

PRESENCE AND PHENOTYPIC VARIABILITY OF *PALMARIS GUSTAVI* (STAUDINGER, 1898) IN NORTHERN CHILE, WITH NOTES ON *PALMARIS PENAI* (HAYWARD, 1967) (LEPIDOPTERA, NYMPHALIDAE, SATYRINAE)

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Abstract: Although it has been assumed that the satyrine butterfly *Palmaris gustavi* (Staudinger, 1898) should be present in northern Chile, no reliable reports of its observation and capture have been provided. Here, we report the presence of *P. gustavi* in several localities of northern Chile stretching from the altiplanic regions of Putre to those of San Pedro de Atacama, 550 km to the south. We also report that this butterfly displays a strong phenotypic variability, ranging from dark forms with entirely dark brown upper wing surfaces to light forms with large silvery discal and marginal areas. Both forms were observed together in one population. Illustrations of the adult habitus and male genitalia are provided, as well as notes and illustrations of the habitat. We suggest that the closely related *Palmaris penai* (Hayward, 1967) may be conspecific with *P. gustavi*, or alternatively that the San Pedro de Atacama population observed by us represents *P. penai* and the diagnostic features of this species have to be reassessed.

Key words: Lepidoptera, Nymphalidae, Satyrinae, *Palmaris gustavi*, *Palmaris penai*, northern Chile.

Presencia y variabilidad fenotípica de *Palmaris gustavi* (Staudinger, 1898) en el norte de Chile y notas sobre *Palmaris penai* (Hayward, 1967) (Lepidoptera, Nymphalidae, Satyrinae)

Resumen: Aunque se sospechaba que el satirino *Palmaris gustavi* (Staudinger, 1898) debería encontrarse en el norte de Chile, no se conocían datos fidedignos de su observación y captura. Aquí describimos el hallazgo de *P. gustavi* en varias localidades del norte de este país que se extienden desde las regiones altiplánicas de Putre a las de San Pedro de Atacama, 550 km al sur. También describimos la fuerte variabilidad fenotípica de esta especie, que va desde formas oscuras, con la cara dorsal de las alas enteramente marrón oscuro, hasta formas claras con amplias zonas discales y marginales plateadas. Ambas formas conviven en por lo menos una población. Se muestran especímenes adultos y genitales masculinas, y también notas y fotografías de su hábitat. Sugerimos que *Palmaris penai* (Hayward, 1967), estrechamente relacionada con *P. gustavi*, sea en realidad la misma especie, o que, alternativamente, la población observada en San Pedro de Atacama represente a *P. penai* y que las características diagnósticas de esta especie tengan que ser reevaluadas.

Palabras clave: Lepidoptera, Nymphalidae, Satyrinae, *Palmaris gustavi*, *Palmaris penai*, norte de Chile.

Introduction

The subtribe Pronophilina is a relatively large group of Neotropical Satyrini (Nymphalidae, Satyrinae), which predominantly includes mountain species. The internal relationships of the taxon are still not resolved, with several genera of uncertain position (Peña *et al.*, 2006; Brower, 2008). One of these is the genus *Palmaris* Herrera, 1965, which consists of a few (four-five) species formerly included in the genus *Argyrophorus* Blanchard, 1852 (details and further references in Lamas, 2004; Brower, 2008).

According to Peña & Ugarte (1997), four species of *Palmaris* occur in Chile. With regards to *P. gustavi* (Staudinger, 1898), these authors state that no reliable records exist for the country, although it would not be surprising that this butterfly would occur in the altiplano of the Tarapacá Region at the extreme North of Chile. This is a reasonable inference since the insect was first collected by Gustavo Garlepp (and named after him by Staudinger, 1898) in Sajama, Bolivia, a dozen kilometers away from the Chilean/Bolivian border and abutting to the Chilean Tarapacá region. In fact, very little is known on the overall distribution of this species. In his original description, Staudinger (1898) wrote that this butterfly is found in the altiplanic region of Bolivia, above 4000 m above sea level (asl). D'Abbrera (1988) just indicates "Bolivia" (with a most likely wrong elevation figure: 1300 ft asl).

