# Biogeography and ecology of southern Portuguese butterflies and burnets (Lepidoptera)

*Thomas Schmitt*

## Abstract

During several visits to the western part of the Algarve (southern Portugal), the author mapped the butterflies and burnets of this region. In total, I observed 58 butterfly species (51 Papilionoidea, 7 Hesperiidae) and 6 Zygaenidae during my observations in spring and summer.

More than 80% of the species are Palaearctic faunal elements, three species are considered Holarctic, three are Nearctic and four are Palaeotropic. Around 75% of the Palaearctic species are Mediterranean faunal elements. Within the Palaearctic group, the 23 species belonging uniquely to the Atlanto-Mediterranean faunal type are by far the largest group. Siberian elements are lacking. Thus, the observed species composition is characteristic for the Atlanto-Mediterranean region.

Some of the observed species can be found all over the study area, often in a variety of habitats. Other species are more or less geographically restricted. Their regional distribution patterns depend on geomorphological and ecological constraints. Several species are restricted to the limestone areas, others are limited to the acid schist and granite areas. Several species were only observed in the western coastal dunes. Some species occur exclusively in the mountain areas. Some species were not recorded along the windy western and south-western coastal areas. Several species become rare or even disappear in suitable habitats that show little diversity of the vegetation. The occurrence of many species is directly linked to one or few distinct types of vegetation like cork oak forests, deciduous forests and natural hedges along water courses, *Cistus* macchias, garigues on limestone, dry grasslands or hot rocky places with little vegetation.

Key words: Algarve, Lepidoptera, Hesperiidae, Papilionidae, Pieridae, Lycaenidae, Nymphalidae, Zygaenidae, Atlanto-Mediterranean region, faunal elements, glacial refugia, climatic compensation.

## Introduction

For more than 100 years, the general inventory of species has been an important subject in biology. This is also true for butterflies as can be demonstrated by the work of Seitz (1909). More detailed publications on the regional distributions of butterflies in Europe combined with maps were mainly published in the last two decades of the 20th century (Bink 1992, Buszko 1997, Delmas & Maechler 1999, Ebert & Rennwald 1991, Emmet & Heath 1990, Fernández-Rubio 1991a, b, Goffart & de Bast 2000, Gonseth 1987, Henriksen & Kreutzer 1982, Huemer & Tarmann 1993, Jacsić 1988, Pamperis 1997, Schaider & Jacsić 1989).

Nevertheless, the knowledge of the distribution of butterflies is unequally distributed over Europe: While the data basis in the northern part of Europe with comparatively small species numbers is quite strong, the distribution patterns in the species rich south of Europe are scarcely known. This also applies for the Iberian Peninsula whose butterfly and burnet fauna is by far not exhaustively investigated (compare Fernández-Rubio 1990, 1991a, b).

For Iberia's most western part, Portugal, the actual knowledge about butterflies has been compiled recently (Maravalhas et al. 2003). Even so, there is no doubt that Portuguese butterflies are still not studied exhaustively. While several publications deal with the regions north of the Tejo (Carneiro-Mendes 1950, Montalvão et al. 1985, Silva Cruz 1967, Silva Cruz & Wattison 1929), large areas of the southern part are faunistically unexplored.

In the south of Portugal, the Algarve occupies an exceptional position: in this holiday region, some faunistical work has been done by Portuguese

