The butterflies (Lepidoptera: Papilionoidea) of the Nipe-Sagua-Baracoa mountains: a preliminary checklist of the most biodiverse Cuban region

Yosiel Álvarez[1*], Douglas M. Fernández[2], Marc C. Minno[3] and Rayner Núñez[4]

1. Departamento de Colecciones Zoológicas, Instituto de Ecología y Sistemática, Carretera de Varona km 3. 5, Capdevila, Boyeros, CP 11900, La Habana, Cuba; * Author for correspondence: alvarezyosiel@gmail.com; https://orcid.org/0000-0002-0687-3094. 2. B No. 61 e/2da y 3ra, Caridad de Méndez, Camagüey 71100, Cuba; douglas7010@nauta.cu. 3. 600 NW 35th Terrace, Gainesville, FL 32607, USA; marccminno@gmail.com. 4. Lepidoptera & Trichoptera Section, Research Museum Alexander Koenig - Leibniz Institute for Animal Biodiversity (ZFMK), Bonn, Germany; R.Nunez@leibniz-lib.de, raynernunez75@gmail.com; https://orcid.org/0000-0001-7921-5028.

Date of issue online: 7 April 2023
Electronic copies (ISSN 2575-9256) in PDF format at: http://journals.fcla.edu/troplep; https://zenodo.org; archived by the Institutional Repository at the University of Florida (IR@UF), http://ufdc.ufl.edu/ufir; **DOI**: 10.5281/zenodo.7790072.

Abstract: Here we present a list of the butterflies of the Nipe-Sagua-Baracoa mountain range, comprising the easternmost Cuban massif and the largest biodiversity hotspot within the Antillean Islands. We retrieved information from the literature and from our own surveys in the area. We compiled butterfly species lists from 25 localities in four of the six phytogeographical districts in which the range is divided: Sierra de Nipe, Sierra Cristal, Sierra de Moa-Toa and the Baracoa limestone mountains. A total of 158 species of six butterfly families were registered, 78% of the known Cuban fauna. The district totals are 69 species from Sierra de Nipe, 76 from Sierra Cristal, 153 from Sierra de Moa-Toa and 114 from the Baracoa limestone mountains. Some 79% of all Cuban endemic butterfly taxa are represented. These values outnumber any other Cuban region and are likely to be caused by the proximity of Hispaniola, elevated age of the mountains and presence of serpentine soils, which together with climatic factors likely triggered the formation of a rich mosaic of highly diverse habitats. The Nipe-Sagua-Baracoa mountain range is one of the richest butterfly hotspots within the Antilles. Further work should focus on the less sampled and non-sampled districts and on the ecology, biogeography and life history of the butterflies in the range, especially species of greatest conservation relevance.

Key words: endemism, habitat, massif, mountain, richness, survey.

Resumen: Se presenta una lista de las mariposas del sistema montañoso Nipe-Sagua-Baracoa, el cual comprende el macizo más oriental del Cuba y el área más biodiversa de las Antillas. Se obtuvo información de la literatura y de las visitas de los autores al área. Se compilaron listas de especies de mariposas de 25 localidades dentro de cuatro de los seis distritos fitogeográficos en los cuales el sistema se divide: Sierra de Nipe, Sierra Cristal, Sierra de Moa-Toa y las montañas calizas de Baracoa. Se registraron un total de 158 especies de las seis familias de mariposas, un 78% de la fauna cubana conocida. Las cifras totales por distrito fueron 69 de Sierra de Nipe, 76 de Sierra Cristal, 153 de Sierra de Moa-Toa y 114 de las montañas calizas de Baracoa. El 79% de las formas de mariposas endémicas de Cuba está representado. Estos valores superan cualquier otra región de Cuba y deben estar causados por la proximidad del sistema a La Española, la edad elevada de las montañas y la presencia de suelos serpentínicos, los cuales en conjunto con factores climáticos impulsaron la formación de un rico mosaico de hábitats muy diversos. El sistema montañoso Nipe-Sagua-Baracoa es una de las regiones más ricas en mariposas dentro de las Antillas. El trabajo futuro debe enfocarse en los distritos menos muestreados y en los no muestreados, y en la ecología, biogeografía e historia de vida de las mariposas en este sistema, especialmente en especies de mayor interés para la conservación.

Palabras clave: endemismo, hábitat, macizo, montaña, riqueza, muestreo.

INTRODUCTION

The Antillean Islands feature a remarkably poor butterfly diversity in comparison to continental Central America, with less than 400 recorded species (Riley, 1975; Smith *et al*., 1994; Warren *et al*., 2022). Nonetheless, few butterfly faunas have been as extensively studied as the ones inhabiting the four major Antillean Islands: Cuba, Hispaniola, Jamaica and Puerto Rico (Comstock, 1944; Brown & Heineman, 1972, Alayo & Hernández, 1987; Schwartz, 1989; Pérez-Asso *et al*., 2017; Turner & Turland, 2017; Racheli, 2019; Mancina *et al*., 2020). The area's complex biogeographical history has shaped a distinctive fauna, featuring several endemic genera and species, particular distribution patterns, and high endemism due to insularity (Smith *et al*., 1994). A prominent feature of this fauna, the Satyrinae are only represented by the genus *Calisto* Hübner, which is also exclusive to the area, and has impressively radiated into 52 currently known species, with more surely to be found (Smith *et al*., 1994; Pérez-Asso *et al*., 2016; Núñez *et al*., 2019a). The Riodinidae are only represented by the monotypic

endemic genus *Dianesia* Harvey & Clench, a rare and restricted butterfly about which little is known, and, as with the previous genus, seems to represent an old, long isolated lineage (Harvey & Clench, 1980; Espeland *et al*., 2015).

Cuba, the largest of the Antillean Islands, has 200 documented butterfly species in six families and 20 subfamilies; 78 taxa are endemic, including 42 species and 36 subspecies (Mancina *et al*., 2020). Inventories of the butterfly diversity of several localities and regions have been published (Fontenla, 1985, Fontenla & de la Cruz, 1986; Fontenla 1987a,b, 1989a,b, 1992, 1994; Hernández *et al*., 1994; Fernández & Rodríguez, 1998; Smith *et al*., 1998; Fontenla, 2003; Núñez & Barro, 2003; Núñez, 2004; Aborrezco, 2006; Fernández, 2007; Núñez, 2010a, 2012; Luna & Hernández, 2013; Fernández & Minno, 2014a,b; Bermúdez *et al*., 2016; Álvarez & Corso, 2020). Most of these projects have focused on a local scale and only explored the butterfly fauna of a single or few habitats within a small area. Comprehensive butterfly lists of large biodiverse regions with heterogeneous habitats in Cuba are limited to the Isle of Pines (Holland, 1916; Hernández *et al*., 1994), the Guanahacabibes peninsula (Smith *et al*., 1998) and the Camagüey province (Fernández & Rodríguez, 1998; Fernández, 2007).

The Nipe-Sagua-Baracoa (NSB) massif is the easternmost Cuban mountain range, extending through the north of Cuba's eastern region, from Sierra de Nipe to Punta de Maisí, Cuba's eastern tip. A geologically complex region, its origin dates to the Cretaceous period and it has experienced several different formative events during the paleogeographical history of the Caribbean (Iturralde-Vinent, 2005). Due to this, several soil types coexist in this mountainous area, formed by ophiolitic, volcanic-arc and sedimentary, metamorphosed and not metamorphosed ultramafic (serpentine) rocks (Iturralde-Vinent *et al*., 2006). The area is characterized by its high biodiversity, with an extremely diverse flora that is one of the richest in the Caribbean and contains 750 regional or local endemics (Samek, 1973a; Borhidi, 1991). Several habitat types have developed in the varied soils of the area, including broadleaf evergreen forest, broadleaf semideciduous forest, serpentine sclerophyllous montane rainforest, semi-dry montane serpentine scrub-woodland, serpentine pine forest, montane evergreen serpentine scrub-woodland, dry serpentine scrub-woodland and mangrove forest, amongst many others (Samek, 1973a,b; Borhidi, 1991). Due to the relevance of this area for Cuban biodiversity, several zones within it have been declared protected areas by the Cuban National System of Protected Areas (SNAP), including the National Reserve "Cuchillas del Toa", the National Parks "Pico Cristal", "Mensura-Pilotos" and "Alejandro de Humboldt", and the minor range reserves "Cañón del Río Yumurí", "Yara-Majayara" and "Yunque de Baracoa" (Ruiz, 2017).

