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Hipparchia azorina (Strecker, 1899) (Satyridae): Ecology and Distribution on the Azores Islands

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Abstract. The present paper deals with the speciation and distribution of *Hipparchia azorina* (Strecker, 1899). The type locality of *H. azorina* is restricted to the central island group of the Azores. The eastern island, São Miguel, is inhabited by *Hipparchia paramichaelensis* (LeCerf, 1936) stat. rev., *Hipparchia caldeirense* sp. n. is restricted to the island Flores in the western group. The larvae on Faial, São Miguel and Flores feed on *Festuca petraea* Lowe. Morphology of adults and early stages is described. The habitat of *Hipparchia azorina*, *H. caldeirense* and *H. miguelensis* is described and suggestions regarding their conservation are given.

Introduction

Hipparchia azorina (Strecker, 1899) was described from a single male specimen, given to Strecker by E. T. Owen, who brought it back from the Azores. Strecker gave "Azores" as the type locality, without any exact data. The synonomy follows:

Satyrus azorinus	STRECKER	1899
Satyrus semele madeirensis Bethune Baker;	REBEL	1917:17
Satyrus azorinus Strecker;	WALKER	1931:77
Satyrus azorinus Strecker;	GAEDE	1931:157
Satyrus azorinus Strecker;	LE CERF	1935:306
Satyrus azorinus provincialis	LE CERF	1935:308
Satyrus azorinus miguelensis	LE CERF	1935:308
Oeneis chamissoi	LEAKI	1936:454
Satyrus semele azorinus Strecker;	REBEL	1936:17
Satyrus semele azorinus Strecker;	REBEL	1936:19
Satyrus semele azorinus Strecker;	REBEL	1940b:10
Hipparchia azorinus Strecker;	LESSE	1952:30
Satyrus semele azorinus Strecker;	CARTHY	1967:210
Hipparchia azorina Strecker;	MARSDEN & WRIGHT	1971:180
Hipparchia azorina Strecker;	KUDRNA	1975:205
Hipparchia aristaeus azorina Strecker;	HIGGINS	1975:226
Hipparchia azorina Strecker;	KUDRNA	1977:97
Hipparchia azorina Strecker;	HIGGINS & RILEY	1978:132

In order to study the relationship of the populations inhabiting the Azores in their natural environment, I visited the Azores from June 26th to

July 10th, 1980. The results of this visit and subsequent studies are giv below.

Original description: Satyrus azorinus Strecker 1899

Body, head and antennae black. Wings dark brown. Primaries somewl dull ochreous on the disk. A small round subapical spot between vein 5 a 6. Secondaries with a strongly sinuate dull ochreous mesial band, this ha deep sinus inwardly between veins 2 and 3, and another at vein 6. Fringe all wings white, with black termination of veins. The disk and mesial ba are not decided or well defined, but dull and suffused, as if showi through from the underside. Under surface, primaries dull pale och Costa brown. At end of and beyond the discoidal cell a brown ma extends from the costa to vein 4. The subapical spot of upper side repeated, beyond this spot to the costa brown. A brown marginal band, small white spots interior to this band between veins 6 and 8. Secondar dark brown, somewhat striated. A mesial band as above but pure white a sharply defined, interior to this band are two white marks, one near t base, is irregular and extends from the costa to within the discoidal ce The other nearly square is below this in the cell. Fringe as above. Expan 1¼ inches. Type, one ♂ received from prof. E. T. Owen, who informs me came from the Azores. The place for this most interesting species I thi would be with or near *Satyrus (Chionobas) pamilus, lama*, etc. In a remo way it also reminds one of *S. neoridis*.

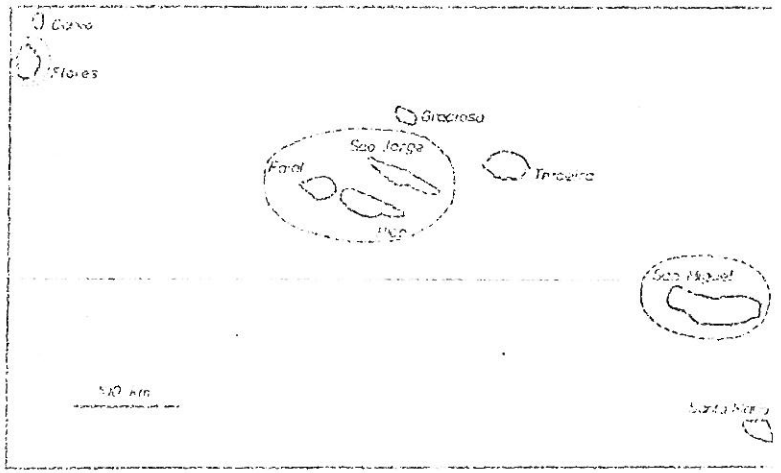

Fig. 1. Distribution of the *Hipparchia* taxa on the Azores Island. - - - *Hipparch miguelensis*, ... *Hipparchia azorina*, ... *Hipparchia caldeirense*

of the Sao Miguel specimens.

Distribution: Pico, Azores, from 300 m on, upwards to 2000 m. Cabeco do Encalvado 900 m. Walker (1931) Serra Gorda, Cabeco do Afonso, Q. Pico. On Pico up to an altitude of 3000 m; LeCerf, 1935. Males only were observed on the northern high plateau of the island. Vegetation on the northern slope of Pico predominantly consists of *Calluna vulgaris* (L.) Hull. amongst *Pteridium aquilinum* (L.) Kuhn and *Erica azorica* Hochst. ex Seub., which grow up to 3 meters tall. Walker (1931) states that specimens from Cabeco do Afonso and Serra Gorda were found only singly "on the S. and SE. of the mountains we found it much commoner". Rebel (1940b) cites Silveira and Lagoa do Caldo on Pico island. The main habitat, however, is found on the southern slopes of Pico island, protected against the northeast tradewinds. The early stages of *H. azorina* on the Pico island remain unknown.

Discussion: Since Strecker (1899) gave as type-locality "Azores", it is necessary to identify and restrict the exact place for taxonomic clarity. The holotype was not inspected directly. However, black and white and color slides of the holotype were available for comparison. The genitalic preparation of the holotype showed great similarity indeed with the genitalia of males from Pico. The holotype was examined by Kudrna (1977), who also examined my material from Pico. In addition the original description of *H. azorina* (Strecker, 1899) agrees very closely with males from Pico, "wings dark brown, primaries somewhat dull ochreous on the disk, under surface, primaries dull pale ochre". Males from Flores as well as males from Sao Jorge are lightly ochreous colored. The Faial males certainly have a stronger ochre coloring on the underside of the forewings, while their upper surfaces are always dark brown. I propose to restrict the type locality of *H. azorina* to Pico.

Material examined: 6 ♂♂, forewing length: 21-22 mm, leg. et coll. S. Oehmig. Azores: Pico: Cabeco do Encalvado 900 m: 2 July 1980.

Appearance: June-September, possible longer.

Faial

Hipparchia azorina obsidiana (Strecker 1899) comb. nov., stat. nov.
Oeneis obsidiana Bang-Haas 1936, Annotnes. zool. jap. 15(4):483-485 [Azores]: Faial; Caldeira, Pico Gorda: 1021 m; 24 Aug. 1935 and 30 Oct. 1935, leg. H. Obsidina. Holotype ♂, Allotype ♀, Paratypes 2 ♂♂, 3 ♀♀, Entomological Laboratory, Kyushu Imperial University, Fukuoka, Japan.

