

ISSN 1021-0296

REVISTA NICARAGUENSE DE ENTOMOLOGIA

N° 75.

Diciembre 2013

ADDITIONS TO THE BUTTERFLY FAUNA OF NICARAGUA.

Hilary E. Erenler, Michael P. Gillman & Erico M. Téllez.



**PUBLICACIÓN DEL MUSEO ENTOMOLÓGICO
ASOCIACIÓN NICARAGÜENSE DE ENTOMOLOGÍA
LEON - - - NICARAGUA**

La Revista Nicaragüense de Entomología (ISSN 1021-0296) es una publicación reconocida en la Red de Revistas Científicas de América Latina y el Caribe, España y Portugal (Red ALyC) e indexada en los índices: Zoological Record, Entomological Abstracts, Life Sciences Collections, Review of Medical and Veterinary Entomology and Review of Agricultural Entomology. Los artículos de esta publicación están reportados en las Páginas de Contenido de CATIE, Costa Rica y en las Páginas de Contenido de CIAT, Colombia. Todos los artículos que en ella se publican son sometidos a un sistema de doble arbitraje por especialistas en el tema.

The *Revista Nicaragüense de Entomología* (ISSN 1021-0296) is a journal listed in the Latin-American Index of Scientific Journals. It is indexed in: Zoological Records, Entomological, Life Sciences Collections, Review of Medical and Veterinary Entomology and Review of Agricultural Entomology. And reported in CATIE, Costa Rica and CIAT, Colombia. Two independent specialists referee all published papers.

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Foto de la portada: *Strymon zyba* (HEWITSON, 1868).

ADDITIONS TO THE BUTTERFLY FAUNA OF NICARAGUA.

Hilary E. Erenler¹, Michael P. Gillman² & Erico M. Téllez³.

Abstract

Central America is an important biogeographical junction where many Nearctic and South American butterfly populations overlap. Whilst some countries, such as Costa Rica and Mexico, have been the focus of intensive sampling effort to document the species that exist there, others have received less attention.

Here we confirm the presence of 10 species not formally listed for Nicaragua, together with the sighting of a species known only from a specimen collected in the country more than 140 years ago. Twenty-two additional species (the majority of which were recorded ~40 years ago) which do not yet appear in the most comprehensive online resource for Nicaraguan butterflies are also listed, based on our own recent observations. Data covering all 33 species are derived from Pollard walk-and-count transects at seven lowland Pacific dry-forest sites. Live specimens were documented by taking digital images of individuals *in situ* or displayed in the hand following net capture.

Approximately 80% of the species come from by individuals recorded at a single location, with 55% represented by a single specimen. Hesperidae account for the greatest number of species (16), followed by Lycaenidae (7), Riodinidae (7), Nymphalidae (2) and Pieridae (1).

Taking all 33 species into account, Isla de Ometepe in Lake Nicaragua yielded the highest number of species based on standardised encounter rates. This may reflect the fact that limited sampling has been done on the island or that the forest fragments present there benefit from increased humidity, which in turn support greater host-plant diversity.

The value of ongoing data gathering in a country that has, to date, been incompletely sampled is discussed.

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Introduction

Central America is a known biodiversity hotspot (Conservation International, 2014). Underpinned by a rich flora, its lowland forests support a wealth of invertebrates, of which butterflies are a charismatic group (Horner-Devine et al., 2003).

The region's zoological and botanical wealth was documented at length by Godman and Salvin in the late eighteenth and early nineteenth centuries in their 63-volume *Biologica Centrali-Americana* (Godman and Salvin, 1879-1915). In their general discussion on Central American butterfly richness (relating to an area extending from Mexico to the isthmus of Panama), they concluded that the region's diversity was heightened by tropical South American butterfly groups at the northern limits of their ranges converging with those that extended south from the Nearctic (Godman and Salvin, 1901). Following on from this view, there is the continued expectation that species noted as present in countries north and south of a location, are reasonably likely to be encountered if sufficient sampling effort is employed (Robbins et al., 2012).