The area is home to many Cuban butterfly species, including

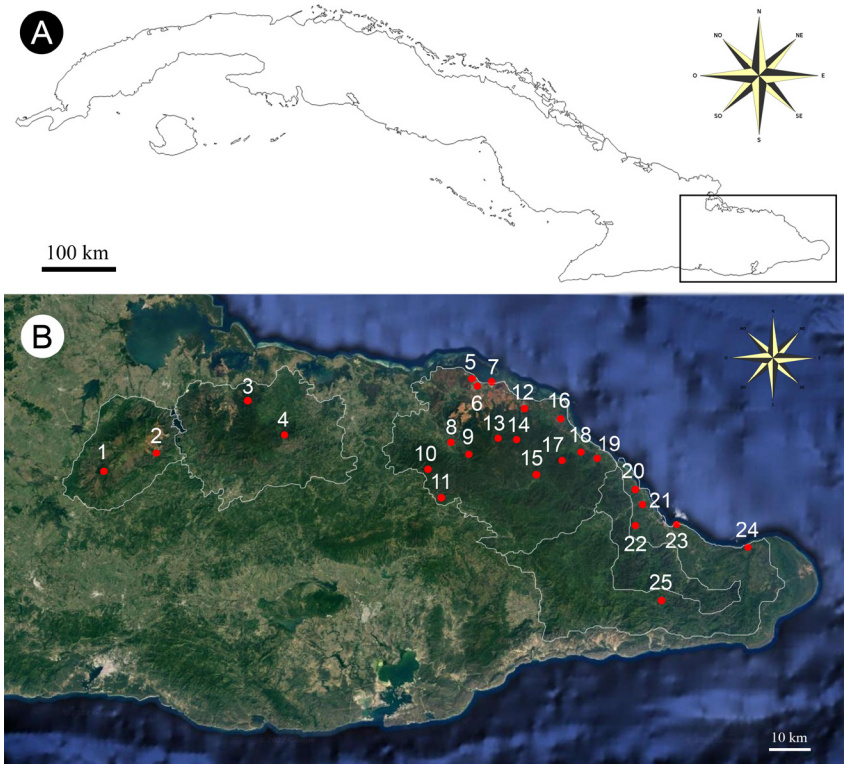

Figure 1. Geographical location (A) and satellite image (B) of the Nipe-Sagua-Baracoa mountain range, Eastern Cuba, including its phytogeographical districts and the surveyed localities. In B, districts are highlighted by thin white lines and localities are marked by red dots. Districts, from left to right: Sierra de Nipe, Sierra de Cristal, Sierra de Moa-Toa, and the limestone mountains of Baracoa. Within the latter, a boot-shaped area lacking red dots represents the serpentine mountains of Baracoa, another district, absent from our sampling. Localities, numbered: 1. La Mensura. 2. La Cueva. 3. La Zoilita. 4. Pico Cristal. 5. Miraflores. 6. Rolo Monterrey. 7. Los Mangos. 8. Ojito de Agua. 9. Farallones de Moa. 10. Cupeyal del Norte. 11. Las Municiones. 12. Monte Lejos. 13. El Toldo (peak). 14. El Toldo (slopes). 15. La Melba. 16. Yamanigüey. 17. Meseta de Iberia. 18. Balcón de Iberia. 19. Los Mellizos. 20. Cayo Güin. 21. Río Toa. 22. Yunque de Baracoa. 23. Playa Blanca. 24. Boca de Yumurí. 25. Alto de Cotilla. Satellite image © Google.

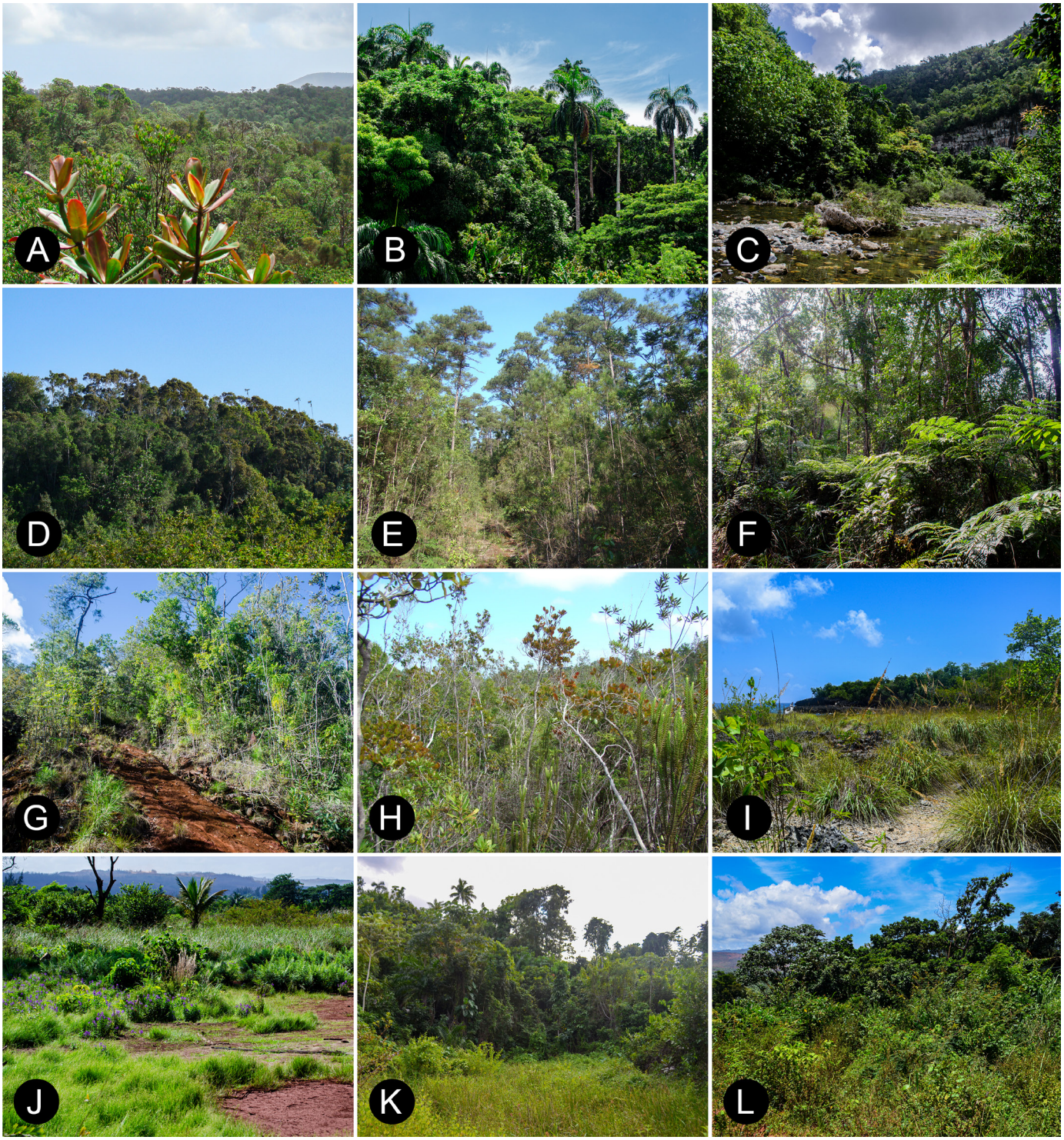

Figure 2. Photographs of habitat types present throughout the Nipe-Sagua-Baracoa mountain range, Eastern Cuba. A. Broadleaf evergreen forest in Meseta de Iberia. B. Broadleaf semideciduous forest in the base of Yunque de Baracoa. C. Gallery forest along the margins of the Yumurí River in Boca de Yumurí. D. "Mogote" vegetation complex of limestone patches in La Munición. E. Serpentine pine forest in La Zoilita. F. Serpentine sclerophyllous montane forest in Balcón de Iberia. G. Dry serpentine scrub-woodland in Los Mellizos. H. Montane evergreen serpentine scrub-woodland in Yamanigüey. I. Coastal scrub-woodland in Playa Blanca. J. Low vegetation associated with mangrove forest in Los Mangos. K. Secondary forest in the base of Yunque d Baracoa. L. Ruderal vegetation along urban areas in Rolo Monterrey. Photographs A, D, E, H © Rayner Núñez; B, C, F, G, I-L © Yosiel Álvarez.

national, regional and local endemics, such as *Atlantea perezi* (Herrich-Schäffer, 1862), *Lycorea halia demeter* Felder & Felder, 1865, *Burca cubensis* (Skinner, 1913), *Oarisma bruneri* Bell, 1959 and several species of *Calisto* (Alayo & Hernández, 1987; Núñez *et al*., 2020a). Alayón & Solana (1987) published a list of the butterflies from four localities of "Cuchillas de Toa" reserve, reporting 113 species. More recently, Varona-Álvarez (2022) elevated to 74 the known species of Cupeyal del Norte,

one of the localities surveyed by Alayón and Solana (1987). Based on these initial accounts and given the biogeographical and ecological relevance of this area for biodiversity, we add more observations to provide a more comprehensive, yet still preliminary, butterfly list of the Nipe-Sagua-Baracoa massif.

MATERIALS AND METHODS

Description of the study area

According to the criteria of Samek (1973a) and Borhidi (1991), the NSB massif is the northeastern section of their Cuban phytogeographical arrangement, which they further divided into six districts. We obtained butterfly data from four of these districts: Sierra de Nipe, Sierra Cristal, Sierra de Moa-Toa and the Baracoa limestone mountains (Fig. 1). The remaining, unsampled districts are the Baracoa serpentine mountains and the karstic "mogotes" of Nipe-Yateras (Borhidi, 1991). Habitat classification followed the criteria of Capote & Berazaín (1984), adapted to the descriptions of Borhidi (1991). Photographs of the most representative of these habitats are shown on Figure 2.

