TAXONOMIC SITUATION OF THE SPECIES OF THE GENUS *PARARGE* HÜBNER, 1819 - *P. AEGERIA*, *P. XIPHIA* AND *P. XIPHIOIDES* - (LEPIDOPTERA: SATYRIDAE) IN THE MACARONESIAN ISLANDS

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With 2 figures and 1 table

SUMMARY. *Pararge* xiphia and *P. xiphioides* of the Macaronesian islands have frequently been considered two subspecies of *P. aegeria* (Speckled Wood). This paper compares their different behaviour, the differences among their eggs, larvae, pupae and imagoes (external morphology, male and female genitalia) concluding that *P. aegeria*, *P. xiphia* and *P. xiphioides* should be considered three different "bona species". Later, they suggest the probable route that these butterflies have used for the colonization of the Macaronesian islands. Finally, a valoration is undertaken in order to foretell the impact that the recent introduction of *P. aegeria* in Madeira could cause on the closely related endemic species, *P. xiphia.*

RESUMO. Baseado na comparação de comportamentos, tipos de ovos, larvas, pupas, da morfologia externa e das genitalias masculinas e femininas, os autores propõem a aceitação de *P. aegeria*, *P. xiphia* e *P. xiphioides* como espécies válidas. P. xiphia e P. xiphioides eram consideradas até agora como subespécies de P. aegeria.

É ainda sugerida a provável rota utilizada por estas espécies para colonização das ilhas macaronésicas.

KEY WORDS: *aegeria, xiphia, xiphioides, Pararge*, Macaronesia, Satyridae, Lepidoptera, Insecta.

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INTRODUCTION

Within the subfamily Satyrinae BOISDUVAL, 1836 tribe Elymniini HERRICH-SCHÄFFER, 1846, subtribe Lethiti CLACK, 1948 (according to the re-classification by HARVEY 1991), the genus *Pararge* HÜBNER, 1819 (revised by DE LESSE in 1952) is represented in the Macaronesian islands by three species, two of which fly in Madeira [*P. xiphia* FABRICIUS, 1775 and *P. aegeria* (LINNAEUS), 1758 (of recent introduction)], whereas in the Canary islands only one [*P. xiphioides* STAUDINGER, 1871] exists and this one only in some of these islands.

It could seem surprising that authors who had studied the butterflies of Madeira (HIGGINS 1975, HIGGINS *et al.* 1955, DE LESSE, 1952) did not quote the presence of *P. aegeria*, although now very abundant -(according to our observations (FERNÁNDEZ-RUBIO, 1982)-, at least in the last 15 years.

The just record of capture of *P. aegeria* was by N.D. RILEY on 8th October 1976, in Ribeiro Frio (Madeira) at 680 m. altitude (HIGGINS 1977, OWEN *et al.* 1986). Authors prior to that date (BAKER 1891, COCKERELL 1923, GADNER *et al.* 1960, HIGGINS 1975, HIGGINS *et al.* 1955) who studied the Lepidoptera of the island do not indicate their presence, which suggests a very recent introduction.

The taxonomic situation of these three species is very much under debate. HIGGINS and RILEY in 1955 described them as separate species, but observed that they only could be two ssp. of *P. aegeria*. HIGGINS, in 1975, after describing the differences in there respective andropigius (small, but constant) suggest *P. xiphia* and *P. xiphioides* to be two very prominent ssp. of *P. aegeria* which would thus be a politypic species.

In 1970 MANLEY indicated *P. xiphia* a species although he estimated that it could be considered a form of *P. xiphioides* which, at the same time, would be only an extreme form of *P. aegeria.*

Field observations on the behaviour rules of these species, the fact of their tendency to occupy different ecological niches as well as their constant and evident differences in their external morphology and of their andropigius and ginopigius induced one of us (FERNÁNDEZ-RUBIO 1991) to consider that *P. xiphia* and *P. aegeria* (both present in Madeira) and *P. xiphioides* (occuring only in the Canary islands) were three separate species and not ssp. of *P. aegeria.*

The different points of view between the mentioned authors induced us to carry out a series of studies in order to clarify their taxonomic status.