In recent times, specific countries rather than the region as a whole have been the subject of intense research effort. As a result, Costa Rica and Mexico have come to dominate the present-day literature on Mesoamerican butterflies (Janzen 1983, DeVries 1987a,b, Luis-Martínez et al. 2003 and Glassberg 2007). Other countries in Central America such as Honduras, Guatemala and Nicaragua remain less well documented, relying instead on intensive, but sporadic, collecting events to contribute to country lists (Anderson, 2007 and Robbins et al. 2012).

Here we present confirmed additions to the butterfly fauna of Nicaragua for specific inclusion in the online resource, Bio-Nica (Maes, 2014). These additions are based on our own observations made during visits to the country over a five-year period, and include our own sightings of some species first observed in the mid-1970s by Anderson and Sullivan (Anderson 2007 and Robbins et al., 2012).

Methods

Seasonally-dry forest fragments in lowland Pacific Nicaragua were the focus for our sampling with most, but not all, forest patches (maximum altitude 350m) associated with nearby active volcanoes, (Table 1, Figure 1). We used standard Pollard walk-and-count techniques (Pollard, 1977) to observe and document butterflies in wet and dry seasons during visits to the country from 2008 to 2013. The time spent recording along each transect was noted to allow a standardised 'encounter rate per hour' calculation to be made for each site.

Where possible, digital images of butterflies *in situ* were taken. Species requiring specific identification features to be checked were caught in a net and photographed in the hand.

Table 1 Location and description of the seven sites used for butterfly sampling.
(MARENA = Ministerio del Ambiente y los Recursos Naturales)

Location and District (Site name used in Table 2)	Number on Map (Figure 1)	Description
Reserva Telica-Rota, León (Telica-Rota)	1	MARENA-administered area, with controlled agricultural activities. Slopes of Volcán Rota and Santa Clara
Parque Nacional Volcán Masaya, Masaya (PNVM)	2	MARENA-administered National Park containing Volcán Masaya
San Juan de la Concepción, Masaya (San Juan)	3	Private land and public right of way south west of San Juan de la Concepción. Partially under the plume of Volcán Masaya
Masaya (South)	4	Private forested land with seasonally-dry river bed
Laguna de Apoyo, Masaya/Granada (Apoyo)	5	MARENA-administered area comprised of an old caldera (now a fresh water lagoon) surrounded by mature seasonally-dry forest
Isla de Ometepe, Rivas (Ometepe - Conc.)	6	MARENA-administered area with agricultural activities. Slopes of Volcán Concepción
Isla de Ometepe, Rivas (Ometepe - Mad.)	7	MARENA-administered area with agricultural activities. Slopes of Volcán Maderas

