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THREE NEW CRYPTIC SPECIES WITHIN THE *DARGIDA PROCINCTUS* (GROTE) COMPLEX (LEPIDOPTERA: NOCTUIDAE: HADENINAE) FROM THE NEOTROPICS

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Abstract.—Based on morphological analysis, the species *Dargida procinctus* (Grote), currently considered to be widespread from Canada to Bolivia, is found to include three previously unrecognized species: ***Dargida spinicassida*, n. sp.**, from northern Mexico; ***Dargida juxta*, n. sp.**, from southern Mexico and Costa Rica; and ***Dargida lilium*, n. sp.**, from Bolivia. Adults and male and female genitalia of all four species are illustrated. *Dargida grammivora* Walker and *Dargida meridionalis* (Hampson) are closely related species that could be confused with those of the *Dargida procinctus* complex. Adults and male and female genitalia of these are illustrated for comparison. A key is provided for differentiation of these six closely related species.

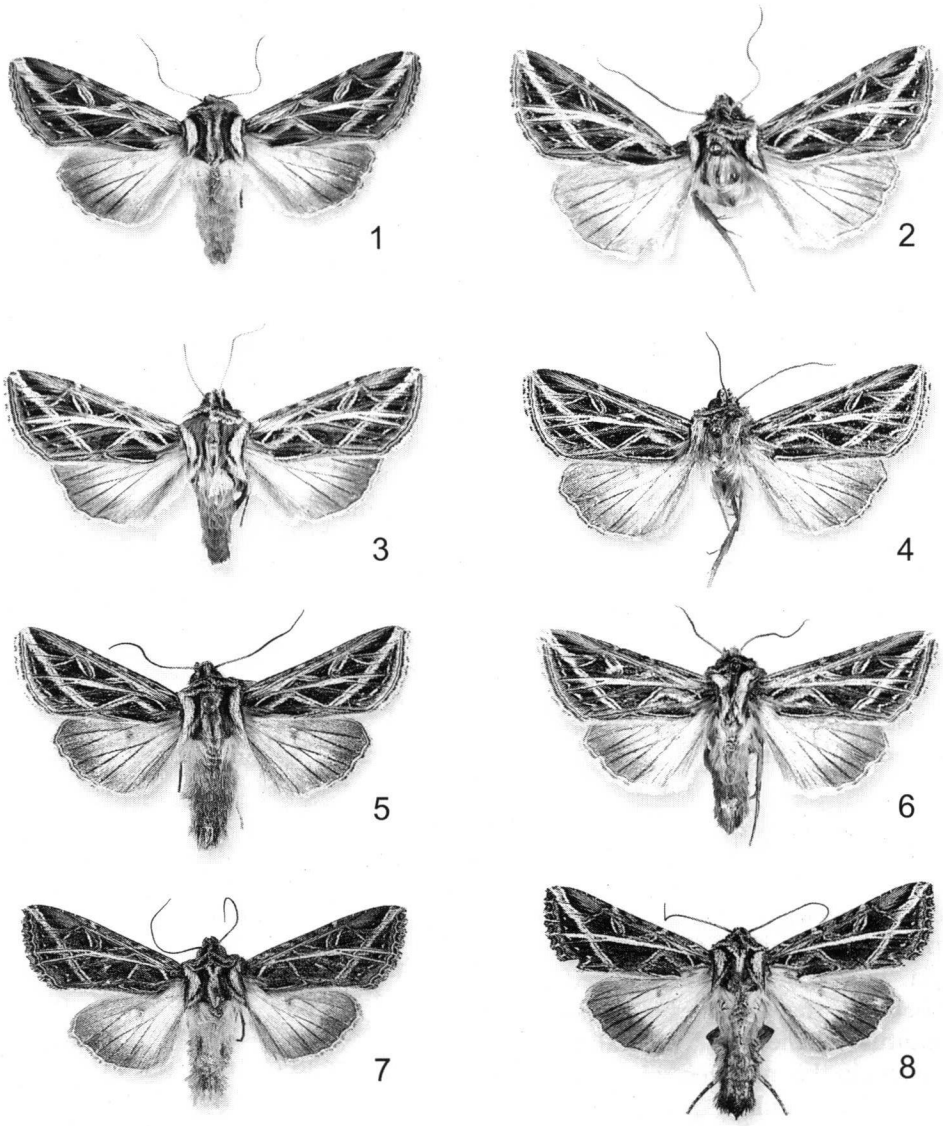
Key Words: host plants, new species, New World, taxonomy

Cryptic species are being recognized more frequently through the use of mitochondrial DNA (COI) (Scheffer 2000, Scheffer and Lewis 2001, Simmons and Scheffer 2004), especially the 648-bp region of COI termed the DNA barcode (Burns and Janzen 2001, 2005; Hebert et al. 2004; Ball and Armstrong 2006; Hajibabaei et al. 2006; Smith et al. 2006; Burns et al. 2007, 2008). The use of COI and DNA barcodes has shown to be an effective tool for initial separation of closely related taxa. Upon closer examination, systematists often then can find differences in morphology, biology, and ecology to support the recognition of the DNA groupings as cryptic species.