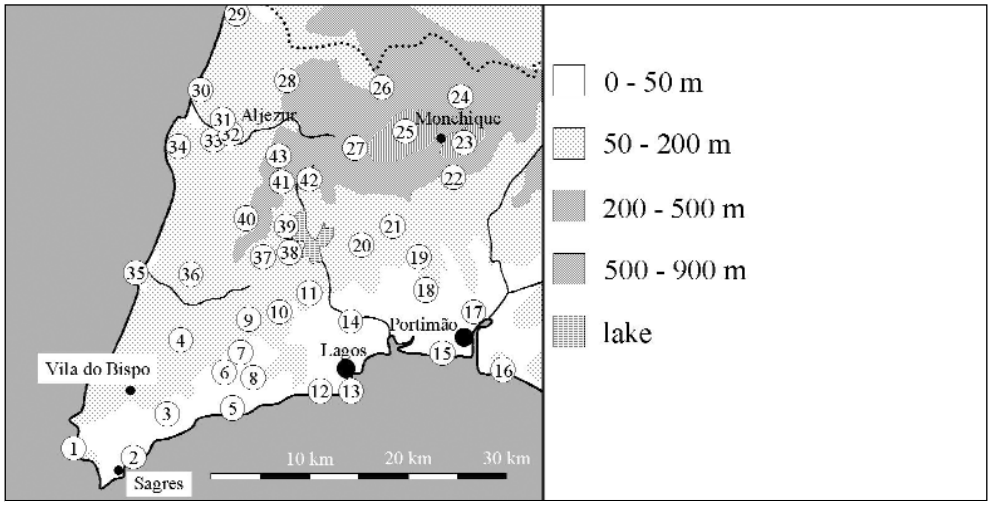


Figure 1
Map of the study area with indication of elevations (see legend). Study sites are numbered from 1 to 43. 1: Cabo de São Vicente, 2: Sagres, 3: between Raposeira and Hortas de Tabual, 4: Pedralva, 5: east of Salema, 6: south-west of Barão de São Miguel, 7: east of Barão de São Miguel, 8: Almádena, 9: Barão de São João, 10: Bensafrim, 11: Colinas Verdes, 12: Porto de Mós, 13: Ponte da Piedade, 14: Odiaxere, 15: Praia do Vau, 16: Ferragudo, 17: around 3 km north of Portimão, 18: Torre, 19: north of Alcalá, 20: Pereira, 21: Montes de Cima, 22: south of Caldas de Monchique, 23: Picota, 24: around 5 km north of Monchique, 25: Foia, 26: Foz do Farelo, 27: Marmelete, 28: Moinhos do Sogro, 29: Odeceixe, 30: Praia das Amoreiras, 31: north of Aljezur, 32: west of Aljezur, 33: castle of Aljezur, 34: Monte Clerigo, 35: Carrapateira, 36: around 2 km east of Bordeira, 37: Pincho, 38: western bank of Barragem da Bravura, 39: Corsino, 40: Peso, 41: Três Figos, 42: Romeiras, 43: Mosqueiro.

and foreign scientists (Corley et al. 2000, Passos de Carvalho & Corley 1995, Teodoro Monteiro 1969, Teodoro Monteiro & Passos de Carvalho 1984). Yet the distribution patterns are still incompletely known for many species in the Algarve. Especially the interactions between distribution, natural preconditions and human impact as well as the ecology and biogeography of species have hardly been investigated.
Therefore, I intensively studied the meso-scale distribution of the butterflies and burnets in the western part of the Algarve. Based on these data, I give an overview of their biogeographic status in the first part of this article. In a second part, I relate the obtained regional distribution patterns to the physico-geographical preconditions (such as geology, soils, relief), the intensity and way of land use as well as to the observed ecological demands of the different species.

## Material and methods

During several stays in the western part of the Algarve, I made excursions to 43 different places (fig. 1); most of these places were visited at least twice. The excursions were made from March to May and from July to September from 1986 to 2000 with increasing intensity. However, the studies were more intensive in spring than in summer. During the excursions, I took note of all butterfly and burnet species, their estimated number of individuals, their habitats and their behaviour. For some species, I searched also for their pre-imaginal stages.
Based on the results of these excursions, I generated preliminary distribution maps for the observed species.
The nomenclature is according to Karsholt & Razowski (1996).

