

2017, Volumen 2, Número 2: 77-96

---

## The hawkmoths (Insecta, Lepidoptera, Sphingidae) of Rancho Laguna Blanca, Departamento San Pedro, Paraguay with documentation of five new country records

P. Smith<sup>1,2</sup>, S.D. Ríos<sup>2,3</sup>, O. Petko<sup>2</sup>, R. Smith<sup>2</sup> y K. Atkinson<sup>2</sup>

<sup>1</sup>FAUNA Paraguay, Encarnación, Itapúa, Paraguay [www.faunaparaguay.com](http://www.faunaparaguay.com)

<sup>2</sup>Para La Tierra, Centro IDEAL, Mariscal Estigarribia 321 c/ Tte. Capurro, Pilar, Dpto. Ñeembucú, Paraguay  
[www.paralatierra.org](http://www.paralatierra.org) E-mail: [faunaparaguay@gmail.com](mailto:faunaparaguay@gmail.com)

<sup>3</sup>Museo Nacional de Historia Natural del Paraguay, Sucursal 1 Campus., Central XI, San Lorenzo, Paraguay  
E-mail: [sergiord40@gmail.com](mailto:sergiord40@gmail.com)



**The hawkmoths (Insecta, Lepidoptera, Sphingidae) of Rancho Laguna Blanca, Departamento San Pedro, Paraguay with documentation of five new country records**

**P. Smith<sup>1,2</sup>, S.D. Ríos<sup>2,3</sup>, O. Petko<sup>2</sup>, R. Smith<sup>2</sup> y K. Atkinson<sup>2</sup>**

<sup>1</sup>FAUNA Paraguay, Encarnación, Itapúa, Paraguay [www.faanaparaguay.com](http://www.faanaparaguay.com)

<sup>2</sup>Para La Tierra, Centro IDEAL, Mariscal Estigarribia 321 c/ Tte. Capurro, Pilar, Dpto. Ñeembucú, Paraguay  
[www.paralatierra.org](http://www.paralatierra.org) E-mail: [faanaparaguay@gmail.com](mailto:faanaparaguay@gmail.com)

<sup>3</sup>Museo Nacional de Historia Natural del Paraguay, Sucursal 1 Campus., Central XI, San Lorenzo, Paraguay  
E-mail: [sergiord40@gmail.com](mailto:sergiord40@gmail.com)

**ABSTRACT.** An annotated catalogue of the hawkmoths (Sphingidae) of Rancho Laguna Blanca (RLB) is provided. A total of 63 species was recorded, about two-thirds of the Paraguay fauna, including formal documentation of five previously unrecorded species, which takes the country total to 95. The reserve is located in a transitional area from Atlantic Forest to Cerrado. This catalogue is the first published single site list for such a habitat, and the only single site list published for Paraguay to date that is based on year round sampling supported by voucher specimens. The importance of the RNLB for conservation at both the national and international level is highlighted.

**Key words:** *catalogue, conservation, distribution, inventory, specimens*

**RESUMEN.** Los esfingidos (Insecta, Lepidoptera, Sphingidae) de Rancho Laguna Blanca, Departamento de San Pedro, Paraguay, con documentación de cinco nuevos registros. Se presenta un catálogo anotado de las 63 especies de esfingidos del Rancho Laguna Blanca (RLB), representando estas el 66.32% de las especies documentadas en Paraguay. Documentación formal se provee para 5 especies nuevas de esfingidos para la fauna paraguaya, siendo ahora 95 especies documentadas en el país. La reserva está localizada en un área de transición entre Bosque Atlántico y Cerrado. Este catálogo es la primera lista exhaustiva de esfingidos de un solo sitio en este hábitat y el primer inventario en Paraguay, a la fecha, que está basado en un muestreo de todo el año, además de presentar especímenes. Se destaca la importancia de la RNLB para la conservación a nivel nacional e internacional.

**Palabras clave:** *catálogo, conservación, distribución, inventario, especímenes*

## Introduction

Hawkmoths (Lepidoptera: Sphingidae) are one of the best-known families of nocturnal Lepidoptera due to their often considerable size and the frequency with which they are attracted to light sources (Moré *et al.* 2005). Despite this, little is known about the ecology of many Neotropical species, and a shortage of museum specimens leads to an incomplete picture of the distributions of all but the most widespread hawkmoths in the region (Kitching *et al.* 2001).

Although there has been a renewed interest in sphingid biodiversity in the Southern Cone of South America in recent years, few single site inventories have been published (Laroca *et al.* 1989, Valverde 1999, Brown & Freitas 2000, Schmitt *et al.* 2004, Nuñez-Bustos 2008, Nuñez-Bustos 2009). The sphingid fauna of Paraguay is particularly poorly known (Schade 1927) and over 20 years have passed since the last general publication on the group in the country, which documented 83 species (Drechsel 1994).

Of these 83 species, two (*Manduca tucumana*, *Pachygonidia subhamata*) have since been generally discounted because of a lack of documentation and *Erinnyis domingonis*, though well documented, is now considered only a colour form of *E. obscura* (Tuttle, 2007; Kitching *et al.* 2014). Furthermore, Drechsel (1994) omitted two further species that had been previously mentioned for Paraguay, *Manduca lichenea* (cited by Poulard [1983]) and *Hyles lineata* (cited by Podtiaguin [1941]). The next major publication on Paraguayan Sphingidae was that of Ríos Díaz (2014), based on the collection in the Museo Nacional de Historia Natural del Paraguay, which confirmed the presence of *Manduca lichenea* by specimen citation and added formal documentation of a further seven species (*Adhemarius daphne*, *Callionima nomius*, *Cocytius antaeus*, *Manduca corumbensis*, *Nyceryx furtadoi*, *Perigonia ilus*, and *P. passerina*) to the national list, bringing the then total number of species to 89. Several more species are known to occur in the country but these await formal documentation in the scientific literature (Drechsel & Peña Escobar 2014, FAUNA Paraguay 2017).

In providing the results of a six year inventory of Sphingidae at Rancho Laguna Blanca (RLB), Departamento San Pedro, Paraguay we aim to begin to fill some gaps in our knowledge of sphingid distributions in the country and provide initial data upon which environmental monitoring of the “health” of the property can be based. RLB lies at the transition zone between the Atlantic Forest and Cerrado eco-regions (Guyra Paraguay 2008), which are considered two of the most threatened habitats on the planet (Critical Ecosystem Partnership Fund 2015). Hence the results of this inventory are the first published data on sphingid diversity in such an area of intergrade between these two eco-regions. Furthermore, this is the first single site list for any Paraguayan locality that is based on year round sampling.

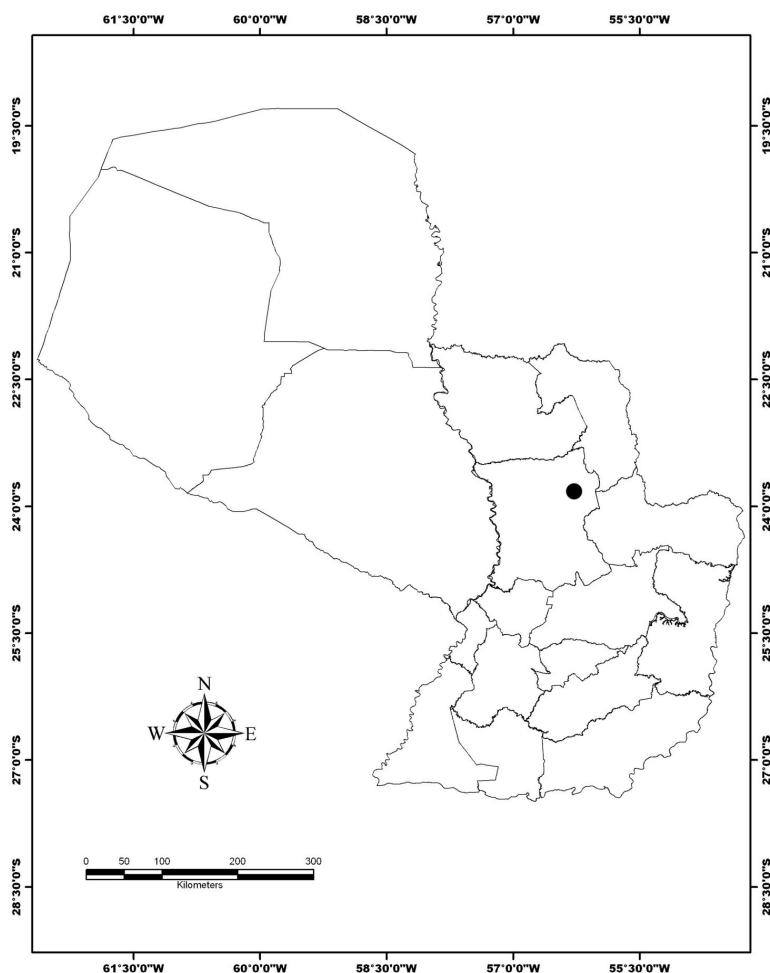
## Study site

The RLB is a small 804 ha reserve consisting of over 400 ha of near pristine Cerrado, a patch of degraded Atlantic Forest and some semi-deciduous transitional humid-dry gallery forest, centred around the 157 ha Laguna Blanca lake. A basic review of the area and its floral composition was provided by Guyra Paraguay (2008).