* Accepted by Robert R. Kula

Having a wide distribution can be an indication of the presence of possible cryptic species (Hebert et al. 2004, Pogue 2009). Cryptic species can be discovered not only by DNA barcode analysis but also by simply dissecting species with unusually wide distributions. For example, *Tripudia quadrifera* (Zeller) (Noctuidae: Eustrotiinae) had a distribution from Massachusetts to west Texas in the United States, and south through Mexico, Central America and the Caribbean, to Paraguay. Dissections of the genitalia revealed that this species complex consisted of two previously described species and six new ones (Pogue 2009).

Dargida procinctus (Grote) (Figs. 1, 7–8, 17) is an economically important general grass feeder—it is an important pest of ryegrass in the Willamette Valley



Figs. 1–8. Adults. 1, *Dargida procinctus*. 2, *D. spinicassida*, holotype. 3, *D. spinicassida*. 4, *D. juxta*, holotype. 5, *D. juxta*. 6, *D. lilium*. 7, *D. grammivora*. 8, *D. meridionalis*.

of Oregon (Kamm 1985)—that has also been recorded from other hosts including sedges, rushes, wheat, lupine, vetch, and clover (Crumb 1956, Tietz 1972). The species is currently considered to occur from southwestern Manitoba and British Columbia, south to California, Nevada, Utah and Colorado, but also in Mexico, Costa Rica, and Bolivia. Consequently, it was considered an appropriate candidate to examine in detail for the possible presence of previously unrecognized cryptic species.

Materials and Methods

Genitalia dissections followed the method in Pogue (2002) except specimens were mounted in Euparal and stained in mercurochrome and chlorazol black. Terms used in the descriptions of

male genitalia follow Forbes (1954) and those for the female genitalia follow Klots (1970). Images of adult moths and genitalia were taken with a Visionary Digital Imaging System using a Nikon D1X camera with a modified K2 long-distance lens and a pulsed xenon flash. Forewing length was measured using a calibrated ocular micrometer from the juncture of the thorax to the apex, including fringe.

The original spelling of species names is retained to follow the catalog of Poole (1989) and recent changes to the unpublished checklist of the Moths of North America (D. Lafontaine pers. comm.).

Specimens examined were from the American Museum of Natural History, New York, NY (AMNH); The Natural History Museum, London (BMNH); Canadian National Collection, Ottawa, Ontario (CNC); and the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).

Results and Discussion

Examination of the male and female genitalia resulted in the recognition of three new species within the *D. procinctus* complex in Mexico, Costa Rica, and Bolivia. The most easily recognized difference between these species is the shape of the digitus in the male genitalia. Other differences in the male genitalia include the shape of the cucullus, structures on the adoeagus, and the shape of the vesica. In the female genitalia, the shapes of the ostium and ductus bursae, appendix bursae, and number of signa are diagnostic. As a consequence, *D. procinctus* (Figs. 1, 7–8, 17) is now restricted to the North American part of its previous distribution.