In accordance with the suggestion by Peña & Ugarte (1997), we report the finding of *P. gustavi* in several Chilean localities relatively close to Sajama. A population, possibly also of *P. gustavi*, was found more than 500 km South of Sajama, suggesting a wide range for this butterfly in Chile. In addition, we find that *P. gustavi* displays high phenotypic variability, with dark and light forms. Since the light forms approach the closely related species *P. penai* (Hayward, 1967), we discuss the similarities between these two species and illustrate the male genitalia of *P. gustavi*.

Materials and methods

All the field work and photographs (unless otherwise credited) are due to the first author (JM). A brief account of field notes is given below. The voucher specimens mentioned (9 males, 3 females) are kept in his private collection. Coordinates, distances and elevations were determined with the help of maps (1/250.000) of the Instituto Geográfico Militar de Chile and satellite maps from Google Earth. Details for the field locations visited and specimens collected are as follows.

Site A. Putre, Tarapacá Region. Plateau at the foot of the Nevados de Putre by the side of international route 11

(which links Arica, Chile with La Paz, Bolivia), 69° 24' 38"W, 18° 10' 44"S; 4400 m asl, 47 km W of Sajama. 7-XI-1996, one male. 28-X-2003, four males.

Site B. Putre, Tarapacá Region. Dirt-road connecting route 11 to the Salar de Surire, 10 km SE of site A. ca. 4400 m asl. 29-X-2003, one female.

Site C. Salar de Surire, Tarapacá Region. Northern edge of the Salar de Surire, 69° 04' 43"W, 18° 47' 55"S; 4300 m asl, approximately 77 km SSE of site A, about 0.5 km E from the CONAF (Confederación Nacional Forestal) refuge. 29-X-2003, two females.

Site D. San Pedro de Atacama, Antofagasta Region. 10 km to the SSE of the Licancábur volcano and ca. 36 km E of San Pedro de Atacama. 67° 51' 13"W, 22° 55' 25"S; 4300 m asl, by the side of international route 27 (which links San Pedro de Atacama with Paso Jama, at the Chilean-Argentinian border). 3-XII-2005, four males.

Besides using the available literature (Staudinger, 1898; Hayward, 1967; D'Abrera, 1988; Peña & Ugarte, 1997), identification was corroborated on the basis of curated specimens kept in the British Museum of Natural History (BMNH) and the Museo de Historia Natural, Universidad Mayor de San Marcos, Lima, Perú, and the Luis Peña collection (at insectoschile.com).

For simplicity, the numerical notation is used to designate the wing veins and the intervein spaces. Thus the veins are named as V1 (or V1a, V1b), V2-V8 from the anal margin to the costal one, and the corresponding between-vein spaces as s1 (s1a-s1b in the fore wing, s1a-s1c in the hind one) and s2 and so forth in the same costal-wise direction.

Results and discussion

1- Field notes

On 07-XI-1996 one of us (JM) collected one male of *P. gustavi* (Fig. 1A) at site A, 47 km West of Sajama. The habitat, at 4400 m asl is a dry open plateau at the foot of the Nevados de Putre (Fig. 2), with sandy soft soil of presumably volcanic origin. It has abundant growths of "paja brava" (or coirón: *Stipa sp.*) and scattered small bushes of another plant, possibly a "vautro" (*Baccharis sp.*). This vegetation type is usually known as "pajonal". The butterfly was collected (at ca. 10:30 AM and with sunny weather) during a few minutes of butterfly searching, together with four specimens of *Faunula leucoglène eleates* (Weyer, 1890). On 28-X-2003 at exactly the same place and about the same hour of the day, during an interval of approximately 40 minutes many specimens of *P. gustavi* were seen (in contrast, not a single *Faunula* was observed). Four males were collected (Figs. 1B-E), two of them in a quite worn condition and one of these with part of both hind wings missing in a symmetrical way (Fig. 1C), which suggests an attack by an unknown predator. The butterflies had a fast flight and were difficult to approach. They landed on the ground and on the vautro and the paja brava, and seemed to be more abundant in places where the former of both plants occurred at highest densities. These males (Figs. 1B-E) had darker upper wing surfaces than those of the male collected in 1996 (Fig. 1A), with the light gray postdiscal markings on both wings comparatively reduced.