Broadly speaking, Cerrado habitat can be divided into four categories or “ecotopes”: campo limpio (grassy field), campo sucio (grassy and bushy fields with scattered trees), cerrado sensu stricto (bushy fields without grass) and cerradón (cerrado dry forest). These ecotopes represent observable trends in habitat types and are not associated with any specific floral communities, which may vary greatly in any given ecotope from one area to another (Eiten 1972, 1978). The four main Cerrado ecotopes are present at RLB and grow on a predominately sandy substrate.

## Methods

Fieldwork was undertaken from April 2010 to the end of March 2015 at Para La Tierra Ecological Station, (S 23 48' 45.4", W 56 17' 41.7") in the Cerrado zone (Figure 1). Collections were carried out unsystematically during all months of the year by staff and volunteers resident at the station. Specimens were captured when attracted to lights at the accommodation block or light traps with mercury vapor lamps located throughout the reserve.



**Figure 1.** Location of Rancho Laguna Blanca, San Pedro department, Paraguay.

Specimens are deposited in the Colección Entomológica de Para La Tierra (CZPLT-i), Rancho Laguna Blanca, Municipalidad de Santa Barbara, Distrito de Santa Rosa del Aguaray, Departamento San Pedro, Paraguay, or in the Museo Nacional de Historia Natural del Paraguay (MNHNP), San Lorenzo, Paraguay.

## Results

A total of 929 specimens of 63 species were collected at RLB. Five of these represent newly documented records for Paraguay: *Protambulyx eurycles* (Figure 2), *Manduca leucospila* (Figure 3) *Unzela japix* (Figure 4), *Nyceryx stuarti* (Figure 6) and *Isognathus caricae* (Figure 7), together with

another that has been generally omitted from Paraguayan lists: *Callionima guiarti* (Figure 5). The specimen number is given in italics followed by collection date in parentheses.



**Figure 2.** *Protambulyx eurycles* (CZPLT 610). Photo S. Harrison.



**Figure 3.** *Manduca leucospila* (CZPLT 211). Photo S. Harrison.



**Figure 4.** *Unzela japix* (CZPLT 2615). Photo S. Harrison.





**Figure 5.** *Callionima guiarti* (CZPLT 1571). Photo J.P. Brouard.



**Figure 6.** *Nycteryx stuarti* (CZPLT 2461). Photo D. Schoenberger.



**Figure 7.** *Isognathus caricae* (CZPLT 2948). Photo S. Harrison.

FAMILY SPHINGIDAE  
SUBFAMILY SMERINTHINAE  
Tribe Ambulycini

*Protambulyx astygonus* (Boisduval, 1875)

(5 specimens): 854 (26 IV 2012); 1021 (30 XII 2012); 1613 (30 VI 2013); 2363 (23 VIII 2014); 2556 (30 X 2014).

*Protambulyx eurycles* (Herrich-Schäffer, 1854)

(24 specimens): 314 (23 II 2011); 570 (8 XII 2011); 610 (24 II 2012); 687 (15 XI 2012); 1071 (4 XI 2011); 1202 (4 III 2013); 1769 (4 X 2013); 1882 (4 XI 2013); 1927 (14 III 2014); 1983 (7 III 2014); 2007 (14 V 2014); 2185 (30 VII 2014); 2269 (10 VIII 2014); 2383 (11 VIII 2014); 2413 (15 X 2014); 2516 (13 IX 2014); 2703 (8 XI 2014); 2745 (17 XI 2014); 2805 (25 XI 2014); 2835 (29 XI 2014); 2882 (6 XII 2014); 2890 (6 XII 2014); 2971 (19 XI 2014); 3137 (29 I 2015).

Apparently the most frequent member of the genus at RNLB. Drechsel (2014a) provides photographs of a male at Pirareta, Depto. Cordillera (3 January 2012) and of a male and female at Mbatovi, Depto. Paraguari (17 May 2014), mentioning that four individuals (3 males and 1 female) were recorded at this latter locality. However, no reference was made as to whether specimens were taken, and if so where these were subsequently deposited. Consequently, the specimens reported here provide formal documentation for this species in Paraguay (Figure 2). The species was previously known from Colombia to southern Brazil (Martin *et al.* 2011).

*Protambulyx strigilis* (Linnaeus, 1771)

(15 specimens): 841 (7 V 2012); 859 (11 IV 2012); 885 (21 V 2012); 886 (2 VI 2012); 887 (21 V 2012); 1702 (31 VII 2013); 1909 (26 XII 2013); 2005 (14 V 2014); 2834 (29 XI 2014); 2836 (1 XII 2014); 2889 (6 XII 2014); 2990 (26 XII 2014); 2991 (28 XII 2014); 2992 (3 I 2015); 3430 (27 III 2015).

*Orecta lycidas* (Boisduval, 1875)

(8 specimens): 362 (11 III 2011); 534 (13 II 2012); 1209 (2 III 2013); 1736 (2 X 2013); 1985 (3 III 2014); 2946 (18 XII 2014); 3163 (8 II 2015); 3361 (13 III 2015).

*Adhemarius* specimens were tentatively identified following the characters for specific identification detailed by Martin *et al.* (2011). Specimens with a sub-basal band that did not reach the costa were identified as *A. daphne*, but considerable variation in the size and shape of the subapical spot was present in these specimens and in some specimens the black sub-basal band reaches the subcosta. All specimens in which the sub-basal band reached the costa were then identified based on the following characters: *A. gannascus*: sub-apical spot tending towards comma shape; *A. eurysthenes*: posterior border of hind wing black rather than pink, sub-basal band with uneven edges posteriorly.

*Adhemarius daphne* (Boisduval, 1875)

(26 specimens): 001 (30 IV 2010); 004 (30 V 2010); 151 (30 IX 2010); 572 (21 XI 2011); 858 (26 IV 2012); 936 (16 XII 2012); 1137 (3 III 2013); 1484 (28 IV 2013); 1761 (8 X 2013); 1892 (11 XII 2013); 1893 (19 XII 2013); 1902 (14 XII 2013); 2009 (18 V 2014); 2022 (19 V 2014); 2072 (7 VI 2014); 2092 (20 VI 2014); 2287 (22 VIII 2014); 2327 (12 IX 2014); 2374 (13 IX 2014); 2769 (24 XI 2014); 2804 (25 XI 2014); 2883 (7 XII 2014); 2929 (17 XII 2014); 2972 (14 XI 2014); 3006 (8 I 2015); 3248 (4 III 2015).

*Adhemarius eurysthenes* (C. & R. Felder, 1874)

(1 specimen): 642 (30 IX 2011).

*Adhemarius gannascus* (Stoll, 1790)

(3 specimens): 1966 (16 III 2014); 2951 (20 XII 2014); 3431 (31 III 2015).

#### SUBFAMILY SPHINGINAE

##### Tribe Acherontiini

*Agrius cingulata* (Fabricius, 1775)

(5 specimens): 2767 (25 XI 2014); 2893 (2 XII 2014); 2894 (7 XII 2014); 2952 (21 XII 2014); 3427 (29 III 2015).

##### Tribe Sphingini

*Neogene dynaeus* (Hübner, 1831)

(2 specimens): 288 (12 II 2011); 636 (28 X 2011).

*Manduca contracta* (Butler, 1875)

(4 specimens): 286 (10 II 2011); 680 (24 X 2011); 1180 (3 III 2013); 1862 (15 XI 2013).

Listed by Drechsel (1994) as *Manduca lucetius* (Cramer, 1780). Kitching & Cadiou (2000) established that the correct name for the species in the Southern Cone of South America is *Manduca contracta* (Butler, 1875), with the name *Manduca lucetius* referring to a species occurring in northern South America. A second species, *Manduca exiguus* (Gehlen, 1942) is of potential occurrence in Paraguay, having been collected close to Paraguay in Formosa, Argentina (Nuñez-Bustos, 2015). This species was previously considered a synonym of *M. contracta* (Haxaire *et al.* 2015).

*Manduca corumbensis* (Clark, 1920)

(1 specimen): 203 (16 X 2010).