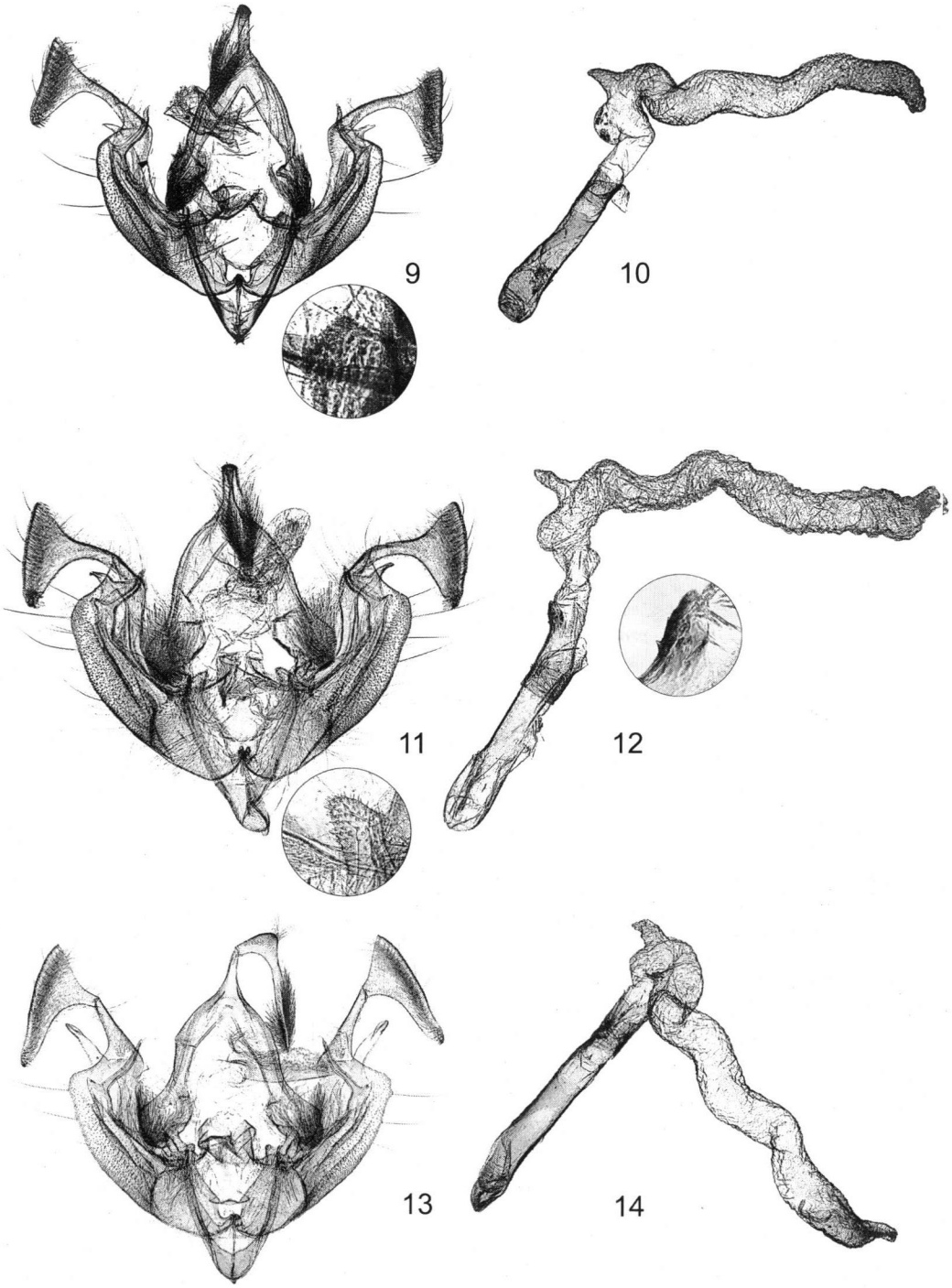
The species of the *D. procinctus* complex also are compared below with two other closely related species, *D. grammivora* Walker and *D. meridionalis* (Hampson), with which they could be confused. *Dargida grammivora* (Figs. 5, 13–14, 20) occurs from Arizona to Peru. Its hosts include corn (*Zea mays* L., Poaceae) in Colombia (Robinson et al. 2008) and Ecuador (Evans and Zambrano 1991) and African bermuda grass (*Cynodon nlemfuensis* Vanderyst, Poaceae), which is an introduction in Costa Rica (Janzen and Hallwachs 2008). *Dargida meridionalis* (Figs. 6, 15–16, 21) is distributed from Minas Gerais to Rio Grande do Sul in southeastern Brazil, and Uruguay. It is a minor pest of apple (*Malus* sp., Rosaceae) in Rio Grande do Sul, Brazil (Fonesca 2006).

Three additional similar species were not included in the *D. procinctus* complex because they can be easily separated from members of this complex. *Dargida elaeistis* (Druce) and *D. oenistis* (Druce) both lack the short angled band from the M vein to the middle of vein 1A + 2A that is present in the *D. procinctus* complex. *Dargida graminea* (Schaus) is small (forewing length of 14 mm) with a shiny white hind wing; members of the *D. procinctus* complex all have a forewing length greater than 14 mm, and the hind wing is always suffused with gray scales and has a dark marginal band.

Key to Species

Species in the *D. procinctus* complex superficially resemble each other and have been considered a single species with a broad distribution extending from central and western North America to Bolivia. Two additional Neotropical species can be confused with members of the *D. procinctus* complex. The following key will provide guidance in differentiating these species.

1. Forewing with terminal line curved (Figs. 1–6) 2
- Forewing with terminal line crenulate (Figs. 7–8) 9
2. Male 3
- Female 6
3. Genitalia with short, triangular-shaped digitus (Figs. 9–11) 4
- Genitalia with elongate digitus with round apex 5



