Cosmopterosis Amsel has been a monotypic genus since 1956 when it was described. Recently, we discovered two new species that D.H.J. reared from larvae in Costa Rica on Capparaceae, and an additional undescribed species in material from museum collections. We provide a hypothesis of monophyly for Cosmopterosis and for relationship between the species. One of the characters that defines Cosmopterosis is the radiodiscal process on the male forewing, a secondary sexual character and presumably an androconial scent pouch. Recent systematic studies have shown that secondary sexual characters can be phylogenetically informative. We discuss the previously unknown biology of the genus and the paucity of larval feeding on Capparaceae by Lepidoptera.

**KEY WORDS** Pyraloidea, systematics, larval morphology, Costa Rica, Capparaceae

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**Materials and Methods**

**Material Examined.** We studied Cosmopterosis specimens in 12 collections worldwide and 11 collections in the United States. Institutions with material that contributed significantly to this study included: (BMNH) The Natural History Museum, London, U.K.; (INBIO) Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica; (RMNH) National Natuurhistorisch Museum, Leiden, The Netherlands; (USNM) National Museum of Natural History, Smithsonian Institution, Washington, DC, U.S.A.; and the (SDNHM) The San Diego Natural History Museum, San Diego, CA, U.S.A. We deposited type material in these institutions as designated within the text. Specimens are listed at the end of each species description with identification number such as slide numbers for either the USNM or BMNH and/or specimen numbers, including those in the format “nn-SRNP-nnnnn” from the database of Janzen and Hallwachs (2005).
We examined and dissected pinned specimens after abdomens were soaked in 10% potassium hydroxide and wings soaked in bleach. Dissections were stained in chlorozal black for genitalia, and Eosin-Y for wings. Genitalia were placed in vials with glycerine and/or slide mounted in Canada balsam or Euparol (Clarke 1941, Holloway et al. 1987). Measurements were made with an ocular micrometer. Terminology follows Hinton (1946), Neunzig (1979), Wooton (1979), Klots (1970), Maes (1985, 1995, 1997), Yoshiyasu (1985), Phillips and Solis (1996), and Solis and Maes (2002). Morphological structures were photographed using the Micropics imaging system and retouched with Adobe Illustrator (Adobe Systems, Mountain View, CA).

Cladistic Methods. We studied six taxa for potentially informative characters and disregarded only those that were not stable within a species. Autapomorphic characters were included in the matrix because they may be informative for future studies. We conducted an exhaustive search in PAUP* (Swofford 1998) to find all possible trees. Decay indices were calculated using TreeRot (Sorenson 1999). Character state changes were plotted on the hypothesized tree using unambiguous character transformation using Winclada (Nixon 1999).

**Systematics**

**Taxa.** Because of the lack of knowledge of the phylogenetic relationships among the 33 Neotropical glaphyriine genera, representatives of each genus were examined externally. Outgroup taxa were chosen from the currently described genera of Glaphyriinae, with special consideration given to those genera that shared one or more diagnostic characters with the holotype of the type species *C. thetysalis*. These shared features of particular importance included the presence of cataclystiform spots (Munroe 1991) as well as squamiform and/or piliform scales between veins CuA2 and CuP on the dorsal surface of the hindwing. Species with these shared characteristics were then assessed for similarities in the male and female genitalia, notably a prolonged uncus and a posteroverentral extension of the sacculus. Ingroup species were determined to possess hypothesized autapomorphies for the genus, which included specialized scales on the male forewing and male genital characters that were tested in the cladistic matrix.

**Characters.** The 21 characters and their states used for the analysis are listed below and presented in Table 1. All characters are binary. Seven characters are from the wings, one from the abdomen, 10 from the male genitalia, and three from the female genitalia.

| Taxon       | Character/state |
|-------------|----------------|
| argentistriata | 0 0 0 0 0 0 0 0 0 0 0 1 1 0 |
| punctissimalis | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 |
| hispida       | 1 1 1 1 0 1 0 0 1 1 1 1 1 1 |
| jasonhalli    | 1 1 0 1 0 1 0 1 0 1 1 1 1 1 |
| spatha        | 1 1 1 0 1 0 1 1 1 1 1 1 1 1 |
| thetysalis    | 1 1 1 1 0 1 0 0 1 1 1 1 1 1 |

1. Male forewing with radiodiscal process: (0) absent; (1) present (Fig. 11). The males of *Cosmopterosis* possess a set of strong, fused setae whose bases originate above the discal cell at the confluence of the radial sector. This fingerlike process is hinged along the radial vein and is covered with long, dense scales that lay over the discal cell. The discal cell is obscured by the scales on this process as well as similar scales more basal along the radial sector and more apical along vein Rs₄. The specimens with this process also possess a dense patch of appressed setae along the anterobasal border of the discal cell that may represent an additional character. This radiodiscal process (often referred to as a costal fold) has never been described previously and is considered to be a autapomorphy for *Cosmopterosis*.

2. Distal discal cell of male forewing with a dense patch of erect setae: (0) absent; (1) present (Fig. 11). The males of *Cosmopterosis* have the membrane at the apex of the discal cell covered by an erect patch of setae that is distinct from the appressed setae along the anterobasal border.

3. Male forewing with a patch of erect setae distal to the discal cell above M₅: (0) absent; (1) present (Figs. 1 and 4). *Cosmopterosis thetysalis* and *C. hispida* have males with an additional patch of erect setae as described above.

4. Forewing postmedial line color: (0) brown; (1) silver (Figs. 1–4).

5. Hindwing spatulate scales between veins CuA₂ and CuP: (0) absent; (1) present.

6. Hindwing cataclystiform spots: (0) circular, entire; (1) basally bifid, medially separate (Figs. 1–4).

7. Hindwing cataclystiform spots ventrally: (0) visible; (1) not visible.

8. Venter VII with a distinct set of more robust setae on the posterolateral corner: (0) absent (Fig. 7); (1) present (Fig. 8). The abdomens of all the investigated taxa are covered with dense scales and setae; *C. jasonhalli* and *spatha* have a patch of setae located on the posterolateral corner of venter VII. These setae are distinct in that they are longer and stronger and the sockets fitting to their bases are larger and noticeable even after the setae are removed during dissection.

Table 1. Character matrix

| Taxon  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|--------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|
| argentistriata | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |   |
| punctissimalis | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |   |
| hispida       | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| jasonhalli    | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| spatha        | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| thetysalis    | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
9. Base of uncus: (0) narrow, not expanded much wider than rest of uncus, subtended or terminate, adjacent to posterior margin of tegumen (Figs. 9 and 10); (1) expanded dorsolaterally and medially invaginate, significantly overlapping posterior margin of tegumen (Fig. 16). In all of the species of Cosmopterosis, the base of the uncus is concave ventrally and expanded dorsolaterally giving it a carapacelike appearance. Likewise, there is a deep notch medially at the anterior margin. This invagination seems to accommodate the phallus when it everts during copulation.

10. Ninth segmental ring of male terminalia with vinculum: (0) composing no >50% of circumference, tegumen equal in size or larger (Figs. 9 and 10); (1) composing at least 80% of circumference, tegumen much smaller in size (Figs. 14–17).

11. Dorsal articulation between vinculum and valva: (0) condylate (Figs. 9 and 10); (1) adjacent (Figs. 14–17). See Solis and Maes (2002), character 10.

12. Uncus with dorsal recurved setae: (0) absent (Figs. 9 and 10); (1) present (Figs. 12 and 14–17).

13. Pseudognathos: (0) small, simple (Figs. 9 and 10); (1) large, complex (Figs. 12 and 14–17). Outgroup taxa have an extremely short pseudognathos that is evident as an abrupt terminus of cuticle. All species of Cosmopterosis have a pseudognathos that is not only extremely long, but constricted.
subbasally before widening, and sharpened by carinae dorsolaterally, dorsomedially, and ventromedially. The dorsomedial carina is heavily armed with recurved spines apically.

14. Pseudognathos with “apical cone:” (0) absent (Figs. 9 and 10); (1) present (Figs. 12 and 14–17). In addition to the uniformity in the shape of the pseudognathos, the species of Cosmopterosis also possess a membranous process at the apex of the pseudognathos. This process is conical in shape with a pair of anteriorly pointing, setiform extensions.