Sierra de Nipe. Located south of the Bay of Nipe, at the western end of the mountain range, this area is 600 km^2 in extent and comprises a plateau (500-700 m altitude) delimited west and south by the Cauto Valley and north by the Bay of Nipe. The area continues to the east in Sierra Cristal. The Mayarí River forms the natural boundary between these ranges (Samek, 1973b). Loma de la Mensura reaches a peak altitude of 995 m, and serpentine soils occupy 280 km^2 within the core of the plateau, surrounded by limestone slopes with numerous rivers. There are two annual rain peaks (August-February and April-June), with total precipitation up to 230 cm per year, and annual temperatures oscillate between 23.5-29°C (Borhidi, 1991).

A well-defined phytogeographical district, the Sierra de Nipe comprises endemic-poor broadleaf evergreen and semideciduous forests along the limestone slopes, and endemic-rich serpentine sclerophyllous montane rainforest, serpentine pine forest and montane evergreen serpentine scrub-woodland on the serpentine plateau (Samek, 1973a,b). Human disturbance has affected large areas of these habitats, allowing the development of semi-natural pine forests and ruderal vegetation. The floristic composition resembles that of Sierra Cristal, with many shared endemic taxa (Borhidi, 1991).

Sierra Cristal. Located east of the previous range, this area is nearly 2000 km^2 in extent and consists of a mountain massif (700-1000 m altitude) narrowly separated from Sierra de Nipe by the Mayarí River, whilst the northern and southern boundaries are the same as the previous range, and the eastern boundary is Sagua de Tánamo Valley (Samek, 1973a; Borhidi, 1991). Pico Cristal reaches an altitude of 1231 m (the highest peak of the entire NSB massif), and reddish serpentine soils extend from 700 m up to the top, replaced at lower elevations by limestone-derived mountain clays. More uniform in terms of climate than the previous range, in January-February a short dry season occurs in the lower areas, while the upper hills feature uninterrupted rains; annual precipitation oscillates between 160-230 cm and annual temperatures range between 20-29°C (Borhidi, 1991).

Although it has lower plant diversity than the previous and next ranges, Sierra Cristal is also distinctive and shares many phytogeographical similarities with Sierra de Nipe due to their minimal separation. Moist, broadleaf evergreen forests are found up to 600 m from the base, with scattered patches of secondary forest amongst these; serpentine pine forests extend between 600-1100 m. From this altitude up to the summit, semi-dry montane serpentine scrub-woodlands dominate, a type of cloud forest on serpentine bedrock (Samek, 1973a; Borhidi, 1991).

Sierra de Moa-Toa. The largest and most complex of the districts, this mountain range extends nearly 3000 km^2 and comprises several sharp mountains, plateaus and ridges (500-900 m altitude) along the coast between Sagua de Tánamo Valley and the limestone areas of Baracoa, delimited south by the karstic mountains of Nipe-Yateras (Samek, 1973a; Borhidi, 1991). Pico El Toldo reaches an altitude of 1175 m. The district has a variety of different serpentine soils, with older representatives found in the inner hills and younger ones predominating near the coast. The most humid area of Cuba, in this range precipitation oscillates between 140-300 cm per year, with local peaks of 500 cm. The core features a moist climate throughout the year, while in all boundaries, with exception of the eastern one, two short dry seasons are present between January-February and March-April. Annual temperatures oscillate between 16-30°C (Borhidi, 1991).

This area is considered to be the oldest district of the Cuban flora and the core of biodiversity of the region (Borhidi, 1991). Biogeographic isolation of this serpentine range, a product of its wide limestone boundaries such as Sagua de Tánamo Valley and the mountains of Baracoa, has shaped a distinctive flora. Many endemic plant genera and species are found within the several vegetation types present in the range (Samek, 1973a; Borhidi, 1991). A brief, accurate habitat description is challenging. Broadleaf semideciduous and evergreen forest cover most inner mountains up to 250 m, with serpentine sclerophyllous montane rainforest replacing them up to nearly 1000 m. Summits are covered by semi-dry montane serpentine scrub-woodlands. Serpentine pine forests thrive in the Cupeyal Plateau and the Toa Valley, as well as above 1000 m in many northern hills. These pine forests mix with microphyllous evergreen serpentine scrub-woodland along the coast and with dry serpentine scrub-woodland in higher areas. Mangrove forests and coastal scrub-woodlands grow near the coast, and secondary forests and ruderal vegetation replace native habitats in disturbed areas (Samek, 1973a; Borhidi, 1991)

Baracoa limestone mountains. The easternmost area of the massif, this district occupies nearly 2500 km^2 and consists of a highly varied landscape of mountains, "mogotes" (karstic, irregularly-shaped isolated hills) and plateaus (100-400 m altitude) extending along the coast between Sierra de Moa-Toa and Punta de Maisí, Cuba's eastern tip, with the Santiago-Guantánamo coast district being the southern geological boundary (Borhidi, 1991). The Baracoa serpentine mountains are contained within this district but their boundaries are quite evident (see Fig. 1). Yunque de Baracoa reaches a peak altitude of 575 m, and limestone-derived soils predominate. Several

climate types coexist and no transition is perceptible between these: some areas receive rains all throughout the year with precipitation of up to 220 cm per year, while others feature two long dry seasons, and northern mountains have dry summers. Annual temperatures range between 23-28°C (Borhidi, 1991).

Lower plant diversity and endemism are features of this limestone area, and broadleaf evergreen forest covers most of the hills, with some montane humid forest occurring at the summit of the moist highest peaks. The karstic cliffs of Yumurí Valley are occupied by the "mogote" vegetation complex and

Table 1. Localities included in the compilation of the butterfly list (Lepidoptera: Papilionoidea) from the Nipe-Sagua-Baracoa mountain range, eastern Cuba. Geographic placement, habitats and survey dates of the visited localities are also provided. Habitats: BEF: Broadleaf evergreen forest. BSF: Broadleaf semideciduous forest. CSW: Coastal scrub-woodland. DSW: Dry serpentine scrub-woodland. GF: Gallery forest. MF: Mangrove forest. MSW: Montane evergreen serpentine scrub-woodland. MVC: "Mogote" vegetation complex. RV: Ruderal vegetation. SF: Secondary forest. SSW: Semi-dry montane serpentine scrub-woodland. SMF: Serpentine sclerophyllous montane forest. SPF: Serpentine pine forest.

Province	District	Locality	Habitat	Date	Source
Holguín	Sierra de Nipe	La Mensura	MSW	8/XI/2015; 13 & 15/VI/2016; 2/IX/2018; 7/XII/2018	Authors' visit
		La Cueva	BSF, MSW, SPF	2-9/VII/ 2018; 27/VI/2019	Vallejo *et al.* (2021) Authors' visit
	Sierra Cristal	La Zoilita	MSW, SPF, GF	15-19/II/2010; 3-10/IV/2012	Authors' visit
		Pico Cristal	SSW, SPF	No date specified	ENPFF (2009)
	Sierra de Moa-Toa	Miraflores	DSW	11/XI/2017 24/VIII/2018; 8/XII/2018; 3/VII/2022	Authors' visit
		Rolo Monterrey	SF, RV	9/XI/2015; 11-12/XI/2017; 11/XII/2018; 17/VI/2019; 20/XI/2021; 3/V/2022; 15/VII/2022	Authors' visit
		Los Mangos	MF	21/XI/2021	Authors' visit
		Ojito de Agua	BEF, BSF, RV	1987 (no date specified)	Alayón & Solana (1987)
		Farallones de Moa	BSF, RV	1987 (no date specified) 23/VIII/2018; 9/XII/2018; 18/VI/2019	Alayón & Solana (1987) Authors' visit
		Cupeyal del Norte	BSF, SMF	1987 (no date specified); 11-17/VI/2019	Alayón & Solana (1987) Varona-Álvarez (2022)
		Las Municiones	MVC, SPF	20-21/VIII/2021	Authors' visit
		Monte Lejos	SMF, GF	26/VIII/2018; 10-11/XII/2018; 19 & 21/VI/2019	Authors' visit
		El Toldo (peak)	SSW, SMF	21/VII/2001	Authors' visit
		El Toldo (slopes)	BEF, BSF	23-24/VII/2001	Authors' visit
		La Melba	SMF, GF	1987 (no date specified)	Alayón & Solana (1987)
		Yamanigüey	MSW	24/IX/2009; 27/VIII/2018; 22/VI/2019	Authors' visit
Guantánamo		Meseta de Iberia	BEF, SMF	28-30/IX/2009; 29/IV/2011; 4-8/IV/2012; 12-13/VII/2022	Authors' visit
		Balcón de Iberia	BSF, SMF	10/XI/2015 30/VIII/2018; 20/VI/2019; 27/XI/2021	Authors' visit
		Los Mellizos	DSW, SPF	16/VI/2016; 28/XI/2021	Authors' visit
	Baracoa limestone mountains	Cayo Güin	MSW	5/II/2013; 23/VI/2019	Author's visit
		Río Toa	GF	26/VII/2001; 22 & 29/VI/2019	Authors' visit
		Yunque de Baracoa	BEF, GF, RV	2/VI/2007; 23/IX/2009; 18/VI/2019; 26/XI/2021; 8/VII/2022	Núñez (2010) Authors' visit
		Playa Blanca	CSW	22/XI/2021; 5/VII/2022	Authors' visit
		Boca de Yumurí	GF, MVC, RV	23/XI/2021; 6-7/VII/2022	Authors' visit
		Alto de Cotilla	SF	21/VI/2016	Authors' visit

gallery forest thrives along the numerous, powerful rivers. Coastal scrub-woodlands cover seashores, and broadleaf semideciduous forest and secondary vegetation are found elsewhere at lower elevations (Samek, 1973a; Borhidi, 1991).

