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Cover Illustration:
Hadena ectypa (Morrison, 1875), larva and adult. Larva collected 3 August 2009, photographed in the lab 15 August 2009. Adult collected (as larva) 28 July 2009, emerged from pupa 4 September 2009, photographed in the lab 6 September 2009. Both individuals collected at the Knightville State Wildlife Management Area in the town of Huntington, Hampshire County, Massachusetts, USA. Photos by Michael W. Nelson, Massachusetts Natural Heritage & Endangered Species Program. See article on page 1.

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Journal of the Lepidopterists' Society
66(3), 2012, 121–132

NOCTUIDAE (LEPIDOPTERA) SPECIES SAMPLED FROM KHABR NATIONAL PARK, KERMAN, IRAN PART I.

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ABSTRACT. Forty two species of the family Noctuidae, excluding *Saragossa siccanorum poecilographa* Varga & Ronkay, 1991 are first reported form the Khabr National Park, Kerman, Iran. *Cucullia cineracea argyllacea* Hacker, Ronkay & Ronkay, 1990 is first reported for Iran. The distribution of each species is presented. Adults are illustrated together with notes on phenology and regional occurrence for each taxon. Maps illustrate the location of the Khabr National Park and its geographical location.

Additional key words: Khabr National Park, fauna, new record, Iran.

Khabr National Park (KNP), one of the biggest National Parks of the country (3rd place), is located in south Iran, Kerman Province. The Park's 149,982 ha area covers a vast extent of lands from high mountains to tropical plains with altitude ranges of 1040–3860 m. The cold, semi-arid climate of the region is derived from a mean annual precipitation of 200–300mm and a temperature range of 9–21 °C. Because of the diverse flora of trees and shrubs, KNP plays the important role as wildlife refuge. Climate change and global warming are serious threats for diversity of the region. Not long ago, species such as black bear and gazelle occurred in KNP. These species are now presumed extinct. Low levels of precipitation over the last decade threaten to exacerbate species extinctions.

Currently there are about 160,000 described species of Lepidoptera (Kristensen et al. 2007). Of those, Noctuoidea represent about 42,000 species (Speidel & Naumann 2004), making it the largest superfamily worldwide. The adults of this family are known to have a robust body, but the size of them varies from 7 mm wingspan (*Micronoctua* Karsholt, 1997) to 250 mm (*Thysania* Dalman, 1824) (Speidel & Naumann 2004). The monophyly of Noctuoidea is based on the presence of metathoracic tympanal organ and associated abdominal organs (Kitching & Rawlins 1998). This superfamily comprises the families Oenosandridae, Doidae, Notodontidae, Arctiidae, Lymantriidae, Noctuidae, Nolidae and Pantheidae. The higher classification of the families of this taxon has been subject to the frequent changes. On the basis of recent morphological and molecular studies, Lafontaine and Fibiger (2006) added the subfamilies Nolinae, Strepsimaninae, Arctiinae, Lymantriinae and Erebinae to the Noctuidae family. Consequently, the Noctuoidea comprises the families Oenosandridae, Doidae, Notodontidae, Micronoctuidae and Noctuidae. The Noctuidae (*sensu* Fibiger & Lafontaine 2005) contains about 25,000 species (Fibiger 1990), including species of great economic importance such as *Helicoverpa armigera* (Hübner, 1808).

Although the faunistic discoveries on Noctuidae of Iran have a history of more than a century, there is still no comprehensive monographic publication (except that of Hacker 1990 which includes available records of Noctuidae of Asia Minor and the Middle East). Faunistic and taxonomic investigations on the Noctuidae fauna in south and southeast of Iran bear great importance not only because this region is virtually unexplored but also because new species remain to be described (Ronkay & Gyulai 2006; Shirvani et al. 2008a). The present paper contains the list of 42 species collected from KNP during 2009. All species excluding *Saragossa siccanorum poecilographa* (Varga & Ronkay, 1991) are reported for KNP for the first time. *Cucullia cineracea argyllacea* (Hacker et al. 1990), which was collected in a region close to KNP, is considered the first report for the species from Iran. Family-group names follow Speidel and Naumann (2004) and the taxonomic order of each species is after the work of Fibiger and Lafontaine (2005). All species are deposited in the collection of Entomology, Shahid Bahonar University of Kerman.

MATERIALS AND METHODS

Adult moths were collected using light traps in different locations of KNP (Figs. 45 & 46). Genitalia were dissected and everted following Fibiger (1997) with a little change. The genitalia and abdomen then were mounted using either canada balzam or euparal. Arc GIS 9.2 software was used to make the geographical maps of the KNP.

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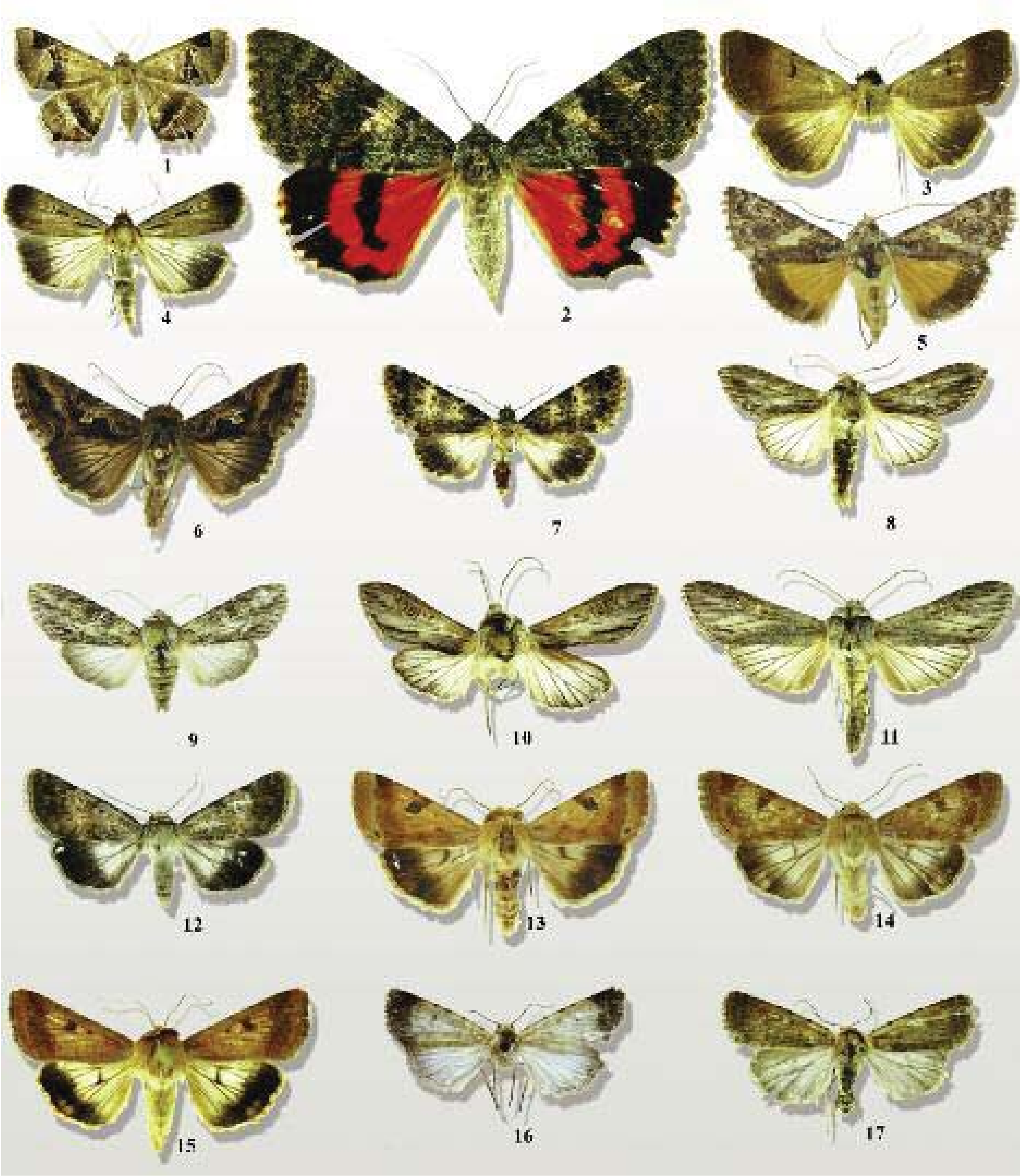

FIGS. 1-17: Adults, **1.** *Zethes nemea* **2.** *Catocala elocata* **3.** *Lygephila craccae* **4.** *Lygephila exsiccata* **5.** *Thysanoplusia exquisita* **6.** *Cornutiplusia circumflexa* **7.** *Drasteroides leprosa* **8.** *Cucullia boryphora* **9.** *Cucullia hemidiaphana* **10.** *Cucullia santonici* **11.** *Cucullia cineracea argyllacea* **12.** *Oncocnemis erythropsis* **13.** *Heliothis peltigera* **14**. *Heliothis nubigera* **15.** *Helicoverpa armigera* **16.** *Caradrina didyma* **17.** *Caradrina bodenheimeri*

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FIGS 18-32: Adults, **18.** *Phoebophilus veternosa* **19.** *Boursinia oxygramma* **20.** *Maraschia grisescens* **21.** *Polymixis zagrobia* **22.** *Polymixis crinomima* **23.** *Polymixis apotheina laristana* **24.** *Saragossa siccanorum poecilographa* **25.** *Hecatera dysodea* **26.** *Leucania herrichii* **27.** *Parexarnis damnata* **28**. *Dichagyris elbursica* **29.** *Dichagyris tyrannus beluchus* **30.** *Dichagyris argentea darius* **31.** *Dichagyris singularis* **32.** *Dichagyris forficula*

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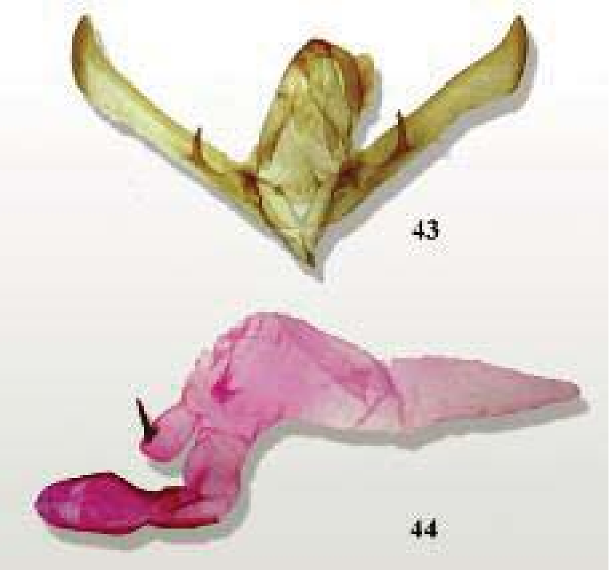
FIGS 33-42: Adults, **33.** *Dichagyris amoena* **34.** *Dichagyris eureteocles* **35.** *Yigoga truculenta toxistigma* **36.** *Euxoa conspicua* **37.** *Euxoa canariensis diamondi* **38.** *Agrotis obesa scytha* **39.** *Agrotis segetum* **40.** *Agrotis ipsilon* **41.** *Eugnorisma chaldaica* **42.** *Eugnorisma insignata* (above)



FIGS 43-44: Male Genitalia of *Cucullia cineracea argyllacea* slide no. AS428m, **43.** Armature **44.** Aedeagus and vesica. (right)

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TAXONOMIC ACCOUNTS

Subfamily CATOCALINAE BOISDUVAL, [1828] 1829

Genus: *Zethes* Rambur, 1833

1. *Zethes nemea* Brandt, 1938 (Fig. 1)

Bionomics: Bivoltine species which inhabits desert and semi desert locations up to 2300 m. Adults fly from March to July and come to the artificial light.

Collected localities and dates: Chah Anar, 10.04.2010; Darniyan, 22.07.2009. (7 specimens)

Distribution: Afghanistan (Hacker 1990). In Iran, it has originally been collected from Fars province (Brandt 1938).

Genus: *Catocala* Schrank, 1802

2. *Catocala elocata* (Esper, [1787]) (Fig. 2)

Bionomics: Univoltine, this species was collected in late summer and early autumn. *Catocala elocata* inhabits mountainous and semi mountainous regions with dry climates.

Collected localities and dates: Hesarouyeh, 9. 09.2009; Shah-e-Velayat, 25.10.2009. (3 specimens)

Distribution: Ponto- Mediterranean; Meditrranean ilands, Kazakhstan (Goater et al. 2003); Turkmenistan (Ivinskis & Miatleuski 1999). In Iran, this species has been reported from Tehran, Khouzestan (Ebert & Hacker 2002) and Golestan (Wieser & Stangelmaier 2005) provinces.

Genus: *Lygephila* Billberg, 1820

3. *Lygephila craccae* ([Denis & Schiffermüller], 1775) (Fig. 3)

Bionomics: Bivoltine in southern Europe (Goater et al. 2003), late flying species. This species was collected in October and inhabits cold-dry altitudes.

Collected localities and dates: Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (9 specimens)

Distribution: Eurasiatic. Southern Ural Mountains (Nupponen & Fibiger 2002); Daghestan Republic (Nikolaevitch & Vjatcheslavovna 2002); Cyprus (Fibiger et al. 1999), England, China and Japan (Goater et al. 2003). In Iran, it has been collected from Mazandaran, Tehran, Khouzestan, Kordestan and Lorestan provinces (Hacker 1990; Ebert & Hacker 2002).

4. *Lygephila exsiccata* (Lederer, 1855) (Fig. 4)

Bionomics: This species was taken in early spring and inhabits mountainous and semi mountainous regions up to 3000 m.

Collected localities and dates: Chah Anar, 10.04.2009. (5 specimens)

Distribution: Palaeotropical-subtropical, North Africa, Europe, United States of America (Goater et al. 2003), Yemen (Hacker & Fibiger 2006). In Iran, this species has been reported from Fars (Hacker & Kautt 1999), Tehran, Sistan va Balouchestan and Hormozgan provinces (Hacker 1990; Hacker & Ebert 2002).

Subfamily PLUSIINAE BOISDUVAL, [1828] 1829

Genus: *Thysanoplusia* Ichinose, 1973

5. *Thysanoplusia exquisita* (Felder & Rogenhofer, [1874]) (Fig. 5)

Bionomics: This species probably has more than one generation and early stages are polyphagous (Goater et al. 2003).

Collected localities and dates: Khabr Mountain, 15.03.2009; Dashtab, 24.06.2009. (2 specimens)

Distribution: In Iran, this species has been collected from Fars province (Hacker & Kautt 1999).

Genus: *Cornutiplusia* Kostrowicki, 1961

6. *Cornutiplusia circumflexa* (Linnaeus, 1767) (Fig. 6)

Bionomics: This species flies all year in southeast Iran, and was collected in almost all sampling locations; multivoltine species, inhabits deserts, semi deserts and dry elevations.

Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009; Darniyan, 22.07.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (35 specimens)

Distribution: Palaeotropical, this species has almost been reported from all countries throughout Africa, Asia, and Europe: in Turkmenistan (Ivinskis & Miatleuski 1999), Cyprus (Fibiger et al. 1999), Mongolia (Gyulai & Ronkay 1999). In Iran, this species has been reported from Azarbayjan-e-Gharbi, Tehran, Mazandaran, Ardabil, (Ebert & Hacker 2002), Sistan va Balouchestan (Brandt 1941), Fars and Lorestan provinces (Hacker & Kautt 1999).

Subfamily ACONTIINAE GUENÉE, 1841

Genus: *Drasteroides* Hampson, 1926

7. *Drasteroides leprosa* (Brandt, 1938) (Fig. 7)

Bionomics: Specimens of this species were collected in late summer and early autumn, probably univoltine, adults come to light and inhabit desert and dry altitudes to 3000 m.

Collected localities and dates: Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009. (4 specimens)

Distribution: Iraq (Hacker 1990). In Iran, reported

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FIG. 45. Map showing zone of Khabr National Park

from Sistan va Balouchestan and Lorestan provinces (Brandt 1941).

Subfamily CUCULLIINAE
HERRICHSCHÄFFER, 1850

Genus: *Cucullia* Schrank, 1802

8. *Cucullia boryphora* Fischer de Waldheim, 1840 (Fig. 8)

Bionomics: Bivoltine, this species was collected twice; first generation in March, and again in September.

Collected localities and dates: Khabr Mountain, 15.03.2009; Hesarouyeh, 9. 09.2009. (12 specimens)

Distribution: Ponto-Turkestanian; Turkmenistan (Ivinskis & Miatleuski 1999), Levant (Hacker 2001), Afghanistan (Ronkay & Ronkay 1994). In Iran, *C. boryphora* has been collected from Sistan va Balouchestan and Khorasan provinces (Brandt 1941).

9. *Cucullia hemidiaphana* Graeser, 1892 (Fig. 9)

Bionomics: Specimens of this species were collected in September and October. This species inhabits semi desert and dry mountainous regions.

Collected localities and dates: Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (13 specimens)

Distribution: Levant (Hacker 2001). In Iran, this species has been reported from Sistan va Balouchestan and Khorasan provinces (Brandt 1941).

10. *Cucullia santonici* (Hübner, [1813]) (Fig. 10)

Bionomics: Bivoltine (Ronkay & Ronkay 1994). One specimen was collected from dry mountainous region at 2300 m altitude.

Collected localities and dates: Dashtab, 24.06.2009. (1 specimen)

Distribution: Eurasiatic (Ronkay & Ronkay 1994). In Iran, it was reported from Sistan va Balouchestan and Khorasan provinces (Brandt 1941).

11. *Cucullia cineracea argyllacea* Hacker, Ronkay & Ronkay, 1990 (Figs 11, 43 and 44)

Identification: Wingspan 47–49 mm. Head, tegulae, thorax, abdomen and forewing colour ash grey. Forewing elongate, ash grey suffused with brown, marginal are convex at costal margin; veins covered with black; orbicular and reniform stigmata large, bordered with black, fine lines, both centered with black; fine tornal dash present; crossveins absent; terminal line fine, black; fringes grey. Hindwing white, marginally brown scales; veins covered with brown; fringes light brown.

Male genitalia: uncus long, curved, tapering, dorsally with hairs; tegumen wide, high; vinculum V-shaped. Valva simple, elongated, narrow; costa sclerotized; cucullus acute, corona present; sacculus small, harpe asymmetrical, longer on right side. Aedeagus short and thick; vesica with small basal diverticula, one of them strongly bulbed bearing a long, strong cornutus; large pointed sac present; ductus ejaculatorius originated from the middle of the sac.

Bionomics: univoltine, adults come to artificial light and are on wing in June. Early stages and food plants are still unknown.

FIG. 46. Map showing position of KNP in Kerman province, Iran

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Collected localities and dates: Lalehzar Mountain, 25.06.2009. (4 specimens)

Distribution: Afghanistan, Tajikistan; first report for the Iranian fauna.

Subfamily ONCOCNEMIDINAE FORBES & FRANCLEMONT, 1954

Genus: *Oncocnemis* Lederer, 1853

12. *Oncocnemis erythropsis* Brandt, 1938 (Fig. 12)

Bionomics: Univoltine, this species was collected in September and inhabits semi desert and mountainous altitudes up to 2800 m.

Collected localities and dates: Hesarouyeh, 9. 09.2009. (10 specimens)

Distribution: This species has originally been collected from Iran, Fars province (Brandt 1938).

Subfamily HELIOTHINAE BOISDUVAL, [1828] 1829

Genus: *Heliothis* Ochsenheimer, 1816

13. *Heliothis peltigera* ([Denis & Schiffermüller], 1775) (Fig. 13)

Bionomics: Multivoltine, this species is active through the year and feeds on various forms of vegetations such as shrubs, herbaceous plants and trees.

Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009; Darniyan, 22.07.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (43 specimens)

Distribution: Palaeotropical, Central Europe, Turkey, Levant, Iraq, Israel (Kravchenko et al. 2005), Turkmenistan (Ivinskis & Miatleuski 1999). In Iran, this species has been reported from Tehran, Mazandaran, Esfahan, Yazd, Semnan, Qom, Qazvin, Zanjan, Azarbayjan-e-Sharghi, Azarbayjan-e-Gharbi, Kohkiluyeh va Boyer-Ahmad, Kermanshah, Fars, Lorestan, Hormozgan, Sistan va Balouchestan and Kerman provinces (Hacker 1990; Ebert & Hacker 2002; Matov et al. 2008).

14. *Heliothis nubigera* Herrich-Schäffer, 1851 (Fig. 14)

Bionomics: Probably bivoltine with summer aestivation. This species is active through the year and larvae are polyphagous which feed on herbaceous plants.

Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009; Darniyan, 22.07.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (18 specimens)

Distribution: Palaearctic. Europe (migrant in the north), North and East Africa, Caucasus, Transcaucasia, Central Asia, India (Matov et al. 2008), Levant, Iraq, Israel (Kravchenko et al. 2005), Turkmenistan (Ivinskis & Miatleuski 1999). In Iran, it has been recorded from Yazd, Khorasan, Zanjan, Qom, Lorestan, Bushehr, Markazi, Golestan, Semnan, Khorasan, Tehran, Azarbayjan-e-Gharbi, Kerman and Sistan va Balouchestan provinces (Hacker 1990; Ebert & Hacker 2002; Matov et al. 2008).

Genus: *Helicoverpa* Hardwick, 1965

15. *Helicoverpa armigera* (Hübner, 1808) (Fig. 15)

Bionomics: Multivoltine with summer aestivation. This species is collected throughout the year in tropical and subtropical territories of the Old World.

Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009; Darniyan, 22.07.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (48 specimens)

`**Distribution:** Palaeotropical. Europe, Africa, Middle East, Central and South-East, Australia. In Iran, this species has been recorded from Tehran, Fars, Qom, Semnan, Golestan, Guilan, Yazd, Markazi, Kohkiluyeh va Boyer-Ahmad, Zanjan, Qazvin, Kerman, Sistan va Balouchestan, Ardabil, Hormozgan, Kermanshah, Lorestan, Mazandaran, Ardabil, Khorasan, Bushehr, Ilam, Azarbayjan-e-Gharbi and Azarbayjan-e-Sharghi provinces (Hacker 1990; Ebert & Hacker 2002; Matov et al. 2008).

Subfamily XYLENINAE GUENÉE, 1837

Genus: *Caradrina* Ochsenheimer, 1816

16. *Caradrina didyma* (Boursin, 1939) (Fig. 16)

Bionomics: This species was collected in late autumn. Caradrina didyma inhabits cold, dry semi desert and mountainous regions.

Collected localities and dates: Khabr road, 28.11.2009. (3 specimens)

Distribution: In Iran, it has been collected from Fars province.

17. *Caradrina bodenheimeri* (Draudt, 1934) (Fig. 17)

Bionomics: Bivoltine, active in early spring and winter, this species almost inhabits semi-desert and semi-mountainous regions in Iran from 500 m to more than 3000 m.

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Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009. (23 specimens)

Distribution: Turkmenistan (Ivinskis & Miatleuski 1999), Egypt (Lehmann & Saldaitis 2006), Lebanon, Palestine, Jordan (Hacker 2001). In Iran, it has been collected from Sistan va Balouchestan (Brandt 1941), Khorasan, Golestan (Wieser & Stangelmaier 2005), Fars, Lorestan (Hacker & Kautt 199), Hormozgan, Guilan, Mazandaran, Tehran, Kerman and Esfahan provinces (Ebert & Hacker 2002).

Genus: *Phoebophilus* Staudinger, 1888

18. *Phoebophilus veternosa* (Püngeler, 1907) (Fig. 18)

Bionomics: Univoltine, the specimens were collected in late summer. This species inhabits high altitudes and mountainous regions.

Collected localities and dates: Shah-e-Velayat, 8.09.2009. (3 specimens)

Distribution: Turkmenistan (Ivinskis & Miatleuski 1999). In Iran, it has been reported from Khorasan (Ebert & Hacker 2002).

Genus: *Boursinia* Brandt, 1938

19. *Boursinia oxygramma* Brandt, 1938 (Fig. 19)

Bionomics: Univoltine, late flying species, the specimens were collected in October. This species inhabits dry mountainous regions.

Collected localities and dates: Khabr road, 20.10.2009; Shah-e-Velayat, 8.10.2009. (8 specimens)

Distribution: In Iran, it has originally been reported from Fars province (Brandt 1938).

Genus: *Maraschia* Osthelder, 1933

20. *Maraschia grisescens* Osthelder, 1933 (Fig. 20)

Bionomics: Univoltine, this species was collected in October. Maraschia grisescens inhabits desert, semi desert and dry mountainous regions with scarce vegetations.

Collected localities and dates: Shah-e-Velayat, 8.10.2009; Khabr road, 20.10.2009. (9 specimens)

Distribution: Ponto-Mediteranean-Iranian. This species is known from Turkey (Varga & Ronkay 1991b), Turkmenistan (Ivinskis & Miatleuski 1999). In Iran, it is reported from Zagros Mountains (Ebert & Hacker 2002).

Genus: *Polymixis* Hübner, [1820]

21. *Polymixis zagrobia* (Wiltshire, 1941) (Fig. 21)

Bionomics: Univoltine, autumnal species. This species inhabits mountainous forest, desert and semi desert localities.

Collected localities and dates: Shah-e-Velayat, 8.10.2009; Khabr road, 20.10.2009; Rochun Mountain, 07.11.2009. (5 specimens)

Distribution: Iraq (Hacker 1990). In Iran, *P. zagrobia* has been reported from Fars (Wiltshire 1993) province.

22. *Polymixis crinomima* (Wiltshire, 1946) (Fig. 22)

Bionomics: Univoltine, this species is flying from October to November and inhabits cold habitats in semi-desert and mountainous regions.

Collected localities and dates: Khabr road, 20.10.2009; Rochun Mountain, 07.11.2009. (3 specimens)

Distribution: Turkey (Hacker 1990). In Iran, this species is found in Fars province (Ebert & Hacker 2002).

23. *Polymixis apotheina laristana* (Brandt, 1941) (Fig. 23)

Bionomics: Univoltine, this species is flying from October to November, typical of its other congeners, and inhabits cold habitats in semi desert and mountainous regions.

Collected localities and dates: Khabr road, 20.10.2009; Rochun Mountain, 07.11.2009. (9 specimens)

Distribution: This subspecies is found in central and southern Iran, in Fars, Sistan va Balouchestan and Lorestan provinces (Brandt 1941).

Subfamily **HADENINAE** GUENÉE, 1837

Genus: *Saragossa* Staudinger, 1900

24. *Saragossa siccanorum poecilographa* Varga & Ronkay, 1991 (Fig. 24)

Bionomics: Univoltine, this species was taken in summer and inhabits mountainous regions with low precipitation. Adults come to light.

Collected localities and dates: Darniyan, 22.08.2009; Chah Anar, 10.09.2009. (10 specimens)

Distribution: This subspecies has been reported from Iraq and Turkey (Varga & Ronkay 1991a). In Iran it was reported from Kerman province (Shirvani et al. 2008b).

Genus: *Hecatera* Guenée, 1852

25. *Hecatera dysodea* ([Denis & Schiffermüller], 1775) (Fig. 25)

Bionomics: Bivoltine, with two generations in spring and autumn. This species was taken in September and inhabits mountainous and semi mountainous regions up to 2500 m.

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Collected localities and dates: Chah Anar, 10.09.2009. (2 specimens)

Distribution: Ponto-Mediterranean, with wide range in Europe, North Africa, Near and Middle East (Hacker et al. 2002). In Iran, this species has been reported from Azarbayjan-e-Gharbi, Guilan, Tehran, Kordestan and Fars provinces (Ebert & Hacker 2002).

Genus: *Leucania* Ochsenheimer, 1816

26. *Leucania herrichii* Herrich – Schäffer, 1849 (Fig. 26)

Bionomics: Univoltine, this species prefers open and xerotherm regions. Leucania herrichii was taken in September.

Collected localities and dates: Chah Anar, 10.09.2009. (1 specimen)

Distribution: Mediterranean-Iranian. This species has been reported from Morocco, Turkey, Armenia, Lebanon, Jordan and Iran (Kravchenko et al. 2007; Hacker 1990).

Subfamily NOCTUINAE LATREILLE, 1809

Genus: *Parexarnis* Boursin, 1946

27. *Parexarnis damnata* (Draudt, 1937) (Fig. 27)

Bionomics: Univoltine, the adult are on wing from May to August. This species inhabits open lands with scarce vegetation up to an altitude of 3200 m.

Collected localities and dates: Chah Anar, 10.04.2009; Dashtab, 24.06.2009; Darniyan, 22.08.2009. (7 specimens)

Distribution: Turkey, Armenia (Hacker 1990). In Iran it has been recorded from Tehran and Mazandaran provinces (Ebert & Hacker 2002).

Genus: *Dichagyris* Lederer, 1857

28. *Dichagyris elbursica* (Draudt, 1937) (Fig. 28)

Bionomics: Univoltine, this species appears from May to August in arid and semiarid mountainous and semi mountainous regions up to 3000 m.

Collected localities and dates: Chah Anar, 10.04.2009; Dashtab, 24.06.2009; Darniyan, 22.08.2009. (8 specimens)

Distribution: Afghanistan, Turkmenistan, Turkey (Hacker 1990), Israel (Kravchenko et al. 2006). In Iran, this species is reported from Tehran, Fars, Sistan va Balouchestan, Lorestan and Kermanshah provinces (Hacker 1990; Ebert & Hacker 2002).

29. *Dichagyris tyrannus beluchus* Brandt, 1941 (Fig. 29)

Bionomics: Univoltine, this species inhabits semi mountainous regions with scarce vegetation. Adults are on wing from May to August and come to artificial light.

Collected localities and dates: Chah Anar, 10.04.2009; Dashtab, 24.06.2009; Darniyan, 22.08.2009. (23 specimens)

Distribution: In Iran, this subspecies has been reported from Khorasan and Sistan va Balouchestan provinces (Brandt 1941).

30. *Dichagyris argentea darius* (Boursin, 1940) (Fig. 30)

Bionomics: Univoltine, autumnal subspecies, this subspecies inhabits arid and semiarid regions up to 2000 m.

Collected localities and dates: Shah-e-Velayat, 25.10.2009. (3 specimens)

Distribution: Afghanistan (Hacker 1990). In Iran this subspecies has been collected from Tehran and Markazi provinces (Ebert & Hacker 2002).

31. *Dichagyris singularis* (Staudinger, 1877) (Fig. 31)

Bionomics: Univoltine, autumnal species. This species inhabits extensively cultivated areas from Palestine to Afghanistan.

Collected localities and dates: Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (11 specimens)

Distribution: Turkmenistan (Ivinskis & Miatleuski 1999), Israel (Kravchenko et al. 2006), Iraq, Turkey (Hacker 1990). In Iran, this species has been reported from Tehran and Khorasan provinces (Hacker 1990).

32. *Dichagyris forficula* (Eversmann, 1851) (Fig. 32)

Bionomics: Univoltine, adults are active from May to July and come to the artificial light. This species inhabits open countries up to 3000 m.

Collected localities and dates: Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009; Darniyan, 22.07.2009. (44 specimens)

Distribution: Mediterranean-Asiatic. Turkey, Syria, Iraq, Afghanistan (Fibiger 1990), Turkmenistan (Ivinskis & Miatleuski 1999). In Iran, this species has been reported from Tehran, Azarbayjan-e-Gharbi, Azarbayjan-e-Sharghi, Kermanshah, Khouzestan, Fars, Boushehr and Hormozgan provinces (Hacker 1990; Ebert & Hacker 2002).

33. *Dichagyris amoena* (Staudinger, 1892) (Fig. 33)

Bionomics: Univoltine, automnal species. Dichagyris amoena inhabits arid, semiarid mountainous and semi mountainous regions.

Collected localities and dates: Shah-e-Velayat, 25.10.2009. (3 specimens)

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Distribution: Turkey, Armenia (Hacker 1990), Israel (Kravchenko et al. 2006). In Iran, this species was reported from Guilan and Fars provinces (Hacker 1990; Ebert and Hacker 2002).

34. *Dichagyris eureteocles* (Boursin, 1940) (Fig. 34)

Bionomics: Univoltine, autumnal species. This species inhabits mountainous and semi- mountainous regions up to 2400m.

Collected localities and dates: Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (25 specimens)

Distribution: Turkey, Armenia (Hacker 1990). In Iran, *Dichagyris eureteocles* has been reported from Markazi, Tehran and Sistan va Balouchestan provinces (Ebert & Hacker 2002).

Genus: *Yigoga* Nye, 1975

35. *Yigoga truculenta toxistigma* (Hampson, 1903) (Fig. 35)

Bionomics: This subspecies inhabits a wide range of habitats including steppe, mountainous and semi mountainous regions.

Collected localities and dates: Dashtab, 24.06.2009; Hesarouyeh, 9. 09.2009. (8 specimens)

Distribution: Syria (Hacker 1990), Armenia, Turkey, Lebanon and Iraq (Fibiger 1990). In Iran, the taxon was reported from Tehran, Fars, Lorestan and Khorasan provinces (Ebert & Hacker 2002).

Genus: *Euxoa* Hübner, [1821]

36. *Euxoa conspicua* (Hübner, 1827) (Fig. 36)

Bionomics: Bivoltine, this species inhabits mountainous regions with scarce vegetations up to 3000 m.

Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009. (53 specimens)

Distribution: This species is widespread form Europe to north of Mongolia and east of India (Fibiger 1990). In Iran, it has been reported from Mazandaran, Tehran, Azarbayjan-e-Gharbi, Azarbayjan-e-Sharghi, Fars, Kermanshah, Kordestan, Lorestan, Zanjan, Hamadan, Kerman and Khouzestan provinces (Hacker 1990; Ebert & Hacker 2002).

37. *Euxoa canariensis diamondi* Boursin, 1940 (Fig. 37)

Bionomics: Univoltine, this subspecies was collected in April and inhabits arid and semi arid regions up to 2300 m.

Collected localities and dates: Chah Anar, 10.04.2009. (3 specimens)

Distribution: In Iran, this subspecies has been reported from Khouzestan, Kordestan, Lorestan, Hormozgan, Boushehr, Fars and Sistan va Balouchestan (Hacker 1990; Ebert & Hacker 2002).

Genus: *Agrotis* Ochsenheimer, 1816

38. *Agrotis obesa scytha* Alphéraky, 1889 (Fig. 38)

Bionomics: Univoltine, late flying subspecies. Agrotis obesa scytha inhabits cold, open habitats with scarce vegetations up to 2600 m.

Collected localities and dates: Shah-e-Velayat, 25.10.2009. (2 specimens)

Distribution: In Iran, this subspecies has been reported from Tehran, Ardabil and Guilan provinces (Hacker 1990; Ebert & Hacker 2002).

39. *Agrotis segetum* ([Denis & Schiffermüller], 1775) (Fig. 39)

Bionomics: Multivoltine, this species inhabits wide range of habitats. Its early stages are pests of agricultural crops and feed on roots of their hosts.

Collected localities and dates: Khabr Mountain, 15.03.2009; Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Dashtab, 24.06.2009; Darniyan, 22.07.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (38 specimens)

Distribution: Palaeotropical, this species is widespread throughout the Palaearctic, Afro-tropical and Oriental regions. In Iran, it has been reported from Azarbayjan-e-Sharghi, Ardabil, Tehran, Mazandaran, Kordestan, Lorestan, Kermanshah, Khorasan, Zanjan, Hamadan, Fars, Kerman, Sistan va Balouchestan and Hormozgan provinces (Hacker 1990; Ebert & Hacker 2002).

40. *Agrotis ipsilon* (Hufnagel, 1766) (Fig. 40)

Bionomics: Multivoltine, ubiquitous species. This species inhabits a wide range of habitats including agricultural and also uncultivated areas.

Collected localities and dates: Chah Anar, 10.04.2009; Rochun Mountain, 15.05.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009; Shah-e-Velayat, 25.10.2009. (13 specimens)

Distribution: Paleotropical, this species is widespread throughout the Palaearctic, Afro-tropical and Indo-Australian regions. In Iran this species has been reported from Azarbayjan-e-Sharghi, Ardabil, Tehran, Mazandaran, Kordestan, Lorestan, Kermanshah, Khorasan, Zanjan, Hamadan, Fars, Kerman, Sistan va Balouchestan and Hormozgan provinces (Hacker 1990; Ebert & Hacker 2002).

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Genus: *Eugnorisma* Boursin, 1946

41. *Eugnorisma chaldaica* (Boisduval, 1840) (Fig. 41)

Bionomics: Univoltine, this species is on wing from September to November. Eugnorisma chaldaica inhabits steppes and semi mountainous regions.

Collected localities and dates: Hesarouyeh, 9. 09.2009; Shah-e-Velayat, 25.10.2009; Darniyan, 04.11.2009. (5 specimens)

Distribution: Eurasiatic; Turkey (Varga & Ronkay 1994), Turkmenistan (Fibiger 1990). In Iran, this species has been reported from Tehran and Markazi provinces (Ebert and Hacker 2002).

42. *Eugnorisma insignata* (Lederer, 1853) (Fig. 42)

Bionomics: Univoltine, this species is active from August to October; its habitats are arid steppes with scarce vegetations.

Collected localities and dates: Darniyan, 22.08.2009; Hesarouyeh, 9. 09.2009; Khabr road, 20.10.2009. (36 specimens)

Distribution: Eurasiatic, Turkey, Syria, Caucasus, Afghanistan and Armenia (Fibiger 1990). In Iran, this species has been reported from Guilan, Tehran, Lorestan and Khorasan provinces (Hacker 1990; Ebert and Hacker 2002).

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LITERATURE CITED

BRANDT, W. 1938. Beitrag zur Lepidopteren-fauna von Iran. Entomol. Rundschau 55: 72 pages.

BRANDT, W. 194l. Beitrag zur Lepidopteren-Fauna von Iran #3. Neue Agrotiden nebst Faunenverzeichnissen. Mitteilungen Münchner Entomol. Gesells. 31: 835–863.

EBERT, G. & H. H. HACKER. 2002. Beitrag zur Fauna der Noctuidae des Iran: Verzeichnis der Bestände im staatlichen Museum für Naturkunde Karlsruhe, taxonomische Bemerkungen und Beschreibung neuer Taxa. Esperiana 9: 237–409.

GOATER, H., L. RONKAY & M. FIBIGER. 2003. Catocalinae & Plusiinae. - Noctuidae Europaeae. Volume 10. Entomological Press, Soro, Denmark, 452 pages.

GYULAI, P. & L. RONKAY. 1999. The Noctuidae (Lepidoptera) material collected by two Hungarian expeditions to Mongolia in 1996 and 1997 (Plts. XXVI–XXVII). Esperiana 7: 678–713.

FIBIGER, M. 1990. Noctuinae I. - Noctuidae Europaeae. Volume 1. Entomological Press, Sorø, Denmark, 208 pages.

FIBIGER, M. 1997. Noctuinae III. - Noctuidae Europaeae. Volume 3. Entomological Press, Sorø, Denmark, 418 pages.

FIBIGER, M. & J. D. LAFONTAINE. 2005. A review of the higher classification of the Noctuoidea (Lepidoptera) with special reference to the Holarctic fauna. Esperiana 11: 7–92.

FIBIGER, M., D. NILSSON & P. SVENDSEN. 1999. Contribution to the Noctuidae fauna of Cyprus, with descriptions of four new species, six new subspecies, and reports of 55 species not previously found on Cyprus (Lepidoptera, Noctuidae) (plts. XXIV–XXV). Esperiana 7: 639–667.

HACKER, H. 1990. Die Noctuidae Vorderasiens (Lepidoptera) Systematische Liste mit einer Übersicht über die Verbreitung unter besonderer Berücksichtigung der Fauna der Türkei (einschließlich der Nachbargebiete Balkan, Südrußland, Westturkestan, Arabische Halbinsel, Ägypten). Neue Entomol. Nachrichten 27: 1–707.

HACKER, H. 2001. Fauna of the Nolidae and Noctuidae of the Levant with descriptions and taxonomic notes (Lepidoptera, Noctuoidea). Apendix: Revision of the genus Clytie HBN. Esperiana 8: 7–398.

HACKER, H. & P. KAUTT. 1999. Noctuoidea aus dem Iran, gesammelt 1997 von A. Hofmann und P. Kautt (Insecta, Lepidoptera). Esperiana 7: 473–484.

HACKER, H & M. FIBIGER. 2006. Updated list of Micronoctuidae, Noctuidae (s.l.), and Hyblaeidae species of Yemen, collected during three expeditions in 1996, 1998 and 2000, with comments and descriptions of species. Esperiana 12: 75–166.

IVINSKIS, P. & J. MIATLEUSKI. 1999. Data on Noctuidae (Lepidoptera) of Turkmenistan. Acta Zool. Lituan. 9: 201–208.

KITCHING, I.J., & J. E. RAWLINS. 1998. The Noctuoidea. In: Kristensen, N. P. & de Gruyter W. (Vol.1), Lepidoptera: moths and butterflies. Evolution, systematics and biogeography. Handbook of Zoology. Berlin, pages 355–401.

KRAVCHENKO, V. D., O. B. ORLOVA., M. Fibiger., L. Ronkay., J. Mooser., C. Li & G. C. Müller. 2005. The Heliothinae of Israel (Lepidoptera: Noctuidae). Shilap Revista de Lepidopterol. 33: 365–374.

KRAVCHENKO, V. D., M. FIBIGER., J. MOOSER., & G. C. MÜLLER. 2006. The Noctuinae of Israel (Lepidoptera: Noctuidae). Shilap Revista de Lepidopterol. 34: 353–370.

KRAVCHENKO, V. D., M. FIBIGER., J. MOOSER., A. JUNNILA & G. C. MÜLLER. 2007. The Hadeninae of Israel (Lepidoptera: Noctuidae). Shilap Revista de Lepidopterol. 35: 441–454.

LAFONTAINE, J. D. & M. FIBIGER. 2006. Revised higher classification of the Noctuoidea (Lepidoptera). Canad. Entomol. 138: 610–635.

LEHMANN L. & A. SALDAITIS. 2006. Beitrag zur Nachtfalter-Fauna des Sinai (Lepidoptera). Esperiana 12: 205–209.

MATOV, A., R. ZAHIRI & J. D. HOLLOWAY. 2008. The Heliothinae of Iran (Lepidoptera: Noctuidae). Zootaxa 1763: 1–37.

MATTHEWS, M. 1991. Classification of the Heliothinae. Nat. Res. Inst. Bull. 44: 1–195.

NIKOLAEVITCH, P. A. & I. E. VJATCHESLAVOVNA. 2002. The Noctuidae (Lepidoptera) of the Daghestan Republic (Russia). Phegea 30: 11–36.

NUPPONEN, K. & M. FIBIGER. 2002. Contribution to the knowledge of the fauna of Bombyces, Sphinges and Noctuidae of the Southern Ural Mountains, with description of a new Dichagyris (Lepidoptera: Lasiocampidae, Endromidae, Saturniidae, Sphingidae, Notodontidae, Noctuidae, Pantheidae, Lymantriidae, Nolidae, Arctiidae). Phegea 30: 121–185.

RONKAY, G. & L. RONKAY. 1994. Cuculliinae I. - Noctuidae Europaeae. Volume 6. Entomological Press, Sorø, Denmark. 282 pages.

RONKAY, L. & P. GYULAI. 2006. New Noctuidae (Lepidoptera) species from Iran and Tibet. Esperiana 12: 211–241.

RONKAY, L., J. L. YELA & M. HREBLAY. 2001. Hadeninae II. - Noctuidae Europaeae. Volume 5. Entomological Press, Sorø, Denmark, 452 pages.

SHIRVANI, A., RONKAY L. & TALEBI A. A. 2008a. A new Brachygalea Hampson, 1906 species from Iran (Lepidoptera, Noctuidae, Oncocnemidinae). Esperiana 14: 573–576.

SHIRVANI, A., K. KAMALI., L. RONKAY & A. A. TALEBI. 2008b. Taxonomic and Faunistic notes of certain Noctuidae species (Lepidoptera) for Iran. Esperiana 14: 565–571.

VARGA, Z. & L. RONKAY. 1991a. Taxonomic Studies on the Genera Sideridis Hübner, Saragossa Staudinger and Conisania Hampson (Lepidoptera, Noctuidae: Hadeninae). Acta Zool. Hung. 37: 145–172.

VARGA, Z. & L. RONKAY. 1991b. Taxonomic studies on the Palaearctic Noctuidae (Lepidoptera) I. new taxa from Asia. Acta Zool. Hung. 37: 263–312.

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VARGA, Z. & L. RONKAY. 1994. Additional notes with the description of a new species and redescription of two misidentified species (Lepidoptera, Noctuidae). Acta Zool. Hung. 40: 87–97.

WIESER, V. CH. AND G. STANGELMAIER. 2005. Zwischenergebnisse einer lepidopterologischen Forschungsreise in den Nordiran, Oktober 2003 (Insecta: Lepidoptera). Carinthia 195: 659–674.

WILTSHIRE, E. P. 1993. Middle East Lepidoptera 50: Notes on some hitherto misunderstood forms near Polymixis bischofJii (Herrich-Schäffer, 1850) (Noctuidae). Nota Lepid. 15: 257–267.

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BEHAVIOR OF *LYMANTRIA LUCESCENS* (BUTLER) (EREBIDAE: LYMANTRIINAE); ESPECIALLY DURING AN OUTBREAK NEAR TOYOTA CITY, HONSHU, JAPAN

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ABSTRACT. *Lymantria (Lymantria) lucescens* (Butler) collections and observations were made at Toyota and Azumino, Honshu, Japan. Larvae are now recorded to feed on Fagaceae (*Quercus*, four species); Ulmaceae (*Ulmus* and *Zelkova*) and Moraceae (*Morus*). During the moth flight (July in Toyota), both sexes (but only 15% females) were attracted to commercial lighting and settled on lit surfaces such as storefronts. Females (wingspan av. 72 mm) carried on average 758 eggs each. Periodicity of male moths responding to either synthetic sex pheromone or to visible lights showed that flight activity peaked between 2000 and 2100 h. Three different larval parasitoids from *L. lucescens* were recovered. *L. lucescens* is discussed in light of attributes favoring its potential invasiveness.

Additional key words: Food plants, fecundity, population outbreak, flight to lighting, potential for invasion, parasitoids.

Lymantria (Lymantria) lucescens (Butler) is considered "rare" and "local" and is distributed on the Japanese islands of Honshu, Kyushu and Hokkaido and in Korea (Inoue 1957; Nam & Kim 1981; Sato 1987, Pogue & Schaefer 2007). In 1997, I targeted *L. lucescens* for an on-going systematic study of sex pheromone communication systems. That effort culminated in the 2000 field season in Toyota City, Aichi Prefecture, Japan (Gries et al. 2002). This season coincided with an apparent rare occurrence—an outbreak of *L. lucescens*. Given this unusual opportunity, I assessed female fecundity, apparent dispersal potential and flight distance, recorded food plants, recovered natural enemies and noted overall behavior. At Azumino (then known as Toyoshina), Nagano Prefecture, I encountered *L. lucescens* as well, and independently, in Ueda, in the same prefecture, Nishio (2000) (cited in error as "Noritaki, 2000" in Pogue & Schaefer 2007) recorded another outbreak location similar to what I experienced. Nishio and I both witnessed localized outbreaks of this usually scarce moth. In concluding, I briefly discuss the behavior of this moth especially with regard to its potential for invasion into new habitats.

METHODS

Late stage larvae of *L. lucescens* were collected from *Quercus* spp. in a forest fragment in the suburban community of Mifune (N 35.14°, E 137.19°) in the outskirts of Toyota City. With assistance from Ban Tanaka (Toyota City) and Yasutomo Higashiura (Tokyo Univ. Pharmacy & Life Sciences, Tochachi), we collected larvae from various oak species, noting the species involved. All larvae within our reach were collected using 4 m pruning pole clippers. We tallied each species captured at the conclusion of our collecting. While other species were released, the collected *L. lucescens* caterpillars were reared on fresh *Quercus* sp. leaves until pupation. Pupae were isolated for eventual emergence (females being used for sex pheromone analysis reported elsewhere (Gries et al. 2002)) and any natural enemies were frozen and then pinned for identification. Only a qualitative assessment of natural enemies was made.

At the time of moth flight in August, we returned for pheromone field tests. During this period, I noted the general flight of moths into Toyota center city, noted their sex, photographed some accumulated adults, and collected specimens. I preserved one series of females from a convenience storefront by placing specimens directly into Listerine® liquid mouthwash, (21.6 % ethanol, Warner-Lambert Co, Morris Plains, NJ) as a temporary preservative. Subsequently, I dissected these preserved females and counted the number of ova per female.

To gain insight into the flight periodicity of *L. lucescens*, at Azumino (N 36.28°, E 137.92°), in 1997 and at several subsequent visits, I recorded the time of arrival at various light sources. At Mifune, I recorded male moth arrival at pheromone traps and at all-night convenience store-front lights. At first light, I revisited several well lit locations and noted and collected from the nightly accumulation of moths.

RESULTS AND DISCUSSION

On May 27–28, 2000, late stage larvae (Fig. 1) were collected in Mifune on *Quercus variabilis* Blume, *Q. serrata* Thunb. ex. Murray, and *Q. glauca* Thunb. A total of 326 *L. lucescens*, 181 *L. dispar japonica* (Motschulsky) and 29 *L. mathura* Moore larvae were collected on the mentioned *Quercus* spp. Often all three moth species were taken from the very same *Quercus* spp. foliage indicating that these moths were all competitors. We previously recorded three *Quercus*

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spp. as food trees (Gries et al. 2002). On 3 June 2000, at Azumino, I collected *L. lucescens*, *L. dispar*, and *L. mathura* larvae, all on *Quercus acutissima* Carruthers, again competing for the same food source. Nishi (2000) reported further that late instars, in addition to feeding on *Quercus* spp., also fed on *Ulmus davidiana* Planchon, *Ulmus parvifolia* Jacquin, *Zelkova serrata* (Thunb.) Makino (all Ulmaceae), and *Morus bombycis* Koidz. (Moraceae). The known food plants recorded to date appear in plant families Fagaceae (*Quercus*, four species), Ulmaceae (*Ulmus* and *Zelkova*), and Moraceae (*Morus*).

In rearing the collected *L. lucescens* larvae, *Meteorus* sp. (Hymenoptera: Braconidae), *Glyptapanteles liparidis* (Bouche) (Hym.: Braconidae), and *Exorista* sp. (Diptera: Tachinidae) were recovered.

Our main accomplishment concerning *L. lucescens* was the identification of the sex pheromone (Gries et al. 2002). This followed earlier hints of male attraction to a blend we earlier found best for *L. monacha* (L.) (Schaefer & Kishida 1999). This "blend" included the sex pheromone of *L. lucescens* as one of three components, explaining the earlier male captures, however minimal. Availability of the *L. lucescens* sex pheromone has made it possible to survey for this moth or to conduct behavioral studies. Baited Delta-like sticky traps were highly specific and most effective (Fig. 2).

Adult *L. lucescens* males (Figs. 3 and 4) at Azumino responded to blacklight in the early evening hours (Table 1), similar to the time of response to synthetic sex pheromone (Gries et al. 2002), and similar to the arrival of males at convenience store lights (Fig. 5) in Mifune (Table 1). All evidence suggests that males fly during the early evening hours, whether they are responding to synthetic sex pheromone or to lights (either UV, white light, or commercial lighting) (Table 1). During the week (10–17 July 2000), repeated observations at lights near downtown Toyota revealed ca. 85% males vs. 15% females at outdoor lighting at overnight job site lights at the Toyota Stadium (then under construction), on the attractive Yahagi River bridge spanning the river leading from center city to the stadium, and at all-night convenience store lighting (Fig. 5). It remains unknown if this skewed ratio of the sexes was a reflection of the emerging adult sex ratio or whether it might reflect sex differential behavior.

All observations confirmed that moths (fewer females) appeared within center city nightly. Although it was never entirely clear just how far they had traveled, it was apparent they moved some distance to reach center city. Forested areas outside Toyota were < 2 km from center city. However, it was not possible to pinpoint just where the outbreak population had originated. On the night of 12–13 July, assessment of the composition of the moth flight showed that *L. lucescens* predominated (85% males in sample of 182), but that a few specimens of both *L. d. japonica* and *L. mathura* (both sexes) were also in flight. Elsewhere in the Toyota vicinity, we successfully pheromone trapped these latter

TABLE 1. Nocturnal periodicity of *Lymantria lucescens* male flight, based on both attraction to lights and to synthetic sex pheromone baited sticky traps, Honshu, Japan. End = termination of surveillance; Next AM = numbers found when checking the scene soon after dawn the following day. 15 July data also grafted in Gries et al. (2002).

Location:	Mifune	Mifune	Toyota City	Azumino	Azumino
Date:	15 Jul 2000	16 Jul 2000	16 Jul 2000	27 Aug 1997	31 Aug 2000
Method:	Phero. Trap, N=5	Phero. Trap, N=5	Storefront lights	Hg Vap. Light	UV Light
Elevation:	48 m	48 m	48 m	567 m	567 m
Time:					
1900	0	0	0	0	0
1930		0	0	2	1
2000	6	1	18	4	3
2030		15	33	1	4
2100	50	15	28	0	0
2130		5	8	1	0
2200	4	1	13	0	0
2230		4	7	0	0
2300	4	2	5	0	0
2330		2	11	end	0
2400	0	3	end		1
0030		4			0
0100	0	end			end
0130	end				
Next AM	1	12			0
Total:	65	64	123	8	9

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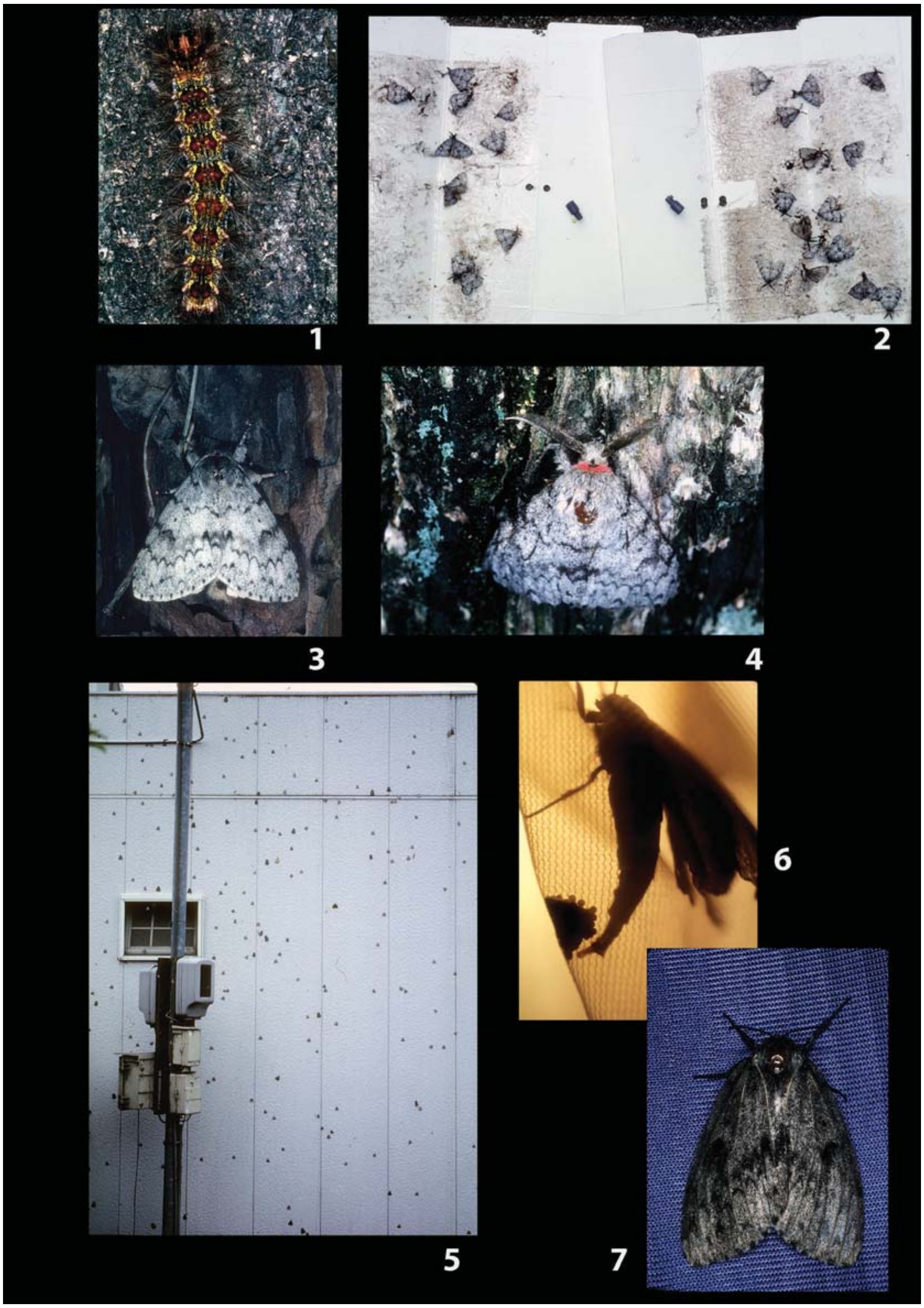

FIGS. 1-7: *Lymantria lucescens* Butler, life stages except as noted. **1.** Late stage caterpillar **2.** Males captured in two sticky traps, at Mifune, near Toyota city, on 14 July 2000 after two nights of exposure. Synthetic lure was dispensed by the two respective rubber septa shown near image center. **3 & 4.** Males with latter showing pinkish-red setal collar on pronotum just behind the head. **5.** External wall of a convenience store showing accumulated moths, on the early morning of 13 July 2000. *L. lucescens* predominated but occasional *L. mathura* and *L. dispar japonica* were also present. Total moth count in view was 192 with 81% of these male *L. lucescens*, Toyota city, Aichi Prefecture, Japan. **6 & 7.** Females, with former showing tapered abdomen and telescoping ovipositor used to insert eggs in cracks or under bark scales on tree boles (illustration ex Pogue & Schaefer (2007)). All photos by Paul W. Schaefer.

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two species. All three species were coincident in their flight periods although the peak periods for *L. d. japonica* and *L. mathura* appeared to precede that of *L. lucescens*.

Efforts to clarify the periodicity of male moth flight were consistent and illustrated that most flight activity occurred between sunset and 2100 h. (Table 1). Regardless of the method used (i.e. attraction to Hg light, UV light, pheromone baited traps, or arrival at lights of existing storefronts), male activity peaked 2000–2100 h, precisely the same hours reported by Nishio (2000). In all our previous work on sex pheromones (citing two relevant cases (Gries et al. 1999; Schaefer et al. 1999)), we based nocturnal periodicity upon the arrival of males at synthetic sex pheromone baited traps at forests in complete darkness. Here we have evidence that attraction of male *L. lucescens* to both lighting and to a sex pheromone lure coincides.

Fecundity measurements of females (wingspread av. 72.0 mm, S.D. = 3.92) (Figs. 6 and 7) collected at a convenience store at 0445 h on 15 July 2000 averaged 758.0 eggs each (S.D.= 183.5, Max. = 1096, N= 18) when arriving at store lights. It was not clear from my data just when normal mating occurred, however, Nishio (2000) reported mating and oviposition occurred 2000–2100 h. At the time these collections were made, I noted that when disturbed, females would usually raise their wings up over their back, curl their abdomens upward and feign death by remaining motionless for a minute or more. Some others, upon being disturbed, would fly but flew for only a very short, quick flight before promptly re-landing.

Inoue (1957, 1959) had indicated that the *L. lucescens* moth flight is July and/or August. My experiences corroborate this flight period while further illustrating that at the two sites visited (Toyota and Azumino), the respective moth flight periods differed by more than one month's time, likely due to the higher elevation at Azumino (cooler temperatures and slower moth development) than at Toyota (see Table 1). Weather, geography, elevation, and population density (outbreak) are all factors impacting the timing of moth flight.

When compared morphologically to *L. d. japonica*, females of *L. lucescens* possess a very long, tapered ovipositor (i.e. insertion type) (Fig. 6, also in Pogue & Schaefer (2007)), used to insert eggs *en masse* into holes, under bark scales or cracks in tree trunks. Nishio (2000) illustrated one such egg mass. *L. mathura* and *L. lucescens* are similar in this regard, but both species are very unlike that of sympatric *L. d. japonica*, which possess a non-telescoping ovipositor and lay their eggs on the surface of a suitable substrate, often that of a tree bole. With the observed female flight propensity, dispersal capability, egg laying behavior, and larval food plant acceptance, *L. lucescens* possesses attributes that could easily result in eggs being deposited on ship superstructures or on containerized cargo in well-lit seaports or other holding yards. *L. lucescens* might in this way easily invade and establish in oak forests on new continents. One should now be alert to another potentially invasive species and another threat to temperate deciduous habitats (especially oak forests) most anywhere outside Japan and Korea, as first suggested by Pogue & Schaefer (2007).

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Literature Cited

Gries, G., P. W. Schaefer, G. Khaskin, R. Hahn, R. Gries & J.-T. Chao. 1999. Sex pheromone components of Casuarina moth, *Lymantria xylina*. J. Chem. Ecol. 25(11): 2535–2545.

Gries, G. P. W. Schaefer, R. Gries, Y.-B. Fan, Y. Higashiura & B. Tanaka. 2002. 2-Methyl¬(Z)-7-Octadecene: Sex pheromone of allopatric *Lymantria lucescens* and *L. serva*. J. Chem. Ecol. 28(3): 469–478.

Inoue, H. 1957. A revision of the Japanese Lymantriidae (II). Jap. M. Sci. & Biol. 10: 187–219.

Inoue, H., T. Nakane, & K. Yasumatsu (eds.). 1959. Iconographia Insectorum Japonicorum. Colore naturali edita. Vol. 1. Hokuryukan Co, Tokyo, Japan, 284 pp.

Nam, S. H. & C. W. Kim. 1981. A synonymic list of tussock moths (Orgyidae: Lep.) in Korea. Entomological Research Bulletin 8: 73–100.

Nishio, N. 2000. Biological notes on *Lymantria lucescens* (Butler) (Lymantriidae). Yugatoh 161: 95–97. (in Japanese)

Pogue, M. G. & P. W. Schaefer. 2007. A review of selected species of *Lymantria* Hübner [1819] including three new species (Lepidoptera: Noctuidae: Lymantriinae) from subtropical and temperate regions of Asia, some potentially invasive to North America. U. S. Dept. Agric., Forest Health Tech. Enterprise Team, Tech. Transfer, FHTET-2006-07, 223 pp.

Sato, S. (ed.). 1987. Larvae of larger moths of Japan. Kodansha Co. Ltd., Tokyo (pg. 287).

Schaefer, P. W., G. Gries, R. Gries & D. Holden. 1999. Pheromone components and diel periodicity of pheromone communication in *Lymantria fumida*. J. Chem. Ecol. 25: 2305–2312.

Schaefer, P. W. & Y. Kishida. 1999. Capture of *Lymantria lucescens* males (Lepidoptera: Lymantriidae) in traps baited with sex pheromone components of *Lymantria monacha*. Tinea (Japan Hetero. Soc.) 16(1): 50–51.

(2002).

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THE PROSTERNAL GLAND IN PACIFIC NORTHWEST BUTTERFLY LARVAE WITH PRELIMINARY CHEMICAL ANALYSES OF EMISSIONS

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ABSTRACT.. During rearing studies, larvae of 41 Pacific Northwest butterfly species from three families (Nymphalidae, Hesperiidae and Pieridae) were identified as possessing a prosternal gland. Observations on larvae of *Argynnis* spp. (Nymphalidae) showed the gland appeared in the second instar as a pale-colored ventral suture. Rough handling of final instars caused eversion of a single-lobed papilla and emission of a 'musky' odor. The prosternal glands of all nymphalid and hesperid larvae examined were similar morphologically but the pierids, *Neophasia menapia* and *Nathalis iole* possessed a pair of bi-lobed glands. Chemical analyses revealed that the glands of final instar *Argynnis* spp. contained hydrocarbons, fatty alcohols, carboxylic acids and acetate esters. Dodecene or dodecanol and/or associated alkanes and acetate esters occurred in nearly all *Argynnis* samples as well as in the glands of *N. menapia* (Pieridae) and *Polites sonora* (Hesperiidae) larvae. These compounds have a dispersive function in other arthropods. Terpenoid compounds were found in most samples and likely have a defensive function. Glands contained other potentially defensive compounds including disulfides, squalene, acridine, diphenyl ether and diphenylamine. Based on these preliminary data, the prosternal gland appears to have at least two functions in butterfly larvae: defense and dispersion. The apparent widespread occurrence of prosternal glands in larvae of Nymphalidae and Hesperiidae suggests that this gland is important in the ecology of many species although experimental evidence for function is needed.

Additional key words: defense, dispersion, chemistry, hydrocarbons, acetate esters, terpenoids

The existence of a prosternal gland (also known as ventral eversible gland or adenosma) in some lepidopteran larvae was first reported by De Geer in 1745 (Latter 1897). Prosternal glands occur in larvae of Noctuidae, Notodontidae, Nymphalidae, Hesperiidae and Pieridae according to Peterson (1962). Detailed anatomical and chemical studies on prosternal glands in lepidopteran larvae have been conducted for moths of the families Notodontidae and Noctuidae (Geertsema et al. 1976; Marti & Rogers 1988), where emissions from the gland have been suggested to have defensive (Weatherston et al. 1979; Severson et al. 1991) or dispersive (Weatherston et al. 1986) properties. Formic acid is the major component of prosternal gland secretions in *Schizura concinna* (J.E. Smith) larvae (Weatherston et al. 1979), but in another notodontid species, *Datana ministra* (Drury), secretions are dominated by the alkanol acetates, dodecanol, dodecyl acetate, and dodecyl formate (Weatherston et al. 1986). Prosternal gland volatiles from larvae of the noctuid *Spodoptera frugiperda* (J.E. Smith) contain saturated hydrocarbons, primarily *n*-pentadecane (Severson et al. 1991). In butterflies, Scott (1986) briefly mentioned the occurrence of prosternal glands in some nymphalids, pierids and hesperiids. Muyshondt and Muyshondt (1976) and McCorkle and Hammond (1988) reported prosternal glands in larvae of *Colobura dirce* L. and *Speyeria* (= *Argynnis*) *zerene hippolyta* (Boisduval) (Nymphalidae), respectively. James (2008) described the presence of a prosternal gland in second to sixth instars of 5 *Argynnis* spp. from Washington State. Images of the gland in a sixth instar *A. coronis simaetha* (Behr) were also presented. Morphological studies on prosternal glands in *Abananote hylonome* (Doubleday) and *Heliconius erato* (L.) (Nymphalidae) were reported by Osborn et al. (1999) and Borges et al. (2010), respectively. To date, the only chemical analysis of prosternal glands in butterfly larvae was reported by Osborn and Jaffe (1998), who showed carboxylic acids and terpenes were present in prosternal gland secretions in the nymphalids *Dione juno* (Cramer) and *A. hylonome*.