On the following day (29-X-2003) a female (Fig. 1F) was captured on a similar terrain at site B, by the side of the

dirt-road to the Salar de Surire. It was most similar to the males collected at the first site. Further 25 km away, along the same road, another specimen was sighted (not collected). Then, at approximately 2 PM of the same day, on the northern edge of the Salar de Surire (site C, Fig. 3), another specimen whose underside suggested that it was also *P. gustavi* was sighted at a stretch full of well grown bushes of *Baccharis sp.* (Fig. 4) on the side of the narrow dirt-road that borders the salt lake, near the CONAF refuge. The specimen was sitting on a *Baccharis* plant and, when it took off, it was apparent that it had much lighter upper wing surfaces than any of the former specimens. Two female individuals were collected (Figs. 5E, F). These displayed very light upper wing surfaces due to extended silvery areas with greenish flashes, while their underside wing areas and general habitus was nevertheless that of *P. gustavi*. *Faunula leucoglène* were also flying at the place.

Finally, on 3-XII-2005, similar butterflies, presumably *P. gustavi*, were observed in site D, a more Southern location on a slope at 4300 m asl between San Pedro de Atacama and Paso Jama, again with plenty of "paja brava" (Fig. 6). Here, the butterflies were quite abundant and both dark and light silvery forms were flying together. One male of the dark and three of the light form were collected (Figs. 5A-D). In the latter, the silvery areas were of a more neutral color, without the light brownish tinge of the Surire females.

2- Wing features

The upper side of the dark form individuals is almost uniformly dark brown except for the narrow light postdiscal stripes in the intervein spaces. The hind wing usually shows a small black spot in s2, and eventually traces of other spots within the light stripes. These stripes occur in s2-s4 or s5 in the fore wing dorsum and in s2-s5 in the hind wing one, as narrow individual traits. However in one specimen the area around the light stripes is invaded by numerous light scales, giving the impression of a light band (Fig. 1A), while in other the light stripes are virtually absent (Fig. 5D). In the light forms, the width of the upper side silver discal/marginal area can vary in both wings and may (Fig. 5F) or may not (Fig. 5E) cover the veins, rendering them almost invisible.

The complex design of the hind wing underside shows some apparently consistent differences between the northern-most Tarapacá specimens and those collected at site D, near S. Pedro de Atacama. Among these, we remark a light arrow-point shaped whitish marking along v6 (with the point directed towards the body); the sides of this point tend to be acutely angled in the samples from the northern populations (Fig. 7B, arrow), and to form a more open angle (at least 90 degrees, unless it is not identifiable) in the southern ones (Fig. 7C, arrow). A second light marking occurs in the basal half of the space s4 along vein v4; this extends inward along the vein to almost touch the cell tip in most individuals from sites A-C (Fig. 7B, arrowhead, but cf. Fig. 1F), while in the adults of site D it does not extend that way (Fig. 7C, arrowhead). Similarly, the specimens from sites A-C have a dark postdiscal patch in s3 covering roughly one half of the space (Fig. 7B, asterisk); this tends to be much less evident in samples from site D (Fig. 7C, asterisk). In general, most markings tend to be more diffused in the southern specimens, specially in two males which show rather dull hind wing undersides (Figs. 5B, D). Remarkably, in the

other two (Figs. 5A, C) the wing underside is very similar to that of *P. penai* (to judge from the type specimen, Fig. 7A), although none has the fully silvery wing dorsum of this species. The fore wing underside of the northern specimens shows a coloration of the cell area lighter than that of the discal area (Fig. 1 and 5E, F). This light area is absent in the southern individuals from site D, and also from the *P. penai* holotype.

Three specimens of the light form are kept in the Luis Peña collection (Marcelo Guerrero, personal communication). They were captured on 28-31 of December 1953 at Quebrada Honar and Talabre (Antofagasta Region, Chile), respectively, ca. 35 and 53 km to the south of site D. As judged by the picture of one specimen available to us (not shown), its hind wing underside fits closely with those of our specimens from site D, as well as with that of the *P. penai* holotype.