Data sources

For the compilation of this list, we retrieved data from 25 localities from within the four aforementioned districts of the NSB massif (see Fig. 1). From these localities, two belong to the Sierra de Nipe district, two to the Sierra Cristal district, 15 to the Sierra de Moa-Toa district and six to the Baracoa limestone mountains district. Butterfly lists from these localities were obtained from published papers (Alayón & Solana, 1987; Núñez, 2010b; Vallejo *et al*., 2021; Varona-Álvarez, 2022), as well as unpublished lists from field surveys performed by the authors, comprising 88 sampling days from 2001 to 2022, covering most months and seasons. These surveys consisted of walks along trails of the visited localities, with butterflies identified and recorded as they were seen. Data from these localities and surveys are summarized in Table 1. Family arrangement and taxonomic treatment of species follows the criteria of Mancina *et al*. (2020), except for the genera *Phoebis* Hübner and *Agraulis* Boisduval & Le Conte, which follow the modifications proposed by Núñez *et al*. (2019b) and Núñez *et al*. (2021), respectively.

Although we compiled an individual list for each one of the available localities, we combined all these lists to obtain a single list for each district. Even though habitat and microclimate varied somewhat between the localities within a district, their overall similar biogeographical and phytogeographical structure (Samek, 1973a; Borhidi, 1991) suggested this was the best approach. Individual lists from all localities are available in Supplementary File 1 (DOI: 10.5281/zenodo.7796591).

Table 2. Butterflies (Lepidoptera: Papilionoidea) detected in four of the six phytogeographical districts of the Nipe-Sagua-Baracoa mountain range, Eastern Cuba. Taxonomic treatment followed the criteria of Mancina *et al*. (2020) with modifications of Núñez *et al*. (2019b, 2021). For butterflies: E. Endemic species. S. Endemic subspecies. R. Regional endemic (species or subspecies). G. Greater Antillean endemic species. Antillean endemic species refers to species mostly restricted to the four Greater Antilles, the Lucayan Archipelago (Bahamas and Turks and Caicos Islands), the southernmost portion of Florida and Cayman and the Virgin Islands. Districts: NIP. Sierra de Nipe. CRI. Sierra Cristal. MOT. Sierra de Moa-Toa. BAR. Baracoa limestone mountains.

Species	Districts			
	NIP	CRI	MOT	BAR
Nymphalidae				
Apaturinae				
Asterocampa idyja idyja (Geyer, 1828)			X	X
Doxocopa laure druryi (Hübner, 1823) S	X	X	X	X
Biblidinae				
Dynamine postverta mexicana d'Almeida, 1952			X	X
Dynamine serina calais Bates, 1934 S/G	X	X	X	
Eunica heraclitus (Poey, 1847) E			X	
Eunica monima (Stoll, 1782)			X	X
Eunica tatila tatilista Kaye, 1926			X	
Hamadryas februa diasia (Fruhstorfer, 1916)	X	X	X	X
Lucinia sida sida Hübner, 1923 S/G	X	X	X	X
Charaxinae				
Anaea cubana (Druce, 1905) G			X	
Archaeoprepona demophoon crassina (Fruhstorfer, 1904) S			X	X
Cymatogramma echemus echemus (Doubleday, 1849) S/G			X	
Hypna clytemnestra iphigenia (Herrich-Schäffer, 1865) S			X	
Siderone galanthis nemesis (Illiger, 1802)		X	X	X
Cyrestinae				
Marpesia chiron chironides (Staudinger, 1886) S	X	X	X	X
Marpesia eleuchea eleuchea (Hübner, 1818) S/G	X	X	X	X
Danainae				
Anetia briarea numidia Hübner, 1823 S/G		X	X	
Anetia cubana (Salvin, 1869) E			X	
Danaus eresimus tethys Forbes, 1943			X	
Danaus gilippus berenice (Cramer, 1779)		X	X	X
Danaus plexippus plexippus (Linnaeus, 1758)		X	X	X
Greta cubana (Herrich-Schäffer, 1862) E			X	
Lycorea halia demeter Felder & Felder, 1865 S			X	

Species	Districts			
	NIP	CRI	MOT	BAR
Heliconiinae				
Agraulis insularis Maynard, 1869	X	X	X	X
Dryas iulia nudeola (Bates, 1934) S/G	X	X	X	X
Eueides isabella cleobaea Geyer, 1832 S/R			X	
Euptoieta claudia (Cramer, 1779)			X	
Euptoieta hegesia hegesia (Cramer, 1779)		X	X	X
Heliconius charithonia ramsdeni Comstock y Brown, 1950	X	X	X	X
Libytheinae				
Libytheana motya (Hübner, 1826) E	X		X	
Limenitidinae				
Adelpha iphicleola iphimedia Fruhstorfer, 1915 S			X	X
Nymphalinae				
Anartia chrysopelea Hübner, 1825 E			X	X
Anartia jatrophae guantanamo Munroe, 1942	X	X	X	X
Anthanassa frisia frisia (Poey, 1832)	X	X	X	X
Antillea pelops anacaona (Herrich-Schäffer, 1864) S/G			X	X
Atlantea perezi (Herrich-Schäffer, 1862) E/R	X		X	X
Colobura dirce wolcotti (Comstock, 1942)	X	X	X	X
Historis acheronta semele (Bates, 1939)	X		X	X
Historis odius odius (Fabricius, 1775)	X	X	X	X
Hypanartia paullus (Fabricius, 1793) G		X	X	
Junonia neildi (Brévignon, 2004)			X	X
Junonia zonalis Felder & Felder, 1867	X	X	X	X
Siproeta stelenes biplagiata (Fruhstorfer, 1907)	X	X	X	X
Vanessa virginiensis (Drury, 1773)			X	
Satyrinae				
Calisto brochei Torre, 1973 E/R			X	
Calisto bruneri Michener, 1949 E/R	X	X	X	X
Calisto dissimulatum Núñez, 2013 E/R		X	X	X
Calisto herophile Hübner, 1823 E	X	X	X	X
Calisto israeli Torre, 1973 E/R		X	X	
Calisto lastrai Núñez, 2019 E/R			X	
Calisto occulta Núñez, 2012 E/R			X	
Calisto sharkeyae Núñez, Minno & Fernández, 2019 E/R	X			
Riodinidae				
Riodininae				
Dianesia carteri ramsdeni (Skinner, 1912) S/G	X		X	X
Lycaenidae				
Polyommatinae				
Cyclargus ammon (Lucas, 1857) G	X	X	X	X
Cyclargus thomasi noeli (Comstock & Huntington, 1943) G			X	X
Hemiargus ceraunus filenus (Poey, 1832)		X	X	X
Leptotes cassius theonus (Lucas, 1857)	X	X	X	X
Theclinae				
Allosmaitia coelebs (Herrich-Schäffer, 1862) E			X	X
Chlorostrymon simaethis simaethis (Drury, 1770)			X	
Electrostrymon angelia angelia (Hewitson, 1874) G	X	X	X	X
Eumaeus atala (Poey, 1832) G	X		X	X
Ministrymon azia (Hewitson, 1873)				X
Nesiostrymon celida celida (Lucas, 1857) S/G	X		X	
Strymon acis casasi (Comstock & Huntington, 1943)			X	
Strymon bazochii gundlachianus Bates, 1934			X	X
Strymon istapa cybira (Hewitson, 1874)		X	X	X
Strymon limenia (Hewitson 1868) G			X	
Strymon martialis (Herrich-Schäffer, 1864) G			X	