*Manduca diffissa* (Butler, 1871)

(4 specimens): 577 (9 XII 2011); 1459 (21 IV 2013); 2741 (17 XI 2014); 2845 (23 XI 2014).

*Manduca florestan* (Stoll, 1782)

(23 specimens): 315 (23 II 2011); 318 (23 II 2011); 493 (undated); 614 (27 II 2012); 628 (undated); 630 (2 XI 2011); 711 (23 XII 2011); 888 (21 III 2012); 1144 (2 III 2013); 1377 (7 III 2013); 1266 (19 III 2013); 1315 (22 III 2013); 1327 (20 III 2013); 1368 (2 IV 2013); 1925 (14 III 2014); 1936 (14 III 2014); 1982 (1 III 2014); 2397 (23 IX 2014); 3213 (20 II 2015); 3214 (20 II 2015); 3245 (26 II 2015); 3359 (15 III 2015); 3602 (19 X 2011).

*Manduca lefeburii* (Guérin-Méneville, 1844)

(1 specimen): 1232 (1 III 2013)

*Manduca leucospila* (Rothschild & Jordan, 1903)

(1 specimen): 211 (13 X 2010).

The first specimen and documentation of this species from Paraguay (Figure 3). The species is known only from scattered records in South America and the closest records to Paraguay are from the Argentine provinces of Jujuy and Salta (Moré *et al.* 2005).



*Manduca manducoides* (Rothschild, 1895)

(5 specimens): 1864 (15 XI 2013); 2406 (29 IX 2014); 2460 (15 X 2014); 2573 (24 X 2014); 2460 (15 X 2014).

*Manduca rustica* (Fabricius, 1775)

(14 specimens): 356 (10 III 2011); 486 (undated); 569 (26 I 2012); 629 (28 X 2011); 693 (28 XI 2011); 1022 (1 I 2013); 1138 (4 III 2013); 1367 (25 III 2013); 1372(30 III 2013); 2514 (27 IX 2014); 2619 (26 X 2014); 2638 (25 X 2014); 2978 (9 I 2015); 3091 (25 I 2015).

*Manduca sexta* (Linnaeus, 1763)

(50 specimens): 222 (22 XI 2010); 223 (23 XI 2010); 231(24 XI 2010); 242 (?? XI 2010); 360 (11 III 2011); 627 (3 IX 2011); 707 (7 I 2012); 1140 (28 II 2013); 1141 (4 III 2013); 1177 (1 III 2013); 1178 (1 III 2013); 1207 (8 III 2013); 1235 (4 III 2013); 1381 (1 IV 2013); 1405 (4 IV 2013); 1408 (3 IV 2013); 1929 (4 I 2014); 1930 (8 III 2014); 1932 (22 II 2014); 1934 (12 II 2014); 1937 (12 III 2014); 1955 (8 IV 2014); 1986 (6 III 2014); 1995 (20 II 2014); 2014 (15 V 2014); 2501 (29 IX 2014); 2518 (9 X 2014); 2572 (24 X 2014); 2704 (10 XI 2014); 2740 (14 XI 2014); 2742 (15 XI 2014); 2877 (15 X 2014); 2917 (14 XII 2014); 2918 (17 XII 2014); 2919 (15 XII 2014); 2969 (14 XI 2014); 2979 (8 I 2015); 2980 (5 I 2015); 2981 (3 I 2015); 2982 (3 I 2015); 2983 (8 I 2015); 2984 (2 I 2015); 2985 (4 I 2015); 3057 (12 I 2015); 3058 (16 I 2015); 3092 (23 I 2015); 3139 (2 II 2015); 3140 (30 I 2015); 3161 (7 II 2015); 3162 (7 II 2015).

*Cocytius antaeus* (Drury, 1773)

(1 specimen): 1907 (26 XII 2013).

*Cocytius duponchel* Poey, 1832

(4 specimens): 704 (24 XI 2011); 2024 (20 V 2014); 2382 (9 X 2014); 2618 (26 X 2014).

*Cocytius lucifer* (Rothschild & Jordan, 1903)

(2 specimens): 932 (18 XI 2011); 933 (17 XI 2011).

## SUBFAMILY MACROGLOSSINAE

## Tribe Dilophonotini

*Unzela japix* (Cramer, 1776)

(2 specimens): 1775 (4 VI 2013); 2615 (23 X 2014).

These specimens provide formal documentation for this genus and species in Paraguay (Figure 4). The species has also been previously photographed (but not collected) at the Mbaracayú Forest Reserve, Departamento Canindeyú (PS, 2 October 2013) and was listed for Paraguay by D'Abbrera (1987) with a query.

*Enyo gorgon* (Cramer, 1777)

(11 specimens): 152 (2 VII 2010); 210 (15 X 2010); 219 (20 XI 2010); 220 (22 XI 2010); 238 (?? XII 2010); 850 (24 IV 2012); 2428 (10 X 2014); 2429 (13 X 2014); 2468 (20 X 2014); 2611 (27 X 2014); 2941 (14 XII 2014).

*Enyo lugubris* (Linnaeus, 1771)

(35 specimens): 221 (22 XI 2010); 325 (3 VI 2011); 739 (16 III 2012); 741 (10 II 2012); 774 (5 III 2012); 834 (17 IV 2012); 1631 (9 VI 2013); 1680 (5 VII 2013); 1904 (15 XII 2013); 1980 (7 III 2014); 2495 (13 IX 2014); 2544 (20 X 2014); 2609 (25 X 2014); 2611 (27 X 2014); 2612 (30 X 2014); 2641 (1 XI 2014); 2696 (10 XI 2014); 2717 (16 XI 2014); 2720 (21 XI 2014); 2721 (21 XI 2014); 2734 (17 XI 2014); 2735 (19 XI 2014); 2791 (22 XI 2014); 2799 (22 XI 2014); 2800 (21 XI 2014); 2801 (23 XI 2014); 2862 (21 XI 2014); 2863 (25 XI 2014); 2888 (6 XII 2014); 3120 (18 I 2015); 3121 (20 I 2015); 3135 (XII 2014); 3136 (XII 2014); 3199 (24 II 2015); 3201 (17 II 2015).

*Enyo ocypete* (Linnaeus, 1758)

(21 specimens): 306 (22 II 2011); 464 (undated); 555 (17 II 2012); 699 (11 XI 2011); 700 (11 XI 2011); 849 (23 IV 2011); 883 (17 V 2012); 884 (17 V 2012); 1256 (14 II 2013); 2135 (15 VII 2014); 2337 (2 IX 2014); 2718 (16 XI 2014); 2792 (28 XI 2014); 2829 (25 XI 2014); 2830 (25 XI 2014); 2840 (2 XII 2014); 2887 (9 XII 2014); 2934 (15 XII 2014); 2936 (12 XII 2014); 3034 (9 I 2015); 3142 (29 I 2015).

*Callionima inuus* Rothschild & Jordan, 1903

(29 specimens): 032 (8 VI 2010); 036 (16 VI 2010); 294 (12 II 2011); 299 (16 I 2011); 394 (21 III 2011); 396 (21 III 2011); 688 (14 XI 2011); 843 (17 IV 2012); 856 (12 V 2012); 1339 (25 III 2013); 1413 (3 IV 2013); 1415 (4 IV 2013); 1542 (3 V 2013); 1629 (6 VI 2013); 1762 (28 X 2013); 1999 (11 V 2014); 2034 (20 V 2014); 2239 (2 IX 2014); 2462 (20 X 2014); 2467 (22 X 2014); 2575 (26 X 2014); 2753 (15 XI 2014); 2754 (15 XI 2014); 2851 (30 XI 2014); 2973 (19 XI 2014); 3004 (?? XII 2014); 3005 (30 XII 2014); 3433 (23 III 2015); 3434 (29 III 2015).

*Callionima guiarti* (Debauche, 1934)

(8 specimens) 1181 (3 III 2013); 1547 (3 V 2013); 1571 (22 IV 2013); 2652 (31 X 2014); 2662 (31 X 2014); 2700 (?? XI 2014); 2998 (2 I 2015); 3059 (16 I 2015).

The identification of species in the genus *Callionima* is complex, but specimens were identified as *C. guiarti* on the basis of the extremely uniform, less contrasting background coloration when compared with *C. parce*. This species was originally described as a subspecies of “*Hemeroplanes*” *parce* (*Callionima parce*) by Debauche (1934) on the basis of a Paraguayan specimen. The species may have been overlooked previously due to its similarity to *C. parce* and *C. falcifera*, added to the fact that it has only recently been recognized as a full species (Eitschberger 2001), having been previously considered a subspecies of *C. parce* (Soares 1993; Carcasson & Heppner 1996; Kitching & Cadiou 2000).