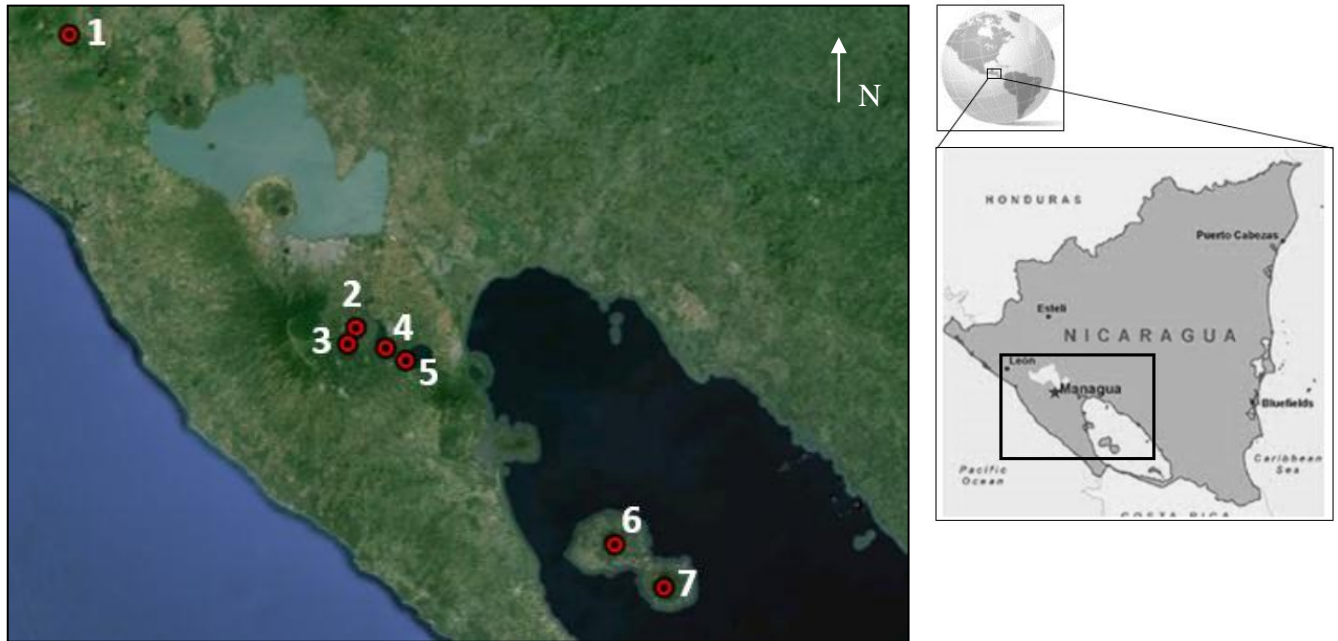


Figure 1 Location of the seven sites visited for butterfly sampling (2008-2013). 1 - Reserva Telica-Rota, León, 2 - Parque Nacional Volcán Masaya, Masaya, 3 - San Juan de la Concepción, Masaya, 4 - Masaya (South), 5 - Laguna de Apoyo, Masaya/Granada, 6 - Isla de Ometepe, Rivas (Volcán Concepción), 7 - Isla de Ometepe, Rivas (Volcán Maderas). (Images: Google Earth, 2014 and WikiMedia Commons, 2014).

Three sources were used to identify the species observed: DeVries (1987), Glassberg (2007) and the website Butterflies of America (Warren et al., 2014)

Of the 285 species recorded (represented by ~8500 individuals), 33 species appeared to be new country-record candidates based on their absence from either the *Catálogo De Los Insectos Y Arthropodos Terrestres de Nicaragua Volumen III* (Maes, 1999), or the website Bio-Nica (Maes, 2014). Together, these two resources represent the most comprehensive list of Lepidoptera for the country. To check further for prior existence of these species in the country, additional searches were made using the images of live butterflies and pinned museum specimens on the Butterflies of America website (Warren et al., 2014), together with the lists of HesperIIDae and LycaenIDae collected in the mid-1970s by Anderson and Sullivan (Anderson, 2007 and Robbins et al., 2012).

Following this two-stage process, a species was categorised as:

- A) A new country record i.e. not previously recorded or documented in the sources outlined above
- B) Not listed in the Maes (1999) or Bio-Nica (Maes, 2014) sources, but represented by an image taken in Nicaragua and included on the Butterflies of America website

- C) Not listed in the Maes (1999) or Bio-Nica (Maes, 2014) sources, but listed in either Anderson (2007) or Robbins (2012)
- D) Listed on the Bio-Nica (2014) website, but with the sole material examined listed as being more than 140 years old

Species names conform to those used on the Butterflies of America website (Warren et al. 2014) and are presented alphabetically within family. Digital images of the species presented here are given in Appendix I.

Results

Based on category A in the Methods section, 10 species of butterfly emerged as new records for Nicaragua. These 10 were from the families HesperIIDae, Nymphalidae and Riodinidae. In addition, four species were represented by a photograph of a single individual on the Butterflies of America website (category B), with a further 16 species listed in the works of Anderson (2007) and Robbins et al. (2012) (category C). Two species were found to be in both categories B and C. Finally, one species was known from a single Nicaraguan specimen collected more than 140 years ago by Thomas Belt (Table 2).

Parque Nacional Volcán Masaya (PNVM) was the site where the greatest proportion of species were encountered (24 of the 33 species, Table 2). However, when sampling effort was accounted for (calculated as the rate of encountering a new species per hour of sampling), Volcán Maderas on Isla de Ometepe within Lake Nicaragua was the richest location for both new country records and all records combined (Figure 2).

