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CROMARCHA STROUDAGNESIA, A NEW CHRYSAUGINE SPECIES BORING IN SHOOTS OF *TABEBUIA OCHRACEA* (BIGNONIACEAE) IN A COSTA RICA DRY FOREST (LEPIDOPTERA: PYRALIDAE: CHRYSAUGINAE)

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ABSTRACT.– *Cromarcha stroudagnesia* Solis, **n. sp.**, from the dry-forested Pacific coastal lowlands of northwestern to central Costa Rica and from the state of Jalisco in Mexico is described. Information on the biology and immature stages is also presented. The larvae bore inside the shoots of new rainy season growth of *Tabebuia ochracea* (Bignoniaceae) saplings. *T. ochracea* is known as corteza amarilla and is a tropical timber tree in Costa Rica.

KEYWORDS: biology, Braconidae, Central America, chaetotaxy, Chalcidoidea, *Clydonopteron*, ***Cromarcha stroudagnesia*** n.sp., *Cryptoses*, Guanacaste, Hymenoptera, immatures, larva, Mesoamerica, Mexico, Neotropical, parasitoids, pupa, Santa Rosa, taxonomy.

The Chrysauginae are a large subfamily with about 400 described species in the Western Hemisphere (Solis *et al.*, 1995). The Neotropical chrysaugines have never been revised, but Cashatt (1968) revised the Nearctic species and included a few genera that occur in the Neotropics. During studies of Costa Rican Chrysauginae (Solis, ms) as part of an on-going project to inventory the Costa Rican fauna of the Pyraloidea in conjunction with D. H. Janzen and W. Hallwachs, and INBio (Instituto Nacional de Biodiversidad), a new chrysaugine species was discovered. This species has the newly coined common name of tabebuia shoot-borer (Sullivan, 2000), and is from the dry forests on the Pacific coastal lowlands of Costa Rica.

The biologies of most chrysaugines are unknown, although a few unusual species have been extensively documented (e.g., adults of *Cryptoses* Dyar live in the fur of sloths). There are records of chrysaugine caterpillars feeding on a wide variety of plant families. A common North American species (*Clydonopteron sacculana* (Bosc) (= *tecomae* Riley)) and other Neotropical species have been reared from mature Bignoniaceae fruits in which they are seed predators. Between 1995 and 1999, Sullivan studied the biology of the tabebuia shoot-borer within the tropical dry forests of Sector Santa Rosa, Area de Conservación Guanacaste (ACG), northwestern Costa Rica (Sullivan, 2000). The larvae are abundant in these secondary dry forests, boring through the upper shoots of saplings of the common *Tabebuia ochracea* (Chamisso) Standley and saplings of the rare *T. impetiginosa* (Martius ex A. P. de Candolle) Standley (Bignoniaceae). *Tabebuia* has about 100 species distributed throughout tropical America, including Mexico.

Cromarcha stroudagnesia Solis, new species

(Fig. 1-17)

Diagnosis.– Jagged medial edge of juxta; fine spine-like scobination on vesica.

Description.– *Head* (Fig. 1-2, 5-6): Head with white scales. Ocelli present. Chaetosemata absent. Frons protruding in male; round in female. Antenna of both sexes filiform, finely pubescent; heavily scaled scape 3-4 times longer than other antennal segments. Pilifers prominent in both sexes with sclerotized setae as long as pilifer. Labial palpus porrect, sexually dimorphic, female labial palpus almost twice as long as that of male; male with second segment 5 times longer than third segment, third segment medially with many very short heavily sclerotized setae, vom Rath's organ 2 times smaller than that of female; female with second segment 2.5 times longer than third segment, third segment without heavily sclerotized setae. Proboscis present, in male 1.5 times longer than labial palpus, in female only slightly longer than labial palpus. Male with 1-segmented maxillary palpus, about 1/8 length of first labial palpal segment, absent in female. *Thorax*: Tegula with raised, spatulate white scales. All legs (Fig. 9) white with black scales on tibia, femur, and coxa only; mid- and hindlegs with tufts of elongated spatulate scales (white, black distally only) on tibiae and first tarsal segments; foreleg tibia with epiphysis, midleg tibia with one pair of tibial spurs, and hindleg with 2 pairs of tibial spurs. *Forewing* (Fig. 1-2, 7-8): Length of female forewing 8.2mm (range: 8.0-10.0mm) (n=11); length of male forewing 6.8mm (range: 5.0-9.0mm) (n=18). Two forms, ground coloration either white or light brown scales, antemedial and postmedial lines prominent in both forms. Basal area light brown with dark brown raised scales or white with light brown raised scales; a patch of black, elongated scales extending outwardly on posterior margin basad of antemedial band. Medial lines with red scales, less so when with white ground color. Area between medial and postmedial line: dark brown or light brown from anterior margin of discal cell to wing margin and from 1A to 2A to posterior margin; dark red scales between with bright yellow reniform spot. Postmedial line light brown with dark brown raised scales or white scales with light brown raised scales. Area from postmedial line to subterminal line with dark red scales, yellow scales in elongated circles from M_1 to R_2; veins with scales. Subterminal line with white scales suffusing to a mixture of dark red to dark brown scales at the terminal line. Fringe dark brown. Underside with dark brown scales; subterminal line with white scales; yellow scales in elongated circles from M_1 to R_2. Wing venation (Fig.7-8) with Sc from base of wing, R_1 separate from discal cell, R_2, R_3, and R_{4+5} with a common base from anterior margin of discal cell, R_3 and R_{4+5} fused from discal cell anterodistally. M_1 from discal cell anterodistally, M_2 and M_3 fused at base. CuA_1 and CuA_2 separate from posterior margin of discal cell, in male M_2, M_3, and CuA_1 fused from posterior margin of discal cell, but M_3 and CuA_1 fused at base in female; 1A and 2A present forming a closed cell at base. CuP present as a tubular vein in female only, absent in male. 3A forked at posterior margin. Male with a costal frenulum hook; female with retinaculum comprised of a group of deciduous costal scales and a group of setae at base of wing below vein Cu. *Hindwing* (Fig. 1-2, 7-8): Upper- and underside with dark brown scales; upperside with terminal line with some red scales from apex to 1A+2A and where CuA_2 intersects with discal cell. Wing venation (Fig. 7-8) mostly complete, but CuP present toward outer margin only. Discal cell open in females, almost completely