*Callionima grisescens* (Rothschild, 1894)

(82 specimens): 224 (12 XI 2010); 287 (12 II 2011); 300 (18 I 2011); 692 (8 XI 2011); 838 (12 IV 2012); 845 (24 IV 2012); 1240 (14 III 2013); 1529 (11 V 2013); 1535 (3 V 2013); 1544 (11 V 2013); 1875 (12 XI 2013); 2027 (8 IV 2014); 2030 (16 V 2014); 2304 (16 VIII 2014); 2430 (14 X 2014); 2463 (24 X 2014); 2464 (24 X 2014); 2465 (20 X 2014); 2520 (29 IX 2014); 2521 (29 IX 2014); 2522 (?? X 2014); 2523 (29 IX 2014); 2578 (25 X 2014); 2582 (27 X 2014); 2583 (27 X 2014); 2584 (29 X 2014); 2585 (29 X 2014); 2586 (26 X 2014); 2587 (28 X 2014); 2588 (29 X 2014); 2589 (25 X 2014); 2590 (25 X 2014); 2592 (26 X 2014); 2593 (26 X 2014); 2595 (26 X 2014); 2596 (26 X 2014); 2597 (24 X 2014); 2598 (28 X 2014); 2600 (29 X 2014); 2601 (25 X 2014); 2602 (28 X 2014); 2603 (28 X 2014); 2604 (28 X 2014); 2605 (28 X 2014); 2606 (29 X 2014); 2607 (26 X 2014); 2608 (25 X 2014); 2609 (25 X 2014); 2610 (27 X 2014); 2614 (23 X 2014); 2627 (31 X 2014); 2630 (31 X 2014); 2631 (31 X 2014); 2653 (31 X 2014); 2654 (1 XI 2014); 2655 (1 XI 2014); 2656 (3 XI 2014); 2657 (5 XI 2014); 2658 (1 XI 2014); 2659 (31 X 2014); 2660 (1 XI 2014); 2663 (31 X 2014); 2664 (31 X 2014);

2665 (5 XI 2014); 2670 (2 XI 2014); 2705 (8 XI 2014); 2706 (6 XI 2014); 2713 (12 XI 2014); 2714 (12 XI 2014); 2715 (10 XI 2014); 2750 (15 XI 2014); 2755 (15 XI 2014); 2853 (23 XI 2014); 2854 (25 XI 2014); 2855 (25 XI 2014); 2933 (18 XII 2014); 3002 (10 I 2015); 3003 (26 XII 2014); 3060 (14 I 2015); 3130 (19 I 2015); 3202 (25 II 2015); 3247 (27 II 2015).

*Callionima parce* (Fabricius, 1775)

(38 specimens) 042 (undated); 358 (10 III 2011); 1182 (2 III 2013); 1259 (15 III 2013); 1279 (19 III 2013); 1638 (5 VI 2013); 1641 (5 VI 2013); 1696 (6 VII 2013); 1998 (12 V 2014); 2002 (12 V 2014); 2577 (25 X 2014); 2591 (26 X 2014); 2594 (26 X 2014); 2648 (3 XI 2014); 2661 (31 X 2014); 2666 (3 XI 2014); 2667 (3 XI 2014); 2708 (9 XI 2014); 2709 (9 XI 2014); 2711 (6 XI 2014); 2722 (21 XI 2014); 2731 (15 XI 2014); 2796 (23 XI 2014); 2852 (25 XI 2014); 2899 (8 XII 2014); 2935 (12 XII 2014); 2958 (20 XII 2014); 2999 (8 I 2015); 3000 (7 I 2015); 3001 (9 I 2015); 3093 (28 I 2015); 3127 (22 I 2015); 3129 (23 I 2015); 3143 (4 II 2015); 3165 (10 II 2015); 3195 (23 II 2015); 3216 (19 II 2015); 3360 (12 III 2015).

*Callionima falcifera* (Gehlen, 1943)

(16 specimens) 003 (1 V 2010); 290 (12 II 2011); 736 (1 III 2012); 1389 (4 IV 2013); 1400 (4 IV 2013); 2096 (23 VI 2014); 2322 (10 IX 2014); 2470 (22 X 2014); 2576 (28 X 2014); 2669 (2 XI 2014); 2850 (2 XII 2014); 2856 (23 XI 2014); 2896 (7 XII 2014); 2898 (9 XII 2014); 3066 (14 I 2015); 3125 (17 I 2015).

*Madoryx oiclus* (Cramer, 1779)

(6 specimens): 1023 (2 I 2013); 1239 (4 III 2013); 2574 (24 X 2014); 2651 (31 X 2014); 2770 (24 XI 2014); 2846 (3 XII 2014).

*Pachylia ficus* (Linnaeus, 1758)

(36 specimens): 040 (22 I 2010); 285 (9 II 2011); 337 (17 V 2011); 338 (17 V 2011); 355 (10 III 2011); 430 (16 VI 2011); 431 (16 VI 2011); 544 (3 II 2012); 683 (7 VI 2011); 891 (16 V 2012); 892 (18 V 2012); 1142 (2 III 2013); 1453 (26 IV 2013); 1508 (19 V 2013); 1592 (9 VI 2013); 1593 (5 VI 2013); 1635 (9 VI 2013); 1662 (8 VII 2013); 1698 (6 VII 2013); 1699 (6 VII 2013); 1700 (6 VII 2013); 2020 (16 V 2014); 2025 (20 V 2014); 2026 (20 V 2014); 2073 (7 VI 2014); 2074 (30 V 2014); 2101 (25 VI 2014); 2141 (16 VII 2014); 2158 (22 VII 2014); 2232 (31 V 2014); 2233 (16 V 2014); 2617 (28 X 2014); 2768 (22 XI 2014); 2928 (18 XII 2014); 2968 (11 XI 2014); 2987 (3 I 2015).

*Pachylioides resumens* (Walker, 1856)

(94 specimens): 008 (6 V 2010); 015 (29 V 2010); 037 (16 VI 2010); 241 (?? XI 2010); 307 (22 II 2011); 316 (26 II 2011); 322 (25 II 2011); 361 (11 III 2011); 391 (21 III 2011); 472 (undated); 477 (undated); 571 (21 XII 2012); 613 (1 III 2012); 624 (26 X 2011); 862 (22 XII 2011); 893 (17 V 2012); 894 (15 IV 2012); 895 (2 VI 2012); 896 (22 V 2012); 1139 (28 II 2013); 1338 (25 III 2013); 1388 (6 IV 2013); 1461 (17 IV 2013); 1485 (28 IV 2013); 1532 (8 V 2013); 1534 (10 V 2013); 1536 (29 IV 2013); 1548 (29 V 2013); 1549 (29 V 2013); 1568 (10 V 2013); 1594 (31 V 2013); 1625 (14 VI 2013); 1666 (18 VII 2013); 1667 (18 VII 2013); 1967 (8 IV 2014); 2008 (12 V 2014); 2016 (18 V 2014); 2023 (16 V 2014); 2033 (19 V 2014); 2037 (18 V 2014); 2038 (18 V 2014); 2049 (29 V 2014); 2069 (4 VI 2014); 2071 (5 VI 2014); 2075 (17 XI 2011); 2078 (10 VI 2014); 2091 (23 VI 2014); 2093 (27 VI 2014); 2099 (9 VII 2014); 2138 (14 VII 2014); 2139 (11 VII 2014); 2140 (16 VII 2014); 2142 (14 VII 2014); 2143 (14 VII 2014); 2145 (22 VII 2014); 2146 (22 VII 2014); 2147 (22 VII 2014); 2148 (22 VII 2014); 2186 (27 VII 2014); 2231 (9 VIII 2014); 2238 (15 VIII 2014); 2348 (7 IX 2014); 2390 (8 VI 2014); 2507 (30 IX 2014); 2512 (2 X 2014); 2513 (4 X 2014); 2515 (30 IX 2014); 2551

(24 X 2014); 2552 (28 X 2014); 2560 (28 X 2014); 2561 (29 X 2014); 2562 (29 X 2014); 2564 (25 X 2014); 2565 (26 X 2014); 2566 (26 X 2014); 2568 (29 X 2014); 2569 (27 X 2014); 2635 (8 XI 2014); 2636 (26 X 2014); 2637 (31 X 2014); 2701 (13 XI 2014); 2771 (23 XI 2014); 2772 (28 XI 2014); 2773 (23 XI 2014); 2774 (22 XI 2014); 2775 (22 XI 2014); 2857 (25 XI 2014); 2858 (25 XI 2014); 2880 (6 XII 2014); 2931 (15 XII 2014); 2975 (17 XI 2014); 3007 (6 I 2015); 3204 (14 II 2015); 3378 (23 III 2015).

*Nyceryx alophus* (Boisduval, 1875)  
(1 specimen): 625 (13 IX 2011).