Table 2 Confirmed additions to the online Bio-Nica lists of the butterfly fauna of Nicaragua. Categories A-D are described in full in Methods. Category B includes the image date as recorded on the Butterflies of America website. The location and date column relates to observations made by the authors from 2008-13. Images are provided in Appendix I.

Family and species	Country record category (see Methods above)	Location(s) and date(s) observed (2008-2013) (See Table 1 for descriptions of each site)
Hesperiidae		
<i>Amblyscirtes tolteca tolteca</i> Scudder, 1872	C	Masaya (PNVM) VII-13
<i>Callimormus juvenis</i> Scudder, 1872	C	Apoyo XII-13, Ometepe (Mad. And Conc.) XII-13
<i>Copaeodes minima</i> (W. H. Edwards, 1870)	C	Masaya (PNVM) VIII-10, XII-11
<i>Cymaenes alumna</i> (A. Butler, 1877)	C	Ometepe (Mad.) XII-13
<i>Cynea irma</i> (Möschler, 1879)	C	Masaya (PNVM) XII-13
<i>Epargyreus aspina</i> Evans, 1952	B (2003)	Masaya (PNVM) VIII-10, Apoyo XII-13
<i>Lerodea arabus</i> (W. H. Edwards, 1882)	C	Masaya (PNVM) XII-11, Ometepe (Conc.) XII-13
<i>Monca crispinus</i> (Plötz, 1882)	A	Masaya (PNVM) XII-11, San Juan VII-13
<i>Neoxeniades luda</i> (Hewitson, 1877)	C	Masaya (PNVM) XII-11
<i>Ocyba calathana calanus</i> (Godman & Salvin, 1894)	B (2003), C	Masaya (PNVM) VIII-10
<i>Perichares poaceaphaga</i> Burns, 2008	A	Telica-Rota XII-13
<i>Quasimellana eulogius</i> (Plötz, 1882)	C	Masaya (South) VII-13, Masaya (PNVM) XII-13
<i>Staphylus caribbea</i> (R. Williams & E. Bell, 1940)	C	Apoyo XII-13
<i>Staphylus vulgata</i> (Möschler, 1879)	C	Masaya (PNVM) VIII-10, XII-11, VII-13, XII-13, Telica-Rota XII-13, Apoyo XII-13, Ometepe (Conc. & Mad.) XII-13
<i>Urbanus pronus</i> Evans, 1952	A	Masaya (PNVM) VIII-10
<i>Vacerra litana</i> (Hewitson, 1866)	D (1868-72)	Masaya (PNVM) XII-13
Lycaenidae		
<i>Atlides rustan</i> (Stoll, 1790)	C	Masaya (PNVM) VIII-10, II-13
<i>Chlorostrymon simaethis sarita</i> (Skinner, 1895)	C	Masaya (PNVM) II-12
<i>Panhiades bathildis</i> (C. Felder & R. Felder, 1865)	B (1976), C	Masaya (PNVM) II-12, II-13, VII-13, XII-13
<i>Strymon cestri</i> (Reakirt, [1867])	C	Masaya (PNVM) II-13
<i>Strymon istapa istapa</i> (Reakirt, [1867])	C	Masaya (PNVM) II-10, II-12
<i>Strymon ziba</i> (Hewitson, 1868)	C	Masaya (PNVM) I-11, II-11, XII-11, XII-13