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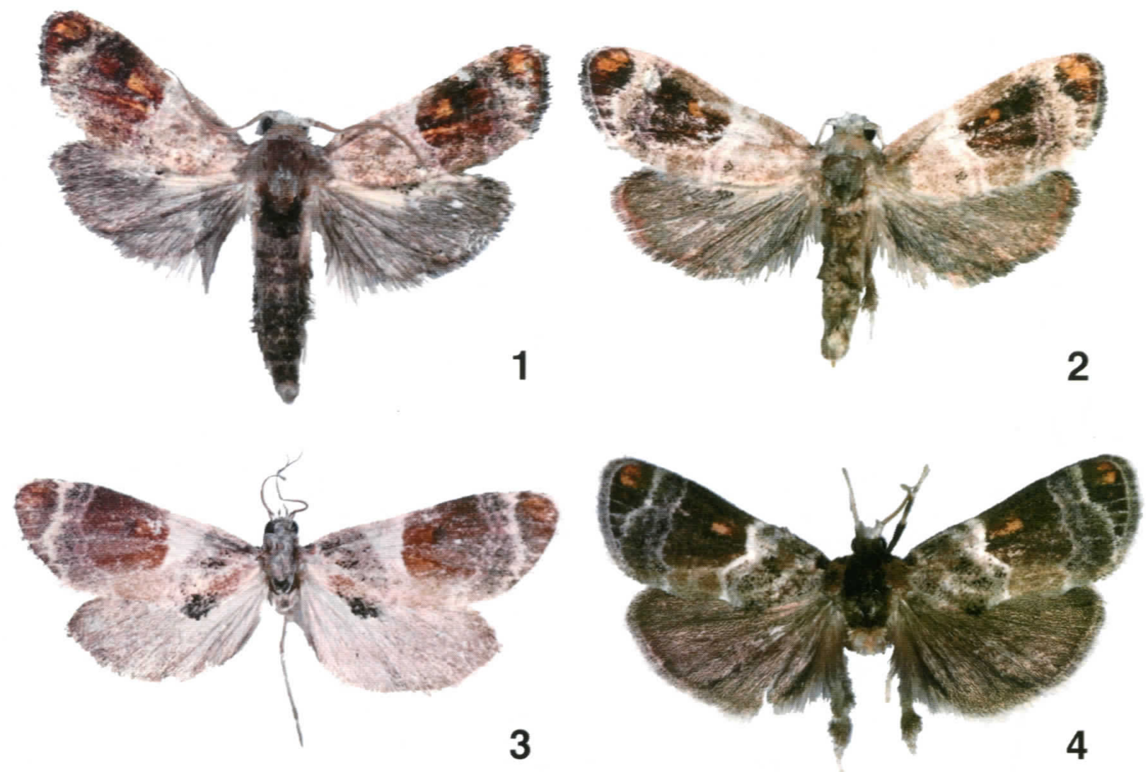
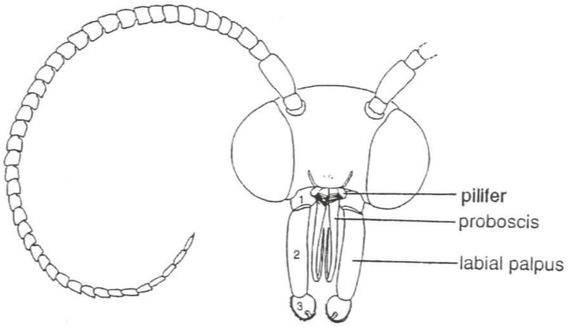


Fig. 1-4. *Cromarcha* adults: 1) Holotype male adult of *C. stroudagnesia*, forewing length 6mm. 2) Allotype female adult of *C. stroudagnesia*, forewing length 7mm. 3) Holotype of *C. polybata* Dyar; forewing length 9mm. 4) Adult male of undescribed species of *Cromarcha* from Arizona, forewing length 9mm.

closed in males. M_2 and M_3 separate at the outer margin only. Female with 3A absent, males with 3A present. Female frenulum with 3 bristles; male frenulum with 1 bristle. *Abdomen*: Tympanal organ present with secondary venulae, extending only one quarter length of second segment. *Male genitalia* (Fig. 10-12): Uncus simple, square-shaped apically; gnathos present, hooked distally, base as long as uncus arms; valvae simple, tapering in distal half to rounded apex, transtilla membranous medially; juxta plate-like, rounded, jagged edges medially; saccus as long as juxta, tubular, bending dorsally. Vesica of aedeagus finely, densely scobinate distally (Fig. 11-12). *Female genitalia* (Fig. 13): Papillae anales three times wider basally than posteriorly. Eighth segment ventrally with a sclerotized, upside-down T-shaped area. Ostial opening membranous. Ductus bursae as long as seventh segment; corpus bursae membranous, shorter than eighth segment. Posterior and anterior apophyses almost equal in length (0.9 mm).

