectable differences. In contrast, females were found to be much more variable in morphological details of their subgenital plate. The morphology of the female subgenital plate in eumastacoid grasshoppers is most commonly species specific. Two groups, one from the northern areas, the other from more southern areas (Fig. 6) could be recognized. In the northern populations the median process is thicker and the lateral lobes show less serration than females in southern populations, which have a longer and more slender median process, as well as markedly more serration on the lateral lobes. Based on the overall available evidence, we conclude that *E. darlingtoni* should be considered a single species which displays a relatively large amount of phenotypic plasticity, especially in the female sex and specifically in the subgenital plate.

4. The distinctiveness of *Tainacris nitaina* and *Tainacris quisqueiana*.

Both of these species have a similar aspect and their biology should also be about the same, as both inhabit the ground of rather dry environments with subxerophytic shrubs and grasses between 200 and 800 m in elevation. The type populations are separated by a straight-line distance of only about 25 km, however these localities are found on different southern branches of the Cordillera Central.

Two males and two females from each of the type localities (Las Yayitas, for *T. nitaina*) and (Rd. to Los Martinez, for *T. quisqueiana*) were dissected and examined in comparative fashion. These individuals are different from those examined earlier either in Perez et al. (1997) or in our accompanying paper (Rowell & Perez-Gelabert, this issue).

Specimens dissected.—Males (*T. nitaina*): DOMINICAN REPUBLIC, Las Yayitas, Azua Prov., 21-22.v.1993, Daniel E. Perez leg. DOMINICAN REPUBLIC, Las Yayitas, Azua Prov., 7.xii.1994, D. E. Perez, G. Dominici. Males (*T. quisqueiana*): DOMINICAN REPUBLIC, Peravia Prov., Km. 2 Rd. to Los Martinez, Ocoa Prov., 29.ix, 1996, D. E. Perez. Females (*T. nitaina*): DOMINICAN REPUBLIC, Las Yayitas, Azua Prov., 7.xii.1994, D. E. Perez, G. Dominici. DOMINICAN REPUBLIC, Las Yayitas, Azua Prov., 21-22.v.1993, Daniel E. Perez leg. Females (*T. quisqueiana*): DOMINICAN REPUBLIC, RD-070 ~3km Rd to Los Martinez, S. J. de Ocoa Prov., 654 m, lat 18°27.686'N, long 70°27.858'W, 24.xi.2002, D. Perez, B. Hierro, H. Andújar. All deposited at the ANSP.

Results.— Our analysis supports the earlier conclusion in Perez *et al*. (1997) that these populations indeed represent different, though very similar, species. The features noted here are consistent in all the specimens examined, both here and in previous studies. Most obviously, females can be differentiated by their external genitalia (Fig. 7A-D). The subgenital plate of *T. nitaina* (Las Yayitas population) is smaller and less robust, with lateral lobes that flank a smaller median process, from which they are separated by a shallower incision; the tips of the lobes do not extend beyond half the length of the median process. In *T. quisqueiana* (Rd to Los Martinez population), females have a subgenital plate that is overall larger and more robust, with lateral lobes that flank a thicker median process, from which they are separated by deeper incisions; the lobes extend to more than half the length of the process.

The male genitalia also present several consistent distinctions. These are illustrated in detail in our accompanying paper (Rowell & Perez-Gelabert, 2006). Opposite to what is seen in the females, the phallic complex of *T. nitaina* is larger and more robust than that of *T. quisqueiana*. The epiphalli of both species are of a similar size and general appearance, but in *T. nitaina* the epiphallus is rounder, with heavily sclerotized vertical lophi that are more widely separated and with an anterior opening that is smaller in *T. quisqueiana* (the general shape is more elongated, with lophi less widely separated and a larger anterior opening in *T. quisqueiana*). Additionally, in the ectophallus the processes of the apical shields in both species are heavily sclerotized, curved and pointed, but those of *T. nitaina* have tips directed outwards, while those of *T. quisqueiana* are straighter.

Additionally, one pair was available from just outside the western end of the town of Baní [male and female: DOMINICAN REPUBLIC, RD-208 Southern slope Cerro Gordo, Baní, Peravia Prov., lat 18°16.337'N, long 70°21.091'W, 3.iv.2004, D. Perez, B. Hierro]. This location is found at <100 m elevation and is the farthest east the genus has been collected. The female specimen was examined externally while the male was dissected. Both specimens resemble their closer geographical neighbors from the Rd to Los Martinez and Matadero and belong to *T. quisqueiana*.

Acknowledgments

We are very thankful to Ruth Bastardo (Universidad Autónoma de Santo Domingo and Fundación Moscoso Puello, Inc.) and Brígido Hierro (Secretaría de Medio Ambiente y Biodiversidad, Santo Domingo) for their excellent support of our field-work efforts in the Dominican Republic. Denia Veloz, Sardis Medrano, Litay Ramos and Juana Peña (Museo Nacional de Historia Natural, Santo Domingo) pinned most of the specimens taken during 2001 - 2004. Accommodations and graceful personal attention in Santo Domingo have been provided for over 15 years by DEPG's relatives, Doris and Raul Fermín. We also thank Matilde Mota and Ramón Ovidio Sánchez in the Dirección Nacional de Parques and Bienvenido Santana, Gloria Santana, and José Ramón Albaine in the Departamento de Vida Silvestre, Secretaría de Medio Ambiente y Biodiversidad, Santo Domingo for collecting and export permits. Ramón Elías Castillo of Fundación Progressio, Inc., provided permits to collect at the Reserva Científica Ebano Verde. Primary support for the insect survey in the Dominican Republic was from the National Science Foundation, grant DEB-0103042 to Daniel Otte (ANSP) and Daniel Perez-Gelabert (NMNH).

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