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This paper presents information on the occurrence of prosternal glands in larvae from three butterfly families in the Pacific Northwest. We also provide the results of preliminary chemical analyses of prosternal gland emissions mainly from *Argynnis* spp.

MATERIALS AND METHODS

During butterfly rearing studies in the Pacific Northwest during 2002–2010, observations were made on the presence or absence of prosternal glands in late instars of selected species of the families Pieridae, Nymphalidae and Hesperiidae. Observations on gland appearance during larval development, size, eversion and color differences between species were made for *Argynnis* spp. (Nymphalidae). Some larvae were mounted, ventral surface up, restrained by sticky tape and photographs of glands were taken using a Canon EOS 1DS Mark II, digital SLR camera mounted on a tripod. A Canon MP-E 65 mm 1 X – 5 X macro lens was used together with a macro Twin Lite MT – 24 EX flash lighting system.

During 2007–2009, seventy eight extracts obtained from the prosternal glands of late instars of *Argynnis* (*Speyeria*) spp. (Nymphalidae) (76)), *Polites sonora* (Scudder) (Hesperiidae) (1)) and *Neophasia menapia* (C. & R. Felder) (Pieridae) (1)) were analyzed using gas chromatography/mass spectrometry (GC/MS). Seven species of *Argynnis* (*Speyeria*) were examined in 2007: *A.* (*S.*) *zerene* (Boisduval), *A.* (*S.*) *coronis* (Behr), *A.* (*S.*) *hydaspe* (Boisduval), *A.* (*S.*) *hesperis* (Edwards), *A.* (*S.*) *egleis* (Behr), *A.* (*S.*) *cybele* (F.) and *A.* (*S.*) *mormonia* (Boisduval). *A. coronis*, *A. zerene* and *A. mormonia* were reexamined in 2008 as were *A. zerene* and *A. hydaspe* in 2009. *Argynnis* spp. were reared in the laboratory on *Viola adunca* Sm. (Blue Violet) and *V. labradorica* Schrank (Labrador Violet), after first instars in diapause were held at 5 ºC for 2–3 months (James 2008). Gland extracts were taken from sixth instars. Single extracts were taken from a fourth instar *P. sonora* and a fourth instar *N. menapia* reared in the laboratory on Yellow Foxtail Grass (*Setaria glauca* (L.) P. Beauv) and Douglas Fir (*Pseudotsuga menziesii* Mirb. Franco), respectively. Extracts were obtained by restraining larvae, ventral side up, under a stereomicroscope and squeezing the anterior part of the body until the prosternal gland was everted. A small piece (~ 5 × 5 mm) of filter paper was held to the gland and fluid drawn off. The filter paper was deposited into a clean glass vial containing 0.5–2.0 ml of dichloromethane. Vials were stored in a freezer (1–2 weeks) until analyses using gas chromatography-mass spectroscopy (GC/MS) were conducted over the course of several days. Extracts were analyzed using 2µl samples in an Agilent 6890N Gas Chromatograph with 5973N Mass Selective Detector (MSD) and an Agilent 7683 auto sampler. The carrier gas was ultrapure helium and the oven was held at 50 ºC for 1 minute, raised to 260 ºC at 5 º C /minute and held for 30 minutes. Masses between m/z 50 and 500 were scanned. Mass spectra were identified by comparison of retention times and mass spectra in the NIST library.

RESULTS

Observations on gland incidence and morphology. Larvae of at least 41 Pacific Northwest butterfly species belonging to three families (Nymphalidae, Hesperiidae and Pieridae) possess a prosternal gland (Table 1). None of the larvae of Lycaenidae (23) and Papilionidae (8) had a prosternal gland. In the Pieridae, 11 species representing the genera *Neophasia, Pieris, Pontia, Euchloe, Anthocharis* and *Nathalis* were examined, and only *Neophasia menapia* and *Nathalis iole* Boisduval had larvae with a prosternal gland. Although only four species of Hesperiidae were confirmed to have a prosternal gland, no other species were examined, but it is likely that larvae of all members of this family have a prosternal gland. Similarly, prosternal glands are likely to be a common feature of all Nymphalidae larvae, given that all nymphalid larvae examined in this study have a prosternal gland.

Observations on 7 *Argynnis* spp. used in chemical studies (below) showed the gland was not present in the first instar but appeared in the second instar as a pale-colored suture. In sixth instars, the non-everted gland was a transverse slit bordered by two 'lips' (Fig. 1). From the third to sixth instar, rough handling of larvae resulted in eversion of a single-lobed papilla (Fig. 2) and emission of a 'musky' odor. Gland size was comparable in all *Argynnis* spp. with the non-everted

TABLE 1. Pacific Northwest butterfly larvae confirmed to possess a prosternal gland.

Pieridae: *Neophasia menapia, Nathalis iole*

Nymphalidae: *Euptoieta claudia, Argynnis (Speyeria) cybele, Argynnis (S.) coronis, Argynnis (S.) zerene, Argynnis (S.) callippe, Argynnis (S.) egleis, Argynnis (S.) atlantis, Argynnis (S.) hesperis, Argynnis (S.) hydaspe, Argynnis (S.) mormonia, Boloria selene, Boloria bellona, Boloria epithore, Boloria freija, Boloria astarte, Boloria chariclea, Chlosyne acastus, Chlosyne palla, Phyciodes cocyta, Phyciodes pulchella, Phyciodes pallida, Phyciodes mylitta, Polygonia satyrus, Polygonia gracilis, Nymphalis l-album, Nymphalis californica, Nymphalis antiopa, Aglais milberti, Vanessa virginiensis, Vanessa annabella, Vanessa cardui, Vanessa atalanta, Junonia coenia, Adelpha californica, Erebia epipsodea*

Hesperiidae: *Epargyreus clarus, Thorybes pylades, Pyrgus communis, Oarisma garita*

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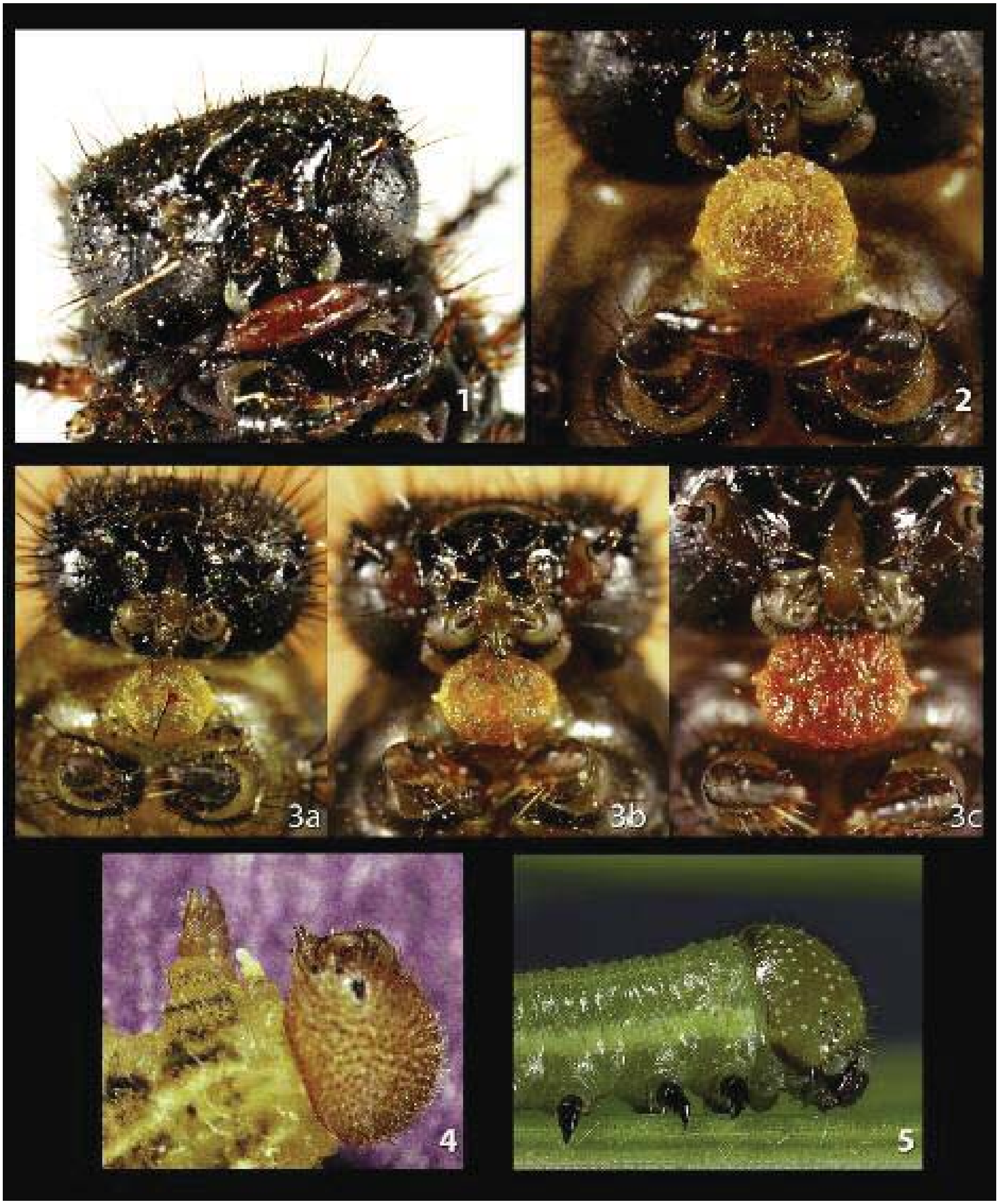

FIGS. 1–5. **1.** Non-everted prosternal gland of sixth instar *Argynnis coronis*. **2.** Everted prosternal gland of sixth instar *Argynnis hydaspe*. **3.** Everted prosternal gland in sixth instars of *Argynnis zerene* (**3a**), *A. egleis* (**3b**) and *A. coronis* (**3c**). **4.** Lateral view of everted prosternal gland in fourth instar of *Erebia epipsodea* (Nymphalidae: Satyrinae). **5.** Lateral view of prosternal gland in third instar *Neophasia menapia* (Pieridae).

NOTE: THIS NEEDS TO REFER TO FIGS. 3a, b and c rather than upper middle lower as stated in Word.doc fig. captions... check for consistency in text and caption for how images in plate are referred to. Please have author check to see labels & images for 3a,b,c are correctly matched.

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gland in sixth instar *A.* (*S.*) *cybele* measuring 1.1–1.5 mm along the suture and the everted gland measuring 1.0–1.25 mm in width. Amongst *Argynnis* spp. there was a gradient in color of the everted gland from yellow-orange-red with *A.* (*S.*) *zerene* yellow, (*S.*) *egleis*, orange and *A.* (*S.*) *coronis* red (Fig. 3).

The prosternal glands of most other nymphalid (and hesperiid) species were similar in structure and size (although varied in color) to those found in *Argynnis* spp., with eversion and odor emission occurring when larvae were roughly handled. However, the gland in the only species examined in the subfamily Satyrinae was ovoid and the everted papilla was small and pale colored (Fig. 4). In the pierids *N. menapia*, and *N. iole* there were two bi-lobed glands situated laterally on the same segment (Fig. 5). In *N. menapia*, the glands appeared largest in the third and fourth instar, diminishing in the final (fifth) instar.

Chemical analyses: *Argynnis* spp. Chemical analyses revealed that prosternal gland extracts of final instars of seven *Argynnis* spp. contained hydrocarbons, fatty alcohols, carboxylic acids and acetate esters (Table 2). There were no apparent species-specific differences and data were combined. Extracts from all larvae examined (76) contained large quantities of dodecene or dodecanol and/or associated alkanes and acetate esters. Terpenoid compounds (e.g. germacrene-B, pentanoic acid, hexanedioic acid, 1, 3-bis (1, 1-dimethylethyl) benzene, 2, 6-dimethyl, 2, 6-octadiene-1, 8-diol) occurred in gland extracts of 61.8 % (47/76) of larvae. Squalene, a C30 polyunsaturated triterpene hydrocarbon was found in gland extracts of 19 larvae (25 %) and the secondary amines diphenylamine or diphenyl ether were found in gland extracts of 16 larvae (21 %). The alkaloid, 9, 10-dihydro-9, 9-dimethyl-acridine was found in the gland extracts of 17 larvae (22.4 %) and disulfide compounds were present in 23 extracts (30.3 %).

***Neophasia menapia* and *Polites sonora*.** The single extract samples from each of these species showed similar chemistry to *Argynnis* spp., with dodecene/dodecanol and esters, and 1, 3-bis (1, 1-dimethylethyl) benzene present in each gland. The gland of *P. sonora* also contained diphenyl ether and diphenylamine with the latter also present in the gland of *N. menapia*.

DISCUSSION

Larvae of forty-one species of Pacific Northwest butterflies representing three families (Pieridae, Nymphalidae and Hesperiidae) were found to possess a prosternal gland. Among 11 species of Pieridae examined only *Neophasia menapia* and *Nathalis iole* have this gland but all of the nymphalid species examined possessed it as did the four hesperids examined. It is likely that most if not all species in these two latter families have larvae with prosternal glands. In contrast, examination of lycaenid and papilionid larvae showed no evidence of prosternal glands. However, papilionid larvae are well documented to possess an analogous bifurcate eversible dorsal gland just behind the head, which secretes defensive chemicals (Eisner & Meinwald 1965; Omura et al. 2006).

Prosternal glands of *Argynnis* spp. larvae were very similar in size and form and varied in color from red to yellow. The glands of other nymphalid species also had similar morphology and were variable in coloration. The gland of the only species examined from the subfamily Satyrinae (*E. epipsodea*) was small and pale. Prosternal glands of hesperiid species ranged from red to brown and were similar morphologically to nymphalid glands. The prosternal glands of the pierid larvae, *N. menapia* and *N. iole*, differ significantly from the other families, in that both species have a pair of bi-lobed glands. In all species, the prosternal gland was absent in first instar larvae, appearing in the second instar and becoming progressively larger during development. An apparent exception occurred in *N. menapia* which had the glands largest in the third and

TABLE 2. Presence of compounds in prosternal gland extracts of *Argynnis* spp. (Nymphalidae) obtained and analyzed during 2007–09.

YEAR and # of extracts	dodecene dodecanol & esters	terpenes	squalene	diphenylamine diphenyl ether	acridine	disulfides
2007 (27)	X	X	X		X	
2008 (37)	X	X				X
2009 (12)	X	X		X		X

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fourth instars, but smaller in the final instar. Rough handling of larvae usually resulted in gland eversion and, in *Argynnis* spp., emission of a noticeable musky odor.

Our analyses of prosternal gland emission chemistry in seven species of *Argynnis* showed the presence of dodecene or dodecanol and/or associated alkanes and acetate esters in nearly all samples. These compounds were also present in gland emissions of *N. menapia* and *P. sonora*. Dodecanol and associated acetate esters were found in the prosternal gland of mature *Datana ministra* (Drury) (Notodontidae) larvae and were suspected of acting as a 'dispersal pheromone' keeping the larvae solitary (Weatherston et al. 1986). Similar compounds, decyl acetate and dodecyl acetate, comprise the alarm pheromone of western flower thrips (*Thrips occidentalis* (Pergande)), which causes dispersion of conspecifics (Teerling et al. 1993). Dodecanol and acetate esters in prosternal gland secretions of *Argynnis* spp. caterpillars might serve to keep individuals well separated to reduce competition for host plant resources. Alternatively, the secretions may serve as a warning pheromone to disperse conspecifics when a larva is attacked by a predator.

Terpenoid compounds were found in most *Argynnis* spp. samples as well as in *N. menapia* and *P. sonora*, and likely have a defensive function. Terpenoids dominate the osmeterial secretions of early-mid instar papilionid larvae whose major enemies are invertebrate predators (Omura et al. 2006), and also were found in prosternal glands of nymphalid larvae, *Dione juno* and *Abanote hylonome* (Osborn & Jaffe 1998). All *Argynnis* spp. samples contained disulfides or squalene, but other potentially defensive compounds varied in their occurrence in the larvae examined. Acridine and/or diphenylamine were also found in some samples. Diphenyl ether and diphenylamine were found in *P. sonora*, but only the former was found in *N. menapia*. Squalene, a C30 polyunsaturated hydrocarbon and an intermediate in the biosynthesis of other triterpenoids and sesquiterpenoids (Bonner 1965), is the dominant component of the defense secretion of the American dog tick, *Dermacentor variabilis* (Say) and is repellent to fire ants, *Solenopsis invicta* Burren (Yoder & Domingus 2003). If squalene is repellent to ants generally, the value of this secretion to near ground or ground-dwelling caterpillars, such as those of *Argynnis* spp. and *Polites* spp., is apparent. Disulfides are generally toxic or repellent to insects (Huang et al. 2000) as are diphenylamine and diphenyl ether (Debboun et al. 2006). Despite some inconsistency in the GC-MS data apparent between the sampling years (which may have accrued from minor variations in larval rearing methodology and GC-MS procedures), there was overall consistency in *Argynnis* spp. prosternal gland emissions which contained compounds with likely dispersive and defensive functions. However, more research is needed to demonstrate their functions experimentally.

The results of this study suggest that the prosternal gland occurs in larvae of most if not all species of the butterfly families Nymphalidae and Hesperiidae. It is present also in larvae of at least two species of Pieridae. Based on our preliminary chemical evidence, the prosternal gland appears to have at least two functions: to defend and to disperse. Previous studies on the chemistry of prosternal gland emissions in notodontid and noctuid moth larvae also suggested defense and dispersal functions. The glands of *Schizura concinna* (J.E. Smith) and *Datana ministra* (Drury) larvae contain dodecyl acetate and/or dodecanol/dodecyl acetate, but only *D. ministra* also has a defensive compound (formic acid) (Weatherston et al. 1979, 1986). The prosternal gland of the noctuid, *Spodoptera frugiperda* contains saturated hydrocarbons, primarily *n*-pentadecane, likely to have a defensive function. The only previous chemical analysis of prosternal glands in butterflies was reported by Osborn and Jaffe (1998), who showed carboxylic acids and terpenes were present in prosternal gland secretions of the nymphalids *D. juno* and *A. hylonome*. These compounds were shown to be repellent to ants (Osborn & Jaffe 1998), thus the gland in these nymphalids appears to have a defensive function only.

The existence of a prosternal gland in larvae of two pierid species is noteworthy because most species in this family in the Pacific Northwest do not have this gland. Chemistry of the *N. menapia* gland suggests dispersive and defensive functions. Larval chemical defense in many pierid species is attributable to oily droplets attached to the tips of dorsal setae. Smedley et al. (2002) showed that in *Pieris rapae* (L.) these droplets contain unsaturated lipids (mayolenes) that repel ants. *Neophasia menapia* larvae do not carry oily droplets on their setae (James & Nunnallee 2011) and may rely instead upon the prosternal gland for defense. *Nathalis iole*, on the other hand, has setal droplets in instars 1–3 but no droplets and a well developed prosternal gland in the fourth (final) instar (James & Nunnallee 2011). *Nathalis iole* was the only species in the pierid subfamily Coliadinae that we examined. Other species in this subfamily may also possess prosternal glands.

The apparent widespread occurrence of prosternal glands in butterfly larvae of the families Nymphalidae and Hesperiidae suggests that this gland is important in

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the ecology of many species. Defense is likely to be a major function providing protection perhaps against ground-dwelling predators like ants, beetles and scorpions. Our study involved butterfly species in the temperate Pacific Northwest. Other studies have indicated some tropical butterfly larvae (Nymphalidae) also possess prosternal glands (Muyshondt & Muyshondt 1976; Aeillo & Silberglied 1978; Osborn et al. 1999; Borges et al. 2010). It would be useful to determine the relative incidence of prosternal glands among larvae of tropical and temperate butterfly species.

Literature Cited

Aeillo, A. & R. E. Silberglied. 1978. Life history of *Dynastor darius* (Lepidoptera: Nymphalidae: Brassolinae) in Panama. Psyche 85: 331–345.

Bonner, J. 1965. The isoprenoids. Pp 665–692. *In* J. Bonner and J. E Varner (eds.). Plant Biochemistry, Academic Press, London, England.

Borges, E., M. Faccioni-Heuser & G. Moreira. 2010. Morphology of the prosternal glands of *Heliconius erato* (Lepidoptera: Nymphalidae). Psyche 2010, Article ID 892960, 8 pages.

Debboun, M., S. Frances & D. Strickman. 2006. Insect repellents: Principles, methods and uses. CRC Press. 503 pp.

Eisner, T. & Y. C. Meinwald. 1965. Defensive secretion of a caterpillar (Papilio). Science 150: 1733–1735.

Geertsema, H., B. V. Burger, M. Le Roux & H. S. C. Spies. 1976. The chemical nature of the defensive larval secretion of the moth, *Catochria catocaloides*. J. Insect Physiol. 22: 1369–1370.

Huang, Y., S. X. Chen & S. H. Ho. 2000. Bioactivities of methyl allyl disulfide and diallyl trisulfide from essential oil of garlic to two species of stored product pests, *Sitophilus zeamais* (Coleoptera: Curculionidae) and *Tribolium castaneum* (Coleoptera, Tenebrionidae). J. Econ. Entomol. 93: 557–543

James, D. G. 2008. Comparative studies on the immature stages and developmental biology of five *Argynnis* spp. (Subgenus *Speyeria*) (Nymphalidae) from Washington. J. Lepid. Soc. 62 (2):61–70.

James, D. G. & D. N. Nunnallee. 2011. Life histories of Cascadia butterflies. Oregon State University Press. 448 pp.

Latter, O. H. 1897. The prothoracic gland of *Dicranura vinula* and other notes. Trans. London Entomol. Soc. 45: 113–126.

Marti, O. G. & C. E. Rogers.1988. Anatomy of the ventral eversible gland of fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) larvae. Ann. Entomol. Soc. Am. 81: 308–317.

McCorkle, D. V. & P. C. Hammond. 1988. Biology of *Speyeria zerene hippolyta* (Nymphalidae) in a marine-modified environment. J. Lepid. Soc. 42(3): 184–192.

Muyshondt, A. & A. Muyshondt. 1976. Notes on the life cycle and natural history of butterflies of El Salvador. 1 *C. colobura dirce* L. (Lepidoptera-Coloburinae). New York Entomol. Soc. 84: 23–33.

Omura, H., K. Honda & P. Feeny. 2006. From terpenoids to aliphatic acids: further evidence for late instar shift in osmeterial defense as a characteristic trait of swallowtail butterflies in the tribe Papilionini. J. Chem. Ecol. 32: 1999–2012.

Osborn, F. & K. Jaffe. 1998. Chemical ecology of the defense of two nymphalid butterfly larvae against ants. J. Chem. Ecol. 24: 1173–1186.

Osborn, E., F. Sanchez & K. Jaffe. 1999. Ultrastructure of the spines and neck gland of *Abananote hylonome* Doubleday 1844, (Lepidoptera: Nymphalidae). Int. J. of Insect Morph. and Embryol. 28: 321–330.

Peterson, A. 1962. Larvae of insects. An introduction to Nearctic species Part 1. Lepidoptera and plant-infesting Hymenoptera. Ohio State University, Columbus, Ohio, USA , 4th Edition.

Scott, J. A. 1986. The butterflies of North America, a natural history and field guide. Stanford Univ. Press, 583 pp.

Severson, R. F., C. E. Rogers, O. G. Marti, R. C. Gueldner & R. F. Arrendale. 1991. Ventral eversible gland volatiles from larvae of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae). Agric. Biol. Chem. 55: 2527–2530.

Smedley, S. R., F. C. Schroeder, D. B. Weibel, J. Meinwald, K. A. LaFleur, J. A. Renwick, R. Rutowski & T. Eisner. 2002. Mayolenes: labile defensive lipids from the glandular hairs of a caterpillar (*Pieris rapae*). Proc. Natl. Acad. Sci. USA 99: 6822–6827.

Teerling, C. R., H. D. Pierce, J. H. Borden & D. R. Gillespie. 1993. Identification and bioactivity of alarm pheromone in the western flower thrips, *Frankliniella occidentalis*. J. Chem. Ecol. 19: 681–697.

Weatherston, J., J. E. Percy, L. M. MacDonald & J. A. MacDonald. 1979. Morphology of the prothoracic defensive gland of *Schizura concinna* (J. E. Smith) (Lepidoptera: Notodontidae) and the nature of its secretion. J. Chem. Ecol. 5: 165–177.

Weatherston, J., J. A. MacDonald, D. Miller, G. Riere, J. E. Percy-Cunningham & M. H. Benn. 1986. Ultrastructure of exocrine prothoracic gland of *Datana ministra* (Drury) (Lepidoptera: Notodontidae) and the nature of its secretion. J. Chem. Ecol. 12: 2039–2050.

Yoder, J. A. & J. L. Domingus. 2003. Identification of hydrocarbons that protect ticks (Acari: Ixodidae) against fire ants (Hymenoptera: Formicidae, but not lizards (Squamata: Polychrotidae), in an allomonal defense secretion. Int. J. Acarol 29: 87–91.

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IMMATURE STAGES OF THE NEOTROPICAL MISTLETOE BUTTERFLY *CUNIZZA HIRLANDA PLANASIA* FRUHSTORFER (PIERIDAE: ANTHOCHARIDINI)

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ABSTRACT. The immature stages of the Neotropical mistletoe butterfly *Cunizza hirlanda planasia* Fruhstorfer (Pieridae: Anthocharidini) are described and illustrated for the first time from cerrado areas of Central Brazil Plateau. Eggs are laid in small loose clusters (2–7 eggs) on new red leaves of the mistletoe *Passovia ovata* (Pohl ex DC.) Kuijt (Loranthaceae). Larvae are semi-gregarious and underwent five instars. Host plant use, morphology, and behavior of immature stages are similar to those of related genera in the *Hesperocharis* group of Anthocharidini.

Additional key words: Brazil, Cerrado savanna, *Hesperocharis* group, host plant, Loranthaceae

The Neotropical fauna of Pieridae is especially distinct when compared with other regions due to the relatively high species diversity and great generic/subgeneric endemism (Braby et al. 2006; Braby & Nishida 2007). Somewhat surprisingly, information on the natural history and early stages is still lacking for many species and genera (e.g. Courtney 1986; DeVries 1987; Llorente-Bousquets & Gerardino 2007; Braby & Nishida 2007, 2010; Freitas 2008). For example, little was known about the pierine clades Aporiina and the *Hesperocharis* group (Anthocharidini) and recent studies by Braby & Nishida (2007, 2010), led to a considerable progress in our knowledge of the natural history of these groups.

The *Hesperocharis* group is a well-supported monophyletic group composed of four Neotropical genera; *Eroessa* Doubleday, *Hesperocharis* Felder, *Mathania* Oberthür, and *Cunizza* Grote (see Braby et al. 2006; Braby & Trueman 2006). The genus *Cunizza* contains a single polytypic species *C. hirlanda* (Stoll) with nine subspecies, occurring from Costa Rica to Brazil (Lamas 2004; Braby & Nishida 2007). This is the least known genus in the clade, and the only information about immature stages is a brief note on oviposition behavior and host plant record by Romero & González (2009). Even though it has been suggested that *Cunizza* could use mistletoes (Loranthaceae) as host plant (see Salazar 2004; Braby & Nishida 2007), this was only recently confirmed by Romero & González (2009).

The subspecies *Cunizza hirlanda planasia* Fruhstorfer is regarded as one of the most typical butterflies of the Central Brazil Plateau, and has been recorded in several cerrado sites in altitudes from 600 to 1,350 m above sea level (Brown & Mielke 1967a, b; Emery et al. 2006, K. S. Brown Jr. unpub.). The present study describes the immature stages of *C. hirlanda planasia*, and provides a new host plant record plus general observations about natural history and behavior of this subspecies.

Materials and Methods

Study sites. Collections were carried out in two sites of cerrado savanna in Distrito Federal (DF) and Goiás (GO) States, Central Brazil Plateau: (1) Fazenda Água Limpa (15°30'S, 47°25'W; 1000m a.s.l.), Brasília, DF; Parque Estadual da Serra dos Pireneus (15°47'S, 48°49'W; 1300m a.s.l.), Cocalzinho de Goiás, GO. In both sites the vegetation consists of a dense scrubland of shrubs and trees, classified as "cerrado *sensu stricto*" and "cerrado rupestre", respectively (see Oliveira-Filho & Ratter 2002).

Sampling and rearing of immature stages. Available mistletoe host-plants (Loranthaceae and

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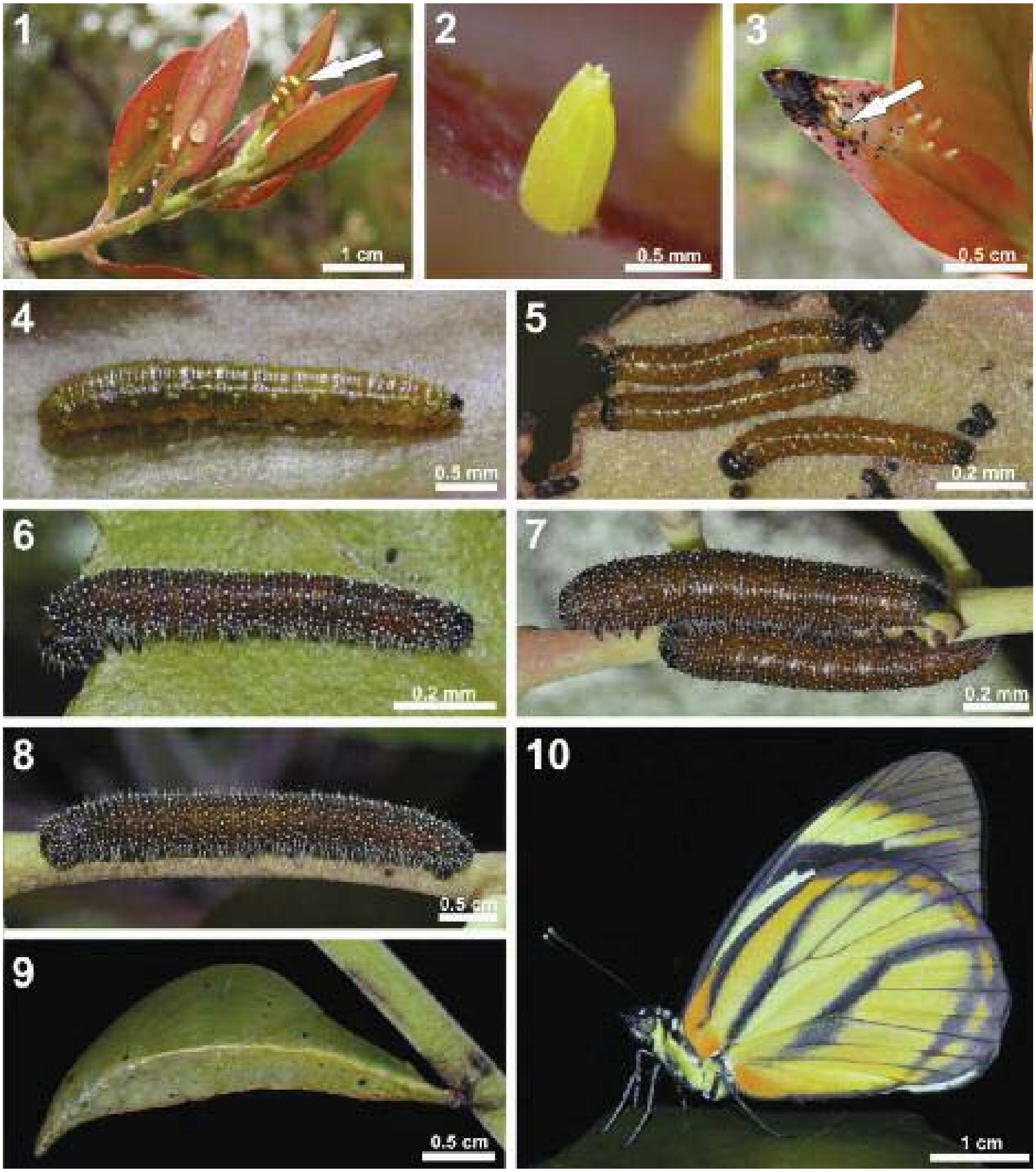
Viscaceae) in the study sites were visually scanned for the presence of immatures (as in Bodner et al. 2010). Plants with immatures (eggs and larvae) were collected for identification. The immatures of *C. hirlanda planasia* used for morphological description were collected in the field and reared as follows: eggs were placed in Petri dishes and observed daily until eclosion; newly hatched larvae were reared individually in transparent 500mL plastic pots under controlled conditions (25 ± 2○C; 12 h L: 12 h D). Branches of the



FIGS. 1–10. Life stages of *Cunizza hirlanda planasia* on *Passovia ovata*, from Brasília (1000m), Distrito Federal, central Brazil. **1,** loose cluster of eggs (arrow) on the new red leaf. **2,** egg in lateral view. **3,** first instar larvae on leaf, note the graze damage and accumulation of feces. **4,** first instar. **5,** second instar. **6,** third instar. **7,** fourth instar. **8,** fifth (last) instar. **9,** pupa. **10,** freshly emerged adult.

