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Revision of New World *Cosmorrhyncha* Meyrick, 1913 (Lepidoptera: Tortricidae: Olethreutinae), with descriptions of five new species

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Revision of New World *Cosmorrhyncha* Meyrick, 1913 (Lepidoptera: Tortricidae: Olethreutinae), with descriptions of five new species

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Abstract. Although well studied in the Afrotropical Region, the genus *Cosmorrhyncha* Meyrick, 1913 (Lepidoptera: Tortricidae: Olethreutinae), has received little attention in the New World, where it apparently is restricted to the Neotropics from Guatemala south to Paraguay. Seven species are recognized, five of which are described as new*: C. tonsana* (Walker, 1863) (Type locality: Brazil); *C. ocelliferana* (Walker, 1863) (TL: Brazil); *C. landryi* Brown and Razowski, **sp. n.** (TL: French Guiana); *C. parintina* Brown and Razowski, **sp. n.** (TL: Brazil); *C. macrospina* Brown and Razowski, **sp. n.** (TL: Brazil); *C. albistrigulana* Brown and Razowski, **sp. n.** (TL: Costa Rica); and *C. osana* Brown and Razowski, **sp. n.** (TL: Costa Rica). Our circumscription of *C. ocelliferana* is rather broad and most likely encompasses a species complex rather than a single entity. Larvae of *C. tonsana* have been reared from *Picramnia latifolia* Tul. (Picramniaceae), *Dialium guianense* (Aubl.) Sandwith (Fabaceae), and *Machaerium seemannii* Benth. ex Seem. (Fabaceae) in Costa Rica; and those of *C. albistrigulana* from *Dialium guianense* (Fabaceae).

Key words. Afrotropical Region, *Eccopsis*, *Neorrhyncha*, Neotropics, Fabaceae

Introduction

Cosmorrhyncha Meyrick, 1913 exhibits a geographic distribution that is remarkable among tortricid genera, with species recorded only from the Afrotropical (Madagascar and mainland Africa) and Neotropical Regions (Central and South America). The only other tortricid genera with similar distributions are *Apotoforma* Busck, 1934, and *Eccopsis* Zeller, 1852. *Apotoforma* is recorded from the Caribbean, Central America, and southern Africa (Razowski 1993). *Eccopsis* is recorded from western South America and throughout the Afrotropical Region; however, it recently has been questioned whether Neotropical and Afrotropical species are congeneric (Brown 2014; Vargas-Ortiz et al. 2017).

Species of *Cosmorrhyncha* and its putative sister group *Neorrhyncha* Aarvik, 2004, the latter of which is restricted to the Afrotropical Region, have a characteristic and highly distinctive forewing shape and pattern that includes a costa that is variably bent and then straight in the apical one-third, a pair of iridescent silver lines in the apex, and a distinctive raised circular patch of opalescent silver scales near the end of the discal cell. They also have distinctive elongate labial palpi with blue and orange scales in both sexes. Based on male genitalia and forewing shape, the group is most closely related to *Eccopsis* Zeller, 1852 from the Afrotropical Region. However, significant differences in forewing length and pattern, shape and length of the labial palpi, and development of the signum in the female genitalia provide convincing evidence that *Cosmorrhyncha*, *Neorrhyncha*, and *Eccopsis* are distinct genera.

The purpose of this paper is to clarify the taxonomy of the New World species of *Cosmorrhyncha*, describe five new species, present data on larval host plants, and discuss putative relationships of *Cosmorrhyncha* within the genus group Neopotamiae as defined by Diakonoff (1973) and revised by Aarvik (2004).

Materials and Methods

We examined 197 specimens of Neotropical *Cosmorrhyncha* deposited in collections worldwide, along with 68 genitalia preparations. Abbreviations of depositories are as follows: NHMUK, The Natural History Museum, London, United Kingdom; MNCR, Museo Nacional de Costa Rica (formerly INBio, Instituto Nacional de Biodiversidad), Santo Domingo de Heredia, Costa Rica; and USNM, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA. Other abbreviations used in the materials examined include the following: ACG = Area de Conservación Guanacaste (Costa Rica); em = emerged; GS = genitalia slide number; and r.f. = reared from.

Dissection methods followed those summarized by Brown and Powell (1991), except the phallus was left in situ. Terms for morphological features follow Diakonoff (1966) and Aarvik (2004), except the term "phallus" is used instead of "aedeagus." Forewing length was measured from base to apex, including the fringe. In the descriptions, "hind margin" refers to the forewing margin opposite of (nearly parallel to) the costa, frequently called the "dorsum" in tortricid literature. Slide mounted genitalia were examined using dissecting and compound microscopes. Images of adults and genitalia were captured using a Canon EOS 5D digital camera SLR (Canon U.S.A., Lake Success, NY) mounted on a Visionary Digital BK Lab System (Visionary Digital, Palmyra, VA), and edited in Adobe Photoshop.

Tissue samples (one leg of an adult moth) were used to amplify a ~650bp region of the mitochondrial gene cytochrome oxidase 1 (COI), commonly referred to as the DNA "barcode," using standard procedures employed at the Biodiversity Institute of Ontario, University of Guelph (Hebert et al. 2004, 2013; Craft et al. 2010; Wilson 2012) with the primers LepF1, MLepF1, LepR1, MLepR2 (Hajibabaei et al. 2006), LCO-1490 and HCO-2198 (Folmer et al. 1994). Six species of *Cosmorrhyncha* were sequenced (Table 1): *C. macrospina* (n = 2), *C. tonsana* (n = 75), *C. albistrigulana* (n = 49), *C. landryi* (n = 1), *C. osana* (n = 2), and *C. ocelliferana* (n = 3). Sequences of *Eccopsis praecedens* Walsingham, 1879 (n = 1), *E. nebulana* Walsingham, 1891 (n = 1), and *Paraeccopsis exhilarata* (Meyrick, 1918) (n = 1) were included as outgroups. Because all specimens of *C. tonsana* share extremely similar haplotypes, we included only 10 examples (which capture the haplotype diversity) of it in the analysis. For similar reasons, only 10 specimens of *C. albistrigulana* are included in the analysis.

The software Geneious version 9.1.7 (Biomatters, Auckland, New Zealand) was used to align sequences with the MUSCLE algorithm (Edgar 2004). Pairwise genetic distances among sequences were calculated using MEGA7 (Kumar et al. 2016), based on the Kimura 2-parameter (K2P) model (Kimura 1980). The same software was used to select the best model to describe the substitution pattern based on the lowest Bayesian Information Criterion (BIC) and to conduct neighbor-joining (NJ) analysis. The best-fit model of nucleotide substitution pattern was found to be the Tamura 3-parameter (T92 model), with a Gamma distribution shape parameter (G) of 0.21. For NJ analysis, statistical support of each clade was assessed using the bootstrap method with 10,000 replicates (Felsenstein 1985). The number of haplotypes was estimated using Arlequin 3.5 (Excoffier et al. 2005).

We conducted three analyses (Fig. 1–3) of the barcode data (Table 1): (1) one that included all available sequences, regardless of sequence length (28 sequences of *Cosmorrhyncha* plus outgroups); (2) one that excluded the 200bp segment that could not be amplified for several specimens (e.g., *C. osana* were not included because their short sequences overlapped considerably with the 200bp segment) (24 sequences of *Cosmorrhyncha* plus out-groups); and (3) one that included only those samples with barcodes >500 bp (23 sequences of *Cosmorrhyncha* plus outgroups).

Table 1. Species identities, collecting location (BR = Brazil; CR = Costa Rica; KEN = Kenya; SA = South Africa), accession data, and collection dates, and number of base pairs for specimens included in the molecular analysis. Brazilian locations are states, Costa Rican, South African, and Kenyan locations are provinces. Sequences indicated by an asterisk (*) include a 200bp segment that could not be amplified, but this segment is included in the total sequence length.

Species	Location	Process ID/ GenBank ID	Museum ID	Coll. Date	# bp
C. albistrigulana	Maranhão, BR	NGSFT4203-17	USNM ENT 01237784	27 Nov 1990	537bp*
C. albistrigulana	Rondônia, BR	NGSFT4202-17	USNM ENT 01237783	12 May 1989	654bp*
C. albistrigulana	Rondônia, BR	NGSFT4204-17	USNM ENT 01237785	30 Nov 1991	442bp
C. albistrigulana	Rondônia, BR	NGSFT4201-17	USNM ENT 01237782	30 Nov 1991	654bp
C. albistrigulana	Rondônia, BR	LNAUV629-16	USNM ENT 01237782	30 Nov 1991	258bp
C. albistrigulana	Alajuela, CR	ASHYC5061-12	12-SRNP-67366	9 Mar 2012	654bp
C. albistrigulana	Alajuela, CR	ASHYC5063-12	12-SRNP-67365	7 Mar 2012	654bp
C. albistrigulana	Alajuela, CR	ASHYC5058-12	12-SRNP-67355	8 Mar 2012	654bp
C. albistrigulana	Alajuela, CR	ASHYC5057-12	12-SRNP-67356	7 Mar 2012	654bp
C. albistrigulana	Alajuela, CR	ASHYC5056-12	12-SRNP-67367	8 Mar 2012	654bp
C. landryi	French Guiana	NGSFT4199-17	USNM ENT 01237780	28 Jan 1985	654bp*
C. macrospina	Rondônia, BR	NGSFT4200-17	USNM ENT 01237781	30 Nov 1991	654bp*
C. macrospina	Rondônia, BR	NGSFT4205-17	USNM ENT 01237790	30 Nov 1994	654bp*
C. ocelliferana	Minas Gerais, BR	LNAUV643-16	USNM ENT 01237796	3 Nov 1983	603bp
C. ocelliferana	Mato Grosso, BR	NGSFT4208-17	USNM ENT 01237793	26 Oct 1993	654bp*
C. ocelliferana	Rondônia, BR	LNAUV642-16	USNM ENT 01237795	30 Nov 1991	300bp
C. osana	Puntarenas, CR	LNAUV635-16	USNM ENT 01237788	31 Mar 1994	336bp
C. osana	Puntarenas, CR	LNAUV633-16	USNM ENT 0123778	28 Feb 2002	333bp
C. tonsana	Bahia, BR	LNAUX1517-18	USNM ENT 01523557	15 Mar 2015	654bp
C. tonsana	Guanacaste, CR	MHMYK2468-11	10-SRNP-30731	7 Apr 2010	654bp
C. tonsana	Guanacaste, CR	MHMYK2469-11	10-SRNP-30725	7 Apr 2010	654bp
C. tonsana	Guanacaste, CR	BLPEE7047-14	13-SRNP-71561	20 Sep 2013	654bp
C. tonsana	Guanacaste, CR	MHMYE539-09	08-SRNP-32773	10 Nov 2008	618bp
C. tonsana	Alajuela, CR	BLPAA3980-17	16-SRNP-26886	19 Jun 2016	654bp
C. tonsana	Alajuela, CR	BLPAA3976-17	16-SRNP-26898	26 Jun 2016	654bp
C. tonsana	Alajuela, CR	BLPAA3977-17	16-SRNP-26868	13 Jun 2016	654bp
C. tonsana	Alajuela, CR	BLPAA3979-17	16-SRNP-26835	1 Jun 2016	654bp
C. tonsana	Alajuela, CR	BLPAA3981-17	16-SRNP-26834	30 May 2016	654bp
E. nebulana	Rift Valley, KEN	AFTOR038-12 KJ592317	USNM ENT 00676492	8 Apr 2000	658bp
E. praecedens	Central, KEN	AFTOR044-12 KJ592293	USNM ENT 00676498	19 Jan 2003	658bp
P. exhilarata	Gauteng, SA	EPNG9017-15	USNM ENT 01067923	31 Jan 2015	658bp

Results

Cosmorrhyncha Meyrick, 1912

Type species. *Tortrix ocellata* Mabille, 1900, by original designation.