Description: ♂: upperside forewing color dark blackish-brown, in cells 6 and 2 dark brown spots, some without these spots. ♂: upperside hindwing color dark blackish-brown. Postdiscal area from the underside weakly translucent. ♂: underside forewing pale to middle ochreous color, but not so strong ochreous as the forewing underside from the Sao

Distribution

The *Hipparchia azorina* complex is confined to the Azores. The species complex has been recorded from five of the total nine islands. Their distribution is given in Figure 1. The Azores Archipelago extends between 36°55′ and 39°44′ north latitude and 25° and 31°15′ west longitude. The distance from Sao Miguel in eastern group to Pico Island in the central group is approximately 250 km. Pico island is another 250 km from Flores island in the western group. These distances clearly demonstrate the dispersal required for the insects to settle upon these islands. It is possible, according to the hypothesis of Carter (1981), that the aerial form of migration (the carrying of the insects by the northeast tradewinds) is responsible for establishment of *Hipparchia* on the various islands. A recent good example of this form of migration is the colonisation of Madeira by *Pieris rapae* as documented by Wolff (1975). A few years later Higgins (1977) and Oehmig (1977) reported the reestablishment of *Pararge aegeria* on Madeira.

Populations of the Islands

PICO

Hipparchia azorina azorina (Strecker 1899) stat. rev.
Lepidoptera Rhopalocera and Heterocera indigenous and exotic. Supp. 3:3.
Satyrus azorinus picoensis LeCerf, 1935, Bull. Soc. ent. Fr., 40(20):248. Syntypes 2 ♂♂, 1 ♀, [Azores], Pico, Museum National d'Histoire Naturelle, Paris.

Description: ♂: upperside forewing dark brown, but never as dark as the males from the Faial populations. Discal and postdiscal area with a pale ochre yellow color. Occasional specimens appear with a lightened basal area. In cell 6 a dark brown spot, sometimes as eye spot. ♂: upperside hindwing dark brown postdiscal area light ochre. In cell 2 sometimes a dark brown spot. ♂: underside forewing range from a pale to a strong ochre, always lighter than the males from the Sao Miguel populations. The dark brown eyespot in cell 6 or the spot in cell 2 often absent. Color margin more or less sharply defined. ♂: underside hindwing basal and discal area dark brown and project pointed into the white postdiscal area. Females were not found on the Pico island during this study, therefore they shall not be described here.

Androconial scales: length: 0.14-0.16 mm, width: 0.015 mm. Androconial patch is not always present. Although small, the androconial form is similar to that of males of Sao Miguel population.

Male genitalia: Valva length: 1.6 mm, width: 0.3 mm. The valva are distinctly narrower than in *Hipparchia miguelensis* LeCerf, 1935. The dorsal process on the valva is mostly rounded off and not as pointed as that

Miguel males, with a fine dark brown zigzag postdiscal line. Outer margin dark brown, project into the postdiscal region, and is not sharply defined. Some with a narrow outer margin band. ♂: underside hindwing, basal and discal area blackish brown, always taper off along the discoidal and median veins projecting into the white postdiscal area. The basal area has white spots. ♀: upperside forewing dark brown. Discal and postdiscal area lighter than the males. In cell 6 a dark brown spot or eyespot, in cell 2 a dark brown spot. ♀: upperside hindwing dark brown, but lighter than the males. ♀: underside forewing light ochre with a dark brown zigzag band. Outer margin dark brown, sharply defined. Spots from the upperside sometimes absent. ♀: underside hindwing basal and discal area dark brown, lighter than the males. Outer margin light brown to dark brown.

Androconial scales: length: 0.13-0.14 mm, width: 0.02 mm. Androconial form is somewhat stunted. The androconial patch is often divided into two patches along the median veins in cell 2 and cell 1b. Many specimens appear without an androconial patch. Spatulate androconial scales have been observed, such forms being unique to males from Faial.

Male genitalia: Valva length: 1.8 mm; width: 0.4 mm. The valvae differ from those of specimens from Flores and Pico in their greater width; the dorsal process terminates in a point.

Female genitalia: Signum length: 1.2 mm; width: 0.15 mm. Smaller than the signa from the São Miguel females.

Distribution: Azores, confined to Faial from 700 m to over 1020 m, (Müller, 1931) Caldeira southern inclines 500 m, (Eiski 1936) Caldeira, Pico Gorda 1021 m, (Rebel, 1940b) above Horta, Caldeira. I found this subspecies very common on the southern slopes of the Caldeira at 900 m. The butterflies fly frequently on the south eastern slope of the Caldeira on Pico Gorda. In the Caldeira there are only single specimens in the cliffs of the upper crater wall. The biotope here gives the impression of a mountain meadow. *Festuca jubata* Lowe. is abundant, as is *Calluna vulgaris*. *Daboecia azorica* Tutin & Warb. grows round in nest form with red blossoms in summer. The cliffs are often extremely rugged from water erosion. The grass vegetation also includes occasional plants of *Potentilla* sp. The biotopes of Faial island differ clearly from the biotopes of the other islands in special vegetation.

Early Stages: *Ovum*: Diameter: 1.1 mm; height: 1.1 mm. The terminology follows Doring (1955). The egg form is a half elliptical barrel shape with a convex egg base. The top view is circular with longitudinal ribs, extending from the base to just below the micropylar area, although some ribs do reach the micropylar area. The ribs are in longitudinal ridges with two rows to bladed aeropyles. The chorion is provided with fine hardly visible cross lines. Number of ribs, 24. The taxonomic importance of the micropyles is indicated by Hinton (1981). In many species the number may be constant, and could therefore be used as a reliable taxonomic character

However, I have also noticed some species in which the number of micropyles varies within all the eggs of a female. Four micropyles have been counted in the Faial ova, the micropyle rosettes are seven leaved. The ova are individually attached by the females to the foodplants. The base of the ovum is somewhat adhesive. Eggs are always deposited on plants protected from the wind. Fifteen days elapsed to hatching under handling conditions. The egg is white at first, then becomes dappled with light red brown, and shortly before hatching it is grey-brown. In the field females cease oviposition when the sun disappears behind a cloud. Egg depositon stretched into evening under artificial light. In the laboratory Faial females lay 60-70 eggs.

(L1) first instar: Body length: 3-4 mm; final L1: 6 mm. Duration: 21 days. The larva hatches through a circular gnawing of the chorion on the micropylar area. Usually a cross-piece remains hinged, forming an emergence lid, although sometimes the chorion is entirely gnawed through forming a hole. The chorion itself is not consumed. Emergence of the larva can only occur under humid conditions. Arid conditions inhibit and may even prevent the emerging. The description of the line patterns of the larva follows Shirozu & Hara (1979), Fig. 2, and the description of the head is according to Bach (1974). The coloring of the larva is that of a light sand. Dorsal, subdorsal, subspiracular and spiracular lines are all light brown. The end of L1 is light brown as well. The head capsule has four primary setae on either side of the genae, head diameter 0.8 mm. The dorsal side of the body has four rows of setae, and on the fifth segment of the ventral side there are 6 setae, which are turned caudally. The anal segment is forked, with two setae on each side. The L1 head capsule of *Hipparchia semele* L. has the same number of primary setae as the *Hipparchia* taxa from the Faial, Flores and São Miguel islands. In complete contrast, the genus *Pseudochazara* exhibits primary fine hairs which are very strongly pronounced (Aussem & Hesselbarth, 1980).

(L2) second instar: Body length: 5 mm; final L2: 8-9 mm. Duration: 17 days. The coloring and line patterns of the body are as in L1, although now there is an additional pale white band line. The head is light brown, diameter 1 mm. The density of pubescence increased. Genae are marked on either side with light brown coronal lines, supraocellar lines and ocellar lines. Anal segment is forked.

(L3) third instar: Body length: 9 mm; final L3: 14 mm. Duration: 17 days. Coloring and marking of the body as in L2. Head capsule diameter, 1.5-1.6 mm. The dorsal line often interrupted or dotted. Head capsule dark brown and more pubescent than L2. The lines of the head capsule as in L2. Abdominal fine hair no longer present. Anal segment is forked.

(L4) fourth instar: Body length: 13 mm; final L4: 18 mm. Duration: 16 days. The color is usually dark brown with a few light brown individuals. Dark brown dorsal line often interrupted. Subdorsal line light brown;

subspiracular line dark brown, as broad as dorsal line. The spiracular line light brown, narrow white basal line distinct. Head capsule dark brown. The genae lined patterns as in L3 densely pubescent. The fine hair on the body equally abundant. The anal segment forked. From L4 on, the sexes differ in diameter of head capsule: ♂♂ 2.1 mm, ♀♀ 2.5 mm.