15. Sacculus with enlarged ventral process: (0) absent (Figs. 9 and 10, and 14); (1) present (Figs. 15–17). Excluding one new species (C. hispida), the males of Cosmopterosis all have an extension of the posteroventral margin of the sacculus near its apex. In two of these species, C. jasonhalli and C. thetysalis, the process is pointed (Figs. 15 and 17), and in C. spatha it is spatulate (Fig. 16).

16. Sacculus with denticles above process: (0) absent; (1) present (Figs. 15 and 16). Cosmopterosis jasonhalli and C. spatha have a patch of thickened, denticulate extensions on the inner surface of the sacculus that is located above the posteroventral process in the previous character.

17. Juxta with deep median channel: (0) absent (Figs. 10 and 14); (1) present (Figs. 15–17). The males of three of the species of Cosmopterosis have a juxta that is bilaterally bisected by a deep median channel running its length.

18. Anellus with eversible setae: (0) absent (Figs. 9 and 10, 14, 17); (1) present (Figs. 15 and 16). The membranous area that spans the ring of the ninth segment is described by Klots (1970) as the diaphragm and the eversible cone that connects to the zone of the phallus as the anellus. Two species of Cosmopterosis have a set of setae on the anellus lateral to the juxta. When the phallus is everted, these setae seem to have an association with the denticles of the sacculus (character 16) based on their close, physical proximity.

19. Anterior apophyses with pointed process in middle: (0) absent; (1) present (Figs. 18–20). The females of all the species here analyzed have anterior apophyses that are thickened at the middle. All of the species analyzed except P. punctissimalis have an additional pointed, tooth-
like process extending medially from this thickened area.

20. Signa with thickened denticles: (0) absent; (1) present (Figs. 18–20). The surface of the membrane forming the corpus bursae has denticulate microsculpturing in all females here analyzed. All of the females except P. punctissimalis have signa that are formed from a distinct thickening of these denticles with the denticles becoming increasingly more robust toward the center of the signa.

21. Signa: (0) shorter, length less than distance between signa; (1) longer, length at least 1.5X distance between signa (Fig. 19). C. spatha has the autapomorphic state of the thickened denticles forming the signa to be continuous, that is the outer edge of the left and right signa meet at the anterior end.

**Phylogenetic Analysis.** The exhaustive search in PAUP® produced a single shortest tree (Fig. 13) with a length of 22 steps (CI = 0.95, RI = 0.94). A monophyletic grouping of the species related to C. thetysalis is strongly supported (decay index = 8). The characters that strongly support this are the presence of a
radiodiscal process (character 1) and a dense patch of erect setae (character 2) in the discal cell of the male forewing, an uncus with a concave base (character 9), a ninth segmental ring of the male terminalia with the vinculum at least 80% of circumference (character 10), the dorsal articulation between the vinculum and the valva adjacent (character 11), the uncus with dorsal recurved setae (character 12), and the pseudognathos large and complex (character 13) with an apical cone (character 14).

Cosmopterosis Amsel 1956: 109. Type species Cataclysta thetysalis Walker, 1859: 440, by original designation, Amsel 1956: 110.

**Diagnosis.** Species are easily recognized by the distinct patterns on the fore- and hindwings. The forewings (Figs. 1–4) are mostly reddish and dark brown with obscure lines except the postmedial line, which is a compound line of silver apically and brown basally; the subterminal, which is silver; and the terminal, which is composed of a line of isolated black spots. The postmedial line is strongly angled toward the wing base at the tornus and the area anterior of this longitudinal section, distal to the discal cell, is species specific in its coloration. The area between the subterminal and terminal lines is yellow. Males have a radiodiscal process (character 1) as described above. All species have distinct cataclystiform spots on the hindwing and have erect piliform scales between veins CuA₂ and CuP. In addition to these external features, the males possess distinctive characters in their genitalia described above (characters 9, 12–15). Species are all easily recognized by characters in the genitalia but can also be distinguished by a combination of external characters.

**Adult. Head** (Figs. 1–4). Frons creamy white laterally and dorsally, brown medially. Vertex with setae creamy white to yellow basally and yellow to reddish brown apically, vertex looking mostly reddish brown, but with mixture of pale yellow and creamy white. Antennae filiform, laminate, dull gold; scape covered with mixed creamy white and gray scales; pedicel and flagellomeres covered with silver-gray scales dorsally, with short, golden setae ventrally, and two rows of...
longer, golden setae ventromedially and ventrolaterally. Labial palpus three-segmented, basal segment arcuate, apical segment with an internal channel open apically, basal and middle segments creamy white basally and apically, grayish brown in middle, apical segment creamy white. Maxillary palpus three-segmented, basal and middle segments cylindrical, apical segment spheroidal, mixed creamy white and grayish brown. Proboscis much longer than labial palpus. Ocelli present, disc mostly black, lens metallic gold. Chaetosemata absent.

Thorax (Figs. 1–4). Pronotum brown medially with lateral margins creamy to yellowish white. Mesonotum mostly brown medially, only extreme bases of scales creamy white, creamy to yellowish white laterally. Pleura and sternites yellowish silver. Legs yellowish silver. Forecoxa grayish brown anterodorsally. Fore- and midlegs grayish brown dorsally on femora and tibiae, and basally on tarsomeres. Midleg with one pair of tibial spurs. Hindleg with two pairs of tibial spurs.

Forewing (Figs. 1–4). Costa almost straight, slightly arcuate; apex acute, but evenly rounded; termen straight to CuA₁; tornus obtuse and evenly rounded; distal apex of discal cell poorly defined; M₁ straight, base closer to base of R₁ than M₂, but not approximate; M₂ arising separately from discal cell, but approximate to origin of M₃. Postmedial line continuing from costa posterolaterally in gentle arc, approximate to termen at CuA₂, then strongly angled basally for short distance before angling toward tornus, reflective, metallic, silver when viewed dorsally, gray when viewed obliquely, margined basally by thin, rufous band, silver component not reaching costa anteriorly; subterminal line silver, not reaching costa or tornal margin; area between postmedial line and subterminal line mostly rufous, golden yellow in narrow band approximate to postmedial line; terminal line black, discontinuous and showing up as spots at apices of longitudinal veins; apical fringe double, dorsal fringe dark gray, half length of ventral fringe, ventral fringe whitish silver. Male with a dense patch of appressed, brown-tipped scales from middle of R to furcation of radial sector that obscures most of discal cell and dense patch of erect, filiform setae underneath, and a patch of dense, erect scales at apex of discal cell to anterad base of M₁; these absent in female. Ventral surface mostly yellowish silver to pale brown, inner posterior margin whitish silver to 1A+2A, medial line and postmedial line pale brown, medial line fading toward posterior margin. Retinaculum composed of dense patch of anteriorly facing, appressed scales between bases of CuA₁ and 1A+2A.

Hindwing (Figs. 1–4). Costa almost straight; termen slightly crenulate to tornus. Above basal half white to yellowish white; apical half with diffuse pattern of brown-tipped scales; margin with six large, silver-metallic, black-margined cataclystiform spots, spots rounded along crenulae of termen distally, deeply invaginated proximally; apical fringe double, dorsal fringe yellowish silver proximally, dark grayish brown distally, half length of ventral fringe, ventral fringe yellowish silver. Below mostly yellowish silver, apex pale brown, costa more yellow. Ventral surface lacks a patch of erect scales between veins CuA₂ and CuP. Female frenulum with two setae.

Abdomen. Male tergite I whitish silver, tergites II–VII yellowish silver with pale brown basal border, tergite VIII and dorsal terminalia mostly pale brown, sternites yellowish silver slightly darker basolaterally.
apex of valva pale brown. Tympanal organs crambiform; tergo-sternal sclerite strongly sclerotized; bulla tympani ovate, longer than wide; fornix tympani weakly sclerotized, posteromedial margin extended almost to pons tympani, thus ala tympani extremely short and ligna tympani almost transverse; tympanum greatly enlarged, conjunctivum reduced to transverse strip; spinula pyriform; processes tympani enlarged, broadly lamellate; pons tympani strongly divergent; ramus tympani weakly sclerotized, arcuate, not strongly angled medially; venula prima almost straight, but sharply angled, posterior width of tympanal organs half width of anterior width; zona glabra tympani extremely short; putoelus tympani absent.