MATERIAL AND METHODS

Field observations were done on the behaviour of this species, viz. *P. xiphia* in Madeira, *P. xiphioides* in Canary islands and *P. aegeria* in Madeira, Iberian Peninsula and

Morocco. Laboratory studies on the respective species eggs, larvae and pupae as well as the respective morphology of their imagoes (external aspect and genitalia) were carried.

RESULTS

The differences found between these species are indicated bellow:

A) MORPHOLOGICAL DIFFERENCES BETWEEN THE IMAGOES

The principal differences in their respective external morphology of the imagoes can be summarized as follows:

P. aegeria of Madeira (also in the North of Africa and Iberian Peninsula) is smaller (breadth: 35-40 mm.) than *P. xiphia* (50-52 mm.). *P. xiphioides* has an intermediate size (43-48 mm.).

On the upper-side of the wings the ground colour of *P. aegeria* is paler and its tawny stains clearer and more extensive (in both sexes) than in *P. xiphia*, while *P. xiphioides* occupies an intermediate position, though much closer to *P. xiphia*.

In males the androconius is less marked in *P. aegeria*, somewhat greater in *P. xiphioides* and broader and more visible in *P. xiphia*. On the under-side the differences are more evident: in *P. aegeria* the reddish tone does not exist, but it is present in *P. xiphia* and in *P. xiphioides* (though in the latter it is less stressed). The under-side of the hind-wing shows the prime differences: The basal area of *P. aegeria* is lighter than in the other two. The discal area of *P. aegeria* shows a bright beige diffuse zone while in *P. xiphia* there is a clear white triangle in the costal border (more expanded in the female) and in *P. xiphioides* this stain is much more extended, reaching half of the wing.

B) DIFFERENCES IN THE FLIGHT AREAS

P. aegeria: Its dispersion area extend from West-Europe, Asia Minor and Russia to Central Asia. Today it also flies in Madeira. We have not observed it in the Canary Islands.

P. xiphia: Exclusive to Madeira.

P. xiphioides: Exclusive to four Canary islands (Tenerife, Palma, Gomera and Gran Canaria).

C) DIFFERENCES IN THE BIOTOPES

P. aegeria: Today it is abundant and widespread in Madeira at low altitude, specially in areas without tres of the laurisilva but in reafforested pine areas or in places where eucalyptus has been introduced, and also in cultivated areas and urban gardens at altitudes under 700 m.

P. xiphia: Exclusive in Madeira. Flying preferably in areas of laurisilva, with biotopes of an altitude of 750 m. or higher. It is also frequent in fern-covered slopes. Though HIGGINS held that it flys from sea level up to 750 m., it is scarce at low altitudes. Above 1000 m. a diapausie could exist in winter (as caterpillar).

P. xiphioides: Exclusive to four of the Canary islands, from sea level up to 1.500 m. It is frequent at low altitudes in cultivated areas (bananas).

D) DIFFERENCES IN BEHAVIOUR

The differences in behaviour between *P. aegeria* and *P. xiphia* are very marked. Males of both sp. adopt perching and patrolling mate-location flights. *P. aegeria* is much less active and prefers to rest in the shade, in low bushes, while *P. xiphia* is much more active and prefers the sunny high branches or even the shrub and canopy layers of the laurisilva and, at most, only descends to the top of the ferns situated in treeland.

The patrolling flight of *P. aegeria* is rare, short, undulant and relatively slow, while the flight of *P. xiphia* is much longer, tenser, rectilinear and rapid and is also more active.

The males of both species defend the territory and an encounter between two of them originates a spiral flight, while in *P. aegeria* the circles are of small diameter (< one meter) and with plenty of spires, while in *P. xiphia* the circles are wider, irregular and scarcer in number. It is interesting to remark that the males of each species do not react to the presence of a male of the other species, or do so only for a moment but do not have any interspecific competition.

At noon both species are active, but the activity periods are different. *P. xiphia* decreases its activity in the late afternoon while *P. aegeria* continues active.

It is very significant that in areas where both species are found relatively close-or live together in smaller or greater proportion, as for instance in Serra d'Água, where we have not found any hybrids, in spite of our intensive searching.