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same host-plant on which each larva was found were offered *ad libitum*, and larvae were checked daily for food replacement and cleaning when necessary (following Barbosa et al. 2010). Immatures for morphological analysis were separated, fixed in Dietrich's solution, and then preserved in 70% ethanol. Shed head capsules were collected and preserved for measuring. Voucher specimens of the immature and adult stages were deposited at the Museu de Zoologia "Adão José Cardoso" (ZUEC), Universidade Estadual de Campinas, Campinas, São Paulo, Brazil.

Morphology. Measurements were taken and general aspects of morphology were observed using a Leica MZ7.5 stereomicroscope equipped with a micrometric scale. Egg size is given as height and diameter. Head capsule width of larvae was considered to be the distance between the most external stemmata; maximum total length for both larvae and pupae corresponded to the distance from head to posterior margin of the tenth abdominal segment in dorsal view. Measurements are given as minimum–maximum values. Terminology for early stage descriptions follows Braby & Nishida (2007, 2010).

RESULTS

Description of immature stages. *Egg* (Figs 1–2). 1.16–1.20 mm high, 0.52–0.62 mm diameter (n = 5); yellow; bottle-shaped, with base flattened and similar in width to the middle portion of the egg; exochorion with about seven coarse longitudinal ribs, each terminating at micropylar end where they form small whitish protuberances, a series of finer transverse striae between longitudinal ribs. Duration ≥ 5 days (n = 10).

First instar (Figs 3–4). Maximum length 0.4 cm, head capsule width 0.38–0.42 mm (n = 9); pale orange head and body with numerous long dark brown setae inserted in sclerotized pinaculum, areas around the pinnacles are whitish; light brown prothoracic shield and dark brown anal shield. Duration 4 days (n = 10).

Second instar (Fig. 5). Maximum length 0.6 cm, head capsule width 0.62–0.74 mm (n = 7); black head; dark brown prothoracic and anal shields; orange body similar to first instar, but with primary setae smaller and arising from black conical protuberances, a few white secondary setae on each segment. Duration 4–5 days (n = 8).

Third instar (Fig. 6). Maximum length 1.0 cm, head capsule width 1.09–1.33 mm (n = 13); head dark brown, body orange-brown similar to last instar, but with white secondary setae shorter and less conspicuous. Duration 4–5 days (n = 8).

Fourth instar (Fig. 7). Maximum length 1.6 cm, head capsule width 1.72–2.03 mm (n = 13); general aspect similar to last instar. Duration 4–5 days (n = 8).

Fifth (last) instar (Fig. 8). Maximum length 3.8 cm, head capsule width 2.97–3.00 mm (n = 4); head orange, with numerous small white protuberances from which arise short white setae; body orange-brown, numerous small white protuberances on each segment from which arise short, somewhat flattened, white secondary setae bifurcated at apex; additionally, a series of larger, white conical protuberances from which arise short, spine-like white primary setae clubbed at apex; spiracles white. Duration 5–8 days (n = 11).

Pupa (Fig. 9). Maximum length 2.8 cm (n = 5); pale green, speckled with small black and white spots and a few pairs of black spots on mesothorax and abdominal segment 8; anterior region, with a rounded, slightly upturned and beak-like projection; head with whitish green eyes; wings convex ventrally, cases of forewing with a small black spot; a pale yellow, prominent lateral ridge extending from mesothorax to A10; a broad reddish mid-dorsal line extending from prothorax to A10 (including cremaster). Attached by cremaster, with silk girdle passing over A1. Duration 15–16 days (n = 2) and 101 days (n = 1).

Natural history of *Cunizza hirlanda planasia*. In the study sites several mistletoe species were checked for the presence of immatures, such as *Psittacanthus* Mart. spp., *Struthanthus* Mart. spp. (Loranthaceae), and *Phoradendron* Nutt. spp. (Viscaceae), however, eggs and larvae of *C. hirlanda planasia* were observed only on *Passovia ovata* (Pohl ex DC.) Kuijt (= *Phthirusa ovata* (Pohl ex DC.) Eichler) (Loranthaceae). Eggs were laid in small loose clusters (Figs 1–2), ranging from 2–7 eggs per cluster (n = 11 cohorts), on the upperside of new red leaf and/or petiole of the mistletoe food plant. After hatching, the newly eclosed larvae devoured most of the exochorion, before proceeding to graze the leaf surface. Early instars (first to third) are gregarious and usually covered by their pellets of excrement (Fig. 3). Like described for *Mathania* (Braby & Nishida 2007), this occurs due to the presence of numerous clear fluid droplets, to which the feces adhere, at the tips of the black forked setae. Late instars (fourth and fifth) may be found isolated, and they fed on the whole leaf. For immatures rearing at constant temperature between June–July (dry season) the development time from egg to adult lasted approximately five weeks. For immatures rearing in November (wet season) we observed pupal diapause, with one adult emerging 101 days after pupation.

DISCUSSION

The dates of collected and observed adults of *C. hirlanda planasia* (Fig. 10) in the Brazil Central Plateau indicate that this subspecies flies from late February to September, suggesting that it could be multivoltine (Brown & Mielke 1967b; E. O. Emery & K. S. Brown Jr. unpub.). Nevertheless, the long pupal period, around four months, strongly suggests that *C. hirlanda planasia* could undergo facultative diapauses during the wet season in cerrado, similar to what has been described for *Mathania* (Braby & Nishida 2007). The available data also suggest that this subspecies is highly associated with cerrado vegetation; even though *C. hirlanda planasia* was observed in gallery forests, most known records come from open cerrado areas, including all our rearing records (Brown & Mielke 1967b; E. O. Emery & K. S. Brown Jr. unpublished data). Additionally, males were observed exhibiting hilltopping behavior in Paracatu municipality (Minas Gerais State; 17°12'S,

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46°54'W), a place where this species was frequently observed from February to May (K. S. Brown Jr. pers. comm.).

The use of the mistletoe *Passovia ovata* as host plant agrees with the observations of Romero & González (2009) of the subspecies *Cunizza hirlanda minturna* Fruhstorfer in Venezuela, raising two important points about the natural history of *Cunizza*. First, as discussed by Braby & Nishida (2007), *Cunizza* larvae are specialized on Loranthaceae. But more than that, our host plant records suggest that at least the subspecies *C. hirlanda planasia* is specialized on *Passovia* H. Karst. Although Romero & González (2009) have cited *C. hirlanda minturna* in *Phthirusa* sp., this host plant record must be confirmed due to recent taxonomic changes in these genera of mistletoes (see Kuijt 2011). Anyway, both genera of mistletoes are very close and have not been cited for any other mistletoe-feeding pierids (Braby & Nishida 2007, 2010). Second, larvae of *C. hirlanda planasia* are semi-gregarious or solitary, particularly in the late instars, similar to the situation described for *Mathania* (Braby & Nishida 2007).

According to Braby & Nishida (2007), *Hesperocharis* larvae are gregarious and have longer and more densely covered setae and protuberances on the body, while those of *Mathania* are semi-gregarious or solitary, presenting a smoother body surface. However, the observations made by Romero & González (2009) of the oviposition pattern of *Hesperocharis crocea idiotica* (Butler) suggest that this species, at least, does not show gregarious behavior. Thus, although knowledge of the natural history of Neotropical Pieridae has significantly increased over the last few years, much more information on their natural history is needed to enable understanding of patterns of host plant use and the evolution of gregarious behavior in this butterfly family.

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LITERATURE CITED

BARBOSA, E. P., L. A. KAMINSKI & A. V. L. FREITAS. 2010. Immature stages of the butterfly *Diaethria clymena janeira* (Lepidoptera: Nymphalidae: Biblidinae). Zoologia 27: 296–702.

BRABY, M. F. & K. NISHIDA. 2007. The immature stages, larval food plants and biology of Neotropical mistletoe butterflies (Lepidoptera: Pieridae). I. The *Hesperocharis* group (Anthocharidini). Journal of the Lepidopterists' Society 61: 181–195.

———. 2010. The immature stages, larval food plants and biology of Neotropical mistletoe butterflies (Lepidoptera: Pieridae). II. The *Catasticta* group (Pierini: Aporiina). Journal of Natural History 44: 1831–1928.

BRABY, M. F. & J. W. H. TRUEMAN. 2006. Evolution of larval host plant associations and adaptive radiation in pierid butterflies. Journal of Evolutionary Biology 19: 1677–1690.

BRABY, M. F., R. VILA & N. E. PIERCE. 2006. Molecular phylogeny and systematics of the Pieridae (Lepidoptera: Papilionoidea): higher classification and biogeography. Zoological Journal of the Linnean Society 147: 239–275.

BROWN, K. J., JR. & O. H. H. MIELKE. 1967a. Lepidoptera of the central Brazil plateau. I. Preliminary list of Rhopalocera: Introduction, Nymphalidae, Libytheidae. Journal of the Lepidopterists' Society 21: 77–106.

———. 1967b. Lepidoptera of the central Brazil plateau. I. Preliminary list of Rhopalocera (Continued): Lycaenidae, Pieridae, Papilionidae, Hesperiidae. Journal of the Lepidopterists' Society 21: 145–195.

COURTNEY, S. P. 1986. Oviposition by the mistletoe-feeding pierid butterfly *Mathania leucothea* (Mol.) in Chile. Journal of Research on the Lepidoptera 24: 264–270.

DEVRIES, P. J. 1987. The Butterflies of Costa Rica and Their Natural History. Papilionidae, Pieridae, Nymphalidae. Princeton University Press, Princeton, NJ. xxii+327 pp.

EMERY, E. O., K. S. BROWN JR. & C. E. G. PINHEIRO. 2006. As borboletas (Lepidoptera: Papilionoidea) do Distrito Federal, Brasil. Revista Brasileira de Entomologia 50: 85–92.

FREITAS, A. V. L. 2008. Description of the early stages of *Leucidia* (Lepidoptera: Pieridae). Tropical Lepidoptera 18: 30–31.

KUIJT, J. 2011. Pulling the skeleton out of the closet: resurrection of *Phthirusa* sensu Martius and consequent revival of *Passovia* (Loranthaceae). Plant Diversity and Evolution 129: 159–211.

LAMAS, G. 2004. Pieridae. Pp. 99–117. *In* Lamas, G. (ed.). Checklist: Part 4A. Hesperioidea-Papilionoidea. In Heppner, J.B. (ed.). Atlas of Neotropical Lepidoptera. Gainesville. Association for Tropical Lepidoptera, Scientific Publishers, vol. 5A, XXXIV+439p.

LLORENTE-BOUSQUETS, J. & J. C. GERARDINO. 2007. Estudios en Sistemática de Dismorphiini (Lepidoptera: Pieridae) I: Morfología de huevos y su importancia taxonómica. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales XXXI: 145–164.

OLIVEIRA-FILHO, A. T. & J. A. RATTER. 2002. Vegetation physiognomies and wood flora of the cerrado biome. Pp. 91–120. *In* Oliveira P. S. & R. J. Marquis (eds). The cerrados of Brazil: ecology and natural history of a neotropical savanna. Columbia University Press, New York.

ROMERO, M. F. & J. M. GONZÁLEZ. 2009. Notes on some poorly known pierine butterflies from the Henri Pittier National Park, Aragua, Venezuela (Lepidoptera: Pieridae). SHILAP Revista de Lepidopterología 37: 101–104.

SALAZAR, J. A. 2004. Generos *Hesperocharis* C.Felder 1862 y *Cunizza* Grote 1890. Pp.78–80 in Le Crom, J. F., J. Llorente Bousquets, L. M. Constantino & J. A. Salazar (eds.). Mariposas de Colombia. Tomo 2: Pieridae. CARLEC Ltda, Bogota, Colombia.

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POPULATION LOSS AND GAIN IN THE RARE BUTTERFLY *EUPHYDRYAS GILLETTII* (NYMPHALIDAE)

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ABSTRACT. Fourteen populations of the montane butterfly *E. gillettii* Barnes were surveyed initially during 1982–1984 and again during 2002–2006 to assess reasons for decline, extirpation, and colonization. Surveys were conducted by counting egg masses at each site soon after the flight period. Seven of the 14 populations disappeared between the two surveys because of vegetative succession, drying of meadow habitats, and isolation from other colonies. Populations at low elevations and low latitude were more likely to die out; colonies that were part of a metapopulation were more likely to survive. One population reestablished at a high elevation site where the habitat remained moist. The vegetation had changed conspicuously at all sites where the butterflies were extirpated, with climate change being implicated in the drying of the habitats. Given the modest number of known populations, continued attention to the status of the species is warranted.

Additional key words: extirpation, colonization, metapopulation, climate change, succession

Butterfly populations fluctuate in size from year to year because of variability in resources, weather, predators, competitors, and human activities, as well as distinct events such as storms and fires (Ehrlich 1984; Roy et al. 2001; Hanski 2003; Hanski et al. 2004). Small, localized colonies are especially subject to extirpation, and the likelihood of dying out increases with greater fluctuations in population size (Pollard & Yates 1992) and habitat quality (Ehrlich & Murphy 1987; Hanski et al. 2004). Losses have been reported from sudden catastrophic events such as late snowstorms (Ehrlich et al. 1972) as well as longer-term, more gradual habitat modification (Hanski 2003). The current decline in overall biodiversity (Wilson 1999) has heightened attention to the causes and rates of loss of local populations.

Because it lives in small and highly localized populations in open meadows, the checkerspot butterfly *Euphydryas gillettii* Barnes is sensitive to modification of its habitat by succession and changing climate. This butterfly occupies moist meadow patches and fens (Williams 1995; Kondla 2005) in the central and northern Rocky Mountains, ranging from western Wyoming through Montana and Idaho to southwestern Alberta (Williams 1988). The latitudinal range extends from about 42° to over 51° N, with an elevational range of 1100 m. to over 2700 m. *E. gillettii* often occurs in metapopulations in which individual colonies are connected by occasional dispersal, thus enabling colonization and growth of new populations. As with other species of *Euphydras* (Wahlberg et al. 2002; Singer & Hanski 2004; Wang et al. 2004), however, *E. gillettii* shows limited movement. For example, Boggs et al. (2006) reported average distances between recaptures of *E. gillettii* to be only 44 + 39m for males and 51 + 44m for females. The lack of measurable allozyme variation that Debinski (1994) found in a comparison of specimens from western Idaho, western Wyoming, and northern Montana likely results from recent, post-glacial separation rather than from gene flow. Populations can expand explosively when conditions are favorable (Boggs et al. 2006), but the rates and causes of extirpation and colonization remain unexplored. Checkerspots form a model system for population studies (Ehrlich & Hanski 2004), and a study of populations of *E. gillettii* over time can enhance our understanding of the biology of this system.

The goals of this study were to describe the factors that lead to population loss or gain. A survey of 15 populations from the early 1980s (Williams 1988) provided the basis for a repeated survey during 2002–2006, and that comparison forms the core of the results reported here. These sites represent the full latitudinal and elevational ranges known for the species. In addition, two populations were surveyed annually most years from 1981 to 2011. My goal was to evaluate how many of these populations still existed 20 years later and to look for change in their habitat characteristics. I expected to find drier meadows if climate change were affecting the habitats and greater vegetative biomass if succession were taking place, but I had no expectation about how many populations would still exist.

MATERIALS AND METHODS

Surveys of *E. gillettii* populations were conducted by counting egg masses around the end of the flight period and using these counts to estimate population sizes. Eggs are laid in clusters on the host shrub *Lonicera involucrata* (Rich.) Banks on leaves that are among the highest and most likely to intercept sunlight (Williams 1981; see Bonebrake et al. 2010 for factors that influence this behavior). The eggs require about three

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weeks to hatch (Williams et al. 1984) and form conspicuous feeding webs after hatching, so significant time is available to find and count egg masses (generally, the month of August). Plants other than *L. involucrata* are used only rarely for oviposition (Williams 1990). Following the same procedures, from 2002 to 2006 I repeated the survey that I had conducted from 1982 to 1984 (14 of the original 15 sites); late in the flight period, I revisited the sites where adults or eggs had been observed during 1982–1984 (Williams 1988) and surveyed the core of the habitat of each to count all egg masses and any lingering adults and to record characteristics of the habitat. Habitat patches were defined as discrete meadows with the host plant *L. involucrata*; descriptions of the sites are given in Williams (1988). For each survey, I examined every host shrub in the entire open area where the butterflies were found, areas that ranged up to 3 ha, and counted every egg mass I could find. In addition, at each site I searched surrounding areas for nearby colonies, going up and down stream or valley up to 1 km in each direction and investigating likely habitats (open, moist meadows) within about 5 km, as indicated on USGS topographic maps.

All 14 sites are in the central and northern Rocky Mountains of North America, including two in the

TABLE 1. Characteristics of 14 *E. gillettii* populations, including seven that died out. The numbering follows the descriptions of these sites in Williams (1988) (site 3 was not resurveyed). Counts of egg masses were from a 30m × 30m core of the habitat. The first letter of the site name refers to the state or province (Wyoming, Montana, Idaho, Alberta), while metapop indicates whether or not there were nearby satellite colonies.

Site No.	Site Name	Lat. (deg)	Elev. (m)	Egg masses (adults) 1980s	Egg masses (adults) 2000s.	Meta-pop	Vegetative change at the site by 2006
1	WBC	44.93	2621	94 (185)	0	yes	denser; larger trees near the stream; open meadow drier
2	WGC	43.37	2164	16 (53)	113 (209)	yes	no perceptible change
4	WTP	43.83	2362	2 (13)	52 (122)	yes	no perceptible change
5	WSC	42.52	2576	4 (20)	0	no	all parts of meadow drier; *L. involucrata* scarce and over-topped by *Salix* spp.
6	MMP	48.32	1707	10 (39)	109 (204)	yes	a recently logged area adjacent to an older area filling in by succession
7	MLM	48.53	1494	9 (45)	24 (71)	no	expanded habitat from beaver activity
8	MCC	48.62	1152	21 (65)	0	no	site now dominated by *Salix* spp. and *P. contorta*
9	AOR	50.10	1814	22 (59)	7 (30)	yes	no perceptible change
10	WBG	44.93	2713	11 (41)	38 (98)[a]	yes	no perceptible change; many *L. involucrata* and many nectar sources
11	MSL	47.19	1305	7 (26)	0	no	meadow drier; *L. involucrata* gone, now dominated by *Salix* spp.
12	MSC	48.32	1609	3 (14)	3 (14)	no	no perceptible change
13	ARH	49.83	1448	1 (8)	0	no	over-grown by *Salix* spp.; little nectar available
14	WCV	42.10	1911	1 (8)	0	no	meadow hotter and drier; little *L. involucrata* left
15	IWL	44.59	1634	25 (73)	0	no	meadow drier; no *L. involucrata* left

[a] The population at site 10 disappeared in 1992 and then reestablished in 2005

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Beartooth Mountains, Wyoming, where I have conducted annual surveys of adults and egg masses most years from 1981 through 2011 (all except 1985, 1997, 2003, 2004). These annual surveys provided the opportunity to record the gradual loss of one Beartooth population (site 1 in Table 1) and the loss and then reappearance of the other Beartooth population (site 10). Plants were identified with Hitchcock & Cronquist (1973).

The number of egg masses enables one to estimate population sizes. During 1981 and 1982, I conducted a mark-release-recapture (MRR) study of the population at site 1, analyzed with the Jolly-Seber method (Jolly 1965; Seber 1982), and this yielded estimates of 298 and 238 adults for those two years (unpublished); the egg mass counts for those years were 165 and 135. A larger regression of population size on egg mass counts was determined by Boggs et al. (2006), who also used MRR analysis to determine population estimates. Their regression was: $\ln N = 2.044 + 0.698 * \ln EC$, where EC is the number of egg clusters. This equation yields estimates of 273 and 237 adults for the Beartooth population in 1981 and 1982, estimates that are remarkably close to the Beartooth MRR results. For this study, I used the Boggs et al. equation to approximate sizes of all populations from egg mass counts.

RESULTS

Colony Loss. The repeated surveys from 2002–2006 for *E. gillettii* two decades after the initial surveys yielded only seven extant populations (50%). The characteristics of all 14 sites are given in Table 1. A conspicuous pattern of these sites apparent in Fig. 1 is that the butterflies disappeared from sites that were characterized by a combination of low elevation and low latitude (sites 8, 11, 14, 15); in particular, a population did not survive if its location were such that latitude(deg) + 10*elevation(km) < 62. Three additional populations disappeared: one at low latitude (site 5), one at low elevation (site 13), and one other (site 1, considered in detail below).

Sites 8, 11, and 15 had supported substantial colonies in the 1980s (Table 1), so their disappearance was unexpected. The loss from site 15 was particularly surprising because that population had been large and had served as the study population for a previous analysis of host plant usage (Williams 1990) and as the source of egg masses for a colonization study (Williams 1995). Habitat characteristics changed conspicuously at site 15 in the intervening 20 years, however; a survey in 2002 showed that the meadow was much drier than it had been, and no *L. involucrata* host plants remained. In contrast, more than 20 clumps of *L. involucrata* had been present in the core area in 1984. Three other sites (5, 11, and 14) were also conspicuously drier after 2000 than they had been in the 1980s and had fewer nectar sources and a reduced abundance or complete loss of host shrubs.

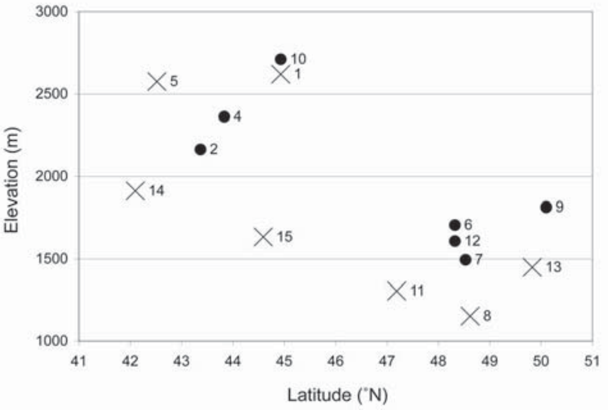

FIG. 1. The fate of 14 populations of *E. gillettii* initially examined during 1982–84 (sites 1–2 and 4–15 from Williams 1988) and then resurveyed in 2002–06. Each population is plotted by its latitude and elevation. When resurveyed, seven had disappeared (marked by an X), while seven continued (marked by solid circles).

Annual counts of *E. gillettii* egg masses at site 1 revealed continuous decline from 1980 through 1992 and disappearance in 1993 (Fig. 2) without subsequent recolonization. Mark-release-recapture studies at this site gave adult population sizes of 539 in 1980, 298 in 1981, and 238 in 1982; egg mass surveys in following years showed a decline to extirpation 12 yr later,

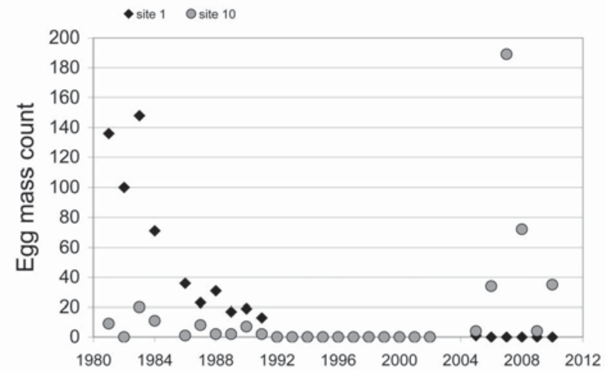

FIG. 2. Annual counts of egg masses late in or after the flight season at site 1 and site 10 through 2011. The counts are from the core area at each site; additional egg masses may have existed outside the core areas. At site 1 the population declined and disappeared by 1992, with a single egg mass seen since (2005). At site 10, the population disappeared from 1992 through 2002 but was present again in 2005; the population then increased greatly, peaking in 2007.

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resulting in an average annual growth rate (λ) of 0.823 (s.d. = 0.577, n =10). Loss of this population was confirmed by thorough observation in 1993 and 1994 and by additional yearly observations thereafter (note that the absence in 1992 was not because it was the off year in a biennial life cycle; Williams et al. 1984).

The vegetation at site 1 changed conspicuously over this time (Fig. 3). The *L. involucrata* shrubs that had received the largest numbers of egg masses in the early 1980s were conspicuously smaller than they had been 20 years earlier: 0.7–0.9m tall in the 1980s and 0.3–0.5m tall in 2006. In the intervening years, other vegetation, including *Salix* spp. shrubs and graminoids, grew luxuriantly and overtopped many *L. involucrata*, making the host plants less accessible to ovipositing females. Based on fire records of the U.S. Forest Service (C. Dawson, Shoshone National Forest, pers. comm.) and the age of the largest trees in the burned area as determined from cores, site 1 burned extensively in the 1890s. Succession has taken place since then, and open meadows near the stream have filled in with trees, primarily *Pinus contorta* Doug. ex Loud. and *Picea engelmanni* Parry ex Engelm. Small trees observed in 1980 are now larger, and the herbaceous vegetation is taller with fewer nectar sources in the habitat. In the early 1980s, adults nectared most frequently on the abundant *Geranium richardsonii* Fisch. & Trautv. (Geraniaceae) but also on *Agoceris glauca* (Pursh) Raf. and *Senecio* spp. (both Asteraceae). These species are now much less abundant; counts of *G. richardsonii* flowers from photographs of a central 8m × 8m plot yielded 410 in 1980 (24 Jul) and 360 in 1982 (29 Jul) but only 74 in 2010 (31 Jul). The only appearance of *E. gillettii* at this site since its disappearance in 1992 has been a single egg mass found during the annual survey on 28 Jul 2005. Regular egg mass surveys each year at least 200m up and down stream from the core area have revealed no evidence of the butterflies. These areas provide little usable habitat, and formerly open patches are now more closed in. The population did not move; it simply disappeared.

Metapopulations. Surveys to more than 2 km around all sites revealed the persistence of satellite populations around sites 2, 4, 6, and 9 (the satellites around sites 2, 4, and 9 were small and unnumbered; site 6 had site 12 as a satellite). It is noteworthy that these four sites sustained *E. gillettii* colonies over the 20-yr observation span, whereas no satellite colonies could be found near six of the seven populations that disappeared (the seventh was site 1; its loss through succession is described above). The structure of the metapopulations varied among locales, while no more than four nearby patches were occupied around any of the known sites, with fewer than 20 egg masses found in any one satellite. Site 2 presents classic metapopulation structure (Levins 1970), with four habitat patches of approximately equal size and abundance, with patches separated by only 0.3 to 0.5 km. Site 9 has a linear structure, with four habitat patches distributed in sequence along a river, with separation distances ranging from 1.0 to 2.4 km. Sites 4 and 6 are best described as having a core-satellite structure, with separation distances of 0.6 and 1.7 km between the larger core and smaller satellite colonies. Surveys around each of these areas revealed no additional colonies.

Reestablishment. The population at site 10, the second location in northwest Wyoming, which is 1.9 km by air from site 1, died out in 1992 but then reestablished in 2005. This site has an abundance of needed resources (Williams 1995), including many large *L. involucrata* host plants and a high density of nectar sources. Up to 11 egg masses (population size 41) were present from 1981, when observations began, until 1991 (Fig. 2), but then *E. gillettii* disappeared from 1992 through 2002, a loss confirmed by yearly surveys. Observations were resumed in 2005, and four egg masses (representing approx. 20 adults) were present that year; in 2006, the numbers had expanded to 38 total egg masses (98 adults), and in 2007 to 189 egg masses (297 adults). The explosion of 2007 was reflected in dense egg clusters on host shrubs and expansion to all parts of the surrounding meadow, from approximately 0.4 ha occupied in previous years to 0.9 ha occupied in 2007. These totals far exceeded the numbers seen in the 1980s. Over the 30-year period of observation, little change in the vegetation took place. This meadow is higher in elevation, moister, and more open than site 1, and that appears to be why the vegetation has not changed as it did at site 1. Trees have not invaded the meadow. The population at this site grew exponentially from 2005 to 2007 ($N = 0.14\ e^{1.82}$) but declined afterward (Fig. 2).

DISCUSSION

Population Loss. The repeated survey showed that half of the sites at which *E. gillettii* existed in the early 1980s no longer supported a population 20 years later. Periodic loss of isolated colonies is not surprising, however, because of habitat change, inbreeding (Saccheri 1998), Allee effect (Kuussaari et al. 1998), and chance events; furthermore, small populations may represent only temporary expansions from nearby colonies (Lewis & Hurford 1997). What is surprising is that two of the populations that disappeared were among the largest known of the species in 1980.

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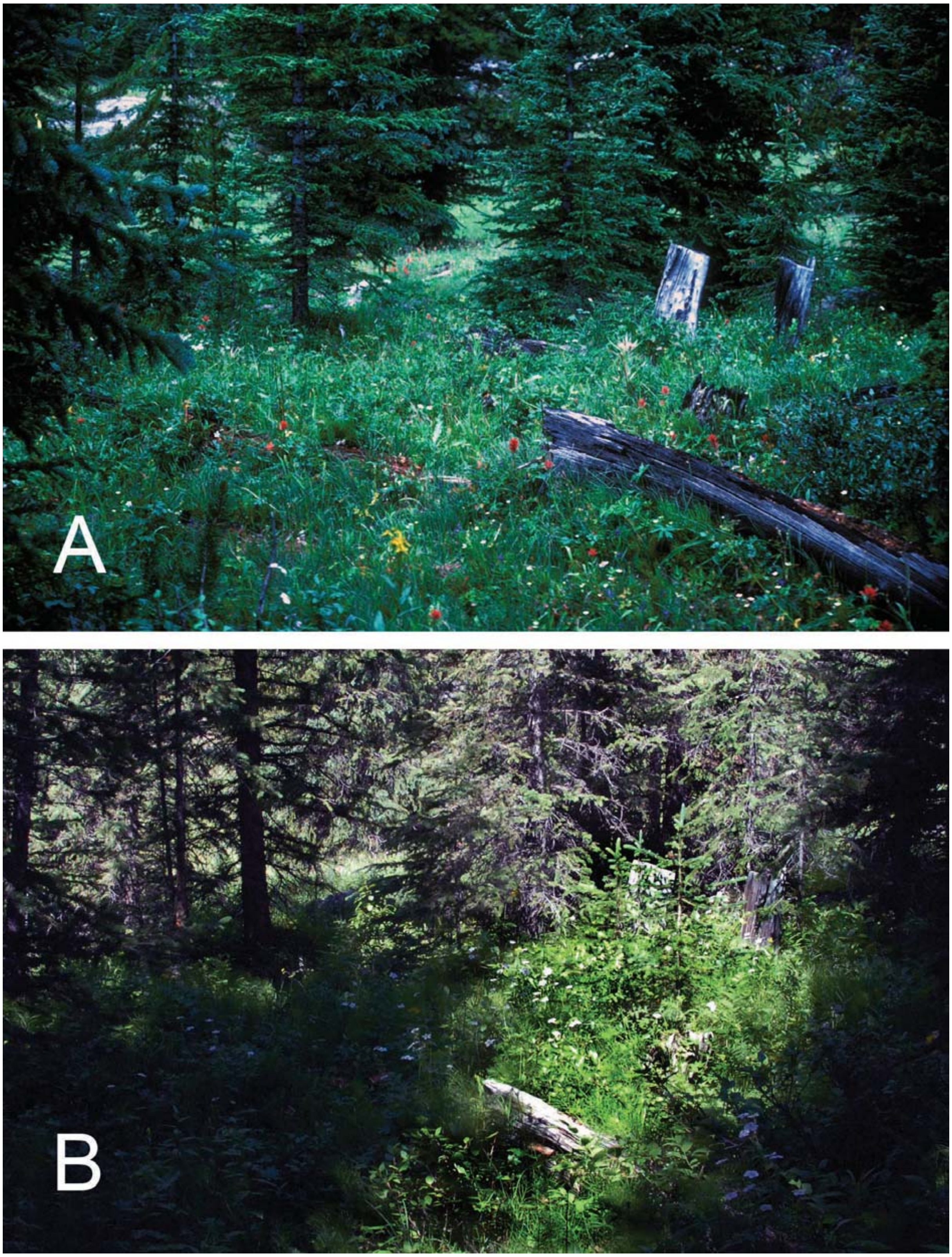

FIG. 3. Views of the same location from the same perspective in the middle of Beartooth site 1 from 29 July 1987 (**A**) and 31 July 2010 (**B**). Note the two stumps to the right. Over time, spruce, herbaceous vegetation, and willows have filled in what had been an open, flower-dominated site.

