

Pigmentation Variation in the 14-Spot Ladybird *Propylea quatuordecimpunctata* (Linnaeus, 1758) in the Edirne Populations, Turkey

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Abstract: Frequency differences in the 2 different coloured forms of the 14-spot ladybird *Propylea quatuordecimpunctata* in the Edirne populations were investigated. The results indicated that black individuals tend to occur more frequently in the habitats than in shady habitats. The body length of the black coloured 14-spot ladybirds was significantly smaller than that of the yellow individuals. The pooled data consisted of 66 % black and 34 % yellow forms.

Key Words: Melanism, thermal selection, 14-spot ladybird, *Propylea quatuordecimpunctata*, Coccinellidae.

14-Noktalı Uğurböceği *Propylea quatuordecimpunctata*'nın Edirne Populasyonlarında Renklenme Varyasyonu

Özet: Bu çalışmada 14-noktalı uğur böceği *Propylea quatuordecimpunctata*'nın siyah ve sarı renkli formlarının Edirne populasyonlarındaki frekansları araştırıldı. Siyah renkli formların direk olarak güneşe açık olan habitatlarda, gölge olan habitatlardan daha yüksek frekansta bulunmaya eğilimli olduğu ortaya çıktı. Diğer taraftan siyah renkli formların, sarı renkli formlardan daha küçük olduğu görüldü. Siyah renkli formların populasyonun % 66'sını, sarı renklilerin ise % 34'ünü oluşturduğu hesaplandı.

Anahtar Sözcükler: Melanizm, termal seleksiyon, 14-noktalı uğurböceği, *Propylea quatuordecimpunctata*, Coccinellidae.

Introduction

Colour/pattern polymorphism in poikilothermal animals particularly in insects may have significant effects on fitness (Kennedy, 1961; Lees, 1981). The survival of such animals in a variety of environments may crucially depend on body pigmentation. Colouration of small insects is usually associated with the ambient temperature. The degree of heat absorption in such animals may be influenced by their colouration, since the darker coloured forms absorb solar radiation more rapidly (Kettlewell, 1973). Thus, this trait may be advantageous for some morphs and disadvantageous for others, resulting in variation through natural selection. Colour pattern forms may vary in fitness as a result.

In this respect, in numerous polymorphic species, the darker forms tend to occur more frequently in cooler habitats than in open habitats directly exposed to sunlight. It has been shown that melanism through thermal selection is an adaptive value for *Colias*

butterflies in alpine cold habitats (Roland, 1982). Thermal melanism has been discussed as an important fitness component in many species such as ladybirds (Scali and Creed, 1975; Brakefield and Willmer, 1985; Stewart, and Dixon, 1989; Majerus, 1998), spittlebugs (Thompson, 1988) grasshoppers (Forsman, 1999), and spiders (Gunnarsson, 1987).

Since many ladybirds are polymorphic for the colour pattern on the elytra, they have been a good subject for the study of evolution in action. Although over 3500 ladybird species are known worldwide (Majerus and Kearns, 1989), the data from Turkey need to be improved. A comprehensive study by Uygun (1981) and various other studies have dealt with several aspects of Turkish ladybirds (Giray, 1970; Demirsoy, 1990; Kaya and Hıncal, 1991; Özbek and Çetin, 1991; Özder, 1998; Yurtsever, 2001).

In the present pilot study, Edirne populations of the 14-spot ladybird *Propylea quatuordecimpunctata* were

investigated, and the frequencies of the black and yellow forms were compared to see whether there is any association with particular habitats due to thermal selection.

Materials and Methods

The sampling was conducted in the Edirne (41 40 N: 26 45 E) populations in north-western Turkey. A total of 262 adult ladybirds was collected from generally rural sampling sites (Table 1). After scoring for colour/pattern, the insects were released. The sampling sites were divided into 2 categories, open and shady habitats, depending on the exposed sunlight level. Open habitats included roadsides, meadow patches and abandoned fields exposed directly to sunlight. Shady habitats included fields that were covered with trees and therefore heavily shaded. These sampling sites can be described as follows: (a) Stream meadows – usually wet meadows throughout the year, covered with many herbaceous plants including several rushes; (b) Kirkpınar woodland – containing several densely mixed deciduous tree species such as *Populus* spp., *Salix* spp., and *Acer campestre* and mainly covered with *Aristolachia clematidis*, *Chenopodium album* and other grasses; (c) Lusanne Monument – including a small meadow covered with thistles and grasses such as *Medicago* spp., *Cardaria draba* and *Trifolium* spp.; (d) Karaağaç woodland – made up of mixed tree species including *Ulmus minor*, *Morus alba*, *Robinia pseudoacacia*, and *Populus* spp. a densely shaded area with herbaceous plants; (e) Dry meadows – usually bare fields with mixed-grass pastures and many thistles, located mainly near agricultural land. These sites were generally dry during the summer; (f) Güllapdere woodland – composed of numerous herbaceous plants