Types.– *Holotype* (Fig. 1), male: Costa Rica, Santa Rosa National Park, Guanacaste Prov., D. H. Janzen, 12 Dec 1978-10 Jan 1979. Deposited at INBio, Santo Domingo, Costa Rica. *Allotype* (Fig. 2), female: Costa Rica, Santa Rosa National Park, Guanacaste Prov., 1 May 1980 DH Janzen & W. Hallwachs, also deposited at INBio.

Paratypes: COSTA RICA: 1 female, Fca. Jenny, 30 km N of Liberia, Prov. Guan. E. Araya & R. Espinoza, Ago 1990 (L-N 316200,364400); 3 males, Estac. Quebrada Bonita, 50m, R. B. Carara, Puntarenas Prov, R. Zuniga, Apr 1989 (L-N 194500,469850); 1 male, Est. Quebrada Bonita, 50m, Res. Biol. Carara, Prov. Punt., R. Zuniga, Jun 1991 (L-N 194500--469850); 1 male Estac. Quebrada Bonita, 50m, R.B. Carara, Puntarenas Pr., Oct 1989, R. Zuniga (L-N 194500, 469850); 2 males, Est. Queb. Bonita, 50m, Res. Biol. Carara, Prov. Punt., Mar 1993, R. Guzman (L-N 194500, 469850) [USNM wing slide #109,170]; 1 male, Estac. Quebrada Bonita, 50m, R.B. Carara, Puntarenas Pr., Nov 1989, R. Zuniga (L-N 194500, 469850); 1 female, Est. Quebrada Bonita, R. B. Carara, Puntarenas, 100m, Dec 1995, R. Guzman (L-N 195250, 469850); Santa Rosa National Park, Guanacaste Prov., 1 female, 1-8 Aug 1980, D. H. Janzen & W. Hallwachs; [locality same as previous] 1 female, 18-20 Dec 1979, D. H. Janzen; [locality same as previous], 1 female, 1 May 1980, D. H. Janzen & W. Hallwachs; [locality same as previous], 1 female, 21-23 May 1979, D.H.Janzen [USNM genitalia slide #108,665]; [locality same as previous], 1 female, Dec 1982, 800m, D. H. Janzen & W. Hallwachs [USNM genitalia slide #108,668; head slide #108,669]; [locality same as previous], 1 male, D. H. Janzen, 12 Dec 1978-10 Jan 1979 [USNM head slide #108,670; genitalia slide #108,671; wing slide #108,859]; [locality same as previous], 1 male, 4-6 Dec 1979 D. H. Janzen [USNM head slide #108,666; genitalia slide #108,667; wing slide #108,858]. Note: All "Santa Rosa" and "Finca Jenny" records above are from what is known today as sector Santa Rosa of the Area de Conservacion Guanacaste. The following are reared voucher specimens: 8 females, Sector Santa Rosa, Area de Conservacion Guanacaste, Provincia Guanacaste, N 313400 E 358900, collected by J. J. Sullivan, reared from *T. ochracea*, JJS-960807-6, eclosed 14 Aug 1996 [USNM genitalia slide #109,175]; 96-SRNP-12777, eclosed 19 Aug 1996 [USNM genitalia slide #109,074]; 96-SRNP-12773, eclosed 23 Aug 1996; 96-SRNP-12771, eclosed 18 Aug 1996; 96-SRNP-12787, eclosed 18 Aug 1996; 96-SRNP-12772, eclosed 23 Aug 1996; 96-SRNP-12773, eclosed 31 Aug 1996 [USNM slide #109,068]; 96-SRNP-12786, eclosed 11 Aug 1996; 15 males, Sector Santa Rosa, Area de Conservacion Guanacaste, Provincia Guanacaste, N 313400 E 358900, Collected by Jon J. Sullivan, reared from *T. ochracea*, 96-SRNP-12764, eclosed 5 Sep 1996 [USNM genitalia slide #109,171]; 96-SRNP-12765, eclosed 8 Sep 1996; 96-SRNP-12769, eclosed 1 Sep 1996; 96-SRNP-12778, eclosed 23 Aug 1996; 96-SRNP-12779, eclosed 23 Aug 1996; JJS-960801-8, eclosed 10 Aug 1996; 96-SRNP-12770, eclosed 18 Aug 1996; 96-SRNP- 12785, eclosed 22 Aug 1996; 96-SRNP--12780, eclosed 15 Sep 1996 [USNM genitalia slide #108,672]; 96-SRNP-12781, eclosed 18 Aug 1996; 96-SRNP-12794, eclosed 31 Aug 1996; 96-SRNP-12783, eclosed 26 Aug 1996; 96-SRNP-12791, eclosed 25 Aug 1996; and reared from *T. impetiginosa,* 96-SRNP-12766, eclosed 1 Sep 1996; 96-SRNP-12767, eclosed 7 Sep 1996. Pupal exuviae only: Costa Rica, Area de Conservacion Guanacaste, D. H. Janzen & W. Hallwachs, female 00-SRNP-16388, male 00-SRNP-16387. All SRNP voucher alphanumerics refer to the caterpillar rearing database to be found at <http://janzen.sas.upenn.edu>. MEXICO: 8 females, Jal. [Jalisco], 5 km N El Tuito (800 m), 20 Oct 1987, J. A. Chemsak & J. A. Powell, bl. [Blacklight] [USNM genitalia slide #109,173]; 6 males, Jal. [Jalisco], 5 km N El Tuito (800 m), 23 Oct 1987, J. A. Chemsak & J. A. Powell, at light [USNM genitalia slide #109, 071]. Paratypes from Costa Rica deposited in USNM (National Museum of Natural History, Smithsonian Institution, Washington, DC, USA) and BMNH (The Natural History Museum, London,