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The disappearance of populations at low latitudes and low elevations, coupled with drying of the habitat and the decline or disappearance of host plants and nectar sources, implicates climate change as a causal agent. The hydrology of the western U.S. has already been altered by climate change (Barnett et al. 2008), leading to shifts in the distribution of plants (Kelly & Goulden 2008). Data from the NOAA National Climate Data Center illustrate the trend of rising temperatures and increasing frequency of drought (Weather Perspectives 2011). In this study, four sites that had appeared as lush meadows in the early 1980s had become dry meadows by 2004. Based on surveys from 1992 to 1996, Parmesan (1996) reported similar losses in California, with local extinction of *E. editha* populations from historically known sites at low latitudes (70% disappeared) and low elevations. With the losses reported here, the range of *E. gillettii* has contracted and is now, on average, farther north. In 1983, the lowest latitude of a known population was 42.10°N, but by 2005 it was 43.37 °N. If new habitat has appeared farther north through climate change and been colonized, it has thus far gone undetected.

Global climate change is known to have affected the distribution and abundance of many organisms (Parmesan & Yohe 2003; Root et al. 2003; Parmesan 2006; Rosenzweig et al. 2008). Populations of some butterfly species have died out (McLaughlin et al. 2002), while the ranges of others have shown reductions in size and shifts upward in latitude and altitude (Dennis 1993; Parmesan 1996, 2003, 2006; Parmesan et al. 1999; Warren et al. 2001; Hill et al. 1999, 2002, 2003; Forister et al. 2010). Insects in general and butterflies in particular are especially sensitive to climate change because of their dependence on multiple resources within their habitats (Dennis et al. 2003) as well as their short generation time and ectothermic physiology (Hill et al. 2003).

Climate change isn't the only factor that alters habitats enough to lead to population loss; monitoring of site 1 showed succession also to be a cause. In 1980 the site 1 population was one of the three largest known of this species (Williams 1988), but by 1992 it had disappeared. The loss of this population highlights the vulnerability of isolated colonies. The population disappeared after succession led to diminished habitat quality, as small trees invaded the moist meadow, and grasses, forbs, and other shrubs displaced or overtopped the host *L. involucrata* and what had been abundant nectar sources. Females alight on the highest parts of their host plants in open, sunlit areas (Williams 1981), so *L. involucrata* may be numerous in shady parts of the habitat but not serve for oviposition. The influence of succession was already apparent during the 1980s survey, when succession was found to have led to loss of one population (reported in Williams 1988). Climate change can affect rates of succession, too, by altering the frequency of forest fire, which opens up patches of meadow habitat (Gavin et al. 2007), so climate change and succession can interact in altering the vegetation of a site.

Colonization. An already mated dispersing female can begin a new population by leaving a single egg mass in an empty patch of habitat (Williams 1995). An egg mass typically contains about 136 eggs (s.d.=54, n=153) (Williams et al. 1984), and although entire clusters usually survive or disappear as a group, both the number of egg masses and the number of eggs per mass influence the success of colonization. Although the source of the colonizing dispersers remains unknown, the colonization of site 10 reported here took place 10 to 12 years after the population had disappeared. Natural colonizations are rarely recorded because observers do not regularly survey empty habitats. Site 10 offers all the resources needed for *E. gillettii* (Williams 1988), and had, in fact, once supported a population, so it was not surprising that the species could reestablish here. Where all the needed resources were available in Colorado, an intentional introduction of *E. gillettii* has been successful (Holdren & Ehrlich 1981).

Once an egg mass has been laid in a previously unoccupied patch, the resultant colony may grow rapidly but with limited genetic variability. In an earlier study, when a single egg mass was introduced to an empty patch of newly disturbed habitat, exponential growth led from 1 to 7 to 35 egg masses in the successive years 1989 to 1991 (estimated adult population sizes 8 to 92) (Williams 1995). In the current study, population growth at site 10 was equally rapid, from 4 to 38 to 187 egg masses in the successive years 2005 to 2007 (adult populations estimated to be 20 to 98 to 297). These populations grew at similar exponential rates ($e^{1.81}$ and $e^{1.82}$) before subsequent decline. The likelihood is low, however, that a growing population develops from a single egg mass in a new habitat patch; seven of Williams's (1995) eight introductions of single egg masses did not succeed, and the one egg mass found at site 1 in 2005 also failed to establish a new colony.

Dispersal occurs through population explosions as well as through occasional emigrants. Explosive increases in the population density of *E. gillettii* led to dispersal that established new colonies in Colorado (Boggs et al. 2006), just as they have with *E. editha* in its range (Murphy & White 1984). Following the 2002

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expansion in Colorado, two new colonies remained after subsequent range contraction (Boggs et al. 2006). In this study, the population explosion of 2007 spread adults and egg masses through a much larger area than the butterflies had occupied previously, and some individuals remained in new areas the following year.

Status. The loss of several populations and re-establishment of one colony between 1982 and 2011 provide evidence of metapopulation dynamics in *E. gillettii*. The metapopulations occur in mountain meadows, where the limited distributions of their host plants and nectar sources, both of which grow more abundantly near streams, restrict their movement. The butterflies fly along riparian corridors, rarely in drier habitat 30m or farther from streamside or wet meadows. Like *E. editha* (Singer & Hanski 2004), *E. gillettii* responds behaviorally to features of the surrounding vegetation, and the forest matrix strongly inhibits butterfly movement (e.g., Ricketts 2001). Outward migration from a population may occur as a result of genetically-based unidirectional flight or as simple ("active") diffusion beyond the edges of the meadows, a movement that prevailing winds can accentuate (Boggs et al. 2006).

A conspicuous feature of the population structure of *E. gillettii* is how few colonies form each metapopulation, usually with a single larger source pool and one to three nearby smaller colonies. The smaller populations may be in poorer quality patches and function as sinks (Pulliam 1988; Dias 1996) or as pseudo-sinks (Boughton 1999) that sometimes endure without immigration. This structure is on a dramatically smaller scale than that of the well-studied checkerspot *Melitaea cinxia*, as described by Hanski et al. (1995), who reported 1502 habitat patches, of which 536 were occupied at one time. The structure is also far more limited than that of its congener *E. editha*, for which many patches are occupied by hundreds of butterflies each (Harrison et al. 1988). The metapopulation structure of *E. gillettii* at the known sites reflects the response of the butterflies to the topological complexity of mountain landscapes and the unpredictable occurrence of disturbance, which creates habitat patches of varying form and orientation. Metapopulations have received extensive study in the last 20 years (e.g., Hanski & Gilpin 1997; Hanski 1999; Ehrlich & Hanski 2004), and that focus is warranted; all surviving populations found in this study were near one or more satellite sites, whereas most of those that died out were isolated.

The distribution of *E. gillettii* is limited, and it is considered imperiled in Montana, Alberta, and British Columbia (insects are not yet ranked in Wyoming or Idaho; NatureServe 2010). The distribution of the species appears to be a relic from the last glaciation given that its closest relatives are Eurasian (Zimmerman et al. 2000). Furthermore, since 1980 more populations have disappeared than have been discovered (unpubl. data). An added problem is that loss of populations of an uncommon species can occur after a time lag, producing an "extinction debt" (Bulman et al. 2007), which occurs when the abundance of a population is below the equilibrium needed for long-term viability. Dispersal of *E. gillettii* occurs at low rates; its closest relative, *E. maturna*, is the species that moved the shortest distances of five species of checkerspot butterflies studied for movement patterns (Wahlberg et al. 2002). Climate change is altering vegetation at the landscape scale (Romme & Turner 1991; Debinski et al. 2006), and drought produced by warming leads to decreased forbs in *E. gillettii*'s habitat (Debinski et al. 2010). As Boggs and Murphy (1997) emphasized, butterflies like *E. gillettii* that are both montane in distribution and sedentary in behavior are at greater risk in a changing climate because of the fragmented nature of their habitat.

Both the range and abundance of *E. gillettii* have been dynamic over the past three decades. Monitoring is difficult, however, because the species occurs in mountainous regions where access is limited. In contrast to the decline in the number of known colonies, favorable characteristics of the species are that single populations can reach substantial densities (50 or more individuals seen during a single day in a habitat patch of one-half hectare), and populations are found through a wide elevational range (1100m to 2800m), even though the resource needs are specific and moist montane meadows are the most common habitat (Williams 1988). New habitat forms through disturbance, primarily by fire, but also by beaver activity, avalanches, storms, and logging, while a dispersing female may, by ovipositing a single egg mass, initiate a new colony in newly disturbed habitat (Williams 1995). Fire, in particular, is a regular disturbance within the range of *E. gillettii* (Romme 1982). The quality of habitat patches is critical for long-term survival of butterfly populations (Thomas et al. 2001; Wahlberg et al. 2002; Thomas et al. 2008), but habitats are dynamic, with both succession and climate change altering the vegetation. The broad effects of climate change (Parmesan 2006) coupled with *E. gillettii*'s limited habitat (Williams 1988) and the fact that fewer sites with *E. gillettii* are known now than was the case in the 1970s suggest continuing concern for the long-term future of the species and a need for continued monitoring.

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LITERATURE CITED

Barnett, T. P., D. W. Pierce, H. G. Hidalgo, C. Bonfils, B. D. Santer, T. Das, G. Bala, A. W. Wood, T. Nozawa, A. A. Miron, D. R. Cayan, & M. D. Dettinger. 2008. Human-induced changes in the hydrology of the western United States. Science 319: 1080–1083.

Boggs, C. L., C. E. Holdren, I. G. Kulahci, T. C. Bonebrake, B. D. Inouye, J. P. Fay, A. McMillan, E. H. Williams, & P. R. Ehrlich. 2006. Delayed population explosion of an introduced butterfly. J. Anim. Ecol. 75: 466–475.

Boggs, C. L. & D. D. Murphy. 1997. Community composition in mountain ecosystems: climatic determinants of montane butterfly distributions. Global Ecol. Biogeogr. Lett. 6: 39–48.

Bonebrake, T. C., C. L. Boggs, J. M. McNally, J. Ranganathan, & P. R. Ehrlich. 2010. Oviposition behavior and offspring performance in herbivorous insects: consequences of climatic and habitat heterogeneity. Oikos 119: 927–934.

Boughton, D. A. 1999. Empirical evidence for complex source-sink dynamics with alternative states in a butterfly metapopulation. Ecology 80: 2727–2739.

Bulman, C. R., R. J. Wilson, A. R. Holt, L. Galvez Bravo, R. I. Early, M. S. Warren, & C. D. Thomas. 2007. Minimum viable metapopulation size, extinction debt, and the conservation of a declining species. Ecol. Appl. 17: 1460–1473.

Debinski, D. M. 1994. Genetic diversity assessment in a metapopulation of the butterfly *Euphydryas gillettii*. Biol. Conserv. 70: 25–31.

Debinski, D. M., R. E.Vannimwegen, & M. E. Jakubauskas. 2006. Quantifying relationships between bird and butterfly community shifts and environmental change. Ecol. Appl. 16: 380–393.

Debinski, D. M., H. Wickham, K. Kindscher, J. C. Caruthers, & M. Germino. 2010. Montane meadow change during drought varies with background hydrologic regime and plant functional group. Ecology 91: 1672–1681.

Dennis, R. L. H. 1993. Butterflies and climate change. Manchester University Press, Manchester, UK. 302pp.

Dennis, R. L. H., T. G. Shreeve, & H. Van Dyck. 2003. Towards a functional resource-based concept for habitat: a butterfly biology viewpoint. Oikos 102: 417–426.

Dias, P. C. 1996. Sources and sinks in population biology. Trends Ecol. Evol. 11: 326–330.

Ehrlich, P. R. 1984. The structure and dynamics of butterfly populations. Pp. 25–40. *In* R.I. Vane-Wright & P.R. Ackery (eds.), The biology of butterflies. Symposium of the Royal Entomological Society of London No 11, Academic Press, London, UK.

Ehrlich, P. R., D. E. Breedlove, P. F. Brussard, & M. A. Sharp. 1972. Weather and the "regulation" of subalpine populations. Ecology 53: 243–247.

Ehrlich, P. R. & I. Hanski. 2004. On the wings of checkerspots: a model system for population biology. Oxford University Press, Oxford, UK. 371pp.

Ehrlich, P. R. & D. D. Murphy. 1987. Conservation lessons from long-term studies of checkerspot butterflies. Conserv. Biol. 1: 122–131.

Forister, M. L., A. C. McCall, N. J. Sanders, J. A. Fordyce, J. H. Thorne, J. O'Brien, D. P. Waetjen, & A. M. Shapiro. 2010. Compounded effects of climate change and habitat alteration shift patterns of butterfly diversity. Proc. Nat. Acad. Sci. U.S.A. 107: 2088–2092. doi: 10.1073/pnas.0909686107.

Gavin, D. G., D. J. Hallett, F. S. Hu, K. P. Lertzman, S. J. Prichard, K. J. Brown, J. A. Lynch, P. Bartlein, & D. L. Peterson. 2007. Forest fire and climate change in western North America: insights from sediment charcoal records. Front. Ecol. Environ. 5: 499–506. doi:10.1890/060161.

Hanski, I. 1999. Metapopulation ecology. Oxford University Press, Oxford, UK. 328pp.

———. 2003. Biology of extinctions in butterfly metapopulations. Pp. 577–602, in C.L. Boggs, W.B. Watt, & P.R. Ehrlich (eds.), Butterflies: ecology and evolution taking flight. University Chicago Press, Chicago, IL.

Hanski, I., P. R. Ehrlich, M. Nieminen, D. D. Murphy, J. J. Hellman, C. L. Boggs, & J. F. McLaughlin. 2004. Checkerspots and conservation biology. Pp. 264–287. *In* P.R. Ehrlich & I. Hanski (eds.), On the wings of checkerspots: a model system for population biology. Oxford University Press, Oxford, UK.

Hanski, I. & M. E. Gilpin. 1997. Metapopulation biology; ecology, genetics, and evolution. Academic Press, San Diego, CA. 512pp.

Hanski, I., T. Pakkala, M. Kuussaari, & G. Lei. 1995. Metapopulation persistence of an endangered butterfly in a fragmented landscape. Oikos 72: 21–28.

Harrison, S, D. D. Murphy, & P. R. Ehrlich. 1988. Distribution of the bay checkerspot butterfly, *Euphydryas editha bayensis*: evidence for a metapopulation model. Amer. Nat. 132:360–382.

Hill, J. K., C. D. Thomas, R. Fox, M. G. Telfer, S. G. Willis, J. Asher, & B. Huntley. 2002. Responses of butterflies to twentieth century climate warming: implications for future ranges. Proc. R. Soc. Lond. Ser. B 269: 2163– 2171.

Hill, J. K., C. D. Thomas, & B. Huntley. 1999. Climate and habitat availability determine 20th century changes in a butterfly's range margin. Proc. R. Soc. Lond. Ser. B 266: 1197–1206.

———. 2003. Modeling present and potential future ranges of European butterflies using climate response surfaces. Pp. 149–167. *In* C.L. Boggs, W.B. Watt, & P.R. Ehrlich (eds.), Butterflies: ecology and evolution taking flight, University Chicago Press, Chicago, IL. 739pp.

Hitchcock, C. L. & A. Cronquist. 1973. Flora of the Pacific northwest. University Washington Press, Seattle, WA. 730pp.

Holdren, C. E. & P. R. Ehrlich. 1981. Long range dispersal in checkerspot butterflies: transplant experiments with *Euphydryas gilletti*. Oecologia 50:125–129

Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigration-stochastic models. Biometrika 52: 225–247.

Kelly, A. E. & M. L. Goulden. 2008. Rapid shifts in plant distribution with recent climate change. Proc. Nat. Acad. Sci. 105: 11823–11826.

Kondla, N. G. 2005. Gillett's checkerspot in the southern headwaters at risk (SHARP) project area, Alberta. Alberta Species at Risk Report No 96, Alberta Fish and Wildlife Division, Edmonton, AB. 29pp.

Kuussaari, M., I. Saccheri, M. Camara, & I. Hanski. 1998. Allee effect and population dynamics in the Glanville fritillary butterfly. Oikos 82: 384–392.

Levins, R. 1970. Extinction. Lect. Math. Life Sci. 2: 75–107.

Lewis, O. T. & C. Hurford. 1997. Assessing the status of the marsh fritillary butterfly (*Eurodryas aurinia*): an example from Glamorgan, UK. J. Insect Conserv. 1: 159–166.

McLaughlin, J. F., J. J. Hellmann, C. L. Boggs, & P. R. Ehrlich. 2002. Climate change hastens population extinction. Proc. Nat. Acad. Sci. 99: 6070–6074.

Murphy, D. D. & R. R. White. 1984. Rainfall, resources, and dispersal in southern populations of *Euphydryas editha* (Lepidoptera: Nymphalidae). Pan-Pac. Ent. 60: 350–354.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life. Version 7.1. NatureServe, Arlington, VA. Accessed 23 July 2010. http://www.natureserve.org/explorer

Parmesan, C. 1996. Climate and species' range. Nature 382: 765–766.

———. 2003. Butterflies as bioindicators for climate change effects. Pp. 541–560. *In* C.L. Boggs, W.B. Watt, & P.R. Ehrlich (eds.),

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Butterflies: ecology and evolution taking flight. University Chicago Press, Chicago, IL. 739pp.

———. 2006. Ecological and evolutionary responses to recent climate change. Ann. Rev. Ecol. Syst. 37: 637–669.

PARMESAN, C., N. RYRHOLM, C. STEFANESCU, J. K. HILL, C. D. THOMAS, H. DESCIMON, B. HUNTLEY, L. KAILA, J. KULLBERG, T. TAMMARU, W. J. TENNENT, J. A. THOMAS, & M. WARREN. 1999. Poleward shifts in geographical ranges of butterfly species associated with regional warming. Nature 399: 579–583.

PARMESAN, C. & G. YOHE. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421: 37–42.

POLLARD, E. & T. J. YATES. 1992. The extinction and foundation of local butterfly populations in relation to population variability and other factors. Ecol. Entomol. 17: 249–254.

PULLIAM, H. R. 1988. Sources, sinks, and population regulation. Amer. Nat. 132: 652–661.

RICKETTS, T. H. 2001. The matrix matters: effective isolation in fragmented landscapes. Amer. Nat. 158: 87–99.

ROMME, W.H. 1982. Fire and landscape diversity in subalpine forests of Yellowstone National Park. Ecol. Monogr. 52: 199–221.

ROMME, W. H. & M. G. TURNER. 1991. Implications of global climate change for biogeographic patterns in the Greater Yellowstone Ecosystem. Conserv. Biol. 5: 373–386.

ROOT, T. L., J. T. PRICE, K. R. HALL, S. H. SCHNEIDER, C. ROSENZWEIG, & J. A. POUNDS. 2003. Fingerprints of global warming on wild animals and plants. Nature 421: 57–60.

ROY, D. B., P. ROTHERY, D. MOSS, E. POLLARD, & J. A. THOMAS. 2001. Butterfly numbers and weather: predicting historical trends in abundance and the future effects of climate change. J. Anim. Ecol. 70: 201–217.

ROSENZWEIG, C., D. KAROLY, M. VICARELLI, P. NEOFOTIS, Q. WU, G. CASASSA, A. MENZEL, T. L. ROOT, N. ESTRELLA, B. SEGUIN, P. TRYJANOWSKI, C. LIU, S. RAWLINS, & A. IMESON. 2008. Attributing physical and biological impacts to anthropogenic climate change. Nature 453: 353–358. doi: 10.1038/nature06937.

SACCHERI, I., M. KUUSSAARI, M. KANKARE, P. VIKMAN, W. FORTELIUS, & I. HANSKI. 1998. Inbreeding and extinction in a butterfly metapopulation. Nature 392: 491–494.

SEBER, G. A. F. 1982. The estimation of animal abundance and related parameters. Macmillan, New York, NY. 506pp.

SINGER, M. C. & I. HANSKI. 2004. Dispersal behavior and evolutionary metapopulation dynamics. Pp. 181–198. *In* P.R. Ehrlich & I. Hanski (eds.), On the wings of checkerspots: a model system for population biology, Oxford University Press, Oxford, UK. 571pp.

THOMAS, C. D., N. A. D. BOURN, R. T. CLARKE, K. E. STEWART, D. J. SIMCOX, G. S. PEARMAN, R. CURTIS, & B. GOODGER. 2001. The quality and isolation of habitat patches both determine where butterflies persist in fragmented landscapes. Proc. R. Soc. Lond. B 268: 1791–1796.

THOMAS, C. D., C. R. BULMAN, & R. L. WILSON. 2008. Where within a geographical range do species survive best? A matter of scale. Insect Conserv. Divers. 1: 2–8. doi: 10.1111/j.1752–4598.2007.00001.x

WAHLBERG, N., T. KLEMETTI, V. SELONEN, & I. HANSKI. 2002. Metapopulation structure and movements in five species of checkerspot butterflies. Oecologia 130: 33–43.

WANG, R., Y. WANG, J. CHEN, G. C. LEI, & R. XU. 2004. Contrasting movement in two species of checkerspot butterflies, *Euphydryas aurinia* and *Melitaea phoebe*, in the same patch network. Ecol. Entomol. 29: 367–374.

WARREN, M. S., J. K. HILL, J. A. THOMAS, J. ASHER, R. FOX, B. HUNTLEY, D. B. ROY, M. G. TELFER, S. JEFFCOATE, P. HARDING, G. JEFFCOATE, S. G. WILLIS, J. N. GREATOREX-DAVIES, D. MOSS, & C. D. THOMAS. 2001. Rapid responses of British butterflies to opposing forces of climate and habitat change. Nature 414: 65–69.

WEATHER PERSPECTIVES. 2011. Weather perspectives for the con-tiguous 48 states, 1896–present. Accessed 18 May 2011. http://www.weatherperspectives.com/

WILLIAMS, E. H. 1981. Thermal influences on oviposition in the montane butterfly *Euphydryas gillettii*. Oecologia 50: 342–346.

———. 1988. Habitat and range of *Euphydryas gillettii* (Nymphalidae). J. Lepid. Soc. 42: 37–45.

———. 1990. Dietary breadth in *Euphydryas gillettii* (Nymphalidae). J. Lepid. Soc. 44: 94–95.

———. 1995. Fire-burned habitat and reintroductions of the butterfly *Euphydryas gillettii* (Nymphalidae). J. Lepid. Soc. 49: 183–191.

WILLIAMS, E. H., C. E. HOLDREN, & P. R. EHRLICH. 1984. The life history and ecology of *Euphydryas gillettii* Barnes (Nymphalidae). J. Lepid. Soc. 38: 1–12.

WILSON, E. O. 1992. The diversity of life. Belknap Press of Harvard University Press, Cambridge, MA. 424pp.

ZIMMERMANN, M., N. WAHLBERG, & H. DESCIMON. 2000. Phylogeny of *Euphydryas* checkerspot butterflies (Lepidoptera: Nymphalidae) based on mitochondrial DNA sequence data. Ann. Ent. Soc. Am. 93: 347.

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DESCRIPTION OF THE EARLY STAGES OF *ECCOPSIS GALAPAGANA* RAZOWSKI & LANDRY (TORTRICIDAE), A DEFOLIATOR OF *PROSOPIS JULIFLORA* (SW.) DC. (FABACEAE) IN COLOMBIA

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ABSTRACT. The biology and early stages of *Eccopsis galapagana* Razowski & Landry are described and illustrated for the first time; details of the adult behavior also are provided. Under outbreak conditions the species has become a serious pest in silvopastoral systems of algarrobo tree (*Prosopis juliflora* (Sw.) DC.; Fabaceae) in Colombia. Although African members of the genus *Eccopsis* feed on a variety of different host plant families (e.g., Fabaceae, Rhizophoraceae, Sterculiaceae, Anacardiaceae, Euphorbiaceae, Flagellariaceae, and Rutaceae), New World species of *Eccopsis* are recorded only from Fabaceae.

Additional key words: asymmetrical genitalia, Olethreutinae, parasitoids, pest species, silvopastoral systems.

Prosopis juliflora (Sw.) DC. (Fabaceae), commonly known as mesquite or algarrobo tree, is a widely distributed and highly adaptable shrub of xeric habitats ranging from the southwestern United States to northern South America (Venezuela, Colombia, Ecuador, and Peru) (Silva 1988; Schnee 1984). It is a multiuse species—in the field it provides shade and food for animals; the fruit is a rich source of proteins and fats (Lima 1994). In stables the fruit is used as fodder for cattle as it is approximately 39% protein and 7–8 % fat (Lima 1994). In rural areas of Venezuela and India, the wood of algarrobo and its charcoal are in high demand by the local people. In Colombia *P. juliflora* is used as a supplementary food source for bovines under intensive silvopastoral systems on the Caribbean coast, in the dry forests of the valleys of the Cauca and Magdalena rivers, and the plains areas of Cesar and Llanos Orientales (Caldas 1975; Lima 1994).

No serious pests of this species were reported until 2006 when conspicuous damage to the foliage was noticed in silvopastoral plantations of *P. juliflora* at El Cerrito, a small town of Valle del Cauca Department, Colombia (Figs. 1–2). An investigation of the foliage revealed that the damage was the result of feeding by larvae of a tortricid moth. Defoliation can reduce fruit production by 60%, which adversely affects livestock since the fruit of algarrobo is an important energy supplement for cattle during dry periods in the silvopastoral system. Adult and larval specimens were sent to the USDA Systematic Entomology Laboratory where they were identified as *Eccopsis galapagana* Razowski & Landry, described from the Galapagos Islands, Ecuador, and recently reported from Chile (Vargas 2011). The purpose of this paper is to describe and illustrate the early stages and damage caused by this species.

Materials and Methods

Larval specimens were collected from the leaves of *Prosopis juliflora* that were in high density in a silvopastoral system at Hacienda El Hatico, El Cerrito, Valle del Cauca, 3°27'N, 76°32'W, Colombia, 1000 m above mean sea level (Fig. 3). Annual mean precipitation at the site is 750 mm, distributed in two rainy periods (March–May and October–November); average temperature is 24°C and relative humidity 75%. All of these characteristics are typical of tropical dry forest habitat *sensu* Holdridge (1978).

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FIGS. 1–2. Algarrobo tree in Hacienda el Hatico, Colombia. **1.** Typical tree. **2.** Same tree after pest damage.

FIG. 3. Map showing the geographical location of the study site (on work).

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FIGS. 4–5. Adults of *Eccopsis galapagana*. **4.** Adult male. **5.** Adult female.

Larvae of different stages were collected and preserved using KAAD and transferred to 70% EtOH. In order to follow the life cycle, last instar larvae were confined in mesh cages (40×50×50 cm) and provided with fresh host plant until they pupated and produced adults. Lots consisting of 10 females and 10 males were transferred to PVC cylinders (15 cm in diameter) with a fine mesh top and a humid sponge at the bottom. Sugar solution (15%) was provided *ad libitum* as an energy source. Branches of bipinnate leaves (bearing both the leaflets and the stems) of *P. juliflora* were placed inside the cylinders to stimulate copulation and oviposition. Rearing was conducted in the laboratory at 26.8°C and 78% relative humidity.

Specimens of larvae and adults were examined using a Wild M5A stereomicroscope and a Leitz Laborlux S compound microscope. Genitalia dissections followed the methods summarized in Brown and Powell (1991). Images of eggs, larvae, pupae, and adults were captured using a Miotic Digital Microscope DM143 camera and Miotic Images Plus 2.0 ML. All images were edited in Adobe Photoshop.

Body length of adults (i.e., from the compound eyes to the distal end of the abdomen) was measured using pinned specimens. Forewing was measured from the base of the wing to the apex. Terminology for morphological features of the genitalia follows that of Aarvik (2004) and Razowski et al. (2008); terminology for larvae and pupae follows Brown (1987) and Scoble (1995), respectively. Specimens examined are deposited in the collections of the Entomological Museum of the Universidad del Valle (Musenuv code 077), Cali, Colombia, and the National Museum of Natural History, Smithsonian Institution, Washington, D. C., USA.

RESULTS AND DISCUSSION

Systematics. The genus *Eccopsis* Zeller, 1852 is comprised of 20 described species, restricted primarily to the Old World Tropics, mostly Africa (Aarvik 2004; Brown 2005). The first New World species of the genus were recently described from Ecuador: two from the Galapagos Islands by Razowski et al. (2008), and one from the mainland by Razowski and Wojtusiak (2008). Subsequently, a species was described from Chile (Vargas 2011). This unusual geographical disjunction between Africa and South America has been reported previously for *Megalota* Diakonoff, 1966, *Cosmorrhyncha* Meyrick, 1913, *Apotoforma* Busck, 1934, and a few other genera (Brown 2009). The four

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New World species differ from Old World *Eccopsis* in two features in the male genitalia: the absence of the characteristic process from the basal or subbasal portion of the valva, which is present in nearly all Old World species of *Eccopsis*; and the shape of the valve, which is much more asymmetrical in the New World species. In the Old World species the pattern of setae on the valvae are conspicuously asymmetrical, but the overall shape is only subtly different between the left and right valva. Hence, it is uncertain whether these New World species truly belong to *Eccopsis* or whether a new genus is required.

Larval food plants are recorded for a few species of African *Eccopsis*: *Acacia mearnsii* De Wild (Fabaceae) and *Aeschynomene schimperi* Hochst (Fabaceae) for *E. incultana* Walker (Ghesquière 1940; Swain & Prinsloo 1986; Krüger 1998; *Cassipourea malosana* (Baker) (Rhizophoraceae), *Theobroma cacao* L. (Sterculiaceae), and *Mangifera indica* L. (Anacardiaceae) for *E. praecedens* Walsingham (Diakonoff 1977; Aarvik 2004; USNM collection); *Drypetes natalensis* (Harv.) (Euphorbiaceae), *Flagellaria* sp. L. (Flagellariaceae), and *Vepris trichocarpa* (Engl) (Rutaceae) for *E. nebulana* Walsingham (USNM collection); and *Ricinus communis* L. (Euphorbiaceae) for *E. walhbergiana* Zeller (Aarvik 2004). Vargas (2011) recently reported *Prosopis* as a host for *E. galapagana* in Chile. Whereas fidelity to a single plant genus, or at least a single plant family, is the most common situation in most Olethreutinae, *Eccopsis* does not appear to demonstrate such host specificity, with larvae in the genus utilizing at least seven different plant families.

Eccopsis galapagana Razowski & Landry, 2008
Figs. 4–10

Description. *Adult.* Body length 4.50 + 0.46 mm; forewing length 3.48 + 0.46 mm (n = 50). Adults (Figs. 4, 5) somewhat variable in forewing pattern. Razowski et al. (2008) provides a brief comparison of *E. galapagana* with *E. floreana* Razowski & Landry. The male genitalia (Fig. 6) of *E. galapagana* can be distinguished from those of all other species of *Eccopsis* by the presence of a long curved spine from the terminal part of the sacculus of the left valva (absent in all other congeners) and the presence of a pair of thick apical setae from the uncus (usually a dense patch of setae from a distally bilobed uncus in congeners). The female genitalia (Fig. 7) are distinguished by the presence of a pair of large lobes of the sterigma.

Egg. Round, width 0.5–0.7 mm (mean = 0.63 mm, SD = 0.54, n = 91), length 0.5–0.7 mm (mean = 0.63 mm, SD = 0.54, n = 91). Five embryonic phases were apparent, allowing an estimate for the overall time for egg development (Fig. 8). Freshly deposited eggs are round, smooth, and translucent; by the second day they are concave, whitish, and in some individuals with two tiny dark spots that correspond to the stemmata. The stemmata are clearly evident by the third day. Mandibles are apparent by the fourth day. When fully developed, the larva ecloses by eating through the micropyle area.

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FIG. 6. Male genitalia of *Eccopsis galapagana*

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Larva. Last instar (Fig. 9) body length mean = 9.76 mm (SD = 0.98; n = 21). Head: Mandible with long ridge becoming confluent with lower tooth; distance between P1 and AF2 on head ca. 0.7 times distance between P1 and P2; a horizontal line connecting the AF2 setae on head passes closer to P2 than P1; stemmata with dark brown patch; a short, brown, patch at genal angle, extending dorsally along posterior margin of head. Thorax: Chaetotaxy typically tortricoid; prothoracic shield pale yellow with distinct brown line at posterior edge (earlier instars usually with shield entirely brown); L-pinaculum sclerotized, situated entirely anterior to spiracle; L-group trisetose on T1; SV group 2:1:1 on T1,2,3. Abdomen: All pinacula weakly sclerotized; all spiracles moderately large (larger on A8), round; SV-group on A1,2,7,8,9 with 3:3:3:2:2 setae; SD2 on A1–8 inconspicuous; SD1 pinaculum on A8 directly anterior to spiracle; D2 setae on A9 on shared dorsal pinaculum; D1 and SD1 on A9 on separate pinacula; distance between V-setae approximately the same on A7, A8, and A9; anal comb present with 6–8 tines. Abdominal prologs with 39–42 partially triordinal crochets (in previous instar 26–27 mostly biordinal crochets, with those on the outer portion of the planta slightly shorter); proleg on A10 with 22–25 biordinal crochets.

The shared D2 pinacula (dorsal saddle) on A9 and the presence of an anal comb immediately identified the larvae as Tortricidae. However, the trisetose SV-group on A7 and the separate D1 and SD2 pinacula on A9 are features more characteristic of Tortricinae than of Olethretinae, the subfamily to which the *Eccopsis* belongs. The larvae of only a few other Olethreutinae possess these typically tortricine characters (e.g., *Lobesia, Paralobesia*) (MacKay 1959).