<i>Theritas theocritus</i> (Fabricius, 1793)	C	Masaya (PNVM) XII-11
Nymphalidae		
<i>Dynamine artemisia</i> (Fabricius, 1793)	A	Ometepe (Mad.) XII-13
<i>Taygetis uncinata</i> Weymer, 1907	A	Masaya (PNVM) XII-11
Pieridae		
<i>Perrhybris pamela chajulensis</i> J. Maza & R. G. Maza, 1989	B (1978)	Ometepe (Mad.) XII-13
Riodinidae		
<i>Baeotis zonata zonata</i> R. Felder, 1869	B (1976)	San Juan VII-13
<i>Behemothia godmanii</i> (Dewitz, 1877)	A	Masaya (PNVM) XII-11
<i>Calephelis costaricicola</i> Strand, 1916	A	Masaya (PNVM) III-08, II-10, VIII-10, 1-11, II-II, XII-11, II-12, III-12, VII-13
<i>Calephelis sixola</i> McAlpine, 1971	A	Masaya (PNVM) XII-11, III-12, Apoyo XII- 13, Masaya (South) XII-13
<i>Euselasia sergia</i> (Godman & Salvin, 1885)	A	Ometepe (Mad.) XII-13
<i>Perophtalma lasus</i> Westwood, 1851	B (1976)	Ometepe (Mad.) XII-13
<i>Voltinia umbra</i> (Boisduval, 1870)	A	Masaya (PNVM) VIII-10, XII-11, XII-13