(L5) fifth instar: Body length: 25 mm; final L5: ♂♂ 27 mm, ♀♀ 30-32 mm. Duration: 26 days. Head capsule diameter: ♂♂ 3.5 mm, ♀♀ 5 mm. Dimorphic, both dark and pale brown forms present. Dorsal line dark brown bordered by two thin white lines occasionally dotted and interrupted. Subdorsal line dark brown, supraspiracular line also dark brown with two fine white border lines. White basal line bordered by two thin dark brown lines. Thin, short dark brown marks present between dorsal line and spiracular line. Body thickly covered with short bristly hair. Both dark and pale brown head capsules observed. On either side of the genae there is a coronal line, supraocellar line and ocellar line. These markings are dark brown, and in many specimens are so wide and so dark that the head appears to be entirely black-brown. The head has a dense covering [illegible] short red-brown hair. The bristles of the Faial specimen, however, are somewhat longer than those of the L5 instar of the Sao Miguel and Flores populations. Males and the females are easily distinguishable by the width of the head.

Prepupa and Pupa: During the prepupa stage the markings of the larva become lighter and more translucent as the body of the larva contracts and thickens. Under laboratory conditions the prepupa lasts 10 days. In comparison with the pupae from Sao Miguel, the Faial pupae are dark brown in coloring, although there is some variation. On the dorsal and lateral sides of the abdominal segments the Faial pupae have dark brown pigment markings. On each segment there are up to 10 marks in a double row. The abdomen of newly formed pupa is capable of movement. Pupation occurs without the preparation of a web, between the leaves of *Festuca jubata* Lowe. Occasionally pupation takes place in open ground. In most cases in the field a grassy area sheltered from the wind is selected for pupation. In the beginning of July 1980 I found L5 larvae capable of pupation and pupae at an elevation of 900 m on the southeast slope of the Caldeira. Under laboratory conditions, at temperature of approximately 20°C, the pupal state lasts 21-30 days. The pupae require a humid environment. If they become too dry, the butterflies cannot eclose properly, or emerge crippled. This could be the result of adaptation to the moist often damp ground vegetation of the Azores mountain regions. Pupa length/width (mm): ♂♂ 15/6; ♀♀ 17/7.

Adult Material Examined: 45 ♂♂, forewing length: 20-22 mm. 25 ♀♀ forewing length: 21-24 mm. Leg. et coll. S. Oehmig, Azores, Faial Caldeira, southeast slope 900 m, 1 July 1980.

Discussion: The dark color of the male upperside is peculiar to Faial

specimens. The stunted form and small size of androconial scales is so different compared with androconial scales of the *Hipparchia* taxa of the islands of Pico and Sao Jorge, that separation of this taxon from the others is justified.

Foodplant: *Festuca jubata* Lowe. (Gramineae).

Appearance: June-October.

SAO JORGE

Hipparchia azorina jorgense Oehmig new subspecies

Holotype ♂; Paratypes ♂, 5 ♀♀, [Azores]: Sao Jorge, Coroas 600 m. leg. D. T. Pombo, 2 Aug. 1981, Nord Biscoitos Transversal, leg. D. S. Furtado, 26 Aug. 1981. All types in my collection.

Description: ♂: upperside forewing dark brown, discal region ranges from a light ochre to a sand color. In cells 6 and 2 a dark brown spot. The light sandy colored discal region is typical of the specimen from Sao Jorge. ♂: upperside hindwing dark brown, postdiscal band is a striking light sandy color. ♂: underside forewing very pale ochre, with an eyespot in cell 6 and a dark brown spot in cell 2. Outer margin dark brown is always narrow and sharply outlined. ♂: underside hindwing basal and discal area dark brown. A characteristic which only occurs amongst the Sao Jorge specimens is that the pale white postdiscal band is laid very broadly. The discal area runs along the discoidal and median veins tapering off into the white postdiscal band. ♀: upperside forewing light ochre to sandy colored discal and postdiscal area. In cells 6 and eyespots or spots in brown color. ♀: upperside hindwing, a pale postdiscal area is typical as well for these specimens. ♀: underside forewing quite pale ochre to sandy color. In cell 6 and 2 brown eyespots or spots. Outer margin brown sharply defined. ♀: underside hindwing basal and discal area dark brown. The discal area project pointed into the white postdiscal area.

Androconial scales: length: 0.14-0.15 mm; width: 0.018 mm. Androconial patch small not always present. The form and size is similar to that of the Faial males. At the base however, the form is never spatulate round, rather it is always pointed.

Male genitalia: Valva length: 1.3 mm; width: 0.35 mm.

Female genitalia: Signum length: 1.3 mm; width: 0.2 mm.

Distribution: Azores, Sao Jorge, from 480 m to over 700 m. Marsden & Wright (1971) between Urzelina and Ouvidor. Mr. Pombo, Coroas 600 m leg. 2 Aug. 1981, Mr. Furtado, Nord Biscoitos Transversal, leg. 26 Aug. 1981. The only information concerning the *Hipparchia* biotopes of the island of Sao Jorge are based on the results of Marsden & Wright (1971), who reported the habitat of *Hipparchia azorina* is to be found from the upper [illegible] pasture to the [illegible] pasture zone. The lower boundary was specified by the authors as being at 480 m on the northern slopes, and 540 m altitude on the southern slopes. The number of

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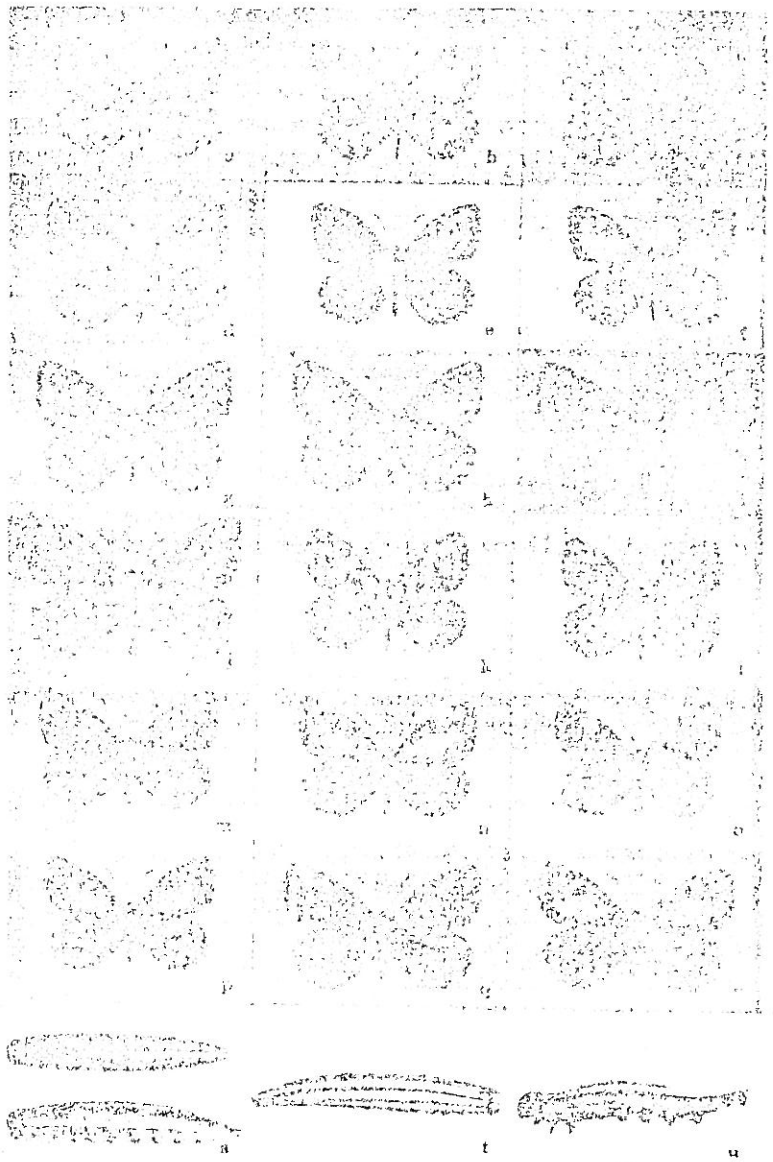

PLATE I.