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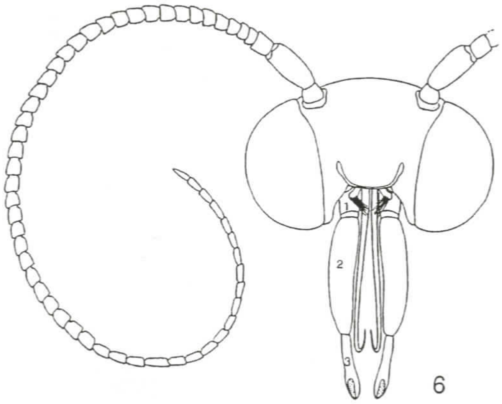

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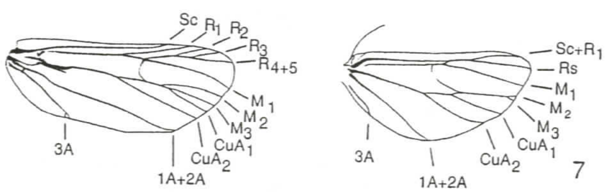

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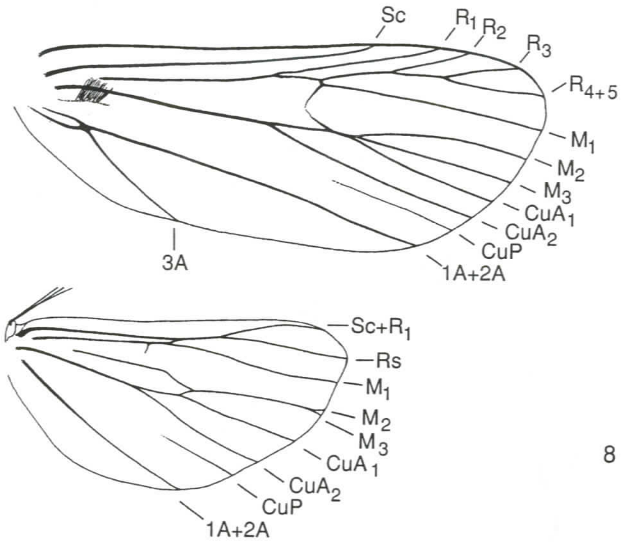
Fig. 5-7. 5) Denuded head of *C. stroudagnesia* male. 6) Denuded head of *C. stroudagnesia* female. 7) Wings of male *C. stroudagnesia*.



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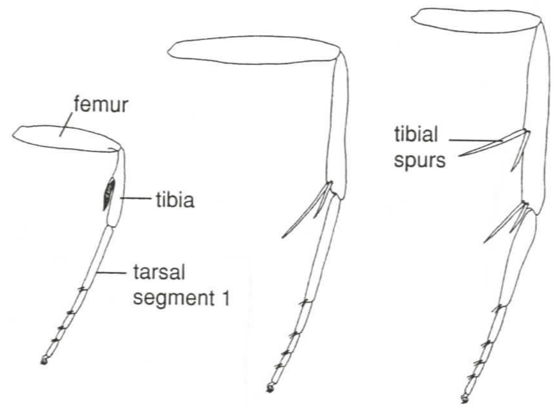

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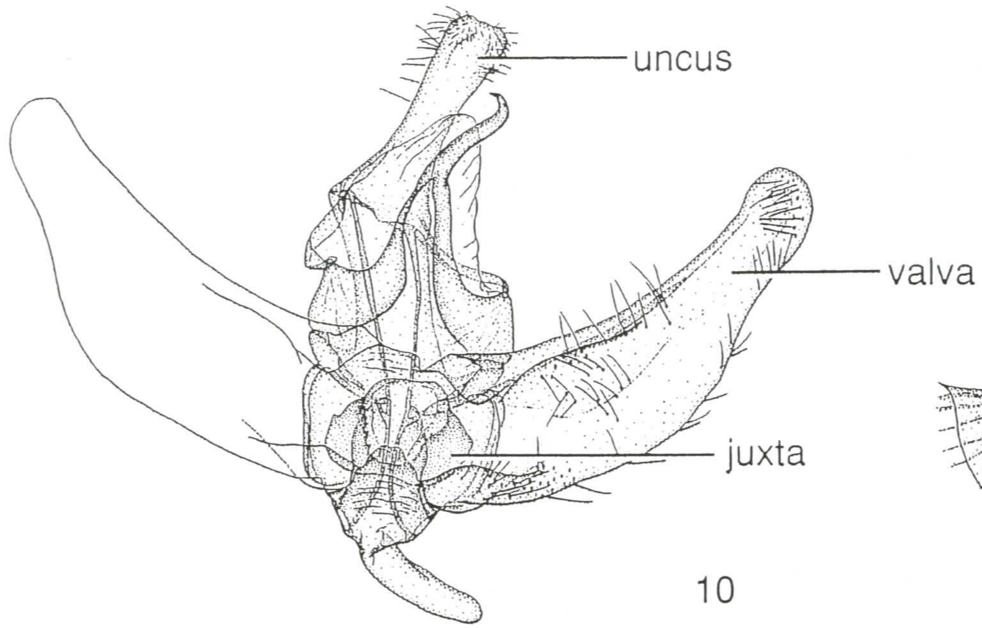
Fig. 8-9. 8) Wings of female *C. stroudagnesia*. 9) Legs of *C. stroudagnesia*.