*Nyceryx continua* (Walker, 1856)  
(3 specimens): 2469 (20 X 2014); 2524 (30 IX 2014); 2563 (25 X 2014).

*Nyceryx furtadoi* Haxaire, 1996  
(1 specimen): 158 (1 IX 2010).

*Nyceryx riscus* (Schaus, 1890)  
(12 specimens): 399 (21 III 2011); 703 (21 XII 2011); 1876 (12 XI 2013); 1911 (23 XI 2013); 2000 (15 V 2014); 2613 (30 X 2014); 2639 (5 XI 2014); 2646 (3 XI 2014); 2751 (17 XI 2014); 2847 (1 XII 2014); 2942 (14 XII 2014); 2955 (19 XII 2014).

*Nyceryx stuarti* (Rothschild, 1894)  
(5 specimens): 1681 (5 VII 2013); 2461 (21 X 2014); 2640 (4 XI 2014); 2693 (9 XI 2014); 2724 (15 XI 2014).

These specimens represent the first documentation of this species from Paraguay (Figure 5). The species has been previously photographed at Mbaracayú Biosphere Reserve (PS, 25 X 2008) but specimen collection was not possible in that instance. *N. stuarti* is extremely similar to *N. riscus*, but is darker in base coloration and has a truncate, as opposed to sinuate forewing apex.

*Perigonia ilus* Boisduval, 1870  
(5 specimens): 2368 (18 IX 2014); 2369 (18 IX 2014); 2644 (5 XI 2014); 2820 (25 XI 2014); 3417 (25 III 2015).

Specimen 3417 has greatly reduced areas of yellow on the hindwing.

*Perigonia pallida* Rothschild & Jordan, 1903  
(9 specimens): 409 (23 III 2011); 631 (24 X 2011); 1175 (1 III 2013); 1612 (2 VI 2013); 2137 (14 VII 2014); 2338 (2 IX 2014); 2571 (25 X 2014); 2932 (11 XII 2014); 3358 (11 III 2015).

*Eupyrrhoglossum sagra* (Poey, 1832)  
(1 specimen): 721 (5 III 2012).

*Aellopos fadus* (Cramer, 1775)  
(2 specimens): 218 (18 XI 2010); 3094 (19 I 2015).

*Aellopos titan* (Cramer, 1777)  
(12 specimens): 049 (23 VII 2010); 706 (30 XII 2011); 720 (5 III 2012); 1539 (27 V 2013); 1916 (16 XII 2013); 2861 (21 XI 2014); 2884 (10 XII 2014); 2885 (7 XII 2014); 2886 (9 XII 2014); 2956 (18 XII 2014); 2957 (20 XII 2014); 3160 (7 II 2015).

*Isognathus caricae* (Linnaeus, 1758)

(4 specimens): 1205 (8 III 2013); 2766 (21 XI 2014); 2948 (20 XII 2014); 2986 (16 XII 2014).

These specimens represent the first documentation of this genus and species from Paraguay (Figure 6). The species has been previously cited from neighbouring Misiones and other provinces in Argentina (Orfila 1933).

*Erinnyis alope* (Drury, 1773)

(33 specimens): 002 (1 V 2010); 035 (12 VI 2010); 038 (18 VI 2010); 239 (?? XII 2010); 321 (23 II 2011); 392 (21 III 2011); 710 (18 I 2012); 770 (16 III 2012); 897 (2 VI 2012); 898 (14 V 2012); 899 (15 V 2012); 1179 (1 III 2013); 1427 (7 III 2013); 1524 (15 V 2013); 1555 (15 IV 2013); 1634 (7 VI 2013); 1697 (6 VII 2013); 2018 (20 V 2014); 2288 (18 VIII 2014); 2459 (20 X 2014); 2620 (2 XI 2014); 2765 (22 XI 2014); 2802 (24 XI 2014); 2821 (25 XI 2014); 2822 (2 XII 2014); 2823 (2 XII 2014); 2824 (29 XI 2014); 2868 (25 XI 2014); 2878 (8 XII 2014); 2879 (9 XII 2014); 2920 (15 XII 2014); 2921 (17 XII 2014); 2950 (20 XII 2014).

*Erinnyis crameri* (Schaus, 1898)

(32 specimens): 012 (24 V 2010); 013 (24 V 2010); 031 (8 VI 2010); 043 (24 VI 2010); 240 (?? XI 2010); 319 (23 II 2011); 879 (2 VI 2012); 880 (22 V 2012); 1145 (2 II 2013); 1390 (4 IV 2013); 1418 (4 IV 2013); 1480 (12 IV 2013); 1538 (1 V 2013); 1563 (14 V 2013); 1566 (11 V 2013); 1665 (18 VII 2013); 1900 (11 XII 2013); 2236 (10 VIII 2014); 2326 (10 IX 2014); 2649 (31 X 2014); 2688 (6 XI 2014); 2733 (17 XI 2014); 2743 (14 XI 2014); 2744 (15 XI 2014); 2788 (23 XI 2014); 2827 (25 XI 2014); 2833 (4 XII 2014); 2837 (2 IX 2014); 2838 (1 XII 2014); 2881 (6 XII 2014); 2953 (19 XII 2014); 3206 (24 II 2015).

*Erinnyis ello* (Linnaeus, 1758)

(85 specimens): 016 (1 VI 2010); 017 (2 VI 2010); 237 (?? I 2011); 296 (16 II 2011); 310 (25 II 2011); 351 (?? XII 2010); 352 (?? XII 2010); 575 (21 XII 2012); 576 (18 XI 2011); 668 (undated); 681 (20 XI 2011); 1311 (21 III 2013); 1373 (1 IV 2013); 1407 (4 IV 2013); 1409 (3 IV 2013); 1537 (21 V 2013); 1546 (7 V 2013); 1570 (11 V 2013); 1731 (11 X 2013); 1898 (11 XII 2013); 1899 (11 XII 2013); 1901 (11 XII 2013); 2006 (12 V 2014); 2019 (18 V 2014); 2032 (16 V 2014); 2013 (22 V 2014); 2398 (30 IX 2014); 2553 (28 X 2014); 2554 (28 X 2014); 2570 (24 X 2014); 2579 (27 X 2014); 2621 (1 XI 2014); 2622 (5 XI 2014); 2623 (5 XI 2014); 2624 (5 XI 2014); 2625 (2 XI 2014); 2626 (31 X 2014); 2628 (31 X 2014); 2632 (31 X 2014); 2633 (31 X 2014); 2634 (31 X 2014); 2668 (2 XI 2014); 2687 (6 XI 2014); 2689 (10 XI 2014); 2690 (8 XI 2014); 2691 (12 XI 2014); 2692 (10 XI 2014); 2702 (12 XI 2014); 2725 (14 XI 2014); 2726 (14 XI 2014); 2727 (14 XI 2014); 2728 (12 XI 2014); 2729 (12 XI 2014); 2732 (15 XI 2014); 2739 (14 XI 2014); 2756 (15 XI 2014); 2757 (15 XI 2014); 2777 (25 XI 2014); 2778 (25 XI 2014); 2779 (23 XI 2014); 2780 (22 XI 2014); 2781 (25 XI 2014); 2782 (25 XI 2014); 2783 (25 XI 2014); 2784 (25 XI 2014); 2785 (25 XI 2014); 2786 (25 XI 2014); 2831 (28 XI 2014); 2867 (25 XI 2014); 2922 (17 XII 2014); 2923 (16 XII 2014); 2924 (16 XII 2014); 2925 (12 XII 2014); 2926 (15 XII 2014); 2940 (15 XII 2014); 2970 (15 XI 2014); 2974 (17 XI 2014); 2988 (30 XII 2014); 2996 (2 I 2015); 3095 (19 I 2015); 3096 (20 I 2015); 3138 (2 II 2015); 3249 (28 II 2015); 3412 (16 III 2015); 3429 (26 III 2015).

*Erinnyis lassauxii* (Boisduval, 1859)

(4 specimens): 882 (22 V 2012); 2021 (19 V 2014); 2787 (25 XI 2014); 2949 (21 XII 2014).

*Erinnyis obscura* (Fabricius, 1775)



(21 specimens): 014 (29 V 2010); 033 (11 VI 2010); 977 (X/XI 2012); 1219 (8 III 2013); 1382 (1 IV 2013); 1386 (6 IV 2013); 2029 (16 V 2014); 2045 (27 V 2014); 2090 (19 VI 2014); 2237 (10 VIII 2014); 2694 (8 XI 2014); 2797 (25 XI 2014); 2891 (6 XII 2014); 2892 (6 XII 2014); 2939 (14 XII 2014); 2976 (17 XI 2014); 2989 (9 I 2015); 3203 (17 II 2015); 3381 (23 III 2015); 3436 (30 III 2015); 3446 (27 III 2015).

