

# Two *Polyommatus (Agrodiaetus)* species new to Bulgaria, with notes on the related Bulgarian taxa (Lepidoptera : Lycaenidae)

Zdravko Kolev

**Abstract.** *Polyommatus aroaniensis* (Brown, 1976) and *P. nephohiptamenos* (Brown & Coutsis, 1978) are reported in sympatry from SW Bulgaria (Mt. Alibotush, 1600 m); their identification, phylogeny, aspects of ecology and conservation status are discussed. The previous Bulgarian record of *nephohiptamenos* from Mt. Rhodopi is shown to be based on misidentification. The number of reliably recorded Bulgarian Lycaenidae thus reaches 57 species. A key to males of the four Bulgarian taxa belonging to the monomorphic *Agrodiaetus* complex is provided.

**Samenvatting.** Twee *Polyommatus (Agrodiaetus)*-soorten nieuw voor Bulgarije, met bemerkingen over verwante Bulgaarse taxa (Lepidoptera : Lycaenidae)  
Het sympatisch voorkomen van *Polyommatus aroaniensis* (Brown, 1976) en *P. nephohiptamenos* (Brown & Coutsis, 1978) in Zuidwest-Bulgarije (Mt. Alibotush, 1600 m) wordt vermeld. Een vroegere vermelding van *P. nephohiptamenos* uit de Rhodopen, gebaseerd op een foutieve determinatie, wordt besproken. De Bulgaarse Lycaenidae fauna telt nu 57 soorten. Een sleutel voor de mannetjes van de bruine, monomorfe *Agrodiaetus*-soorten in Bulgarije wordt gegeven en hun voorkomen wordt besproken.

**Résumé.** Deux nouvelles espèces de *Polyommatus (Agrodiaetus)* pour la Bulgarie, avec des considérations sur les espèces bulgares apparentées (Lepidoptera : Lycaenidae). La présence sympatrique de *Polyommatus aroaniensis* (Brown, 1976) et *P. nephohiptamenos* (Brown & Coutsis, 1978) en Bulgarie du sud-ouest (Mont Alibotush, 1600 m) est rapportée. La mention antérieure de *P. nephohiptamenos* des Monts Rhodopes, basée sur une détermination erronée, est discutée. La faune des Lycaenidae de Bulgarie mentionnés avec certitude s'élève à présent à 57 espèces. Une clef de détermination des mâles des espèces monomorphiques brunes d'*Agrodiaetus* en Bulgarie est présentée et leur présence est discutée.

**Key words:** *Polyommatus - Agrodiaetus - aroaniensis - nephohiptamenos - Mt. Alibotush - Bulgaria - ecology - sympatry - identification - phylogeny - conservation.*

Kolev, Z.: Street Zornitsa 8/A ap.7, BG-4700 Smolyan, Bulgaria.

## Introduction

On 11.VII.1993, during a collecting trip to Mt. Alibotush (Slavyanka) in SW Bulgaria, seven brown *Polyommatus (Agrodiaetus)* specimens were collected at 1500-1600 m. Examination of this material revealed that 5 males and 1 female belong to *Polyommatus nephohiptamenos* (Brown & Coutsis, 1978); the remaining specimen, a male at first inadvertently taken for *P. ripartii* (Freyer, 1830), was found afterwards to belong to *P. aroaniensis* (Brown, 1976).

Sympatric occurrence of *nephohiptamenos* and *aroaniensis*, species with rather different ecological preferences and distribution patterns, has not been

established before. With the first Bulgarian record of *nephohiptamenos* disproved and with the two current additions, as many as 57 Lycaenid species are known from Bulgaria at present. Four of these, including *P. admetus* (Esper, [1783]), are members of the monomorphic complex.

Abbreviations used in the text: upfw = upperside of forewing; uphw = upperside of hindwing; ups = upperside of both wings; unhw = underside of hindwing; uns = underside of both wings; n = haploid chromosome number.