Taxonomic history. *Cosmorrhyncha* was proposed by Meyrick (1913) to accommodate the single species *Tortrix ocellata* Mabille, 1900 from Madagascar. In his description, Meyrick incorrectly concluded that his previously described species *Eccopsis acrocosma* Meyrick, 1908 from Malawi, was conspecific

with *C. ocellata*, and he synonymized the two. Diakonoff (1981) redescribed the genus, comparing it to *Eccopsis*, and retained the synonymy of the two included species. Apparently based on the superficially similarity among the types of the described species, Powell et al. (1995) synonymized the Neotropical *Carpocapsa ocelliferana* Walker, 1863 (from Brazil) with *Cosmorrhyncha ocellata* and *Cosmorrhyncha acrocosma* in the checklist of Neotropical Lepidoptera without comment. Powell et al. (1995) also incorrectly transferred the genus from Olethreutini to Grapholitini. Aarvik (2004) revised the Afrotropical species of *Cosmorrhyncha*; he was the first to recognize that *C. acrocosma* was distinct from *C. ocellata*, and he described one species as new. Aarvik (2004) did not mention the occurrence of *Cosmorrhyncha* in the New World. Razowski (2004) listed the genus in his review of Afrotropical tortricid genera, quoting key elements of Diakonoff's (1981) diagnosis, and likewise mentioned the genus only from the Afrotropical Region. Brown (2005) listed five described species under *Cosmorrhyncha*: *C. acrocosma*, *C. microcosma* Aarvik, *C. ocelliferana*, *C. ocellata*, and *C. tonsana* (Walker), transferring the last to the genus without comment and without noting that it was a new combination. Most recently, Razowski and Wojtusiak (2012) described *C. obuduana* Razowski and Wojtusiak, 2012 from Nigeria.

Morphology. Species currently assigned to *Cosmorrhyncha* are extremely similar in facies and nearly indistinguishable from *Neorrhyncha* Aarvik, 2004 (Aarvik 2004; Razowski and Wojtusiak 2012). All are medium-small, reddish- or grayish-brown moths with a distinct rounded patch of raised silver gray or bluish gray scales near the distal end of the forewing discal cell. Within the group Neopotamiae (sensu Diakonoff 1981; Aarvik 2004), the genitalia of *Eccopsis* are extremely similar to those of *Cosmorrhyncha*, but the forewing shape, size, and pattern of *Eccopsis* are all dissimilar to those of *Cosmorrhyncha* (many *Eccopsis* are superficially similar to members of the Holarctic genus *Olethreutes* Hübner, 1822 and the pantropical genus *Megalota* Diakonoff, 1966). Males of *Cosmorrhyncha* have a well-developed roll of secondary sex scales along the anal margin of the hindwing, and this feature is shared with many species of *Eccopsis*, *Olethreutes*, and *Megalota*. In contrast to related and/or similar genera, the labial palpi in *Cosmorrhyncha* and *Neorrhyncha* are elongate, slender, porrect, and somewhat pointed apically, usually orange or reddish brown with a dorsal or subdorsal iridescent bluish or black longitudinal line along the second segment. However, the labial palpi of *C. tonsana* lack this modification, and hence are more similar to those of putative related genera, e.g., *Eccopsis* and *Megalota*.

The male genitalia of Neotropical *Cosmorrhyncha* are nearly indistinguishable from those of some species of *Eccopsis*, with a broad uncus with a rounded, bifid, spined apex; a broadly hourglass-shaped tegumen with rounded dorso-lateral shoulders; elongate, digitate socii; a short but well-defined subbasal process ("labis" sensu Diakonoff 1966) from the costa of the valva; and a valva that is distinctly expanded at the lower edge of the cucullus. Afrotropical species of *Cosmorrhyncha* can be distinguished from *Eccopsis* by the less developed subbasal process of the valva and an elongate dense row of stout setae along the basal edge of the cucullus. The male genitalia of some species of Neotropical *Cosmorrhyncha* can be distinguished from those of *Eccopsis* by the presence of one or more stout spines from the basal one-third of the valva, immediately basad of the cucullus, but these are absent in a few species. Similar to *Eccopsis* and *Megalota*, a small degree of asymmetry is present in the male genitalia of some species of *Cosmorrhyncha*, mostly in the configuration and number of spines on the valva.

The female genitalia of *Cosmorrhyncha* are extremely similar to those of *Neorrhyncha*. They also are similar to those of *Eccopsis*, but those of *Cosmorrhyncha* can always be distinguished by the shape of the signum—a straight, somewhat spindle-shaped plate from a weakly rounded base, shared with *Neorrhyncha*. The signum in *Eccopsis* usually bears two spindle-shaped plates or blades. In Afrotropical *Cosmorrhyncha* the posterior margin of sternum 7 is broadly V-shaped; in the Neotropical *C. tonsana*, *C. ocelliferana*, and *C. macrospina* it is more narrowly V-shaped (Fig. 22–24); and in the Neotropical *C. albistrigulana* and *C. osana* it is broadly rectangular (Fig. 25–26). This shape (V-shaped vs. rectangular or U-shaped) divides New World members of the genus into two groups. However, because females are unknown for three of the seven species, assignment of all species to one of these groups is not possible.

Relationships within Neopotamiae. On the basis of the nearly indistinguishable forewing shape and pattern, and the signum of the female genitalia, *Cosmorrhyncha* is almost certainly the sister-group to *Neorrhyncha*. However, male genitalia of the two genera are moderately divergent, most likely the result of numerous autapomorphies acquired by *Neorrhyncha*. Based on numerous derived features of

the male genitalia (i.e., uncus broad and distally bifid and spined; rounded dorsal shoulders of the tegumen; valva broadened at the base of the cucullus), *Cosmorrhyncha+Neorrhyncha* is the putative sister-group to *Eccopsis*. Within the context of Neopotamiae, additional related genera include *Paraeccopsis* Aarvik, 2004, *Megalota*, *Metendothenia* Diakonoff, 1973, *Geita* Aarvik, 2004, *Afroploce* Aarvik, 2004, and *Afrothreutes* Aarvik, 2004 (Aarvik 2004), all of which share a similar signum. In contrast, the signum of *Neopotamia* Diakonoff, 1973 is very different – a pair of subequal, U-shaped plates (Diakonoff 1973; Razowski and Brown 2018).

DNA barcodes. Although all specimens from ACG were successfully sequenced (i.e., 75 of *C. tonsana* and 49 of *C. albistrigulana*) (Janzen and Hallwachs 2011), with few exceptions specimens from elsewhere yielded only short or no sequences. Short sequences were generated for *C. albistrigulana* from Brazil (258bp) and *C. ocelliferana* LNAUV642-16 (290bp), as well as for *C. osana* LNAUV633 (286bp) and *C. osana* LNAUV635 (289bp). For a number of specimens, a 200bp segment near the center of the DNA barcode could not be amplified, including two specimens of *C. albistrigulana* (NGSFT4202-17 and NGSFT4203-17), both specimens of *C. macrospina*, and a single specimen each of *C. landryi* (NGSFT4199-17) and *C. ocelliferana* (NGSFT4208-17) (Table 1). All other sequences were trimmed to a length of 654bp. Amplification failure likely was due to specimen age and/or storage in a humid environment, resulting in DNA degradation.

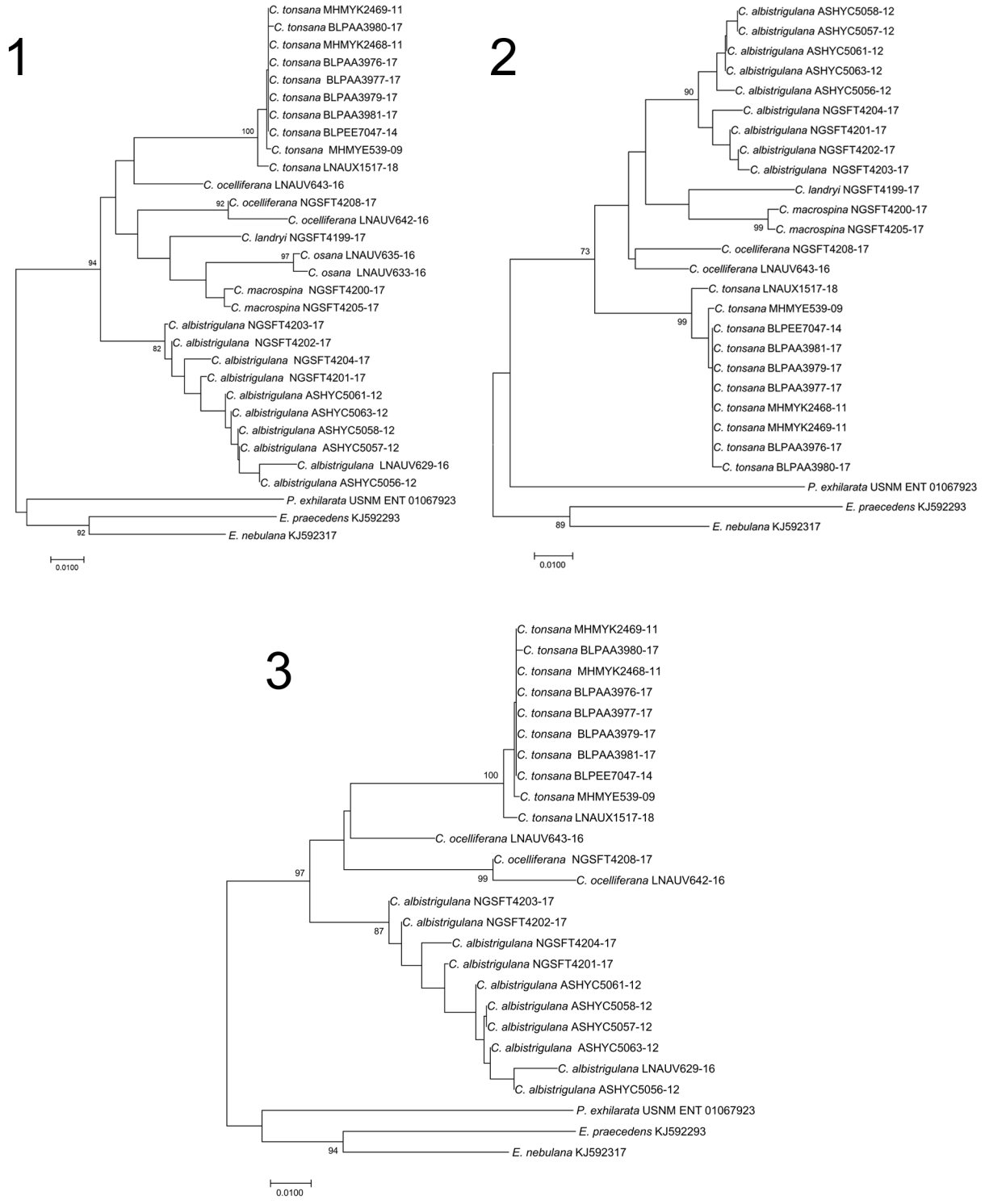
Although single gene trees are a poor substitute for those based on multiple genes and/or morphology, they often are consistent with the distribution of morphological characters at the species level, and hence, possess a degree of phylogenetic signal.