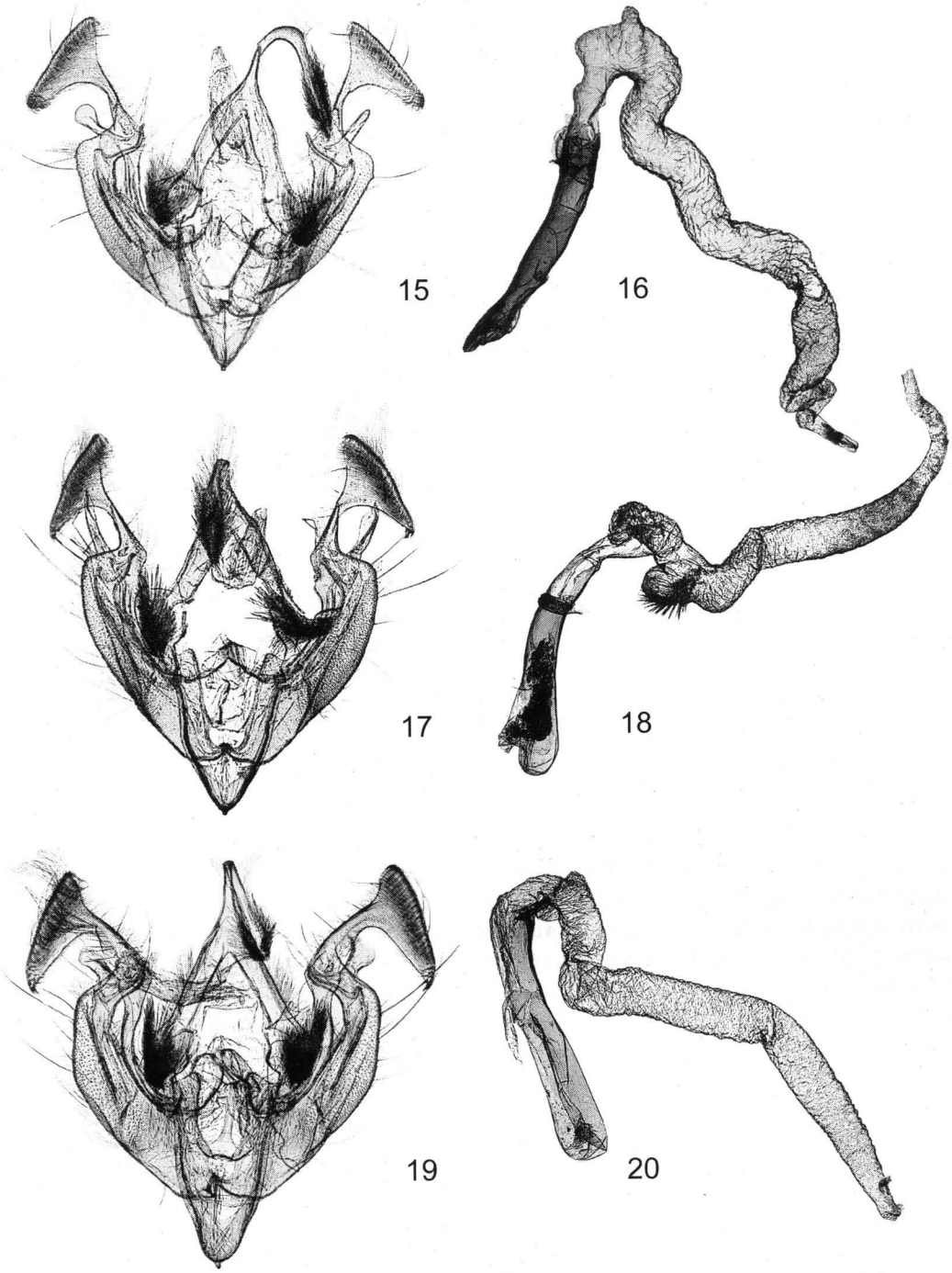
Figs. 9–14. Male genitalia. 9, *Dargida procinctus*. 10, *D. procinctus*, adoeagus. 11, *D. spinicassida*, holotype. 12, *D. spinicassida*, adoeagus. 13. *D. juxta*. 14, *D. juxta*, adoeagus.

4. Genitalia with dorsal projection of sacculus with pointed apex (see inset); apex of adoeagus with helmet-shaped sclerotized area bearing thornlike spines (Fig. 12) . . . . . *D. spinicassida* n. sp.
- Genitalia with dorsal projection of sacculus with truncate apex (see inset); apex of adoeagus lacking helmet-shaped sclerotized area bearing thornlike spines . . . . . *D. procinctus* (Grote)
5. Genitalia with prominent hump on uncus shaft just ventrad to spear-shaped apex; digitus length longer than 3/4 distance between valve and cucullus (Fig. 13) . . . . . *D. juxta* n.sp.
- Genitalia with uncus shaft lacking prominent hump; digitus length less than 3/4 distance between valve and cucullus (Fig. 15) . . . . . *D. lilium* n.sp.
6. Genitalia with elongate and narrow corpus bursae (Fig. 24) . . . . . *D. lilium* n. sp.
- Genitalia with ovate corpus bursae (Figs. 21–23, 25–26) 7
7. Genitalia with appendix bursae angled toward papillae anales (Fig. 21) . . . . . *D. procinctus* (Grote)
- Genitalia with appendix bursae at right angle to corpus bursae (Figs. 22–23) 8
8. Less than 15 signa (Fig. 22) . . . . . *D. spinicassida* n. sp.
- Greater than 15 signa (Fig. 23) . . . . . *D. juxta* n. sp.
9. Male genitalia with dense row of cornuti beyond elongate basal diverticulum (Fig. 18); female genitalia with corpus bursae larger than appendix bursae (Fig. 25) . . . . . *D. grammivora* Walker
- Male genitalia with two small thornlike spines at apex of adoeagus and long and short cornutus at base of vesica (Fig. 20); female genitalia with appendix bursae larger than corpus bursae and extends beyond apex of corpus bursae (Fig. 26) . . . . . *D. meridionalis* (Hampson)

