

A NEW SUBSPECIES OF *PARIDES GUNDLACHIANUS* FROM CUBA (LEPIDOPTERA: PAPILIONIDAE)

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ABSTRACT.— A new subspecies of the endemic Cuban swallowtail butterfly, *Parides gundlachianus* C. Felder & R. Felder, is described, *P. g. alayoi* n. subsp., from a western locality, in Pinar del Río Province. Field observations on the behavior and habitats of these populations and in centers of abundance of the typical insect in eastern Cuba are described. Variation in adult size is recognized as an altitudinal cline. Biogeographical aspects of this and other Cuban papilionids are discussed, and the need for conservation and protection of the western populations is stressed.

KEY WORDS: altitudinal cline, Araneae, Argentina, Aristolochiaceae, behavior, biogeography, biology, Bolivia, Boraginaceae, Brazil, Caribbean, Compositae, conservation, Cuba, distribution, Leguminosae, Mexico, *Papilio*, Paraguay, *Parides gundlachianus alayoi* n. subsp., population biology, Reptilia, Verbenaceae, West Indies.

The New World papilionid genus *Parides* Hübner includes some 45 species (D'Abrera, 1981) ranging from Mexico through Central and South America to northern Argentina, Paraguay and Bolivia, with a center of diversity in Brazil. In addition, subspecies have been described for almost half of these, raising the total of *Parides* taxa to over one hundred. It is represented in the West Indian biogeographical zone by only a single, and very distinctive species, endemic to Cuba.

This swallowtail, now known as *Parides gundlachianus*, was described by Herrich-Schäffer (1862) as *Papilio columbus*, a pre-occupied name that Felder and Felder (1864) replaced by *Papilio gundlachianus*. In 1865, Blake described the same insect as *Papilio grotei*, a name that passed into synonymy. Gundlach (1881) knew this beautiful butterfly as inhabiting "the eastern part of the island of Cuba, and has been seen there at Cabo Cruz, in the highlands to the south of Bayamo, at Brazo del Cauto, at El Cobre and at the coast at Santiago de Cuba." Torre (1971) introduced the name 'calzadilla' for specimens generally referred to by Cuban entomologists as the 'mountain form' of the butterfly, found on the highest eastern peaks and appreciably larger than those from lowland localities. Riley (1975) placed this species in the genus *Parides* Hübner, a course followed by Alayo and Hernández (1987) who also, for the first time, reported a population of *P. gundlachianus* from western Cuba, and placed the form described by Torre under synonymy. In this account, a new subspecies of *P. gundlachianus* is described, the 'mountain form' is considered further, together with ecological, ethological and distributional aspects of the biology of this butterfly.

In preparing this account, we have examined the following collections: the Institute of Ecology and Systematics of the Academy of Sciences of Cuba (CZACC); the 'J.H. Pazos group' of San Antonio de los Baños (CJHP) in care of Adalberto León and Pedro A. Rodríguez; Fernando de Zayas (CFZ); the National Museum of Natural History, La Habana (MHNC), and the collec-

tion of the senior author (CLRH). Alar index (wingspan) was measured with a millimeter scale as twice the mid-point of the thorax to the forewing apex; this morphological character was selected from others as the best indicator of variability. For clinal analysis, specimens were collected at three altitudinal zones: sea-level, between 200m and 800m and above 900m. Material on which the new subspecies is based was obtained during seven visits to the type locality. Genitalic preparations were made according to Alayo and Hernández (1987).

Parides gundlachianus alayoi

Hernández, Alayón & Smith, n. subsp.

(Fig 1a-b, 9)

Diagnosis.— In the nominate subspecies the white spot on FW underside is more or less rectangular, though variable in width (Fig. 2-3), elongate, arising broadly against the costa, truncate at its end (very rarely pointed), touching and sometimes extending slightly beyond the vein linking M_3 and Cu_1 . Genital harpe with posterior and anterior teeth less pronounced, the latter extending further along the lateral margin (Fig. 10).

Description.— MALE: very similar in form and coloration to the nominate subspecies *P. g. gundlachianus*, from which it differs in shape of the white spot on the underside forewing (Fig. 1b) which is spindle-shaped or almost triangular. It arises just below the costa near center of the wing, crosses much of the discal cell and tapers to end sharply above center of the vein joining M_3 and Cu_1 , without touching it. The red distal spot on the HW upperside between M_1 and M_2 is faint or absent. The fold at the HW anal margin is as in *P. g. gundlachianus*. **Genitalia:** harpe with teeth at posterior and anterior tip more grouped and more pronounced than in nominate subspecies (Fig. 9).