Figure 1 is a neighbor-joining tree of 28 *Cosmorrhyncha* sequences, regardless of sequence length, rooted with *Paraeccopsis* and *Eccopsis*. The monophyly of *Cosmorrhyncha* is well supported (i.e., bootstrap support (BS) = 94) in relation to the outgroup taxa, and within the genus, *C. albistrigulana* is portrayed as sister to the remaining species. There is strong support for the monophyly of *C. albistrigulana* (BS = 82), *C. tonsana* (BS = 100), and *C. osana* (BS = 97), but not for *C. ocelliferana* (i.e., two sequences appear to be conspecific, but a third is not). Because the tree is based on sequences of variable length (i.e., missing data), and most of the species are represented by few examples, the relationships portrayed within *Cosmorrhyncha* are not particularly compelling.

Figure 2 is a neighbor-joining tree of 24 *Cosmorrhyncha* sequences, rooted with *Paraeccopsis* and *Eccopsis*. In this tree the sequence data for all specimens excludes the 200bp segment that could not be amplified for several specimens. For example, *C. osana* was excluded from the analysis because its short sequences overlap considerably with the 200bp segment that was missing for several specimens. As in Figure 1, the monophyly of *Cosmorrhyncha* is well supported (BS = 73) in relation to the outgroup taxa. However, within the genus, *C. tonsana* is portrayed as sister to the remaining species. Although this tree suffers from many of the same shortcomings as the tree in Figure 1, the sequences used to generate Figure 2 are more consistent in length among the sampled taxa. This arrangement, with the other *Cosmorrhyncha* comprising a clade without *C. tonsana*, is consistent with morphology; i.e., the short labial palpi and putative plesiomorphic wing pattern of *C. tonsana*; and it is perhaps the most compelling of the three trees.

Figure 3 is a neighbor-joining tree of 23 *Cosmorrhyncha* sequences, rooted with *Paraeccopsis* and *Eccopsis*. This tree includes only specimens for which sequences longer than 500bp were analyzed. As a result, only three species of *Cosmorrhyncha* are included (less than half of the recognized Neotropical species), which provides extremely limited insight into relationships among the species of the genus. As in the other trees, the monophyly of *Cosmorrhyncha* is well supported (BS = 97), as is the monophyly of *C. albistigulana* (BS = 87) and *C. tonsana* (BS = 100), and two of the three specimens of *C. ocelliferana*.

Biogeographic implications. The geographic distribution of *Cosmorrhyncha* is intriguing, with four species from the Afrotropical region, seven species from the Neotropical region, and none from elsewhere. While this Afrotropical-Neotropical connection suggests a Gondwanan origin of the genus, the group is too recent for its distribution to be the result of continental drift (Fagua et al. 2016). Several other tortricid genera are found in both the Afrotropical and Neotropical Regions, but most are not restricted to this distribution. For example, *Megalota* is species-rich in the Neotropical and Afrotropical Regions, but also occurs in Australia and the tropical regions of Asia, and is absent from typical Gondwanan locales



Figures 1–3. Neighbor-joining trees. **1)** Tree based on all available sequences of *Cosmorrhyncha* ($n = 28$), regardless of sequence length. **2)** Tree based on sequences excluding the the 200bp segment that could not be amplified for several specimens of *Cosmorrhyncha* ($n = 24$). **3)** Tree based on all sequences longer than 500bp ($n = 23$). [Bootstrap values ≥70 shown at nodes; BOLD process IDs or GenBank accession numbers next to species names.]

(e.g., Notogea (Australasia) and the Patagonian Province of the Neotropical Region) (Brown 2009). For *Megalota* and other genera, the pattern is pantropical rather than Gondwanan. A similarly intriguing pattern is illustrated by *Hystrichophora* Walsingham, 1879, distributed in the Afrotropical and Nearctic regions (Agassiz and Aarvik 2014; Agassiz 2016). Because these patterns are almost certainly not the result of continent drift, it is likely that the distributions of these and many other tortricid groups are the result of dispersal.

While vicariance undoubtedly played a major role in the early evolution and distribution of Lepidoptera, dispersal may be responsible for many of the observed distributions of Lepidoptera species and genera today (e.g., Kergoat et al. 2012; Rota et al. 2016). Rota et al. (2016) reported dispersal over large, intercontinental distances in Choreutidae: four between Australasia and the Afrotropics, and one each between the Afrotropical and Oriental and Nearctic and Afrotropical Regions. Kergoat et al. (2012) noted for *Spodoptera* Guenée, 1852 (Noctuidae) the "…occurrence of two symmetric long-distance dispersal events between the Afrotropical and the Neotropical region, which appear to have occurred in the late Miocene." However, *Spodoptera* are known to be strong fliers, and hence their observed distributions are more likely to be the result of dispersal. Frolov (2013) also invoked a similar trans-Atlantic dispersal for the scarab beetle genus *Stenosternus* Karsch, 1881 (Coleoptera: Scarabaeidae: Orphninae), concluding that "Vicariance of the previously Gondwanan group due to the continent breakup seems the least probable hypothesis in the case of the orphnines."

Life history. Adults of *C. tonsana* have been reared from field-collected larvae on *Dialium guianense* (Aubl.) Sandwith (Fabaceae) (n = 51 individuals), *Machaerium seemannii* Benth. ex Seem. (Fabaceae) (n = 5), *Picramnia latifolia* Tul. (Picramniaceae) (n = 3), and "unknown Simarbouaceae" (n = 6) in Costa Rica. Adults of *C. albistrigulana* have been reared from *Dialium guianense* (Fabaceae) (n = 45). These records suggest a preference for Fabaceae in Costa Rica.

Larvae are translucent pale green with a black to dark-brown head capsule and a pale greenish-amber prothoracic shield with a narrow, weakly bilobed, anterior band. They construct a shelter from a single rolled leaf from which they feed and within which they eventually pupate (Fig. 27–30). Pupae are typically tortricid with two rows of dorsal spines, and typically olethreutine without a distinct cremaster. The pupal stage lasts 7–8 days, and field-collected larvae reared in captivity rarely produced parasitoids.

Species Accounts

***Cosmorrhyncha tonsana* (Walker)**
Fig. 4, 6, 14, 22, 27, 29, 30

Carpocapsa tonsana Walker 1863: 409.
"*Carpocapsa*" auct. (not Treitschke, 1829) *tonsana*: Powell et al. 1995: 157.
Cosmorrhyncha tonsana: Brown 2005: 218.

Diagnosis. Superficially, *C. tonsana* is easily separated from all other congeners by its mottled forewing pattern (Fig. 6) and short labial palpi (Fig. 4). The costa of the forewing is strongly bent at about 0.6 the distance from the base to the apex, and the labial palpi lack the conspicuous metallic bluish-black dorsal scaling characteristic of all other *Cosmorrhyncha*. In the male genitalia of *C. tonsana*, the subbasal process of the valva has a single tooth (as in *C. albistrigulana*), and the phallus lacks a slender cornutuslike distal spine (present in *C. albistrigulana*), and instead has a small thorn near the middle.

Redescription. *Head*. Vertex dark reddish-brown, small area of purplish brown at apex, frons pale reddish-brown; labial palpus (Fig. 4) pale reddish-brown, dorsum of second segment with extremely faint region of blackish scales. *Thorax*. Nota reddish-brown and cream; tegula dark brown. Forewing (Fig. 6) length 5.5–6.5 mm (n = 10), forewing ground dark reddish-brown speckled with pale cream and maroon, with faint refractive shiny gray scales; a small rounded, upraised patch of pale gray and dark reddish-brown scales near distal end of discal cell, surrounded by small dark-brown circular patch; costa strongly bent downward at ~0.6 length from base to apex; costa without well-defined areas of dense silver white strigulae, but with linear row of small grayish-silver scales along distal 0.65 of costa and along subtermen. Fringe mostly brown with region of orange subapically. Hindwing brown, whitish along costa and subcosta

Figures 4–5. Head of *Cosmorrhyncha* species. **4)** Head of *C. tonsana*. **5)** Head of *C. albistrigulana*.

in area of wing overlap; male with long, well defined anal roll. Fringe brown, paler in anal area. *Abdomen*. Dark reddish-brown, with paler scales at distal end. Male genitalia (Fig. 14) with uncus stout, apically bifid, with dense cluster of long spines on each bifurcation; shoulders of tegumen well developed; socius digitate, pendant, covered with fine setae; valva mostly parallel-sided in basal 0.5, upturned, attenuate, densely spined in distal 0.5; cucullus evenly curved along ventral edge, usually with three conspicuously larger setae; patch of long, slender, hairlike setae at venter immediately basad of cucullus, with a pair of long, slender setae from neck of valva slightly basad of hairlike setae; subbasal process of valva triangular, bearing a single spine and second shorted process; juxta shield-shaped; phallus short, stout, with short dorsal spine (sometimes with second smaller spine) near middle, vesica without cornuti. Female genitalia (Fig. 22) with papillae anales unmodified, slightly narrowed anteriorly; sterigma mostly membranous with a strongly sclerotized, mesal, suborbicular plate, weakly emarginate meso-posteriorly; antrum long, urn-shaped; ductus bursae narrow, 6–7 times as long as wide, membranous anterad of antrum, slightly broadened toward corpus bursae, with distinct junction between ductus and corpus bursae; corpus bursae irregularly rounded, weakly and evenly punctuate throughout; signum a single, broad, thorn-shaped blade arising from a round, weakly sclerotized patch, sometimes with a second very short flange from base; ventro-posterior margin of segment 7 with deep V-shaped excavation mesally, resulting in a pair of rounded, sublateral lobes.