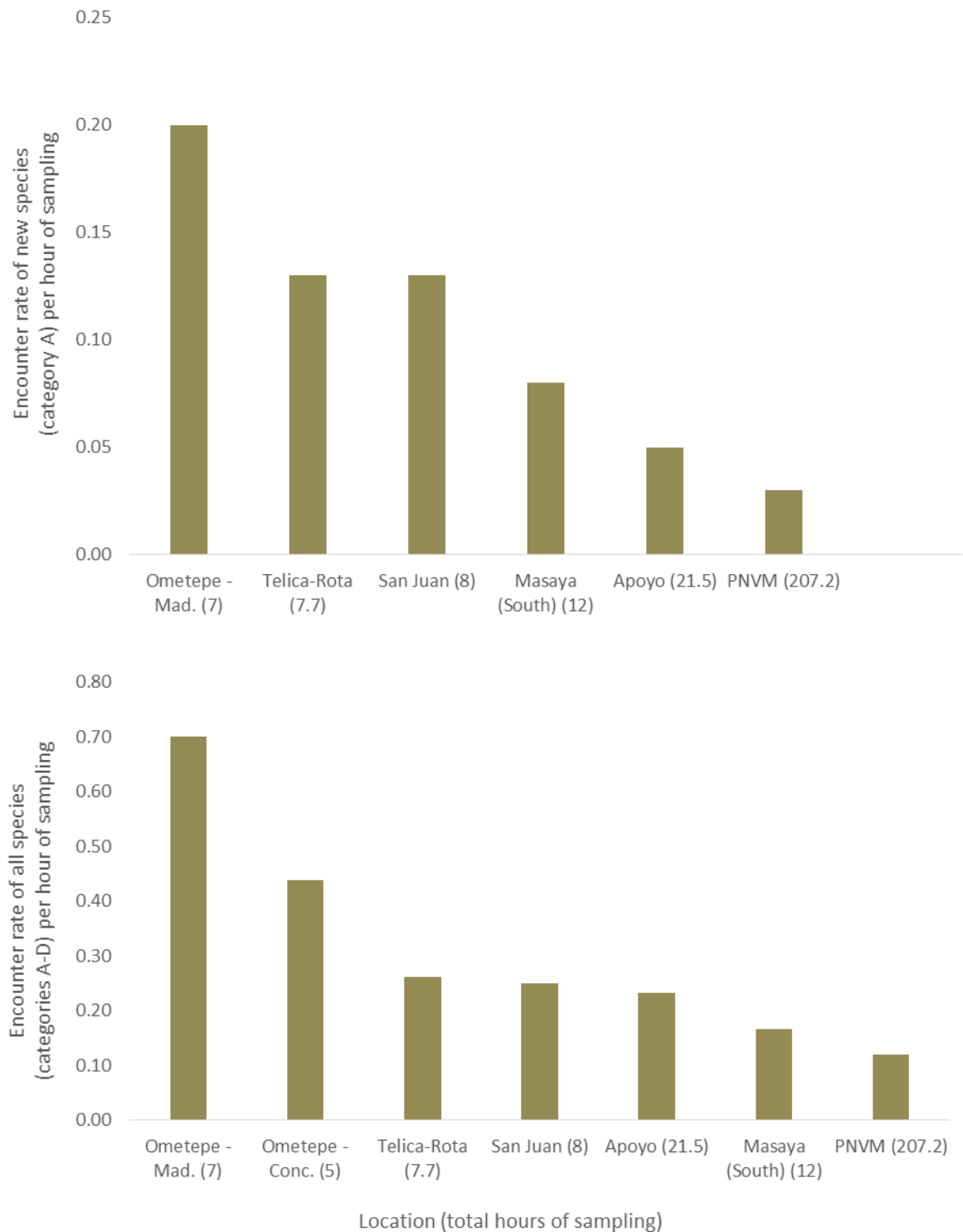


Figure 2 Encounter rate for category A only, and categories A-D combined, per hour of sampling for each location.

Approximately 80% of the species (category A only and categories A-D combined) were represented by individuals observed at only one of the seven sites (Figure 3), with 55% of all species (categories A-D) represented by only a single individual (data not presented).

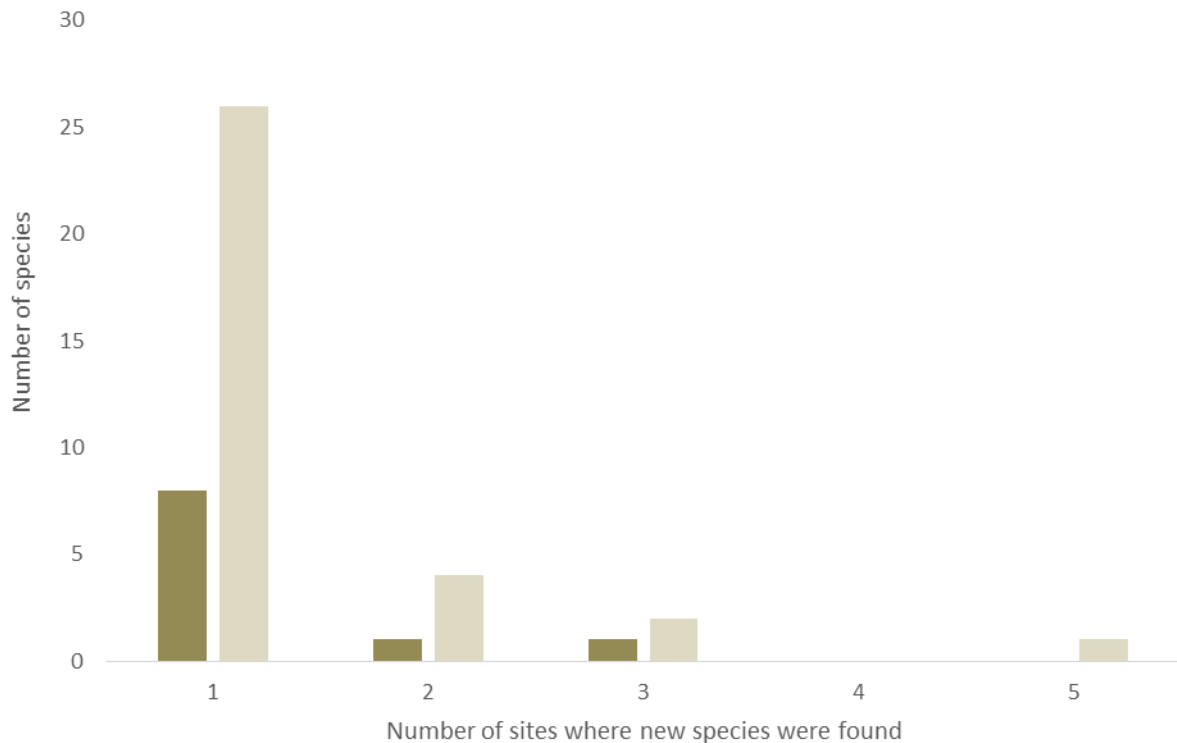


Figure 3 Number of species encountered ranked according to the number of sites where they were present. Dark grey bars - category A only, light grey bars - categories A-D combined.

Discussion

The advantage of using the walk-and-count method to record butterfly species richness is evidenced by both the number of species encountered as well as their spread over five families. This is in contrast to the valuable, but taxonomically more restricted, method of fruit trapping, which skews sampling in favour of a relatively small number of nymphalid species (Wood and Gillman, 1998).