Lorković in Kudrna (1990: 378-379) suggests that the previously separate genera *Agrodiaetus*, *Plebicula* and *Lysandra*, reduced now to subgenera of *Polyommatus*, should form a separate genus (*Agrodiaetus*) due to the possession of common genetic mechanisms responsible for the shared extreme deviations (n = 8-10 to n = 223) from the modal chromosome number of the Lycaenidae (n = 24) which occur among them. Such variations are rarely encountered in the rest of the family. Whilst this combination is well motivated and is accepted here, *Agrodiaetus* is preferably retained at subgeneric level within *Polyommatus*. The monophyletic assemblage of monomorphic (brown) taxa of *Agrodiaetus* will be here referred to as a complex and not as a group, the reason being that it is not homogeneous from karyological point of view and, within it, smaller species groups can be distinguished.

#### *Polyommatus (Agrodiaetus) nephohiptamenos* (Brown & Coutsis, 1978)

**General remarks.** This outstanding relict with the lowest chromosome number in the whole complex (n = 8-10) was described from NE Greece and was known only from the "barren scree slopes above the tree line at 1600-2000 m" of the *locus typicus*: a "higher peak of the Rhodope system [Mt. Pangeon]" (Brown & Coutsis 1978: 210). In Bulgaria it was reported once from Mt. Rhodopi at 1000-1400 m (Ganev 1984) and on this basis was later mentioned by the same author (Ganev 1985a: 116, 1985b: 117). However, as no specific characters supporting his identification were stated, this record has ever since remained controversial. Not surprisingly, a recent examination of Ganev's "*Agrodiaetus nephohiptamenos*" material from Mt. Rhodopi (mine Persenk; Hálpatch) proved that this belongs to *ripartii* instead. Anyhow, even though Rhodopian captures have so far revealed the presence of *ripartii* only, *nephohiptamenos* is almost certainly found in suitable habitats there. A probable locality (unpubl. data) is a sloping meadow surrounded by mixed birch, beech and spruce forest at ca. 1600 m, near Shiroka Láka village. At the end of July of 1991, on a cool, wet and misty day, a few striped brown specimens flying low above the grass were observed there - the only butterflies to be seen on wing. One male was collected but superficially considered *ripartii* and, unfortunately, not preserved. This behaviour, however, is suggestive of *nephohiptamenos* rather than of the heliothermophilous *ripartii*.