3- Male genitalia

To gather more evidence on whether the dark and light forms represent one or two different species, we examined the male genitalia of each form (Fig. 8, the specimens dissected were those depicted in Figs. 1B-C, and 5A-D). Overall, the genitalia was similar to that of *A. penai* represented by Hayward (1967), with a thick uncus of markedly convex ventral margin, well developed brachia (with their tips slightly turned upwards), a moderately long apex angularis and a broad, relatively short and wide saccus. The appearance of the valvae may vary slightly depending of the final position of the mounted specimen. Its distal margins may converge gradually to acquire an almost pointed appearance (Fig. 8C-E), or the distal half of the costal edge may be slightly convex, then gradually taper towards the tip (Fig. 8A, B, F). The costal margin may present a very slight prominence with 2-4 setae at about 2/3 of the valve length (Fig. 8B). However, such a prominence is not evident in some specimens, while a number of 1-4 setae usually occurs at this position. The shape of the aedeagus varies within some limits; it may be thick (Fig. 8C, F) or not, and the caecum penis varies between almost straight to slightly angled. The vesica shows numerous, relatively long but poorly sclerotised cornuti (Fig. 8C, inset at increased magnification).

Some of the differences among the specimens dissected, although not pronounced, might suggest specific differences if they happened to be constant e.g. between localities, or between adult morphs. However, on the basis of the limited number of samples available, we were unable to discover any congruent patterns of that kind. For instance, the aedeagus shape suggests a degree of relatedness between Figs. 8C and 8F (from site D), but this is contradicted by the specimen in Fig. 8D from the same place. Moreover, based on Hayward's (1967) drawing, no feature of the genitalia appeared to be sufficiently meaningful to distinguish between *A. gustavi* and *A. penai*.

4- Discussion

Based on the available literature and reference material, we initially ascribed all the specimens studied here to *P. gustavi*. Although all the literature and museum specimens were of dark forms (including D'Abrera, 1988), our assignment was supported by several lines of evidence: a) the male genitalia does not consistently differ between the

dark and the light forms; b) there are intermediate forms with enhanced radiating silvery areas; and c) both forms (light and dark) have been found together in the San Pedro de Atacama locality (site D).