and trees including *Capsella bursa pastoris*, *Vicia hirsuta*, *Trifolium* spp. *Paliurus spina-christii*, *Rosa canina*, *Rubus sanctus*, *Crataegus monogyna*, *Alianthus altissima*, *Quercus* spp. and several *Salix* and *Populus* species.

One hundred and thirty-five specimens collected from the sampling sites were separately analysed for body length measurements in the laboratory. A binocular stereomicroscope was used for the examination of the insects.

The frequency distributions of the dark and yellow ladybirds in the 2 types of habitat were examined using the chi-squared test with an appropriate degree of freedom (df). The body length (from vertex of the head to the posterior tips of the elytra) was recorded to the nearest millimetre. The mean body lengths (mm) of the dark and yellow ladybirds were compared using one-way ANOVA. Means are given with standard errors (Mean ± SE).

Results

The 14-spot ladybird *Propylea quatuordecimpunctata* occurred abundantly in the sampling sites. In addition, it was one of the commonest ladybird species together with *Coccinella septempunctata*, *Psyllobora vigintiduopunctata*, and *Micraspis sedecimpunctata*. However, the density of *P. quatuordecimpunctata* in the sampling sites was not as high as that of *P. vigintiduopunctata* in the vicinity of Edirne.

Four different clearly separable colour/pattern morphs of *P. quatuordecimpunctata* were observed in the study area. According to the background pigmentation and the spots on the elytra, these 4 morphs can be categorised as follows:

Table. Frequencies of the 2 different colour morphs in *Propylea quatuordecimpunctata* collected from different habitats in Edirne.

Sampling site	Colour Morph		Habitat	
	Black	yellow	open	shady
Stream meadows	5	3	✓	
Kirkpınar woodland	21	6		✓
Lusanne Monument	28	1	✓	
Karaağaç woodland	17	46		✓
Dry meadows	72	10	✓	
Güllapdere woodland	13	1		✓
Stream meadows	18	21	✓	
Total	174	88		

a) Yellow, separated 14 black-spotted: elytra has dark yellow (orange-like) pigmentation and 14 disconnected black spots.

b) Yellow, fused 14 black-spotted: the pigmentation of the elytra is the same as that of the previous morph, but some of the 14 black spots, particularly marginal spots, are fused.

c) Black, separated 14 yellow-spotted: elytra has black pigmentation and 14 disconnected orange spots.

d) Black, fused 14 yellow-spotted: elytra is black, but some of the 14 orange spots are fused as in the second category.

There was no gradual variation between these 4 groups of ladybirds, and they were thus clearly distinguishable from each other. However, the fused spotted forms were not as abundant as the other 2 forms, and they comprised about 10% of the samples. The proportions of the 2 main categories, namely black and yellow individuals, in the Edirne populations ($n = 262$) were 66 % and 34 % respectively, (Figure 1).

Statistical analysis (R x C chi-squared test) of the data (Figure 1) revealed that the proportions of black and yellow pigmented individuals in open and shady habitats were significantly ($\chi^2 = 23.33$, $df = 1$, $P < 0.0001$) different. Thus, the proportion of black forms in open habitats was significantly ($\chi^2 = 29.79$, $df = 1$, $P < 0.001$)

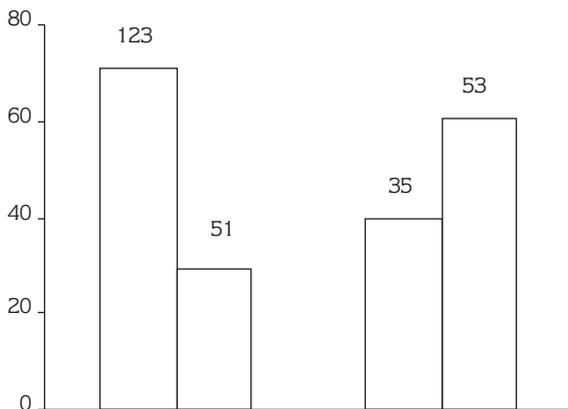


Figure 1. Bar chart for the pooled black and yellow morph frequencies of *Propylea quatuordecimpunctata* found in open and shady habitats in Edirne. The height of the bars (vertical axis) indicates percentage. Each paired bar of diagrams from left to right denotes the black and yellow ladybirds, the numbers observed are given at the top of the bars. The first and second bars in each diagram represent open and shady habitats respectively.