The highest encounter rates for species from the combined categories A-D were at the two Isla de Ometepe sites (Volcán Maderas, 0.7 species hr⁻¹ and Volcán Concepción, 0.44 species hr⁻¹). Volcán Maderas on Ometepe was also the site where the highest number of new species were encountered (category A, 0.2 species hr⁻¹, Figure 2). The fact that the two Isla de Ometepe sampling sites did not materially

differ from the other five sites in respect to altitude, land use or proximity to the Pacific coast, means an alternative explanation for the difference is likely. The higher values may be the result of the location of the sites within Laguna de Nicaragua (resulting in higher humidity levels, and therefore potentially different species compositions in the dry and moist lowland forest fragments present there), or they may simply reflect the limited collecting effort that has taken place there in the past (Anderson, 2007 and Sullivan *pers. comm.*).

The number of species recorded from only a single location is noteworthy, with 80% of the new species (category A) and 79% those in the combined categories A-D observed at only one site (Figure 3). Rather than suggesting site fidelity, these figures may indicate that movement between locations is increasingly difficult (or even impossible), as pressure on land and forests for increased agricultural activities and firewood collection accelerates fragmentation of prime habitat. Further work on landscape use and the turnover of species between sites, such as that by Horner-Devine et al. (2003) is needed to better understand potential restrictions to dispersal between and within Nicaraguan forest fragments.

Some of the observed species, such as *Behemothia godmanii* and *Perrhybris pamela chajulensis* are noted as regional rarities, and are seen only occasionally in the whole of Central America (DeVries, 1987b, Warren et al., 2014). Others, whilst not considered regionally rare, remain as chance encounters, as evidenced by the fact that 55% of the 33 species recorded were from single-individual sightings. The observation of *Vacerra litana* (also from a single sighting) was an unexpected bonus, having only been recorded on one previous occasion in Nicaragua by Thomas Belt whilst working for a gold mining company in Chontales more than 140 years ago.

Conclusion

The results from this work bring together the outcome from recent fieldwork, with that of sampling conducted in the mid-1970s, to update the known country-lists for Nicaraguan butterflies for the online resource, Bio-Nica (Maes, 2014). The work demonstrates that further butterfly monitoring is needed at a range of locations in Nicaragua if the fauna of the country is to be comprehensively documented. Additionally, it highlights the value of long-term and innovative projects using citizen science and local capacity development, such as the activities supported by Earthwatch and the Earthwatch Shulman Award (Earthwatch 2014a,b).

Acknowledgements

HE and MG would like to acknowledge Earthwatch and the many volunteers who helped collect data in PNVM. ETJ and HE wish to acknowledge the support from the Earthwatch Shulman Award made to ETJ in 2013-14. Our thanks also go to Andy Anderson for helpful comments on the manuscript, Bo Sullivan for useful information, and to Liliana Diaz and Nelson Toval for permission to work in PNVM.

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Appendix I Digital images of 32 species according to family. Note - good sight record for *Chlorostymon simaethis sarita* (Skinner, 1895) but image quality too poor to include. Images: Erenler (2008-2013)

Hesperiidae



Amblyscirtes tolteca tolteca
Scudder, 1872



Callimormus juvenus
Scudder, 1872



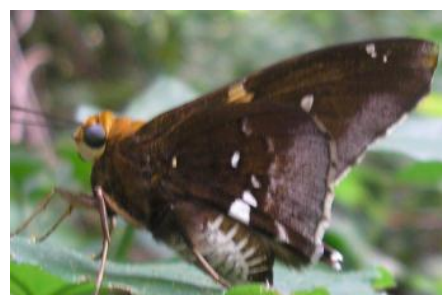
Copaeodes minima
(W. H. Edwards, 1870)



Cybaeus alumna
(A. Butler, 1877)



Cynea irma
(Möschler, 1879)



Epargyreus aspina
Evans, 1952



Lerodea arabus
(W. H. Edwards, 1882)