Lectotype. ♀ [no abdomen], Brazil, Amazonas, Ega (NHMUK).

Paralectotypes. (2♂, 2♀) Same data as holotype, GS 31645, 31646 (NHMUK).

Additional material. BRAZIL: Amazonas: Teffe, "12–19" [Dec 1919] (1♂), "1–20" [Jan 1920] (2♂, 1♀), Parish (NHMUK). Parintins, "10–19" [Oct 1919] (1♂), Parish (NHMUK). Bahía: Camacan, Reserva Serra Bonita, 800 m, 5–15 Mar 2015 (1♀), Neotropical Lepidoptera Course (USNM). Pará: Rio Trombetas, "9–19" [Sep 1919] (4♂, 1♀), Parish (NHMUK). Obidos, "8-19" [Aug 1919] (1♂), Parish (NHMUK). Santarem, "8–19" [Aug 1919] (1♀), Parish (NHMUK), Oct 1884 (1♀), Leech (NHMUK). COSTA RICA: Alajuela: ACG, Brasilia, Gallinazo, 360 m, 11.01825, –85.37199, 14 Apr 2011, D. Briceño, em: 24 Apr 2011 (1♂), r.f. *Dialium guianense*, 11-SRNP-65188 (USNM); same locality, 9 Jan 2012, D. Briceño, em: 24 Jan 2012 (1♂), r.f. *Dialium guianense*, 12-SRNP-65010 (USNM); same locality, 16 Jun 2011, D. Briceño, em: 26 Jun 2011 (1♂), em: 27 Jun 2011 (1♂, 1♀), r.f. *Dialium guianense*, 11-SRNP-65754, 11-SRNP-65399, 11-SRNP-65398, 11-SRNP-65400 (USNM); same locality, 20 Jun 2011, D. Briceño, em: 23 Jun 2011 (1♂), r.f. *Dialium guianense*, 11-SRNP-65471 (USNM); same locality, 27 Jul 2011, D. Briceño, em: 31 Jul 2011 (1♀), r.f. *Dialium guianense*, (USNM); same locality, 27 Jul 2011, D. Briceño, em: 5 Aug 2011 (1♂), em: 15 Aug 2011 (1♀), r.f. *Dialium guianense*, 11-SRNP-65753, 11-SRNP-65755 (USNM). ACG, Sector Rincon

Rain Forest, Casa Keiner, 123 m, 10.95642°, –85.26617°, 21 Dec 2010, C. Moraga, em: 3 Jan 2011 (1♂), em: 5 Jan 2011 (1♀), r.f. *Dialium guianense*, 10-SRNP-68170, 10-SRNP-68171 (USNM). ACG, Brasilia, Piedrona, 340 m, 11.01618°, –85.35902°, 19 Dec 2012, D. Briceño, em: 1 Jan 2012 (1♂), em: 2 Jan 2013 (1♀), r.f. *Dialium guianense*, 12-SRNP-65988, 12-SRNP-65992 (USNM). ACG, Sector Rincon Rainforest, Quebrada Bambu, 109 m, 10.9301°, –85.25205°, 29 May 2014, M. Moraga, em: 6 Jun 2014 (1♀), em: 31 May 2014 (1♀), 11 Jun 2014 (1♀), r.f. *Dalium guianense*, 14-SRNP-76022, 14-SRNP-76023, 14-SRNP-76025 (USNM). ACG, Brasilia, Moga, 320 m, 11.01227°, –85.34929°, 15 Oct 2011, D. Briceño, em: 27 Nov 2011 (1♀), em: 31 Nov 2011 (2♀), r.f. *Dialium guianense*, 11-SRNP-66030, 11-SRNP-66028,11-SRNP-66029 (USNM); same locality, 17 Jun 2013, D. Briceño, em: 27 Jun 2013 (1♂), 13-SRNP-65299, em: 29 Jun 2013 (1♀), 13-SRNP-65300, r.f. *Dialium guianense* (USNM); same locality, 16 Aug 2012, M. Carmona, em: 30 Aug 2012 (1♂), r.f. *Dialium guianense*, 12-SRNP-65566 (USNM). ACG, Sector Rincon Rain Forest, Palomo, 96 m, 10.96187°, –85.28045°, 19 Feb 2013, K. Aragón, em: 4 Mar 2013 (1♂), em: 2 Mar 2013 (1♂), r.f. *Dialium guianense*, 13-SRNP-67619, 13-SRNP-67618 (USNM). ACG, Sector Rincon Rain Forest, Finca Esmeralda, 123 m, 10.93548°, –85.25314°, 16 Mar 2013, M. Moraga, em: 16 Mar 2013 (1♂), em: 31 Mar 2013 (1♂), em: 29 Mar 2013 (1♂), r.f. *Dialium guianense*, 13-SRNP-75873, 13-SRNP-75874, 13-SRNP-75872 (USNM); same locality, 20 Jul 2013, K. Aragon, em: 30 Jul 2013 (1♂), 13-SRNP-76963, em: 3 Aug 2013 (1♂), 13-SRNP-76962, r.f. *Dialium guianense* (USNM). Guanacaste: ACG, Sector del Oro, Margarita, 380 m, 11.03234°, –85.439543°, Mar 2005, E. Cantillano, em: 16 Apr 2005 (1♂), r.f., *Picramnia latifolia*, 05-SRNP-21221, USNM slide 124,774 (USNM); same locality, 4 Mar 2005, E. Cantillano, em: 8 Mar 2005 (1♂), r.f. unknown host, 05-SRNP-20992, em: 10 Mar 2005 (1♀), 05-SRNP-20993 (USNM), r.f. unknown host, 4 Mar 2005, em: 22 Mar 2005 (1♀), 05-SRNP-21014, r.f. *Picramnia latifolia*, em: 19 Mar 2005 (1♂), 05-SRNP-21016, E. Cantillano (USNM), em: 19 Mar 2005 (1♂), 05-SRNP-21017, r.f. unknown host (Simaroubaceae 15470), em: 10 Mar 2005 (1♀), 05-SRNP-21009, r.f. *Picramnia latifolia*, E. Cantillano (USNM); same locality, 4 Mar 2005, L. Ríos, em: 10 Mar 2005 (1♂), r.f. unknown plant, 05-SRNP-21010 (USNM), same locality, 21 Mar 2005, E. Cantillano, em: 7 Apr 2005 (1♀), r.f. unknown plant, 05-SRNP-21219 (USNM). ACG, Sector Pitilla, Amonias, 390 m, 11.04249°, –85.40339°, 2 Apr 2006, C. Moraga, em: 18 Apr 2006 (1♂), em: 20 Apr 2006 (1♂), r.f. *Dialium guianense*, 06-SRNP-31491, 06-SRNP-31497 (USNM). ACG, Sector Pitilla, Medrano, 380 m, 11.01602°, –85.38053°, 7 Sep 2013, D. Martinez, em: 17 Sep 2013 (1♂), 13-SRNP-71540, em: 21 Sep 2013 (1♀), 13-SRNP-71537, r.f. *Machaerium seemannii* (USNM); same locality, 10 Sep 2013, D. Martinez, 20 Sep 2013 (2♂), em: 21 Sep 2013 (1♀), 13-SRNP-71559, 13-SRNP-71561, 13-SRNP-71558, r.f. *Machaerium seemannii* (USNM). ACG, Sector Del Oro, Tangelo, 410 m, 11.01823°, –85.45024°, 9 Jul 2011, F. Quesada, em: 20 Jul 2011 (2♀), em: 21 Jul 2011 (1♀), em: 25 Jul 2011 (3♀), r.f. *Dialium guianense*, 11-SRNP-21489, 11-SRNP-21487, 11-SRNP-21498, 11-SRNP-21484, 11-SRNP-21488, 11-SRNP-21491 (USNM). ACG, Sector Pitilla, Pasmompa, 440 m, 11.01926°, –85.40997°, 17 Mar 2010, C. Moraga, em: 25 Mar 2010 (2♀), em: 26 Mar 2010 (1♂), em: 7 Apr 2010 (2♂, 2♀), em: 8 Apr 2010 (4♂, 1♀), em: 9 Apr 2010 (1♂), em: 10 Apr 2010 (2♀), r.f. *Dialium guianense*, 10-SRNP-30729, 10-SRNP-30748, 10-SRNP-30722, 10-SRNP-30725, 10-SRNP-30898, 10-SRNP-30731, 10-SRNP-30726, 10-SRNP-30893, 10-SRNP-30895, 10-SRNP-30736, 10-SRNP-30896, 10-SRNP-30889, 10-SRNP-30897, 10-SRNP-30742, 10-SRNP-30899 (USNM).

Distribution and biology. *Cosmorrhyncha tonsana* is known from the Brazilian states of Amazonas, Bahía, and Pará, and the Costa Rican provinces of Alajuela and Guanacaste. Specimens from ACG were reared from field-collected larvae on *Picramnia latifolia* (Picramniaceae) ($n = 3$), *Dialium guianense* (Fabaceae) ($n = 51$), and *Machaerium seemannii* (Fabaceae) ($n = 5$). Janzen and Hallwachs (2017) report that the last instar is 10–11 mm in length, the body is translucent yellowish green, and the head and prothoracic shield are black (Fig. 27, 29). Field captures of adults in Brazil from March, August, September, October, and December indicate that this species has multiple generations throughout the year.

Remarks. The two documented centers of distribution of *C. tonsana* (i.e., Brazil and Costa Rica) are widely separated geographically, casting some doubt on the conspecificity of the specimens examined. However, specimens from the two regions are nearly identical in facies and genitalia, and the single DNA barcode of a specimen from Brazil is 99.69% similar to barcodes of specimens from Costa Rica. Hence, it is likely that the species is considerably more widespread than the collection records indicate.

***Cosmorrhyncha ocelliferana* (Walker)**
Fig. 7, 15, 23

Carpocapsa ocelliferana Walker 1863: 408.
Cosmorrhyncha ocelliferana: Powell et al. 1995: 156; Brown 2005: 218.

Diagnosis. Because the lectotype lacks its abdomen, it is impossible to unequivocally associate other specimens with *C. ocelliferana*. Under this species name we include a large number of specimens from Brazil, Paraguay, and Venezuela that lack the distinctive white costal strigulae characteristic of *C. albistrigulana* and *C. osana*, and share similar male and female genitalia. The male genitalia are characterized by a more-or-less rounded outer margin of the valva and a flattened, finlike, hooked flange from the dorso-distal tip of the phallus. The female genitalia are characterized by a distinctly V-shaped posterior margin of sternum 7, similar to that of *C. macrospina* and *C. tonsana*.

In the lectotype, the bend in the distal 0.4 of the costa of the forewing is at a greater angle than in other specimens associated with the name; however, this feature appears to be somewhat variable among individuals throughout its geographic range. For example, in a pair of specimens from Cacaulandia, Rondônia, Brazil, collected on the same date (Becker no. 80239), one has a distinctly angled costa of the forewing as in the lectotype of *C. ocelliferana* (Fig. 7), whereas the other has a more evenly rounded costa. Figure 7, an image of the lectotype, NHMUK, is considerably darker brown than other images, but this is partially an artifact of lighting.