FEMALE: similar; HW with a well marked distal spot between M_1 and M_2 .

Type locality.— Pan de Azúcar, La Pimienta, Pons, Matahambre, Pinar del Río Province, Cuba.



Fig. 1-8. *Parides gundlachianus alayoi* n. subsp.: 1) ♂ paratype (a. dorsum; b. venter); 2-3) *Parides gundlachianus gundlachianus* males; 4) Coastal forest near Jauco, Guantánamo; 5) Viñales Valley, Pinar del Río; 6-7) *Anolis equestris* preying on *Parides g. gundlachianus*; 8). *Parides g. gundlachianus* nectaring on *Eupatorium*.

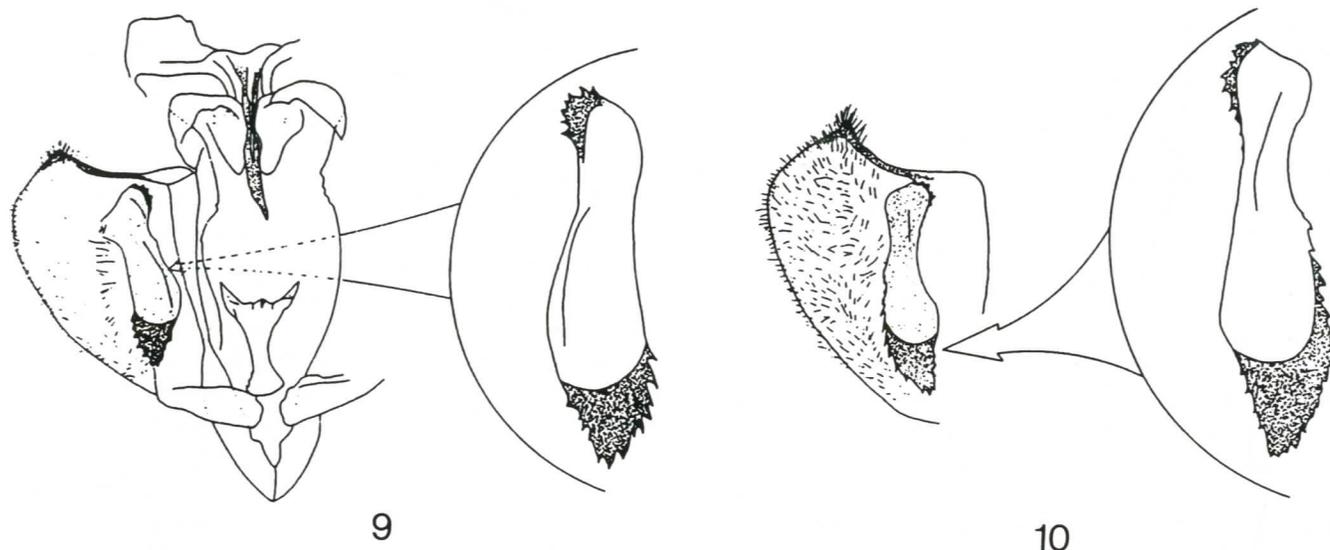


Fig. 9-10. Male genitalia: 9) *Parides g. alayoi*; 10) *Parides g. gundlachianus*.

Types: *Holotype* ♂: collected in above locality by A. León, 2 Dec 1980 (CLRH), deposited in the National Museum of Natural History, La Habana (MHNC).

Paratypes: CUBA.— *Pinar del Río:* *Pan de Azúcar*, (same data as holotype), 13 Apr 1980, A. León (1♂ CLRH in MHNC; 10♂ CJHP); 2 Dec 1979, A. León (1♀ MHNC; 6♀ CJHP); 27 Oct 1979, A. León (1♀ CJHP); 1 Dec 1979, P.A. Rodríguez (2♂, 4♀ CJHP); 1 Feb 1980, P. A. Rodríguez (7♂, 2♀ CJHP); *El Palenque*, Viñales, Oct 1979, L. R. Hernández and G. Alayón (No. 7500246-50, 7500252, 7500255-6, 7500267 CZACC); Oct 1979, J. Cruz (No. 7500253 CZACC). *La Pimienta*, 15 Apr 1979, E. Armentero (No. 7500251 CZACC); (No. 7500254 CZACC). *Pons*, Viñales, Sep 1981, L. R. Hernández and P. Alayo (No. 7500260-6 CZACC); 29 Mar 1994, L. R. Hernández and D. S. Smith (1♂ AMNH, 1♂ ANSP, 1♂ CMNH, 1♂ MCZ, 1♂ AME, 2♂ Hope Entomological Collections, Oxford).