### *Description of the studied area*

The western part of the Algarve has a striking

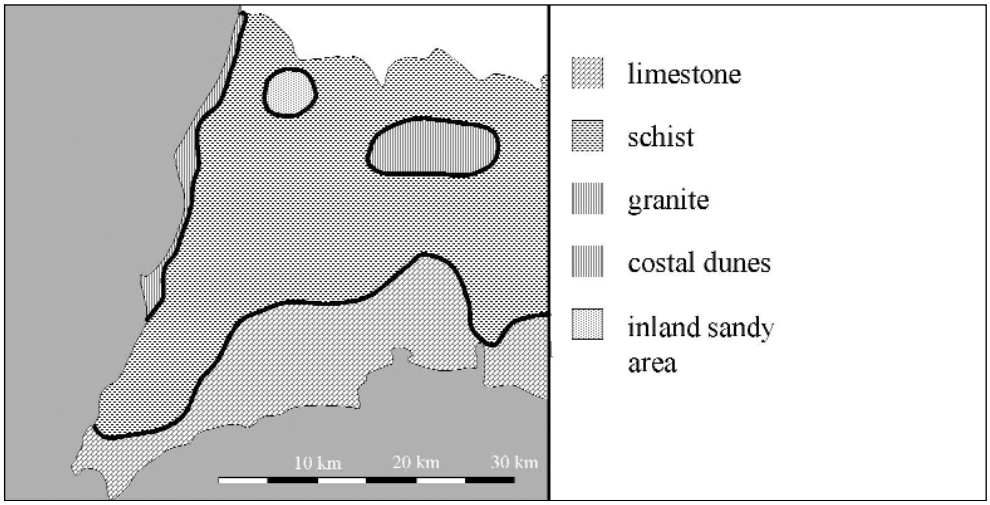


Figure 2
Geology of the study area.

geomorphological (fig. 1, 2) and ecological diversity. Along the southern coast, we find a plain or slightly hilly limestone area with basic soils. Large parts of this area are covered with fig tree and almond plantations. Especially along the coastline, the pressure of urbanisation is constantly increasing. However, also areas with garigue and macchia vegetation exist (often with *Quercus coccifera*, *Cistus albidus*, *C. monspeliensis*, *Thymus* species, several *Ophrys* species and other orchids). An extended hilly area of schist with rather acid soils flanks the limestone area in the north. In its southern part, we find mostly degraded macchias (composed of *Cistus ladanifer*, *Lavandula stoechas*) and dry pastures and grasslands. Further north, the hilly character of the landscape is more pronounced, and we find more species rich macchias (often with *Cistus crispus*, *C. ladanifer*, *C. salvifolius*, *Lavandula stoechas*), cork oak forests (often with *Arbutus unedo*, *Erica arborea*), hedge complexes along river courses (composed of *Rubus fruticosus* agg., *Salix* species) and small pastured patches. All over this schist area, more and more places are forested with *Eucalyptus* trees. Between the limestone and the schist areas, we find a narrow stripe of sandstone (rarely more than 500 m width). A large granite block tops the northern part of the schist area and reaches 900 m above sea level at the Foia mountain. This area is covered by cork oak and *Eucalyptus* forests, *Cistus* garigues and macchias as well as pastures. In the granite area, the plant species composition of the different habitats is similar to the schist area. A narrow strip of coastal dunes with their typical vegetation (often with *Halimium halimifolium*, *Corema alba*, *Thymus camphoratus*, *Armeria* species) extends along the western coastline. In the north-western part of the study area, we find a larger area with sandy soils covered by dry grasslands, some monocultural forests, species poor *Cistus* macchias and garigues.

## Results

### *Faunal elements*

I found a total number of 58 butterfly species (51 Papilionoidea and 7 Hesperiidae) and 6 Zygaenidae. The total list of recorded species is given in table 1. Using the classification of Varga (1977; modified for *I. feisthamelii*), the Papilionoidea are grouped into the following faunal element types:

I) Holarctic or Palaeartic (14 species)
   I.1) Holartic polycentric (3 species: *Celastrina argiolus*, *Lycaena phlaeas*, *Papilio machaon*)

Figure 3
*Euphydryas aurinia beckeri*. Photo Thomas Schmitt.

- I.2) Holopalaearctic polycentric (10 species: *Callophrys rubi*, *Coenonympha pamphilus*, *Euphydryas aurinia*, *Gonepteryx rhamni*, *Melitaea phoebe*, *Pieris brassicae*, *P. rapae*, *Polyommatus icarus*, *P. semiargus*, *Pontia daplidice*)
- I.3) Holomediterranean-Holarctic (1 species: *Euchloe crameri*)