Species	Districts			
	NIP	CRI	MOT	BAR
Pieridae				
Coliadinae				
Abaeis nicippe (Cramer, 1779)	X	X	X	X
Anteos clorinde (Godart, [1824])	X	X	X	X
Anteos maerula (Fabricius, 1775)	X	X	X	X
Eurema daira palmira (Poey, 1852)		X	X	X
Eurema elathea elathea (Cramer, 1777)			X	X
Eurema lucina (Poey, 1853) E			X	
Kricogonia cabrerai Ramsden, 1920 E			X	X
Kricogonia lyside (Godart, 1819)			X	X
Nathalis iole Boisduval, 1836			X	X
Phoebis agarithe antillia Brown, 1929			X	X
Phoebis argante minuscula (Butler, 1869) S			X	X
Phoebis avellaneda (Herrich-Schäffer, 1864) E	X		X	X
Phoebis neleis (Boisduval, 1836) G		X	X	X
Phoebis philea philea (Johansson, 1763)	X	X	X	X
Phoebis sennae sennae (Linnaeus, 1758)	X	X	X	X
Phoebis statira cubana d'Almeida, 1939	X	X	X	X
Phoebis thalestris huebneri Fruhstorfer, 1907 S/G			X	
Pyrisitia dina dina (Poey, 1832) S/G	X	X	X	X
Pyrisitia larae (Herrich-Schäffer, 1862) G	X	X	X	X
Pyrisitia lisa euterpe (Ménétriés, 1832)	X	X	X	X
Pyrisitia messalina (Fabricius, 1787) G	X		X	X
Pyrisitia nise nise (Cramer, 1775)	X		X	X
Pyrisitia proterpia (Fabricius, 1775)			X	X
Zerene cesonia cesonia (Stoll, 1790)	X			
Dismorphiinae				
Dismorphia cubana (Herrich-Schäffer, 1862) E			X	
Pierinae				
Ascia monuste eubotea (Godart, 1819)	X	X	X	X
Ganyra menciae (Ramsden, 1915)			X	X
Glutophrissa drusilla poeyi (Butler, 1872)	X	X	X	X
Melete salacia cubana Fruhstorfer, 1908 S/G			X	
Papilionidae				
Papilioninae				
Battus devilliers (Godart, 1823) G	X	X	X	X
Battus polydamas cubensis (Dufrane, 1946) S	X	X	X	X
Heraclides andraemon andraemon Hübner, [1823] G	X	X	X	X
Heraclides androgeus epidaurus (Godman & Salvin, 1890)	X	X	X	X
Heraclides aristodemus temenes (Godart, 1819) G			X	
Heraclides caiguanabus (Poey, [1852]) E			X	
Heraclides oviedo (Gundlach, 1866) E		X	X	X
Heraclides oxynius (Geyer, 1827) E			X	X
Heraclides pelaus atkinsi (Bates, 1935) S/G	X	X	X	X
Neographium celadon (Lucas, 1852) E		X	X	
Papilio demoleus malayanus (Wallace, 1865)			X	X
Papilio polyxenes polyxenes Fabricius, 1775 S			X	
Parides gundlachianus gundlachianus (Felder & Felder, 1864) E/S	X	X	X	X
Hesperiidae				
Eudaminae				
Aguna asander haitiensis (Mabille & Boullet, 1912)			X	
Autochton potrillo potrillo (Lucas, 1857)		X	X	X
Cecropterus dorantes santiago (Lucas, 1857)	X	X	X	X
Phocides batabano batabano (Lucas, 1857) S/G			X	
Polygonus leo histrio Röber, 1925		X	X	X
Proteides maysi (Lucas, 1857) E	X		X	X

Species	Districts			
	NIP	CRI	MOT	BAR
Proteides mercurius sanantonio (Lucas, 1857) S	X	X	X	X
Telegonus anaphus anausis (Godman & Salvin, 1896)			X	
Telegonus cassander (Fabricius, 1793) E			X	X
Telegonus habana (Lucas, 1857) E		X	X	X
Telegonus talus (Cramer, 1799)			X	
Telegonus xagua xagua (Lucas, 1857) S/G		X	X	X
Urbanus proteus domingo (Scudder, 1872)	X	X	X	X
Hesperiinae				
Asbolis capucinus (Lucas, 1857) G	X	X	X	X
Atalopedes mesogramma mesogramma (Latreille, [1824]) G			X	X
Calpodes ethlius (Stoll, 1782)		X	X	X
Choranthus radians (Lucas, 1857) G	X	X	X	X
Cymaenes tripunctus tripunctus (Herrich-Schäffer, 1865)			X	X
Euphyes cornelius cornelius (Latreille, [1824]) S/G	X		X	X
Euphyes singularis singularis (Herrich-Schäffer, 1865) S/G			X	X
Holguinia holguin Evans, 1955 E	X	X	X	X
Hylephila phyleus phyleus (Drury, 1773)		X	X	X
Lerodea eufala eufala (Edwards, 1869)		X	X	X
Nyctelius nyctelius nyctelius (Latreille, [1824])		X	X	X
Oarisma bruneri Bell E/R	X		X	
Oarisma nanus (Herrich-Schäffer, 1865) E	X	X	X	X
Panoquina corrupta (Herrich-Schäffer, 1865) E	X		X	X
Panoquina lucas lucas (Fabricius, 1793)	X	X	X	X
Panoquina ocola ocola (Edwards, 1863)		X		X
Parachoranthus magdalia (Herrich-Schäffer, 1863) G	X		X	X
Perichares philetes (Gmelin, 1790) G	X	X	X	X
Polites baracoa baracoa (Lucas, 1857) G	X	X	X	X
Pyrrhocalles antiqua orientis Skinner, 1920 S/G	X	X	X	X
Rhinthon cubana (Herrich-Schäffer, 1865)			X	
Saliana esperi soroa Smith & Hernández, 1992 S			X	X
Synapte malitiosa malitiosa (Herrich-Schäffer, 1865)		X	X	X
Wallengrenia misera (Lucas, 1857) G	X	X	X	X
Pyrginae				
Burca braco braco (Herrich-Schäffer, 1865) S/G			X	
Burca concolor concolor (Herrich-Schäffer, 1865) S/G	X		X	X
Burca cubensis (Skinner, 1913) E/R	X		X	
Burnsius crisia (Herrich-Schäffer, 1865) G			X	
Burnsius oileus (Linnaeus, 1767)		X	X	X
Eantis munroei (Bell, 1952)				X
Eantis papinianus (Poey, 1832) G	X		X	X
Ephyriades brunnea brunnea (Herrich-Schäffer, 1865) G	X	X	X	X
Ephyriades zephodes (Hübner, 1820) G			X	X
Erynnis zarucco (Herrich-Schäffer, 1865)			X	X
Gesta gesta (Herrich-Schäffer, 1863) G		X	X	X

RESULTS AND DISCUSSION

A total of 158 butterfly species belonging to six families were detected in the NSB massif (Table 2). This number represents 78% of all known Cuban butterfly species (Mancina *et al*., 2020). From these, 69 species were listed from Sierra de Nipe, 76 from Sierra Cristal, 153 from Sierra de Moa-Toa and 114 from the Baracoa limestone mountains. The family with the largest number of species was Nymphalidae with 52, followed by Hesperiidae with 48, Pieridae with 29, Lycaenidae with 15, Papilionidae with 13 (100% of the Cuban resident taxa), and Riodinidae with 1 species. These proportions of representatives per family were similar in Sierra de Nipe and Sierra de Moa-Toa districts, but in Sierra Cristal both Hesperiidae and Nymphalidae were represented by the same number of species, and in the Baracoa limestone mountains Hesperiidae outnumbered Nymphalidae (Table 2). Photographs of most of the endemics among the observed species are shown in Figures 3-4.