Comparative Material Examined.— *P. g. gundlachianus*: 16♂ and 3♀, Sardinero, Santiago de Cuba, P. Alayo, M. L. Jaime and S. L. de la Torre CZACC); 10♂ and 2♀, Maisí, Guantánamo, P. Alayo and J. Acuña; 1♀, mouth of Río La Mula, Ocuja, Santiago de Cuba [collector not stated]; 2♂ and 3♀, Loma del Gato, Hongolosongo, Santiago de Cuba, P. Alayo and H. Clemente; 2♀, Estación Experimental Agronómica Baracoa, L. R. Hernández; 1♀, Gran Piedra, Santiago de Cuba, P. Alayo; 8♂, Boca de Jauco, Guantánamo, L. R. Hernández and D. S. Smith.

Range.— Known only from the type locality, the adjacent Hoyo de Fanía and near Cueva de los Indios, ca. 15km to the east.

Variability.— In a male paratype of *P. g. alayoi* the triangular white underside FW spot is broken near the middle to assume a tear drop shape, and this spot is very occasionally broken in the nominate subspecies. Otherwise the material conforms to the description.

Etymology.— We name this new subspecies for Dr. Pastor D. Alayo, in recognition of his dedication, for over 50 years, to the study of the insect fauna of Cuba.

BIOLOGY OF *PARIDES GUNDLACHIANUS*

DISTRIBUTION AND FIELD OBSERVATIONS

The two subspecies of this butterfly now known to occur in Cuba not only inhabit widely separated areas of the island, in the

east and west, but within each area the range differs strikingly. The distribution of the nominate eastern subspecies is as follows: in the extreme east from localities at Imías, Maisí, Jauco and Baracoa (Guantánamo Province), in the south-central region at Sardinero, Gran Piedra and Loma del Gato (Santiago de Cuba Province), in the north-central region at Moa, Mayarí and Cupeyal (Guantánamo and Holguín Provinces) and the south-western part of its range lies in the Sierra Maestra (Santiago de Cuba and Granma Provinces). In our experience, it is very rare at Cabo Cruz, where Gundlach found it in abundance over a century ago. In contrast to this relatively wide range, the western subspecies has an extremely restricted distribution, and adults show little ability to disperse from their site of emergence.

It has been known for over a century that the larva of *P. gundlachianus* feeds on members of the genus *Aristolochia* (Aristolochiaceae), plants known in Cuba as *Flor del Pato* or *Gallitos*. Of these, the Cuban flora possesses 13 species, seven of which are endemic to the island. Ten occur in the old province of Oriente (present Santiago de Cuba, Holguín, Guantánamo and Granma), four endemic to the area and others also found further west and/or elsewhere in the Bahamas or Greater Antilles. Three species are known from Pinar del Río, ranging eastwards but none beyond Camagüey, and a possible link between *Aristolochia* and *Parides* populations will be mentioned later. Other than a description of the last larval instar (Bonzon, 1888), the life history of this swallowtail remains unknown.

In the exposed localities around Maisí, subspecies *gundlachianus* may fly rapidly, achieving local migration or dispersal from east to west, at times aided by strong, mainly easterly winds, but elsewhere its flight is usually slow and lazy. It seems generally to occur in very localized but thriving communities. Thus, although confined at the Sardinero locality to an area scarcely a hundred meters square, it is at times very common there and may be picked up by hand, when nectaring. In June 1993, it was likewise abundant in coastal forest at Jauco, east of Maisí, taking nectar at flowering trees and shrubs, when as many as ten could often be seen within a field of view. This locality is shown in Fig. 4: this dry forest of the coastal lowlands and adjoining hills

in places includes tall stands of the the cacti *Pilocerus* and *Dendrocereus*, and extends over wide areas of southeastern Cuba.