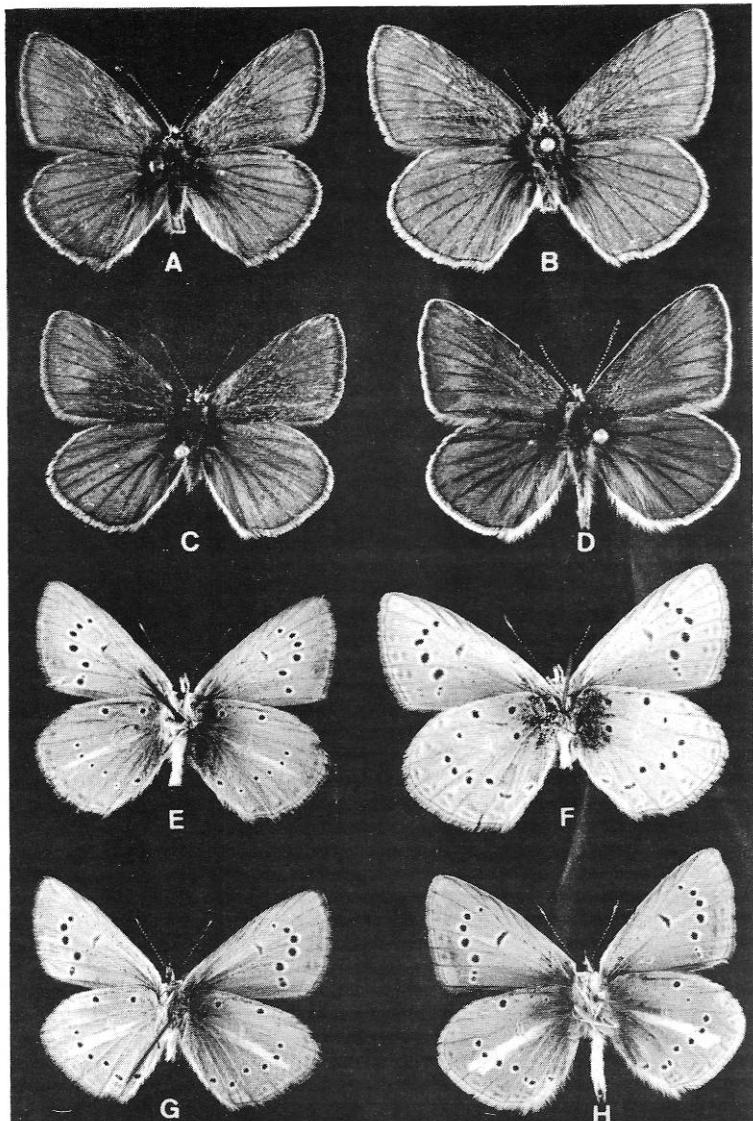


Fig.1. Uppersides (a-d) and undersides (e-f) of males of Bulgarian monomorphic *Polyommatus* (*Agrodiætus*) species, all leg. et coll. Z. Kolev. Data as in fig. 2. Enlarged x1.5. Photo: Reino Tyynelä (Zoological Museum of Helsinki, Finland).

a, e: *Polyommatus* (*Agrodiætus*) *aroaniensis* (Brown, 1976).

b, f: *Polyommatus* (*Agrodiætus*) *admetus* (Esper, [1783]).

c, g: *Polyommatus* (*Agrodiætus*) *ripartii* (Freyer, 1830).

d, h: *Polyommatus* (*Agrodiætus*) *nephohiptamenos* (Brown & Coutsis, 1978).