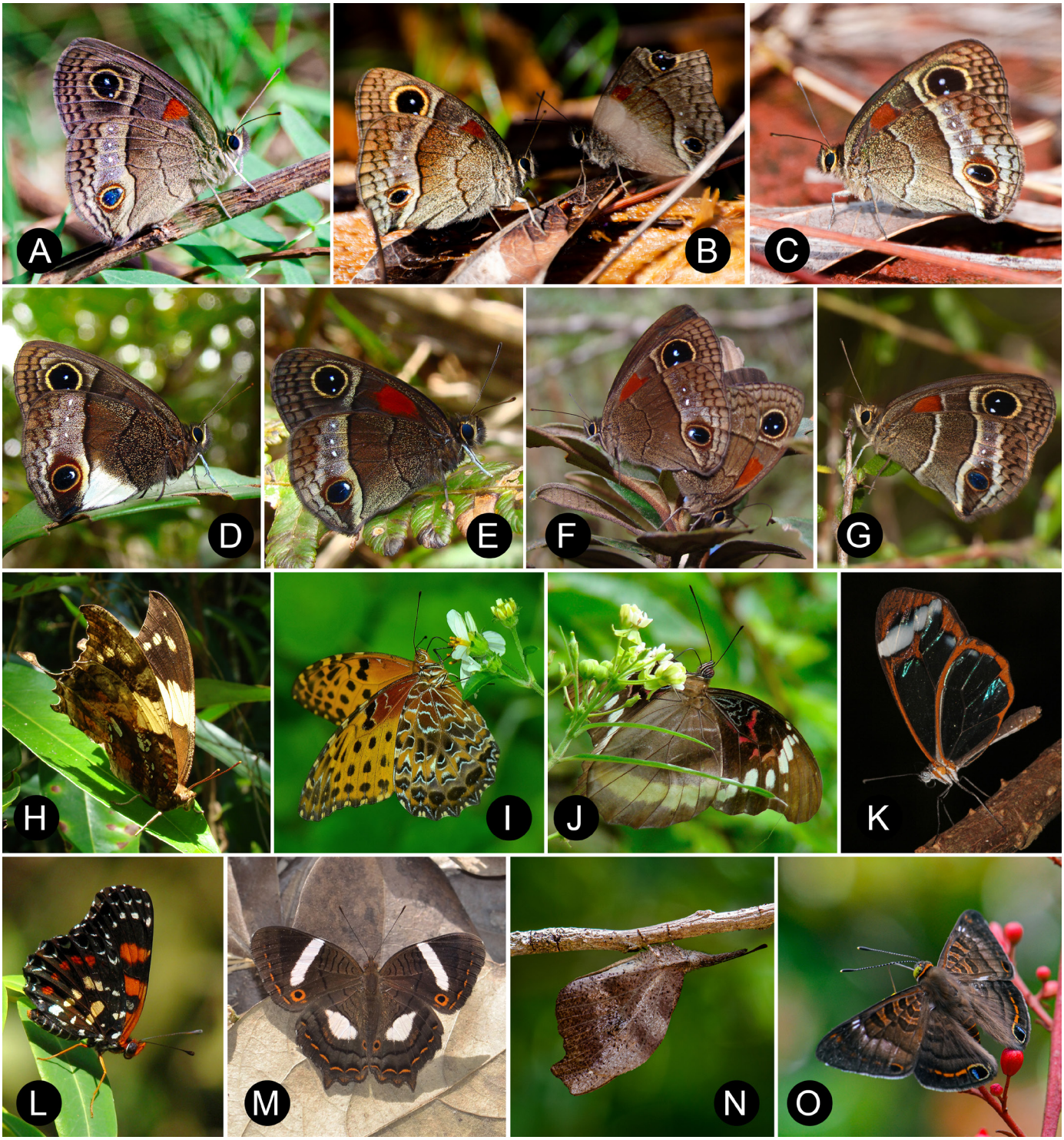

Figure 3. Photographs of live specimens of endemic butterfly species and subspecies of the Nipe-Sagua-Baracoa mountain range, Eastern Cuba. Families Nymphalidae and Riodinidae. A. *Calisto herophile*. B. *Calisto bruneri*. C. *Calisto dissimulatum*. D. *Calisto israeli*. E. *Calisto brochei*. F. *Calisto occulta*. G. *Calisto sharkeyae*. H. *Hypna clytemnestra iphigenia*. I. *Anetia briarea numidia*. J. *Anetia cubana*. K. *Greta cubana*. L. *Atlantea perezi*. M. *Anartia chrysopelea*. N. *Libytheana motya*. O. *Dianesia carteri ramsdeni*. Photographs A-C, N-O © Yosiel Álvarez; D-J, L-M © Rayner Núñez; K © Marc C. Minno.

Several scarce and intermittently distributed Cuban butterflies, many of them endemic, are present in the massif, including: *Hypna clytemnestra iphigenia* (Fig. 3H), *Anetia cubana* (Fig. 3J), *Greta cubana* (Fig. 3K), *Lycorea halia demeter*, *Hypanartia paullus*, *Dianesia carteri ramsdeni* (Fig. 3O), *Nesiostrymon c. celida* (Fig. 4A), *Strymon acis casasi*, *Kricogonia cabrerai* (Fig. 4D), *Phoebis avellaneda* (Fig. 4E), *Phoebis thalestris huebneri*, *Pyrisitia proterpia*, *Melete salacia cubana* (Fig. 4G), *Dismorphia cubana*, *Heraclides pelaus atkinsi*, *Telegonus cassander* (Fig. 4K), *Holguinia holguin* (Fig. 4L), *Oarisma nanus* (Fig. 4M), *Rhinthon cubana*, *Saliana esperi soroa* (Fig. 4O), *Burca b. braco*, *Burca c. concolor*,

Figure 4. Photographs of live specimens of endemic butterfly species and subspecies of the Nipe-Sagua-Baracoa mountain range, Eastern Cuba. Families Lycaenidae, Pieridae, Papilionidae and Hesperiidae. A. *Nesiostrymon c. celida*. B. *Allosmaitia coelebs*. C. *Eurema lucina*. D. *Kricogonia cabrerai*. E. *Phoebis avellaneda*. F. *Phoebis argante minuscula*. G. *Melete salacia cubana*. H. *Parides g. gundlachianus*. I. *Heraclides oxynius*. J. *Proteides maysi*. K. *Telegonus cassander*. L. *Holguinia holguin*. M. *Oarisma bruneri*. N. *Oarisma nanus*. O. *Saliana esperi soroa*. P. *Pyrrhocalles antiqua orientis*. Q. *Burca cubensis*. Photographs A, C, E, G-O, Q © Rayner Núñez; B, D, F, P © Yosiel Álvarez.

Burnsius crisia and *Ephyriades zephodes* (Table 2) (Alayo & Hernández, 1987).

Forty-nine species were found in all four districts, including common butterflies such as *Anartia jatrophae*, *Agraulis insularis*, *Calisto herophile*, *Dryas iulia*, *Leptotes cassius*, *Ascia monuste*, *Phoebis sennae*, *Pyrisitia lisa*, *Choranthus radians*, *Ephyriades brunnea* and *Urbanus proteus*. However, some scarce species were also present in all the districts, such as *Heraclides pelaus*, *Parides gundlachianus*, *Holguinia holguin* and *Oarisma nanus*. The presence of *Dynamine postverta*

mexicana, previously believed to be limited to western Cuba (Alayo & Hernández, 1987), appears to reflect its eastward dispersal.

Except for the widespread, generalist species *Calisto herophile*, all representatives of the genus *Calisto* in NSB are regional endemics; some of them, such as *C. lastrai* and *C. sharkeyae*, are recently described (Fig. 3A-G) (Núñez *et al*., 2012, 2013, 2019a). *Calisto bruneri* seems to be the most widespread and habitat tolerant of these, while *C. brochei*, *C. lastrai*, *C. occulta* and *C. sharkeyae* are the most restricted, according to the available data. The exceptional representation of the genus in the area suggests that NSB is the center of radiation of Cuban *Calisto* (Núñez *et al*., 2019a). According to Iturralde-Vinent *et al.* (2006), before the Miocene this range formed a large land mass along with Puerto Rico and Northern Hispaniola. The last island is the main center of radiation of *Calisto*, and likely the homeland of the closest relatives to Cuban *Calisto* (Matos-Maraví *et al*., 2014; Núñez *et al*., 2019a). Thus, NSB probably hosted the first Cuban populations of the genus. The age and vegetation diversity of these ranges, along with the poor dispersal abilities of these insects, provided the perfect scenario for a rapid diversification of the genus in the region, which subsequently dispersed throughout the rest of the island (Núñez *et al*., 2019a).

In this work we provide the first record of *Dianesia carteri ramsdeni* from a non-serpentinic locality in the NSB range, namely Yunque de Baracoa (Supplementary File 1), where it was not reported by Núñez (2010b). We found the butterfly flying in the shade of the humid montane forest at the summit of this karstic plateau-like mountain, in July 2022. The observed individuals are identical to the typical ones that fly at Meseta de Iberia. Our data suggest that the species, although undetected in Sierra Cristal, may inhabit all the districts in which the NSB range is divided, wherever habitat conditions are favorable. Further study will clarify the current distribution and ecological details of this rare butterfly.

This work also presents the first record of the rare endemic skipper *Holguinia holguin* from a karstic locality of the Baracoa limestone mountains, Boca de Yumurí (Supplementary File 1). This elusive butterfly has been sparsely collected at different localities belonging to the other three surveyed districts of the range (Fernández *et al*., 2020; Núñez *et al*., 2020b). We observed the insect in the deepest areas of the gallery forest that surrounds the Yumurí River, a few miles inland. The karstic nature of the area agrees with the ecological requirements of the species, as reported in the literature (Alayo & Hernández, 1987; Fernández *et al*., 2020).

Eunica heraclitus (Poey, 1847) is an extremely rare, long unrecorded Cuban endemic butterfly (Alayo & Hernández, 1987; Núñez *et al*., 2020a). The voucher specimen collected by Alayón & Solana (1987) during their surveys in Ojito de Agua, Moa, is the last record of the species in Cuba (Supplementary File 1). This individual seems to have been destroyed and no further evidence of is existence is available (Núñez & Barro, 2016). However, we decided to include the record in this list suggesting that it might be an elusive, yet still present, member of the NSB butterfly fauna. Further field surveys might provide new records of this rare insect.

A total of 63 endemic taxa were registered, representing 79% of all Cuban endemic butterfly taxa. Specifically, 30 endemic species and 33 endemic subspecies were registered (Table 2), representing 71% and 91% of all known Cuban endemic butterfly species and subspecies, respectively (Mancina *et al*., 2020). Nine species (including seven species of *Calisto*, *Atlantea perezi* (Fig. 3) and *Burca cubensis* (Fig. 4Q)) are regional endemics, as well as the subspecies *Eueides isabella cleobaea*. Nine further taxa are exclusive to the eastern region of Cuba (Núñez *et al*., 2020a). NSB also harbors 44 of the 49 Cuban species that constitute Greater Antillean endemics, each inhabiting only one or just a few more islands (Table II).

The butterfly species richness and endemism of NSB outnumber any other Cuban region, as previously highlighted by Mancina *et al*. (2020). Two principal factors have contributed to this. First, the NSB massif contains within its territory some of the oldest emerged Cuban lands, which arose near 70 million years ago (Iturralde-Vinent, 2005). This allowed a continuous, uninterrupted diversification process that was prompted by several colonization events from continental America, and by local evolution, both of flora and fauna (Smith *et al*., 1994). This supposition is reinforced when we examine the NSB regional endemics, which include old, long isolated taxa that have evolved in these mountains, speciating even parapatrically in different habitats of a same range, with the genus *Calisto* being one of the most evident examples (Núñez *et al*., 2012, 2013, 2019a). This diversity is also a consequence of the second factor: the soil diversity of the area, especially the predominance of serpentine rocks and their derivatives. These soils had a tremendous effect on the richness and endemism of the vegetation of the range due to their older age and physiochemical features, including high heavy metal content and low nutrient content (Alexander, 2004). They act as "evolutionary islands", accelerating plant diversification by the stimulation of adaptations in these plants to endure the soil's harsh conditions (Harrison & Inouye, 2002; Kazakou *et al*., 2008). The preliminary results of Barro *et al*. (2004) suggest that the highest butterfly endemism values in Cuba are those of ultramafic (serpentine) areas. Azor & Barro (2014) also found that the higher endemism values of Cuban butterflies were expected to be those of the eastern mountain ranges, including NSB.