PLATE I. Imagines of the Azores *Hipparchia* taxa.

a. *H. azorina jorgense*, ♂ upperside
b. *H. azorina jorgense*, ♂ underside
c. *H. azorina jorgense*, ♀ upperside
d. *H. azorina jorgense*, ♀ underside
e. *H. azorina*, ♂ upperside
f. *H. azorina*, ♂ underside
g. *H. miguelensis*, ♂ upperside
h. *H. miguelensis*, ♂ underside
i. *H. miguelensis*, ♀ upperside
j. *H. miguelensis*, ♀ underside
k. *H. azorina ohshimai*, ♂ upperside
l. *H. azorina ohshimai*, ♂ underside
m. *H. azorina ohshimai*, ♀ upperside
n. *H. azorina ohshimai*, ♀ underside
o. *H. calderense* ♂ upperside
p. *H. calderense*, ♂ underside
q. *H. calderense*, ♀ upperside
r. *H. calderense*, ♀ underside
s. *H. azorina ohshimai*, 5th instar
t. *H. miguelensis*, 5th instar
u. *H. miguelensis*, 5th instar

Figures a-r: 0.6 X natural size.
Figures s-u: 1.05 X natural size.

flying adults observed per 5 minute at varying altitudes taken from Marsden & Wright (1971) is as follows: Between 480-540 m, fewer than 10; at 720 m. on the southern side, approximately 30; and on the northern side, 85 adults.

Based on these results, it is apparent that the *Hipparchia azorina* population of Sao Jorge occur most frequently at an altitude of approximately 700 m. The above authors also provided data concerning the temperatures at the high altitude of 700 m, during the month of September. Under clear skies the temperature may drop as low as 7°C with 21°C as the daytime high temperature. One may assume, because larval feeding occurs exclusively during the night, that by September the larvae have already gone into diapause. Under laboratory conditions at a temperature of 20°C, 10 weeks are necessary for the development to the third larval stage. An egg deposited at the beginning of July, would thus be expected to reach a maximum third larval stage by mid September.

Material Examined: Holotype ♂, forewing length: 22 mm, [Azores], Sao Jorge, Cordas 600 m, 2 Aug. 1981, leg. Mr. D. T. Pombo, Santa Maria, Azores. Paratypes ♂ and ♀ leg. Pombo, 7 ♂♂ leg. Mr. D. S. Furtado, Sao Miguel, Azores, Nor'Nordeste Transversal, 20 Aug. 1981. Male forewing length: 22 mm, female 23-26 mm. All types in my collection.

Discussion: Specimens of Sao Jorge are, with respect to the pale

wider than those of the other taxa from the Azores. The terminal extension is always short in form. The dorsal process is well pronounced, and tapers off to a point. The uncus is always distinctly longer than in the taxa of the other island.

Female genitalia: Signum length: 1.6 mm, width: 0.2 mm. Longer and broader than those of the other taxa.

Distribution: Sao Miguel, Azores, from 600 m to over 1000 m. Gafanhoto 715 m, Vista do Rei 600 m (Rebel, 1940b):17, Lagoa do Fogo 700 m, Pico da Vara 1103 m. The important environment requirement of *H. miguelensis* populations is the presence of *Festuca jubata*. This plant shows substantial variation in composition and aspect in the habitats where it is found amongst the islands; from the grassy meadows in the mountains to plant associations which form thickets, and where *Festuca jubata* itself only plays a minor role (Lupnitz, 1975a). In the Vale de Furnas, Gafanhoto 700 m, southern exposure, the habitat is in a densely wooded zone. *Laurus azorica* (Seub.), which stands approximately 2 meters tall, grows in wide intervals together with *Vaccinium cylindraceum* Sm., and *Rubus* sp. In between grows *Calluna vulgaris* (L.) Hull. which intertwines to practically form a surface. *Festuca jubata* prospers in thickets amongst *Blechnum spicant* (L.) Roth., *Osmunda regalis* L., *Woodwardia radicans* (L.) Sm. individual *Heydichium gardnerianum* Roscoe and *Potentilla* sp. Close to the ground are often *Selaginella* sp., *Sphagnum* sp. and *Lycopodium* sp. In most places the ground is heavily covered with foliage. On account of frequent precipitation the vegetation is often dripping wet for the entire day. These plant communities can be found near Pico da Vara. The butterflies, although fewer in number, fly as well on the Vista do Rei. The habitat is small, perhaps a vestigial environment. Many *Lotus uliginosus* Schulz and *Lotus parviflorus* Desf. are in bloom, and *Festuca jubata* is also present. Single butterflies have also been observed at the inaccessible western crater-wall of the Sete de Cidades.

Ovum: diameter: 1.1-1.2 mm; height: 1.1 mm. Micropyles 3. Micropyle rosettes five leaved. There are 26 ribs in longitudinal ridges. The form and coloring is as in the Faial specimens.

Larva: The development of the larvae from the *Hipparchia miguelensis* populations corresponds to that of the population from Faial. The markings of the larva also coincide with those of the larvae from Faial. However, in contrast to Faial larvae, the 5th instar of the Sao Miguel larvae are always a light sandy color with a pattern of light brown lines. The head capsule is always a pale red-brown. The fine hair of the head capsule is shorter in the 5th instar than in the Faial 5th instar. In most larvae, the coronal line and the supraocellar line do not meet in the height of the ocelli, as is the case of the Faial population.

Pupa: The Sao Miguel pupa is always light brown in color. In contrast to the Faial pupa, the dorsal abdominal markings are not present, or are at

forewing upperside and the wide postdiscal area on the hindwing underside, clearly different from the *Hipparchia* taxa of Pico and Faial. Both androconial scales and male genitalia also show differentiation between the taxa of Pico and Faial. These characters justify a distinct subspecies.

Foodplant: Not known, probably *Festuca jubata* (Gramineae).

Appearance: June-September.

SAO MIGUEL

Hipparchia miguelensis (LeCerf, 1935) stat. rev.
Satyrus azorinus miguelensis LeCerf, 1935, Bull. soc. ent. Fr., 40:206-209 [Azores]: Sao Miguel.
Holotype ♂, Allotype ♀, Paratypes 2 ♂♂, Museum National d'Histoire Naturelle, Paris.

Description: ♂: upperside forewing dark brown, but not so dark as males from Faial and Pico, in cell 6 a dark brown eyespot or spot, in cell 2 a dark brown spot. The ocelli of some of the specimens have a strong underlying ochre yellow color. Some males are rather similar to the females due to the distinct ochre yellow markings which they exhibit. Most males, however, are without this strong ochre yellow marking. ♂: upperside hindwing dark brown, some with a dark ochreous postdiscal area, in cell 2 a dark brown spot. ♂: underside forewing dark ochre yellow, typical *H. miguelensis*. In cell 6 a eyespot, in cell 2 sometimes a dark brown spot. Outer margin dark brown and sharply defined. Costa dark brown. ♂: underside hindwing basal and discal area dark brown, but lighter than the Faial taxa. The discal area always terminates round into the white or pale ochre postdiscal area. ♀: upperside forewing dark brown, as in the males. In cell 6 an eyespot, in cell 2 a brown spot. The spots of the specimens have a strong underlying ochre color. The ochreous colored markings of the females are more pronounced than those of the males. ♀: upperside hindwing dark brown with more or less strong ochre postdiscal area. In cell 2 a dark brown eyespot. ♀: underside forewing strong ochre yellow with a finely marked ochre zigzag pattern in the postdiscal area. In cell 6 an eyespot, in cell 2 a dark brown spot. Outer margin dark brown, sharply defined. ♀: underside hindwing basal and discal area dark brown. The discal area between cells 3 and 4 along the discoidal and median veins are always bluntly rounded off, reaching into the light cream colored postdiscal area.