Pupa. Obtect, fusiform, typically tortricoid, head without projection (Fig. 10). As in many tortricids, the pupa is initially green or greenish brown, becoming reddish-brown or dark brown as it matures. Labrum about half the length of proboscis. Proboscis extending just beyond prothoracic legs, approximately 1/3 of the length of the hind wing. Mesothoracic legs and antennal apices extending to about the middle of the A4. Hind wings terminating slightly before the posterior margin of the A4. Dorsum of segments A2–A8 with two rows of transverse spines; spines of anterior row conspicuously larger than those of the posterior row. Dorsum of A9 with a single row of spines near posterior margin. Genital cleft present on venter of A10; anal aperture present on A9 in males and on A8 in females. Cremaster poorly developed, with three pairs of hook-tipped setae.

Reproductive behavior. In the laboratory, adults began to emerge about 1100–1200 hrs. Newly emerged moths were relatively inactive, but by the second day, copulation was observed, usually between 0800 and 1100 hours, and lasting up to 1.5 hrs. In the field, adults were inactive during daylight, concealed in foliage or branches of the host trees. They usually became active at sundown and usually flew until sunrise.

Eggs typically were deposited individually or in pairs. When the moth population in the field was high, masses of 3–5 eggs could be found. A total of 190 eggs was collected in the field, and their locations on the leaves were recorded. Females preferred to lay eggs on the underside (80%) near the tip of the leaf rather than on the upper side.

Larval behavior. In nature, upon hatching, first instars begin to fold the upper surface of leaflets of the host. The characteristic shelters are conspicuous, facilitating identification of the location of the larvae. In some cases, larvae of *E. galapagana* are semi-gregarious, i.e., several first instars may share a leaf petiole, or second and third instars may share a pinna. Once the host leaves are folded, the larvae begin to feed on the surface of the leaf, damaging the tissue. Last instar larvae are the most voracious stage, making small holes in the leaves and, under severe infestations, totally defoliating trees (Figs. 11–16). However, they are always solitary.

FIG.7. Female genitalia of *Eccopsis galapagana*

In the laboratory, when larvae prepared to molt they produced a greater quantity of silk, strongly joining the leaves. The partially eaten remains of dry leaves are used to form a cocoon. Adjacent leaves unaffected by larval feeding also were used for constructing the

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FIG. 8. Daily development of an egg of *Eccopsis galapagana.*

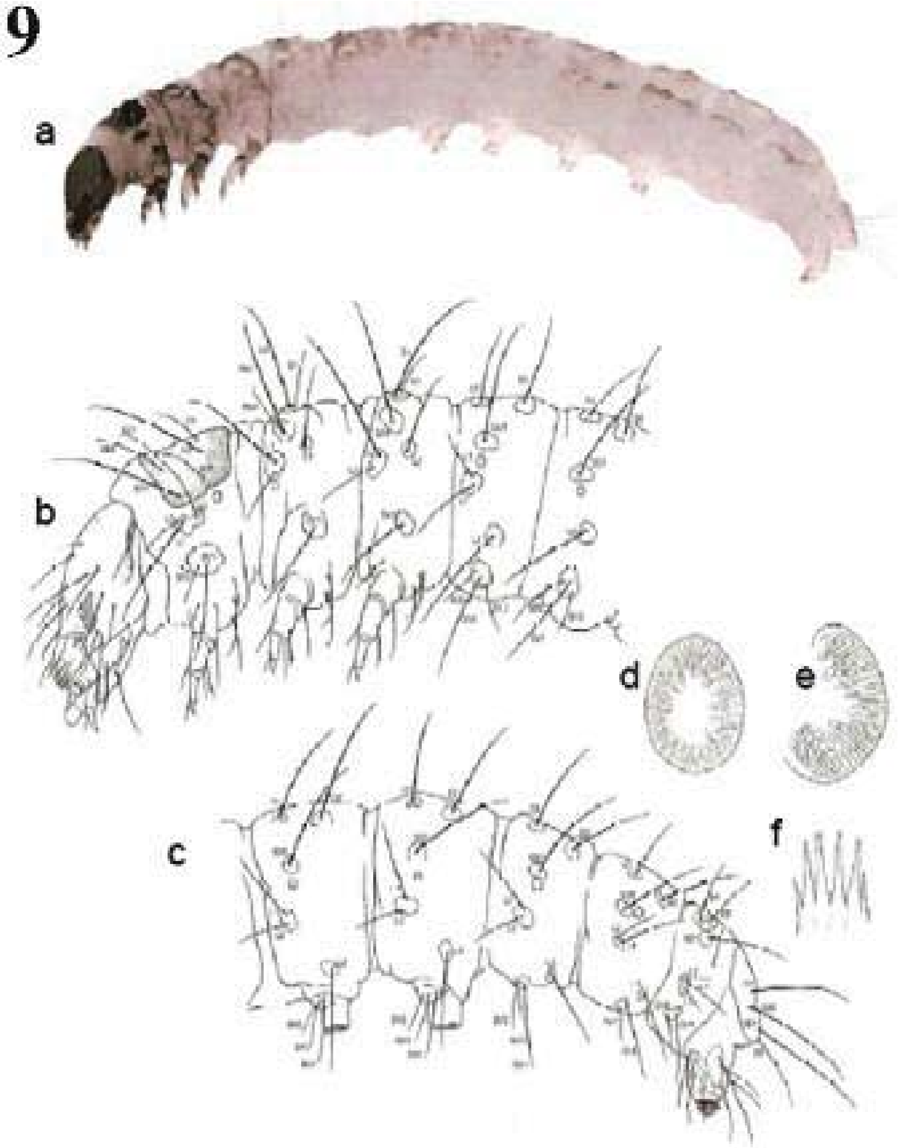

FIG. 9. Last instar larva of *Eccopsis galapagana*. **A)** Preserved larva. **B)** Chaetotaxy of head, thorax and abdominal segments 1 and 2. **C)** Chaetotaxy of abdominal segments 5–10. **D)** Arrangement of crochets on abdominal prolegs 3–6. **E)** Arrangement of crochets on abdominal proleg 10. **F)** Anal comb.

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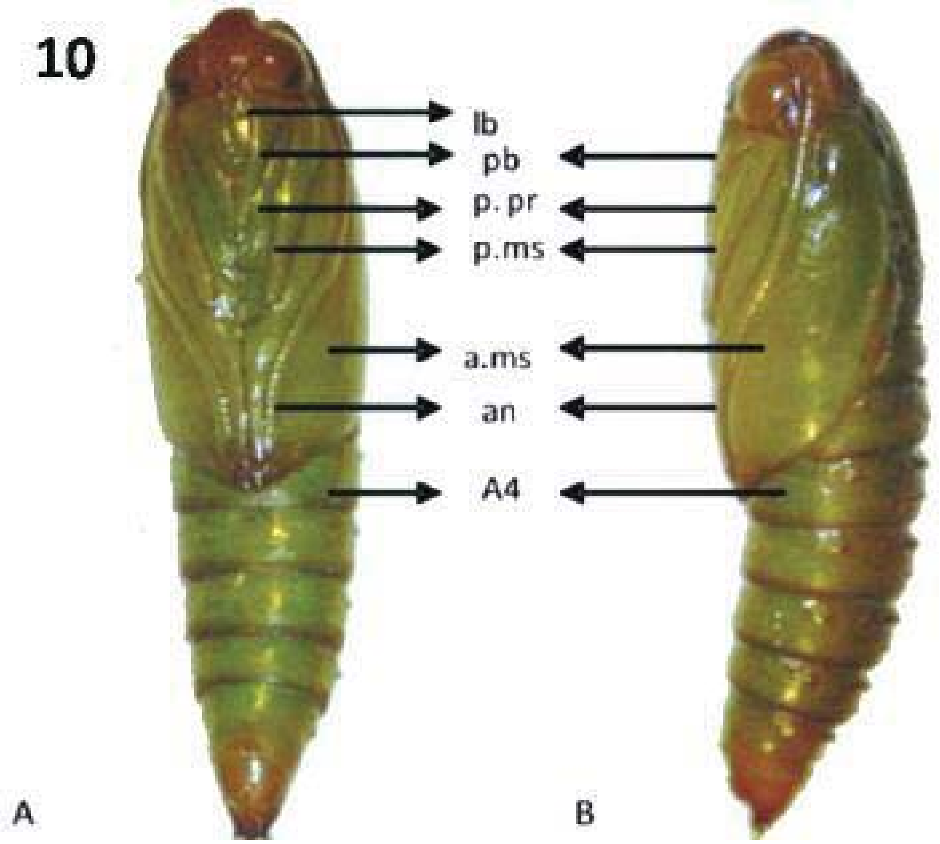
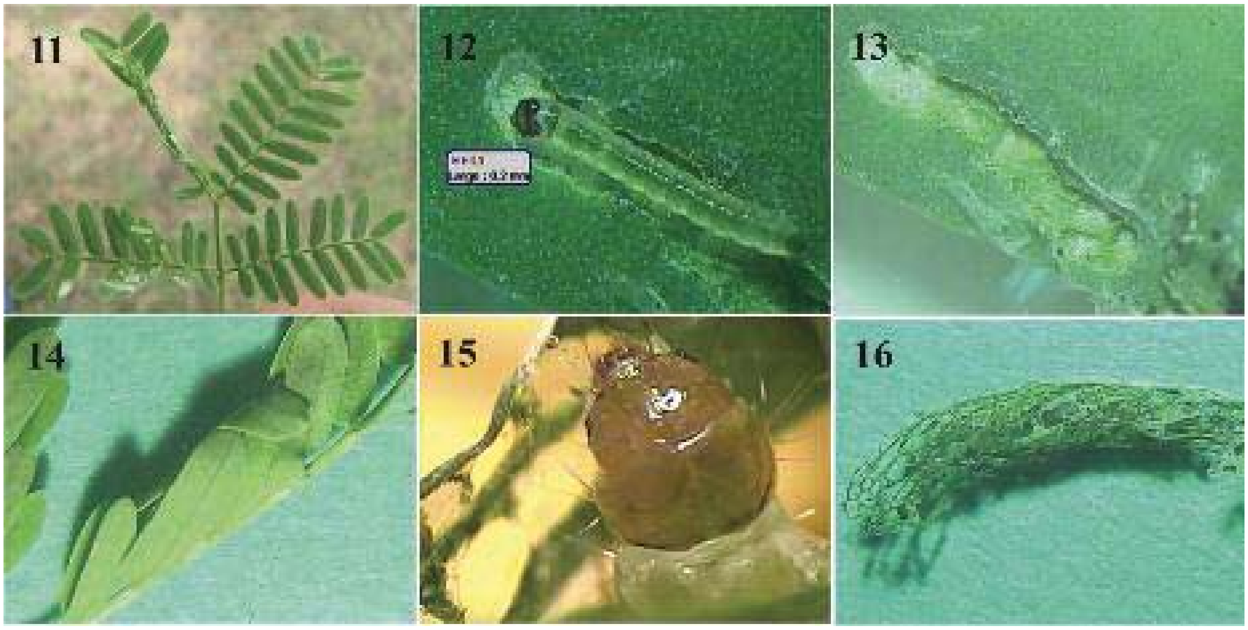


FIG. 10. *Eccopsis galapagana* pupa. **A)** ventral view. **B)** dorsolateral view (4X); labrum (lb), proboscis (pb), prothoracic leg (pr. p), mesothoracic leg (ms l.), mesothoracic wing (ms w.), antenna (an), fourth abdominal segment (A4).



FIGS. 11–16. Damage caused by larvae in the leaves of the *Prosopis juliflora*. First instar larvae (top), last instar larvae (below).

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Table 1. List of the primary Hymenoptera parasitoids attacking *E. galapagana* in a *Prosopis silvopastoral* system in Colombia.

SUPERFAMILY	FAMILY	SUBFAMILY	GENUS
ICHNEUMONOIDEA	Braconidae	Orgilinae	*Orgilus* sp.
	Ichneumonidae	Chremastinae	
CHALCIDOIDEA	Trichogrammatidae		*Trichogramma* sp.
	Chalcididae	Chalcidinae	*Conura* sp.
			Brachymeria sp.
			Brachymeria spp.
	Eurytomidae		
	Eupelmidae	Eupelminae	*Anastatus* sp.
	Eulopidae		
	Pteromalidae		

cocoon, causing additional damage to the host foliage. Immediately following the last larval molt, the larvae were pale and remained practically immobile for the entire day.

Concluding remarks. *Eccopsis galapagana* joins *Ofatulena duodecemstriata* (Walsingham), *Cydia membrosa* (Heinrich), *Rudenia leguminana* (Busck), *Cryptophlebia carpophagoides* Clarke, and *Chileulia stalactitis* (Meyrick) as documented tortricid herbivores of *Prosopis* species in the New World (e.g., Ward et al. 1977; Brown & Passoa 1998; Komai 1999).

The record of *E. galapagana* in Colombia extends northward the known geographical range of this Neotropical tortricid species previously reported from Ecuador (Razowski et al. 2008) and northern Chile (Vargas 2011). Its prior "absence" from Colombia is explained more easily by our poor knowledge of the tortricid fauna of Colombia than as a newly discovered introduction. The presence of this potential pest may serve as a warning for those managing silvopastoral systems, which are expanding in the country. The fact that the larvae were capable of damaging large amounts of vegetative cover in *Prosopis* plantations may represent a control challenge. However, if pesticides prove ineffective or inappropriate in these systems, it is likely that conventional biological control, using primarily parasitoids, would provide an alternative and convenient approach because a remarkably high proportion of *E. galapagana* larvae collected in the field were parasitized by native Ichneumonoidea and Chalcidoidea (see Table 1).

Acknowledgements

The authors are grateful to the Molina-Durán family for allowing us to sample vegetation and larvae at its El Hatico Natural Reserve. We thank E. Murgueitio, Z. Calle, M.D. Heredia, I. Armbrecht, H. Calero, Steven Passoa, and an anonymous reviewer for their helpful comments, suggestions, and criticisms. We extend our gratitude to the scientific personnel at Fundación CIPAV and GEAHNA (Departamento de Biología, Universidad del Valle). Illustrations of the larvae and genitalia were prepared by Taina Litwak, Systematic Entomology Laboratory, USDA, National Museum of Natural History, Washington, D.C.

Literature Cited

Aarvik, L. 2004. Revision of the subtribe Neopotamiae (Lepidoptera: Tortricidae) in Africa. Norw. J. Entomol. 51: 71–122.

Brown, J. W. 2005. World catalogue of insects. Volume 5: Tortricidae (Lepidoptera). Apollo Books. Stenstrup, Denmark, 741 pp.

———. 2009. Discovery of *Megalota* in the Neotropics, with a revision of New World species (Lepidoptera: Tortricidae: Olethreutinae). Zootaxa 2278: 1–50.

Brown, J. W. & S. Passoa. 1998. Larval foodplants of Euliini (Lepidoptera: Tortricidae): From Abies to Vitis. Pan-Pac. Entomol. 74: 1–11.

Brown, J. W. & J. A. Powell. 1991. Systematics of the *Chrysoxena* group of genera (Lepidoptera: Tortricidae: Euliini). Univ. Calif. Publ. Entomol. 111: 1–129.

Brown, R. L. 1987. Tortricidae (Tortricoidea). Pp. 419–433. *In* Stehr, F. W. (ed.), Immature Insects, volume I. Kendall/Hunt, Dubuque, Iowa.

Diakonoff, A. 1977. Tortricidae and Choreutidae from Reunion [Lepidoptera]. Ann. Soc. Entomol. France (N.S.) 13 (1): 101–116.

Ghesquière, J. 1940. Catalogues raisonnés de la faune entomologique du Congo Belge. Lépidoptères, Microlépidoptères (première partie). Ann. Mus. Congo Belge. Zoologie. Serie III (II) 7(1): 1–120.

Holdridge, L. R. 1978. Ecología basada en zonas de vida. Instituto Interamericano de Cooperación para la Agricultura (IICA): serie de libros y materiales educativos No. 34.

Krüger, M. 1998. Identification of the adults of Lepidoptera inhabiting *Ravenelia macowaniana* Pazschke (Uredinales) galls on *Acaia karroo* Hayne (Fabaceae) in southern Africa. African Entomol. 6: 55–74.

Komai, F. 1999. A taxonomic review of the genus *Grapholita* and allied genera (Lepidoptera: Tortricidae) in the Palaearctic region. Entomol. Scand. Suppl. 55: 1–226.

Lima, P. C. F. 1994. Comportamento silvicultural de espécies de Prosopis, em Petrolina- PE, região semi-árida brasileira. Tese (Doutorado) - Escola de Florestas- Universidade Federal do Paraná, Curitiba, 110 p.

MacKay, M. R. 1959. Larvae of the North American Olethreutidae (Lepidoptera). Canadian Entomologist Supplement 10. 338 pp.

Razowski, J., B. Landry & L. Roque-Albelo. 2008. The Tortricidae (Lepidoptera) of the Galapagos Islands, Ecuador. Rev. Suisse Zool. 115: 185–220.

Razowski, J. & J. Wojtusiak. 2008. Tortricidae (Lepidoptera) from the mountains of Ecuador. Part 1. Southern Highlands. Acta Zool. Cracov. 51B: 7–41.

Swain, V. M. & G. L. Prinsloo. 1986. A list of phytophagous insects and mites on forest trees and shrubs in South Africa. Entomology

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Memoirs of the Department of Agriculture and Water Supply, Republic of South Africa 66.

SCOBLE, M. J. 1995. The Lepidoptera. Form, function and diversity. Oxford University Press, Suffolk, 404 pp.

SILVA, M. A. 1988. Taxonomy and distribution of the genus *Prosopis*. Pp. 177–185 *In* The current state of knowledge on *Prosopis juliflora*. International Conference on Prosopis. Rome, FAO.

SCHNEE, L. 1984. *Prosopis juliflora*. Plantas comunes de Venezuela. 3a (ed). Ediciones de la Biblioteca. Universidad Central. Caracas-Venezuela. 249 pp.

VARGAS, H. A. 2011. A new species of *Eccopsis* Zeller (Lepidoptera, Tortricidae) from the coastal valleys of northern Chile, with the first continental record of *E. galapagana* Razowski & Landry. Rev. Bras. Entomol. 55: 216–218.

WARD, C. R., C. W. O'BRIEN, L. B. O'BRIEN, D. E. FOSTER & E. W. HUDDLESTON. 1977. Annotated checklist of New World insects associated with *Prosopis* (mesquite). U.S.D.A. Technical Bulletin 1557. 115 pp.

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A NEW PHYCITINE SPECIES FROM NEW MEXICO (PYRALOIDEA: PYRALIDAE: PHYCITINAE)

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ABSTRACT. The new phycitine species *Lipographis unicolor* is described from Catron Co., New Mexico. Adults and genitalia are illustrated.

Additional key words: *Lipographis unicolor*, New Mexico, Phycitinae, Pyralidae, Pyraloidea

In early August, 2011 I ran UV light traps at a location southwest of Reserve, Catron Co., NM where I had run light traps numerous times in the past. What made 2011 different from previous years was the passage of the massive and destructive Wallow wildfire through the region in June and early July. The area that I visited had not been in the main path of the fire, but was one of many collateral areas of localized fires ignited by airborne burning debris carried by the high sustained winds that persisted through much of the western United States at the time of the fire. The site had sustained total burning of the ground cover and most of the shrubs and scrub oaks, with substantial damage to the crowns of many of the mature ponderosa pine trees. My visit was following the main monsoonal rain period, and dormant seeds had started to sprout (Fig. 7). Moths were surprisingly numerous in my traps considering the fire damage. I found in numbers some species that I had not previously seen in the area (primarily geometrids), and a small series of what looked like a brown crambid that I had never seen before at any location. Subsequent dissection of a male placed the moth in the phycitine genus *Lipographis*, Ragonot. Neunzig (2003) recognized three species in this genus, the adults of which all possess relatively pale and distinctly maculated dorsal forewings: *L. fenestrella* (Packard); *L. truncatella* (Wright); *L. umbrella* (Dyar). The moths in the short series that I collected have uniformly dark golden brown forewings (Figs. 1–2); fresh specimens have a miniscule dark brown dot located about mid-wing. The male genitalia of the three recognized species are quite similar (Heinrich, 1956, figs. 407, 408, 410); Neunzig, 2003, text fig. 92a, b). The female genitalia exhibit greater differences (Heinrich, figs. 896–898); Neunzig illustrated (fig. 92c) only a portion of the female genitalia of *Lipographis fenestrella* (Packard). The male genitalia of the moth that I collected show several differences from the three described species, and the female genitalia show greater differences. I now propose a new species based on a series of seven males and two females.

Lipographis unicolor Ferris, **new species**

(Figs. 1–5)

Diagnosis. The distinctive comb-like cornuti in the aedeagus of the male genitalia (Fig. 4) immediately separate this moth from other members of the Phycitinae and place it in genus *Lipographis*. *L. unicolor* immediately separates from its three paler and clearly maculated congeners by its uniformly dark golden brown forewings and dark brown hindwings.

Description. *Head*: Male antenna with barely visible short sinus, very pale and darker brown speckled; pubescent. Female antenna simple. Haustellum well developed and thickly covered with very pale tan scales. Labial palpi porrect in both sexes, robust, extending approximately 2 mm beyond outer rim of eye, second segment oblique. Maxillary palpi short stout tufts. Ocellus present. Head including frons, palpi, crown, speckled with very pale and darker brown scales, lower and inner portions of labial palpi paler. *Thorax:* Thoracic vestiture similar to head with pronounced pale brown tegulae. Legs nearly white, lightly peppered with pale brown and some darker scales. *Abdomen*: Dorsally brown, ventrally pale tan almost white. *Wings*: Forewing length: males (n = 7) 12–13.5 mm, ave. = 12.4 mm; females (n = 2) 10.5 mm. Dorsal forewing. Ground color tan, overlaid with numerous brown scales producing a golden brown aspect, especially along the inner margin in the males; females a more uniformly duller brown. In fresh specimens there is a very small spot composed of 6–8 dark brown scales located about midwing vertically and one-third of the wing length from the outer margin. Dorsal hindwing of both sexes uniformly dark brown. Wing fringes pale brownish-tan. Ventral surfaces similar to dorsal wings, but very slightly paler. *Male genitalia* (Figs. 3–4; 2 dissections): Uncus triangular with rounded apex, hoodlike. Apical projection of gnathos with short robust hook. Transtilla absent. Valva about one-half length of genital capsule and very narrow with low pointed lobe at base. Anellus weak with slender arms. Saccus broad and strongly indented. Aedeagus (Fig. 4): Length 0.7 that of genital capsule, broad at apex tapering to base, with sclerotized carina along its full length; vesica armed with comb-like array of 5–7 curved tapered cornuti anchored to a basal plate. *Female genitalia* (Fig. 5, ventral aspect; 2 dissections): Ovipositor lobes basally broad tapering to rounded apex, sparsely hirsute with fine hairs. Apophyses moderately robust and of approximately equal length. Sterigma goblet shaped, broad, open, lightly sclerotized. Ductus bursae a slender weakly scobinate membranous tube tapering from ostium bursae to corpus bursae with

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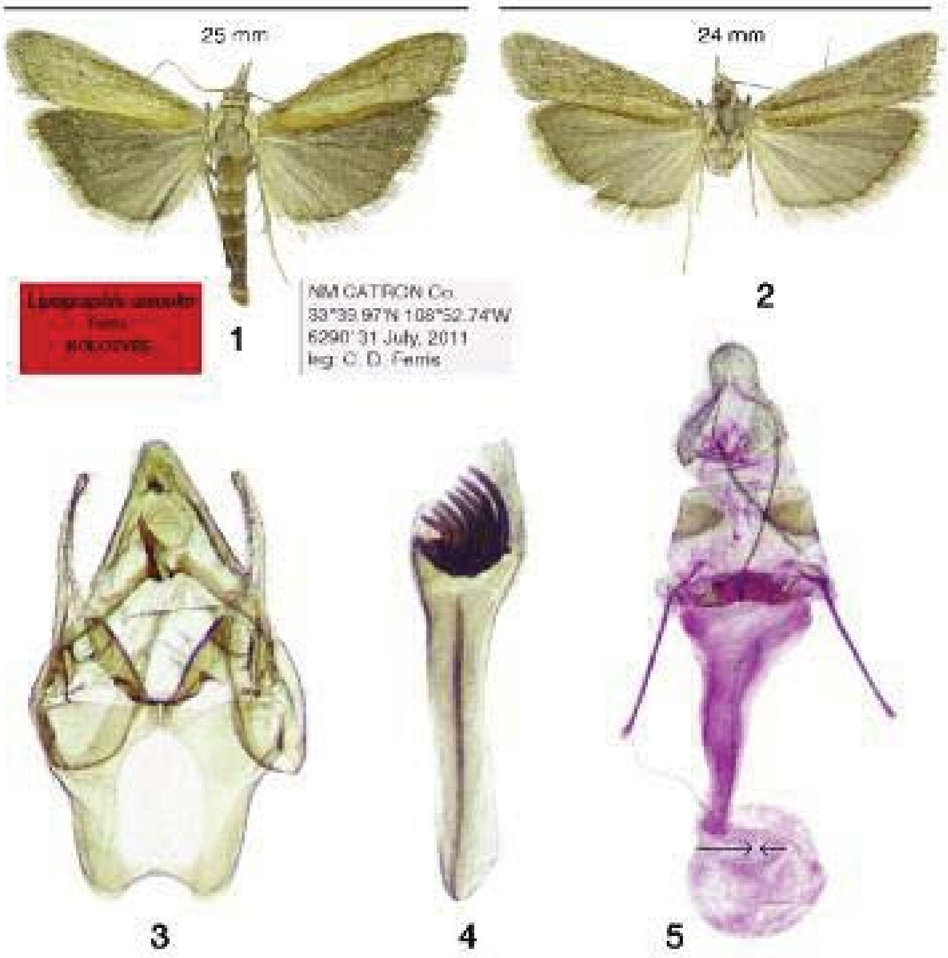
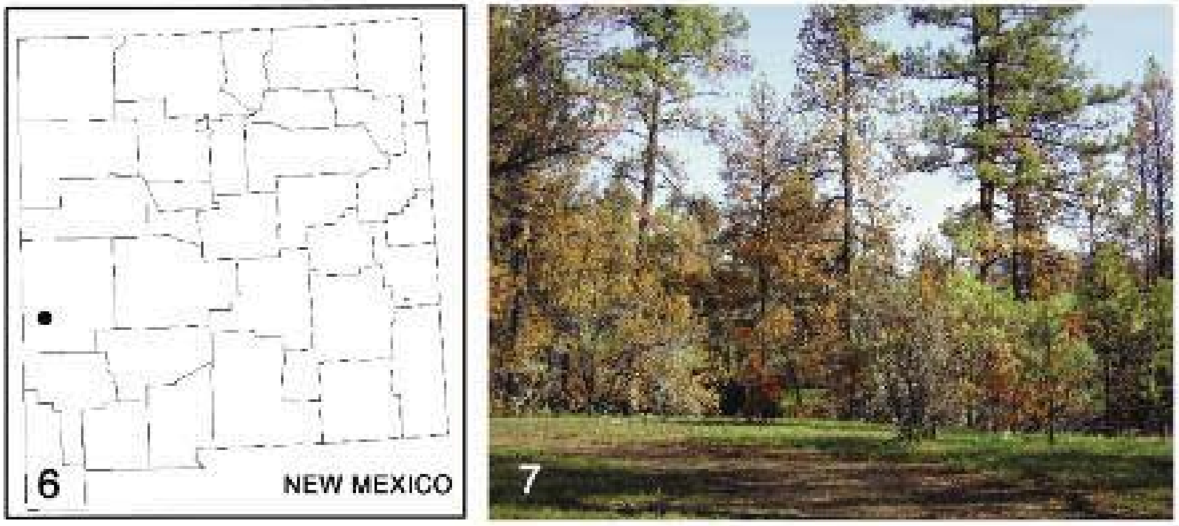


FIGS. 1–5. *Lipographis unicolor*. **1,** male holotype with pin labels. **2,** female paratype. **3–4,** male genitalia. **3,** genital capsule, aedeagus removed. **4,** aedeagus (enlarged). **5,** female genitalia (arrows point to origin of ductus seminalis).



FIGS. 6–7. **6,** Distribution map. **7,** Type locality habitat on 1 August, 2011 showing recovery and remaining burned vegetation.

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length approximately equal to 1.5 times diameter of corpus bursae. Corpus bursae spherical with diameter about equal to width of sterigma; signa absent Ductus seminalis originates from corpus bursae just below junction with ductus bursae, as occurs in many phycitines.

Types. Holotype male (Fig. 1): New Mexico, Catron Co., 33°39.97'N, 108°52.74'W, 6290' (1918m), 31 July, 2011. Deposited in Carnegie Museum, Pittsburgh, PA. Paratypes: 6 m, 2f, same data, in author's collection.

Discussion. In the three previously known species of *Lipographis*, the aedeagus is shorter and broader than in *unicolor* and the sheath lacks a carina. The saccus is not so broad and strongly indented as in *unicolor*. The basal portion of the male antenna in *fenestrella* has a large scale tuft (Neunzig, 2003, text fig. 88b) that is entirely lacking in *unicolor*. The long tapering ductus bursae in *unicolor* differs from the relatively short and nearly uniform diameter ductus bursae found in the other species.

Etymology. The name *unicolor* denotes the nearly uniform brown color of the moths.

Distribution and biology. Known only from the type locality (Fig. 6). Biology remains unknown. The type locality (Fig. 7) is moderately dry oak-conifer forest with *Juniperus, Pinus*, and *Quercus* as the principal woody components.

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Literature Cited

Heinrich, C. 1956. American moths of the subfamily Phycitinae. United States National Museum Bulletin 207, Smithsonian Institution, Washington, DC. 581 pp.

Neunzig, H. H. 2003. Pyraloidea. Pyralidae (part), Phycitinae (part). *In* Dominick, R. B., et al., The Moths of America North of Mexico, fasc. 15.5. Allen Press, Inc., Lawrence, Kansas. 338 pp.

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A NEW *ANTAEOTRICHA* SPECIES FROM UTAH AND NEW MEXICO (GELECHIOIDEA: ELACHISTIDAE: STENOMATINAE)

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ABSTRACT. The new species *Antaeotricha utahensis* is described from San Juan Co., Utah and Catron, Grant and Santa Fe counties, New Mexico. Adults and genitalia are illustrated.

Additional key words: *Antaeotricha utahensis*, Elachistidae, Gelechioidea, New Mexico, North America, Stenomatinae, Utah.

For the past several seasons in the Southwest, I have collected specimens of a middle-sized unmarked creamy-white *Antaeotricha* species. I now have a small series of this moth and my recent examination of the genitalia failed to produce a match with any species in the literature. There are smaller sized pale species known from the eastern United States, but the genitalia in both sexes are very different from what I have collected. In 1964, Duckworth reviewed the North American Stenomatinae and described two new species of *Antaeotricha*, expanding the North American species total to fifteen. I subsequently have described the maculated gray *Antaeotricha arizonensis* (Ferris, 2010). The genus *Antaeotricha* is most easily recognized by the anatomy of the male genitalia. The lightly sclerotized valves are narrow tapering to a rounded tip. The prominent harpe has a thumblike costal projection bearing long, bifurcate, recurved setae (Figs. 2–3).

Materials and methods. Nine specimens of the new species were collected in bucket traps of the author's design using 8 watt BL fluorescent tubes operated from electronic power converters connected to 12 volt motorcycle batteries. Two additional specimens found by John W. Brown in the National Museum of Natural History collection were borrowed for examination. Genitalia dissection was carried out after macerating the abdomens in hot 10% KOH for fifteen minutes. Temporary slides were prepared using glycerin as the suspension medium. The genitalia are stored in glycerin in polyethylene genitalia vials attached to the specimen pins.

Antaeotricha utahensis Ferris, **new species**
(Figs. 1–7)

Diagnosis. The essentially unmarked glossy creamy dorsal surface of the forewings of *Antaeotricha utahensis* separate it from its congeners. It superficially resembles a very pale form of *A. thomasi* (Barnes and Busck), but in the male genitalia the uncus is distally broadly spatulate with a pointed tip, whereas in *A. thomasi* it is distally narrow with a notched apex. In the female genitalia, the signum is different in shape (a modified six-pointed star in *A. utahensis* versus a cross in *A. thomasi*). The male genitalia of *A. arizonensis* Ferris and *A. fuscorectangulata* Duckworth have an uncus shape similar to *A. utahensis*, but adults of both species have heavily maculated dorsal forewings.