In the male genitalia of the specimens examined, there is subtle variation in the shape of the valva and in the number of spines along the sacculus, the latter often variable from the left to the right valva of the same specimen. In the female genitalia, the shape of the signum is somewhat variable, as well. Hence, it is likely that the specimens examined represent a species complex rather than a single species, and the trees (Fig. 1–3) also suggests this, although based on short sequences. In specimens from Brazil the signum may have a pair of long slender spines (Fig. 23) or a more typical spindle-shaped signum subtended by a small pair of short slender spines; rarely there is only a spindle-shaped signum (e.g., in specimens from Paraguay).

Redescription. *Head*. Reddish-brown to brown; labial palpus reddish brown, dorsum of second segment with bluish-black, narrow, longitudinal stripe; third segment mostly bluish black, slightly metallic. *Thorax*. Nota reddish-brown to brown. Forewing (Fig. 7) length 6.0–7.0 mm ($n = 6$), pale reddish-brown with faint refractive pale-blue striations and scale patches, a small rounded, upraised patch of silver-white scales near distal end of discal cell, surrounded by small dark-brown circular patch; costa reflexed downward at approximately 0.6 length from base to apex; distal 0.2 of costa faint orange with few black strigulae; median part of the costa weakly tinged with orange; two pale-cream spots at mid-costa; costa without well-defined areas of dense silver-white striae. Fringe pale-orange tinged with brown, black at apex. Hindwing brown; male with long, well defined anal roll. Fringe brown, paler in the anal area. *Abdomen*. Male genitalia (Fig. 15) with uncus short, stout, apically bifid, with dense cluster of long spines on each bifurcation; tegumen with rounded dorsal half; socius digitate, slightly broader basally, pendant, finely hairy; valva mostly parallel-sided in basal 0.5, upturned, attenuate, densely spined in distal 0.5; cucullus with a few strong setae along ventral edge in basal half, one basal and one subbasal setae conspicuously larger; patch of long, slender, hairlike setae at venter immediately basad of cucullus; a distinct triangular subbasal process of valva bearing a single spine; juxta shield-shaped; phallus short stout, vesica lacking cornuti. Female genitalia (Fig. 23) with papillae anales unmodified; sterigma mostly membranous with a strongly sclerotized, mesal, suborbicular plate and a pair of narrow lateral flanges postero-laterally; antrum long, spindle-shaped, occupying posterior 0.33 of ductus bursae; ductus bursae relatively narrow, membranous beyond antrum, gradually broadening to corpus bursae without distinct junction; corpus bursae irregularly pear-shaped, weakly and evenly punctuate throughout; signum variable with one or two spindle-shaped blades from an irregularly rounded, sclerotized patch; ventro-posterior margin of segment 7 with deep V-shaped excavation mesally, resulting in a pair of rounded, sublateral lobes.

Types. Lectotype ♂ (abdomen missing), Brazil, Amazonas, Ega (NHMUK).

Additional specimens. BRAZIL: Ceara: [no further locality], Aug 1884 (1♀), Leech, USNM slide 72,364 (USNM). Distrito Federal: Planaltina, 1000 m, 15 Mar 1985 (1♂), V. Becker, Becker No. 57384

(USNM). Maranhão: Acailandia, 150 m, 19–27 Nov 1990, (1♀), V. Becker and G. Dubois, Becker No. 77692 (USNM). Mato Grosso: Chapada dos Guimaraes, 26 Oct 1993 (2♀), V. Becker, Becker No. 89332, USNM slides 126,290, 126,374 (USNM). Minas Gerais: Unai, 700 m, 3 Nov 1983 (4♂), V. O. Becker, collection no. 49881 (USNM), USNM slides 124,795, 126,235. Pará: Belém, 20 m, Jan 1984 (2♂), V. Becker, Becker No. 47165 (USNM). Rondônia: Cacaulandia, 140 m, Nov 1991 (1♂, 1♀), V. Becker, Becker No. 80239, USNM slides 124,821, 126,285 (USNM). Santa Catarina: Nova Teutonia, 300–500 m, 27°11′S, 52°23′W, Nov 1961 (1♀), F. Plaumann, USNM slide 124,784 (USNM). PARAGUAY: Parque Nacional Ybycui, 15–18 Mar 1986 (5♂, 9♀), M. Pogue and M. Solis (USNM). VENEZUELA: Barin: Barinitas, 22–26 Feb 1969 (2♀), Duckworth and Dietz, USNM slide 126,234 (USNM). Aragua: Rancho Grande, 8–14 Jul 1967 (4♂), R. W. Poole (USNM).

Distribution and biology. We record this species throughout much of Brazil, south to Paraguay, and northwest to Venezuela, from approximately 100 to 1000 m elevation. A specimen in the NHMUK from Peru may or may not be conspecific with *C. ocelliferana*. Nothing is known of the early stages. Captures throughout the year suggest that the species may have continuous generations.

Cosmorrhyncha landryi Brown and Razowski, sp. n.

Fig. 8, 16

Diagnosis. Superficially, *C. landryi* is similar to the widespread *C. ocelliferana* and *C. parintina* from Brazil. The male genitalia are distinguished from those of congeners by the presence of two long, strong spines from the ventro-basal margin of the cucullus and a narrower, more distally attenuate valva, with the apex of the cucullus more elongate and tapered than in *C. ocelliferana* and *C. parintina*.

Description. *Head*. Reddish brown; labial palpus reddish brown, dorsum of second segment with bluish-black, narrow, longitudinal stripe; third segment mostly bluish black, slightly metallic. *Thorax*. Nota rust brown. Forewing (Fig. 8) length 6.5 mm ($n = 1$), pale rust-brown with faint refractive pale blue strigulae and dots, a small rounded, upraised patch of silver-white scales near distal end of discal cell, surrounded by small dark-brown circular patch; costa strongly bent downward at approximately 0.6 length from base to apex; distal 0.2 of costa faint orange with few black strigulae; median part of the costa weakly tinged with orange; costa without well-defined areas of dense silver-white striae. Fringe pale-orange tinged with brown. Hindwing brown; male with long, well defined anal roll. Fringe brown, paler in the anal area. *Abdomen*. Male genitalia (Fig. 16) with uncus short, stout, apically bifid, with dense cluster of long spines on each bifurcation; tegumen with rounded dorsal half; socius digitate, slightly broader basally, pendant, finely hairy; valva mostly parallel-sided in basal 0.5, upturned, attenuate, densely spined in distal 0.5; cucullus with a few strong setae along ventral edge in basal 0.5, one basal and one subbasal setae conspicuously larger; patch of long, slender, hairlike setae at venter immediately basad of cucullus; a distinct triangular subbasal process of valva bearing a single spine; juxta shield-shaped; phallus short, stout, vesica with one slender cornutus. Female unknown.

Types. Holotype ♂, French Guiana, Piste de la Montague des Singes, km 10, 5°05′N, 52°42′W, 150 m, 28 Jan 1985, J.-F. Landry (USNM).

Distribution and biology. This species is known only from the type locality in French Guiana.

Etymology. The specific epithet is a patronym for our colleague and collector of the holotype, Jean-François Landry.

Cosmorrhyncha parintina Brown and Razowski, sp. n.

Fig. 9, 17

Diagnosis. Superficially, *C. parintina* is similar to *C. ocelliferana* and *C. macrospina*. The male genitalia are easily distinguished by the conspicuously subtriangular cucullus, the narrower neck of the valva, the absence of spines above the sacculus, and the presence of a small dorsoterminal thorn of the phallus.

Description. *Head*. Brownish cream; labial palpus reddish brown, dorsum of second segment with bluish-black, narrow, longitudinal stripe; third segment mostly bluish black, slightly metallic. *Thorax*. Nota

brownish cream. Forewing (Fig. 9) length 5.5 mm (n = 1); forewing weakly expanding terminally, termen straight; ground color cream with distinct brownish grey admixture and somewhat darker, dense straitionss and dots; costal strigulae weak, more or less concolorous with ground color, divisions rust in distal 0.33 of costa followed by four short black stripes; a series of minute refractive dots along termen; small spot black at distal end of discal cell with refractive scales in inner dot. Fringe cream brown, rust orange in costal 0.33. Hindwing pale brownish. Fringe cream. *Abdomen*. Male genitalia (Fig. 17) with uncus stout, rounded-bifurcate apically, with cluster of long setae on each bifurcation; valva somewhat parallel-sided in basal 0.5, with rhomboidal cucullus; sacculus with dense group of setae in posterior half; marginal spines of cucullus rather short; phallus stout, with short flange distally and a single cornutuslike spine (uncertain whether it is attached to the vesica or the outer surface of phallus). Female unknown.

Types. Holotype ♂, Brazil, Parintins, "10–19" [Nov 1919], Parish, USNM slide 126,237 (USNM).

Distribution and biology. This species is known only from the type locality in Brazil.

Etymology. The specific epithet refers to the type locality of Parintins.

***Cosmorrhyncha macrospina* Brown and Razowski, new species**
Fig. 10, 11, 18, 24

Diagnosis. Although superficially similar to *C. albistrigulana* and *C. osana*, the costal strigulae in *C. macrospina* are much less conspicuous (Fig. 10, 11). *Cosmorrhyncha macrospina* is most easily distinguished from those two species by several features of the male genitalia: the absence of the pair of stout spines in the subbasal portion of the costa; and the presence of an elongate, curved spine from the basal margin of the cucullus. Its female genitalia are similar to those of *C. ocelliferana*, but those of *C. macrospina* are distinguished by the broader plate-shaped lateral parts of the sterigma and the single, longer blade of the signum.

Description. *Head*. Vertex pale brown; frons lighter, with some orange; labial palpus pale brown with narrow, longitudinal metallic-blue strip dorsally and slightly subdorsally along outer margin, bordered on each side by a linear area of orange scales; third segment black; pedicel of antenna with subcircular area of dark-brown scales. *Thorax*. Nota pale brown dorsally, with scales cream-tipped; forewing (Fig. 10, 11) length 5.5–6.0 mm (n = 4); forewing ground color cream with distinct brownish-grey admixture and somewhat darker, dense striations and dots; costal strigulae weak, more or less concolorous with ground color, divisions rust in distal 0.33 of costa followed by four black stripes; a series of minute refractive dots along termen; black spot at distal end of discal cell with refractive scales in center. Fringe cream brown, rust orange in costal third. Hindwing pale brownish. Fringe cream. *Abdomen*. Male genitalia (Fig. 18) with uncus stout, rounded-bifurcate apically, with cluster of long setae on each bifurcation; socii with fine setae, broadest at base, digitate in distal 0.6; valva broadest basally, evenly attenuate distally throughout cucullus to a somewhat pointed apex, costa with small triangular process subbasally (probably representing a slight distal displacement of subbasal process); large curved spine from the basal margin of the cucullus ~0.66 distance from costa to sacculus; a long slender setae at lower margin of cucullus; phallus short, broad, with slightly undulate dorsum bearing a few weak serrations in apical 0.25; vesica with a single small, socketed cornutus. Female genitalia (Fig. 24) with papillae anales unmodified, narrowed anteriorly; apophyses relatively short, slender; posterior edge of sterigma straight, lateral parts slightly concave, proximal part weakly convex; ostium bursae bordered postmedially by elongate rounded, posterior convexities; antrum short, spindle-shaped; ductus bursae narrow, about 6 times as long as wide, mostly membranous, slightly dilated ~0.6 distance from ostium to junction with corpus bursae, with junction with corpus bursae distinct; corpus bursae rounded, signum with single, long, median, spindle-shaped blade; posterior margin of sternum 7 deeply V-shaped, resulting in a pair of rounded sublateral lobes.