Specimens 2694 and 3436 are of the variation “*domingonis*”.

*Erinnyis oenotrus* (Cramer, 1780)

(24 specimens): 537 (13 II 2012); 552 (10 II 2012); 573 (20 XI 2011); 705 (9 XII 2011); 1313 (21 III 2013); 1482 (12 IV 2013); 1567 (10 V 2013); 1903 (14 XII 2013); 2003 (14 V 2014); 2004 (12 V 2014); 2056 (1 VI 2014); 2076 (15 VI 2014); 2077 (18 VI 2014); 2426 (24 IX 2014); 2471 (22 X 2014); 2580 (26 X 2014); 2581 (28 X 2014); 2645 (31 IX 2014); 2699 (6 XI 2014); 2723 (15 XI 2014); 2798 (25 XI 2014); 2832 (25 XI 2014); 2839 (28 XI 2014); 2993 (7 I 2015).

*Phryxus caicus* (Cramer, 1777)

(2 specimens): 686 (14 XI 2011); 702 (2 XII 2011).

#### Tribe Philampelini

*Eumorpha analis* (Rothschild & Jordan, 1903)

(14 specimens): 481 (18 X 2011); 484 (19 X 2011); 492 (undated); 554 (1 II 2012); 698 (23 XI 2011); 861 (12 V 2012); 1765 (11 X 2013); 1766 (11 X 2013); 2017 (15 V 2014); 2349 (3 IX 2014); 2466 (20 X 2014); 2895 (7 XII 2014); 2930 (12 XII 2014); 3246 (20 II 2015).

Drechsel (1994) referred to this species as *Eumorpha satellitia* (Linnaeus, 1771). It is a common species throughout eastern Paraguay.

*Eumorpha fasciatus* (Sulzer, 1776)

(1 specimen): 2947 (23 XII 2014).

*Eumorpha labruscae* (Linnaeus, 1758)

(7 specimens): 928 (2 III 2012); 1509 (6 V 2013); 1908 (19 XII 2013); 2427 (8 X 2014); 2825 (1 XII 2014); 2960 (24 XII 2014); 2961 (20 XII 2014).

*Eumorpha vitis* (Linnaeus, 1758)

(8 specimens): 228 (18 XI 2012); 244 (?? I 2012); 326 (2 III 2011); 574 (9 XII 2012); 621 (undated); 684 (8 XI 2011); 709 (9 XII 2012); 2927 (16 XII 2014).

#### Tribe Macroglossini

*Xylophanes chiron* (Drury, 1773)

(21 specimens): 298 (19 I 2011); 304 (22 II 2011); 320 (23 II 2011); 357 (10 III 2011); 698 (23 XI 2011); 851 (19 IV 2012); 976 (X/XI 2012); 1314 (20 III 2013); 1317 (22 III 2013); 1340 (25 III 2013); 1565 (11 V 2013); 1721 (1 IX 2013); 1912 (23 XI 2013); 1974 (21 III 2014); 2557 (25 X 2014); 2558 (27 X 2014); 2559 (25 X 2014); 2843 (1 XII 2014); 2954 (19 XII 2014); 2994 (30 XII 2014); 3090 (28 I 2015).

*Xylophanes elara* (Druce, 1878)

(2 specimens): 1270 (19 III 2013); 2381 (8 X 2014).

*Xylophanes loelia* (Druce, 1878)

(2 specimens): 312 (22 II 2011); 839 (23 IV 2012).

Drechsel (1994) cited this species as *X. libya* (Druce, 1878).

*Xylophanes pluto* (Fabricius, 1777)

(7 specimens): 006 (2 V 2010); 1774 (29 IX 2013); 1879 (15 XI 2013); 1880 (15 XI 2013); 1906 (19 XII 2013); 2841 (19 XI 2014); 2842 (15 X 2014).

*Xylophanes pistacina* (Boisduval, 1875)

(5 specimens): 1267 (19 III 2013); 1737 (2 X 2013); 2334 (25 VIII 2014); 2697 (12 XI 2014); 3164 (10 II 2015).

*Xylophanes porcus* (Hübner, 1823)

(2 specimens): 209 (29 IX 2010); 3432 (30 III 2015).

*Xylophanes tersa* (Linnaeus, 1771)

(20 specimens): 232 (?? XI 2010); 397 (21 III 2011); 485 (25 X 2011); 581 (18 XI 2011); 586 (27 II 2012); 685 (8 XI 2011); 690 (8 XI 2011); 691 (8 XI 2011); 1910 (23 XI 2013); 1939 (12 III 2014); 2361 (20 IX 2014); 2391 (23 IX 2014); 2519 (28 IX 2014); 2642 (2 XI 2014); 2643 (5 XI 2014); 2698 (13 XI 2014); 2752 (14 XI 2014); 2897 (7 XII 2014); 2995 (28 XII 2014); 3379 (25 III 2015).

*Xylophanes tyndarus* (Boisduval, 1875)

(7 specimens): 150 (28 VIII 2010); 510 (14 XI 2011); 840 (10 XII 2011); 878 (30 I 2012); 1905 (15 XII 2013); 2517 (28 IX 2014); 2844 (15 X 2014).

## Discussion

The role of Sphingidae as important pollinators of native plants is well known (Nilsson & Rabakonandrianina 1988, Haber & Frankie 1989, Miyake *et al.* 1998). Pollinators are considered important bioindicators because of their crucial role in plant reproduction in all terrestrial ecosystems, and consequently studies of their diversity can be useful in monitoring levels of environmental stress (Kevan 1999). Given the conspicuous nature of these charismatic moths, the ease with which they may be collected and their obvious utility in measuring the health of ecosystems, it is perhaps surprising that more attention has not been paid to the group by conservationists and no regional or global conservation assessment of the family has ever been proposed or attempted. An alarming recent increase in deforestation rates in Paraguay has been well-documented (Cardozo *et al.* 2013), yet a lack of reliable data on biodiversity in the country means that the impact of this destruction can only be guessed at. The availability of single site inventories such as the present study is a key step towards the effective monitoring and control of the effects of such destruction at the national level.

With the addition of species in this paper, the national list of Sphingidae documented in the scientific literature for Paraguay now stands at 95 species, 63 of which (66.32% of the total) occur in this single small private property.

A summary of the phenology of the collected specimens is provided in Table 1, though care must be taken in interpreting these data because of the unsystematic collecting effort over the study period. The species accumulation curve shows the results of uneven sampling, but levels off during 2014 when sampling was most intense (Table 2), suggesting that the site inventory is close to complete.



<i>Xylophanes chiron</i>	2	2	5	1	1	0	0	0	1	3	2	3
<i>Xylophanes elara</i>	0	0	1	0	0	0	0	0	0	1	0	0
<i>Xylophanes loelia</i>	0	1	0	1	0	0	0	0	0	0	0	0
<i>Xylophanes pluto</i>	0	0	0	0	1	0	0	0	1	1	3	1
<i>Xylophanes pistacina</i>	0	1	1	0	0	0	0	1	0	1	1	0
<i>Xylophanes porcus</i>	0	0	1	0	0	0	0	0	1	0	0	0
<i>Xylophanes tersa</i>	0	1	3	0	0	0	0	0	3	1	10	2
<i>Xylophanes tyndarus</i>	1	0	0	0	0	0	0	1	1	1	1	2
<b>RICHNESS</b>	<b>23</b>	<b>25</b>	<b>37</b>	<b>22</b>	<b>25</b>	<b>16</b>	<b>14</b>	<b>10</b>	<b>27</b>	<b>40</b>	<b>43</b>	<b>40</b>

The list for RLB compares favourably with published lists for single sites at similar latitudes in Paraguay and neighbouring countries: Reserva Natural Dimas, Departamento Alto Paraná, Paraguay (51 species: Drechsel 2014b), Garay Cue, Departamento Alto Paraná, Paraguay (33 species: Drechsel 2014c), Reserva Privada Yacutinga, Provincia Misiones, Argentina (52 species: Rodríguez & Núñez Bustos 2017), PN Calilegua, Provincia Jujuy, Argentina (36 species: Valverde 1999), Aguas Blancas, Provincia Salta, Argentina (39 species: Nuñez-Bustos 2009), Serra do Mar, Paraná State, Brazil (50 species: Laroca *et al.* 1989). Consequently, despite the longer sampling period employed in this study when compared with most of the others, it may be assumed that RLB is of regional importance for the conservation of these moths.