Description. *Imago*: Sexes similar except antenna and genitalia. Except as noted for eye, tarsi and wings, remaining body components are glossy creamy white. [The gloss/sheen presented digital photography problems. In Fig. 1 the dark areas of the hindwing are a photographic artifact.] *Head*: Antenna (shaft and scape) glossy creamy white; ciliated ventrally in male, cilia slightly longer than width of flagellomere with curved tips; simple in female. Eye mottled black. Haustellum present. Labial palpus upcurved extending well above crown of head. *Tarsi:* Blend from creamy white to very pale tan toward tips; claws brown. *Wings:* Forewing length: males (n = 9) 9–11 mm, ave. = 10.2 mm; females (n = 2) both 9.5 mm. Dorsal forewing. elongate with rounded distal margin. Ground color glossy silky creamy white, very sparsely overlaid with very small single brown scales (visible only with magnification); a few single brown scales along base of fringe only; fringe scales otherwise glossy creamy white. Ventral forewing covered with many brown scales producing a dark tan color. Dorsal hindwing glossy, with sightly warmer creamy color and without any small brown scales. Ventral hindwing similar to dorsal but less glossy. *Male genitalia* (Figs. 2–5; 4 dissections): Uncus decurved, spatulate, narrow basally with a sharp apical point. Gnathos upcurved at midpoint with distal portion tapering to a rounded tip. Vinculum complete, arching in front. Anellus without distinct lobes. Valva elongate, expanded in middle, then tapering to broadly rounded tip; harpe thumblike bearing many long recurved bifurcate setae. Aedeagus short and broad (length about 2.5 times diameter) with multiple cornuti and irregular anterior margin; exposed vesica with 2 to 4 apparently deciduous robust spines and additional broad-based semi-fused robust curved spines and a setose brush (arrows in Figs. 4–5). *Female genitalia* (Figs. 6–7; 1 dissection): Ovipositor lobe basally broad and straight with rounded apex, sparsely covered with short fine hairs. Posterior apophyses well developed; anterior apophyses vestigial. Sterigma broad and open. Ductus bursae at top partially heavily sclerotized with lengthwise slender triangular plate, short and broad (only sightly longer than diameter) opening into tear-shaped corpus bursae, the top of which bulges slightly above junction with ductus bursae. Signum a large stylized six-pointed star with central outwardly projecting oblong plate perpendicular to base; plate is nearly rectangular with rounded edges and corners. Ductus seminalis originates from upper quadrant of corpus bursae.

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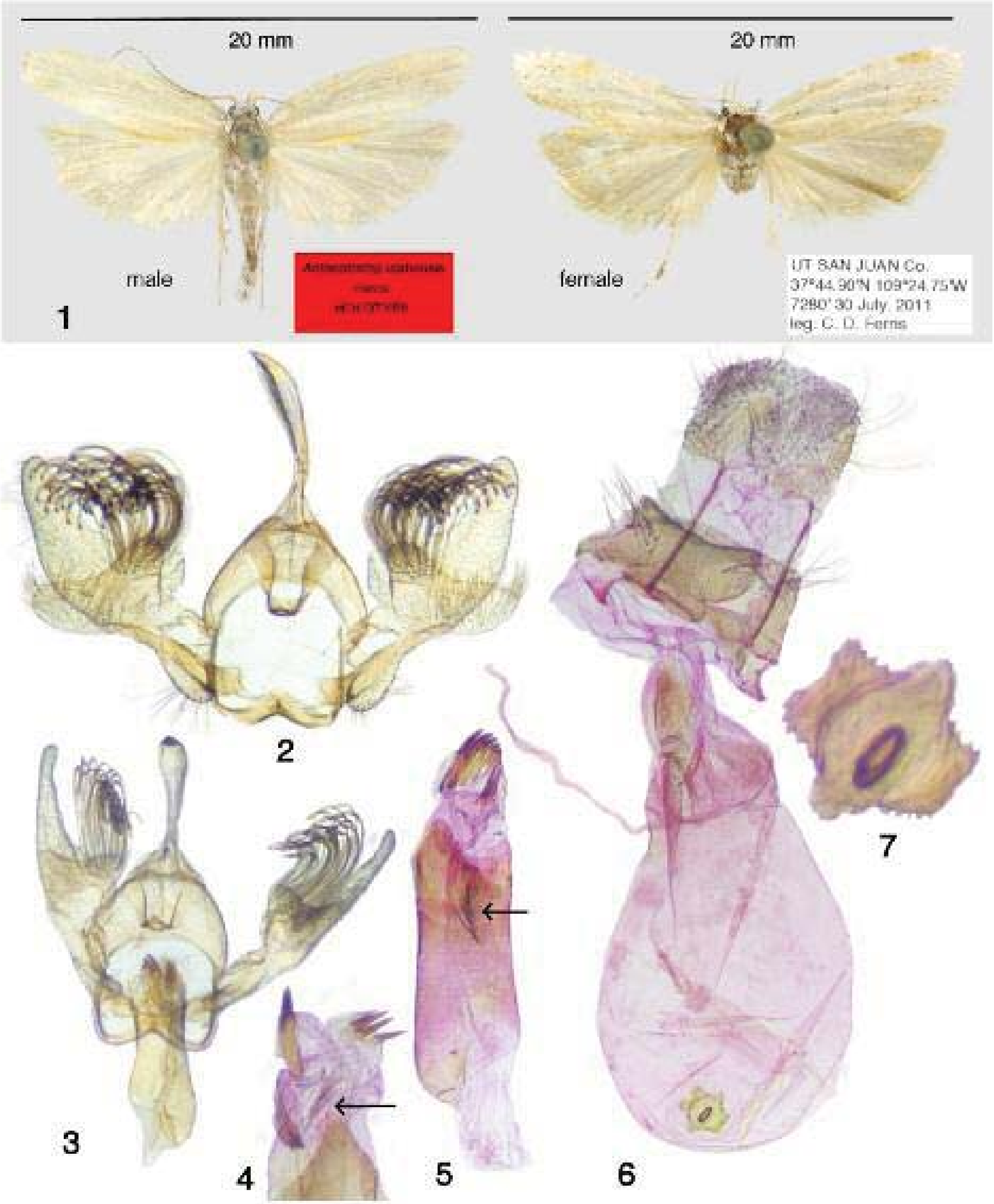

FIGS. 1–7. *Antaeotricha utahensis*. **1,** adult male holotype and female paratype. **2–5,** male genitalia. **2,** genital capsule, aedeagus removed and flattened. **3,** unflattened genital capsule showing spatulate uncus and aedeagus *in situ*. **4,** aedeagus, vesica partially expanded (enlarged; arrow points to setal brush). **5,** aedeagus of second specimen (enlarged and vesica slightly everted; arrow points to setal brush). **6–7,** female genitalia. **6,** full genitalia. **7,** signum (enlarged).

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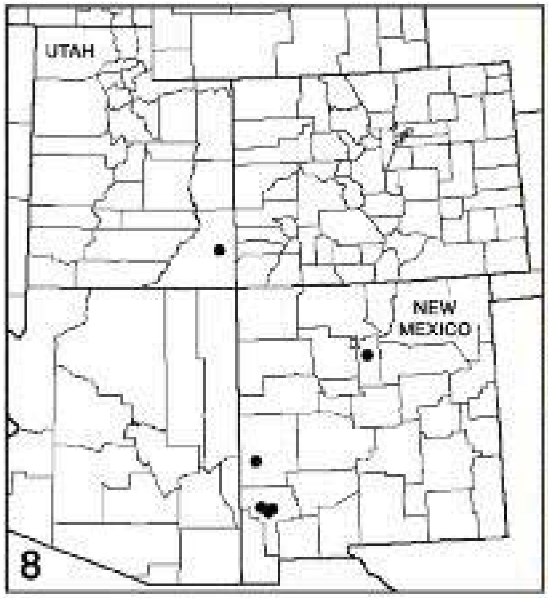

FIG. 8. Distribution map.

FIG. 9. Type locality habitat, San Juan Co., Utah.

Discussion. Based upon the male genitalia, *Antaeotricha utahensis* is closest to *A. fuscorectangulata* (adult forewings heavily maculated), but the tegumen is not produced into a dorsally projecting process in front; the aedeagus is shorter and broader with a different complement of cornuti. The female genitalia are closest to *A. thomasi*, but the signum in *A. thomasi* is a cross with a projecting element. In *A. thomasi*, the ductus seminalis originates from the midpoint of the ductus bursae, while it originates from the upper quadrant of the corpus bursae in *A. utahensis*.

Types. Holotype male (Fig. 1): UTAH, San Juan Co., 37°44.90'N, 109°24.75'W, 7280' (2220m), 30 July, 2011. Deposited in Carnegie Museum, Pittsburgh, PA. Paratypes: 4m (2 dissected), 1f (dissected), same data as holotype; NEW MEXICO, Catron Co., 33°39.97'N, 108°52.74'W, 6290’ (1918m), 5.vii.07, 1m (dissected); Grant Co., 32°64.86'N, 108°13.44'W, 6820’ (2080m), 19.vii.07, 1m (dissected), 33°03.70'N, 108°12.68'W, 6200' (1890 m), 1.viii.11, 1m. Paratypes in author's collection. Two additional paratypes in National Museum of Natural History, Washington DC: NEW MEXICO, Grant Co., Pinos Altos Mts., 6500' (1980m), nr. Silver City, 14.viii.87, R. Leuschner, 1f; Santa Fe Co., Tesuque, 26.vii.89, R. Leuschner, 1m.

Biology. Unknown; adults from early July to early August. The type locality (Fig. 9) and the three sites in southwestern New Mexico are moderately dry oak–conifer forest.

Distribution. Known from southeastern Utah and New Mexico (Fig. 8).

Etymology. The name *utahensis* (adjective) denotes the geographic locality where the holotype was collected.

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LITERATURE CITED

DUCKWORTH, W. D. 1964. North American Stenomidae (Lepidoptera: Gelechioidea). Proceedings of the United States National Museum. 116:23–72.

FERRIS, C. D. 2010. A new *Antaeotricha* species from southeastern Arizona (Gelechioidea: Elachistidae: Stenomatinae). ZooKeys 57:59–62.

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FIRST RECORDS OF THE DOGWOOD BORER, *SYNANTHEDON SCITULA* (HARRIS)(SESIIDAE),IN THE PACIFIC NORTHWEST: A POTENTIAL THREAT TO ORNAMENTAL AND FRUIT TREE GROWERS

Additional key words: introduced, distribution, *Cornus*, *Malus*

The family Sesiidae is comprised of predominantly diurnal mimetic moths, with 126 named species in North America (Eichlin & Duckworth 1988; Eichlin & Taft 1988; Eichlin 1992; Eichlin 1995). Larvae are primarily borers in woody and herbaceous plant tissue. Some sesiids are significant pests of crop and ornamental plants. More rarely, they are beneficial as biological control agents of weeds (e.g., Eichlin & Passoa 1983), and in two cases, carnivorous on scale insects (Bradley 1956; Duckworth 1969).

Synanthedon scitula, the dogwood borer, is the most polyphagous species in the family (Eichlin & Duckworth 1988). Females preferentially oviposit on injuries to the host plant, including pruning scars (Pierce & Nickels 1941), mechanical damage from weed-control equipment and tree wraps (Potter & Timmons 1981; Leskey & Bergh 2005), wounds due to plant diseases (Engelhardt 1946), and galls formed by cynipid wasps (Taft et al. 1991; Eliason & Potter 2000). Larvae feed within the inner bark, even below ground level (Pless & Stanley 1967), and in extreme cases can girdle and kill trees of any age (Underhill 1935; Schread 1965). Adults fly from April to October in the eastern United States (Eichlin & Duckworth 1988), but there is one Ohio specimen in the Charles A. Triplehorn collection at The Ohio State University from December, 1971. It is not clear if this moth was collected outdoors or emerged indoors. A larva from the Peterson collection at the same institution (Ohio, spring 1938, trunk of flowering dogwood) is consistent with the known life cycle in Eichlin and Duckworth (1988) of larval feeding in the spring to early summer, leading to one generation per year.

There is some evidence that high dogwood (*Cornus florida* L.) mortality in natural settings may be caused by *S. scitula* depredation (Walton 1986), although most data suggest a secondary role with mortality primarily due to dogwood anthracnose, *Discula destructiva* Redlin (Daughtrey et al. 1988; Anagnostakis & Ward 1996). Though *S. scitula* may be a secondary threat to wild dogwood populations, it is an expensive and destructive pest of cultivated dogwood. Rogers and Grant (1990) estimated average losses of $1,800 per block in Tennessee nurseries with 7% infestation levels, due to the un-marketability of infested trees.

Previously, *S. scitula* was often called the pecan tree borer or pecan sesia because of the severe damage to pecan (Pless & Stanley 1967; Soloman 1995). Oak is another frequent host (Brown & Mizell 1993), but larvae can secondarily attack many hardwoods, shrubs, and even vines (Soloman 1995), or more rarely, pine trees (Engelhardt 1946). Over the past few decades, *S. scitula* has become a significant pest in production apple orchards. Infestations tend to build slowly, becoming a reoccurring and chronic management problem with time (Weires 1986). The emergence of this species as a tree-fruit pest was traced to the high density of burr knots in nurseries and production orchards, resulting primarily from the increased use of clonal, size-controlling rootstocks (reviewed in Bergh & Leskey 2003). Controlling *S. scitula* can cost growers as much as $40 per acre using conventional controls; even higher costs are associated with mating disruption (P. McGhee personal communication).

The life stages and damage of *S. scitula* have been illustrated many times; recent examples include Pless and Stanley (1967), Eichlin and Duckworth (1988), Taft et al. (1991), Brown and Mizell (1993) and Soloman (1995). Diagnostic features of the adult were summarized by Eichlin and Duckworth (1988). The egg of *S. scitula* is "chestnut brown" with fine hexagonal lines (Wallace 1945), but like many sesiid eggs, is poorly known (Eichlin & Duckworth 1988: 14). Wallace (1945), Peterson (1962), and MacKay (1968) illustrated the larva. The pupa of *S. scitula* was partially described by Beutenmüller (1901: 231) and Mosher (1916). As is typical for the family, the pupal abdominal spine pattern is sexually dimorphic. *Synanthedon scitula* can usually be identified with the above publications if comparisons are also made with *Synanthedon myopaeformis* (Borkhausen), the apple clearwing moth. This sesiid pest was recently introduced from Europe to North America and is currently known from British Columbia, Canada (Judd & Philip 2006) and Whatcom County in Washington State (LaGasa 2009). As a result of this introduction, it would be incorrect to assume unusual pest outbreaks on apple must be *S. scitula*, and immature stages of sesiid borers should be reared to adults for a positive species determination.

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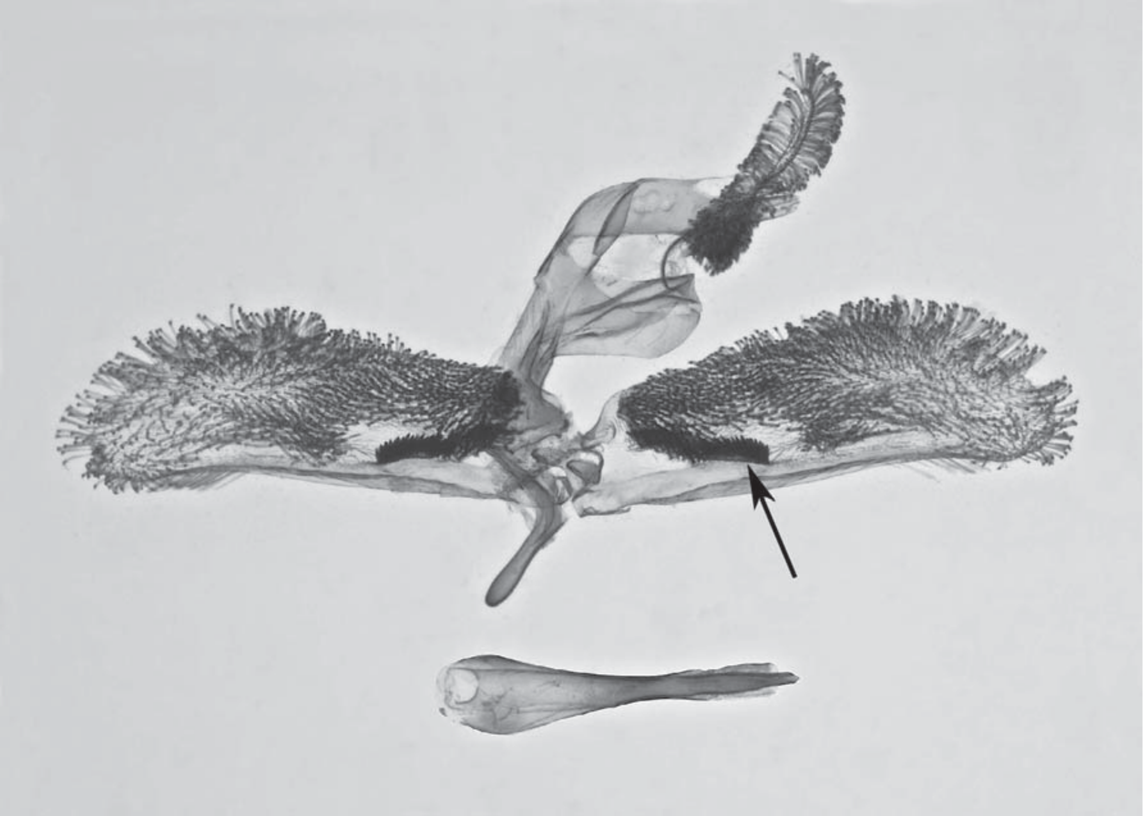

FIG. 1. *Synanthedon scitula* male genitalia. The specimen was collected in Wenatchee WA, 22 Sept., 2008, in a sticky trap baited with a *Synanthedon exitiosa* lure. The arrow points to the distinctive crista sacculi.

Synanthedon scitula is found east of the Rocky Mountains (Eichlin & Duckworth 1988), with central Colorado being the western boundary (Meyer & Cranshaw 1994). Both Engelhardt (1946) and MacKay (1968) specifically mentioned it was absent from the Pacific coast of the United States. In 2008, the Washington State Department of Agriculture conducted surveys for *S. myopaeformis* in northern Washington using sticky-type pheromone traps baited with peachtree borer (*Synanthedon exitiosa* (Say)) lure (1 mg of Z3, Z13-Octadecadienyl acetate). During this survey, a non-target sesiid collected near a nursery in East Wenatchee, WA, was identified by genitalic dissection as *S. scitula*, not previously recorded from Washington State. The genitalia of this moth show the characteristic saccular ridge (crista sacculi) of *S. scitula* (see Eichlin & Duckworth 1988: fig. 19), illustrated in Fig. 1.

Following this initial discovery, commercial peachtree borer lure and a new dogwood borer lure (Z,Z-3,13-ODDA, E,Z-2,13-ODDA, ZE-2,13-ODDA; Zhang et al 2005) were deployed in several sites within the greater Wenatchee area in 2009. Two *S. scitula* specimens were captured at one peachtree borer lure site and 92 specimens at one dogwood borer lure site in East Wenatchee (Douglas Co.). Twenty-four specimens were collected with a dogwood borer lure in Wenatchee (Chelan Co.) (Fig. 2).

In 2010, traps baited with concentrated custom dogwood borer lures (10mg blend of ZZ-3,13-ODDA, EZ-2,13-ODDA, ZE-3,13-ODDA) from Alpha Scents (West Linn, OR) were placed across Washington. Two traps, one in Chelan county and one at a new site in Spokane Co., were positive for dogwood borer, with three and 20 individuals trapped respectively (Fig. 2). Trap captures in Spokane Co. were likely even higher than indicated here; multiple unverifiable specimens damaged by bird predation within the trap could not be included in our results. Our data suggest that *S. scitula* has a localized distribution in Washington State (Fig. 2), although we lack complete data for the north-central region.

Examination of specimens in the James Entomological Museum at Washington State University and the Barr Entomological Collection at the University of Idaho revealed no *S. scitula* specimens from the Pacific Northwest. A single photograph from the Wenatchee area, posted on the Internet site bugguide.net in 2006, shows a possible dogwood borer

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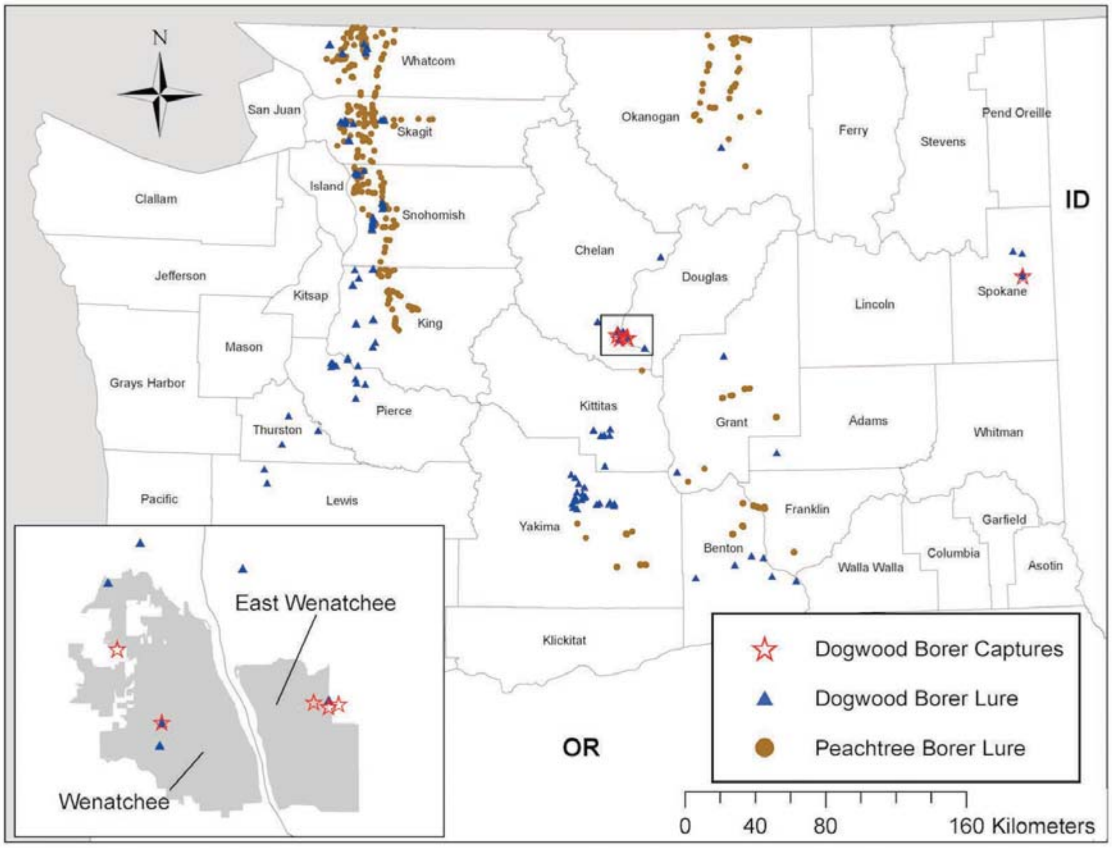

FIG. 2. *Synanthedon scitula* and *S. myopaeformis* trapping sites in Washington State, 2008-2010.

observation a few years before our captures (http://bugguide.net/node/view/63432). This suggests that *S. scitula* may have been present in Washington State for several years, but is only now being confirmed. We speculate that *S. scitula* was transported on nursery stock from the eastern United States, because the widely disjunct distribution from the known range seems to rule out natural spread. This sort of inter-state pathway for exotic insect introduction has been identified as a serious threat within the United States (Paini et al, 2010); indeed, other exotic Lepidoptera detected in the Pacific Northwest in 2010 were almost certainly transported via nursery stock (NAPPO 2010).

It remains to be seen what impact *S. scitula* will have in Washington State. This pest should be a concern for apple growers, particularly those using current, high-density cultivation techniques. Economic impact of *S. scitula* on fruit yields in the northeastern United States has not been thoroughly quantified; however, the ecologically similar *S. mypoaeformis*, has reduced yields by up to 22% in southern Germany (Dickler 1976). Pacific dogwood (*Cornus nuttallii* Audubon ex Torr. & A. Gray) has been heavily impacted by dogwood anthracnose across the region; the addition of this voracious insect pest may further harm dogwood populations.

Control strategies for sesiids include using resistant root-stock and fruiting varieties, cultural techniques to reduce burr knot density or insect access to host plants, mating disruption, and application of conventional pesticides (reviewed in Bergh & Leskey 2003). Attract-and-kill techniques are also being developed (Epstein et al. 2011), made possible by the recent isolation and synthesis of *S. scitula* sex pheromones (Zhang et al. 2005). The localized distribution of *S. scitula* in Washington State suggests that additional delimiting survey and eradication efforts should be considered to protect the region's tree fruit and nursery industries, homeowner landscaping, and native plants from an undesirable pest.

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eral important publications from the Connecticut Agricultural Station library needed for this paper. We thank the curators of the James Entomological Museum at Washington State University, the Charles A. Triplehorn collection at The Ohio State University, and the Barr Entomological Collection at the University of Idaho for access to their specimens and data. Suggestions from two anonymous reviewers significantly improved the manuscript.

LITERATURE CITED

ANAGNOSTAKIS, S. L. & J. S. WARD. 1996. The status of flowering dogwood in five long-term forest plots in Connecticut. Plant Dis. 80: 1403-1405.

BERGH, J. C. & T. C. LESKEY. 2003. Biology, ecology, and management of dogwood borer in eastern apple orchards. Can. Entomol. 135: 615-635.

BEUTENMÜLLER, W. 1901. Monograph of the Sesiidae of America, north of Mexico. Mem. Amer. Mus. Nat. Hist. 1: 217-352.

BRADLEY, J. D. 1956. A new clearwing moth from South Africa predaceous on scale insects (Lep. Aegeriidae). The Entomologist 89: 203-205.

BROWN, L. N. & R. F. MIZELL III. 1993. The clearwing borers of Florida (Lepidoptera: Sesiidae). Tropical Lepidoptera vol 4, supplement 4.

DAUGHTREY, M. L., C. R. HIBBEN & G. W. HULDER. 1988. Cause and control of dogwood anthracnose in northeastern United States. J. Arboric. 14: 159-164.

DICKLER, V. E. 1976. Zur Biologie und Schadwirkung von *Synanthedon myopaeformis* Brkh. (Lepid., Aegeriidae), einem neuen Schädling in Apfeldichtpflanzungen. Z. Angew. Entomol. 82: 259-266.

DUCKWORTH, W. D. 1969. A new species of Aegeriidae from Venezuela predaceous on scale insects (Lepidoptera: Yponomeutidae). Proc. Entomol. Soc. Wash., 71: 487-490.

EICHLIN, T.D. 1992. A new Texas clearwing moth (Sesiidae: Sesiinae). J. Lepid. Soc.46: 265-268.

———. 1995. A new North American clearwing moth and notes on a rare species (Sesiidae). J. Lepid. Soc. 49: 114-118.

EICHLIN, T. D. & W. D. DUCKWORTH. 1988. The Moths of America North of Mexico, fascicle 5.1, Sesioidea, Sesiidae. The Wedge Entomological Foundation, 176 pp.

EICHLIN, T. D. & S. PASSOA. 1983. A new clearwing moth (Sesiidae) from Central America: a stem borer in *Mimosa pigra.* J. Lepid. Soc. 37: 193-206.

EICHLIN, T.D. & W. H. TAFT. 1988. A new *Sesia* clearwing moth from Michigan (Sesiidae). J. Lepid. Soc. 42: 231-235.

ELIASON, E. A. & D. A. POTTER. 2000. Dogwood borer (Lepidoptera: Sesiidae) infestation of horned oak galls. J. Econ. Entomol. 93: 757-762.

ENGELHARDT, G. P. 1946. The North American clear-wing moths of the family Aegeriidae. Bull. U. S. Natl. Mus. 190: 1-222.

EPSTEIN, D. L., L. J. GUT, L. TEIXEIRA & M. GRIESHOP. 2011. Management of the sessiid borer, *Synanthedon scitula* (Harr.) with mating disruption and mass trapping in Michigan apple orchards. In Abstracts of the 85th Annual Western Orchard Pest and Disease Management Conference. Hilton Hotel, Portland, Oregon.

JUDD, G. & H. PHILIP. 2006. Apple clearwing moth, *Synanthedon myopaeformis* (Borkhausen): recent introduction to Pacific Northwest pest complex. In Proceedings of the 80th Annual Western Orchard Pest and Disease Management Conference. Hilton Hotel, Portland, Oregon.

LAGASA, E. 2009. Apple Clearwing Moth Survey in Washington State and Northwestern Washington Detections, 2008. In Proceedings of 68th Pacific Northwest Insect Management Conference. Hilton Hotel, Portland, Oregon.

LESKEY, T. C. & J. C. BERGH. 2005. Factors promoting infestation of newly planted, nonbearing apple orchards by dogwood borer (Lepidoptera: Sesiidae). J. Econ. Entomol. 98: 2121-2132.

MACKAY, M. R. 1968. The North American Aegeriidae (Lepidoptera): a revision based on late-instar larvae. Mem. Can. Entomol. Soc. 58: 1-112.

MEYER, W. L. & W. S. CRANSHAW. 1994. Capture of clearwing borers (Lepidoptera: Sesiidae) with three synthetic attractants in Colorado. Southwest. Entomol. 19: 71-76.

MOSHER, E. 1916. A classification of the Lepidoptera based on characters of the pupa. Bull. Ill. Nat. Hist. Surv. 12: 17-159.

NORTH AMERICAN PLANT PROTECTION ORGANIZATION. 2010. Thirteen new state detections of Duponchelia fovealis, United States. Last accessed 12 May 2010. Available at URL: http://www.pestalert.org/oprDetail.cfm?oprID=466

PAINI, D. R., S. P. WORNER, D. C. COOK, P. J. DE BARRO & M. B. THOMAS. 2010. Threat of invasive pests from within national borders. Nat. Commun. 1:115 doi: 10.1038/ncomms1118 (2010).

PETERSON, A. 1962. Larvae of insects. An introduction to Nearctic species. Part I. Lepidoptera and plant infesting Hymenoptera. Edwards Brothers, Inc. Ann Arbor, Michigan. 315 pp.

PIERCE, W. C. & C. B. NICKELS. 1941. Control of borers on recently top-worked pecan trees. J. Econ. Entomol. 34: 522-526.

PLESS, C. D. & W. W. STANLEY. 1967. Life history and habits of the dogwood borer, *Thamnosphecia scitula* (Lepidoptera:Aegeriidae) in Tennessee. J. Tenn. Acad. Sci. 42: 117-123.

POTTER, D. A. & G. M. TIMMONS. 1981. Factors affecting predisposition of flowering dogwood trees to attack by the dogwood borer. Hort. Science 16: 677-679.

ROGERS, L. E. & J. F. GRANT. 1990. Infestation levels of dogwood borer (Lepidoptera: Sesiidae) on dogwood trees in selected habitats in Tennessee. J. Entomol. Sci. 25: 481-485.

SCHREAD, J. C. 1965. Dogwood borer. The Connecticut Agricultural Experimental Station Circular 199. New Haven, Connecticut.

SOLOMON, J. D. 1995. Guide to insect borers in North American broadleaf trees and shrubs. U.S. Forest Service. U.S. Department of Agriculture. Agricultural Handbook AH-706.

TAFT, W. H., D. SMITLEY & J. W. SNOW. 1991. A guide to the clearwing borers (Sesiidae) of the North Central United States. USDA North Central Region Publication 394: 1-30. East Lansing, Michigan.

UNDERHILL, G. W. 1935. The pecan tree borer in dogwood. J. Econ. Entomol. 28: 393-396.

WALLACE, P. P. 1945. Biology and control of the dogwood borer, *Synanthedon scitula* Harris. In R. B Friend. Connecticut State Entomologist 44th Report. 1944. Connecticut Experimental Station Bulletin 488: 373–395.

WALTON, G. S. 1986. Association of dogwood borer with the recent decline of dogwood. J. Arboric. 12: 196-198.

WEIRES, R. 1986. Five years research and experience with control of dogwood borer and related burr knot problems. Compact Fruit Tree 19: 86-90.

ZHANG, A., T. C. LESKEY, J. C. BERGH & J. F. WALGENBACH. 2005. Sex pheromone of the dogwood borer, *Synanthedon scitula*. J. Chem. Ecol. 31: 2463-2479.

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URBANUS SIMPLICIUS (STOLL) IS AN ESTABLISHED RESIDENT ON GRENADA, WEST INDIES (HESPERIIDAE: EUDAMINAE)

Additional key words: Caribbean, distribution, skipper, Progress Park, St. Andrew

Urbanus simplicius (Stoll, 1790) is a frequently encountered Neotropical skipper butterfly, ranging from northern Argentina through South and Central America to southern Texas, USA (Evans 1952; Rickard 1977), where it appears to be a non-established stray from Mexico (Neck 1996; a single record also exists for California, see Tilden 1976). Its distribution extends from South America into the Caribbean on Trinidad and Tobago, where the species is locally abundant (Evans 1952; Cock 1982, 1986; Smith et al. 1994), and a single record exists for the Windward Islands, from Grenada (Smith et al. 1994). Throughout its range, *U. simplicius* is commonly found in disturbed habitats of many types, as well as undisturbed tropical forest. The larval foodplants for *U. simplicius* are herbaceous legumes (Fabaceae), including *Tipuana tipu* (Benth.) Kuntze in Brazil (Silva et al. 1968), *Phaseolus vulgaris* L. in Argentina (Hayward 1969; also in California, see Tilden 1976), *Glycine max* (L.) Merr. in Uruguay (Biezanko et al. 1974), *Puearia phaseoloides* (Roxb.) Benth. on Trinidad (Cock 1986), and species of *Arachis* L., *Calopogonium* Desv., *Centrosema* (DC.) Benth., *Desmodium* Desv., *Galactia* P. Browne, *Phaseolus* L., *Rhynchosia* Lour., *Teramnus* P. Browne and *Vigna* Savi in Costa Rica (Janzen & Hallwachs 2011).