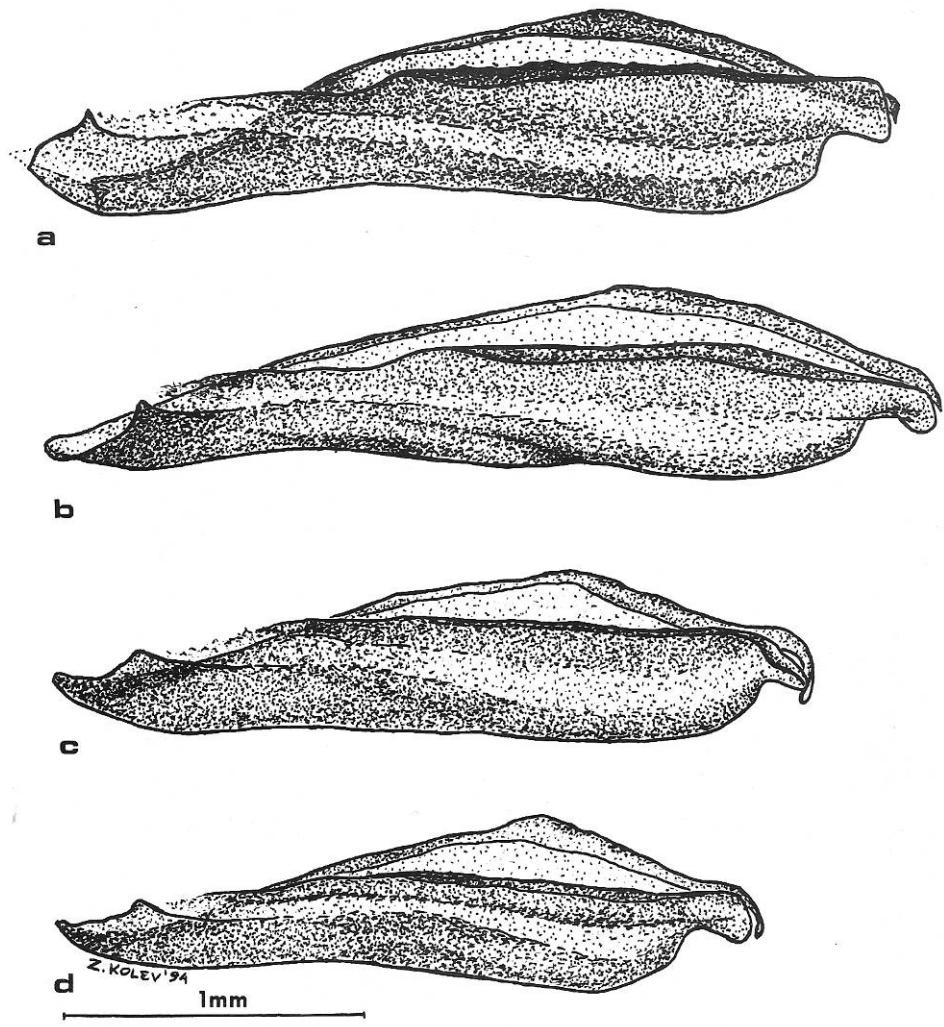


Fig. 2. Side view of inner surface of right valvae, setae omitted.

- a: *Polyommatus (Agrodietus) aroaniensis* (Brown, 1976): Mt. Alibotush, 1600 m, 11.VII.1993.
- b: *Polyommatus (Agrodietus) admetus* (Esper, [1783]): Mt. Rila, Dzherman river S. of Sapareva Banya town, 700 m, 29.VII.1990.
- c: *Polyommatus (Agrodietus) ripartii* (Freyer, 1830): Mt. Rhodopi, Asenova Krepost site, 300 m, 11.VII.1991.
- d: *Polyommatus (Agrodietus) nephohiptamenos* (Brown & Coutsis, 1978): Mt. Alibotush, 1500-1600 m, 11.VII.1993.

and agrees well with the observations on Mt. Pangeon (Brown & Coutsis 1978: 210). Besides, occurrence on Mt. Phalakron could also be expected as it occupies a somewhat intermediate position between Mt. Pangeon and Mt. Alibotush. The taxon *galloii* Balletto & Toso, 1979 from S Italy was tentatively ranked as a subspecies of *nephohiptamenos* by Higgins & Riley (1984), but does not classify well as such. They are undoubtedly distinct species with stable morphological and karyological differences, a view also expressed by Koçak (1983: 32) and Manino *et al.* (1987: 97).

**Bulgarian record.** Morphologically, the series from Mt. Alibotush is rather homogeneous. In all males collected, two outstanding features of *nephohiptamenos* can be observed - the small sex-brand on upfw and the white or, in one specimen, greyish distal half of cilia of uphw. The identity of the male with greyish cilia was also confirmed by its genitalia (Fig. 2d): *nephohiptamenos* has, on average, slightly shorter valvae with a more pronounced inferior curvature than *ripartii* (Fig. 2c) (Brown & Coutsis 1978: 207-210). All six specimens have remarkably strong yellowish and especially olivaceous reflections on ups (much stronger than and not reddish as in *ripartii* and *aroaniensis*); these are also well perceptible in Fig. 1d. However, a slight disagreement with the original diagnosis was noted in the single female obtained: the cilia are not "pale brown" (Brown & Coutsis 1978: 207) but pure white on uphw and only on upfw are they light brownish.

Most of the specimens from Mt. Alibotush, including a pair *in copula*, were taken at 1500 m in Hambar Dere valley, to the southwest of Paril village. The habitat there comprises patchy flowery glades with sparse shrubs of *Rosa spp.* and *Juniperus sp.* on stony ground, at the foot of steep scree slopes. A single male was found well up on one such slope at 1600 m together with the male *aroaniensis* (for habitat description see under the latter). This aggregation might well be explained by the fact that almost no flowering herbs were left on the dry and hot slope in contrast to the relatively humid glades (also providing some shade) immediately below, which is augmented by a peculiar feature of the mountain. As Mt. Alibotush is entirely calcareous, which otherwise has greatly contributed to its great faunal and, especially, floral diversity, in summer the higher habitats become entirely devoid of surface water and this may restrict *nephohiptamenos*, with its rather mesophilous preferences (see above), to such unusually low-lying biotopes, at least during the hot hours of the day.