Androconial scales: length: 0.17-0.19 mm; width: 0.015 mm. These are the largest androconial scales of all the taxa from the Azores. Androconial scales wide and strongly tapered off toward the apex. The androconial patch is most clearly pronounced of all taxa, but not very large. There are two along the median vein of the cell.

Male genitalia: Valva length: 2.25 mm; width: 0.45 mm. The valva is

least very [illegible]. Pupa, length/width (mm): ♂ [illegible]16); ♀ 1.7/.

Material Examined: 90 ♂♂, forewing length: 22-26 mm; 8 ♀♀ forewing length: 24-28mm. Leg. et coll. S. Oehmig, Azores, Sao Miguel, Galamboto 700 m, 27 June 1986.

Discussion: Typical for *H. miguelensis* is the large signum of the females, and the large uncus and the wide valva of the males. The androconial scales are the largest of all the taxa of the islands. The ovum shows 26 ribs and 3 micropyle openings. The micropyle rosette is five leaved. The 5th instar larva, including its head capsule, is a great deal lighter in color than the other taxa. The fine hairs of the head capsule of the last instar are shorter than hairs of the head capsule from the Faial larvae. It is clear that a distinction is in order differentiating this taxon from *H. azorina* based upon the divergent coloring and markings of the larva, as well as the completely different appearance of the imagines.

Foodplant: *Festuca jubata* (Graminene)

Appearance: June-September.

It can surely be assumed that the *Hipparchia* appearing on the Azores islands are of allopatric distribution. The concept of superspecies (Mayr, 1967) should be applied here. Mayr has indicated that the superspecies concept be especially applied to the pattern of variation associated with insular distribution patterns.

FLORES H. occidentalis occidentalis

Hipparchia caldeirensis Oehmig new species

Holotype ♂, Paratypes 33 ♂♂, 6 ♀♀; [Azores], Flores, Caldeira Seca, 700 m, 30 June 1986, leg. et coll. S. Oehmig.

Description: ♂: upperside forewing dark brown, basal and discal area lighter ochre. In cell 6 a dark spot, sometimes with underlying light ochre color. In cell 2 a small dark brown spot, however the spot is not present in all specimens. ♂: upperside hindwing dark brown color, the postdiscal area is only poorly visible. Some specimens with a dark brown spot or eyespot in cell 2. ♂: underside forewing light ochre yellow color in the basal and discal region. The outer margin borders on a dark brown zone, which always broadly reaches into the postdiscal area, and is not sharply defined. The brown spot in cell 2 is never present. ♂: underside hindwing basal and discal region dark brown with distinct white markings in the basal region. This is a typical characteristic of the specimens from Flores, and appear only rarely in specimens from Pico island. The dark brown discal area runs along the discoidal and median veins, tapering to a point and project into the white postdiscal area. ♀: upperside forewing color like the males, but somewhat lighter ochreous in color; dark brown spots in cells 6 and 2 larger than the males. ♀: upperside hindwing like the males. ♀: underside forewing like the males but the outer margin is

not as broad and dark as the males. ♀: underside hindwing like the male but somewhat lighter in color.

Androconial scales: Not present. One may assume that they were lo[st] secondarily.

Male genitalia: Valva length: 0.17 mm; width: 0.2 mm. The Flores specimens are distinguished by their valves which are the narrowest of a the Azores taxa. The terminal extension is especially long.

Female genitalia: Signum length: 1.3 mm; width: 0.1 mm.

Distribution: Flores, Azores, Caldeira Seca 700 m and above. Th butterflies fly along the inclines of the Caldeira Seca and the Pico dos Se[te] Pes, from altitudes of 700 m and more. The environment is pervaded wit[h] valleys formed by erosion. The vegetation is rich in grass and *Festuc jubata*, which grows in dense thickets, is quite common. In the erode[d] valleys by water one can find the following shrubs: *Laurus azoric[a]* *Viburnum tinus* L., *Rhamnus gladulosa* Ait., *Rubus* sp., and occasionall[y] *Vaccinium cylindraceaum*. Dwarfed *Juniperus brevifolia* (Seub.) Ant. an[d] *Erica azorica* can be found in the back of the valley. *Calluna vulgari[s]* appears as well and occasionally one finds *Potentilla sp.* In some areas th[e] environment resembles a fen. A thick cushioning is often built on th[e] ground by *Sphagnum* sp. With exception of the protected valleys th[e] environment gives a barren impression, and is barely protected from th[e] tradewinds. As a result the butterflies remain primarily in the protecte[d] valleys, however when they do fly out of the valley, then they are ofte[n] carried quite some distance by the wind.

Ovum: diameter: 1.0 mm; height: 1.0 mm. The form and coloring i[s] similar to that of the specimens of Faial and Sao Miguel. There are 24 rib[s] in longitudinal ridges, two micropyl openings, micropyle rosettes are [five]-leaved.

Larva: The development of the Flores larva corresponds to the larva[l] development of the taxa from Faial and Sao Miguel. The Flores larva ar[e] much lighter in coloring than the larvae from Sao Miguel. In this respec[t] the Flores larvae are similar to those of Sao Miguel.

Pupa: The pupa is always light brown in color. The distinctly pro[-] nounced abdominal markings of the Faial pupae are barely visible or ar[e] not present. Pupa length/width (mm): ♂♂ 13/6.

Material Examined: 34 ♂♂, forewing length: 19-22 mm; 6 ♀♀, forewing length: 23-26 mm. Holotype ♂, forewing length: 21 mm, and paratypes [♂♂♀♀], Flores, Caldeira Seca 700 m, 30 June 1986, leg. et coll. S. Oehmig.

Discussion: On account of the morphological differences between the imagines, it is reasonable to seperate *H. caldeirense* from *Hipparchia azorina*. In particular the extremely narrow valves of the males and the small signum of the females justify separation. The complete absence of the androconial scales can be seen as a barrier to the mating of the Flores

Table 1. Summary of characteristics of the Azore Island taxa of *Hipparchia*.

	Hipparchia caldeirense	Hipparchia azorina ohshimai	Hipparchia azorina jorgense	Hipparchia azorina	Hipparchia miguelensis
Distribution	Flores	Faial	Sao Jorge	Pico	Sao Miguel
Forewing length (mm)	♂♂ 19-22 ♀♀ 20-24	20-22 21-24	22 23-26	21-22	22-25 24-28
Forewing color upperside	dark brown basal and discal area, light ochre	dark brown	dark brown very light ochre postdiscal area	dark brown with light ochre discal area	dark brown eyespot markings always dark ochre
Androconial scales length/width (mm)	not present	0.13 - 0.14 X 0.02	0.14 - 0.15 X 0.018	0.14 - 0.16 X 0.015	0.17 - 0.19 X 0.015
Valva length/width (mm)	1.7 X 0.2	1.8 X 0.4	1.95 X 0.35	1.8 X 0.3	2.25 X 0.15
Uncus length (mm)	0.8	0.95	0.9	0.9	1.3
Signum length/ width (mm)	1.3 X 0.1	1.2 X 0.15	1.3 X 0.2	----	1.6 X 0.2
Ovum height X diameter (mm)	1.0 X 1.0	1.1 X 1.1	----	----	1.1 - 1.2 X 1.0
Micropyles	2	4	----	----	3
Ribs	24	24	----	----	26
Larva color	light brown	most dark brown	----	----	light brown
Pupa length/width (mm)	♂ 13/6 ♀	15/6 17/7	---- ----	---- ----	15/6 17/7

[illegible] with the *Hipparchia* populations of the other [illegible] islands. Tinbergen (1941) has shown that *H. semele* L. males, from whom the androconial scales have been removed, are still capable of mating. However, in comparison with the males which still possess the androconial scales, the former are clearly at a disadvantage in mating. A further feature supporting the separation of *Hipparchia caldeirense* from *H. azorina* is the different structural character of the ovum upper surface.

Foodplant: *Festuca jubata* Lowe (Gramineae).

Appearance: June-September.