Male Genitalia (Figs. 12 and 14–17). Tegumen short, vinculum composing all but transverse dorsal portion of ninth segmental ring, saccus robust, thickened, lateral arms narrowing dorsally; uncus expanded dorsolaterally and medially invaginate, significantly overlapping posterior margin of tegumen, narrowly extended, dorsally convex and arched in both longitudinal and lateral planes, densely, but finely setose.

Figs. 21–23. Pupa of C. spatha Solis, n. sp. 21. Lateral view. 22. Ventral view. 23. Lateral view of preserved larva of Cosmopterosis spatha (some extremely long setae digitally reconstructed).
dorsally, dorsal subapex with two pairs of strong, recurved setae. Extreme apex in lateral view recurved, in dorsal view bifurcate, ventrolateral margin carinate, sclerotized medially on ventral surface, membranous laterally, median sclerosis acutely pointed posteriorly; pseudogynathos continuous with tegumen, transverse basally, narrowing subbasally, and expanded distally before becoming apically acute, dorsal-lateral margins carinate, medially carinate and heavily armed with recurved spines apically, extreme apex with posteroventral, conical extension and pair of dorsoanteriorly directed spines, ventral surface fully sclerotized with a median carina; transilla weakly sclerotized, but continuous medially, simple, straplike, and arched medially; juxta ovate, much higher than wide; valva spatulate subapically, apex bluntly attenuate, surfaces and margins sparsely setose, inner surface with transverse rugae in distal half, costa strongly thickened basally, attenuate distally, almost reaching apex; coecum long, 0.75× length of remaining phallos, phallos bifid apically, moderately sclerotized, cornutus a dense patch of long, straight spicules.

Female Genitalia (Figs. 18–20). Papillae anales longitudinally shortened, in posterior view kidney-shaped, concave medially, setae densely covering surface, setae stronger at external margin and becoming weaker toward center; tergite VIII weakly sclerotized dorsomedially, membranous laterally; venter VIII membranous; posterior apophyses slender, turning medially near midpoint; anterior apophyses robust, 2× length of posterior apophyses, thickened near midpoint, with a medially directed process at approximately one third its length; ostium bursae narrowing anteriorly to cervix bursae; corpus bursae spherical, ∼0.5× to subequal in length of segment VII, weakly spicate; ductus bursae 2× length of segment VII, slightly expanded near corpus bursae, inserting at corpus bursae posteroventrally; signa oval, 3× longer than wide, medially concave, densely spicate, spicules larger centrally, spicules grading to fine setiform structures toward margin; ductus seminalis inserted into ventral surface of ductus bursae anterad cervix bursae; spermathecal duct coiled, spermathecal vesicle weakly sclerotized laterally.

Species Variation. There is considerable variation among specimens within any given species. Subtle variations of hue and tone exist, but are not explicitly noted.

Distribution. Western Mexico (Nayarit, San Luis Potosi, Sinaloa) east to the Republic of Trinidad and Tobago and south to Paraguay.

Biology. Specimens from Costa Rica have been reared from Capparis and Forchhammeria (Capparaceae).

Remarks. Amsel (1956) described Cosmopterosis for Cataclysta thysalis Walker, which at the time was placed in Aulacodes Guenée. He was impressed by its ornate wing pattern (cosmo = ornamental, ptero = wing) and stated that the morphology precluded it from belonging to Aulacodes, in the Acentropinae or any of its synonyms because those type species had a completely different morphology. But he did not explicitly state which characteristics were unique to C. thysalis. Amsel never saw the holotype and erected the genus based on voucher specimens “determined by Martin” at the BMNH that we subsequently determined to be an undescribed species. Cosmopterosis remains a valid taxon with no species having been added by description or combination.

Munroe (1964) placed Cosmopterosis in Glaphyriinae where it currently resides. Forbes (1920) first defined Glaphyriinae based on a patch of erect scales on the hindwing between veins CuA2, and CuP, but Solis and Adamski (1998) demonstrated that these scales were not present on all species within a genus and were completely lacking among the species in some genera such as Cosmopterosis. Munroe (1964) added several new taxa to the subfamily using the concept of Forbes (1920, 1924), but to date no cladistic analyses based on either morphological or molecular characters among the glaphyriine taxa exist. Generic-level relationships within the subfamily are completely unknown so some of the currently recognized genera are likely to be either paraphyletic or polyphyletic.

Key to Species of Cosmopterosis

1. Hindwing upper surface with cataclystiform spots incomplete, middle area with brown scales concolorous as those of adjacent area of hindwing (Fig. 4). Sacculus with posteroventral flange >5× longer than wide and apex rounded (Fig. 17). Internal, sclerotized part of phallus with spicules (Fig. 17). Apical half of valva parallel-sided, apex evenly rounded (Fig. 17). Basal (posterior) one fourth of ductus bursae <one-third width of segment VII and smooth, with no rugosity (Fig. 20).

Cosmopterosis thysalis

1’. Hindwing upper surface with cataclystiform spots complete, middle area with black and yellow scales differing in color from adjacent area of hindwing (Figs. 1–3). Sacculus with posteroventral flange <4× longer than wide or absent (Figs. 14–16). Internal, sclerotized part of phallos smooth (Figs. 14–17). Apical half of valva attenuate (Figs. 14–17). Basal (posterior) one fourth of ductus bursae >one-half width of segment VII, usually rugose (Figs. 18–19).

2. Forewing medial area, basal to dorsal portion of postmedial line, yellow and brown, with no white scales (Fig. 1). Male forewing with circular patch of erect setae apical to overhanging setae of radiodiscal process above M2 (Fig. 1). Sacculus lacking substantial posteroventral flange or spicules near posterior margin (Fig. 14). Anellus lacking patch of eversible setae (Fig. 14). Juxta with sclerotized dorsal extension with strong, long spines forming large brush (Fig. 14).

Cosmopterosis hispida Solis
2'. Forewing mediolateral area, basal to dorsal portion of postmedial line, with broad areas composed of white scales (Figs. 3–4). Male forewing lacking circular patch of erect setae apical to overhanging setae of radiocalcosal process above M₂ (Figs. 2–3). Saccus with substantial posterovertral flank clearly extending beyond margin and with spicules near posterior margin (Figs. 15–16). Anellus with patch of eversible setae (Figs. 15–16). Juxta with short spicules, but lacking sclerotized dorsal extension (Figs. 15–16) 

3. Hindwing ventral surface with or without cataclystiform spots near margin almost mirroring those on dorsal surface with metallic silver or black scales present. Posteroventral flange of saccus broadly or acutely pointed (Fig. 15). Signa smaller, length less than distance between signa, clearly independent of each other (Fig. 18) 

3'. Hindwing ventral surface without cataclystiform spots. Posteroventral flange of saccus broadly spatulate (Fig. 16). Signa larger, length at least 1.5X distance between signa, sometimes looking confluent anteriorly (Fig. 19) 

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**Cosmopterosis hispida** Solis, New Species

*(Figs. 1, 7, 12, 14)*

**Diagnosis.** Males of *C. hispida* are distinguished from other species of *Cosmopterosis* by the coloration basal to the transverse area of the postmedial line and anterior to the longitudinal portion of the postmedial line (Fig. 1). This area is wholly colored yellow and brown, with no white scales. All other species have white scales posteriorly in this area.

**Adult.** *Head* (Fig. 1). Proboscis with basodorsal scales mostly pale reddish brown with few creamy white.

**Thorax** (Fig. 1). Patagium brown medially, with lateral margins creamy to yellowish white. Tegula mostly brown basally, creamy white centrally, medially and laterally with reddish brown-tipped scales.

**Forewing** (Fig. 1). Above, apical two thirds mostly rufous; most of costa and basal one fourth creamy to yellowish white with brown-tipped scales scattered throughout; basal, subbasal, antemedial, and medial lines obscured by scattered brown-tipped scales; area basal to anterior portion of postmedial line yellow and brown with no white scales. Male with another patch of erect scales beyond appressed scales. Ventral surface with costa and apical one fifth pale brown.

**Hindwing** (Fig. 1). Above, subbasal and medial lines not evident, area between with subbasal rufous spot; postmedial and subterminal lines evident as more densely spaced, brown-tipped scales. Below, medial line not visible, postmedial line pale brown, cataclystiform spots distinct, mostly silver with narrow black margin apically and broader black margin basally.