In the Canary Islands *P. xiphioides* has a behaviour similar to *P. aegeria* of Morocco and the Iberian Peninsula, though it is much less hydrophilus.

E) DIFFERENCES IN GENITALIA

References concerning the andropigius of these three species can be found for all three (FERNÁNDEZ-RUBIO 1991, HIGGINS) or for only some of them (FERNÁNDEZ-RUBIO 1982, DE LESSE, NEKRUTENKO). They are similar (Fig. 1, left-hand side), though present constant differences, specially the following:

P. aegeria has a relatively broad valve, with concavity in the external part of its posterior and middle third. The posterior part presents a short terminal process. Internal tooth with quite broad base and with a blunt extremity. Uncus relatively thin. Bandy and

thin penis in its two posterior thirds.

P. xiphia presents valve relatively broader, with a continual external edge, without concavity. Its terminal process is much shorter and the tooth is less pronounced, with a broader base. The uncus is somewhat broader. Penis almost straight, stouter and uncurved.

P. xiphioides has an even more thinner valve than *P. aegeria*, almost without concavity and with thinner and sharper terminal process. The tooth is thin and of narrow base. The uncus is thinner than that of *P. xiphia* (it is similar to *P. aegeria*). Bandy penis (as *P. aegeria*) but stouter.

The gynopigius (of which we have only found references to *P. aegeria* in the literature consulted (DE LESSE, NEKRUTENKO) is very similar (Fig.1, right-hand side). There are small, but constant, differences: The most important ones are found in the ductus bursae, which in *P. aegeria* is slightly curved with a somewhat greater anterior extremity. In *P. xiphia* it is straight, with elongated pear-shaped aspect, with its anterior extremity somewhat thinner and in *P. xiphioides* it is rather sinuous and slightly broader in the middle of its anterior third. The differences in bursa are also minor: in *P. aegeria* it is somewhat more rounded, in *P. xiphia* somewhat longer and even thinner in *P. xiphioides*.

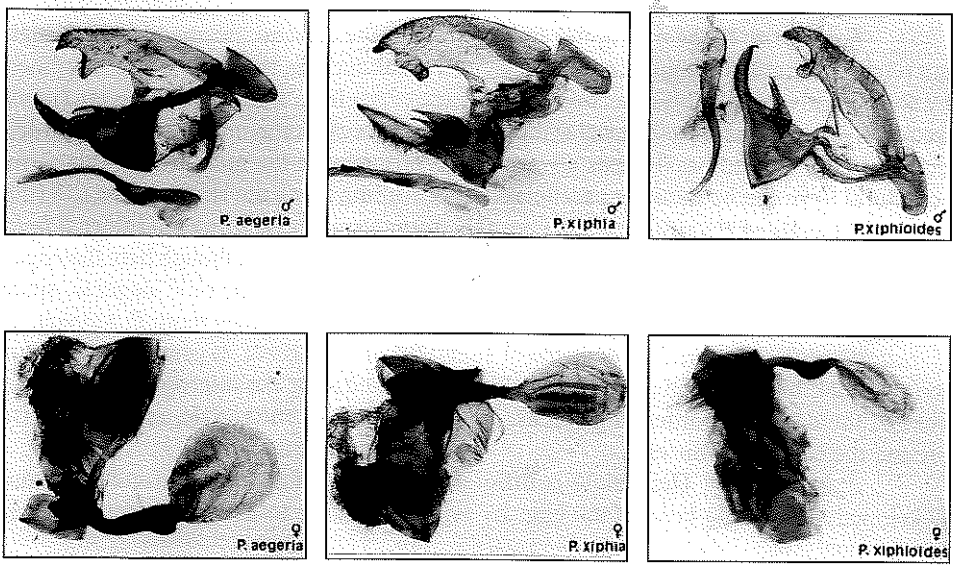

Fig. 1 - Andropigius and ginopigius of *P. aegeria*, *P. xiphia* and *P. xiphioides*.

F) DIFFERENCES IN THE EGGS

References on the morphology of the eggs of *P. aegeria* can be found in DÖRING and in SARLET that coincide with our findings. In the bibliography at our disposal we have not found any reference to the eggs of *P. xiphia* nor of *P. xiphioides*.