When visiting flowers (Fig. 8), the butterfly scarcely alights, the fore-wings moving constantly and rapidly as it passes jerkily from one inflorescence to the next. Flowers either white or approaching the butterfly in color seem to be preferred; red or blue-toned. *Lantana camara* (Verbenaceae) and *Eupatorium odoratum* (Compositae) are often visited by subspecies *P. g. alayoi* but, as with many butterflies, nectaring is often opportunistic; at Sardinero we have seen adults feeding in tall trees of *Pithecellobium unguis-cati* (Leguminosae), occasionally at ground level on *Bidens alba* (Compositae) and at Jauco a white-flowered *Bourreria* (Boraginaceae) tree was the most abundant nectar source at the time of our visit. The undisturbed flight is quite slow and gentle, but swift and direct when the butterfly is alarmed.

The type locality of the newly described subspecies lies in the northern part of the Viñales valley, an area of remarkable scenery (Fig. 5), dominated by steep *mogote* hills arising from the flat valley floor, long intensively cultivated, notably for tobacco. The hills are densely forested, precipitously contoured and support many endemic plants. Here, the butterflies roost high in the forest, move in leisurely flight above the canopy to low nectaring sites within or outside the forest in the morning, retracing their path late in the afternoon. This general pattern of behavior is shared by eastern populations, where localities also include hill and mountain slopes, and lower land rich in flowers.

PREDATION

In common with other *Aristolochia*-feeding swallowtails, *P. gundlachianus* has been viewed as distasteful to predators, and its slow flight and brilliant coloration as aposematic features. No wing damage suggestive of unsuccessful bird or lizard attack has been noted in museum series of either subspecies, or in specimens we have collected. Several butterflies were found in *Nephila clavipes* webs near Jauco in June 1993, but spiders were not seen feeding, though a crab-spider (*Misumenops* sp.) was found there, apparently feeding on a specimen it had captured. We have only once observed predation by a vertebrate: at an eastern site near Jauco, an *Anolis equestris* (Reptilia) was filmed by John Banks in December 1990 as it ate a captured butterfly (Fig. 6-7). Ingestion took over 60 minutes, the lizard remaining motionless for long periods between gulps as the insect's body was taken, head first, into the mouth. While it is tempting to view the slowness of the meal as showing the triumph of hunger over unpalatability, this view remains conjectural!

VOLTINISM

The western subspecies appears to be at least bivoltine, flying mainly from September to May, though annual fluctuations in adult emergence no doubt occur. It was abundant late in December 1990, while on our most recent visit at the end of March 1994, it was again common and most specimens were either very worn, or recently emerged. Only two adults were seen when we visited the type locality in late September 1991, while a few days later typical *P. gundlachianus* was abundant at Sardinero, 900km to the east. The latter seems to be multivoltine and continuously brooded, flying throughout the year, but adults are perhaps most common from June to November. Our colleague L. F. de Armas

found it in great abundance, and including pairs *in copula* on May 1 1974 at Loma El Pilón, Mayarí, Holguín, and it was one of the commonest butterflies when we visited Jauco at the end of June 1993.

VARIATION IN SIZE WITH ALTITUDE

On comparing contiguous or neighboring populations at different altitudes, we find that wing span changes regularly and progressively. Such progressive variation is characteristically clinal; in this instance populations evidently representing an 'altitudinal cline' with form 'calzadilla' representing the upper range of the scale. Table 1 shows the direct relationship between increase in size with increasing altitude of the population, in both sexes. In all populations males have shorter, narrower and more robust wings, presumably facilitating greater flight speed and manoeuvrability during courtship and copulation. It is noteworthy that no substantial difference is seen between eastern populations (typical *P. gundlachianus*) from between 200m and 800m above sea level and those from Pinar del Río (subspecies *P. g. alayoi*), an observation that accords with the position of western populations in the same altitudinal zone as these mid-level eastern colonies. In other words, each population, depending on the altitude it occupies, maintains a more or less uniform size and wingspan. No obvious difference is noted between females of eastern coastal populations and specimens from Pinar del Río, but any conclusion is limited by the small size of our samples of this sex, which is by far the more rarely seen, in the field.