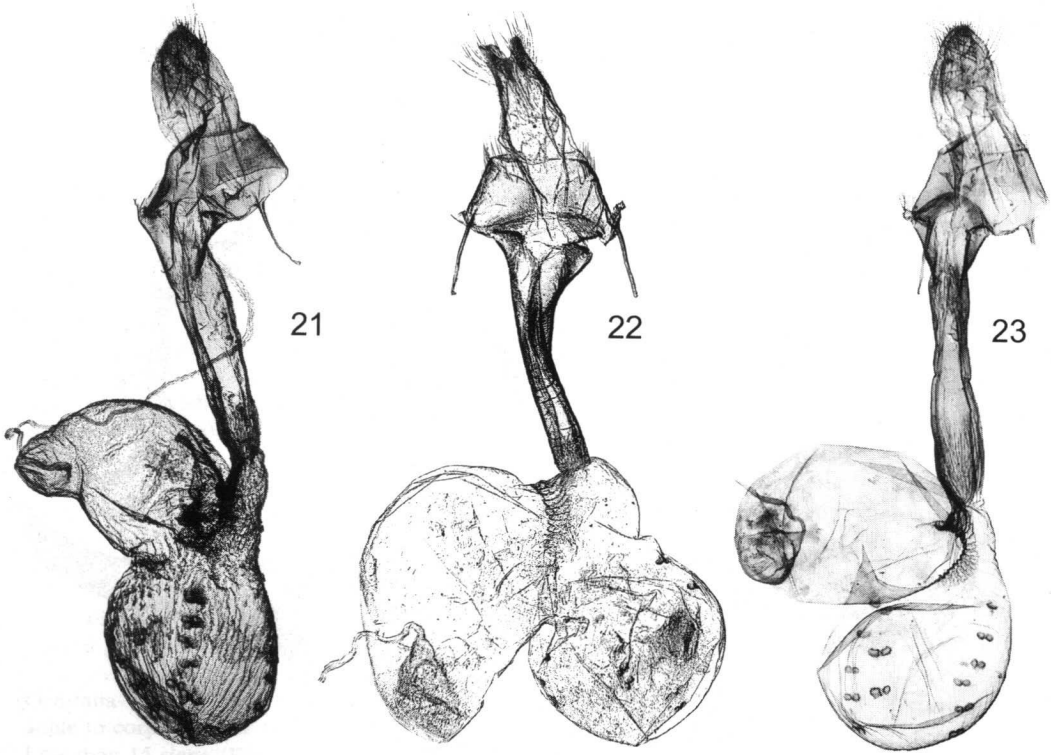
Dargida spinicassida Pogue, new species (Figs. 2–3, 11–12, 22)

Diagnosis.—Male genitalia with ampulla shorter than width of valve and curved with pointed apex; digitus short, curved, apex blunt; clasper a small triangular projection at base of ampulla. Female genitalia has appendix bursae and corpus bursae approximately same size; signa fewer than 15.

Description.—Male. *Head:* Frons with porrect, narrow scales, cream-colored, pair of large black spots distolaterally at eye margin, median black bar below antenna, and black bar between antenna; antenna scape white with black distal margin, flagellomeres scaled dorsally, cream-colored to middle then black to apex; labial palpus erect, black to dark gray, ventral fringe mostly black or dark gray mixed with some cream-colored scales, apex cream-colored. *Thorax:* Patagium erect and fanlike, basally a mixture of white and tan scales, a thin black line, indistinct lines of white and tan, pair of broad black patches not extending to lateral margins, distal margin white; tegula with broad white median band bordered distally by thin black line and long, tan, hairlike scales and bordered proximally by wider black band and brown scales; meso- and metathorax a mixture of white and brown scales; protibiae rufous with rufous and tan fringe, proximal apex black, distal cream-colored band, tarsi gray with or without cream-colored apical bands; mesotibiae black to gray with broad median white stripe, tarsi pale rufous with faint cream-colored apical bands; metatibiae black with mixture of a few rufous and white scales with white apical band, tarsi pale rufous with faint cream-colored apical bands; underside variable from rufous to dark brown. *Forewing* (Figs. 2–3): Length 17.8 mm (n = 1); R vein striped white and gray; orbicular spot angled from M to R vein proximally, mixed with rufous and brown margined with white; reniform spot angled from M to R vein distally (opposite to orbicular), black distally, brown proximally, margined with white; trapezoidal area between orbicular and reniform spots dark gray margined with black; triangular area distal to reniform spot black with dark gray base; M vein tan dorsally and white ventrally; 1A + 2A vein dark gray mixed