By electronic microscopy, we have studied 20 eggs of *P. aegeria* [proceeding from "Soto del Real" (Madrid-Spain), June 1988 and "El Alted" (Alicante-Spain) April 1993], 7 of *P. xiphia* [proceeding 6 from "Madeira", 1990 and one from "Serra d'Água (Madeira)" August 1992] and 8 of *P. xiphioides* [proceeding from "Tenerife (Canary Islands)" December 1990], observing the subsequently described characteristics:

a) General data (Fig. 2, left-hand side):

The egg of *P. xiphia* is notably larger. Estimated by the method of rotation sections, using the average measures and the profile of an egg adjusted to the typical form, we obtain the following volumes: 0.40-0.50 mm3 for *P. aegeria*, 0.90-1.10 for *P. xiphia*, and for *P. xiphioides* an intermediate size, being slightly larger than *P. aegeria*.

b) Relief or other characteristic structures (Fig. 2, right-hand side):

P. aegeria: In the micropilar area of the eggs the cells are fine and bright though not remarkable at low magnification. On the rest of the surface, the cells appear margined by some relatively high blunt section walls. These edges form a poligonal drawing (more frequently pentagonal or tetragonal at the equator of the egg, sometimes hexagonal) which in the micropilar and basal thirds always are identifiable. In the middle third this same sculptural form can be found or parallel reliefs prevailing along the length of the egg (the form of the cells of *P. aegeria* is similar to the form found in *Lasiommata* (at least in *L. megera* (LINNAEUS), 1767 and L. petropolitana FABRICIUS, 1787), though here the edges are very fine. This characteristic could be taken as autoapomorphic of *P. aegeria*, since in *P. xiphioides* it does not exist (the egg of *P. xiphioides* resembles more *P. xiphia*).

P. xiphia: The reticle is different from that of *P. aegeria*. It presents numerous longitudinal, blunt, slightly prominent ribs from the edge of the micropilar area to the base of the egg. The border of the cells, evident around the micropyle, appears diffuse around the equator of the egg.

P. xiphioides: The reticle is different from that of *P. aegeria*, and it is well developed only in the base of the egg. Its aspect is similar to *P. xiphia*, but with less longitudinal ribs.

These differences are summarized in Table 1.