**Abdomen** (Fig. 1). Male tergite I pale brown medially.

**Male Genitalia** (Figs. 12 and 14). Juxta with shallow median channel that dissipates dorsally at anellus, dorsally acuminate; anellus bordered laterally by sclerotized extensions with strong, long spines forming large brush; saccus more strongly sclerotized than rest of valva, apex with very short, bluntly pointed extension.

**Female.** Unknown.

**Immature Stages.** Unknown.

**Material Examined.** Five males.

**Type Material.** HOLOTYPE: 1 male, BRAZIL, Rio de Janeiro, 10 km SW Maracá, “restinga,” sand dune, 11–12–X–1985, coll. SE. Miller (USNM, slide 113,540), (USNM). PARATYPES: BRAZIL: 1 male Rio de Janeiro, Maracá, 5 m, 11-X-1986, coll. V. O. Becker, (USNM, slide 112,922); 2 males (USNM), same data; 1 male (USNM), same locality, 50 m, 29-I-1985, V. O. Becker. Paratypes at the USNM and BMNH.

**Distribution.** This species is known only from five males collected in and near Maracá in the state of Rio de Janeiro, Brazil.

**Biology.** Unknown.

**Etymology.** *hispidus* (Latin, adjective) = bristly; a feminized adjective describing the brushlike lateral projections forming the sclerotized dorsal extension from the base of the juxta.

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**Cosmopterosis jasonhalli** Solis, New Species

*(Figs. 2 and 5, 11, 15, 18)*

**Diagnosis.** Externally, this species can only be recognized by comparison and exclusion and is most easily identified using the key to species. It shares with its sister species, *C. spatha*, the absence of a patch of erect setae distal to the apex of the discal cell on the male forewing as well as the absence of the diagnostic coloration of the forewing of *C. hispida* and the hindwing of *C. thetysalis* (cf. Figure 2 with Figs. 1 and 3, and 4). Specimens can be distinguished from *C. spatha* by the presence of cataclystiform spots on the lower surface of the hindwing, which are absent in *C. spatha*.

**Adult.** *Head* (Fig. 2). Frons pale gray ventrally. Proboscis with basodorsal scales grayish brown.

**Thorax** (Fig. 2). Patagium brown medially, with lateral margins creamy to yellowish white. Tegula mostly brown mixed with some creamy white scales.

**Forewing** (Fig. 2). Above, costa and apical one third golden yellow; basal one fourth ochreous to very pale brown; basal, subbasal, and antemedial lines diffuse, with brown-tipped scales, but indicated by pale brown intersections with costa; medial line pale brown to brown at costa and posteriorly to M₁, fuscous to hind margin; area between antemedial and medial lines rufous; area basal to anterior portion of postmedial line yellow dorsally, white toward middle and posteriorly. Ventral surface with costa and termen reddish yellow, area between dorsal postmedial and median lines yellowish white.

**Hindwing** (Fig. 2). Above subbasal and medial lines composed of diffuse brown-tipped scales; area be-
between rufous; postmedial and subterminal lines composed of diffuse brown-tipped scales, slightly obscured by adjacent scales of similar color. Below medial line and postmedial line obscure, catalyctiform spots visible.

**Abdomen** (Fig. 2). Male tergite I with pair of submedial brown spots. Female tergite I yellowish silver with transverse stripe of brown-tipped scales, tergites II–VIII mostly pale brown with apical margins creamy white, posteralateral corner of venter VII with patch of distinctly longer, more robust setae with enlarged sockets.

**Male Genitalia** (Fig. 15). Juxta with deep median channel that opens posterosdorally to fluted, bifid aperture at anellus; anellus bordered laterally by membranous patch with bristlelike setae; saccus robust, posterior surface deeply concave subapically, medial surface of subapex with broad strip of short spicules, apex with sharply pointed, posteroventral flange.

**Female Genitalia** (Fig. 18). Ostium bursae posteriorly subequal in width to posterior margin of segment VII, rugose on all surfaces; cervix bursae 0.5× width of ostium bursae, with weakly sclerotized ring anteriorly, rugose and finely spiculate dorsally and laterally.

**Larva** (Fig. 5). Preserved larvae not available; larval description based on photographs (see Janzen and Hallwachs 2005). Last instar cylindrical, tapered anteriorly and posteriorly, head dark orange, and A8–A10 dorsally orange. Black dorsally to just above SD1, with an interrupted white subdorsal line. Primary setae arising from distinct pinacula or chalazae (D and SD groups); D2 on white chalazae, smaller on A1, A3, A5, and A7, smaller on T2, T3, A8, and A9. Yellow, lateral stigmatic line from prothorax to A7, transparent ventrally looking greenish.

**Variation.** The ventral surface of the hindwing is marked with distinct catalyctiform spots that mirror those on the dorsal surface, but on some specimens these are faint to almost completely absent, reduced to only a hint of silvery scales. The apex of the posteroventral flap of the male sacculus ranges in shape from an acutely sharp point, to a longer, bluntly rounded terminus; however, despite the broad distribution of the species, no other character or distributional differences were found to consistently covary with the shape of the flange.