II) Western Palaearctic (30 species)
- II.1) Holomediterranean-Turkestanic (2 species: *Nymphalis polychloros*, *Pararge aegeria*)
- II.2) Holomediterranean-Iranic (6 species: *Argynnis pandora*, *Lasiommata megera*, *Maniola jurtina*, *Polyommatus bellargus*, *Satyrium spini*, *Vanessa atalanta*)
- II.3) Mediterranean (22 species)
  - II.3.a) Holomediterranean s.str. (4 species: *Gonepteryx cleopatra*, *Hipparchia statilinus*, *Leptotes pirithous*, *Pyronia cecilia*)
  - II.3.b) Northern Mediterranean (2 species: *Leptidea sinapis*, *Pyronia tithonus*)
  - II.3.c) Atlanto-Mediterranean (16 species: *Aricia cramera*, *Coenonympha dorus*, *Cupido lorquinii*, *Euchloe belemia*, *Euphydryas desfontainii*, *Glaucopsyche melanops*, *Hipparchia fidia*, *Iphiclides feisthamelii*, *Melanargia ines*, *M. occitanica*, *Melitaea aetherie*, *M. deione*, *Pyronia bathseba*, *Satyrium esculi*, *Tomares ballus*)

III) Palaeotropic (4 species: *Charaxes jasius*, *Colias crocea*, *Lampides boeticus*, *Zizeeria knysna*)

IV) Nearctic (3 species: *Danaus plexippus*, *Vanessa cardui*, *V. virginiensis*)

Siberian and other eastern Palaearctic faunal elements were lacking.

After the classification of Naumann et al. (1984), all five *Zygaena* species belong to the Atlanto-Mediterranean faunal element (*Zygaena fausta*, *Z. lavandulae*, *Z. rhadamantus*, *Z. sarpedon*, *Z. trifolii*). According to its distribution (Naumann et al. 1999), *Aglaope infausta* has also to be considered an Atlanto-Mediterranean faunal element. For the Hesperiidae, a classification is not available for all species. Using the work of de Lattin (1957) on the Lepidoptera of the Palatinate, one of the species is of the Atlanto-Mediterranean faunal type (*Spialia sertorius*) and four of the Holomediterranean faunal type (*Carcharodus alceae*, *Thymelicus acteon*, *T. lineolus*, *T. sylvestris*). The distribution patterns of *Gegenes nos-*

Table 1
List of butterfly and burnet species found in the western Algarve during the study. The species are listed according to their phylogenetic classification.

Zygaenidae
*Aglaope infausta* (Linnaeus, 1767)
*Zygaena sarpedon* (Hübner, 1790)
*Zygaena fausta* (Linnaeus, 1767)
*Zygaena rhadamantus* (Esper, 1793)
*Zygaena lavandulae* (Esper, 1783)
*Zygaena trifolii* (Esper, 1783)

Hesperiidae
*Carcharodus alceae* (Esper, 1780)
*Spialia sertorius* (Hoffmannsegg, 1804)
*Muschampia proto* (Ochsenheimer, 1808)
*Thymelicus lineola* (Ochsenheimer, 1808)
*Thymelicus sylvestris* (Poda, 1761)
*Thymelicus acteon* (Rottemburg, 1775)
*Gegenes nostrodamus* (Fabricius, 1793)

Papilionidae
*Zerynthia rumina* (Linnaeus, 1758)
*Iphiclides feisthamelii* (Duponchel, 1832)
*Papilio machaon* (Linnaeus, 1758)

Pieridae
*Leptidea sinapis* (Linnaeus, 1758)
*Pieris brassicae* (Linnaeus, 1758)
*Pieris rapae* (Linnaeus, 1758)
*Pontia daplidice* (Linnaeus, 1758)
*Euchloe crameri* (Butler, 1869)
*Euchloe belemia* (Esper, 1800)
*Colias crocea* (Fourcroy, 1785)
*Gonepteryx cleopatra* (Linnaeus, 1767)
*Gonepteryx rhamni* (Linnaeus, 1758)

Lycaenidae
*Lycaena phlaeas* (Linnaeus, 1761)
*Tomares ballus* (Fabricius, 1787)
*Callophrys rubi* (Linnaeus, 1758)
*Satyrium esculi* (Hübner, 1804)
*Satyrium spini* ([Denis & Schiffermüller], 1775)
*Lampides boeticus* (Linnaeus, 1767)
*Leptotes pirithous* (Linnaeus, 1767)
*Zizeeria knysna* (Trimen, 1862)
*Cupido lorquinii* (Herrich-Schäffer, 1847)
*Celastrina argiolus* (Linnaeus, 1758)
*Glaucopsyche melanops* (Boisduval, 1828)
*Aricia cramera* (Eschscholtz, 1821)
*Polyommatus semiargus* (Rottemburg, 1775)
*Polyommatus icarus* (Rottemburg, 1775)
*Polyommatus bellargus* (Rottemburg, 1775)