The lower richness detected in Sierra de Nipe and Sierra Cristal is a consequence of the small number of localities surveyed in these areas. However, the greater richness of the other ranges, which are phytogeographically related to the aforementioned ones, suggests that a greater richness is likely to be found in these. Due to their biogeographical similarities because of their geological history (Samek, 1973a; Borhidi, 1991), these ranges are also expected to share many butterfly species, including rare and endemic taxa such as *Dianesia carteri*, *Nesiostrymon celida*, *Oarisma bruneri* and *Burca cubensis*. Further field work is necessary on Sierra de Nipe, Sierra Cristal, the non-surveyed districts and non-visited areas of Moa-Toa and Baracoa, not only for a better assessment of this diversity, but also to understand potential distribution, habitat preference, environmental correlates, resource use and threats for this unique, ancestral fauna.

ACKNOWLEDGMENTS

The butterfly lists provided herein could not have been developed without the collaboration of several individuals and institutions. A special recognition to Adrián Serrano, Víctor Manuel Hernández, Juan Carlos Daguerre, Tim Norriss, David L. Auth, Miriam Avello, Matt Cousins, Barbara DeWitt, Duncan Jurman, Julie Jurman, Melissa Lackey, Ricky Ray, John Lampkin and Jane Lampkin for their company during field surveys. We especially thank Norvis Hernández, Gabriel Martínez, Geovanny Rodríguez, Roermis Ortiz, María Alpajón, Yovanis Olivero, Marjoris Rodríguez, Jorge Díaz, Leandro Galano, Yasiel Acosta, Juan Carlos Lobaina, David Lambert, Sara Ilse Suárez, José Luis Gómez and Alejandro Palmarola, for granting access to localities within the "Alejandro de Humboldt" National Park, Yunque de Baracoa and Boca de Yumurí, for the coordination of our visits and their invaluable help during fieldwork. Many thanks to Elisleidy González, Miriam "Macusa" Pineda, José "Papi" Serrano, Frank Serrano, Dalber Serrano, Esmeralda "Coqui" Pineda, Migdalia Bosch, Andrés "Jimmy" Silva, Yenis Martínez and Luis Martínez, for providing housing in the cities of Holguín, Moa and Baracoa and for their kind treatment and support during fieldwork. Traveling for some of the surveys was eased by the help of Renier Rodríguez and José E. Riverón. Fieldwork was sponsored by Carolann Sharkey and Richard Keefe with the TREE Institute International, the Alexander von Humboldt Biodiversity Network and Planta!-PlantLife Conservation Society. We thank the editor and two anonymous reviewers whose comments improved the writing and content of the manuscript.

LITERATURE CITED

Aborrezco, P. 2006. Lista actualizada de mariposas (Lepidoptera: Papilionoidea) presentes en la cayería noreste de Villa Clara. *Agroecología* 4: 61-65.

Alayo, P., Hernández. L. R. 1987. *Atlas de las mariposas diurnas de Cuba (Lepidoptera: Rhopalocera).* La Habana, Editorial Científico-Técnica. 148 pp.

Alayón, G., Solana, E. 1987. Lista de las mariposas diurnas (Lepidoptera: Rhopalocera) colectadas en la Reserva de la Biosfera "Cuchillas del Toa", Holguín-Guantánamo, Cuba. *Garciana* 7: 2-4.

Alexander, E. B. 2004. *Varieties of ultramafic soil formation, plant cover and productivity*, pp. 47-56. *In*: Boyd, R. S., Baker, A. J. M., Proctor, J. (Eds), *Ultramafic Rocks: Their Soils, Vegetation and Fauna. Proceedings of the Fourth International Conference on Serpentine Ecology.* St. Albans, Science Reviews. 347 pp.

Álvarez, Y., Corso, A. J. 2020. Diversity of butterfly assemblages within disturbed habitats of Jardines de Hershey, Mayabeque, Cuba. *Caribbean Journal of Science* 50(1): 139-158.

Azor, L., Barro, A. 2014. Modelación de la distribución potencial de mariposas endémicas cubanas (Lepidoptera: Papilionoidea). *Revista Cubana de Ciencias Biológicas* 3(3): 18-30.

Barro, A., Núñez, R., Rodríguez, K. 2004. *The Lepidoptera of plant formations on Cuban ultramafics: a preliminary analysis*, pp. 223-226. *In*: Boyd, R. S., Baker, A. J. M., Proctor, J. (Eds), *Ultramafic Rocks: Their Soils, Vegetation and Fauna. Proceedings of the Fourth International Conference on Serpentine Ecology.* St. Albans, Science Reviews. 347 pp.

Bermúdez, F., Fernández, D. F., Núñez, R., Villar, Suárez, J. R., Silva, A. 2016. Mariposas de los alrededores de Gibara, Holguín, Cuba (Lepidoptera: Hesperioidea y Papilionoidea). *Poeyana* 502: 39-43.

Borhidi, A. 1991. *Phytogeography and Vegetation Ecology of Cuba*. Budapest, Akadémiai Kiadó. 856 pp.

Brown, F. M., Heineman, B. 1972. *Jamaica and its Butterflies*. London, E. W. Classey Limited. 478 pp.

Capote, R., Berazaín, R. 1984. Clasificación de las formaciones vegetales de Cuba. *Revista del Jardín Botánico Nacional* 5(2): 27-75.

Comstock, W. P. 1944. *Insects of Puerto Rico and the Virgin Islands. Scientific Survey of Puerto Rico and the Virgin Islands, 12, Pt 4*. New York, New York Academy of Sciences. pp. 421-622.

Empresa Nacional Para la Protección de la Flora y la Fauna (ENPFF). 2009. *Plan de Manejo del Parque Nacional 'Pico Cristal'. Informe Anual de la ENPFF 2009*. Cuba, ENPFF. 164 pp.

Espeland, M., Hall, J. P. W., DeVries, P. J., Lees, D. C., Cornwall, M., Hsu, Y. F., Wu, L. W., Campbell, D. L., Talavera, G., Vila, R., Salzman, S., Ruehr, S., Lohman, D. J., Pierce, N. E. 2015. Ancient Neotropical origin and recent recolonisation: phylogeny, biogeography and diversification of the Riodinidae (Lepidoptera: Papilionoidea). *Molecular Phylogenetics and Evolution* 93 : 296-306.

Fernández, D. M. 2007. Butterflies of the Agricultural Experiment Station of Tropical Roots and Tubers, and Santa Ana, Camagüey, Cuba: an annotated list. *Acta Zoológica Mexicana* 23(2): 43-75.

Fernández, D. M., Minno, M. C. 2014a. *Mariposas de Cuba: Provincia Cienfuegos*. Key West, Florida Keys Tropical Research Ecological Exchange Institute. 4 pp.

Fernández, D. M., Minno, M. C. 2014b. *Mariposas de Cuba: Provincias Pinar del Río y Artemisa Provinces*. Key West, Florida Keys Tropical Research Ecological Exchange Institute. 4 pp.

Fernández, D. M., Rodríguez, L. 1998. Las mariposas de Camagüey (Lepidoptera: Papilionoidea y Hesperioidea). *Cocuyo* 7: 21-23.

Férnandez, D. M., Álvarez, Y., Barro, A., Núñez, R., Mancina, C. A. 2020. *Hesperiidae*, pp. 34-67. *In*: Mancina, C. A., Núñez, R., Neyra, B. (Eds.), *Mariposas de Cuba: Guía de Campo.* La Habana, Sello Editorial AMA. 237 pp.

Fontenla, J. L. 1985. Relaciones fagísticas entre mariposas cubanas (Insecta, Lepidoptera). Estudio preliminar. *Ciencias Biológicas* 14: 49-58.

Fontenla, J. L. 1987a. Aspectos comparativos estructurales de tres communidades de mariposas (Lepidoptera, Rhopalocera) en Cuba. *Poeyana* 337: 1-20.

Fontenla, J. L. 1987b. Características zoogeográficas de las ropalóceras (Insecta, Lepidoptera) de Viñales, Pinar del Río, Cuba. *Poeyana* 339: 1-11.

Fontenla, J. L. 1989a. Estructura taxonómica y zoogeografía de las mariposas (Rhopalocera) del Jardín Botánico de Cienfuegos, Cuba. Análisis comparativo. *Poeyana* 367: 1-24.

Fontenla, J. L. 1989b. Partición de recursos en una comunidad de mariposas (Lepidoptera, Rhopalocera). *Poeyana* 385: 1-26.

Fontenla, J. L. 1992. Biogeografía ecológica de las mariposas diurnas cubanas. Patrones generales. *Poeyana* 427: 1-30.

Fontenla, J. L. 1994. Estabilidad y variabilidad temporal de la comunidad de mariposas del Jardín Botánico de Cienfuegos, Cuba. *Ciencias Biológicas* 27: 6-11.

Fontenla, J. L. 2003. Biogeography of Antillean butterflies (Lepidoptera, Rhopalocera), patterns of association among areas of endemism. *Transactions of the American Entomological Society* 129 (3/4): 399-410.