As reported by Smith et al. (1994), *U. simplicius* has been known from Grenada by a single female specimen collected in February 1986, at St. Paul, St. George Parish. They speculated that the individual was likely a stray from Trinidad or Tobago. *Urbanus simplicius* was not found on Grenada during a brief survey in 1995 (Cock 2002), and we are unaware of other captures of this species on Grenada before 2011.

On 20 September 2011, during field activities for a Lepidoptera Identification Workshop held 19-23 September 2011 at the Windward Islands Research and Education Foundation (WINDREF) on the

FIG. 1. Collecting locality—Progress Park, St. Andrew Parish.

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campus of St. Georges University, St. Georges, Grenada, the first two authors collected seven males and two females of *Urbanus simplicius* at Progress Park in St. Andrew Parish (N12 08.033 W61 37.176), a disturbed habitat about forty feet above sea level (Figure 1). Progress Park is south of Pearls Airport and about 1 km west of the coastline of Great River Bay. The park is an agricultural area with small fields, some of which were overgrown with Guinea Grass, *Panicum maximum* Jacq., and some which were being used as cultivated plots with various vegetables. There were a few houses in the vicinity. The specimens of *U. simplicius* represent 35% (> 1/3) of the total number of hesperiid specimens collected that day. Given the local abundance of *U. simplicius* in St. Andrew Parish, we believe the species to be an established breeding resident on Grenada. We urge field workers on Grenada to monitor the distribution and abundance of this species on the island, and to determine local larval foodplants.

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LITERATURE CITED

BIEZANKO, C. M., A. RUFFINELLI & D. LINK. 1974. Plantas y otras sustancias alimenticias de las orugas de los lepidópteros uruguayos. Revista do Centro de Ciencias Rurais 4(2): 107-147.

COCK, M. J. W. 1982. The skipper butterflies (Hesperiidae) of Trinidad. Part II. A systematic list of the Trinidad and Tobago Hesperiidae. Occasional Papers. Department of Zoology. University of the West Indies (St. Augustine, Trinidad). No. 5: 1-47.

———. 1986. The skipper butterflies (Hesperiidae) of Trinidad. Part 4, Pyrginae (second section). Living World, Journal of the Trinidad and Tobago Field Naturalists' Club 1985-1986: 33-47.

———. 2002. *Proteides mercurius grenadensis* Pinchon & Enrico (Hesperiidae) in Grenada, with notes on Nyctelius nyctelius Latreille (Hesperiidae) and other Lepidoptera observed, October 1995. Living World, Journal of the Trinidad and Tobago Field Naturalists' Club 2002:45-48, 2003: 76.

EVANS, W. H. 1952. A catalogue of the American Hesperiidae indicating the classification and nomenclature adopted in the British Museum (Natural History). Part II. Pyrginae. Section I. London, British Museum. 178 pp. + pls. 10-25.

HAYWARD, K. J. 1969. Datos para el estudio de la ontogenia de lepidópteros argentinos. Miscelánea. Instituto Miguel Lillo. Universidad Nacional de Tucumán 31: 1-142.

JANZEN, D. H. & W. HALLWACHS. 2011. Dynamic database for an inventory of the macrocaterpillar fauna, and its food plants and parasitoids, of Area de Conservacion Guanacaste (ACG), northwestern Costa Rica (nn-SRNP-nnnnn voucher codes) <http://janzen.sas.upenn.edu>.

NECK, R. W. 1996. A field guide to the butterflies of Texas. Gulf Publishing Co., Houston, Texas. xvii + 323pp.

RICKARD, M. A. 1977. A record of *Urbanus simplicius* (Hesperiidae) for the USA. Journal of the Lepidopterists' Society 31: 138.

SILVA, A. G. D'A., C. R. GONÇALVES, D. M. GALVÃO, A. J. L. GONÇALVES, J. GOMES, M. DO N. SILVA & L. DE SIMONI. 1968. Quarto catálogo dos insetos que vivem nas plantas do Brasil seus parasitos e predadores. Edição ampliada do "3° catálogo dos insetos que vivem nas plantas do Brasil" de autoria do Prof. A. M. da Costa Lima. Parte II. Insetos, hospedeiros e inimigos naturais. Indice de insetos e índice de plantas. Rio de Janeiro, Ministério de Agricultura. I:xxvii + 622pp.; 2:[viii] + 265pp.

SMITH, D. S., L. D. MILLER & J. Y. MILLER. 1994. The butterflies of the West Indies and south Florida. Oxford University Press, Oxford. [vi] + 264pp, 32pls.

TILDEN, J. W. 1976. *Urbanus simplicius* (Stoll), a new record for California. Journal of Research on the Lepidoptera 15(1): 40.

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A Tribute to John W. Johnson (1914–2010)

"To walk the fields or coastline with John was to find instant recall of everything moving and growing."
—Kenneth G. Denton, Jr.

John Warren Johnson, conservationist, biologist, lepidopterist, teacher and friend, was born to Lulu May Berryman and John Waldo ("Brownie") Johnson on May 12, 1914, in Olinda, California. He was raised in the small farm town of Fullerton, in the heart of Orange County, California. In John's day, it was a rural America; complete with farm chores, a tiny one-room school house, and vast ranch lands to explore. Dirt roads enriched with acres of orange groves, walnut groves, the fragrance of wildflowers and orange blossoms called out to John for exploration from the porch of his ranch up into the wilds of the Santa Ana Mountains and back down to the pristine tide pools and beaches. John was born to study the acres of nature that blanketed the upper Newport Bay and surrounding San Joaquin Hills.

In 1918, the Johnson Family took temporary residency in Newport Beach, while preparing for life as walnut growers in Fullerton, California. The Johnson ranch land was purchased in 1919 and it was here, at age five, that John captured his first butterfly, a "Mourning Cloak" with his fingers. Little did he know that he had already caught "the bug." It was in this world, while as a young farmer and an inquisitive high school student that he strengthened and grew into the strong thin man he remained for his entire life. It was also in this place where, at about age 12, he met a frail young man who lived on a nearby orchard, and so John befriended Erich Walter, thus beginning a lifetime of true friendship and camaraderie. No tribute of John W. Johnson would be complete without mentioning Erich C. Walter. I always saw them as the "Lewis and Clark" of the Lepidoptera world, Erich with his keen eye and John with his fine analysis.

Imagine for a moment his days as a teenager. John and Erich would jump in Erich's beefed up Model-A Ford and drive wildly down dirt roads in search of life. Eric had even wired up a train horn for that special "watch out, here we come!" effect (already a gifted electrician, Erich would later become a county electrician inspector and aviator). Some of that "life" was found right on the Walters' farm. John became entranced with Erich's father's moth collection and later in life began his own fine Lepidoptera collection, while also working with Erich in curating one of the most comprehensive California moth collections ever privately assembled. In time, Erich C. Walter's collection was donated to the California Academy of Sciences, and John W. Johnson's collection was donated to The Los Angeles Museum of Natural History, where there exists Johnson's twelve volumes of detailed field notes, abstracts, manuscript drafts, rearing records and photographs; a must read for any student of *Catocala* and California Lepidoptera.

After graduation from Fullerton High, John dabbled at studies at Fullerton Junior College and continued to faithfully work on the family farm. But he was anxious to strike out on his own. His opportunity came in 1934. The Civilian Conservation Corps (C.C.C.) was recruiting young men for the physical ardors and "romance" of cleaning and opening forest lands at Jones Springs and Lytle Creek in the San Gabriel

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Mountains. John joined up and spent most of his time at Camp Lytle Creek. By May of 1935, his unit, known as Company 908, was moved to the recently declared Death Valley National Monument. One of only 12 companies employed during the great depression, the Company lived in tents at an altitude of 4,175 feet in Wildrose Canyon in the Panamint Mountains. On a weekend collecting outing he climbed Telescope Peak (11,045 ft.) and in nearby Tuber Canyon Spring he netted a unique variation of Melitaea palla that he called "The Death Valley Checker Spot." John claimed, "This was one of the happiest times in my life."

John stayed with the C.C.C. for about a year, acting as an educational advisor and toning his already strong and lean build. He also developed what those who met him could affectionately call "The Handshake." He took great pride in letting you know that he was shaking your hand and you sure did feel it! While John is certainly not listed on any C.C.C. registry of immortality, he did however find immortality in the Lepidoptera world with the discovery of his "Death Valley Checker Spot." In August of 1935, he resigned from the C.C.C. to go back to school.

John continue his education at U.C. Berkley, where in 1938, he earned his Bachelor of Science Degree in Entomology. While at Berkley, John published "Three Butterflies" (Johnson 1936a). It was his first of a lifetime of over twenty professional articles and publications which included seven pertaining to the *Catacola* and two on Saturniidae. The "Three Butterflies" was a description of three species of *Vanessa* that John observed during a hike to the top of Telegraph Peak near Death Valley when he was in the C.C.C., namely: (a) West Coast Lady (*V. carye*); (b) Painted Lady (*V. cardui*); and (c) Virginia Lady (*V. viginiensis*). He observed this interesting record of three species of the same genus that had very different geographical ranges coming together on a high desert peak. He was a pioneer of the study of "Hilltopping", which many years later would be detailed in a work pertaining to Dictionary Hill, in San Diego, California. John's second publication was about dragonfly eggs, "A Dragonfly Lays its Eggs." (Johnson 1936b). His third professional publication described "Notes on *Catocala piatrix* race *dionyza*" (Johnson 1938a) and his fourth publication pertained to the aforementioned Death Valley Checker Spot "A New Subspecies of Melitaea palla" (Johnson 1938b).

We must jump back a decade to the fall of 1928, when Sequoia National Park Ranger Robert "Bob" Fry (who would later teach biology at Newport Harbor High School) while working at Three Rivers captured a Saturniid moth in a lighted store window. Having been acquainted with the Walters on their earlier visits to the Sequoia Park, Fry mailed the specimen to Erich Walter who then handed it over to John Johnson. This was the first specimen of *Saturnia albofasciata* later described and named by Johnson in 1938 (Johnson 1938c). This was no simple find, no drab unremarkable species. *Albofasciata* is a remarkable beauty, with a brick red male flying only at dusk in the fall and a frosty white female caught flying to about ten at night in October, even with snow on the ground. John had also independently discovered an unknown Saturniid larvae at Toll Road Camp in the San Bernardino Mountains and was already "on the trail" of this new species. Later, at Toll Road Camp, more *albofasciata* females were captured, with Erich at blacklights yielding eggs and caterpillars, permitting a detailed instar study. Males were later lured in with newly hatched females (before pheromone "collecting").

In the late thirties and early forties vast sections of forested lands were turning brown and dying. This was a desperate time and the logging industry near Mt. Lassen was losing hundreds of acres of wilderness pines. John Johnson came to the rescue. In 1939, John joined the United States Department of Agriculture's Bureau of Entomology and Plant Quarantine. He was assigned to the Forest Insect Investigation Unit and went off to the forests of northern California. During his four year tenure he and his colleagues solved the mystery. It was not the bark beetles themselves that were killing the pine trees, rather it was a fungus spore they carried. In his "spare" time John wrote an article on *Calosaturnia meridionalis* (Johnson 1940).

Fifteen years earlier in March of 1925, on a summer family outing in Santiago Canyon in the Santa Ana Mountains, Erich's brother, Werner Walter, had collected a large brown moth. Later, Erich gave this to John for study and he described it as a new species. This was later the subject of a joint authorship by Hogue and Johnson entitled "A New Name for *Calosaturnia meridionalis*." (Hogue & Johnson 1940). John also dabbled in chemistry, drafting an article entitled "Silver Nitrate as a Stain for Use of Conduction of Liquids in Wood" (Johnson 1941). John left the Forest Service in 1942 and performed some biology graduate work, earned his teaching certificate and moved back to Orange County, California to be closer to his family and to begin what was to become a full career as a parent, teacher and lepidopterist.

John began teaching Biology at Newport Harbor High School in 1942 and continued his call for conservation. He was a huge proponent of field trips. Taking classes to the La Brea Tar Pits: the Scripps Institute of Oceanography; Modjeska Canyon's Bird Sanctuary; the San Diego Zoo and of "collecting trips" to local tide

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pools, where he asked his students to collect only one specimen and not the bags full of wasted marine life collected by bus loads of schoolchildren in the 50's and 60's along Orange County's coastline. He is quoted as saying, "If we destroy the seas and its inhabitants, we will destroy ourselves along with it and much more quickly than we could with an atom bomb." His concern for marine life and its human interdependence was only one factor leading to his earning the 1947 California Governor's Award for his conservation efforts.

Like something out of a Norman Rockwell painting, John's classrooms were filled with aquariums, plant presses, insect nets, collections, jars, posters, graphs, books, cages and various critters alive and preserved. He made life jump out at you and always while smiling. When he found or caught something new, that became the "Theme of the Day." After class he would stay as long as any student needed and one could often hear him say, with that gentle smile of his that, "teaching is like being a parent, it never ends." He loved it, and his students loved and respected him. The Newport Harbor High School's 1958 Yearbook was dedicated in his honor.

However, 1948 was also a very special year for John, while as a young biology teacher he met a shy math teacher, who also taught at Newport Harbor High School. John W. Johnson married Ruth B. Daniell in June of '48. (…and in secret, so they wouldn't be hazed by their students!) All who knew Ruth will never forget the twinkle in her eyes and her high energy. It was as though she was always running to get some milk and cookies just for you, but if you didn't do your homework…watch out! They were a match made in heaven and before long moved into a modest home in nearby Corona del Mar. There, over the next forty-two years, they would raise a family of three talented and educated sons, John, Norman and Nelson, watch their families and grandchildren grow and inspire the lives of hundreds of students, friends and colleagues, many of whom went on to a life in science or science-related fields. One such inspired was Douglass R. Miller, who in 1967 named a new species of Homoptera; *Oregmopyga johnsoni* in John's honor (Miller 1967). A.E. Brower would also honor John by the naming of *Catocala johnsoniana* (Brower 1976).


John and Ruth on a collecting trip, 1976.

Currently, eldest son John lives in Santa Barbara with his wife Mary and their children. He is a professor and anthropologist at Santa Barbara's Museum of Natural History. Second born son Norman, a writer at heart, lives with his wife Julie in Costa Mesa, where they founded Newport Custom Woodworking in 1988 and is the master cabinet maker. Youngest son Nelson lives with his wife Mariel in New York and is a successful partner in a major environmental law firm. As a proud father, one paragraph for his sons will not allow for all accomplishments, accolades and awards, however, let it be noted it is not a short list.

While living and teaching in Newport Beach during the 60's and 70's, John assumed the title of Assistant Research Biologist, (M.S.B, U.C.I.) and was also involved in a massive political undertaking spearheaded by the Museum Director of Systematic Biology at The University of California at Irvine, Gordon Marsh. John was active in assisting Gordon in establishing the first Orange County natural history museum (now defunct) and saving, what we currently call the "Upper Newport Bay." Again, using biology as a sword, they succeeded in convincing people (including The Irvine Company) of the importance of conserving such native wetlands. No small task considering the ever looming developers' interests. These lands are still preserved to this day waiting to be dedicated to these two gentlemen. From saving carpets of old northern growth pine trees to the saving of sea-bird feeding grounds in a southern California back-bay, John W. Johnson was truly a pioneering California conservationist—but he was also an outstanding lepidopterist!

By 1961, John W. Johnson was the recipient of a grant from The National Science Foundation and subsequently took a sabbatical and completed his Masters of Arts in Biology thesis at Humboldt State College in 1963. His studies were with an emphasis on plant ecology of Humboldt Bay's Natural Wildlife Preserve's sand dunes. His research led directly to funding from The Nature Conservatory, ultimately leading to the acquisition and preservation of significant additional wild lands into Humboldt Bay's Lanphere-Christensen Preserve. If his ever present sword could

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have been engraved, it would read "biology" on one side and "conservationist" on the other (Johnson 1963).

Another study John often spoke about was of a small sand dune wasp who somehow could find its small sand hole even after flying hundreds of yards off. When items around the nest hole were moved, the wasp became lost. He and Erich often marveled at the wonders of nature, including the tiny butterfly chrysalis who could survive under ten feet of snow all winter long and the moth that flew day and night after living two years as larvae on a handful of leaves. It was John and Erich that I first heard say, "the future of automobiles is electric."

There was a new high school opening in Corona del Mar, and John jumped at the opportunity to be the first chairman of the science department. He taught biology and chemistry at C.D.M. High School from 1962 to his retirement in 1974. As it was at Harbor High School, his students loved and respected him. The Corona del Mar High School's 1962 and 1965 Yearbooks were dedicated in his honor. In 1968 John W. Johnson was elected "The Orange County Teacher of The Year." In 1969, John received the prestigious National Audubon Society's Conservation Award of Merit and in 1970 he was elected as "Orange County's Newport/Mesa School District Teacher of The Year." Yet John would always turn the topic back to you and yours, with a smile and a gentle head nod, upon being questioned about his many accolades. Besides always being a gentleman, he was also very humble in every way, except maybe that handshake of his! It was just something you never forgot.

Retirement in 1974 left John more time to travel across North America where he and Ruth and their good friends Erich and his (forever cheerful) wife Velda would explore distant desert and forest campgrounds, fully equipped with nets, black lights, a remarkable folding table & chairs, and a portable black light sheet frame, created by Erich, and of course their favorite game, Yahtzee.

John's first of many articles after retirement (eleven in all from 1978 to 1985) was a 1978 submitted study of *Catocala* wings. "Similarities and Differences in Forewing Shape of Six California *Catocala* Species." (Johnson 1978). John first became acquainted with *Catocala* by viewing Erich's father's collection. Later, with Erich, they reared and described many species and set forth unique observations and aspects associated with this group. In 1978, John Johnson and Erich Walter co-authored a parallel publication pertaining to *Catocala* forewings; "Similarities and Differences in Forewing Shape of Six California *Catocala* Species" (Johnson & Walter 1980).

After driving hours on rough forest dirt roads in his '55 Chevy, complete with seventeen inch rims and a dual battery system for black lighting, Erich Walter and yours truly, were finally black lighting in the Coxey Meadows of the San Bernardino Mountains of California. I'll never forget the cool evening breeze of June 1, 1965, or that suddenly around 9:00 p.m. what initially looked like just another *Coloradia pandora* hit the sheet. Instinctively, Erich's first words were, "This is something new." It was. In 1981, John Johnson and Erich Walter co-authored and described this moth as "*Coloradia velda*," named in honor of Erich's wife; "A New Species of *Coloradia* in California" (Johnson & Walter 1981).

Gloveria medusa, a remarkable sub-species, first caught by John blacklisting with Ruth July 1978, at Pinyon Flats in the Santa Rosa Mountains was also described and named by John Johnson in 1981; "A Desert Subspecies of *Gloveria medusa*." (Johnson 1981). These paratypes, along with John's Lepidoptera collection of some 7,000 meticulously pinned specimens were donated to the Los Angeles County Museum of Natural History in 1982.

In between camping, rearing various species of *Catocala* and *Papilio*, assisting Erich with his *Papilio* genetic studies and donating his private collection, John found the time in 1982 to draft and have published two professional articles describing new food plants for butterflies. Namely, "Two food plant observations for *Euphydras chalcedona*" (Johnson1982a) and "Another Food plant of *Erynnis tristis tristis*" (Johnson 1982b). Based upon a sighting in the East Bluffs of the upper Newport Back Bay in 1961, near the then present salt ponds, John produced a third article pertaining to an extinct California Satyridae and it too was published in 1982; "An Extinct Population of a Third Species of Southern California Satyrid" (Johnson 1982c). In 1983, John Johnson authored "Two New California *Catocala* Subspecies" (Johnson 1983).

John was a student of and mastered the genitalia dissection techniques of F.N. Pierce, F.E.S. and others. He developed new staining techniques for easier study and taxonomical research. He applied this discipline in 1884 and with Erich described immature *Catacola erichi* in what was to become a befitting last co-authorship between these lifelong friends, entitled, "The Immature Stages of *Catocala erichi*." (Johnson & Walter 1984). John also published an internal systems study in "*Ascapha* and *Catocala*" (Johnson 1984). His last professional article was "The Immature Stages of Six California *Catocala*." (Johnson 1985).

Both John and Erich were lifelong avid lepidopterists and active members of The Lorquin Entomological

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Society at The Los Angeles Museum of Natural History (Erich for nearly seventy years). It goes without saying, that upon Erich's death on December 22, 1990, John truly mourned his loss. In 2001, he authored an eloquent tribute to his comrade Erich, "A Tribute to The Lepidopterist Erich Carl Walter" (Johnson 2001). That same year Ruth and John moved to Santa Barbara to be closer to their grandchildren. In 1991, John provided advice while assisting Lawrence Shaw, Ken Osborne and this author, Ken Denton, in preparing Erich C. Walter's collection of 14,178 meticulously pinned specimens for photographing and then donation. Erich's remarkable collection was officially accessioned into The California Academy of Sciences by Norman D. Penny on December 24, 1991.

In what could not have come at a better time in John Johnson's life, John was nominated by Ken Osborne, and others, and subsequently was the recipient of The 1963 John Adams Comstock Award. An eloquent tribute and publication index was written by Lawrence H. Shaw (Shaw 1993). John was unable to attend the award presentation due to the high altitude in Colorado and his breathing difficulties. However, John continued to be active in his comfort zones of biology, chemistry, conservation, paleontology, zoology, botany, entomology and, of course, preparatory and taxonomical studies in Lepidoptera. To walk the fields or coast line with John was to find instant recall of everything moving and growing. An encyclopedia of natural science even in his ageing years, he remained as comfortable in a remote forest as behind a microscope and just at ease discussing DNA or the birds and wildflowers of his area.

In 2003, after fifty-five years, John lost his beloved Ruth, but in spite of the irreplaceable loss he always took the time to write and meet with those interested in biology or Lepidoptera, whether students or friends he was always anxious to discuss collecting. At age 94, as head of the gardening committee, he took on the task of identifying and labeling the 124 species of plants located around his Santa Barbara retirement community. John delighted in showing off the monarch caterpillars and their colorful chrylisis hanging about his patio. Also hanging about were several Coastal Scrub Jays (*Aphelocoma californica*) he had tamed in exchange for peanuts, however, there was a particular velvet black American *Corvus brachyrhynchos* that one could say had "trained John."

He remained sharp and at peace until his passing on August 26, 2010, at the tender age of 96. He told me that he felt ready to fall from the tree of life. He is quoted as saying, "Understanding of the world around us and how we interact with it and each other is what biology is all about." In his many adventuresome letters to this author, John would recollect his adventures and passions. Like his visit to Gene Stratton Porter's home, who wrote *Moths of the Limberlost*, or his outings with Erich in the late 20's into Orange County Park (now Irvine Park) in search of *Hemileuca electra* and discovering it does not fly to blacklights at night. "It is a moth I cherish," said John.

As a young lad, when I knocked on your door that fateful summer, how did you know to tell me, "Well, if it's that big, catch it and bring it back to me…" instead of showing me your drawer of tarantula hawk wasps you had already collected? How did you know it might take me all summer to spot it again, and that I'd spend weeks collecting everything else? Did it read "future lepidopterist on my forehead?" I don't think so. I think there are very few people born with the natural gifts and instincts you were given. Very few. It's rare, as rare as the *Glaucopsyche lygdamus palosverdesensis*.

Thank you John; for lending me my first net, for introducing me to Erich Walter, and for teaching me the fascinating world of butterfly collecting. I'm not sure of the exact date the bug bit me, but it never let go. Above all, thank you "Mr. Johnson" for being my teacher and my friend.

Literature Cited

Brower, A.E. 1976. New *Catocala* of North America (Noctuidae). J. Lepid. Soc. 30: 33-37.

Hogue, C. L. & J. W. Johnson. 1958. A new name for *Calosaturnia meridionalis* (Lepidoptera, Saturniidae). Lep. News 21: 17.

Johnson, J.W. 1936a. Three butterflies. NATURE, a magazine. 27: 23-28.

——. 1936b. A dragonfly lays its eggss. NATURE, a magazine. 27: 51-56.

——. 1938a. Notes on *Catocala piatrix* race *dionyza* Hy. Edw. and *Siamia gloveri*, Strecker, in California (Lepidoptera, Noctuidae and Saturniidae). Bull. South. Cal. Acad. Sci. 37: 21-22.

——. 1938b. A new subspecies of *Melitaea palla* Boisduval 1852 (Lepidoptera, Nymphalidae). Bull. South. Cal. Acad. Sci. 37: 18-20.

——. 1938c. *Calosaturnia albofasciata* species nova (Lepidoptera, Saturniidae). Bull. Brooklyn Entomol. Soc. 33:128-130.

——. 1940a. The allotype of *Calosaturnia albofasciata* (Lepidoptera, Saturniidae). Bull. Brooklyn Entomol. Soc. 35: 46-50.

——. 1940b. *Calosaturnia meridionalis* species nova (Lepidoptera, Saturniidae). Bull. Brooklyn Entomol. Soc. 35: 100-102.

——. 1941. Silver nitrate as a stain for use in studies of conduction of liquids in wood, phytopathology. Bull. Brooklyn Entomol. Soc. 31: 1035-1039.

——. 1963. An ecological study of the dune flora of the North split of Humboldt Bay. Masters thesis, Humboldt State College.

——. 1978. Similarities and differences in forewing shape of six California *Catocala* Species (Noctuidae). Manuscript submitted for publication July 1978; *Not published; all of the research is contained in the volumes at Los Angeles Natural History Museum.*

——. 1981. A desert subspecies of *Gloveria medusa* (Lasiocampidae). J. Lepid. Soc. 35: 147-154. (*NOTE Correction: Two of the *medusa* paratypes were, with permission of John W. Johnson, photographed and donated by Kenneth G. Denton, Jr. to The Smithsonian in Washington D.C. in August, 2003; The remaining paratypes are at the L.A. County Museum of Natural History.)

——. 1982. Letter to "Ripples" on two food plant observations for

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Euphydryas chalcedona (Lepidoptera, Nymphalidae). News Lepid. Soc. 34: Page 42.

——. 1982a. Another food plant of *Erynnis tristis tristis* Bvv. (Lepidoptera, Hesperiidae). ATALA 8: 44.

——. 1982b. An extinct population of a third species of Southern California satyrid (Lepidoptera, Satyridae). ATALA 8: 50-51.

——. 1983. Two new California *Catocala* subspecies (Noctuidae). J. Res. Lepid. 20: 245-248.

——. 1984. An intimate association between the colleterial gland system and the hind gut in *Ascalapha* and *Catocala* (Lepidoptera, Noctuidae). Inter. J. Insect Mophol. Embryol. 13: 247-248.

——. 1985. The immature stages of six California *Catocala* (Lepidoptera, Noctuidae). J. Res. Lepid. 23: 303-327.

——. 2001. A tribute to the lepidopterist Erich Carl Walter (1903-1990) and his father Carl Walter (1878-1932). MYIA 6: 213-218.

JOHNSON, J.W. & E. C. WALTER. 1980. Similarities and differences in the forewing shape of six California *Catocala* species (Noctuidae). J. Res. Lepid. 17: 231-239.

JOHNSON, J.W. & E.C. WALTER. 1981. A new Species of *Coloradia* in California (Saturniidae, Hemileucinae). J. Res. Lepid. 18: 60 -66. (*NOTE Correction: The Kenneth G. Denton, Jr. paratypes were donated to The Smithsonian, Washington D.C. along with the Kenneth G. Denton, Jr. series collection. No collection remains at U.C.I.)

JOHNSON, J.W. & E.C. WALTER. 1984. The immature stages of *Catocala erichi* Brower (Lepidoptera, Noctuidae). J. Res. Lepid. 23: 231-235.

MILLER, D. R. 1967. *Oregmopyga johnsoni*, new species. Hilgardia Univ. Cal. J. Agricul. Sci. 38: 493-495.

SHAW, L. H. 1993. The 1993 John Adams Comstock Award; the man we honor – John Warren Johnson. Unpublished.

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GUIA DOS SPHINGIDAE DA SERRA DOS ÓRGÃOS, SUDESTE DO BRASIL. A GUIDE TO THE HAWKMOTHS OF THE SERRA DOS ORGAOS, SOUTH-EASTERN BRAZIL by Martin, M., A. Soares, and J. Bizarro. Softcover. REGUA Publications, Oxford, 143 pp. ISBN: 9780956829108. Avaliable from NHBS, UK (www.nhbs.com). Price: £ 24.99, US$ 39

Located along the densely populated coast of Brazil, the Atlantic rainforest is one of the most endangered biomes in the world. Its extraordinary diversity and levels of endemism warrants its designation as a biodiversity hotspot in South America. Although vertebrates and trees are relatively well known, invertebrate diversity is poorly understood. Due to the ongoing loss of biodiversity, guides to identification of insect species are essential tools to aid in faunal documentation. The authors Alan Martin, Alexandre Soares and Jorge Bizarro try to fill this gap for the moth family Sphingidae in their book "A Guide to the Hawkmoths of the Serra dos Orgãos South-eastern Brazil". Alan Martin is an amateur British entomologist with passion for Lepidoptera. Alexandre Soares is Brazilian and a research Professor at the National Museum (Museu Nacional, Universidade Federal do Rio de Janeiro). Jorge Bizarro is Portuguese but was trained as an entomologist in Brazil. The authors are engaged with conservation projects at REGUA natural reserve (Reserva Ecologica de Guapiaçu), in the heart of the Atlantic rainforest, Rio de Janeiro State.

The book is written in English but includes introductory chapters in Portuguese. It is richly illustrated with about 400 color figures, including dorsal and ventral views of pinned museum specimens and more than 100 live specimen photographs. It treats both males and females of the 110 species registered for the Serra dos Órgãos region, Rio de Janeiro State. Four additional species not known to the Serra dos Órgãos but registered to other regions of Rio de Janeiro are also included, making this book the first guide to Sphingidae moths of that state. Considering that there are 230 known species of sphingids in Brazil, this book represents the first field guide to the Sphingidae of Brazil.

The book starts with a checklist of hawkmoths with species names organized according to the Sphingidae phylogeny of Kitching and Cadiou (2000); each species name has a number linking it to the images of pinned and live specimens, making it easier for the reader to locate images. The first three chapters are short and to the point. Chapter one is an introduction to the Atlantic rainforest and the Serra dos Órgãos. It details the different habitats in the biome, the huge loss of forest cover due to human action since European colonization, and the conservation actions to mitigate it. In the second chapter the authors explain the taxonomy of the family and what species are treated in the book. Maybe one of the limitations of this chapter is that the phylogeny used by the authors has already been revised twice, and there is no graphical representation allowing quick and easy interpretation of evolutionary relationships between subfamilies and tribes. The contribution of Henry Pearson to the Sphingidae collection of the National Museum in Rio is also mentioned. Pearson was an amateur English entomologist who immigrated to Brazil in the 1950's. For many years Pearson was engaged with the entomology collection of the National Museum. He built a collection of over 12,000 specimens, especially Mimallonidae, Saturniidae and Sphingidae, and introduced Alexandre Soares to entomology in the 1980's. Pearson passed away in 2004, leaving the National Museum his legacy: his collection and his pupil. Life history and development are described in the third chapter, along with highlights on biological differences between males and females, and hawkmoth flight capabilities and seasonal occurrence.

The fourth and last chapter is the largest and contains detailed taxonomical information for each species, i.e. scientific name, author and date of description, original description data, synonyms and type specimen locality. It also contains common names (when available), species distributions, notes to help with identification, and forewing length. This last item is very important since the pinned specimen photographs are not to scale, and forewing length is a crucial species character. The identification plates follow, including pinned museum specimens, images illustrating the Atlantic rainforest, and photos of live specimens in nature.

The book ends with six Appendices. Appendix I is a short biography of Henry Pearson, including a list of his publications. In Apendix II one can find further information about REGUA natural reserve and its conservation actions. Appendix III is a list of species organized according to the initial checklist with label data for all specimens that were measured. Appendix IV is a list of host-plants (from several sources) for all genera treated in the book that is organized by family and genus. In Appendix V and VI one can find a list of species reported from the five municipalities included

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in the Serra dos Órgãos region, and a list of species recorded by month at REGUA natural reserve.

In general I found the book excellent, and the very good plates and images will certainly be of great help identifying adults. However, I have two philosophical issues on how the book was produced. First, who is the target audience of this book? The foreword states that it was written to "stimulate the enthusiasm and interest of volunteer naturalists with no prior specialist knowledge". Considering the level of scientific content, the book seems written mainly for researchers rather than amateurs. Second, it is admirable that the authors tried to produce a bilingual book, but if the authors were attempting to stimulate volunteer naturalists, why are only the introductory chapters in Portuguese? Indeed, there are many "volunteer naturalists" in Brazil who would prefer to read the descriptions in their native language.

LITERATURE CITED

KITCHING, I.J. & J.M. CADIOU. 2000. Hawkmoths of the World: an annotated and illustrated revisionary checklist. Cornell University Press, London, 256 p.

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