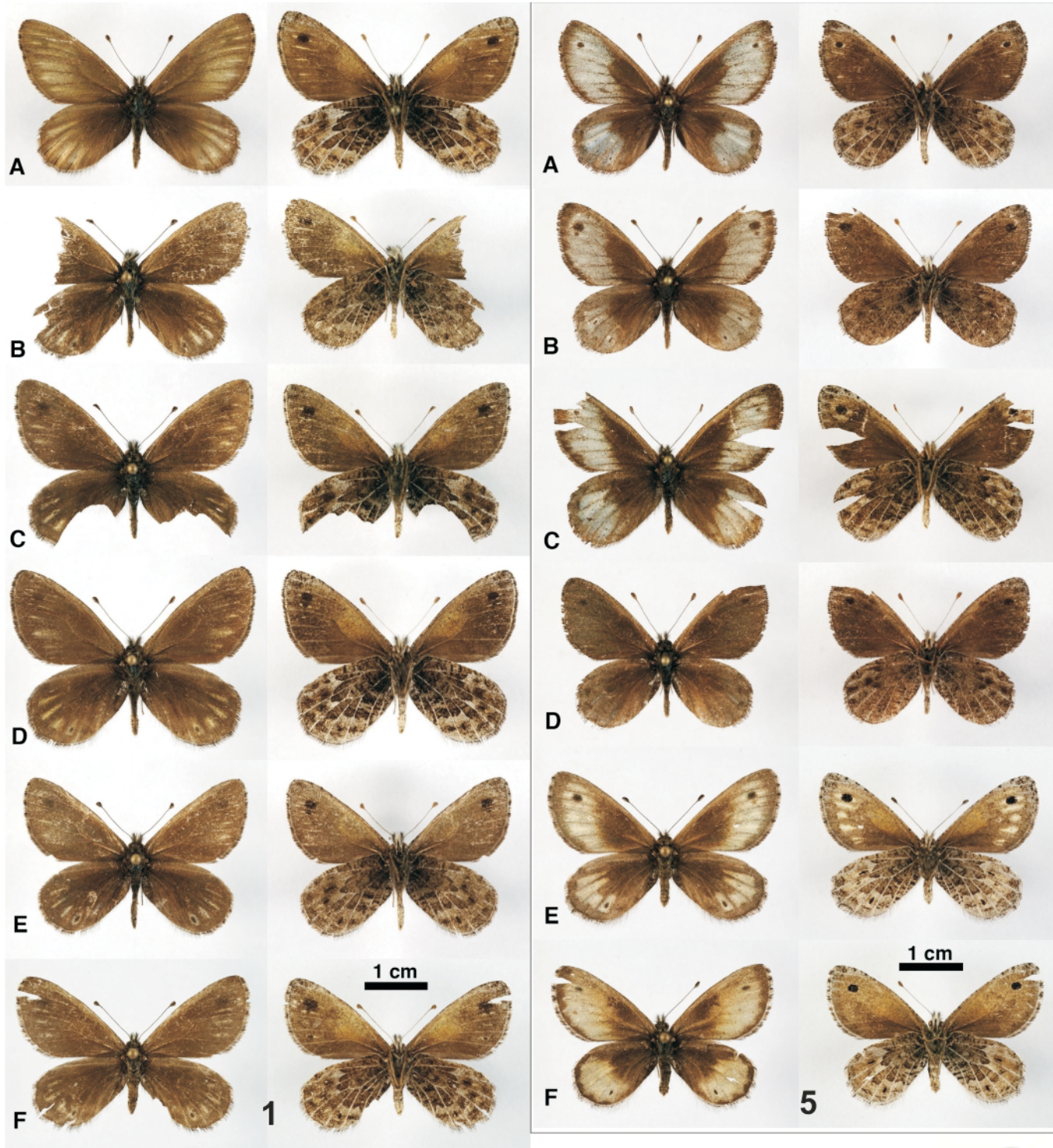
However, if we focus on the wing undersides, all the samples studied might broadly fit into two groups, both showing remarkable variation in the extension of the dorsal light silvery wing patches: one comprising the specimens of the northernmost area (sites A-C), which undoubtedly represents *P. gustavi*, and a southern group that includes the specimens collected near San Pedro de Atacama (including site D). Except for its fully light wing upperside, the underside of *P. penai* fits with the second group. Hence, our southern samples might represent *P. penai* specimens. This implies recognising the type material of *P. penai* as an extreme light morph within a range of variation much wider than that previously suspected (in fact, wider than the one shown by *P. gustavi* s. str. at sites A-C). Moreover, the type material of *P. penai* (Fig. 7A) was captured in the Alto de Pajonales (4700 m asl), a locality approximately 3 km S of site D, and in comparable dates (the first half of December).

Against the interpretation of considering our southern specimens as *P. penai* argues the fact that we did not find significant differences between the male genitalia of either the southern and northern groups or the light and dark morphs. Interestingly, within the limitations of the published drawing (Hayward, 1967), the male genitalia of *P. penai* does not appreciably differ from those of our specimens. Since the differences in the wing undersides of southern and northern specimens are of limited extent and not absolutely constant, our observations are also compatible with all our specimens representing different forms of *P. gustavi*. This alternative interpretation opens the possibility that *P. penai* (Hayward, 1967; Peña & Ugarte, 1997) might represent an extreme light form of *P. gustavi* with maximally extended silvery areas and that these two taxons may be conspecific.