Types. Holotype, ♂, Brazil, Rondônia, Cacaulandia, 140 m, Oct 1991, V. O. Becker, Col. Becker 80239; USNM slide 124,792 (USNM). Paratypes (1♂, 2♀). BRAZIL: Pará: Rio Trombetas, "9–19" [Sep 1919], Parish, USNM slide 72338 (USNM). Rondônia: Cacaulandia, 140 m, Nov 1994 (1♀), Becker No. 96273, USNM slide 126,236 (USNM). 62 km S Ariquemes Fazenda, Rancho Grande, 165 m, 10°32′S, 62°48′W,

29 Oct–10 Nov 1991 (1♀), R. Leuschner, USNM slide 126,289 (USNM).

Distribution and biology. This species is recorded from the states of Rondônia and Pará in northern Brazil. Nothing is known of the life history.

Etymology. The specific epithet refers to the long, curved spine at the inner base of the cucullus in the male genitalia.

Remarks. The genitalia of the two females designated as paratypes above have a V-shaped posterior margin of sternum 7, and are associated with males of *C. macrospina* by sequence data. Two other females from the type locality of *C. macrospina* have genitalia with a U-shaped posterior margin, indistinguishable from that of *C. albistrigulana*, and their barcodes align them with the latter species.

***Cosmorrhyncha albistrigulana* Brown and Razowski, sp. n.**
Fig. 5, 12, 19, 20, 25, 28

Diagnosis. Superficially, *C. albistrigulana* is nearly indistinguishable from *C. osana*; both have conspicuous white costal strigulae on the forewing. In the male genitalia of *C. albistrigulana* the cucullus is much shorter and somewhat rhomboidal with a flattened outer margin compared to the longer, evenly curved outer margin of the cucullus of *C. osana*. The female genitalia of *C. albistrigulana* and *C. osana* are extremely similar, with a rectangular or U-shaped posterior margin of sternum 7.

Description. *Head*. Vertex pale brown; frons lighter, with some orange; labial palpus (Fig. 5) pale brown with narrow, longitudinal metallic blue stripe dorsally and slightly subdorsally along outer margin, bordered on each side by a narrow line of orange scales; third segment black; pedicel of antenna with subcircular patch of dark-brown scales. *Thorax*. Nota pale brown dorsally, with scales cream-tipped. Forewing (Fig. 12) length 5.5–7.0 mm in male (n = 10), 6.0–7.0 mm in female (n = 5); costa slightly and evenly arched throughout; ground color pale reddish brown with cream olive hue; distal portion of costa and postapical portion of termen with narrow orange line; costal strigulae numerous, especially in basal 0.7, cream to white, divisions olive grey and pale orange; a slightly raised, roundish patch of silver opalescent scales near apex of discal cell, surrounded by small patch of black scales; similar patch near costa approximately 0.3 distance from base to apex, more elongate than rounded, less defined. Fringe pale reddish brown. Hindwing pale brown, paler in marginal region. Fringe pale-gray to cream. *Abdomen*. Brown. Male genitalia (Fig. 19, 20) with uncus rounded-bifurcate apically, with cluster of long setae on each bifurcation; socii with fine hairs, broadest at base, digitate in distal 0.8, angled in basal 0.1; valva slightly broader basally, somewhat parallel-sided, without neck; costa with small, slightly hairy, triangular subbasal process without spine(s); weakly elevated lobe with a pair of large, stout setae beyond subbasal process; a pair of long, slender setae near outer edge of basal cavity; cucullus short, rhomboidal, occupying distal 0.40–0.45 of valva differentiated by slightly elevated ridge along basal edge, with small lobelike expansion bearing a single long seta near middle; ventral edge of cucullus mostly evenly rounded to apex, except for small, weakly concave region subapically; a few spines along outer edge; phallus short, broad, with slightly undulate dorsum bearing a few weak serrations in apical 0.25; vesica with a single small, socketed cornutus. Female genitalia (Fig. 25) with papillae anales unmodified; sterigma large, weakly sclerotized throughout, ostium bursae flanked subterminally by large, posteriorly expanded lobes, notched postero-medially; antrum urn-shaped, broadest posteriorly, tapering proximally; ductus bursae narrow, straight in posterior 0.5, with slightly expanded portion ~0.6 distance from ostium to junction with corpus bursae, infrequently coiled one-half revolution (possibly as the result of mating), slightly broadened in anterior 0.33, with junction between ductus bursae and corpus bursae less defined; corpus bursae ovoid, finely punctate throughout, signum with single, large, spindle-shaped blade; posterior margin of segment 7 with deep U-shaped excavation with sclerotized edges.

Types. Holotype ♂, Costa Rica, Heredia, Estación Biologia La Selva, 50–150 m, 10°26′N, 84°01′W, 2 Dec 1998, MNCR-OET, USNM slide 124,923 (MNCR). Paratypes (21♂, 38♀). BRAZIL: Maranhão: Açailândia, 150 m, 19–27 Nov 1990 (1♂), V. O. Becker and G. S. Dubois, col 77692, USNM slide 124,818 (USNM). Rondônia: Cacaulandia, 140 m, Nov 1994 (1♀), Col. Becker 96273, USNM slide 124,796, Nov 1991 (1♀), Col. Becker 80239. Porto Velho, 180 m, 12 May 1989 (3♀), Col. Becker 76348, USNM slide 124,409. COSTA

RICA: Alajuela: Finca San Gabriel, 2 km SW Dos Rios, 600 m, May 1989 (1♀), GNP Biodiv. Survey (MNCR). ACG, Sector Rincon Rain Forest, Conguera, 420 m, 10.91589, –85.26631, 19 Feb 2012, P. Calderon, em: 29 Feb 2012 (2♂), em: 2 Mar 2012 (1♀), em: 3 Mar 2012 (2♂, 3♀), em: 4 Mar 2012 (2♂), em: 6 Mar 2012 (1♂), em: 14 Mar 2012 (1♀), r.f. *Dialium guianense*, 12-SRNP-40588, 12-SRNP-40603, 12-SRNP-40578, 12-SRNP-40573, 12-SRNP-40595, 12-SRNP-40602, 12-SRNP-40575, 12-SRNP-40597, 12-SRNP-40604, 12-SRNP-40596, 12-SRNP-40607, 12-SRNP-40586 (USNM); same locality, 25 Feb 2012, A. Cordoba, em: 7 Mar 2012 (2♀), r.f. *Dialium guianense*, em: 8 Mar 2012 (2♀), em: 9 Mar 2012 (1♂), em: 11 Mar 2012 (1♀), em: 12 Mar 2012 (1♂), r.f. *Dialium guianense*, 12-SRNP-40785, 12-SRNP-40800, 12-SRNP-40787, 12-SRNP-40794, 12-SRNP-40777, 12-SRNP-40796, 12-SRNP-40768 (USNM). ACG, Sector Rincon Rain Forest, Sendero Pila, 157 m, 10.93038, –85.25682, 18 Feb 2012, C. Umaña, em: 29 Feb 2012 (2♂, 4♀), em: 2 Mar 2012 (4♂, 4♀), r.f. *Dialium guianense*, 12-SRNP-75468, 12-SRNP-75463, 12-SRNP-75485, 12-SRNP-75479, 12-SRNP-75493, 12-SRNP-75459, 12-SRNP-75461, 12-SRNP-75478, 12-SRNP-75478, 12-SRNP-75487, 12-SRNP-75491, 12-SRNP-40778, 12-SRNP-75474 (USNM). ACG, Sector Rincon Rain Forest, Palomo, 96 m, 10.96187, –85.28045, 26 Feb 2012, K. Aragón, em: 7 Mar 2012 (3♀), em: 8 Mar 2012 (3♂, 2♀), em: 9 Mar 2012 (2♀), r.f. *Dialium guianense*, 12-SRNP-67351, 12-SRNP-67356, 12-SRNP-67358, 12-SRNP-67365, 12-SRNP-67360, 12-SRNP-67352, 12-SRNP-67355, 12-SRNP-67367, 12-SRNP-67366, 12-SRNP-67357; same locality, 5 Mar 2012, K. Aragón, em: 6 Mar 2012, (1♀), em: 16 Mar 2012 (1♂), 12-SRNP-67354, 12-SRNP-67394 (USNM); same locality, 25 Feb 2014, K. Aragón, em: 10 Mar 2014 (1♀), em: 3 Mar 2014 (1♀), r.f. *Dialium guianense*, 14-SRNP-45426, 14-SRNP-45423 (USNM). Heredia: Estación Biologia La Selva, 50–150 m, 10°26′N, 84°01′W, 4 Nov 1998 (1♀), MNCR-OET (MNCR). GUATEMALA: Cayuga, W. Schaus [no date] (1♀), May (1♀), April (3♀) (USNM). USA: Pennsylvania: Philadelphia, [intercepted on] "steamer" [other data illegible] from Guatemala (1♂) (USNM).

Distribution and biology. *Cosmorrhyncha albistrigulana* is known from Guatemala, Costa Rica (provinces of Alajuela, Heredia), and Brazil (states of Maranhão and Rondônia), below 600 m elevation. It has been reared numerous times in Costa Rica from field-collected larvae on *Dialium guianense* (Fabaceae).

Etymology. The specific epithet refers to the bright white costal strigulae of the forewing.

Remarks. This is another putatively widespread species that may represent more than a single entity. Although there is little doubt that specimens from Central America are conspecific, those from Brazil may not be. For example, in the male genitalia of specimens from Central America, the base of the large spine near the middle of the lower margin of the cucullus is sometimes contiguous with the margin of the cucullus (Fig. 19), whereas in specimens from Brazil, the base of the spine is slightly separated from the lower margin of the cucullus (Fig. 20). However, this may be, in part, an artifact of slide mounting, because in the NJ trees (Fig. 1–3), specimens from Brazil cluster convincingly with those from Costa Rica.