#### *Polyommatus (Agrodiaetus) aroaniensis* (Brown, 1976)

**General remarks.** Described from S Greece: Mt. Chelmos (1200 m, "on mountain flowery slopes") as a subspecies of *alcestis* Zerny, 1932 (Brown 1976: 78-79), *aroaniensis* was soon afterwards raised to a good species (Brown & Coutsis 1978: 210). Its range comprises several Greek mountains

from Peloponnisos northwards to Drama [Mt. Phalakron] at 1200-1600 m (Brown 1977: 165); Mt. Alibotush in SW Bulgaria (see below) and probably also some southerly mountains of ex-Yugoslavian Macedonia. The locality near Drama is rather close to the Bulgarian one.

**Bulgarian record.** The single specimen from Alibotush is a typical representative of this species; it matches completely the original description (Brown 1976: 78-79) and especially the illustrations therein (Pl. 5, Figs. 7 & 8) in that it has a whitish vestigial streak on unhw, which is why it was taken for *ripartii* upon capture. However, this streak is, unlike in most *ripartii*, narrow and rather vaguely outlined (Fig. 1e), and is altogether absent in ca. 40% of the individuals (Brown 1976: 79). Such an "unstriped" male from N Greece (Mt. Triklario, 1400-1600 m) was sent recently to me by Mr J.G. Coutsis. A useful feature to distinguish between the two species is the ground colour of unhw that usually has a reddish tinge in *aroaniensis* (more of greyish in *ripartii*). Coutsis (1972: Pl. VIII, Fig. 7: b & c, recorded as *ripartii* in text and figure (Coutsis 1978: 139); 1983: Figs. 2, 3, 5 & 6) provides good illustrations of, correspondingly, male and female *aroaniensis*. Anyhow, on the one hand, some *ripartii* show a somewhat reduced streak and/or reddish unhw (sometimes even with very small postdiscal ocelli, typically a feature of *aroaniensis*) and, on the other, some *aroaniensis* may have, along with traces of a streak, greyish unhw. If distinction between striped *aroaniensis* and *ripartii* cannot be achieved on superficial clues, the male genitalia usually provide reliable evidence (preferably, dissection should be used whenever possible, even in 'doubtless' cases). The most conspicuous difference is that valvae are on average noticeably longer in *aroaniensis* (Brown 1976: 80), as can be seen also in Fig. 2a & c.

Together with all above mentioned external characters, the valvae of the Alibotush specimen (Fig. 2a) confirm the identification as *aroaniensis*. It was collected at 1600 m on a steep, southeast-facing calcareous slope with scree formations and sparse vegetation: *Pinus heldreichi* trees and grasses, the latter almost completely sun-dried. Only a few other Rhopalocera were present there, such as *Satyrus ferula* (Fabricius, 1793) and *Spialia phlomidis* (Herrich-Schäffer, [1845]) (Kolev, in print). The presence of only one individual in an unbiased sample of seven probably shows that there it is rarer than *nephohiptamenos*. Another possibility is that, though not reported from over 1600 m in Greece, on Alibotush *aroaniensis* may prefer barren places at a greater altitude as it seems able to tolerate more arid conditions than *nephohiptamenos* can. Unfortunately, during my trip further ascent was not possible.

#### Key to males of the brown *Agrodiætus* species in Bulgaria

Generally, the features in this key provide, when used together, reliable

identifications; sometimes, though, accurate results are difficult to achieve either due to certain intraspecific variability and interspecific character overlap or due to poor condition of specimens. Locality data, though likely to be of some help, should not be relied exclusively upon for sympatry is common (though not universal) between some of the species. The haploid chromosome numbers, within all probability, will not be of direct use in a key like this. However, as they constitute an important part of the specific character set for these taxa, they are added as well, following Brown (1976), Brown & Coutsis (1978), and de Lesse (1960).

A. Marginal area of uns with clear dark markings of varying intensity. Usually no white median streak on unhw (rarely, white patch may be present postdiscally; see also the end of this chapter). Cilia to uphw brownish, often slightly faded distally. Valvae long.

*P. admetus* (Esper, [1783]) : n = 78-80 (Figs 1b, 1f, 2b).

a. On uns, marginal dark markings absent or vestigial.

B. Distal half of cilia of uphw white or (rarely) slightly greyish, divided from brownish proximal half by pronounced border (best seen with magnifying glass on dark background). Ups greyish-brown. Sex-brand smooth, small, barely extends distally beyond end of cell. Prominent white median stripe on unhw invariably present. Valvae short, with pronounced inferior curvature.