Sustained inventory work by PLT at RLB has demonstrated the cross-taxon importance of the property at a national level, with numerous taxa currently recorded here that are not known to occur elsewhere in Paraguay (Cacciali *et al.* 2013, Smith *et al.* 2013a,b, Smith *et al.* 2014, Brouard *et al.* 2015, Smith *et al.* 2015, Smith *et al.* 2016). RLB has been recognised as an Important Bird Area PY021 by Birdlife International (Guyra Paraguay 2008), proposed as an Important Area for Amphibians and Reptiles (Smith *et al.* 2016) and proposed as an AZE site (Alliance for Zero Extinction). The results here indicate that the importance of this property for the protection of biodiversity in Paraguay also extends to Sphingidae.

Despite its indisputable value as a conservation unit, the long term protection of the site remains unconsolidated, and the reserve status it once held expired at the end of January 2015. The property is now up for sale and facing imminent destruction. Securing the long term protection of the site must now be made a national conservation priority.

**Table 2.** Sampling Effort: Number of specimens collected per year per species. (+X) refers to additional specimens for which no precise phenological data is available.

	2010	2011	2012	2013	2014	2015	TOTAL
SUBFAMILY SMERINTHINAE							
<i>Protambulyx astygonus</i>	0	0	2	1	2	0	5
<i>Protambulyx eurycles</i>	0	3	2	3	15	1	24
<i>Protambulyx strigilis</i>	0	0	5	2	6	2	15
<i>Orecta lycidas</i>	0	1	1	2	2	2	8
<i>Adhemarius daphne</i>	3	1	2	6	12	2	26
<i>Adhemarius eurysthene</i>	0	1	0	0	0	0	1
<i>Adhemarius gannascus</i>	0	0	0	0	2	1	3
SUBFAMILY SPHINGINAE							
<i>Agrius cingulata</i>	0	0	0	0	4	1	5
<i>Neogene dynaeus</i>	0	2	0	0	0	0	2
<i>Manduca contracta</i>	0	2	0	2	0	0	4
<i>Manduca corumbensis</i>	1	0	0	0	0	0	1
<i>Manduca diffissa</i>	0	1	0	1	2	0	4
<i>Manduca florestan</i>	0	5	2	6	4	4	21 (+2)
<i>Manduca lefeburii</i>	0	0	0	1	0	0	1
<i>Manduca leucospila</i>	1	0	0	0	0	0	1
<i>Manduca manducoides</i>	0	0	0	1	4	0	5

<i>Manduca rustica</i>	0	3	1	4	3	2	13 (+1)
<i>Manduca sexta</i>	4	2	1	9	20	14	50
<i>Cocytius antaeus</i>	0	0	0	1	0	0	1
<i>Cocytius duponchel</i>	0	1	0	0	3	0	4
<i>Cocytius lucifer</i>	0	2	0	0	0	0	2
SUBFAMILY MACROGLOSSINAE							
<i>Unzela japix</i>	0	0	0	1	1	0	2
<i>Enyo gorgon</i>	5	0	1	0	5	0	11
<i>Enyo lugubris</i>	1	1	4	3	22	4	35
<i>Enyo ocypte</i>	0	4	3	1	10	2	20 (+1)
<i>Callionima inuus</i>	2	5	2	6	12	2	29
<i>Callionima grisescens</i>	1	3	2	5	66	5	82
<i>Callionima guiarti</i>	0	0	0	3	3	2	8
<i>Callionima parce</i>	0	1	0	6	19	11	37 (+1)
<i>Callionima falcifera</i>	1	1	1	2	9	2	16
<i>Madoryx oiclus</i>	0	0	0	2	4	0	6
<i>Pachylia ficus</i>	1	7	3	10	14	1	36
<i>Pachylioides resumens</i>	4	8	6	15	56	3	92 (+2)
<i>Nyceryx alophus</i>	0	1	0	0	0	0	1
<i>Nyceryx continua</i>	0	0	0	0	3	0	3
<i>Nyceryx furtadoi</i>	1	0	0	0	0	0	1
<i>Nyceryx riscus</i>	0	2	0	2	8	0	12
<i>Nyceryx stuarti</i>	0	0	0	1	4	0	5
<i>Perigonia ilus</i>	0	0	0	0	4	1	5
<i>Perigonia pallida</i>	0	2	0	2	4	1	9
<i>Eupyrhroglossum sacra</i>	0	0	1	0	0	0	1
<i>Aellopos fadus</i>	1	0	0	0	0	1	2
<i>Aellopos titan</i>	1	1	1	2	6	1	12
<i>Isognathus caricae</i>	0	0	0	1	3	0	4
<i>Erinnyis alope</i>	4	2	5	6	16	0	33
<i>Erinnyis crameri</i>	5	1	2	9	14	1	32
<i>Erinnyis ello</i>	4	5	1	12	56	7	84 (+1)
<i>Erinnyis lassauxii</i>	0	0	1	0	3	0	4
<i>Erinnyis obscura</i>	2	0	1	3	10	5	20 (+1)
<i>Erinnyis oenotrus</i>	0	2	2	4	15	1	24
<i>Phryxus caicus</i>	0	2	0	0	0	0	2
<i>Eumorpha analis</i>	0	3	2	2	5	1	13 (+1)
<i>Eumorpha fasciatus</i>	0	0	0	0	1	0	1
<i>Eumorpha labruscae</i>	0	0	1	2	4	0	7
<i>Eumorpha vitis</i>	0	2	4	0	1	0	7 (+1)
<i>Xylophanes chiron</i>	0	5	2	6	7	1	20 (+1)
<i>Xylophanes elara</i>	0	0	0	1	1	0	2
<i>Xylophanes loelia</i>	0	1	1	0	0	0	2
<i>Xylophanes pluto</i>	1	0	0	4	2	0	7
<i>Xylophanes pistacina</i>	0	0	0	2	2	1	5
<i>Xylophanes porcus</i>	1	0	0	0	0	1	2
<i>Xylophanes tersa</i>	1	6	1	1	10	1	20
<i>Xylophanes tyndarus</i>	1	2	1	1	2	0	7
Species accumulation by year	22	21	5	10	5	0	63
Total species collected by year	22	35	31	42	48	31	
Total specimens collected by year	46	89	64	153	481	84	917 (+12)

### Acknowledgements

We thank SEAM for issuing the relevant collecting permits. Particular thanks to Malvina Duarte the co-owner of Laguna Blanca for her foresight and support, without which the fieldwork would not have been possible. All PLT staff volunteers and interns who contributed to the hawkmoth inventory



by assisting in the field work deserve praise for their efforts and dedication to the cause, including Jorge Ayala, Jean-Paul Brouard, Kevin Guest and Helen Pheasey. Thanks to Stefan Harrison and Daniel Schoenberger (Para La Tierra) for taking photos of the specimens. Ian Kitching (Natural History Museum, London, UK) very helpfully sent us some hard to find literature. Funding for this work was partly provided by the PRONII program of CONACYT (PS, SDR, KA).

### References

- Brouard, J.P., Manders, R. & Smith, P. 2015. *Elachistocleis matogrosso* Caramaschi 2010, (Amphibia: Anura: Microhylidae) first records for Paraguay. *Cuadernos de Herpetología* 29: 97-98.
- Cacciali, P., Smith, P., Kallberg, A., Pheasey, H. & Atkinson, K. 2013. Reptilia, Squamata, Serpentes *Lygophis paucidens* Hoge, 1952: First record for Paraguay. *Check List* 9: 131-132.
- Carcasson, R.H. & Heppner, J.B. 1996. Sphingidae. In: Heppner, J.B. (Ed.): *Atlas of Neotropical Lepidoptera Vol. 4B Drepanoidea, Bombycoidea, Sphingoidea*, pp. 50-60. Association of Tropical Lepidoptera, Gainesville.
- Cardozo, R., Palacios, F., Rodas, O. & Yanosky, A. 2013. Cambio en la cobertura de la tierra del Gran Chaco Americano en el año 2012. *Paraquaria Natural* 1(2): 43-49.
- Critical Ecosystem Partnership Fund. 2015. Hotspots South America. <http://www.cepf.net/resources/hotspots/South-America/Pages/default.aspx> (Consulted: June 2015).
- D'Abraera, B. [1987] 1986. *Sphingidae Mundi. Hawkmoths of the World*. E.W. Classey, Oxon, UK, 226 pp.
- Drechsel, U. 1994. Beitrag zur Kenntnis der Sphingidenfauna von Paraguay (Lepidoptera: Sphingidae). *Entomologische Zeitschrift* 104: 265-276.
- Drechsel, U. 2014a. *Protambulyx eurycles* (Herrich-Schaeffer, 1854) new record from Paraguay (Lepidoptera: Sphingidae). *Paraguay Biodiversidad* 1: 19-21.
- Drechsel, U. 2014b. Biodiversity research in "Reserva Natural Dimas". *Paraguay Biodiversidad* 1: 38-43.
- Drechsel, U. 2014c. Preliminary studies of the biodiversity in Garay Cue "Reserva Natural Privada Cerrados del Tagatiya". *Paraguay Biodiversidad* 1: 51-60.
- Drechsel, U., Escobar, J. & Peña Escobar, S. 2014. Paraguay Biodiversidad. <http://www.pybio.org/5614/sphingidae-1/> (Consulted: July 2014).
- Eitschberger, U. 2001. Die Gattung *Callionima* Lucas, 1857 (Lepidoptera, Sphingidae). *Neue Entomologische Nachrichten* 51: 153-224.
- Eiten, G. 1972. The cerrado vegetation of Brazil. *Botanical Review* 38: 201-341.
- Eiten, G. 1978. Delimitation of the cerrado concept. *Vegetation* 36: 169-178.
- FAUNA Paraguay 2014. FAUNA Paraguay Checklist of Paraguayan Hawkmoths. (Consulted: December, 2014) <http://www.faanaparaguay.com/sphingidae.html>.
- Guyra Paraguay. 2008. *Áreas importantes para la conservación de las aves del Paraguay*. Guyra Paraguay, Asunción, 470 pp.
- Haber, W.A. & Frankie, G.W.. 1989. A tropical hawkmoth community: Costa Rican dry forest Sphingidae. *Biotropica* 21: 155-172.