**Material Examined.** Forty-five males, 73 females.

**Type Material.** HOLOTYPE: 1 male, INBIO, 90-SRNP-1227.1, COSTA RICA, Guanacaste, Parque Nacional Santa Rosa, Ojochal, 10 m, 10.78506° N, 85.6637° W, 7-VII-1990, reared from Capparis frondosa Jacq. (Capparaceae); 4 males (INBIO, 01-SRNP-12685, 01-SRNP-12686, 01-SRNP-12690, 01-SRNP-12698); 2 females (INBIO, 01-SRNP-12692), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque San Emilio, 10.84384° N, 85.61384° W, 300 m, 5-VII-1997, feeding on Capparis frondosa (Capparaceae); 1 male (INBIO, 01-SRNP-12691, slide 113,557), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque San Emilio, 10.84389° N, 85.61386° W, 300 m, 31-VII-1990, reared from Capparis frondosa Jacq. (Capparaceae); 1 male (INBIO, 01-SRNP-12692), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque San Emilio, 10.84389° N, 85.61384° W, 300 m, 1-VI-2001, feeding on Capparis frondosa (Capparaceae); 1 female (INBIO, 01-SRNP-12691, slide 113,559), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque San Emilio, 62 km S Ariquemes, Fazenda Rancho Grande, 165 m, 10° 32’ 32” S, 62° 48’ 14” W, 14–25 XI, 1993, coll. R. Leuschner; 1 female (INBIO), same data, 29-X–10-XI-1991. COSTA RICA: PROVINCIA DE GUANACASTE: 1 female (INBIO, 90-SRNP-1227), slide 113,551, Area de Conservación Guanacaste, Sector Santa Rosa, Ojochal, 10.78506° N, 85.6637° W, 10 m, 7-VII-1990, feeding on Capparis frondosa (Capparaceae); 2 males (INBIO, CR0000563858, slide 563,858; CR1000563866, slide 563,866), Parque Nacional Santa Rosa, Playa Naranjo, L-N-309300-354200, V-1991, coll. E. Alcazar; 1 female (INBIO, INB0003165616, slide 113,552), Parque Nacional Palo Verde, Sector Palo Verde, Bagaces, L-N-260052-385020, 0–50 m, 3–8-IV-2000, de Luz, coll. H. Méndez; 1 female (INBIO, CR0003118596, slide 113,553), Parque Nacional Palo Verde, Sector Palo Verde, Bagaces, L-N-260052-385020, 0–50 m, 2–6-VI-2000, de Luz, H. Méndez; 1 female (INBIO, INB0003485677, slide 113,554), Z. P. Nosara, Filo Maravilla, L-N-221350-381700, 800 m, 9–14-V-2002, Trampa de Luz, coll. H. Méndez; 2 males (INBIO, 91-SRNP-1836.1, slide 113,556; 91-SRNP-1836.2, line 113,555), 1 female (INBIO, 91-SRNP-1835), Area de Conservación Guanacaste, Sector Santa Rosa, Las Mesas, 10.84653° N, 85.60915° W, 305 m, 16-VII-1991, reared from Capparis flexuosa (Capparaceae); 1 male (INBIO, 90-SRNP-1740, slide 113,557), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque San Emilio, 10.84389° N, 85.61384° W, 300 m, 31-VII-1990, reared from Capparis frondosa Jacq. (Capparaceae); 4 males (INBIO, 01-SRNP-12685, 01-SRNP-12686, 01-SRNP-12690, 01-SRNP-12698); 2 females (INBIO, 01-SRNP-12692), Area de Conservacion Guanacaste, Sector Santa Rosa, Bosque San Emilio, 10.83432° N, 85.57164° W, 300 m, 3-8-V-2000, de Luz, coll. H. Méndez; 1 female (INBIO, 91-SRNP-1836.1, slide 113,556; 91-SRNP-1836.2, line 113,555), 1 female (INBIO, 91-SRNP-1835), Area de Conservación Guanacaste, Sector Santa Rosa, Las Mesas, 10.84653° N, 85.60915° W, 305 m, 1-VI-2001, feeding on Capparis frondosa (Capparaceae); 1 female (INBIO, 01-SRNP-12691, slide 113,559), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque San Emilio, 10.83432° N, 85.57164° W, 300 m, 3-VIII-2004, feeding on Capparis frondosa (Capparaceae), coll. K. Araya; 1 female (INBIO, CR000115178, slide 103,726), Santa Rosa National Park, 10–12-VII-1980, D. H. Janzen and W. Hallwachs; 1 female (INBIO, CR000115159, slide 113,560), Santa Rosa National Park, 300 m, 1–15-VIII-1982, colls. D. H. Janzen and W. Hallwachs; 1 female (INBIO, 94-SRNP-328, slide 113,561), Area de Conservación Guanacaste, Sector Santa Rosa, Bosque Humedo, 10.85145° N, 85.60801° W, 290 m, 18-I-1994, feeding on Capparis frondosa (Capparaceae); 1 male (INBIO, 01-SRNP-12682, slide 113,563); 3 females (INBIO, 01-SRNP-12674, 01-SRNP-12675, 01-SRNP-12680), Area de Conservación Guanacaste, Sector...
Santa Rosa, Sendero Natural, 10.83575° N, 85.61253° W, 290 m, 1-VI-2001, feeding on Capparis frondosa (Capparaceae); 1 male (INBio, 01-SRNP-12679, slide 113,562), same data; 1 female (INBio, 01-SRNP-15771), same data, 18-VII-2001; 1 female (INBio, 01-SRNP-16131, slide 113,564), same locality, 30-VII-2001, feeding on Capparis flexuosa (L.) L. (Capparaceae), coll. D. Garcia; 1 female (INBio, CR1001115182, slide 113,566), W of Carmona Nicoya, 600–700 m, 19-VIII-1982, dr. H. D. Janzen and W. Hallwachs; 1 female (INBio, CR1001115184, slide 113,565), same data. PROVINCIA DE PUNTARENAS: 1 female (INBio, CR1000345554, slide 113,568), Reserva Biológica Carara, Estación Quebrada Bonita, 50 m, VI-1991, L-N-194500, 469850, coll. R. Zuniga; 1 female (CR1000345464, slide 113,567), same data; 1 male (INBio, CR000127283, slide 127,283), same data, X-1989; 1 male (INBio, CR1001655645, slide 655,645), same data, IX-1993, coll. J. Saborio; 1 female (INBio, CR1002409749), Estación San Miguel Sendero Mirador, 120 m, L-N-174350-411450, 3-X–2-XI-1997, coll. F. Alvarado, Trampa de Luz; 1 female (INBio, CR1000115179, slide 113,569), Parque Nacional de Corcovado, Osa Peninsula, Sirena, 10–12-VIII-1989, colls. D. H. Janzen and W. Hallwachs. GUATEMALA: 2 males, 3 females (USNM), Cayuga, IV, colls. Schaas and Barnes; 1 male (USNM), same locality and collectors, IX; 1 female (USNM), same locality and collectors, II; 1 female (USNM), same locality and collectors, V; 1 female (USNM, same locality and collectors, VI; 1 female (USNM, slide 108,146), same data. MEXICO: 2 males, 5 females (USNM), Sinaloa, Presidio [Presidia] River, coll. B. P. Clark; 1 male (USNM, slide 113,547), 1 female (USNM, slide 113,546), same data; 2 females, Sinaloa, Venado [Venadio], coll. B. P. Clark; 2 males, 2 females, (SDNHM), Sinaloa, Micro. Ej. El Indio, N. Mazatlan, 20-VIII-1985, Faulkner, Bloomfield; 1 female (USNM), Nayarit, Islas Marias, Isla Maria Magdalena, 20-V-1925, coll. H. H. Keifer; 1 male (SDNHM), Nayarit, Micro. Penitras, nr. Tuxpan, 17-VIII-1985, Faulkner, Bloomfield; 1 female (USNM), San Luis Potosi, 2 miles N Tamazunchale, 400 feet, 16–18-VII-1963, colls. Duckworth and Davis. PANAMA: 2 males (USNM), Cerro Campana, nr. Chica, 2–5-V-1965, colls. S. S. Duckworth and W. D. Duckworth; 1 male (USNM), Burro Colorado Island, 10–17-V-1964, W. D. Duckworth and S. S. Duckworth; 1 female (USNM), same data, 1–9-V-1964; 1 female (USNM), same data, 18–28-IV-1964; 1 female (USNM, slide 110,135), same data; 2 males (USNM), same locality, at light, lot no. 42-4149, 20-III-1942, coll. J. Zetek; 1 male (USNM, slide 110,054), 1 female (USNM, slide 110,055), same data, lot no. 41-17178, 26-IX-1941; 1 female (USNM), same locality, at light, 4-III-1979, colls. Silberglied and Aiello; 1 male (USNM), Alhajuuelo, 14-IV-1911, coll. A. Busck; 1 female (USNM), San Lorenzo, 9° 17′ N, 79° 58′ W, 22.X.2003, coll. R. L. Kitching. PARAGUAY: 1 female (USNM, slide 113,548), Departamento de Concepción, Arroyo Tagatiya-mi, 22° 39′ S, 57° 32′ W, 3–5-IV-1986, colls. M. Pogue and M. Solis; 1 female (USNM), Departamento de Paraguarí, Cerro Acahay, 25° 53′ S, 57° 08′ W, 13–14-III-1986, colls. M. Pogue and M. Solis; 1 female (USNM), Departamento de Paraguari, 26.2 km SE Ybycui, Parque Nacional Ybycui, 26° 07′ S, 56° 47′ W, 15–18-III-1986, M. Pogue and M. Solis. PERU: 1 male (USNM), coll. Dognin; 1 male (USNM), Madre de Dios, Rio Tambopata Res, 30 air km. SW Pto. Maldonado, 290 m, 6–10-XI-1979, subtropical moist forest, J. B. Heppner; 2 females, same data, 11–15-XI-1979; 1 male, 1 female, same data, 16–20-XI-1979; 1 female, same data, 21–25-XI-1979. REPUBLIC OF TRINIDAD AND TOBAGO: 1 male, 1 female (USNM), Montserrat, coll. W. Schaus. VENEZUELA: 1 male (USNM), 1 female (USNM), Guarico, Hato Masaguaral, 45 km S Calabozo, 85.75° N, 67.58° W, Gallery Forest 9, 75 m, 10-VII-1989, uv light, colls. M. Epstein and M. Deza; 1 male (USNM, slide 113,550), 1 female (USNM, slide 113,549), same data; 1 male (USNM), same locality, Gallery Forest 8, 8–9-VII-1989, light, coll. M. Epstein; 1 male (USNM), same locality, Gallery Forest 6, 20–21-IX-1990, uv and mv light, colls. M. Epstein and J. Wilterding III; 1 female (USNM), same locality, Gallery Forest 4, 29-VI-1989, uv light, colls. M. Epstein and M. Deza; 1 female (USNM), same locality, Gallery Forest 10, 23–24-IV-1988, uv light, colls. M. Epstein and R. Blahnik; 1 female (USNM), same locality, Gallery Forest 20, 13–16-V-1988; 2 males, 1 female (USNM), Aroa, coll. W. Schaus; 1 male (USNM) Valera, XI-1922, coll. H. Pittier; 2 females (USNM), same locality, coll. E. P. de Bellard; 1 male (USNM), Barinas, Rio Caparo Research Station, 32 km E El Canton, b light, 3–5-II-1978, seasonal forest, coll. J. B. Heppner; 1 female (USNM), San Esteban, Carabobo, 1–20-XII-1939, coll. P. J. Anduse; 1 female (USNM), Aragua, Playa de Cata, 9 km E El Playon, 21-I-1978, riverine forest, J. B. Heppner; 1 female (USNM), Lara, 4 km NW La Pastora, 2–3–III-1978, riparian forest, blacklight, coll. J. B. Heppner; 1 female (USNM), Zulia, Guasare coal camp, 45 km W Carrasquero, Sierra Perija, 19–25-VIII-1981, 80–140 m, J. Heppner.