*P. nephohiptamenos* (Brown & Coutsis, 1978) : n = 8-10 (Figs 1d, 1h, 2d).

b. Distal half of cilia of uphw greyish brown, not contrasting to or only slightly paler than proximal half. Ups reddish-brown. Sex-brand 'hairy', extensive, reaches distally quite beyond end of cell.

C. On unhw, prominent white median stripe usually present. Ground colour of unhw brownish-grey mostly without reddish tinge. Valvae short but slightly longer than in *nephohiptamenos* and with a weaker inferior curvature.

*P. ripartii* (Freyer, 1830) : n = 90 (Figs 1c, 1g, 2c).

c. On unhw, no or vestigial whitish streak. Unhw ground colour usually with reddish tinge and postdiscal ocelli extremely small. Valvae long as in *admetus*.

*P. aroaniensis* (Brown, 1976) : n = 15-16 (Figs 1a, 1e, 2a).

The *admetus* male figured here (Figs 1b & f) has both ups and uns very pale, the pale brownish-grey cilia of ups conspicuous and the marginal markings on uns less prominent than usually; this is an infrequent phenotype. A male *admetus* with prominently striped unhw, a very rare variant as well, was collected at Kalotina (NW Bulgaria) by De Lesse (1960: 243, Pl. 1: Fig. 1, c) together with a good number of typical specimens, all identified through chromosome counts.

Though, generally, female *admetus* are readily recognized by the heavy marginal markings on uns and unstriped female *aroaniensis* by the absence of any, it is not always possible to tell apart females of *ripartii* and *nephohiptamenos* (which both may have similarly coloured cilia and not too different brown tone on ups), or those of striped *aroaniensis* and *ripartii* with reduced stripe. Besides, so far no reliable differences have been tracked down in the female genitalia.

### Remarks on phylogeny

*Nephohiptamenos* and *aroaniensis* are placed in the *alcestis*-group, which is delimited on karyological grounds and includes also several W Asiatic species with n from 19 to 32 (see De Lesse 1960). This arrangement is also supported, from a zoogeographical point of view, by the current distribution of this group in a rather compact area: the S Balkans and the Near East (Turkey and Lebanon to Iran). This latter area seems to have been a major centre of speciation within the monomorphic complex and of the subgenus *Agrodiaetus* as a whole.

As to the evolution of the two Balkan species, there are two ways of reasoning. According to Brown & Coutsis (1978: 206), in groups like the ex-genera *Lysandra* and *Agrodiaetus* phylogenetically ancient species are indicated by low n. Therefore, it should be suggestive that these both have the lowest chromosome numbers within the *alcestis*-group and, consecutively, in the whole complex. A possible interpretation might be that it was in the Balkan Peninsula, known as a prominent refugium during the Glacials, where the splitting of taxa occurred in the first place, from a hypothetical ancestor supposedly closest to *nephohiptamenos* (as inferred from its lowest n).

A better motivated view, which at present predominates, states that the ancestor of a given group (genus, subgenus etc.) should have been closest to those species which have n nearest to the modal number of the family (Robinson 1971; Lorković in Kudrna 1990). Robinson's (1971: 560) general presentation of this standpoint seems to apply well in this particular case: "Over the vast number of generations which had elapsed, this [modal] number had been modified by random events within and between the chromosomes. With such a time scale, none of these events would be expected to be selectively neutral but a random component could operate in the sense that a reduction or increase in the number could be partly independent of the conferred selective advantage. This could explain the scatter both up and down the range". Then, as the modal number of Lycaenidae is n = 24, *P. (A.) mithridates* (Staudinger, 1879) from Central Turkey, with n = 21-27 (De Lesse 1960: 257-258) would be one of the most likely candidates for being closest to the ancestors of the complex. With regard to species with n less than the modal number (like the two discussed), Robinson continues (p. 560): "However, the change in number is not wholly independent from selective advantage. ... The tendency towards a numerical reduction is probably due to a general factor, such as progressive adaptation, which could remove the need for a high rate of genetic recombination". Lorković in Kudrna (1990: 365), discussing the *Erebia tyndarus* group, where a karyological situation is found very similar to that in the brown complex, also states that decrease of the chromosomes through their fusion "leads to a reduction of the genetic recombination in these species, or to a greater stability of the genome". He

suggests that in such species "an already achieved high adaptation to a definite environmental situation has been promoted, which during a high variability (high recombination rate) would soon be disadvantageous".