TABLE 1. Variation in size of adults of *Parides gundlachianus* Subspecies *P. g. alayoi* in Pinar del Río (PR) and populations of subspecies *P. g. gundlachianus* in eastern localities (O: Oriente). The latter are grouped in three altitudinal levels: s.l. (sea level), -900 (200-800m), +900 (over 900m). Alar index is measured as mid-point of thorax to forewing apex x2 (for discussion see text).

		n	Alar Index (mm)	x	S
MALE	PR	22	82-92	86.6	2.42
	O (+900)	4	92-96	94.8	1.89
	O (-900)	6	82-90	85.5	2.81
	O (s.l.)	25	70-84	77.9	2.72
FEMALE	PR	13	82-96	88.8	4.44
	O (+900)	4	100-104	103.0	2.00
	O (-900)	6	88-95	92.5	3.98
	O (s.l.)	5	72-90	83.2	6.87

DISCUSSION

The swallowtails are represented in the West Indies by some 20 resident species, of which 14 are endemic to the area and four strictly confined to Cuba: *Parides gundlachianus*, *Heraclides oxynius*, *H. caiguanabus* and *Protesilaus celadon*. Three species, *Heraclides aristodemus*, *H. thoas* and *Battus polydamas*, whose range extends to the continent and to other islands, are represented on Cuba by endemic subspecies, and *Papilio polyxenes* by a possibly extinct Cuban race (Alayo and Hernández, 1987). *Battus devilliers* is primarily Cuban, but also widespread on Andros, in the Bahamas. The Antillean species *Heraclides pelaus* and *H. andraemon* have also evolved endemic forms on Cuba, where *H. cresphontes* has an uncertain distribution, with occasional vagrants of *H. troilus* and *H. palamedes* completing the island list.

In this account, we are not considering the possible origins of the Cuban butterfly fauna, other than noting that while dispersal has often been viewed as the sole means by which the Greater Antilles were, and continue to be populated (Brown and Heineman, 1972), others have envisaged a vicariant origin for the ancestral stock of at least some endemic forms, reflecting tectonic events in the formation of the islands (Miller and Miller, 1989). Whatever the means by which *Parides* first reached Cuba, the distinctiveness of *P. gundlachianus* suggests long separation from continental relatives; at least, from extant members of the genus. We view the widely separated eastern, and the recently discovered western populations as perhaps reflecting early fragmentation of the range of a once widely distributed species, the divergence between the two present centers representing incipient speciation.

The variation in size with altitude is of secondary significance, common to both centers but seen as a cline only in the east, where the butterfly's range passes from lowland localities to the highest mountain peaks. It is well known that temperature and rainfall patterns differ markedly between the mountains and coastal lowlands: in the former the mean temperature is cooler and relative humidity higher. Ray (1960) suggested that when individuals of a population are reared at differing temperatures, those exposed to a colder regime develop more slowly but eventually reach a greater size. Such may account for the presence of smaller to larger individuals in species such as *P. gundlachianus*, whose distribution covers a wide altitudinal range. Alayo and Hernández (1987) mention this effect in the context of butterflies, and future work may reveal similar altitudinal clines in other Cuban species.

The wide separation of the two centers of *P. gundlachianus* is remarkable in view of the occurrence of *Aristolochia* throughout Cuba. However, the coincidence between the distribution of the butterfly and of several eastern endemic members of the plant genus, and of 'western' *Aristolochia* species in the Viñales Valley is noteworthy. It is possible that the disjunct distribution of the butterfly is maintained by an ancient hostplant selectivity; a possibility that will be supported or otherwise, when the life histories of the two subspecies are fully known. It may be that a more catholic taste in *Aristolochia* underlies the wide distribution of *Battus devilliers* in Cuba, its presence on the neighboring island of Andros, and its recent successful colonization of New Providence (Knowles and Smith, in press).

CONSERVATION

Although the well known nominate subspecies of *P. gundlachianus* is not at present under any threat, subspecies *P. g. alayoi* occupies only a very restricted area, entirely tied to the *mogotes* of the Viñales Valley. Fontenla (1987) recorded a colony in the same *mogote* group as the type locality; one was found in similar terrain a few kilometers to the east, and careful search of the Vinales area might well reveal additional small colonies. At the type locality in December 1990, butterflies were plentiful in flowery, open scrub vegetation, beyond the edge of the *mogote* forest, but in March 1994 this area had been lost to cultivation, and butterflies visited nectar sources within the forest. Any encroachment of cultivation, or tree felling within the forest would place its already restricted colonies under further stress. To prevent its disappearance, we suggest that it should not be

intensively collected, and most importantly that its habitat, together with its available hostplants, must be preserved without further change. These measures are needed if a hitherto unrecognized piece of Cuba's evolutionary history, shown by one of the island's most beautiful butterflies, is to survive.

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