One additional female (USNM) from the W. Schaus collection with the labels reading “52” and “Trillista thyetsalis W. comp. B.” in hand-written ink has no locality label. Paratypes deposited at BMNH, INBIO, and USNM.

Distribution. Sinaloa, Mexico south to Paraguay, Peru to Venezuela, and on the islands of Trinidad and Tobago.

Biology. Several larvae collected in Costa Rica were reared from Capparis frondosa Jacquin and Capparis flexuosa (L.) L. (Capparaceae) (Janzen and Hallwachs 2005). The adult moths fly year-round and are found between 50 and 900 m.

Etymology. A patronym honoring the spouse and good friend of the first author, Dr. Jason P. W. Hall, an expert on the family Riodinidae.

Cosmopteropsis spatha Solis, New Species (Figs. 3 and 6, 8, 16, 19, 21, 22, 23)

Diagnosis. Specimens of this species lack cataclysm spots on the lower surface of the hindwing.
Adult. Head (Fig. 3). Frons grayish brown ventrally. Proboscis with basodorsal scales mostly grayish brown with few creamy white.

Thorax (Fig. 3). Patagium creamy to yellowish white. Tegula mostly brown basally grading to creamy white laterally and posteriorly.

Forewing (Fig. 3). Above, costa and apical one third golden yellow; basal one fourth ochreous to very pale brown; basal, subbasal, and antemedial lines diffuse, with brown-tipped scales, but indicated by pale brown intersections with costa; medial line pale brown to brown at costa and posteriorly to M₁, fuscous to hind margin; area between antemedial and medial lines rufous; area basal to anterior portion of postmedial line yellow dorsally, white toward middle, often with rufous or brown scales through the middle. Ventral surface with costae and termen reddish yellow, area between dorsal postmedial and medial lines yellowish white.

Hindwing (Fig. 3). Above subbasal and medial lines composed of diffuse, brown-tipped scales; area between rufous; postmedial and subterminal lines composed of diffuse brown-tipped scales, slightly obscured by adjacent scales of similar color. Below medial line and postmedial line pale brown, catacystiform spots absent.

Abdomen (Fig. 3). Male tergite I with pair of submedial brown spots. Female tergite I yellowish silver with transverse stripe of brown-tipped scales. Tergite II–VIII mostly pale brown with apical margins creamy white, posterolateral corner of venter VII with patch of distinctly longer, more robust setae with enlarged sockets.

Male Genitalia (Fig. 16). Juxta with deep median channel that opens posterodorsally to fluted, bifid aperture at anellus; anellus bordered laterally by membranous patch with peglike setae; saccusus robust, posterior surface deeply concave subapically, medial surface of subapex with narrow strip of short spicules, apex with broadly spatulate, posterovertnonal flange.

Female Genitalia (Fig. 19). Ostium bursae posteriorly subequal in width to posterior margin of segment VII, rufous ventrally and laterally; cervix bursae 0.5× width of ostium bursae, with weakly sclerotized ring anteriorly, rufous and gently spicate dorsally and laterally.

Larva (Figs. 6, 23). Last instar cylindrical, tapered anteriorly and posteriorly. Thick and extremely long setae arising from distinct pinacula or chalazae of D and SD groups (Fig. 23). Black dorsally to just above SD1 except T2, A1, A3, A5, A7 with only posterior half black. Yellow lateral stigmatal line from prothorax to A7, transparent ventrally looking greenish. Head hypognathous, dark orange; epicranial suture present; fr ontoclypeus and labrum dark brown, ~1.25× as long as wide; six stemmata, 1 and 2 approximate, 3 and 4 approximate, 5 antero-ventral to 6; S2 1.3× as long as S1, SS3 longer than SS2, MG1 short, F1 present near middle of frons, AF1 and AF2 on adfrontal area rather short, La and Aa present, P1 longer than P2, P2 base slightly elevated; labrum with three setae on each side externally and no seta on each side internally; man-
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slide 113,572), Area de Conservacion Guanacaste, Sector San Cristobal, Potrero Argentina, 520 m, 10.8902° N, 85.38803° W, 26-V-2000, feeding on Capparis mollicella (Capparaceae), coll. F. Quesada; 1 male (INBIO, 02-SRNP-3024, USNM slide 113,573) same data; 2 males (INBIO, 02-SRNP-220, 02-SRNP-262), 2 females (INBIO, 02-SRNP-285, 02-SRNP-286), Area de Conservacion Guanacaste, Sector San Cristobal, Potrero Argentina, 520 m, 10.8902° N, 85.38803° W, 16-1-2002, feeding on Capparis mollicella (Capparaceae), coll. O. Espinoza; 1 male (INBIO, 03-SRNP-6592), 2 females (INBIO, 03-SRNP-6593, 03-SRNP-6607), same data, 13-VI-2003; 1 female (INBIO, 03-SRNP-6604), same data, 8-VI-2003, coll. C. Cano; 1 female (INBIO, 04-SRNP-618), Area de Conservacion Guanacaste, Sector San Cristobal, Corrales Viejos, 495 m, 10.89974° N, 85.38805° W, 27.12.2004, feeding on Capparis mollicella (Capparaceae), coll. E. Araya; 2 males (INBIO, 03-SRNP-5567, 03-SRNP-5572), 3 females (INBIO, 03-SRNP-5563, 03-SRNP-5568, 03-SRNP-5578), same data, 21-1-2003, feeding on Capparis mollicella (Capparaceae), coll. O. Espinoza; 1 male (INBIO, 03-SRNP-5566, USNM slide 113,580), same data; 1 male (INBIO, 03-SRNP-5573, slide 113,581), same data; 3 females (INBIO, 03-SRNP-11680.0, 03-SRNP-11680.21, 03-SRNP-11680.30), Area de Conservacion Guanacaste, Sector San Cristobal, Vado Rio Cucaracho, 640 m, 10.870° N, 85.39153° W, 11-VII-2003, feeding on Capparis mollicella (Capparaceae), coll. J. Perez; 3 males (INBIO, 03-SRNP-11036, 03-SRNP-11051, 03-SRNP-11053, 03-SRNP-11085), 3 females (INBIO, 03-SRNP-11048, 03-SRNP-11053, 03-SRNP-11091), same data, 24-V-2003; 2 males (INBIO, 03-SRNP-11348, 03-SRNP-11353), 1 female (INBIO, 03-SRNP-11355, USNM slide 113,591), same data, 11-VI-2003; 1 male (INBIO, 03-SRNP-11360, USNM slide 113,579) same data; 2 males (INBIO, 03-SRNP-11256, 03-SRNP-11259), 1 female (INBIO, 03-SRNP-11254), same data, 9-V-2003, coll. M. Carmona; 1 male (INBIO, 01-SRNP-3455), 3 females (INBIO, 01-SRNP-3452, 01-SRNP-3454, 01-SRNP-3456), Area de Conservacion Guanacaste, Sector San Cristobal, Rio Blanco Abajo, 10.90037° N, 85.37254° W, 11.00766° W, 26-V-2000, feeding on Capparis mollicella (Capparaceae), coll. O. Espinoza; 1 male (INBIO, 01-SRNP-3459, 01-SRNP-3460), A. C. Arenal, Monteverde, L-N-286000-567500, 150 m, X-1993, coll. P. Rios; 1 male (INBIO, CRIO002135396), same locality, VI-1995, coll. C. Moraga; 1 male (INBIO, CRIO01115615), 1 female (INBIO, CRIO01115181, slide 113,594), Estacion Mengo, SW side Volcan Cacao, 1,100 m, 13-26-VI-1987, colls. D. H. Janzen and W. Hallwachs, LIMON: 1 male (INBIO, CRIO01641981), Sector Cerro Cocori, Finca de E. Rojas, L-N-286000-567500, 150 m, X-1993, coll. E. Rojas; 1 male (INBIO, CRIO03879644), A. C. Tortuguero, Sector Cocori, 30 km N de Cariari, Finca E. Rojas, L-N-286000-567500, 100 m, V-1994, coll. E. Rojas. PUNTARENAS: 1 male (INBIO, CRIO01919250), 1 female (INBIO, CRIO01919266, USNM slide 113,593), A. C. Arenal, Monteverde, San Luis, L-N-250850-449250, 1,040 m, IX-1993, coll. Z. Fuentes; 1 female (INBIO, CRIO003554791, USNM slide 113,595), Parque Nacional Piedras Blancas, Alrededor de Estacion el Bonito, L-S-292700, 548350, 100–200 m, XI-2002, “Red de Golpe,” coll. M. Moraga; 1 female (INBIO, CRIO01919087, USNM slide 113,596), Peninsula de Osa, Rancho Quemado, L-S-292500, 511000, 200 m, IX-1991, coll. F. Quesada; 1 male (INBIO, CRIO03838369), same locality, XII-1991, coll. F. Quesada; 1 male (INBIO, CRIO01110125), Osa Peninsula, Corcovado National Park, Sirena, 1-V-1984, colls. D. H. Janzen and W. Hallwachs; 1 female (INBIO, CRIO01115185), same data, 10–12-VIII-1980; 1 male (INBIO, CRIO00946789), Reserva Biologica Monteverde, Estacion La Casona, L-N-253250-449700, 1,520 m, IX-1992, coll. N. Obando; 1 male (INBIO, CRIO00992268), Peninsula de Osa, Filo Draque, L-N-294000-508200, 24-VI-1999, coll. F. Quesada. Paratypes deposited at BMNH, INBIO, and USNM.
Distribution. Costa Rican provinces of Alajuela, Guanacaste, Limon, and Puntarenas.