Clearly, *nephohiptamenos* is among the most stenobiotic species of the complex and its most reduced karyotype agrees very well with the inferred importance that this reduction has had for its habitat adaptation. Though thus deprived of its "key-role" in the phylogeny of the complex fixed by the first hypothesis, it is anyway a very ancient taxon, which is supported by its distribution being confined exclusively to a part, though a peripheral one, of the oldest dry land on the Balkans - the Rhodopian mountain system (see also Brown & Coutsis 1978: 206). On these grounds *nephohiptamenos* is here presumed an autochthonous element in the fauna of the Balkan Peninsula.

Within all probability, *aroaniensis* is an autochthon too, but of a more recent origin. It is obviously closer in appearance, karyotype and genitalia to *alcestis* Zerny, 1932 from Central Turkey with  $n = 19\text{--}22$  (De Lesse 1960: 251-252) than to *nephohiptamenos*, and its distribution pattern is rather similar to that of some endemic Greek taxa like *Colias aurorina heldreichi* Staudinger, 1862 and *Polyommatus (Agrodiaetus) iphigenia nonaciensis* (Brown, 1977), with similar subspecies in the Near East.

I shall abstain, however, from further guessing at their probable ages as there does not seem to be sufficient evidence for this, and shall content with the estimate of Kostrowicki (1969). In regard to the problems with fixing the age of the "purely west Asiatic" species (p. 264) where he places *admetus* and *ripartii* (and where, following his classification, also both *nephohiptamenos* and *aroaniensis* clearly belong), he points out that "the exclusively west Asiatic species ... may have existed in the Tertiary, but they could also have appeared in the Holocene. The separation of palaeo-endemic species from neo-endemic ones in this group is practically impossible", and finally states: "It seems most safe to place their origin in the Pleistocene" (Kostrowicki 1969: 271). Obviously, a much more advanced understanding of the genetical aspects of the evolution of this complex must be attained before more precise reconstruction of the phylogeny is possible.

#### Conservation status

The European members of the intricate monomorphic complex are distributed very locally throughout S Europe, with range sizes and abundances varying greatly. In Bulgaria, the commonest taxon, *ripartii*, is locally but widely distributed especially in southern regions from low mountain foothills up to 1400 m (Mt. Rhodopi). Often sympatric with the former, *admetus* is generally rarer though may be extremely abundant in suitable habitats - as in Mt. Rhodopi south of Asenovgrad town at 300-400 m and on arid south-facing slopes of Mt. Pirin east of Paril village at 900 m (unpubl. data). On Mt. Alibotush, its so far only locality in Bulgaria, *nephohiptamenos* was observed

to be not uncommon but restricted to a limited calcareous area at 1500-1600 m, though almost certainly attaining greater altitudes. So far, no conclusions about the abundance of Bulgarian *aroaniensis* can be made. Whatever the case, it may safely be taken that *aroaniensis* and especially *nephohiptamenos* are vulnerable in the sense that these are endemic relict species with restricted ranges and extremely localized populations. Among Bulgarian Rhopalocera, it is *nephohiptamenos* that has the most confined distribution along with *Pseudochazara orestes* De Prins & van der Poorten, 1981 (endemic to the same region of the Balkan Peninsula). Taking into account the great value of this complex as a whole and especially of remarkable taxa like *aroaniensis* and *nephohiptamenos*, for taxonomical, zoogeographical and evolutionary studies, it is strongly advisable that these two, or at least *nephohiptamenos*, are granted protected status in Bulgaria. With this regard it should be noted, however, that probably no immediate threat arising from human activities exists to their Alibotush populations as these are situated in the Slavyanka Biosphere Reserve and this, plus the immediate proximity to the Bulgarian-Greek border, maintains a negligible disturbance level of their habitat, the major source of human impact being probably herb-collecting in the summer. Nevertheless, future research on their distribution, habitat preferences and bionomics in Bulgaria is most welcome and actually necessary.