Nymphalidae
*Argynnis pandora* ([Denis & Schiffermüller], 1775)
*Vanessa atalanta* (Linnaeus, 1758)
*Vanessa cardui* (Linnaeus, 1758)
*Vanessa virginiensis* (Drury, 1773)
*Nymphalis polychloros* (Linnaeus, 1758)
*Euphydryas aurinia* (Rottemburg, 1775)
*Euphydryas desfontainii* (Godart, 1819)
*Melitaea phoebe* ([Denis & Schiffermüller], 1775)
*Melitaea aetherie* (Hübner, 1826)
*Melitaea deione* (Geyer, 1832)
*Charaxes jasius* (Linnaeus, 1767)
*Pararge aegeria* (Linnaeus, 1758)
*Lasiommata megera* (Linnaeus, 1758)
*Coenonympha dorus* (Esper, 1782)
*Coenonympha pamphilus* (Linnaeus, 1758)
*Pyronia tithonus* (Linnaeus, 1771)
*Pyronia cecilia* (Vallantin, 1894)
*Pyronia bathseba* (Fabricius, 1793)
*Maniola jurtina* (Linnaeus, 1758)
*Melanargia occitanica* (Esper, 1793)
*Melanargia ines* (Hoffmannsegg, 1804)
*Hipparchia statilinus* (Hufnagel, 1766)
*Hipparchia fidia* (Linnaeus, 1767)
*Danaus plexippus* (Linnaeus, 1758)

*trodamus* and *Muschampia proto* make the Holomediterranean type of dispersal likely for these two species.

***Regional distribution patterns***

Several geomorphological and ecological constraints influence the regional geographic distribution of the butterfly and burnet species in the western part of the Algarve. In the following, I give examples for geology, altitude, wind exposure, diversity and type of vegetation.

Geology: Several species were mostly restricted to the limestone areas (*Aglaope infausta*, *Satyrium esculi*, *S. spini*, *Zygaena fausta*, *Z. sarpedon*). Other species were only found in the granite and schist areas (*Callophys rubi*, *Charaxes jasius*, *Gonepteryx rhamni*, *Hipparchia fidia*, *H. statilinus*, *Leptidea sinapis*, *Nymphalis polychloros*, *Polyommatus bellargus*, *Pyronia tithonus*, *Zerynthia rumina*).

Altitude: Some species apparently are restricted to the mountain range of the Serra de Monchique and their foothills (*Gonepteryx rhamni*, *Hipparchia statilinus*, *Leptidea sinapis*, *Nymphalis polychloros*, *Pyronia tithonus*).

Wind exposure: A number of species were not

Figure 4
*Polyommatus bellargus*. Photo Thomas Schmitt.

found in the windy area along the western coastline and the south-western tip of the Algarve (*Aricia cramera*, *Celastrina argiolus*, *Euphydryas aurinia*, *Gonepteryx cleopatra*, *Leptotes pirithous*, *Muschampia proto*, *Pararge aegeria*, *Polyommatus bellargus*, *Satyrium esculi*, *Thymelicus acteon*, *T. sylvestris*).

Diversity of vegetation: The southern parts of the schist area have a high proportion of macchias that are poor in plant species diversity and *Eucalyptus* monocultures. These habitats are relatively poor in butterfly and burnet species. Species often missing in these habitats (although being generally widely distributed) are: *Charaxes jasius*, *Gonepteryx cleopatra*, *Iphiclides feisthamelii*, *Muschapia proto*, *Papilio machaon.*