Foodplants—Adults and Larvae

The imagines of all *Hipparchia* populations from all the islands primarily visit the blossoms of *Rubus ulmifolius* Schott and *Rubus hochstetterorum* Seub., as well as *Potentilla erecta* (L.) Raesch and *Potentilla anglica* Laicharding as their nectar sources. On Sao Miguel I observed individual butterflies as they fed from the blossoms of *Calluna vulgaris*. All of the habitats are quite poor in the flowering plants, which give rise to questions of nutrition for the adult butterflies. Present in the environment are also the following blossoming plants, which by observation are not visited by the butterflies for feeding: *Vaccinium cylindraceum* on Flores and Sao Miguel islands, *Thymus caespititius* Brot. on Pico, and *Daboecia azorica* on Faial and Pico islands. The females prefer grass cushioned areas, which are compact and not too large, for oviposition. Oviposition in all observed cases is confined to *Festuca jubata*.

The feeding of the larvae always begins at the tip of the leaf and continues down approximately ⅓ of the length to the plant base. If there are several larva in the plant, then the surface is eaten away quite evenly. The larvae of *Hipparchia azorina* were found on Faial island at the southeastern slopes of Caldeira at 900 m altitude on July 1, 19[illegible], in the grass cushioning of *Festuca jubata* Lowe. Up to five larvae were found on a single plant, but usually one finds only one or two larvae per plant. The larvae appear to favor plants which grow in wind protected rivulets or valleys. Marsden & Wright (1971) have already pointed out the strong feeding activity of the larvae upon the grass vegetation. Economic damage by *Hipparchia* larvae to the grass vegetation is not cited. It appears likely that the larvae of all the *Hipparchia* populations on the various Azores islands feed monophagously on *Festuca jubata*, which grows only in montane regions. On the coast it is replaced by *Festuca petraea* Seub. On Sao Miguel, Faial and Flores several females were taken for egg laying, the eclosed larvae being available during the author's visit to the Azores. In breeding these larvae, first on Madeira and later in Germany, the problem of foodplants presented itself. *Festuca jubata* was no longer available, and *Festuca ovina* L., which occurs in Germany, was not accepted as nutriment.

Festuca scoparia Kerner et Hack, from the Pyrenees, was the first plant the larvae accepted. All the bred specimens have been reared with this plant.

Behavior of Larvae

The larvae are nocturnal. On July 1, 1980, toward 1800 hours on Faial island I found L5 instars of *H. azorina* hidden in the cushioning grass. Sometime after dusk the larvae wander out of the middle of the plants in order to eat from the tip of the leaves. In such fashion they work their way down towards the base of the plant, minimizing visible evidence of damage and their presence. During the day the larvae hide in the grass with their heads facing upward. In cases of heavy feeding by the larvae, up to half the total height of the cushioning grass can be eaten away. While still dark, after feeding, the larvae wander back inside the grass cushion.

Behavior of Adults

The flight of the butterfly begins as soon as the sun breaks through in the early morning hours. The butterflies interrupt their flight during sudden rainstorms, but continue to fly during light drizzles. When adults rest they prefer to settle down on plants. The butterflies always fly on the regions of the mountains which are protected from the wind. The flight is short and after a short flight the butterflies land again. The butterflies take a resting position of 45° with their wings shut as they alight. They fly always more or less close above the ground vegetation. Oviposition was not observed in nature, but I assume females deposit eggs on the plant. On the islands of Sao Miguel, Faial and Flores, I observed the flight of the butterflies by and large ceased after 1800 hours.

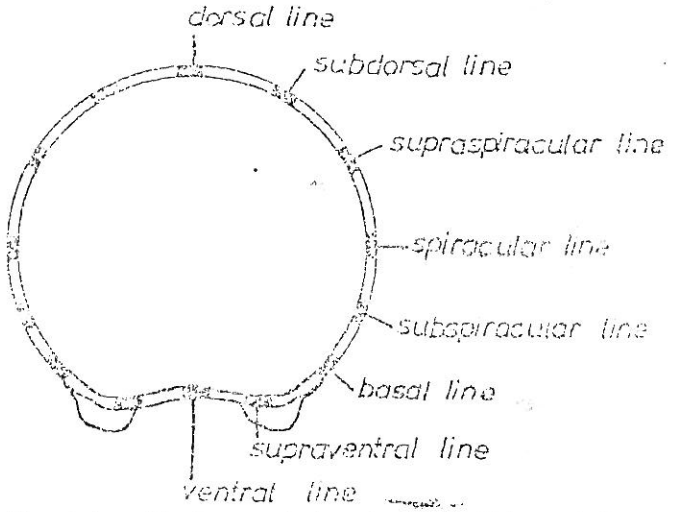

Fig. 2. Description of the lines on the larva body after Shirouzu & Hara, 1971

Parasitoides and Predators

No evidence of parasitoides were found from the approximately thirty larvae collected on Faial island. It is not known whether the eggs are subject to parasitism. Walker (1931) described some imagines from the Pico island as having parts of the wings bitten off, and assumed that the bites were caused by *Serinus canaria* (Linnaeus, 1758). It would appear that *Motacilla cinerea patriciae* (Vaurie, 1957) could use *H. azorina* as their diet includes insects. Predators as *Lacerta* spec. do not occur in the habitats of the *H. azorina* complex. There are not sufficient data at present to make judgments on the role of either predation or parasitization in regulating the populations of these butterflies.

Protection of the Species

On all of the Azores islands the intensive use of land for pasture is of great economic importance to local agricultural production. As a result large areas of naturally growing fescue grass vegetation are often broken up by bulldozers in order to be replanted with pasture grasses for higher productivity. The Azores *Hipparchia* species cannot, however, live in these cultivated pastures. It is reasonable to assume that in the middle of the 15th century, when the Azores were first colonized, that the islands were covered to a great extent with woods. The present environment of the *Hipparchia* populations on the islands can be seen as secondarily arising after the initial clearing of the woods by the early settlers. As a result *Festuca jubata* was probably able to strongly expand, and the *Hipparchia* populations during that period found a still better environment. Through today's methods of agriculture, this development is regressing, and the pasture environment is now being supplanted by artificially selected grasses for agricultural reasons.

An extensive use of pasture of the natural fescue grasses, as has always been done in the past, did not harm the prospering of the *Hipparchia* populations. The method best suited for the conservation of the butterflies is the conservation of initially produced native pasture habitats, most appropriate biotopes being those with a southern to southeastern exposure. The most suitable habitats on Sao Miguel are Gafanhoto, 715 m and the regions near Pico da Vara. On Faial island the slopes of Pico Gordo and the Caldeira in the described conditions, and on Flores the best areas are the slopes of Pico das Pedras. For the islands of Sao Jorge and Pico there are no data available yet that species habitats require protection. In any case, care should be taken that such habitats are not allowed to become afforested with *Cryptomeria japonica* (L.F.) D. Don., which is employed in the Azores.

Conclusions

1. Comparative investigations of morphology of adults and particularly

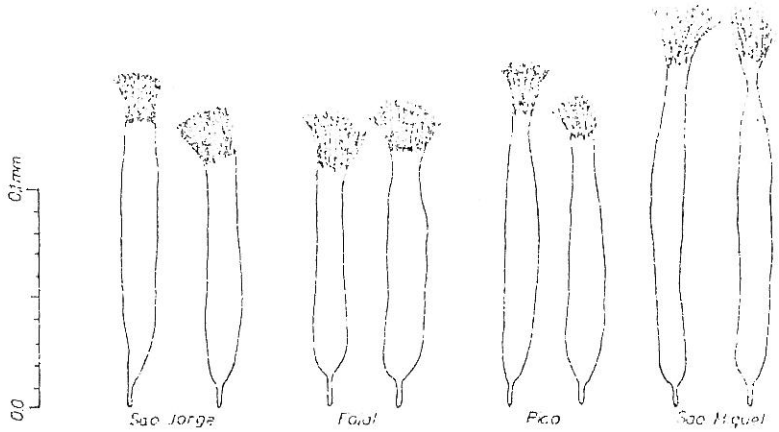

Fig. 3. Androconial scales of the Azores *Hipparchia* taxa. Sao Jorge: *Hipparchia azorina jorgense*; Faial: *Hipparchia azorina ohshimai*; Pico: *Hipparchia azorina*; Sao Miguel: *Hipparchia miguelensis*.

of the early stages, provided the basis for a revision of the taxa of *Hipparchia azorina* complex.

