THE LEPIDOPTERA OF THE MACARONESIAN REGION. VI BIOGEOGRAPHICAL ASPECTS OF MACROLEPIDOPTERA IN NORTHERN MACARONESIA (MADEIRA, AZORES)

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With 1 figure and 2 tables

ABSTRACT. The following families of Macrolepidoptera occur in northern Macaronesia (archipelagoes of Madeira and the Azores): Pieridae, Lycaenidae, Danaidae, Nymphalidae (Satyrinae & Nymphalinae), Geometridae, Sphingidae, Arctiidae and Noctuidae. A total of 112 species have been recorded from this region, 96 for Madeira, 53 for the Azores, 43 % being endemic forms. The majority of non endemic elements are palearctic (45 sp.) while other biogeographical elements are less represented (holarctic: 2 sp.; nearctic: 4 sp.; paleotropic: 9 sp.; cosmopolitan: 2 sp.).

INTRODUCTION

The lepidoptera fauna of the Azores and Madeira has been studied since the middle of the 19th century: the first publications being those of WOLLASTON (1858), MORELET (1860), DROUET (1861), FELDER (1862) and GODMAN (1870). Since the beginning of this century numerous contributions to this subject have been published (BIVAR de SOUSA, 1982a, 1982b, 1985a, 1985b, 1985c, 1991; CARVALHO, 1981, 1982, 1983; FONTENEAU, 1971, 1972; FUCHS, 1993; GARDNER & CLASSEY, 1959; HERBULOT, 1968; KARSHOLT, 1988; MARTIN, 1941; OEHMIG, 1977; PINKER, 1971, 1983; PROUT, 1939; REBEL; 1906ff, SWASH & ASKEW, 1982; WARREN, 1905; WEHRLI, 1939; WOLFF, 1997a, 1977b, but in many cases uncertain or wrong data have been published or simply copied from previous authors, already pointed out by the author (MEYER, 1991a, 1991b, 1993, 1995; MEYER & HELLERS, 1990). Actually, we are missing a synthetic overview on this insect group from the biogeographical region called "Macaronesia". The present contribution will analyse the knowledge on Macrolepidoptera (Papilionoidea, Geometroidea, Sphingoidea, Noctuoidea) from the

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taxonomic and biogeographical point of view. During the last decades some contributions were published on the biogeographical aspects of lepidoptera in Macaronesia (BALLETTO et al., 1990; BERNARDI, 1961; LEESTMANS, 1975, 1978; MEYER, 1993; OEHMIG, 1983; RIBEIRO et al., 1984; SOUSA, 1985c), but generally these publications only deal with the better known Rhopalocera.

The author had the opportunity to spend 6 weeks on both archipelagoes: 2 weeks in May-June 1989, 2 weeks in July-August 1991 and 2 weeks in October 1993 on Madeira, 4 weeks in July-August 1990 and 2 weeks in July 1994 on the Azores. The islands visited during these journeys were the following: Madeira, Porto Santo; São Miguel, Santa Maria, Flores, Faial, Pico, São Jorge, Terceira. A great majority of the endemic lepidoptera taxa have been collected. The heterocera have been attracted by a light trap, mainly an 80 W mercury lamp driven by a generator.

THE ARCHIPELAGOES

The Madeiran archipelago is composed of the main island Madeira (741 km^2, highest mountain is Pico Ruivo with 1.861 m, 300.000 inhabitants), the island Porto Santo situated 40 km NE (42 km^2, highest mountain is Pico do Facho with 507 m, 3.600 inhabitants) and the three Desertas situated 20 km SE (Chão, Deserta Grande, Bugio, highest mountain with 442 m is on Deserta Grande).

Madeira is +/- 30 My old and created by submarine eruptions with subsequent vulcanic activities. The climate is quite homogenous, so the daily amplitude of temperature reaches 5° C and the annual variation is of 6° C. Trade winds have a great influence on precipitations, mainly on the northern slopes of the higher mountains where 3.000 mm can be reached.

A considerable part of Madeira was covered by an endemic evergreen forest called 'laurisilva', but nowadays this forest type is restricted to some deep valleys of the northern side of the island (SANTOS, 1990).