### Acknowledgments

My sincere thanks are due to Mr John G. Coutsis (Athens, Greece) for his comments on the identification of the Balkan monomorphic taxa and for providing comparative material of Greek *aroaniensis*, and to Mr Julius Ganey (Sofia, Bulgaria) for readily making his collection available for examination. I am greatly indebted to Mr Reino Tyynelä (Zoological Museum of Helsinki, Finland), who produced the photographs and, last but not least, to Dr Kauri Mikkola of the same institution, who critically revised the manuscript and provided many valuable corrections and additions.

### References

- Balletto, E. & Toso, G.G., 1979. On a new species of *Agrodiaetus* from Southern Italy. - *Nota lepid.* 2 (1 & 2): 13-25.
- Brown, J., 1976. Notes regarding previously undescribed European Taxa of Genera *Agrodiaetus* Hübner, 1822 and *Polyommatus* Kluk, 1801 (Lep., Lycaenidae). - *Entomologist's Gaz.* 27: 77-84.
- Brown, J., 1977. Subspeciation in the butterflies (Lepidoptera) of the Peloponnesos with notes on adjacacent [sic] parts of Greece. - *Entomologist's Gaz.*, 28: 141-174.
- Brown, J. & Coutsis, J.G., 1978. Two newly discovered Lycaenid butterflies (Lepidoptera: Lycaenidae) from Greece, with notes on allied species. - *Entomologist's Gaz.* 29: 201-213.
- Coutsis, J.G., 1972. List of Grecian Butterflies : Additional Records, 1969-1971. - *Entomologist's Rec. J. Var.* 84: 145-151.
- Coutsis, J.G., 1978. List of Grecian Butterflies : Additions and Corrections. - *Entomologist's Rec. J. Var.* 90: 137-140.
- Coutsis, J.G., 1983. The female of *Agrodiaetus iphigenia nonaciensis* Brown. - *Entomologist's*

- Rec. J. Var.* **95**: 196-199.
- Ganev, J., 1984. Zwei neue Arten Lycaenidae für die Bulgarische Fauna (Lepidoptera, Lycaenidae). - *Articulata*, Bd.II, **5**: 125-126.
- Ganev, J., 1985a. Red list of Bulgarian butterflies and larger moths. - *Entomologist's Gaz.* **36**: 115-118.
- Ganev, J., 1985b. Systematic list of Bulgarian Rhopalocera and Grypocera (Lepidoptera). - *Phegea* **13**: 115-119.
- Higgins, L.G. & Riley, N.D. 1984. *A field guide to the butterflies of Britain and Europe* (Fifth Edition). Collins, London, 384 pp.
- Koçak, A.O. 1983. Critical check-list of European Papilioidea (Lepidoptera). - *Priamus* **3** : 11-37.
- Kostrowicki, A.S. 1969. *Geography of the Palaearctic Papilioidea (Lepidoptera)*. Panstwowe Wydawnictwo Naukowe, Krakow, 380 pp.
- Lesse, H. DE 1960. Les nombres de chromosomes dans la classification du groupe d'*Agrodiætus ripartii*. - *Revue fr. Ent.* **27**: 240-264.
- Lorković, Z. 1990. The butterfly chromosomes and their application in systematics and phylogeny. - In: Kudrna, O. (ed.) *Butterflies of Europe. Vol.2: Introduction to lepidopterology*. - pp. 332-396; Aula Verlag, Wiesbaden.
- Manino, Z., Leighéb, G. , Cameron-Curry, P. & Cameron-Curry, V. 1987. Descrizione degli stadi preimmaginali di *Agrodiætus humedasae* Toso & Balletto, 1976 (Lepidoptera: Lycaenidae). - *Boll. Mus. reg. Sci. nat. Torino* **5** (1): 97-101.
- Robinson, R. 1971. *Lepidoptera genetics*. Pergamon Press, Oxford-Braunschweig, 687 pp.