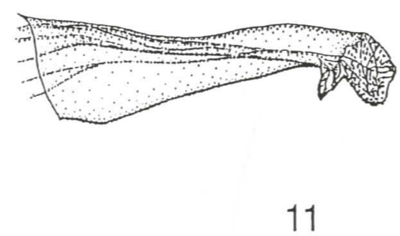
England); paratypes from Mexico deposited in UNAM (Universidad Nacional Autonoma de Mexico, Mexico, D.F.), USNM, and the Essig Museum of Entomology, University of California at Berkeley, USA.

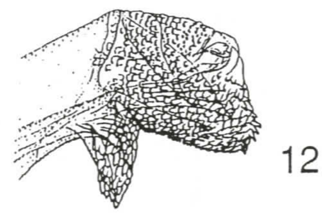
Larva (Fig. 14-15).– Length: approximately 15mm (last instar). Head reddish brown with darker brown platelets. Epicranial suture present. Clypeus dark brown, almost black. Capsule area on either side of clypeus highly sclerotized. T1-3 and A1-10 integument rugose, pinacula yellow. Without pinaculum rings at the base of SD1 on T3 or A8. Prothoracic shield yellow with dark brown platelets posteromedial to SD1 and XD2. A raised, "wrinkled" area on prothoracic shield between D2 and medial line. T1 with a lobe anterior to thoracic legs; 2 L setae below and anterior to spiracle. T1-3 with legs sclerotized dark brown anteriorly; dark brown platelets between thoracic legs. T2-3 with D1-D2 and SD1-SD2 on same pinaculum; an asetose pinaculum present dorsal to SV1; SV1 with one seta. A1-8 with L1 and L2 present ventral to spiracle; SD1 on a large pinaculum with 4 or more platelets anterodorsal to pinaculum; both D1 setae on a continuous pinaculum across the midline, D2 on an elongated pinaculum to midline, but not continuous with D2 on other side. A1 with 2 SV setae, A2-6 with 3 SV setae. A1-6 with one L3 seta and an asetose pinaculum anterior to L3, and SD2 present anterior to spiracle. SD1 pinaculum on A7-8 almost triangular. Spiracle on A8 at least twice as large and slightly more dorsal than other abdominal spiracles. A9 with L setae on separate pinacula; L1 pinaculum twice as wide as L2 and L3 pinacula; D1, D2, and SD1 on same pinaculum. Prolegs with crochets triordinal in a circle.

Pupa (Fig. 16-17).– Length: Male 8.5-9mm (n = 2); female 9-12mm (n = 8). Ventral view: Front flat but with round bumps, especially at juncture with antennae, and two short, thin setae; labial palpus a small triangle posterior to labrum; labrum bilobed; pilifers prominently lobed; maxillary palpus absent; forefemur usually not visible (only slightly visible on 2 specimens), prothoracic legs (foreleg) half length forewing, reappearing just above hindtarsus, mesothoracic leg (midleg) and antenna extending about 7/8ths length of forewing; hind tarsus extends only to length of forewing; abdominal segment 5 without spines; abdominal segments 6-9 covered with tiny circular depressions, setae thick and highly sclerotized; abdominal segments 9-10 with fewer circular depressions than abdominal segments 6-9, one small conical spine anterolateral to each side of anal orifice; male with 1 rounded protrusion on each side of genital orifice, female without rounded protrusions on each side of genital orifice; male genital orifice at midpoint of length of abdominal segments 9-10, female genital orifice adjacent to anterior margin of abdominal segment 9-10. Lateral view: prothorax rugose; abdominal segments with spiracles extruded and highly sclerotized; abdominal segments 2-9 dorsally with larger (in comparison to ventrally) circular depressions, setae thick and darkly sclerotized; abdominal segment 10 with two large conical spines laterally, 4-5 smaller conical spines dorsolaterally.

Comparison to other species.– The type species of *Cromarcha* Dyar is *C. polybata* Dyar (Fig. 3). This species was described from a single "male," but subsequent dissection [USNM slide #105,865] revealed the type to be a female (USNM type no. 16516). The type specimen is from Tehuacan, Mexico, collected by R. Müller in July, 1913. Only one other specimen, also a female, of this species is in the USNM. It is from Tamazulapan, Oaxaca, Mexico, collected by Flint and Ortiz, 7-8 June 1967 [USNM slide #109,172]. A comparison of female *C. stroudagnesia* to the two known females of *C. polybata* shows the following differences: externally, the female of *C. polybata* appear to be larger (wing length = 9mm) than most females of *C. stroudagnesia;* in the forewing the basal area of *C. stroudagnesia* has light brown scales, but *C. polybata* has red scales as well; and in *C. stroudagnesia* yellow scales occur from M_1 to R_2, but in *C. polybata* they occur only from M_1 to R_3; in C. stroudagnesia, the genitalia the eighth segment of the female is ventrally







