THE SYSTEMATICS, BEHAVIOUR AND HABITATS OF THE MADEIRAN GRAYLING (GENUS *Hipparchia*: LEPIDOPTERA, SATYRINAE)

By A.G.SMITH & T.G.SHREEVE[1]

INTRODUCTION

Descriptions of the systematics, habitats and ecology of the Madeiran grayling differ between authors. Mainly using adult wing morphology, Higgins & Riley (1970, 1975) describe the Madeiran grayling as a subspecies (*maderensis*) of *Hipparchia aristeus*, a species represented by at least five subspecies distributed from the western Mediterranean to Greece and Asia Minor. The related Azores grayling is given specific status, *H.azorina*. Higgins (1975) retains the same subspecific status for the Madeiran grayling but places the Azores grayling as another subspecies (*azorina*) of *H.aristeus*. This change was made because of similarity of male genitalia.

In his revision of the genus *Hipparchia* Kudrna (1977) raises the Azores grayling to specific status (*H.azorina*), suggesting that this species is 'probably one of the phylogenetically oldest taxa of the genus'. He also points to invalidity in the use of *aristeus* as a specific name and replaces it with the oldest synonym *algirica*. He thus describes the Madeiran grayling as *H.algirica maderensis*, retaining the butterfly as a subspecies of the mainland *H.algirica* group, and describes an incomplete cline from Madeira in the west to Turkey in the east. This cline is based on androconial scale structure and male genital morphology. However, some of his descriptions of genitalia differ from those of Higgins.

[1]School of Biological and Molecular Sciences, Oxford Brookes University, Headington, Oxford, OX3 0BP, UK

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Descriptions of the Madeiran grayling differ. In part this is because of labelling confusion. Kudrna (1977), states that the original female used by Higgins and Riley (1970) bears two labels, one for Madeira and another for the Skopje district in Macedonia. Pointing to what he describes as "the usual inaccuracies characteristic of many of Hargreaves' illustrations", Kudrna states that his examination of this butterfly and its genitalia led him to identify it as *H.volgensis delattini* from Macedonia. Kudrna goes on to describe the phenotype of the Madeiran grayling and states that in the female the postmedial band on the hindwing underside is absent. This is not the case, as we have recorded the presence of this band in the majority of females. Our observations also reveal variation in the phenotype of both males and females and the original specimen described by Higgins & Riley (1970) falls within the phenotypic range recorded by us. Clearly there is confusion about the systematics, morphology and genital anatomy of the Madeiran and Azores graylings and the rest of the *H.algirica* group.

Describing the ecology of the Madeiran grayling Higgins & Riley (1970, 1975) state that it is as a very local butterfly which flies in July/August on grassy and stony slopes from 100m upwards. Kudrna (1977) also describes it as local and rare, but gives its habitats as rocky clearings in sparse deciduous woodland between 100 and 1700m, with a flight period from the end of July to early September. Neither works describe the host plants.

FIELD OBSERVATIONS

Between 7th and 21st September 1989 the Madeiran grayling was observed at several sites on the island. Observations suggest that it is most commonly associated with areas of light (conifer) woodland with extensive grass and herb layers. No individuals were observed at Ponta de S. Laurenço, the large area of open treeless grassland at the eastern tip of the island or on Paul de Serra, the most extensive area of high altitude grassland. It was, however, recorded on the lightly wooded southern and eastern slopes of this last area. Its absence from these two grassland areas may be because of the climate, dry nature and openness of the two sites. Paul de Serra is very exposed and subject to heavy grazing pressure. In combination with low air temperatures the dry nature of the site and lack of trees and bushes probably make the area unsuitable. The eastern grassland area is very dry at the end of the summer period and lacks hostplants (see below) which are suitable for sustaining larval growth.

Studies of the butterfly in coniferous woodland just south of Poiso demonstrate that it can occur at very high density and that certain habitats may support large numbers because of local climate and topography. The slopes of this coniferous site are subject to strong updraughts and fog from mid-day onwards. The area where the butterfly was abundant was at the head of a steep south facing valley which was subject to some shelter from these updraughts and tended to be less cloudy than immediately adjacent slopes. Aggregations may arise for two reasons. First, individuals may be carried on updraughts to particular sites causing locally high population density. Second, the sheltered nature of particular sites may facilitate the formation of resident high density populations because prolonged sunshine may extend the time available for flight, facilitating feeding, mate-location and egg-laying.

Field work at Poiso has enabled us to determine some of the host plants of this butterfly and suggest reasons for the development of its particular wing morphology. Six females were observed egg-laying and the placement of nine eggs recorded. Six were placed low (<10mm) on green shoots of *Holcus* grass species, the remainder on dry stems and exposed roots of *Agrostis* species. The behaviour of egg-laying females is similar to that of *H.semele* (Shreeve, 1990) of northern Europe.

TABLE 1. The location and behaviour of the Madeiran grayling in relation to weather, recorded in open conifer woodland at Poiso on 17 September 1989.

WEATHER				NUMBER OF INDIVIDUALS					
Time	Air Temp °C	Ground Temp °C	Radiation W/m²	Settled				Feeding	Flying
				Ground	Logs/ Trunks	Dry Grass	Bracken		
11.10	19	22	250	1	4	7	2	13	29
12.10	20	25	400	2	2	0	4	20	21
13.10	20	26	800	2	1	1	3	19	14
14.10	22	23	850	2	2	0	2	19	21
15.10	20	35	850	2	0	0	4	19	27
16.15	17	22	140	4	20	0	3	2	5

Basic behaviour patterns in relation to sunshine and temperature are shown in Table 1. Throughout, most individuals were at flowers and few were settled on high temperature basking substrates (bare ground and leaf-litter). We could not identify any true territorial perching mate location behaviour by males and no male-male interactions were observed. Attempted courtship seemed to consist of flying males approaching settled females and for the male to continue in flight after a momentary inspection of the female, most of whom appeared to reject the male by a quick 'wing-flick'. Thus the behaviour of this butterfly may differ from that of other grayling species (*H.semele*; Findlay, Young & Findlay, 1983; Shreeve, 1990; *Arethusena arethusa*; Shreeve, pers. obs.), in which settling site use is closely related to temperature and in which males are obviously territorial. The apparent lack of territoriality may be due to high population density rendering male-male interactions time consuming and ineffective, and/or the late season. Observations coincided with the near end of the period of adult activity in which receptive females will be scarce. In such circumstances active searching (flight) may be the best strategy for males to adopt in order to locate scarce receptive females.

Intensive observations (Table 1) were made on a day which was subject to the sudden occurrence of fog in mid-afternoon (c.16.00 hrs). With its arrival all activity ceased and individuals of both sexes flew to the trunks of pine. Such sites may provide the major roosting sites and resting sites of this butterfly which are used when it is incapable of effectively employing secondary defences of flash coloration and eyespot exposure in conjunction with escape flight. The butterfly is a lateral basker and the underside of the hindwing must have thermoregulatory and defence functions. The latter must function when the butterfly is incapable of activity. We suggest that the underside hindwing phenotype, with a prominent pale post-medial band may render individuals the most cryptic when viewed against tree trunks.

CONCLUSIONS

In conclusion, the evolutionary relationships between Madeiran, Azores and mainland graylings are confused and need investigation. We suggest that the quantitative analysis of the phenotype of different island and mainland forms is essential to make progress. This should also be combined with studies of hostplant and habitat use, behaviour, life-history, morphology and anatomy, all of which are related to phylogeny and current ecology.

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