Type of vegetation: The existence of many butterfly and burnet species is more or less linked to the existence of one or a few vegetation types such as deciduous and cork oak forests (*Charaxes jasius*, *Gonepteryx rhamni*, *Nymphalis polychloros*), natural hedges (especially *Rubus*) (*Celastrina argiolus*, *Euphydryas aurinia*, *Pyronia tithonus*), *Cistus* macchias (*Leptidea sinapis*, *Thymelicus sylvestris*, *Zerynthia rumina*), garigues and macchias on limestone (*Satyrium esculi*, *S. spini*, *Zygaena fausta Z. sarpedon*), dune vegetation (*Melitaea phoebe*, *Polyommatus semiargus*, *Zygaena lavandulae*, *Z. rhadamantus*), dry grassland (*Carcharodus alceae*, *Coenonympha pamphilus*, *Colias crocea*, *Muschampia proto*, *Polyommatus bellargus*, *Pyronia cecilia*), wet grassland (*Euphydryas desfontainii*) or rocky places with little vegetation (*Hipparchia fidia*, *H. statilinus*, *Lasiommata megera*, *Lycaena phlaeas*).

Some highly opportunistic and/or migrating species were found nearly at all study sites (*Colias crocea*, *Euchloe belemia*, *E. crameri*, *Lampides boeticus*, *Lasiommata megera*, *Lycaena phlaeas*, *Maniola jurtina*, *Melanargia ines*, *Pieris rapae*, *Polyommatus icarus*, *Pyronia bathseba*). For opportunistic and/or migrating species, which occur at comparatively low densities in the study region, I obtained seemingly confusing distribution patterns (*Carcharodus alceae*, *Coenonympha pamphilus*, *Papilio machaon*, *Pieris brassicae*, *Pontia daplidice*, *Vanessa atalanta*, *V. cardui*). Other species were found so rarely that their distribution patterns are still poorly understood (*Argynnis pandora*, *Coenonympha dorus*, *Cupido lorquinii*, *Gegenes nostrodamus*, *Glaucopsyche melanops*, *Melanargia occitanica*, *Melitaea aetherie*, *M. deione*, *Thymelicus lineola*, *Tomares ballus*, *Vanessa virginiensis*, *Zizeeria knysna*, *Zygaena trifolii*).

## Discussion

***What are the origins of the southern Portuguese butterflies and burnets?***

The butterfly and burnet species observed in the study region resemble a typical Atlanto-Mediterranean fauna. Thus, 23 of the 64 butterfly and burnet species (35.9%) belong to the Atlanto-Mediterranean faunal element which had its single centre of dispersal in the Iberian Peninsula. It is very likely for these species that they occurred in the study region also during the last glaciation.

Several dispersal centres in the Mediterranean region are suggested for 20 species (31.3%) which belong to the western Palaearctic-Mediterranean element (s.l.). Like the Atlanto-

Mediterranean species, the majority of these Mediterranean species (s.l.) is widely distributed in Spain (Fernández-Rubio 1991a, b) and Portugal (Maravalhas et al. 2003). Therefore, it is also likely that they existed in the Atlanto-Mediterranean core area and occurred in the study region during the last glaciation. This suggestion is supported by genetic studies of *Maniola jurtina* and *Polyommatus bellargus* (Schmitt & Seitz 2001).

Also in the group of polycentric species of the Holopalaearctic, Holomediterranean-Palaeartic and Holarctic faunal type (14 species, 21.9%), many representatives (if not all of them) probably were distributed in the Iberian Peninsula during the last glaciation as has been proved for *Euphydryas aurinia* (Joyce & Pullin 2001) and *Polyommatus icarus* (Schmitt & Seitz 2001) by genetic studies (for a review of these studies see Schmitt 2003a)

Thus, up to 89.1% of the butterfly and burnet species have persisted in the study region for at least 100 000 years. Maybe this percentage is even higher because the four species classified by Varga (1977) as Palaeotropical faunal elements and *Vanessa cardui* classified as a Nearctic element might have immigrated into Europe prior to the last glaciation. If so, they might have had expansion centres in the Atlanto-Mediterranean region too.

Therefore, postglacial immigration to the study region is only sure for two of the observed butterfly species: *Vanessa virginiensis* and *Danaus plexippus*. While *V. virginiensis* seems to have become established in Portugal during the last century (for an overview see Schmitt 2003b), *D. plexippus* is still a rare migrant along the western European coasts (Emmet & Heath 1990, Fernández-Rubio 1991b, Tolman & Lewington 1998).

A characteristic feature of the studied Lepidoptera fauna is the complete lack of Siberian or other eastern Palaearctic faunal elements. As shown by de Lattin (1967), these species are mostly absent from the Iberian Peninsula and most of the Mediterranean region. Only few species out of this group were able to colonise the northern most regions of Spain (Fernández-Rubio 1991a, b).