higher than that of those found in shady habitats. On the other hand, the proportions of the yellow pigmented 14-spot ladybirds in the 2 types of habitat did not differ significantly ($\chi^2 = 3.68$, $df = 1$, $P > 0.05$).

In addition to the frequency differences between the black and yellow pigmented 14-spot ladybirds in the 2 types of the habitat, the body lengths of the 2 different forms also showed significant differences (Figure 2). The body length of the individuals ($n = 72$) with black elytra (3.838 ± 0.029 mm) was significantly (one-way ANOVA: $F = 7.64$, $P < 0.01$) smaller than yellow pigmented (3.958 ± 0.032 mm) individuals ($n = 64$).

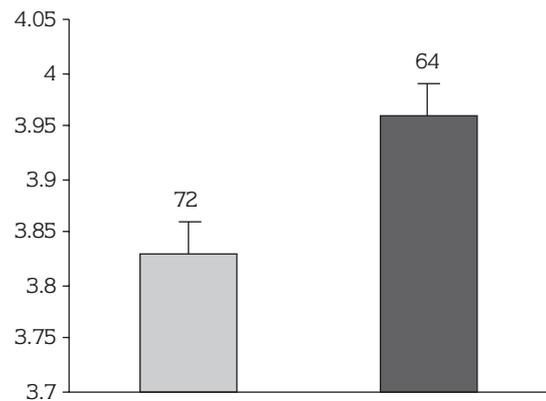


Figure 2. Body length (Mean \pm SE) of the 2 forms of *Propylea quatuordecimpunctata* in Edirne. The vertical axis denotes the length in millimetres. The dotted black and white bars represent the black and yellow ladybirds respectively, and the numbers are given at the top of the bars.

Discussion

This study revealed that black pigmented individuals in open habitats tend to occur more frequently than those in shady habitats. However, the frequencies of the yellow forms did not show any significant differences in the 2 types of habitat studied. Similar studies have been performed with other arthropod species, but conflicting results have been reported. For example, the frequencies of the darker forms in the polymorphic spittlebug *Philaenus spumarius* are positively associated with cooler places, which with greater altitude, latitude or rainfall. (Thompson, 1988; Yurtsever, 2000, references therein). The darker forms in such cooler habitats take advantage of and increase their frequencies through thermal selection. Similarly, the melanic frequencies of the ladybird *Adalia bipunctata* have been reported to increase with altitude (Scali and Creed, 1975). Recent research by

Majerus (1998) also suggests that thermal effects act on the European populations of the 14-spot ladybird because the mean proportion of the black forms increases from south towards the north, establishing a latitudinal cline between the Mediterranean region and Scandinavia. Although we have no evidence of any selective factors affecting the Edirne populations of the 14-spot ladybird, periodical studies, particularly on a large geographical scale, may be more informative.

Melanic forms of *P. quatuordecimpunctata* in the Edirne populations were smaller than the yellow forms. Stewart and Dixon (1989) point out that some coccinellid species that are larger in size are not melanic because their body temperatures more frequently reach deleterious levels on sunny days. It has also been suggested that even in cooler conditions melanic forms may be at a disadvantage because of intensive predation.

Since they are more active than non-melanics, they will be caught more often by predators (Gunnarsson, 1987). Thus, being melanic does not always seem to be advantageous in certain environments.

Although the present paper makes a good contribution to our knowledge of 14-spot ladybird morph frequencies in Turkey, the data are not very extensive. Accordingly, pigmentation variations of the *P. quatuordecimpunctata* in Edirne as well as other Turkish populations should be studied in detail in the future. Although colour polymorphism in this ladybird is inherited polygenically (Majerus, 1998), the genetic basis and the pattern of inheritance of polymorphism in Edirne populations should be studied, because the genetic control of the inherited traits in geographically separated populations is expected to differ due to various effects of evolutionary influences.

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