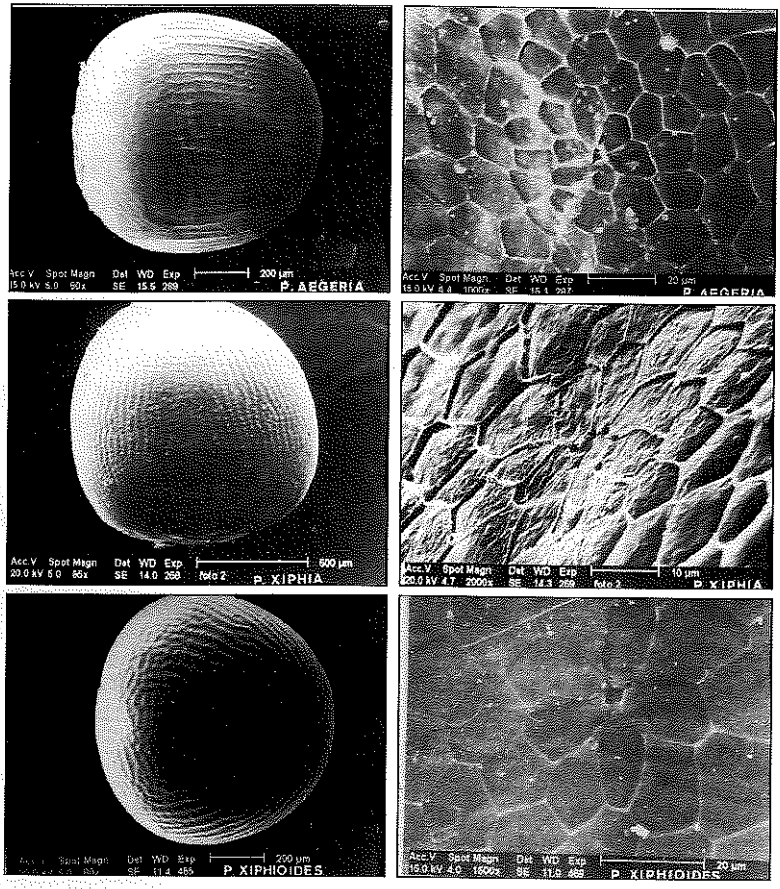

Fig. 2 - General aspect (on left) and micropilar area (on right side) of the respective eggs of *P. aegeria*, *P. xiphia* and *P. xiphioides*.

TABLE 1 - Differences between the eggs of *P. aegeria*, *P. xiphia* and *P. xiphioides*.

sp.	length (mm)	diameter (mm)	N°. of ribs in equator	N°. of cells primary	colour at ovoposition
P. aegeria	0.75-0.95	0.70-0.95	40-50	4-6	pale yellow
P. xiphiax	1.10-1.30	1.10-1.30	60-80	6-8	pale yellow
P. xiphioides	0.80-1.00	0.89-0.97	38-52	5-6	pale yellow

G) DIFFERENCES IN THE LARVAE

We have only been able to obtain few data, but they are interesting and meaningful:

P. aegeria larva of the last instar:

1- It is green (it is unknown in chestnut-colour)

2- Lacks the longitudinal inky bands that imply marked melanization of the cuticle.

3- The "tails" of the tenth urotergite of *P. aegeria* are shorter than those of *P. xiphia.*

P. xiphia larva of the last instar:

1- Can be of two colours: green or light-brown. This dimorphism is probably due to environmental origin, but its causes are unknown. The same type of dimorphysm is found in *Melanargia* (at least in *M. lachesis* HÜBNER, 1790 and *M. occitanica* ESPER, 1793) and in Pyronia tithonus (LINNAEUS), 1771.

2- The dorsal and subdorsal bands are clearly darker than the ground-colour, due to the presence of melanized areas in the cuticle (in green caterpillars these bands appear as dark-green or dusky and in chestnut-coloured caterpillars as inky-brown or grey).

3- In *P. xiphia* the "tails" of the tenth urotergite are longer than in *P. aegeria.*

P. xiphioides larva of the last instar:

They are very similar to those of *P. aegeria*, but somewhat larger.

H) DIFFERENCES IN THE PUPAE:

All species chrysalise hanging by the cremaster. Besides the differences in size (smaller in *P. aegeria*, intermediate in *P. xiphioides* and larger in *P. xiphia*) the latter seems to have a more bulky and opaque cuticle. The same dimorphism of colour of the larva occurs also in the pupa. The pupa of *P. aegeria* is green (only in one of them we have observed a green colour inclining somewhat towards yellow) but in *P. xiphia* it can be green or chestnut-coloured.

The pupa of *P. xiphioides* is comparable, in this aspect, to *P. aegeria.*

The most important differences appear in a double row of yellow mid dorsal tubercles:

In *P. aegeria* it is slightly prominent (this may be because its pupa is smaller). In *P. xiphia* it is moderately prominent, without black stain. In *P. xiphioides* it is somewhat larger and with a black stain.

DISCUSSION

Such a number of differences prevent us from continuing to consider the two

Macaronesia endemic *Pararge* butterflies as ssp. of *P. aegeria*, and justify in clasifying them as three clearly separate species. In consequence, we estimate that *P. aegeria*, *P. xiphia* and *P. xiphioides* are three "bona species", clearly differentiated.

We do not know the date of the colonization of Macaronesia by the predecessors of *P. xiphia* and *P. xiphioides*. The external morphology of *P. aegeria* in Madeira is similar to that of the other specimens proceeding from the Iberian Peninsula and Morocco and are very different from the populations proceeding from the northern localities (ssp. *tirsis* BUTLER, 1867). The behaviour of these ssp. of *P. aegeria* are similar throughout all the studied area. This suggests that the colonization of Madeira by *P. aegeria* is very recent. This is confirmed by the fact that the first record is from 1976 and from this date onwards it has been very frequent, particularly in cultivated areas, town-gardens and localities reforested with pines and specially with Eucalyptus. [in historical eras these colonizations have occurred in Madeira with other species (*e.g. Vanessa indica* HERDST, 1794, *Pieris rapae* (LINNAEUS), 1758, *Danaus plexippus* (LINNAEUS), 1758) and further colonizations may be expected in the future].