***Habitat preferences and climatic compensation***

For many species, their preferred habitat type in the western Algarve is quite similar to their ecological demands observed elsewhere in Europe (Asher et al. 2001, Bink 1992, Ebert & Rennwald 1991, Hofmann 1994, Maravalhas et al. 2003, Naumann et al. 1999, Settele et al. 1999, Tolman & Lewington 1998, Weidemann 1986, 1988). Only some species differ remarkably from their habitat demands in Central Europe. For instance, *Euphydryas aurinia* (flying in the Algarve exclusively with its subspecies *beckeri*) occurs in the western Algarve preferably along the edges of small watercourses and on small pastures along these watercourses. In the northern parts of Europe, this species occurs at swampy or even semidry meadows (Asher et al. 2001, Emmet & Heath 1990, Ebert & Rennwald 1991). *Thymelicus sylvestris*, which is most characteristic of macchias in the western Algarve, has to be considered a species of meadows more in the north of Europe. *Polyommatus semiargus*, which is restricted to some humid places in the dunes near Aljezur, is a species of meadows in Central Europe, and *Melitaea phoebe* is restricted to the warmest semidry meadows in Central Europe (Ebert & Rennwald 1991).

These ecological differences seem to be a strategy to compensate for the rather different climatic regimes over a large area of distribution. So the species prefer warm, sunny and dry habitats in the cooler north and cooler and wetter, shady habitats in the south (Erhardt & Thomas 1991).

The absence of several species in the lowland region of the western Algarve might indicate climatic compensation too, especially because several of these species (*Gonepteryx rhamni*, *Pyronia tithonus*, *Nymphalis polychloros*) prefer woody habitats in Central Europe (Asher et al. 2001, Ebert & Rennwald 1991, Emmet & Heath 1990). Such species have no other possibility than to climb up mountains for climatic compensation, a general feature observed in southern Europe (Tolman & Lewington 1998, Zahm 1999).

In the western Algarve, the preference of geological structures deviates from the findings elsewhere for some species. Thus, *P. bellargus*, in the western Algarve found only in habitats with acid soils, clearly prefers limestone regions further

north (Bink 1992, Ebert & Rennwald 1991, Emmet & Heath 1990). Furthermore, the great majority of species (if not all), restricted in the western Algarve to the schist and granite areas, can also be found in other regions in limestone areas (Asher et al. 2001, Bink 1992, Ebert & Rennwald 1991, Emmet & Heath 1990, Settele et al. 1999, Weidemann 1986, 1988). While limestone regions and especially south facing slopes within these regions are often remarkably warm, the restriction to non-limestone regions of the western Algarve might also be a strategy for climatic compensation.

***Ecological demands and distribution patterns***

As shown above, many of the ecological constraints seem to be responses to the necessity of climatic compensation, making climate a predominant factor in the shaping of regional distribution patterns. Apparently, some distribution constraints are not dependent on climate itself.

Thus, species occurring in forests or in habitats with hedges are missing or much less abundant along the western coast and in the south-western tip of the Algarve. These regions, strongly exposed to the wind, only have few wind-protected places, thus not offering suitable conditions for the existence of this ecological group of butterflies.

Human land-use locally reduced the diversity in plant species by exhaustive agriculture and the plantation of monocultural forests (especially of *Eucalyptus* trees). While lepidopteran diversity is linked with plant diversity (Steffan-Dewenter & Tscharntke 2000), this human impact also caused local reductions in butterfly and burnet species numbers.

## Concluding remarks

Summing up, the distribution patterns revealed for the western part of the Algarve seem to be shaped by the ecological demands of the respective species. Thus, the distribution patterns of the different habitat types are of enormous importance for the local distribution of the butterfly and burnet species. While these habitat types directly depend on natural preconditions (geology, soils, altitude, wind exposure) and human activities (intensity and type of land use), the study of these constraints is of great importance for an understanding of the meso-scale distribution patterns.

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T. Schmitt,
Institut für Biogeographie
Fachbereich VI
Wissenschaftspark Trier-Petrisberg
Gebäude 24
Universität Trier
D-54286 Trier
Germany
thsh@uni-trier.de