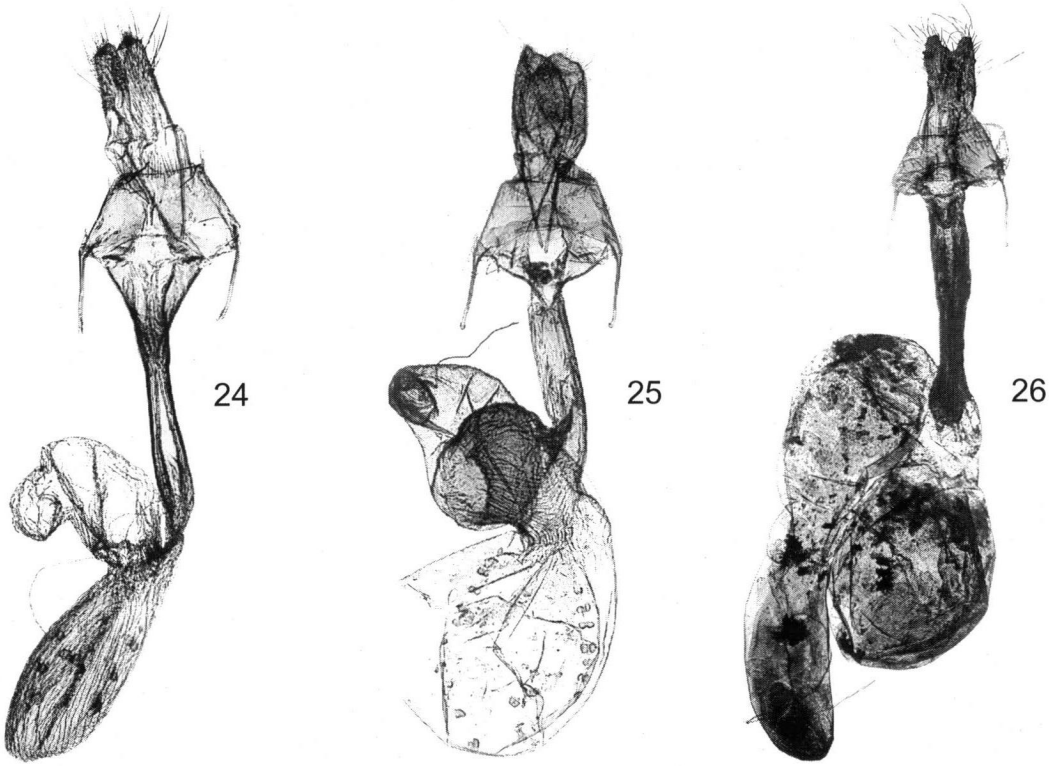


Figs. 15–20. Male genitalia. 15, *D. lilium*. 16, *D. lilium*, adoeagus. 17, *Dargida grammivora*. 18, *D. grammivora*, adoeagus. 19, *D. meridionalis*. 20, *D. meridionalis*, adoeagus.



Figs. 21–23. Female genitalia. 21, *Dargida procinctus*. 22, *D. spinicassida*. 23, *D. juxta*.

with tan and rufous distally; basal area black with thin curved white line from vein 1A + 2A to M vein; angled band from base to vein 1A + 2A white, angled band from vein 1A + 2A to M vein white with thin median line of black and rufous scales, black triangle between these angled lines above vein 1A + 2A; elongate, broad angled band from middle of vein 1A + 2A to apex white with thin median line of black and rufous scales; ground color of areas between cells in distal area of wing black; veins in distal area of wing gray and margined with gray over black cells; a series of distal white dashes in black areas between veins forming slightly curving line from CuA2 to R5; distal margin with thin black line of scales; fringe banded from margin with tan, black, white, and black-tipped scales. *Hind wing:* White becoming gray distally; veins highlighted gray; fringe banded from margin with tan, dark gray, and white; underside white with wide costal and marginal areas mottled with rufous and gray scales; discal spot gray. *Abdomen:* Gray dorsally; brownish rufous mixed with white and black scales ventrally. *Genitalia* (Figs. 11–12): Uncus thin, elongate, curved toward venter, covered with long, hairlike setae, apex spear-shaped; valve with smooth, gently curved ventral margin; cucullus well developed and anvil-shaped; corona well developed; ampulla curved, length less than width of valve, barely extending past and perpendicular to costal margin, apex pointed; digitus short, thornlike, curved, apex blunt; clasper a short, triangular process at base of ampulla near ventral margin of valve; dorsal projection of sacculus with pointed apex; juxta triangular with curved ventral margin, elongate medial-



Figs. 24–26. Female genitalia. 24, *D. lilium*. 25, *D. grammivora*. 26, *D. meridionalis*.

ly, apex truncate; saccus U-shaped with minute ventroapical projection; adoeagus slightly curved near apex, sclerotized ovate area with thornlike spines at apex; vesica emerges straight from adoeagus for short distance then is bent at obtuse angle, digitate diverticulum at bend, slightly sinuate.

Female. Coloration and maculation as in male except forewing length 16.7–17.2 mm (n = 3); short angled band from middle of vein 1A + 2A to M vein and elongate band from middle of vein 1A + 2A to apex not contiguous at vein 1A + 2A. *Genitalia* (Fig. 22): Papillae anales short, triangular, apex broadly rounded; posterior apophyses thin, approximately 1.2× longer than slightly wider anterior apophyses; ostium bursae with convex distal margin; ductus bursae elongate, sclerotized, slightly ribbed in proximal tenth; appendix bursae at juncture of ductus and corpus bursae, slightly larger than corpus bursae, broadly joined to corpus bursae; a sclerotized, crenulate ribbon extends from base of ductus bursae and curves partially around base of appendix bursae; corpus bursae ovate; signa consists of 11 paired, round, spiculate indentations arranged in parallel rows.