Conclusions

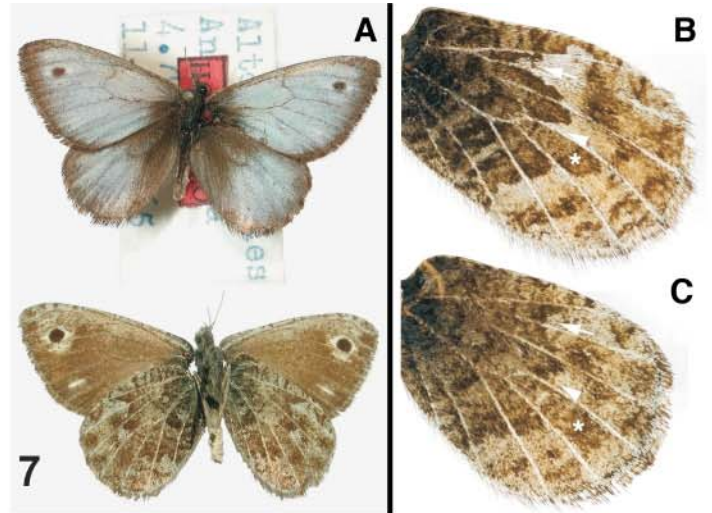
1. The presence of *P. gustavi* in Chile is confirmed in the northern high plateau of the Tarapacá region.
2. *P. gustavi* is a butterfly endowed with a large variability, in fact broader than suspected by Staudinger (1898), and includes specimens with broad dorsal light bands.
3. The Chilean populations of this species range southward to the San Pedro de Atacama area and open the possibility that the names *P. gustavi* and *P. penai* refer to the same taxon; or, alternatively:
4. The San Pedro de Atacama specimens represent the closely related *P. penai* and this taxon displays a high degree of variation in the extension of the light upper wing patches (in fact from nearly 0% to almost 100%), which would contradict the diagnostic features given by Hayward (1967) for this species.

The small amount of material studied and the absence of comparative evidence on the range of phenotypic variation in wing morphology and male genitalia in the species of this genus precludes us from taking a decision between alternative conclusions 3 and 4. Obviously, however, the entity of *P. penai* has to be reassessed on the basis of a broader evidence.





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Fig 1. Dark form *Palmaris gustavi* from Chile. Dorsal (left column) and ventral (right column) views. Putre, Tarapacá Region (site A). **A**, male, 7-XI-1996; **B-E**, males, 28-X-2003; **F**, Putre, Tarapacá Region (site B), female, 29-X-2003.

Fig 2. Habitat of *P. gustavi* at the foot of the Nevados de Putre (site A) showing mostly *Stipa sp.* grasses of the "pajonal" vegetation.

Fig 3. Habitat of *P. gustavi* at Salar de Surire, Tarapacá Region, showing *Stipa sp.* grasses and abundant *Baccharis sp.* bushes.