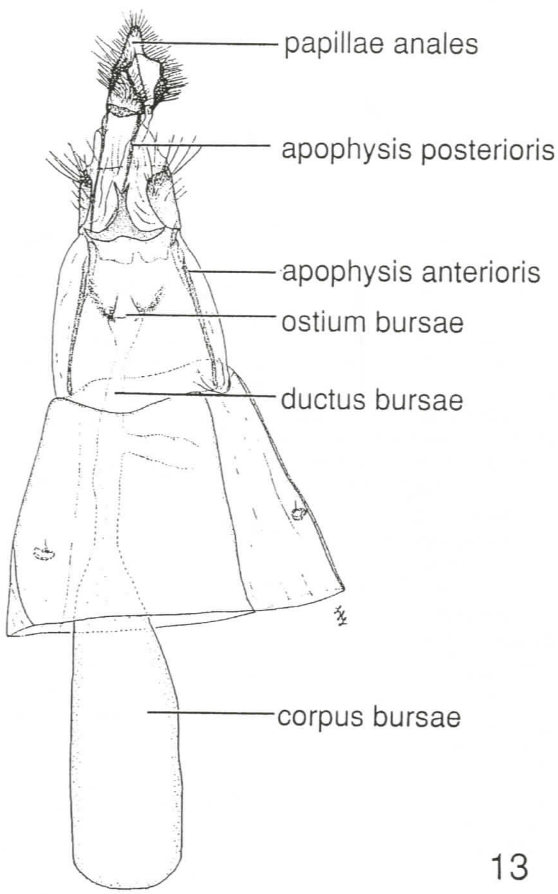


Fig. 10-13. Genitalia: 10) Male genitalia of *C. stroudagnesia.* 11) Aedeagus of *C. stroudagnesia.* 12) Magnified view of vesica with scobinations. 13) Female genitalia of *C. stroudagnesia.*

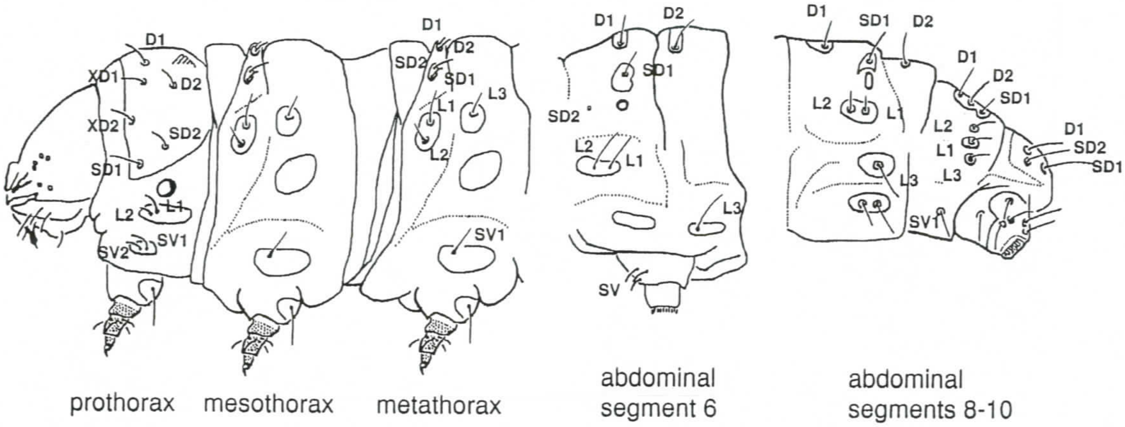
sclerotized with an upside-down T-shaped area, but in *C. polybata* this area is completely sclerotized; the ostial opening in *C. stroudagnesia* is membranous, but slightly sclerotized in *C. polybata.*

Male specimens of *C. stroudagnesia* were compared to one male specimen of an undescribed species (Fig. 4) with the following label data: Peña Blanca, 3950', Santa Cruz Co., Arizona, 7 Aug 1959, J. G. Franclemont [USNM slide #109,067]. This undescribed species will be described at a later date when more specimens and females become available. This male specimen is larger than most male specimens of *C. stroudagnesia* (wing length = 9mm). The major external difference is that the background coloration between the medial and postmedial line of the forewing is light brown rather than red as in *C. stroudagnesia*, and the yellow scales that comprise the reniform spot and those at the apex of the wing are not as prominent as in *C. stroudagnesia.* The male genitalia are almost identical except that the juxta of the undescribed Arizona species lacks the jagged medial edge of the juxta of *C. stroudagnesia* and the vesica lacks the fine spine-like scobination of *C. stroudagnesia.* This undescribed species from Arizona also has a sclerotized projection from the anterior end of the aedeagus, but *C. stroudagnesia* lacks this structure.

Etymology.– This species is named in recognition of a decade of strong support for the development of facilities and habitat diversity of the Area de Conservacion Guanacaste by the Stroud family, and for Agnes Stroud Peelle's proactive and generous support of rainforest conservation. The epithet is a noun.

BIOLOGY (Fig. 18-23)

The dry forests of Sector Santa Rosa of the Area de Conservación Guanacaste (ACG) are characterized by a six month dry season. Much of the forest is deciduous at that time. The six-month



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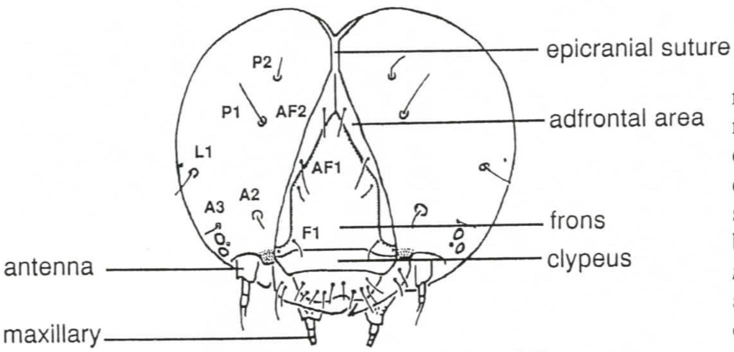

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Fig. 14-15. Last instar larva: 14) Lateral view of larva of *C. stroudagnesia*. 15) Frontal view of larval head of *C. stroudagnesia*.