The archipelago of the Azores is composed of 9 inhabited islands (from E to W): Santa Maria, São Miguel, Terceira, Graciosa, São Jorge, Pico, Faial, Flores and Corvo. All islands together build a surface of 2.333 km^2 with 250.000 inhabitants. The Azores are younger than Madeira (7-1 My) and recent vulcanic eruptions have been observed, so in 1957/58 on Faial (MITCHELL-THOMÉ, 1976). The highest mountain is Pico do Pico with 2.351 m. The climate is similar to the situation on Madeira, but lightly colder and only the months of July and August can be considered as 'dry'. The natural vegetation of all islands was a special evergreen forest type. Today, there are only a few relictual forests left, mainly on Corvo, Flores, Faial, São Jorge and São Miguel. Many of the endemic lepidoptera are strictly linked to these vegetation types and therefore sensible to human influence.

MACROLEPIDOPTERA FROM NORTHERN MACARONESIA

TABLE 1 - Number of Macrolepidoptera species recorded from the Madeiran and Azorean Archipelagoes with indication of their origin (incl. migrants and erratic species).

Family	Madeira n sp	Azores n sp	Total n sp	% end.	Faunistical element (sensu De Lattin, 1967) mc	pa	ho	ne	pt	co
Pieridae	4	2	4	25%		1	3			
Lycaenidae	2	1	2	50%		1	1			
Danaidae	2	1	2	0%				1	1	
Satyrinae	4	3	7	71%		5	2			
Nymphalinae	6	4	6	17%	1	1	1	1	1	1
Geometridae *	21	9	25	88%	22	2	1	1		
Sphingidae *	5	4	5	20%	1	2			2	
Arctiidae	1	1	1	0%					1	
Noctuidae *	52	29	61	34%	21	33		1	5	1
Total	97	54	113	43%	52	44	2	4	9	3

* = provisional numbers
mc = macaronesian, pa = palearctic, ho = holarctic, ne = nearctic, pt = paleotropic, co = cosmopolitan

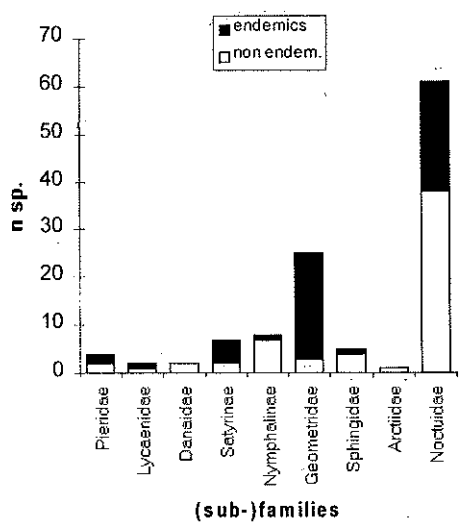

Figure1 - Species numbers and proportions of endemics for the (sub-)families of Macrolepidoptera in northern Macaronesia.

TABLE 2 - List of endemic Macrolepidoptera from northern Macaronesia

Geometridae

Xenochlorodes nubigena (WOLLASTON,1858)	mad
Xenochlorodes magna WOLFF, 1977	mad
Cyclophora puppillaria (HšBNER,[1799])	
ssp. *lilacinipes* (SCHAUS & COCKERELL, 1923)	mad
ssp. *granti* (PROUT, 1935)	azo
Cyclophora azorensis (PROUT, 1920)	azo
Cyclophora maderensis (BETHUNE-BAKER,1891)	mad
Scopula irrorata (BETHUNE-BAKER,1891)	mad
Idaea maderae (BETHUNE-BAKER,1891)	mad
Idaea atlantica (STAINTON,1859)	mad
Episauris kiliani REBEL,1898	mac
Xanthorhoe purpurariarum (REBEL,1917)	mac
Xanthorhoe rupicola (WOLLASTON, 1858)	mad
Xanthorhoe inaequata WARREN, 1905	azo
Gymnoscelis lundbladi PROUT,1939	mad
Gymnoscelis insulariata (STAINTON,1859)	mac
Gymnoscelis sp. (nec *rufifasciata* (HAWORTH, 1809)	azo
Eupithecia latipennata PROUT, 1914	mad
Eupithecia rosai PINKER	mac
Eupithecia atlanticata PINKER,1971	mad
Eupithecia ogilviata (WARREN, 1905)	azo
Herbulotina maderae PINKER,1971	mad
Menophra maderae BETHUNE-BAKER,1891	mad
Cleora fortunata BLACHIER,1887	mac
ssp. *azorica* PINKER, 1971	azo
ssp. *wollastoni* BETHUNE-BAKER,1891	mad