Etymology.—The specific epithet *spinicassida* (spiny, helmet), a noun in apposition, refers to the spiny, helmet-shaped structure at the apex of the male adoeagus.

Type material.—*Holotype:* m, Mexico, Durango, 10 mi W El Salto, 9000′, 17 VI 1964, J.E.H. Martin, genitalia slide MGP 1237. Deposited in CNC. *Paratypes:* 3 specimens. (1f) same data as holotype. genitalia slide MGP 1240; (2f) same data as holotype except 19 June 1964 and 11 August 1964. Deposited in CNC and USNM.

Distribution.—Known only from the type locality in Durango, Mexico.

Discussion.—This species is most closely related to *D. procinctus* by the very similar digitus shape in the male genitalia; however, the digitus has a blunt apex in *D. spinicassida* but is pointed in *D. procinctus*. The helmet-shaped, spiny area at the apex of the adoeagus in *D. spinicassida* easily separates it from *D. procinctus*, which lacks any additional ornamentation on the adoeagus. There is a triangular projection at the basal costal margin of the valve that is pointed in *D. spinicassida* but truncated in *D. procinctus*.

In the female gentialia the ductus bursae is narrower in *D. spinicassida* than in *D. procinctus*. The appendix bursae and corpus bursae are side by side in *D. spinicassida*, but in *D. procinctus* the appendix bursae is dorsal to the corpus bursae. The number of signa is 13 in *D. spinicassida* and 26 in *D. procinctus*.

Dargida juxta **Pogue, new species**
(Figs. 4–5, 13–14, 24)

Diagnosis.—Male genitalia with ampulla length approximately the same as valve width and slightly bent medially; digitus elongate, extends approximately 0.8–0.9× distance to cucullus, apex round; clasper a small triangular projection at base of ampulla. Female genitalia with large appendix bursae that is slightly larger than ovate corpus bursae.

Description.—Male. Coloration and maculation similar to *D. spinicassida* except forewing (Figs. 4–5): Length 16.2–18.8 mm (n = 4). *Genitalia* (Figs. 13–14): Uncus thin, elongate, curved toward venter, covered with long, hairlike setae, apex spear-shaped; valve with smooth, gently curved ventral margin; cucullus well developed and anvil-shaped; corona well developed; ampulla elongate, approximately same width as valve, slightly bent medially, perpendicular to costal and ventral margins of valve, gradually tapering to round apex; digitus wider and slightly shorter than ampulla, parallel to costal and ventral margins of valve, apex round and twisted 90°; clasper a short, triangular process at base of ampulla near ventral margin of valve; juxta triangular with curved ventral margin, elongate medially, apex truncate; saccus U-shaped with minute ventroapical projection; adoeagus slightly curved; vesica emerges straight from adoeagus for short distance then bends 90° or more, digitate diverticulum at bend, sinuate and slightly twisted with one coil near apex.

Female. As in male except forewing length 16.3–19.6 mm (n = 8). *Genitalia* (Fig. 23): Papillae anales short, triangular, apex broadly rounded; posterior apophyses thin, approximately 1.2–1.4× longer than wider anterior apophyses; ostium bursae with convex distal margin; ductus bursae elongate, sclerotized, slightly ribbed in proximal fourth; appendix bursae at juncture of ductus and corpus bursae, slightly larger than corpus bursae; sclerotized, crenulate ribbon extending from base of ductus bursae and curves partially around base of appendix bursae; corpus bursae ovate; signa consists of 20 paired, round, spiculate indentations arranged in parallel rows.

Etymology.—The specific epithet refers to the short and long angled bands of the forewing that are contiguous in the middle of vein 1A + 2A.

Type material.—*Holotype:* m, Mexico, Veracruz, genitalia slide USNM 49950, Wm. Schaus Coll. Deposited in USNM. *Paratypes:* All specimens are in USNM. 11 specimens. (1f) same data as holotype. COSTA RICA: ALAJUELA: Parque Nacional Volcan Poas, 2500 m, August 7–8, 2007 (2m, 1f), m genitalia slide USNM 50422, uv-trap, sheet, J. Bolling Sullivan. CARTAGO: Juan Vinas, May (1m, 1f), m genitalia slide USNM 49951,

Wm. Schaus Coll. HEREDIA: Refugio Vara Blanca, 6 km ENE Vara Blanca, 1900 m, 14 Apr. 2002 (1m), 10°11′N, 84°07′W, D. & M. Davis. MEXICO: [no specific locality], (2f), genitalia slide USNM 50423, 15 Feb. 1932 (1f), genitalia slide USNM 50324, 10 Oct. 1932 (1f), T. Escalante Coll. DISTRICTO FEDERAL: Mexico City, (1f), R. Muller.

Distribution.—Known only from the vicinity of Mexico City and Veracruz, Mexico and in the mountains of central Costa Rica.