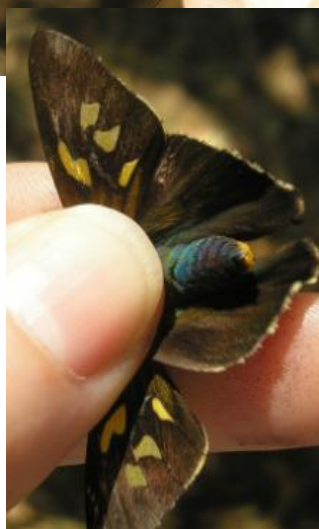
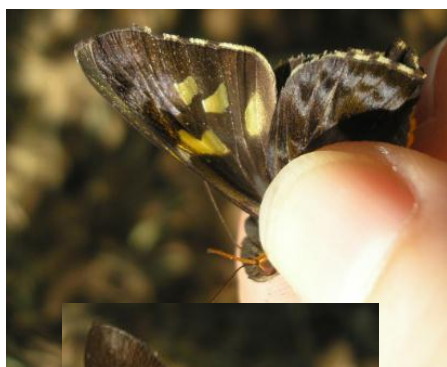
Monca crispinus
(Plötz, 1882)



Neoxeniades luda
(Hewitson, 1877)



Ocyba calathana calanus
(Godman & Salvin, 1894)



Perichares poaceaphaga
Burns, 2008



Quasimellana eulogius
(Plötz, 1882)



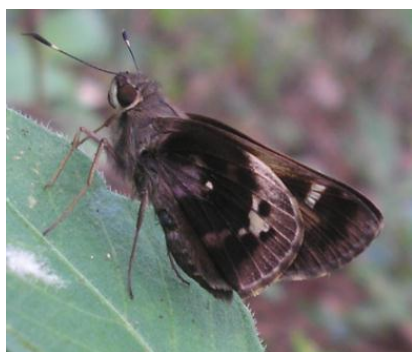
Staphylus caribbea
(R. Williams & E. Bell, 1940)



Staphylus vulgata
(Möschler, 1879)



Urbanus pronus
Evans, 1952



Vacerra litana
(Hewitson, 1866)

Lycaenidae



Atlides rustan
(Stoll, 1790)



Panthiades bathildis
(C. Felder & R. Felder, 1865)



Strymon cestri
(Reakirt, [1867])



Strymon istapa istapa
(Reakirt, [1867])



Strymon ziba
(Hewitson, 1868)



Theritas theocritus
(Fabricius, 1793)

Nymphalidae



Dynamine artemisia
(Fabricius, 1793)



Taygetis uncinata
Weymer, 1907

Pieridae



Perrhybris pamela chajulensis
J. Maza & R. G. Maza, 1989

Riodinidae



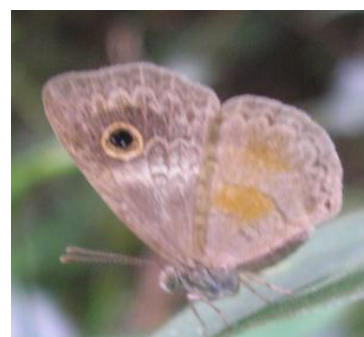
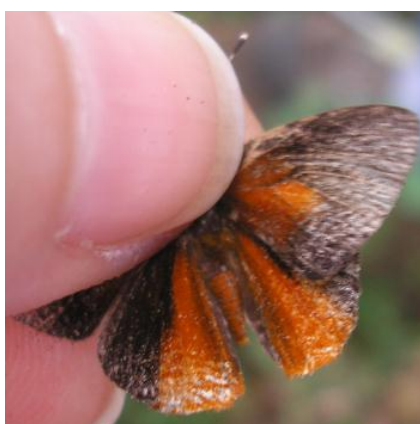
Baeotis zonata zonata
R. Felder, 1869



Behemothia godmanii
(Dewitz, 1877)



Calephelis costaricensis
Strand, 1916



Calephelis sixola
McAlpine, 1971

Euselasia sergia
(Godman & Salvin, 1885)

Perophtalma lasus
Westwood, 1851



Voltinia umbra (Boisduval, 1870)

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