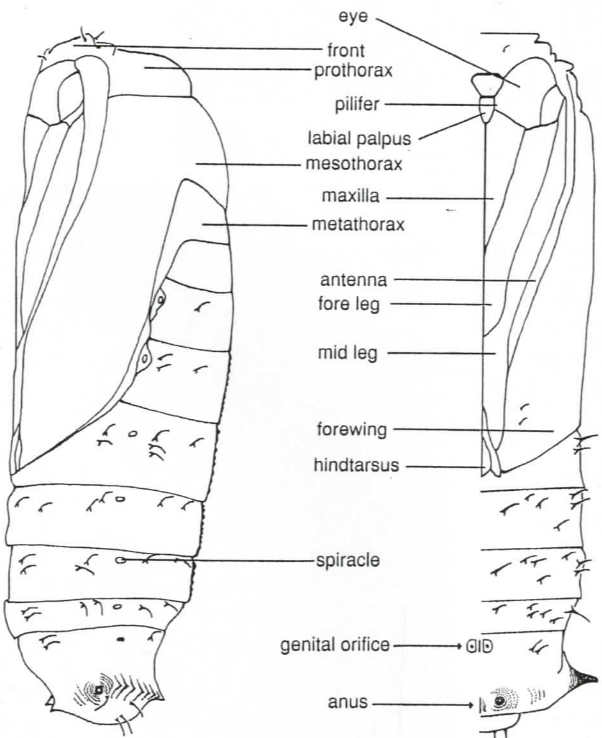

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Fig. 16-17. Pupa: 16) Lateral view of pupa of female *C. stroudagnesia*. 17) Ventral view of pupa of female *C. stroudagnesia* (rounded protrusions of male on each side of genital orifice are shown).

rainy season, May to December, receives between 1000-2500mm rainfall. In these forests, *C. stroudagnesia* is a herbivore of saplings of the trees *Tabebuia ochracea* and *T. impetiginosa*. The biology described here of *C. stroudagnesia* in the ACG dry forests is a summary of the account of *C. stroudagnesia* natural history given by Sullivan (2000). It is based on the natural history of *C. stroudagnesia* on *T. ochracea*, the much more abundant of its two hosts, although all observations of *C. stroudagnesia* on *T. impetiginosa* are concordant with this natural history. Despite intensive search, *C. stroudagnesia* has not been found in any other plant, including the third species of *Tabebuia*, *T. rosea* (Bertoloni) A. P. de Candolle, in the ACG dry forests.

C. stroudagnesia larvae bore in the central axis of the shoots of *T. ochracea* saplings (a shoot is the stem growth from an active meristem in the current rainy season) (Fig. 18-20). Larvae feed mostly in the longest shoots; the average sapling shoot is 5.1 cm long (s.e.= 0.14cm, n = 1909), while the average sapling shoot containing a *C. stroudagnesia* larva is 14.8cm long (s.e.= 0.44cm, n = 539). There is normally one larva per shoot, and almost all larvae complete their development within a single shoot. Larvae are typically absent from plants less than 50cm high, and occur in very low frequencies in adult tree crowns (0.2-0.4% of shoots). Long shoots are rare on small seedlings and in adult tree crowns.

C. stroudagnesia development from egg to adult occurs over 3 months of the rainy season (range: 61-96 days). Longitudinally striated 1mm long white eggs are laid, usually singly, on the outside walls of shoots. A first instar larva tunnels into a shoot and then bores a partial or complete transverse ring around the outside of the shoot pith. The shoot above this bored ring wilts within days of larval entry (Fig. 19). This makes larvae easy to find. Young larvae usually feed upwards from this bored ring, while later instar larvae completely hollow out and kill the shoot, usually by feeding downwards (Fig. 20-21). Completed tunnels range from 5-41cm long. Larval development from egg to pupa takes approximately 11 weeks.

Pupation occurs naked in the base of the tunnel, below a silk and frass barrier, and near a hole that was cut by the larva almost through the shoot wall leaving the outer epidermis intact. The pupa is a striking bright red immediately after the final molting, darkening to red brown over about a day, and a dark brown near eclosion. Pupal duration is 10-24 days, with females remaining as pupae longer than males (males: average = 16.7 days, s.e.= 1.3, n = 11; females: average = 20.1 days, s.e. = 0.41, n = 16). Eclosion occurs during the day. The adult moth pushes its way out of the anterior