Cosmorrhyncha osana Brown and Razowski, new species

Fig. 13, 21, 26

Diagnosis. Superficially, *C. osana* is indistinguishable from *C. albistrigulana*. The male genitalia of *C. osana* share with those of *C. albistrigulana* a similarly small, unarmed subbasal process and a pair of stout spines from costa of valva beyond the subbasal process. The male genitalia of *C. osana* can be distinguished from those of *C. albistrigulana* by the longer, more evenly rounded outer margin of the cucullus and a small lobed expansion at the basal edge of the cucullus that bears a long spine. The female genitalia cannot be distinguished from those of *C. albistrigulana*, the two species sharing a U-shaped posterior margin of sternum 7.

Description. *Head*. Vertex pale brown; frons lighter, with some orange; labial palpus pale brown with narrow, longitudinal metallic-blue stripe dorsally and slightly subdorsally along outer margin, bordered on each side by a narrow line of orange scales; third segment black; pedicel of antenna with subcircular patch of dark-brown scales. *Thorax*. Nota brown dorsally, with scales cream-tipped. Forewing (Fig. 13) length 5.5–6.5 mm (n = 4) in males, 6.0–7.0 mm in females (n = 5); costa slightly and evenly arched throughout; ground color pale reddish brown with cream olive hue, suffusion in terminal area pale olive-grey; distal portion of costa and postapical portion of termen with narrow orange line; costal strigulae

numerous, especially in basal 0.7, cream to white, divisions olive grey and pale orange; a slightly raised, roundish patch of silver opalescent scales near apex of discal cell, surrounded by small patch of black scales; similar patch near costa approximately 0.3 distance from base to apex, more elongate than rounded, less defined. Fringe cream. Hindwing pale brown. Fringe pale gray to cream. *Abdomen*. Brown. Male genitalia (Fig. 21) mostly symmetrical, with uncus short, stout, rounded-bifurcate apically, with cluster of long setae on each bifurcation; socii hairy, broadest at base, digitate in distal 0.8, angled in basal 0.1; valva slightly broader basally, somewhat parallel-sided without neck; costa with small, slightly hairy, triangular process at base; weakly elevated lobe with a pair of short, stout setae subbasally; a pair of long, slender setae near outer edge of basal cavity; cucullus occupying distal 0.40–0.45 of valva differentiated by slightly elevated ridge along basal margin, with small lobelike expansion bearing a single long seta near middle; ventral edge of cucullus mostly evenly rounded to apex, except for small, weakly concave region subapically; a few spines along outer edge; phallus short, broad, with slightly undulate dorsum bearing a few weak serrations in apical 0.25; vesica with a single small, socketed cornutus. Female genitalia (Fig. 26) with papillae anales unmodified; sterigma large, weakly sclerotized, ostium bursae bordered subterminally by large, posteriorly expanding lobes; posterior part of antrum broad, urn-shaped, tapering proximally; ductus bursae membranous beyond antrum, slender, straight in posterior 0.5, then slightly expanded, half-coiled, with longitudinal wrinkles ~0.6 distance between ostium and junction with corpus bursae; corpus bursae irregularly rounded, signum with single, relatively short, spindle-shaped proximal blade from a narrow sclerotized patch.

Types. Holotype ♂, Costa Rica, Puntarenas, Bosque Esquinas, Peninsula de Osa, 200 m, M. Segura (MNCR). Paratypes (3♂, 5♀). COSTA RICA: Puntarenas: Bosque Esquinas, Peninsula de Osa, 200 m, Mar 1994 (1♂, 1♀), M. Segura (MNCR). Golfito, Parque Naciónal Piedras Blancas, Estación El Bonito, 100 m, Jan-Feb 2002 (1♀), M. Moraga (MNCR). Rancho Quemado, Peninsula de Osa, 200 m, Oct 1991 (2♂, 2♀), F. Quesada (MNCR). Fila Draque, Peninsula de Osa, 5 Apr 1992 (1♀), F. Quesada (MNCR).

Distribution and biology. *Cosmorrhyncha osana* is known only from the Osa Peninsula in southwestern Costa Rica, at elevations below 200 m.

Etymology. The specific epithet refers to the type locality of the Osa Peninsula.

List of species of *Cosmorrhyncha* (with country of type locality)

Cosmorrhyncha

acrocosma (Meyrick, 1908) (TL: Malawi)
albistrigulana Brown and Razowski, n. sp. (TL: Costa Rica)
landryi Brown and Razowski, n. sp. (TL: French Guiana)
macrospina Brown and Razowski, n. sp. (TL: Brazil)
microcosma Aarvik, 2008 (TL: Zaire)
obuduana Razowski and Wojtusiak, 2012 (TL: Nigeria)
ocelliferana (Walker, 1863) (TL: Brazil)
ocellata (Mabille, 1900) (TL: Madagascar)
osana Brown and Razowski, n. sp. (TL: Costa Rica)
parintina Brown and Razowski, n. sp. (TL: Brazil)
tonsana (Walker, 1863) (TL: Brazil)

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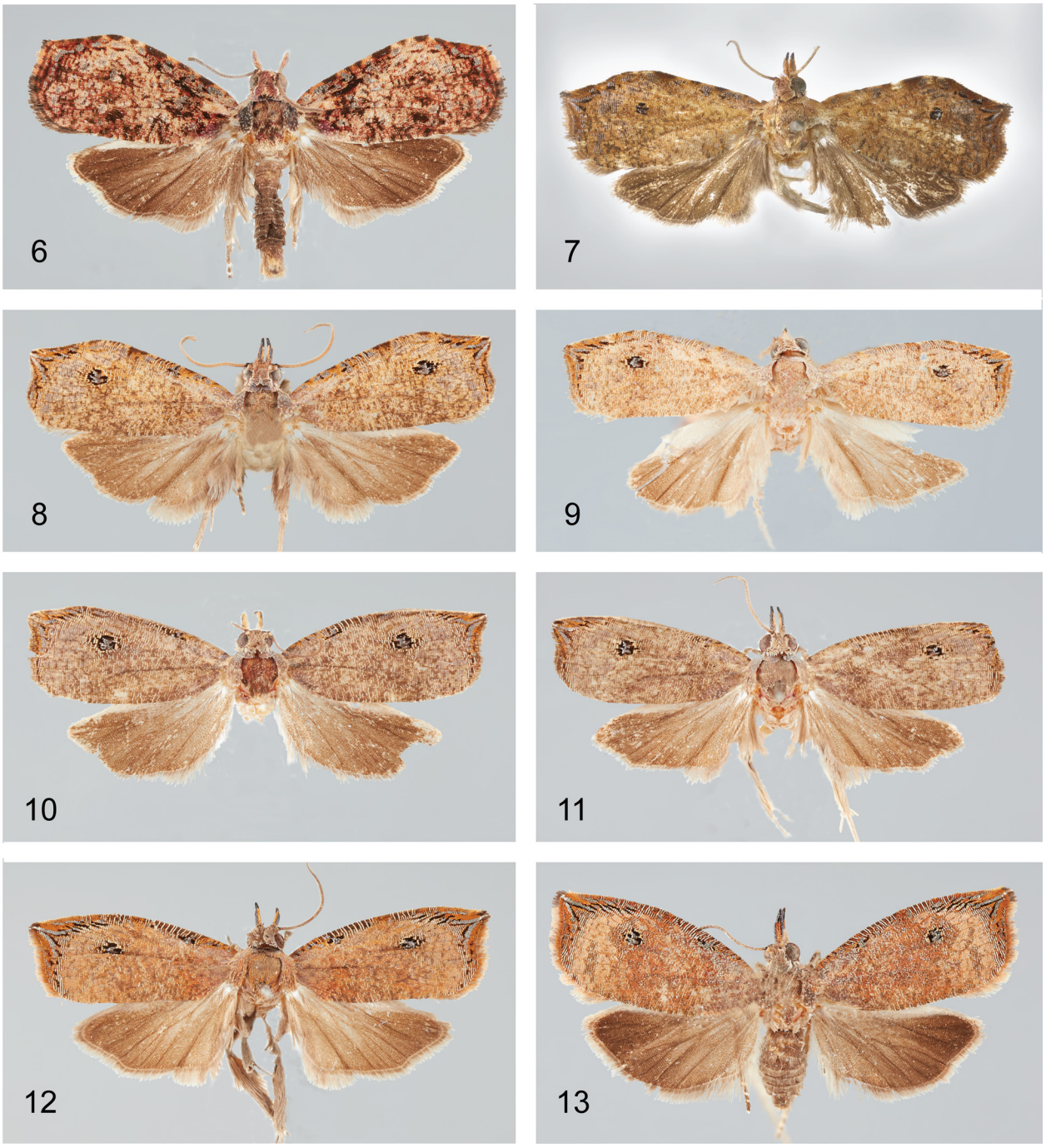
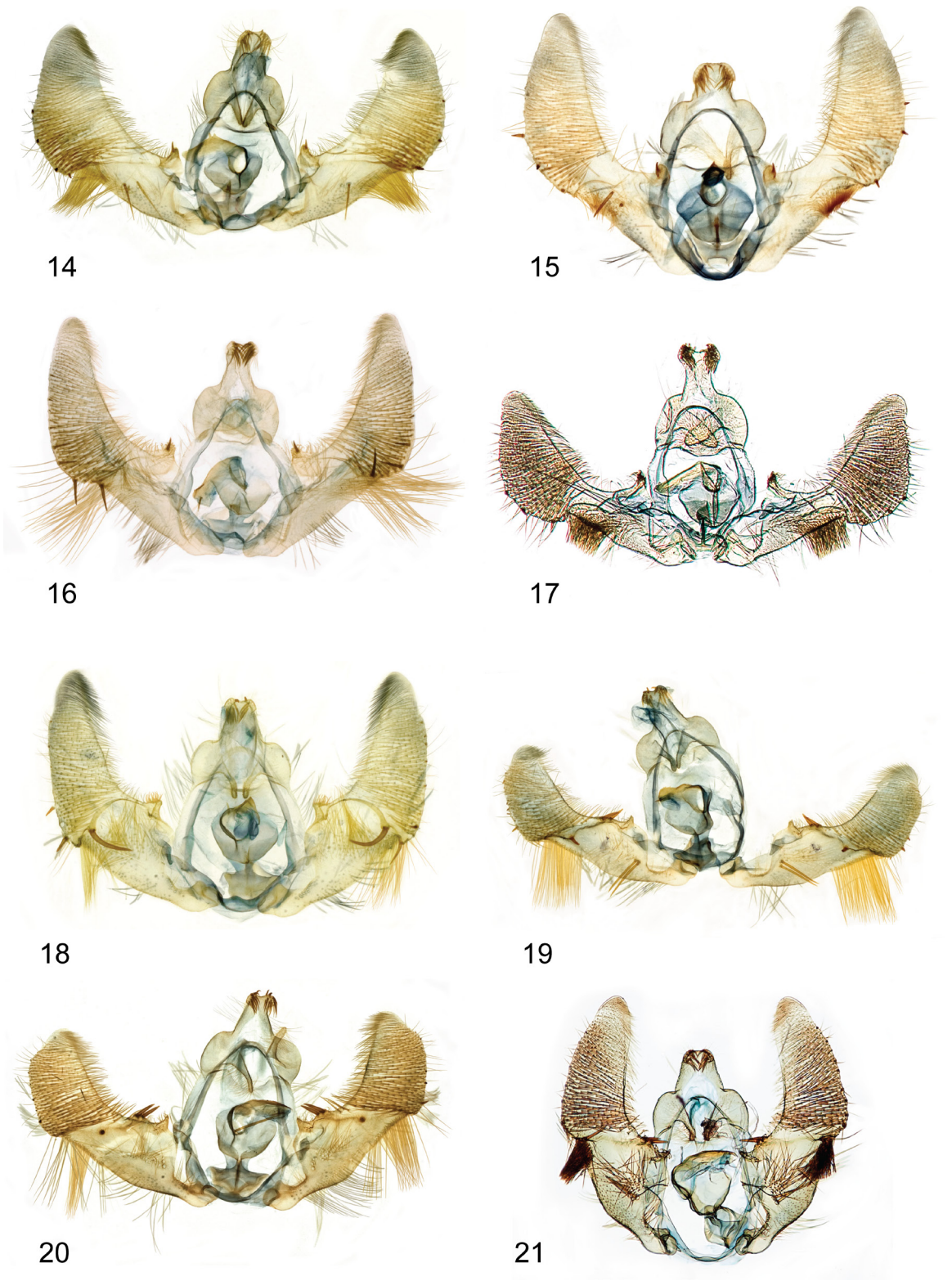
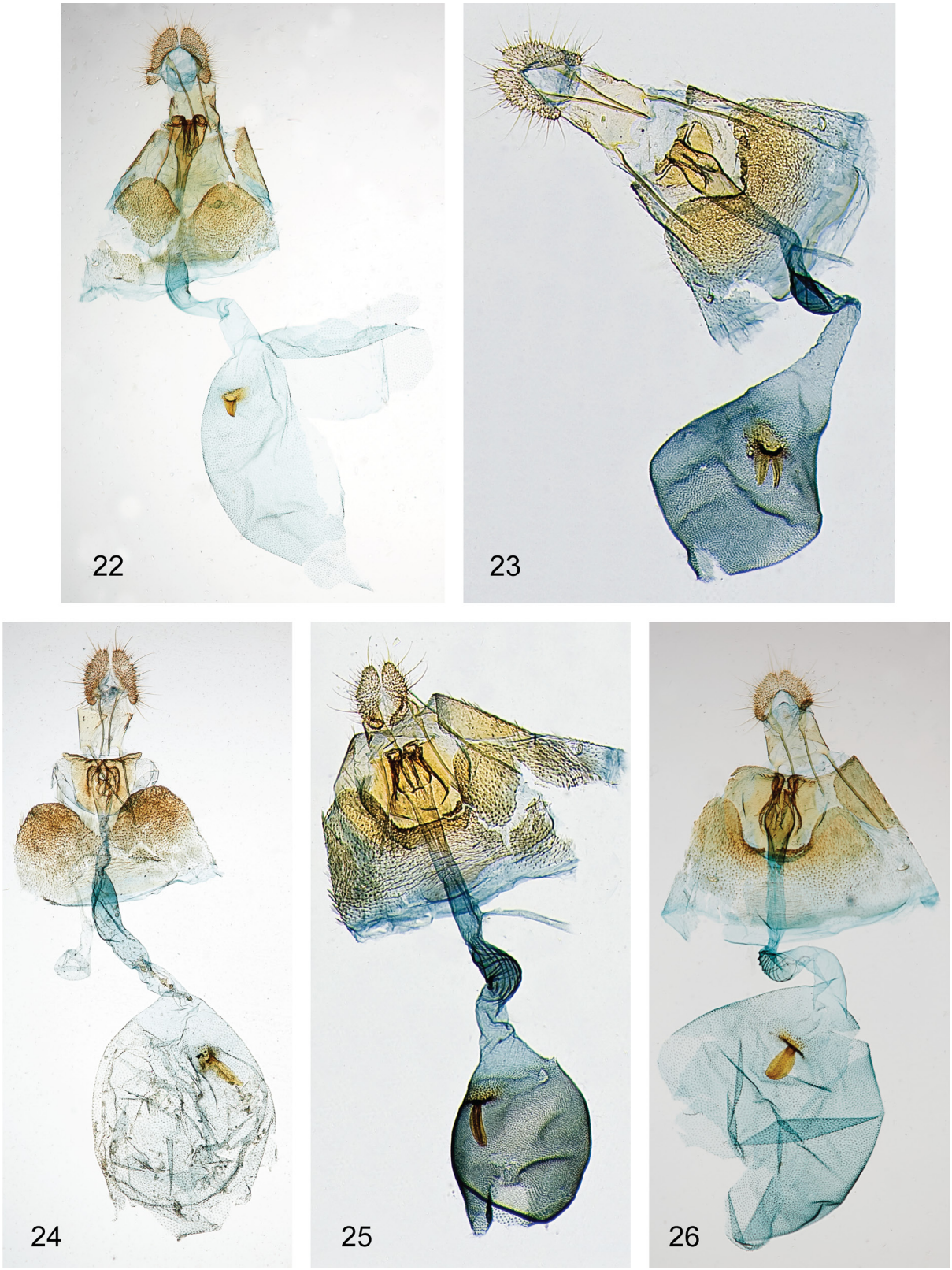