Discussion.—Both *D. juxta* and *D. lilium* Pogue differ from *D. procinctus* in the shapes of the ampulla, digitus, clasper, and vesica of the male genitalia. In *D. juxta* the ampulla is longer and only slightly bent medially, but in *D. procinctus* it is shorter and more curved medially. The digitus in *D. juxta* is elongate and wide with a round apex, whereas in *D. procinctus* it is a short thornlike process. In *D. juxta*, the clasper is triangular with a broad base; in *D. procinctus* it is more thornlike with a narrow base. The straight section of the vesica as it leaves the adoeagus is short and lacks any bumps in *D. juxta*, but in *D. procinctus* it is longer and has a large bump prior to the digitate diverticulum. The female genitalia is similar in general appearance, but the ductus bursae in *D. juxta* is somewhat longer and slightly swollen in anterior half, and in *D. procinctus* it is shorter and straight in anterior half. The appendix bursae and corpus bursae are also larger in *D. juxta* than in *D. procinctus*.

Dargida lilium Pogue, new species
(Figs. 6, 15–16, 24)

Diagnosis.—Male gentialia with ampulla length shorter than valve width and curved in distal fourth; digitus elongate, extending approximately 0.55–0.60× distance to cucullus, apex round; clasper a short, round process at base of ampulla. Female genitalia with bilobed appendix bursae, smaller than elongate corpus bursae.

Description.—Male. Coloration and maculation similar to *D. spinicassida* except forewing (Fig. 6) length 17.1–18.1 mm (n = 5); short angled band from middle of vein 1A + 2A to M vein and elongate band from middle of vein 1A + 2A to apex not contiguous at vein 1A + 2A. *Genitalia* (Figs. 15–16): Uncus thin, elongate, curved toward venter, covered with long, hairlike setae, apex spear-shaped; valve with smooth, gently curved ventral margin; cucullus well developed and anvil-shaped; corona well developed; ampulla elongate, shorter than width of valve, perpendicular to costal and ventral margins of valve, curved in distal 1/4, apex round; digitus wider and approximately same length as ampulla, parallel to costal and ventral margins of valve, apex round, twisted 90°, and wider than shaft; clasper a short, round process at base of ampulla near ventral margin of valve; juxta triangular with curved ventral margin, elongate medially, apex truncate; saccus U-shaped with minute ventroapical projection; adoeagus slightly curved; vesica emerges straight from adoeagus with small and large hump prior to the more than 90° bend, digitate diverticulum at bend, sinuate and slightly twisted with one coil near apex.

Female. Coloration and maculation as in male except forewing length 18.5 mm (n = 1). *Genitalia* (Fig. 24): Papillae anales short, triangular, apex broadly rounded; posterior apophyses thin, approximately 1.3–1.4× longer than anterior apophyses; ostium bursae with convex distal margin; ductus bursae elongate, sclerotized, slightly wrinkled on proximal 1/4; appendix bursae bilobed, at juncture of ductus and corpus bursae, smaller than corpus bursae; sclerotized, crenulate ribbon extending from base of ductus bursae and curves partially around base of appendix bursae; corpus bursae an elongate oval; signa consists of 13 paired,

round, spiculate indentations arranged in parallel rows.

Etymology.—The specific epithet, a noun in apposition, refers to the lilylike shape of the ductus bursae in the female genitalia.

Type material.—*Holotype:* m, Bolivia, Cochabamba, Incachaca, J. Steinbach. Deposited in USNM. *Paratypes:* All specimens are in USNM. 5 specimens. (4m, 1f) same data as holotype, m genitalia slides USNM 42555, 50421, f genitalia slide USNM 50325.

Distribution.—Known only from the type locality in Bolivia.

Discussion.—This species is more closely related to *D. juxta* than to *D. procinctus* by the similarly shaped digitus; however, it is shorter and the apex is greatly expanded in *D. lilium*, whereas in *D. juxta* the digitus is longer and the apex is only slightly broader than the shaft. The ampulla is shorter and curved in distal fourth in *D. lilium* but in *D. juxta* the ampulla is longer and bent medially. The clasper is a small round process at the base of the ampulla in *D. lilium* but is triangular in *D. juxta*. As the vesica leaves the adoeagus, it is straight for a short distance then abruptly bends. This straight section is much longer with both a small and large hump prior to the bend in *D. lilium*, but in *D. juxta* the straight section is much smaller and lacks any humps. The female genitalia differ in the width of the ductus bursae, which is narrower in *D. lilium* than in *D. juxta*. The appendix bursae is bilobed and smaller than the corpus bursae in *D. lilium*, but in *D. juxta* it is ovate and larger than the corpus bursae. The corpus bursae is an elongate oval shape in *D. lilium* but ovate in *D. juxta*.

Conclusion

The recognition of three additional species of *Dargida* from the Neotropics increases the potential for introduction of novel alien and potentially invasive species into the United States via the importation of cut flowers. There is one record of an adult "*D. procinctus*" recovered from a shipment of baby's breath, *Gypsophila* sp. (Caryophyllaceae), from Colombia in the U.S.D.A. A.P.H.I.S.-P.P.Q. (Animal and Plant Health Inspection Service, Plant Protection and Quarantine) database. This host plant family is not consistent with those of *D. procinctus*, and because the total range of these three new Neotropical species is not fully known, the specific identity of this specimen remains uncertain.

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