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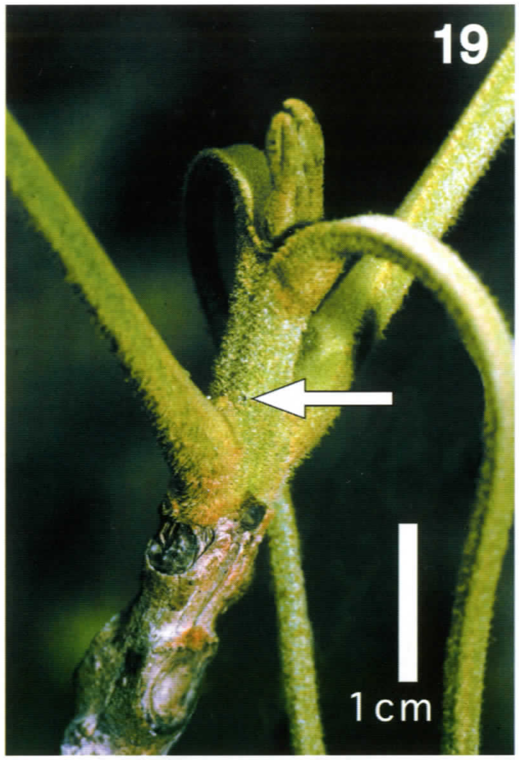
10cm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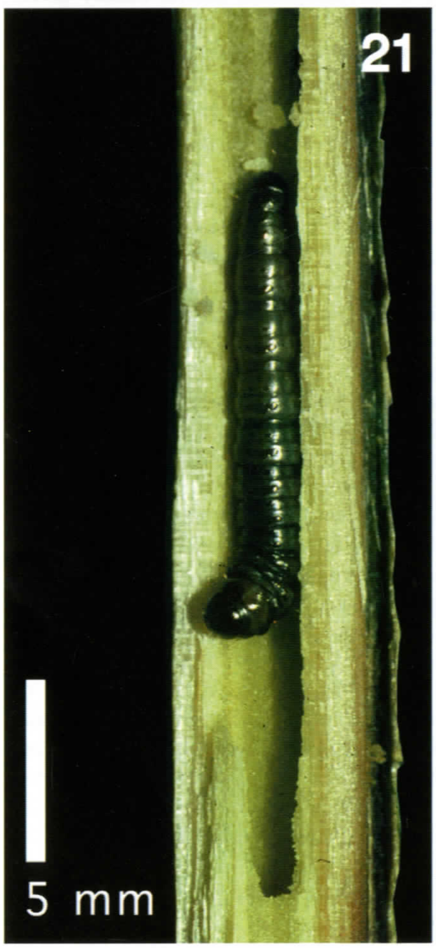
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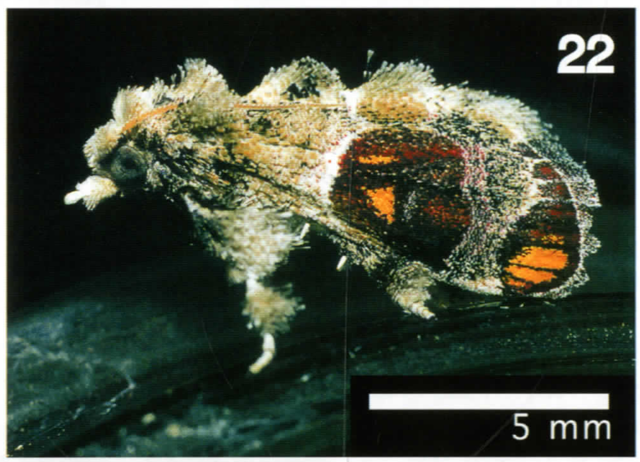
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5 mm


23


24

end of the pupal exuvia and then breaks out of the exit hole to leave the shoot (Fig. 20, 22).

There are two successive rainy season generations, one beginning in May and the other in September. May-June and September-October are the two peak periods of annual shoot growth by *T. ochracea* saplings. A few individuals may have a third generation during the dry season, boring in the few evergreen shoots of *T. ochracea* growing in riparian areas. However, these few individuals do not account for the massive influx of new borers at the beginning of each annual rainy season. These 3rd-generation borers are descendents of individuals that survived the dry season as active adults. Second generation pupae (December) do not wait out the dry season in shoots. Adults also appear at lights before the rainy season begins.

C. stroudagnesia larvae are abundant in the Santa Rosa secondary successional dry forests. Larvae occur in an average 13.3% of all growing shoots per generation (s=8.1, n=7 generations, >500 shoots per generation). Repeated infestation at these frequencies can drastically alter *T. ochracea* sapling architecture (Fig. 23-24) and greatly reduce vertical growth rates (Sullivan, 2000). Larvae are less abundant in old growth dry forests in Santa Rosa, where *T. ochracea* saplings are less common and sapling growth is slower. On the average only 1.2% of the shoots in old growth forests contain larvae (s = 1.2, n = 7 generations, >400 shoots per generation). *C. stroudagnesia* larvae are sometimes common in *T. ochracea* plantations in Guanacaste Province (e.g., in the experimental plantations of Sector Horizontes of the ACG). They are occasionally found in shoots of isolated young trees in cities and the acroscape.

Rearing of 243 late instar larvae and pupae has revealed two undescribed species of parasitoids. A single cream colored larva, identified as *Apanteles* sp. (Braconidae, Microgastrinae) by J. B. Whitfield, can emerge from a last instar borer larva. It spins a white cocoon inside the tunnel. A single adult yellow and brown wasp (Chalcididae), identified by D. H. J., can emerge from a borer pupa. During 1996-1999, natural parasitism frequencies during the first *C. stroudagnesia* generation in Santa Rosa secondary successional dry forests have ranged from 0% (n = 74) to 16.5% (n = 97) of late instar *C. stroudagnesia* larvae for the braconid, and from 2% (n = 53) to 17% (n = 86) of *C. stroudagnesia* pupae for the chalcidid.

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Fig. 18-24. Biology: 18) An undamaged shoot of *T. ochracea*, the food of *C. stroudagnesia* larvae. 19) A *T. ochracea* shoot 1-2 days after the entry of a first instar *C. stroudagnesia* larva. The arrow indicates the larval entry hole. It is rare to find a *C. stroudagnesia* larva in a shoot as short as this one, and this larva was unlikely to complete development. Most larvae are found in longer shoots such as that shown in Fig. 18. 20) A *T. ochracea* shoot killed by a *C. stroudagnesia* larva. The shoot has wilted due to the *C. stroudagnesia* tunnel. The arrow indicates the adult exit hole. This dead shoot is one of two regrowth shoots from the vertical shoot killed by a *C. stroudagnesia* larva in the previous rainy season. 21) A last instar larva of *C. stroudagnesia* at the base of its tunnel in a *T. ochracea* shoot. 22) A newly eclosed adult of *C. stroudagnesia*. 23) A sapling of *T. ochracea* that has had multiple shoots killed by *C. stroudagnesia* larvae over many years. Each dead stem was killed in a past year by a *C. stroudagnesia* larva. Contrast the architecture of this sapling with Fig. 24, a sapling of *T. ochracea* that has never had a shoot killed by a *C. stroudagnesia* larva.