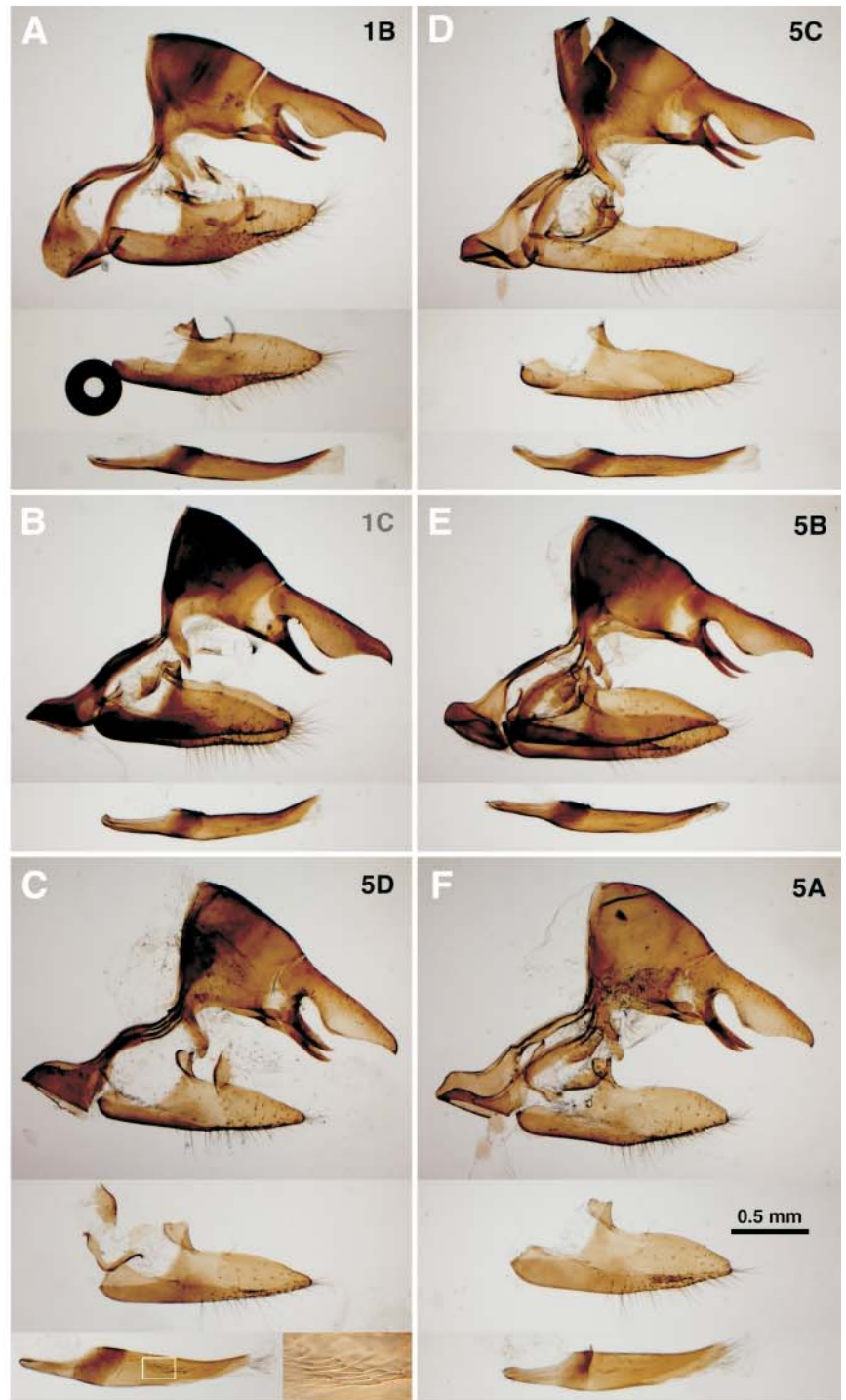
Fig 4. Detail of *Baccharis sp.* (from Salar de Surire, Tarapacá Region, site C).

Fig 5. Specimens of the light (**A-C**, **E**, **F**) and dark forms (**D**). Dorsal (left column) and ventral (right column) views. San Pedro de Atacama, Antofagasta Region (site D). **A-D** males, 3-XII-2005. Salar de Surire, Tarapacá Region (site C). **E**, **F** females, 29-X-2003.

Fig 6. Habitat south of Licancábur volcano near San Pedro de Atacama, Antofagasta Region (site D), where light and dark forms were collected. Note the "pajonal" vegetation. Photo courtesy Josefa Goñi.

Fig 7. **A**, holotype of *P. penai* captured at Alto de Pajonales (4700 m asl), a locality approximately 3 km S from site D, on 11-XII-1965, and deposited in the Luis Peña collection. Photographs courtesy Marcelo Guerrero. **B**, **C**. Ventral sides of hind wings of specimens shown in Figs. 1A and 5A, respectively, from Putre (site A) and San Pedro de Atacama (site D). Some differential features are indicated by arrows, arrowheads and asterisks. See text for description. The pattern of the wing in **B** clearly matches that of published images of *P. gustavi* (D'Abbrera, 1988) and museum specimens from Museo de Historia Natural, Universidad Mayor de San Marcos, Lima, Perú.

Fig 8. Male genitalia. **A**, **B**: Tarapacá Region, Putre (site A), dark forms. **C** (dark form), **D-F** (light forms): Antofagasta Region, San Pedro de Atacama (site D). The correspondence with the specimens illustrated in Fig. 1 and Fig. 5 is indicated at the upper right angle of each photograph. Inset in **C** shows a high magnification view of cornuti from the adjacent aedeagus.



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