2. *H. azorina* Strecker 1899 is present only on the central group of the Azores. The type locality is restricted to Pico island. *H. azorina ohshimai* comb. nov. stat. nov. inhabit Faial island, on Sao Jorge one finds *H. azorina jorgense* ssp. n.

3. *H. miguelensis* LeCerf 1935 stat. rev. comb. nov. inhabits Sao Miguel island.

4. *H. calderense* sp. n. inhabit Flores island.

5. The habitat of the populations from Sao Miguel, Faial and Flores identified of the *Festuca jubata* zone. The foodplant of the larva is *Festuca jubata* Lowe., although record of the foodplants on Sao Jorge and Pico has yet to be brought forth.

6. All populations are monovoltine, hibernation taking place during the larva stage.

7. The continuing expansion of the area devoted to modern agricultural production necessitates protection of the species.

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After the completion of this work in May 1982, *Hipparchia* specimens from the Azores were sent to the following addresses: Allyn Museum of Entomology, Sarasota, Florida, U.S.A.; Mr. W. L. Florijt, Groningen, NL; Dr. O. Kudrna, Bonn; Prof. Dr. C. Naumann, Bielefeld; and W. Schmidt-Koehl, Saarbrucken, the remainder are in my collection.

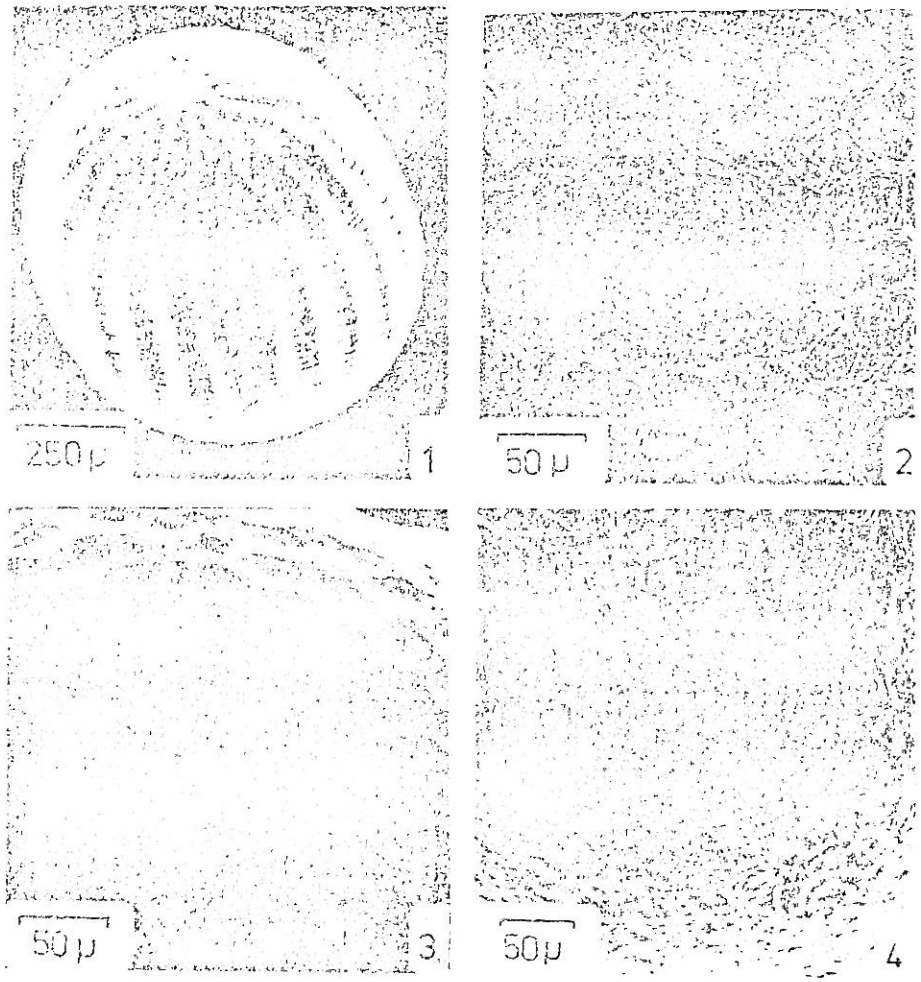

Fig. 4. Eggshells of the Azores *Hipparchia* taxa, 1 ± 2: *Hipparchia azorina ohsimai*, 3: *Hipparchia caldeirense*, *Hipparchia miguelensis*.

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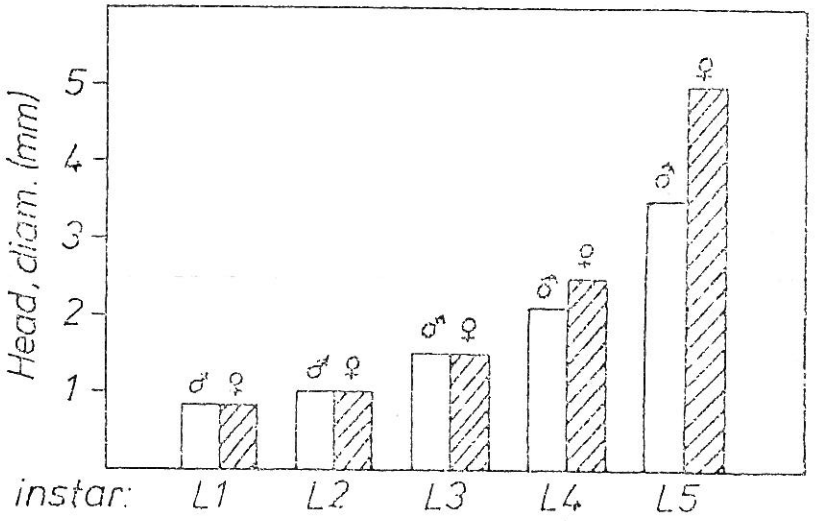

Fig. 5. Head diameter of the larva.