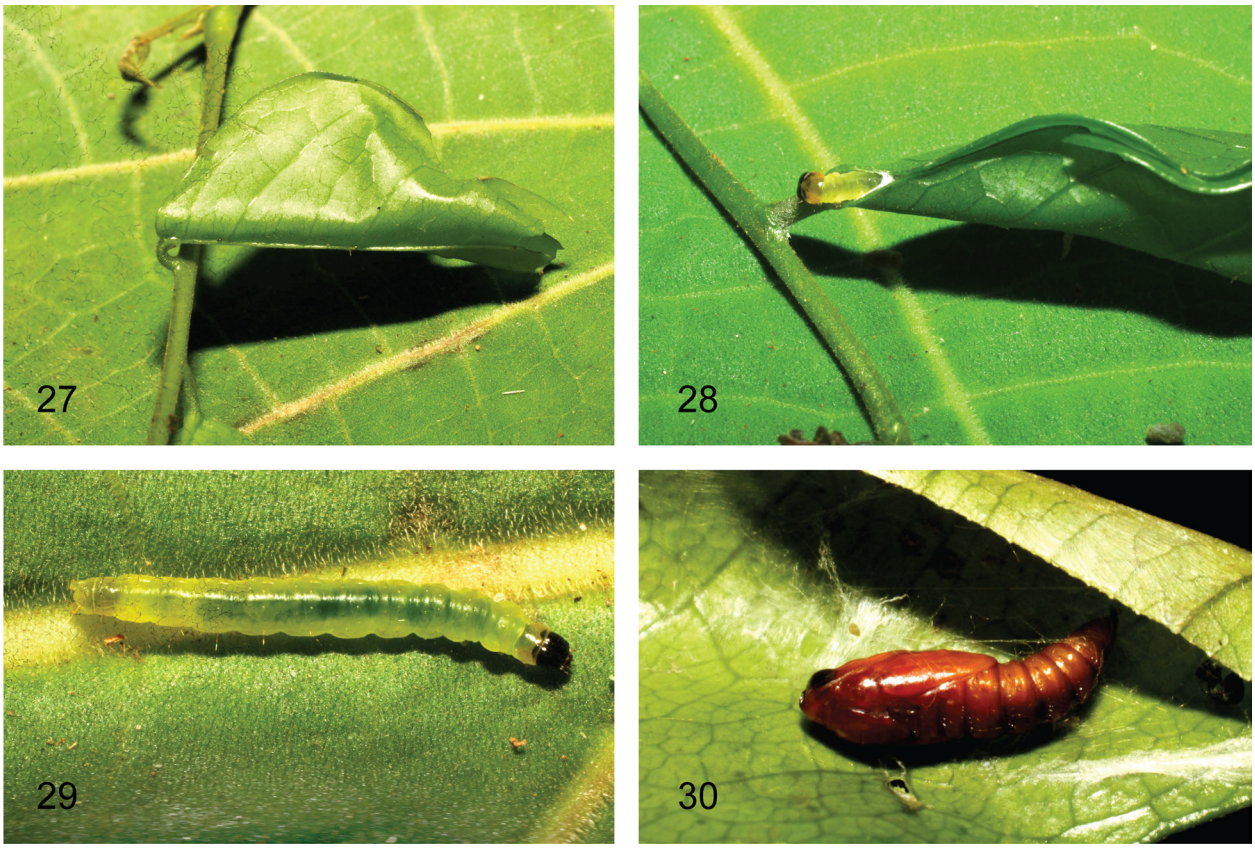
Figures 6–13. Adults of *Cosmorrhyncha*. **6)** *C. tonsana* from Costa Rica. **7)** *C. ocelliferana* from Brazil (image of lectotype from NHMUK). **8)** *C. landryi* from French Guiana. **9)** *C. parintina* from Brazil. **10)** *C. macrospina* female from Brazil. **11)** *C. macrospina* male from Brazil (apex of right forewing damaged). **12)** *C. albistrigulana* from Brazil. **13)** *C. osana* from Costa Rica.



Figures 14–21. Male genitalia of *Cosmorrhyncha*. **14)** *C. tonsana* from Costa Rica, USNM slide 124,813. **15)** *C. ocelliferana* from Brazil, USNM slide 124,821. **16)** *C. landryi* from French Guiana, USNM slide 126,233. **17)** *C. parintina* from Brazil, USNM slide 126,237. **18)** *C. macrospina* from Brazil, USNM slide 124,792. **19)** *C. albistrigulana* from Costa Rica, USNM slide 124,923. **20)** *C. albistrigulana* from Brazil, USNM slide 124,818. **21)** *C. osana* from Costa Rica, USNM slide 142,211.



Figures 22–26. Female genitalia of *Cosmorrhyncha*. **22**) *C. tonsana* from Brazil, USNM slide 145,538. **23)** *C. ocelliferana* from Brazil, USNM slide 124,775. **24)** *C. macrospina* from Brazil, USNM slide 126,236. **25**) *C. albistrigulana* from Guatemala, USNM slide 124,801. **26**) *C. osana* from Costa Rica, USNM slide 142,202.



Figures 27–30. Early stages of *Cosmorrhyncha* in Costa Rica. **27)** Rolled leaf shelter of *C. tonsana*. **28)** Larva of *C. albistrigulana* emerging to feed from leaf roll. **29)** Last instar larva of *C. tonsana*. **30)** Pupa of *C. tonsana*.