P. aegeria has specially occupied the ecological niche not taken adventage of by *P. xiphia*, scarcely encroaching the laurisilva. Both species are very close and feed on the same food-plants in Madeira (*Brachypodium sylvaticum* HUDSON, *Holcus lanatus* LINNAEUS and *Agrostis giganthea* ROTH, according to LACE & JONES). These authors think that *P. xiphia* is reducing its flight area since the arrival of *P. aegeria*. This phenomenon may rather be due to the alteration of the laurisilva (reforestations with Eucalyptus *e.g.*) than to the interspecific competition between both species. We believe that the conservation of the laurisilva is essential for the persistence of *P. xiphia*.

The absence of hybrids of *P. aegeria* x *P. xiphia* indicates a deep separation between both, which is being corroborated by their preferences of biotopes, differences in their behaviours and also, in the morphology of their eggs, larvae, pupae and imagoes.

P. xiphioides (which seems more closely related to *P. aegeria* than to *P. xiphia*) flies only in the Canary islands. Its flight area reaches greater differences of altitude. This can be due to the absence of a close competitor sp. The form of the penis and eggs, as well as the size of the imagoes and its behaviour rules, are closer to *P. aegeria* than to *P. xiphia*, but the white stain on the under-surface of the hind-wing is more reminiscent of *P. xiphia* then of *P. aegeria*. The authors considerer that the three species proceed from a common trunk and that two independent colonization processes had occured in the Macaronesia from a continental species -one for each island group-. This "continental species" could be *P. aegeria* or a common predecessor "*P. aegeria*-like", in some unspecified prehistoric time, and the subsequent speciations in isolation has followed.

P. aegeria is not a strong flier. It could not cross by direct and sustained flight the maritime distance that separates Macaronesia from Africa, but rather it is more probable that individuals had been carried passively by a strong air current.

It is also imaginable that two branches were separated from a common

predecessor and one branch originated *P. aegeria*, while the other was the origin of *P. xiphioides* with *P. xiphia*, later being separated. But considering the size of the respective islands compared with the African coast and the direction of the dominant winds, and also the verified fact that their divergences do not continue in the same evolutionary line, this second possibility seems to be less probable.

The colonization for the endemic species of the respective islands is very archaic, due to the time required for the speciation in *P. xiphia* and in *P. xiphioides*, whereas the colonization of Madeira by *P. aegeria* has been very recent, as indicated not only by the date when it begun to be captured on the island but also by the aspect of the imagoes etc., that are completely similar to the forms of Morocco and Iberian Peninsula.

CONCLUSIONS

The authors emphasize that *P. aegeria*, *P. xiphia* and *P. xiphioides* are three different species, easily distinguished, even by external morphology.

The pronounced differences found between the three populations do not permit to consider them ssp. of *P. aegeria* but as three different "bona species", two of them endemic species one restricted to Madeira (*P. xiphia*) and the other to some of the Canary Islands (*P. xiphioides*). *P. aegeria* of Madeira is not different from the populations from the north-west of Africa and south-west to Europe, which indicates a settling of much more modern origin. This agrees with the date of the first record (1976) and its absence from the authors list before then. In Madeira today *P. aegeria* is relatively isolated from *P. xiphia* (both tend to occupy different biotopes and have different behaviour rules). This difference in the respectively preferred biotopes secure the persistence in Madeira of both sp., and will not lead to the supplanting by the invader *P. aegeria* of the closely related endemic *P. xiphia* [as opposed to what occurred with *Pieris (Artogeia) rapae* (LINNAEUS), 1758 in 1971 which, in the few years elapsing from its introduction, has practically eliminated the endemic Pieris brassicae *wollastoni* BUTLER, 1886 with which it competed in biotopes and resources].

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