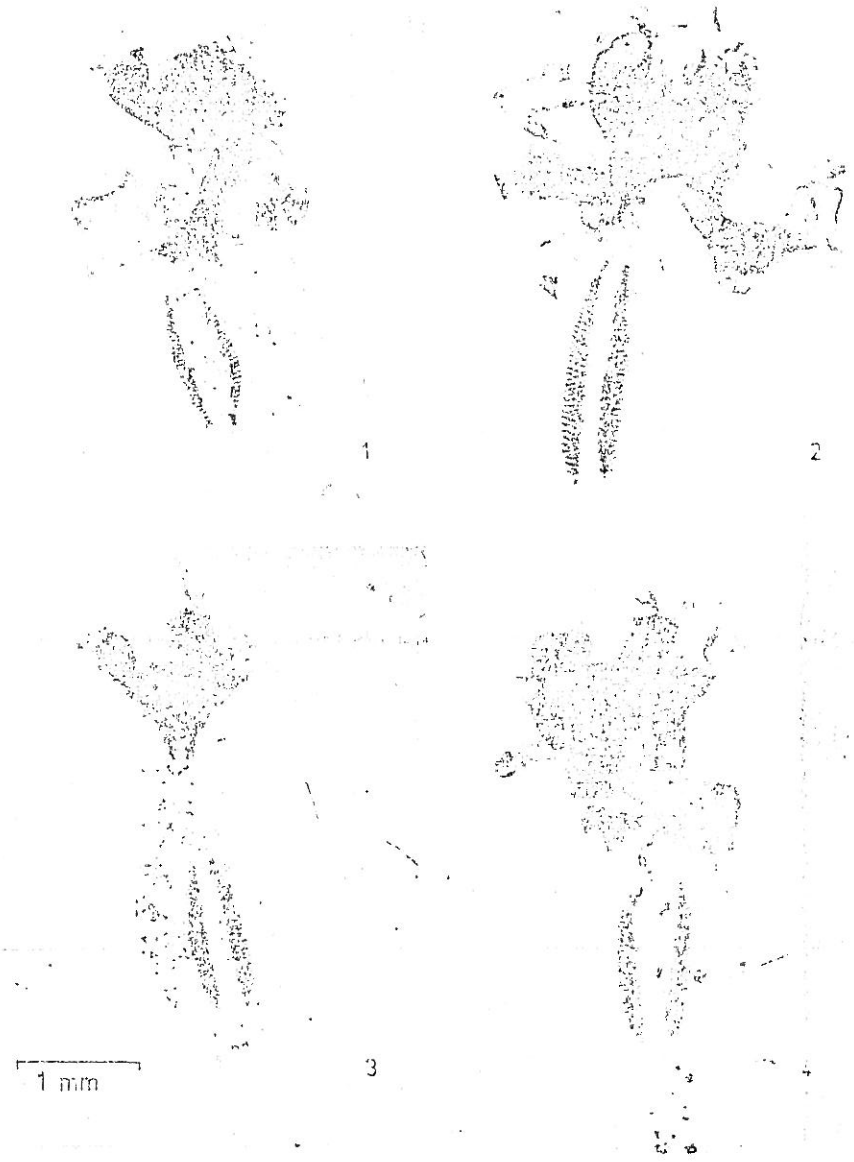

Fig. 7. Female genitalia. 1. *Hipparchia calderense*, 2. *Hipparchia miguelensis*, 3. *Hipparchia azorina obshimai*, 4. *Hipparchia azorina jorgense*.

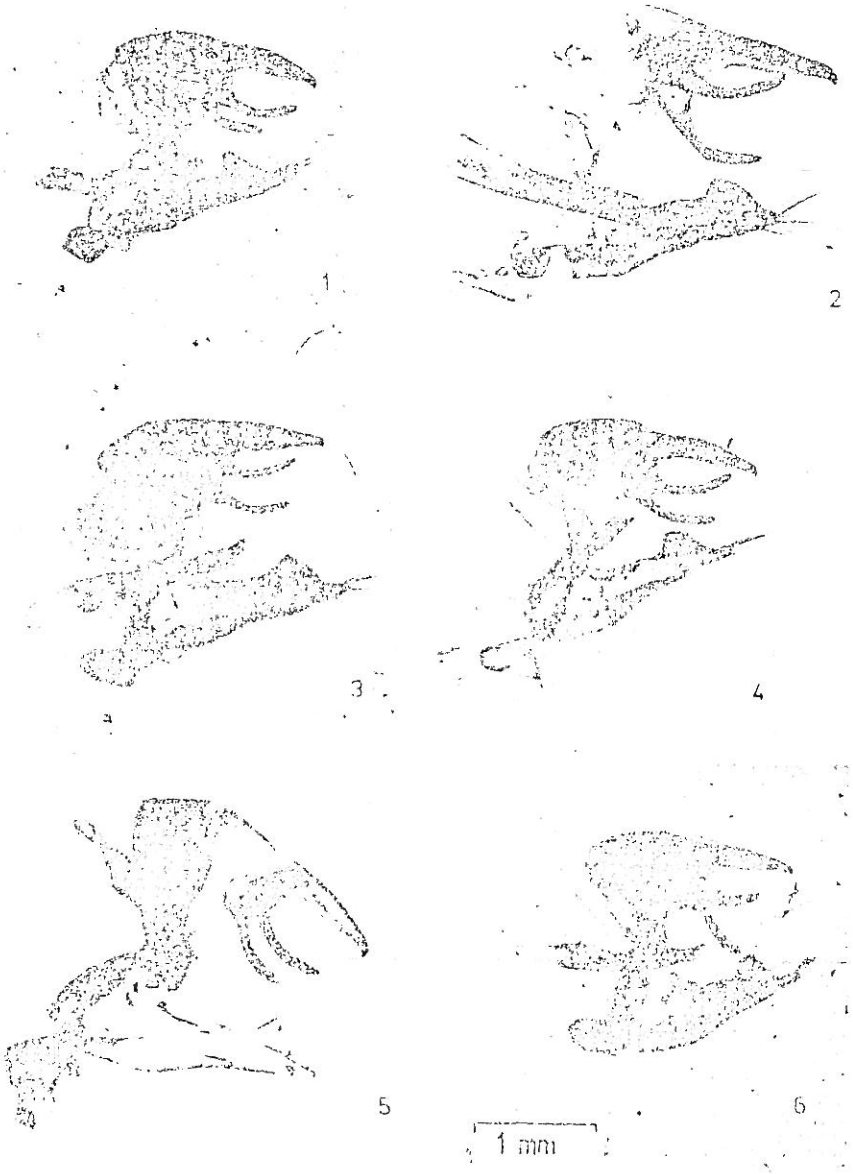

Fig. 6. Male genitalia. 1. *Hipparchia calderense*, 2. *Hipparchia miguelensis*, 3. *Hipparchia azorina obshimai*, 4. *Hipparchia azorina*, 5. *Hipparchia azorina jorgense*, 6. Holotype.

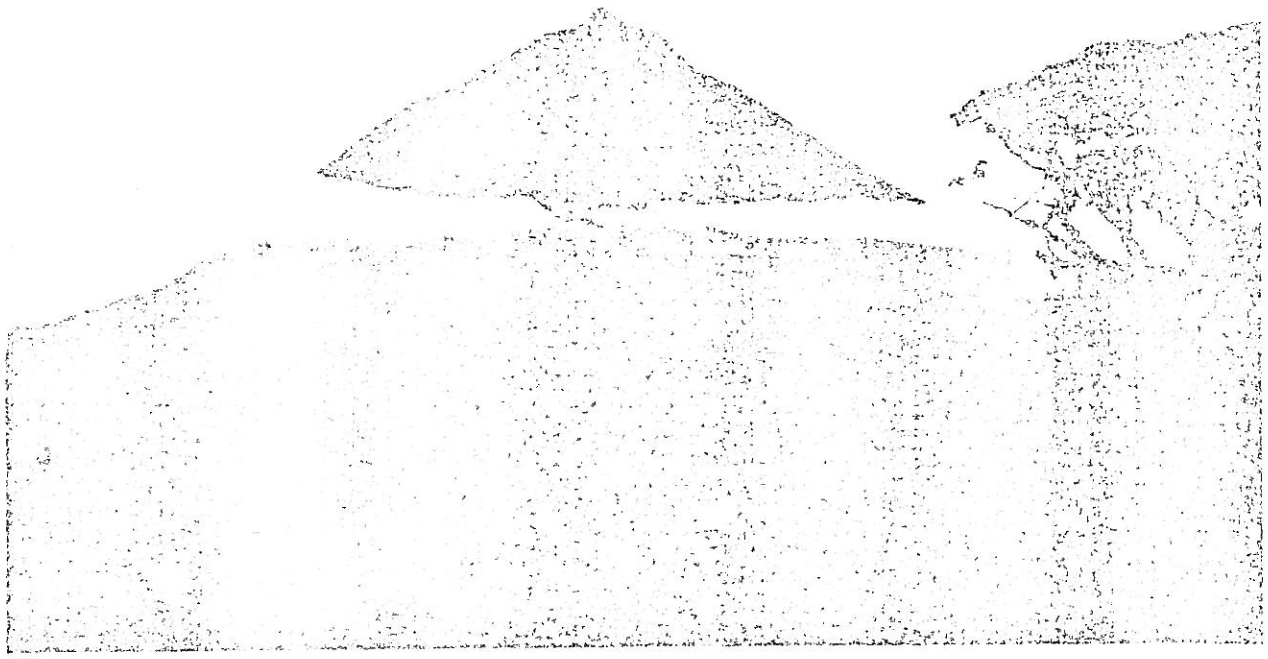

Fig. 8. Pico island, north side, view from Lagoa do Capitao 800 m, to the Pico 2351 m, only single males of *H. azorina* were observed on this high plateau.