Biota. Several larvae were collected and reared from Capparis mollicella (Capparaceae), as well as Forchhammeria trifoliata (Capparaceae), (Janzen and Hallwachs 2005). The adults moths fly year-round and have been collected between 50 m and 1,600 m.

Etymology. spatula (Latin, noun, feminine) = broad blade; a noun in apposition describing the broadly spatulate, posteroventral flange on the sacculus of the male.

Cosmopterosis thetysalis (Walker) (Figs. 4, 7, 17, 20)

Cataclysta thetysalis Walker, 1859: 440; Amsel 1956: 110.

Diagnosis. This species can be recognized by the distinct pattern of the cataclystiform spots on the upper hindwing (Fig. 4). The middle of each spot has brown scales the same color as those of the adjacent area of the hindwing rather than the silver and black invaginated pattern present in the other species.

Adult. Head (Fig. 4). Setiform scales on vertex apex yellow.

Thorax (Fig. 4). Patagium uniformly creamy white. Tegula reddish brown laterally and medially, but creamy white centrally.

Forewing (Fig. 4). Above, costa and apical one third golden yellow: basal one fourth ocherous to very pale brown; basal, subbasal, and antemedial lines diffuse, with brown-tipped scales, but indicated by pale brown intersections with costa; medial line pale brown to brown at costa and posteriorly to M₁, fuscous to hind margin; area between antemedial and medial lines rufous; area basal to anterior portion of postmedial line yellow dorsally, white toward middle. Male with another patch of erect scales beyond appressed scales.

Hindwing (Fig. 4). Above subbasal spot obscure, medial line composed of diffuse rufous scales; postmedial and subterminal lines composed of diffuse brown-tipped scales, slightly obscured by adjacent scales of similar color. Cataclystiform spots discontinuous centrally, scales the same color as adjacent area of hindwing. Below medial line and postmedial line pale brown, vestiges of cataclystiform spots, black scales visible.

Abdomen (Fig. 4). Male tergite I with pale brown-tipped scales medially.

Male Genitalia (Fig. 17). Juxta with deep median channel that opens postero-dorsally to fluted, bifid aperture at anellus; sacculus slightly thickened, surface smooth, lacking denticules, apex with narrow posteroventral flange 6× longer than wide.

Female Genitalia (Fig. 20). Ostium bursae posteriorly 0.5× width of posterior margin of segment VII, surfaces smooth; cervix bursae 0.75× width of ostium bursae, rugose and finely spiculate dorsally and laterally; left and right signa isolated anteriorly.

Immature Stages. Unknown.

Material Examined. Five males, 5 females.

Type Material. HOLOTYPE: 1 female (BMNH, examined): BRAZIL, Rio Amazonas, Villa Nova [Parintins], coll. H. W. Bates. Additional specimens examined. FRENCH GUIANA: 1 male (USNM), Ca cc, 30-III-1986, coll. C. V. Covell, Jr.; 1 male (USNM), Cayenne, coll. W. Schaus; 2 females (USNM), Saint Jean, Saint Laurent du Maroni, coll. W. Schaus; 2 males (USNM), Saint Laurent du Maroni, coll. Dognin.

SURINAME: 1 male (BMNH slide 21,198), 1 female (BMNH slide 21,199), Marowew Valley, Aroewawa Creek, June 1905, coll. S. M. Klages. VENEZUELA: 1 female (USNM), Amazonas, Rio Orinoco.

Distribution. Southern Venezuela and northeast Brazil north to the coast of Suriname and French Guiana.

Biota. Unknown.

1 female (USNM slide 113,539) from BRAZIL (Bahia, Jequité, 500 m, 15-IV-1992, coll. V. O. Becker) may represent an additional species, but more material is needed before we can be certain.

Discussion

There has been significant progress in the last two decades on the study of Lepidoptera, but many aspects about their biology and morphology remain poorly known. In Costa Rica progress has been made by D.H.J. and W. Hallwachs where a massive rearing effort has resulted in data about immature stages and in long series of adult specimens of Lepidoptera. Such studies, and other similar studies all over the world, expand our knowledge about species; we learn what it looks like during its many early stages of life, what it is doing in its habitat, what it eats, and perhaps what eats it. In addition, the morphological and biological data that the immature stages provide has resulted in more robust phylogenetic studies. The long series of specimens collected in the same locality has opened the doors to the study of intraspecific variation in adults and the discovery of behaviorally interesting characters such as secondary sexual structures.

Secondary sexual structures such as scent-producing structures, associated modified scales, and their glands (Brown and Miller 1983, Birch et al. 1990) provide a window into the diversity of lepidopteran adult reproductive behavior. Lepidopteran behavior, glands, and structures such as coremata, androconia, hairpencils, Stobbe’s gland, brushes,alar organs, and osmophores are succinctly summarized by Hallberg and Poppy (2003). In the past male secondary sexual structures on various parts of the body were thought to be too complex and too variable to provide any phylogenetic information above the species level. Recent articles have shown that they can be used to define taxa at different levels, for example, at the superfamily level in Yponomeutoidea (Hsu and Powell 2005, Landry 2007), at the subfamily level in Noc tuidae (Wagner 2007), at the tribal level in Ctenuchini (Weller et al. 2000) and Tortricinae (Brown 1990), at the tribal, generic, and species level in Riodinidae (Hall and Harvey 2002), at the generic level in noctuids (Troubridge and Lafontaine 2007), at the ge-
neric and species level group in Heliodinidae (Hsu and Powell 2005), and at the species group level in conjunction with mitochondrial data in Ctenuchini (Schneider et al. 1999) and with host plant data and ultrasound production in milkweed tussock moths (DaCosta et al. 2006).

In Pyraloidea, many species have secondary sexual structures with specialized scales, singly or in patches, sometimes associated with membranous structures such as folds or hairpencils on various parts of the body such as antennae, maxillary and labial palpi, alar organs such as pockets, costal wing folds, and forewing sound producing organs, hairpencils on the thorax, legs, and abdomen, and coremata associated with the eighth abdominal segment. Often this information is buried in published taxonomic studies and unpublished taxonomic theses (Cashatt 1968, Clavijo 1990).