Noctuidae

Cryphia maderensis (BETHUNE-BAKER. 1891)	mad
Caradrina rebeli (STAUDINGER,1901)	mac
Paradrina clavipalpis (SCOPOLI,1763)	
ssp. *pinkeri* KOBES,1975	mad
Euplexia dubiosa (BETHUNE-BAKER,1891)	mad
Phlogophora wollastoni BETHUNE-BAKER,1891	mad
Phlogophora interrupta (WARREN, 1905)	azo

Phlogophora furnasi PINKER, 1971	azo
Phlogophora cabrali PINKER, 1971	azo
Mniotype albostigmata (BETHUNE-BAKER,1891)	mad
Mesapamea storai (REBEL, 1940)	azo
Mesapamea maderensis PINKER,1971	mad
Hecatera maderae (BETHUNE-BAKER,1891)	mad
Hadena atalantica (HAMPSON, 1903)	mad
[*Mamestra*(?) *freyi* REBEL, 1940	azo]
Graphania granti (WARREN, 1905)	azo
Mythimna serradaguae WOLFF, 1977	mad
Noctua atlantica (WARREN, 1905)	azo
Noctua carvalhoi (PINKER, 1983)	azo
Noctua teixeirai PINKER,1971	mad
Agrotis atrux PINKER,1971	mad
Agrotis trux (HÜBNER, 1824)	
ssp. *maderensis* PINKER,1971	mad
Agrotis rutae REBEL,1939	mad

Pieridae

Pieris brassicae (LINNAEUS,1758)	
ssp. *wollastoni* BUTLER,1886	mad
ssp. *azorensis* REBEL, 1917	azo
Gonepteryx maderensis FELDER,1862	mad

Lycaenidae

Lycaena phlaeas (LINNAEUS,1761)	
ssp. *phlaeoides* (STAUDINGER & REBEL,1901)	mad

Nymphalidae

Hipparchia occidentalis SOUSA, 1982	azo
Hipparchia azorina (STRECKER, 1899)	azo
Hipparchia miguelensis (LE CERF, 1935)	azo
Hipparchia maderensis (BETHUNE-BAKER,1891)	mad
Pararge xiphia (FABRICIUS,1775)	mad
Vanessa vulcania (LATREILLE & GODART, 1819)	mac

azo = azorean endemic, mad = madeiran endemic, mac = macaronesian endemic

CONCLUSIONS

It is strikening to note the different proportions of endemic forms between the families, like 17 % for the Noctuidae and 88 % for the Geometridae. It seems that families that contain species with high flight performances like Sphingidae and Noctuidae show a lower level of endemism and, reciprocally, a higher proportion of non differentiated continental elements.

Within the endemic taxa it is possible to select clusters of related species:

- for the Geometridae the Sterrhinae genera *Cyclophora, Scopula* and *Idaea*, the Larentiinae genera *Xanthorhoe*, *Gymnoscelis* and *Eupithecia*,
- for the Noctuidae the genera *Phlogophora, Noctua* and *Agrotis*,
- for the Nymphalidae the genus *Hipparchia*.

Such clusters are also known from other invertebrate groups, like molluscs and millipedes.

Most of the endemic forms are closely related to palearctic species but there are a few exceptions, like the *Phlogophora* species: both endemics, *P. interrupta* from the Azores and *P. wollastoni* from Madeira are closely related to nearctic species and so the first records of non-palearctic *Phlogophora* were published under the name of *P. periculosa* (a nearctic species), before the description of the names for the endemic taxa.

An interesting observation is that for certain endemics the variation in wing patterns is very high compared to related continental species. This may be due to the fact that the absence of closely related species concurrencing the same ecological niches, allows the recognition of partners for reproduction independently from the high intraspecific variation of wing colours and patterns.

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