Fontenla, J. L., de la Cruz, J. 1986. Análisis zoogeográfico de las mariposas antillanas (Lepidoptera, Rhopalocera) a nivel subespecífico. *Ciencias Biológicas* 15: 107-122.

Harrison, S., Inouye, B. D. 2002. High β diversity in the flora of Californian serpentine "islands". *Biodiversity & Conservation* 11: 1869-1876.

Harvey, D. J., Clench, H. K. 1980. *Dianesia*, a new genus of Riodinidae from the West Indies. *Journal of the Lepidopterists' Society* 32(2): 127-132.

Hernández, L. R., Smith, D. S., Davies, N., Aceres-Mallea, A. 1994. The butterflies and vegetational zones of Guanahacabibes National Park, Cuba. *Bulletin of the Allyn Museum* 139: 1-20.

Holland, W. J. 1916. Lepidoptera of the Isle of Pines, being a list of the species collected on the island by Mr. J. L. Graf and Mr. G. A. Link, Sr., in 1910 and 1912-1913. *Annals of the Carnegie Museum* 10: 487-518.

Iturralde-Vinent, M. 2005. La paleogeografía del Caribe y sus implicaciones para la biogeografía histórica. *Revista del Jardín Botánico Nacional* 25: 49-78.

Iturralde-Vinent, M., Díaz-Otero, C., Rodríguez-Vega, A., Díaz-Martínez, R. 2006. Tectonic implications of paleontologic dating of Cretaceous-Danian sections of Eastern Cuba. *Geologica Acta* 4(1-2): 89-102.

Kazakou, E., Dimitrakopoulos, P. G., Baker, A. J. M., Reeves, R. D., Troumbis, A. Y. 2008. Hypotheses, mechanisms and trade-offs of tolerance and adaptation to serpentine soils: from species to ecosystem level. *Biological Reviews* 83: 495-508.

Luna, L. H., Hernández, A. 2013. Mariposas diurnas (Lepidoptera: Rhopalocera) de Cayo Caguanes (Parque Natural Caguanes), Sancti Spiritus, Cuba. *Boletín de la Sociedad Entomológica Aragonesa* 52: 226-228.

Mancina, C. A., Núñez, R., Neyra, B. 2020. *Introducción*, pp. 8-21. *In*: Mancina, C. A., Núñez, R., Neyra, B. (Eds.), *Mariposas de Cuba: Guía de Campo.* La Habana, Sello Editorial AMA. 237 pp.

Matos-Maraví, P. F., Núñez, R., Peña, C., Miller, J. Y., Sourakov, A., Wahlberg, N. 2014. Causes of endemic radiation in the Caribbean: evidence from the historical biogeography and diversification of the butterfly genus *Calisto* (Nymphalidae: Satyrinae: Satyrini). *BMC Evolutionary Biology* 14(199): 1-18.

Núñez, R. 2004. Lepidoptera (Insecta) de Topes de Collantes, Sancti Spiritus, Cuba. *Boletín de la Sociedad Entomológica Aragonesa* 34: 151-159.

Núñez, R. 2010a. Especies del orden Lepidoptera (Insecta) en el Área Protegida de Recursos Manejados "Mil Cumbres", Pinar del Río, Cuba. *Poeyana* 498: 31-38.

Núñez, R. 2010b. Lista preliminar de las mariposas (Lepidoptera: Papilionoidea) de El Yunque de Baracoa, Guantánamo, Cuba. *Cartacuba* 2(2): 22-24.

Núñez, R. 2012. The butterflies of Turquino National Park, Sierra Maestra, Cuba (Lepidoptera: Papilionoidea). *Arxius de Miscel-lània Zoològica* 10: 29-49.

Núñez, R., Barro, A. 2003. Composición y estructura de dos comunidades de mariposas (Lepidoptera: Papilionoidea) en Boca de Canasí, La Habana, Cuba. *Revista Biología* 17(1): 8-17.

Núñez, R., Oliva, E., Matos, P. F., Wahlberg, N. 2012. Cuban *Calisto* (Lepidoptera, Nymphalidae, Satyrinae), a review based on morphological and DNA data. *Zookeys* 165: 57-105.

Núñez, R., Matos-Maraví, P. F., N. Wahlberg. 2013. New *Calisto* species from Cuba, with insights on the relationships of Cuban and Bahamian taxa (Lepidoptera, Nymphalidae, Satyrinae). *Zootaxa* 3669(4): 503-521.

Núñez, R., Barro, A. 2016. Eunica heraclitus, pp. 179-180. *In*: Hidalgo-Gato, M. M., Espinosa, J., Rodríguez-León, R. (Eds.), *Libro Rojo de Invertebrados Terrestres de Cuba*. Editorial Academia, La Habana. 241 pp.

Núñez, R., Barro, A., Minno, M., Fernández, D. M., Hausmann, A. 2019a. The *herophile* species group of *Calisto* (Lepidoptera: Nymphalidae: Satyrinae), new taxa and historical biogeography. *Invertebrate Systematics* 33: 644-660.

Núñez, R., Genaro, J. A., Pérez-Asso, A., Murillo-Ramos, L., Janzen, D. H., Hallwachs, W., Wahlberg, N., Hausmann, A. 2019b. Species delimitation and evolutionary relationships among *Phoebis* New World Sulphur butterflies (Lepidoptera, Pieridae, Coliadinae). *Systematic Entomology* 45(2): 481-492.

Núñez, R., Neyra, B., Caballero, H., Fernández, D. M., Norris, T., Mancina, C. A. 2020a. *Nymphalidae*, pp. 116-163. *In*: Mancina, C. A., Núñez, R., Neyra, B. (Eds.), *Mariposas de Cuba: Guía de Campo.* La Habana, Sello Editorial AMA. 237 pp.

Núñez, R., Alegre-Barroso, A., Hausmann, A. 2020b. Redescription and evolutionary relationships of the Cuban endemic monotypic genus *Holguinia* Evans, 1955. *Systematics and Biodiversity* 19(1): 1-12.

Núñez, R., Willmott, K., Álvarez, Y., Genaro, J. A., Pérez-Asso, A. R., Querejeta, M., Turner, T., Miller, J. Y., Brévignon, C., Lamas, G., Hausmann, A. 2021. Integrative taxonomy clarifies species limits in the hitherto monotypic passion-vine butterfly genera *Agraulis* and *Dryas* (Lepidoptera, Nymphalidae, Heliconiinae). *Systematic Entomology* 47(1): 152-178.

Pérez-Asso, A. R., Núñez, R., Genaro, J. A. 2016. Morphology and COI barcodes reveal four new species in the *lycieus* group of *Calisto* (Lepidoptera, Nymphalidae, Satyrinae). *Zootaxa* 4170(3): 401-450.

Pérez-Asso, A. R., Genaro, J. A., Bastardo, R. H., López, A. 2017. *Mariposas de La Española*. Miami, Editorial Cocuyo. 245 pp.

Racheli, T. 2019. An updated list to the butterflies of Hispaniola, with notes on the classification of *Calisto* Hübner, 1823 (Lepidoptera, Hesperiodea, Papilionoidea). *Neue Entomologische Nachrichten* 76: 1-135

Riley, N. D. 1975. *A Field Guide to the Butterflies of the West Indies*. London, Collins. 224 pp.

Ruiz, I. 2017. *Las Áreas Protegidas de Cuba*. La Habana, Centro Nacional de Áreas Protegidas. 392 pp.

Samek, V. 1973a. Regiones Fitogeográficas de Cuba. *Serie Forestal* 15: 1-63.

Samek, V. 1973b. Pinares de la Sierra de Nipe: estudio sinecológico. *Serie Forestal* 14: 1-56.

Schwartz, A. 1989. *The Butterflies of Hispaniola*. Gainesville, University of Florida Press. 580 pp.

Smith, D. S., Miller, L. D., Miller, J. Y. 1994. *The Butterflies of the West Indies and South Florida*. New York, Oxford University Press. 256 pp.

Smith, D. S., Hernández, L. R., Davies, N. 1998. The butterflies of the Isle of Pines, Cuba: eighty years on. *Annals of Carnegie Museum* 67(4): 281-298.

Turner, T. W., Turland, V. 2017. *Discovering Jamaican Butterflies and their Relationships Around the Caribbean*. Safety Harbor, Caribbean Wildlife Publications, LLC. 492 pp.

Vallejo, R. S., Núñez, R., Velazco, K., Noel, F., Hernández-Rodríguez, S., Gómez, J. L., López, A., Cordero, A., Expósito, A., Tejeda, A., Hernández, B., Martínez-Álvarez, G., Moreira, M., Reyes, S., Sánchez, S., Márquez, W., Díaz-Álvarez, González-Torres, L. R., Palmarola, A. 2021. Inventario biológico de la fauna terrestre en La Cueva, Sierra de Nipe, Holguín, Cuba. *Revista Cubana de Ciencias Biológicas* 9(2): 1-12.

Varona-Álvarez, L. M. 2022. Lista taxonómica de las mariposas (Insecta: Lepidoptera) del sector Cupeyal del Norte, Parque Nacional Alejandro de Humboldt, Holguín-Guantánamo, Cuba. *Novitates Caribaea* 20: 155-168.

Warren, A. D., Davis, K. J., Grishin, N. V., Pelham, J. P. 2022. *Interactive list of American butterflies*. http://butterfliesofamerica.com/ Accessed April 2022.