In the Pyralidae, secondary sexual structures include alar organs in Chrysauginae (Cashatt 1968) and Epipaschiinae (Solis 1993), antennal, maxillary and labial palpi modifications of epipaschiine heads (Solis 1993), and in the Phycitinae antennal modifications and abdominal coremata (Heinrich 1956; Horak 1997; Neunzig 1986, 1990, 1997, 2003; Simonsen 2008). Contrary to prevalent opinion at the time, Janse (1931), after his outstanding study of epipaschiinae male heads, stated: “I now consider [secondary sexual organs] of so much importance, that I hold that they should always be taken into consideration, not only in defining the species, but also in the limiting of a genus...” A phylogenetic analysis on a monophyletic group of genera of the Epipaschiinae of the Western Hemisphere by Solis (1993) corroborated Janse’s idea that secondary sexual characters could be informative at the generic level despite the homoplasy associated with these structures that was often observed superficially and/or casually from a higher level taxonomic perspective. Most recently, Simonsen and Roe (2009) investigated the taxonomic significance of complex scale brushes associated with the eighth abdominal sternite in Dioryctria Zeller (Phycitinae). They found the majority to be homoplastic, but eight characters were unique apomorphies.

Descriptions of secondary sexual structures in the Crambidae exist in taxonomic research papers, but there is a paucity of major phylogenetic analyses that cite examples of informative secondary sexual characters. In the Odontiinae, Leraut and Luquet (1982) described a tribe based on the presence of highly modified structures associated with the male genitalia and androconia associated with sternite VIII. In the Spilomelinae, Clavijo (1990) discussed the generic distribution (Diaphania Stephens, Omiodes Guenée, Palpita Hübner, and Sparagmos Guenée) of an apisternal scale organ, two clusters of scale-like structures on the mesothorax. He also proposed the term “parategumen sclerites” for commonly found lateral sclerites located near the base of the tegumen with long hairpencils or brushes. He described the “anal tuft” as specialized scales on the parategumen sclerites and the eighth abdominal segment and as an apomorphy for Diaphania. Sutrisno (1999) found coremata with complex basal structures to be an apomorphy of Glyphodes Guenée group I and coremata with simple basal structure with broad, long scales, with sculpted scale tufts as an apomorphy for the monophyletic group of Agriotypyga + Talanga. In Musotiminae, Phillips and Solis (1996) mention specialized thoracic and leg scales at the species level in Neurophyeseta Hampton not found in other musotimines, and Solis et al. (2005) mention a costal forewing swelling or pocket in Undulambia Lange.

Claphyriinae had been historically defined by the presence of spicate scales on the male hindwing between CuA2 and CuP, but Solis and Adamski (1998) illustrated that not all genera had these scales and that these scales could be piliform, spicate, or a combination of these scales. In this paper we described the radiodiscal process, a new secondary sexual character on the male forewing, but the diversity of the Claphyriinae is such that we suspect many secondary sexual structures will be discovered to be apomorphies for other genera.

In addition, caterpillar collecting efforts in Costa Rica (Janzen and Hallwachs 2005) yielded considerable morphological and ecological data about Cosmopteropsis larvae reared on Capparis L. In the Área de Conservacion Guanacaste (ACG) in northwestern Costa Rica, C. jasonhalli larvae (Fig. 5) were encountered feeding in presumably sibling groups at very low frequency on the both sides of mature leaves of just three (C. frondosa, C. flexuosa, and C. discolor) of the eight species of Capparis (Capparaceae) that occur in the lowland dry forest that covers the Pacific coastal plain of the ACG between 0- and 600-m elevation (see http://janzen.sas.upenn.edu for individual records). Larvae skeletonized the leaf blades and spun light silk over the surface of the leaves, but moved about freely on the leaf surface. There may be 1–100+ larvae in one group depending on how much the initial group of siblings has been disturbed. They fed both night and day, and were very conspicuous in having red-to-orange heads and rears, and strong white-caste dorsal patches against a black background. In ACG, C. jasonhalli larvae have been found only in dry forest (14 different larval groups discovered in 26 yr), and the very similar C. spatha was restricted to ACG rain forest and the lower margins of cloud forest (400–1,200 m). Like its congener, its conspicuous (Fig. 6) and social/gregarious larvae fed on the mature leaves of two species of Capparis (C. frondosa and C. mollicella) and on Forcammeria trifoliata Radlk. (Capparaceae), an upper elevation treelet in the lower margins of the cloud forest (22 different larval groups discovered in 11 yr).

Adults of C. jasonhalli have been collected with light traps from the semideciduous intermediate elevation rain forests near Tamazunchale, S.L.P., Mexico, and the very decidious dry forest of Isla Maria Magdalena, Nayarit, Mexico, south to the dry forests of Paraguay, with the habitats in between ranging from strongly deciduous (e.g., Mexican and ACG Pacific coastal forests) to rain forest (Sirena, Osa Peninsula, Costa Rica) to lower cloud forest (Cerro Campana, Panama). This
very broad ecosystem coverage over their entire range stands in strong contrast to the apparent restriction of *C. jasonhalli* to dry forest in ACG. Light-caught adults of *C. spatha* are known only from Costa Rican rain forest and lower elevation cloud forest sites, just as are the larvae of *C. spatha* in ACG. These two species undoubtedly co-occur in the area at 400–600-m elevation on the ACG west slopes of the Cordillera Guanacaste where dry forest and rain forest intergrade. But in general terms, *C. jasonhalli* is the dry forest *Cosmopterosis* and *C. spatha* is the rain forest *Cosmopterosis*. Both are unambiguously specialists on Capparaceae. The ACG caterpillar inventory has reared >350,000 wild-caught larvae of >3,000 species on thousands of food plant species without encountering the very distinctive *Cosmopterosis* larvae on any other plant family (as well as being conspicuously absent from at least five other species of *Capparis*).

_Cosmopterosis* larvae are rarely attacked by parasitoids. During a 27-yr period, rearing of 738 wild-caught ACG *Cosmopterosis* caterpillars have yielded only four tachinids (one species in *C. jasonhalli*) and 12 braconids (a species of *Hypomicrogaster* and a species of *Microchelonus* in *C. spatha*).

Finally, another interesting observation is the paucity of Capparaceae larval feeders in the Lepidoptera. With an upper estimate of ~482,000 lepidopteran species (Solis and Pogue 1999), larval feeding of Capparaceae is relatively rare in lepidopteran families and restricted to specific genera presumably due to glucosinolates that may serve as either detection cues to the adapted or as a deterrent to unadapted lepidopterans (Futuyma 1986). The Pieridae is an exception where hundreds of species are known to feed on Capparaceae, ~90 species on *Capparis*, and their ecological interactions with Capparaceae and Brassicaceae have been well studied (e.g., Renwick 2001). But there are only 11 known *Capparis*-feeding species in other lepidopteran families: Cosmopterigidae (one species), Gelechiidae (one species), Gracillariidae (two species), Lymnaudiidae (one species), Tortricidae (three species), Yponomeutidae (two species), and Thyrididae (two species) (Robinson et al. 2007).

Capparaceae-feeding in the Pyraloidea has infrequently evolved independently geographically and taxonomically in several subfamilies of the Crambidae; there are no published records of species reared on *Capparis* or Capparaceae in Pyralidae. Published records of *Capparis*-feeding includes Crocidolomia Zeller (11 species; Evergestinae; two species reared) in Asia and Africa, *Stiphrometasia* Zerny (four species; Cybalomiinae; one species reared) in the Middle East and Russia, and *Stropholepis* Hampson (six species; Midilinae; one species reared) and *Dolichobela* Turner (one species; Midilinae; reared) in Australia (Shaffer et al. 1996, Robinson et al. 2007). Published records of *Capparis*-feeding in the Western Hemisphere include Dichogama Lederer (11 species; Dichogaminae; four species; reared), Alutunusia Amsel (five species; Dichogaminae; one species reared), and *Cosmopterosis* Amsel (four species; Glaphyrininae; two species reared). There are two other known pyraloids feeding on Capparaceae in Costa Rica, a gallmaker and a leafminer on fruit (M.A.S., unpublished). It is expected that other species in the pyraloid genera listed above also feed on *Capparis* or other genera of Capparaceae.

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