- Haxaire, J., Rougerie, R., Mielke, C.G.C. & Kitching, I.J. 2015. *Manduca exiguus* (Gehlen, 1942): a valid species from southern and southeastern Brazil, Uruguay and northeastern Argentina (Lepidoptera : Sphingidae). *Nachrichten des Entomologischen Vereins Apollo* 36: 49-54.
- Kevan, P.G. 1999. Pollinators as bioindicators of the state of the environment: species, activity and diversity. *Agriculture, Ecosystems and Environment* 74: 373-393.
- Kitching, I.J. & Cadiou, J.M. 2000. *Hawkmoths of the world: An Annotated and Illustrated Revisionary Checklist (Lepidoptera: Sphingidae)*. The Natural History Museum, London & Cornell University Press. Ithaca. 226 pp.
- Kitching, I., Ledezma, J. & Baixeras, J. 2001. An annotated checklist of the Sphingidae of Bolivia. Una lista comentada de los Sphingidae de Bolivia (Insecta: Lepidoptera). *Gayana* 65(2): 79-111.
- Kitching, I.J., Scoble, M.J., Smith, C.R., James, S., Young, R. & Blagoderov, V. 2014. *CATE Sphingidae*, <http://www.cate-sphingidae.org> (Consulted: April, 2014).
- Laroca, S., Becker, V.O. & Zanella, F. 1989. Diversidade, abundancia relativa e fenología em Sphingidae (Lepidoptera) na Serra do Mar (Quatro Barras, Pr), sul do Brasil. *Acta Biologica Paranaense* 18: 13-53.
- Miyake, T., Yamaoka, R. & Yahara, T. 1998. Floral scents of hawkmoth pollinated flowers in Japan. *Journal of Plant Research* 111: 199-205.
- Martin, A., Soares, A. & Bizarro, J. 2011. *Guia dos Sphingidae da Serra dos Órgaos, Sudeste do Brasil. A Guide to the hawkmoths of the Serra dos Orgaos, South-eastern Brazil*. Regua Publications. Oxford, United Kingdom. 143 pp.
- Moré, M., Kitching, I.J. & Cocucci, A.A.. 2005. *Sphingidae: Esfingidos de Argentina*. LOLA, Buenos Aires. 166 pp.
- Nilsson, L.A. & Rabakonandrianina, E. 1988. Hawk-moth scale analysis and pollination specialization in the epilithic Malagasy endemic *Aerangis ellisii* (Reichenb. fil.) Schltr. (Orchidaceae). *Botanical Journal of the Linnean Society* 97: 49-61.
- Núñez-Bustos, E. 2008. Las especies de Sphingidae de la Reserva Privada Yacutinga, Provincia de Misiones, Argentina. *SHILAP Revista de Lepidopterología* 36: 219-226.
- Núñez-Bustos, E. 2009. Sphingidae de la zona de Aguas Blancas, provincia de Salta (Argentina), con comentarios sobre nuevos registros provinciales (Lepidoptera: Sphingidae). *SHILAP Revista de Lepidopterología* 37: 363-369.
- Núñez Bustos, E. 2015. Catálogo revisado y actualizado de Sphingidae de Argentina, con seis nuevos registros (Lepidoptera: Sphingidae). *SHILAP Revista de lepidopterología*, 43(172): 615-631.
- Orfila, R.N. 1933. Estudios de lepidopterología III. Catálogo sistemático de los Sphingidae (Lep.). *Revista de la Sociedad Entomológica Argentina* 23: 189-206.
- Podtiaguin, B. 1941. Notulae entomologicae. III. Notas lepidopterológicas. Algunos pequeños datos sobre los esfingidos de Asunción y sus alrededores. *Revista de la Sociedad Científica del Paraguay* 5(3): 64-72.
- Poulard, J. 1983. Colección de lepidópteros de las zonas de Caaguazú, Isla Yacyretá y Cerro León, Paraguay. *Informes Científicos* 4: 128-129.
- Ríos Díaz, S.D. 2014. Catálogo de los Sphingidae (Insecta: Lepidoptera) depositados en el Museo Nacional de Historia Natural del Paraguay. *Boletín del Museo Nacional de Historia Natural del Paraguay* 18:111-124.
- Rodríguez Ramírez, J. & Núñez Bustos, E. 2017. Dos nuevos registros de Sphingidae (Lepidoptera: Bombycoidea) de Salta, con nuevos aportes de distribución de nueve especies en la Argentina. *Revista de la Sociedad Entomológica Argentina* 76 (1-2): 57-60.
- Schade, F. 1927. Entomologische skizzen aus Paraguay. IV. Sphingidae. *Entomologische Rundschau*, 44(5-6): 20/23-24.

- Schmit, P., Meister, F. & Knorke, A. 2004. Contribution à la connaissance des Sphingidae (Lepidoptera) de deux Parcs Nationaux du Nord de l'Argentine. *Bulletin Lépidotéristes Parisiens* 13: 42-45.
- Smith, P., Atkinson, K., Brouard, J.P. & Pheasey, H. 2016. Reserva Natural Laguna Blanca, Departamento San Pedro: Paraguay's first Important Area for the Conservation of Amphibians and Reptiles? *Russian Journal of Herpetology* 23: 25-34.
- Smith, P., Cacciali, P., Scott, N., del Castillo, H., Pheasey, H. & K. Atkinson. 2014. First record of the globally-threatened Cerrado endemic snake *Philodryas livida* (Amaral, 1923) (Serpentes, Dipsadidae) from Paraguay, and the importance of the Reserva Natural Laguna Blanca to its conservation. *Cuadernos de Herpetología* 28: 169-171.
- Smith, P., Rios Diaz, S.D., Atkinson, K., Mielke, O. & Casagrande, M. 2013a. *Almeidaia aidae* Mielke & Casagrande (Lepidoptera: Saturniidae): First record for Paraguay. *Entomological News* 123: 38-40.
- Smith, P., Rios Diaz, S.D., Petko, O. & Atkinson, K. 2015. The giant butterfly moths (Insecta, Lepidoptera, Castniidae) of Reserva Natural Laguna Blanca, Departamento San Pedro, Paraguay with a new country record. *Boletín de la Sociedad Entomológica Aragonesa* 57: 304-306.
- Smith, P., Scott, N., Cacciali, P., Atkinson, K. & Pheasey, H. 2013b. Confirmation of the presence of *Philodryas nattereri* Steindachner, 1870 (Squamata: Dipsadidae) in Paraguay. *Herpetozoa* 26: 91-94.
- Soares, A. 1993. Nota sobre o gênero *Callionima* Lucas, 1856 (Lepidoptera, Sphingidae, Macroglossinae, Dilophonotini). *Revista Brasileira de Entomologia* 37: 35-39.
- Tuttle, J.P. 2007. *The Hawk Moths of North America. A Natural History Study of the Sphingidae of the United States and Canada*. The Wedge Entomological Research Foundation. xviii+253 pp.
- Vaglia, T. & Haxaire, J. 2005. Revision des *Adhemarius* du complexe *gannascus*. *Lambillionea* 1(3): 3-45.
- Valverde, L. 1999. Sphingidae del Parque Nacional Calilegua (Jujuy, Argentina) (Insecta, Lepidoptera). *SHILAP Revista de Lepidopterología* 27: 215-223.

**Recibido: 14 noviembre 2017**

**Aceptado: 6 diciembre 2017**