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Habitat Occupancy and Mobility of the Violet Copper (*Lycaena helle*) in West Khentii, Northern Mongolia

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Abstract

The violet copper (*Lycaena helle* Denis & Schiffermueller, 1775) was studied using mark-release-recapture method in West Khentii in northern Mongolia. The netting method was used for collecting the violet copper during one hour standardised sample in different biotopes. Violet copper was found predominantly in the wet, mesophilous grassland and herb meadows, but it also found in the birch forests in the riparian zone the valley as well as in the mixed forests consisted of *Larix sibirica* and *Betula platyphylla*. We examined the movement and individual occurrence through the habitat types of West Khentii. The mean distance between the first and subsequent capture points in the open area were greater than that of in fragmented landscapes for both sexes (107±76 and 44±41 m for females and males, respectively). The single greatest movement distance between recaptures was 386 m for females and 163 m for males.

Key words: *Lycaena helle*, habitat occupancy, mobility, West Khentii, Mongolia

Introduction

Lycaena helle (Denis & Schiffermueller, 1775) is one of the rarest butterfly species in Central Europe (Fischer *et al*., 1999) and is considered to be an endangered species in Germany (Bundesamt fuer Naturschutz 1998).

Afforestion, peat extraction and management to improve the quality of cattle grazing (such as drainage, burning and chemical treatment) are main factors in Central Europe in disturbing the suitable habitat of this species (Kudrna, 1986). The local extinction and decline of many butterfly species are related to changes in habitat quality (van Swaay & Warren, 1999; Summerville *et al*., 2002; William, 1998; Rodriguez *et al*., 1994). Many authors documented the influence of landscape patterns on butterfly community (Schneider 2003; Natuhara *et al*., 1999; Saarinen, 2002; Dover *et al*., 1997; Schneider & Fry, 2001; Pullin 1997; Rodriguez *et al*., 1994; Summerville *et al*., 2003; Summerville & Thomas, 2004). Sparks and Carey (1995) revealed the influence of the floral composition on butterfly diversity. Dover *et al*. (1997) discussed the importance of shelter in the open habitats for butterflies. The feature of the landscape is most important predictor that influences the population and community structure of butterfly species (Hunter, 2002; Tews *et al*., 2004; Rodriguez, 1994; Pullin, 1997; Root, 1972; Ehrlich & Murphy, 1987; Dennis & Eales, 1997).

In comparison with those environmental conditions of Europe and all other regions in the similar latitude, ecosystems in Mongolia are relatively undamaged.

In this study we chose the violet copper, *Lycaena helle*, which lives as small populations on fragmented and isolated habitat islands in Central Europe (Fischer *et al*., 1999; Van Swaay & Warren, 1999).

The main aim of this study was to investigate the occupancy of violet copper in different habitat types of West Khentii, Mongolia. The specific objectives of this study are to characterise the influence of landscape structure and vegetation type on violet copper population with comparison of their habitat occupancy, and to determine the mobility of the individuals in natural landscape.

Material and Methods

Study area. The Khentii Mountains are located north-central part of Mongolia and covered by boreal taiga forests. This is one of the coldest areas in Mongolia and contains continuous and isolated forms of permafrost (Gantsetseg & Sharkhuu, 2002). West Khentii is a part of the Khentii mountain range and is located in the transitional zone between the taiga forest and steppe ecosystems. Main data on climate characteristics in West Khentii can be found in Velsen-Zerweck (2002) and Gantigmaa (2005).

The forest area in West Khentii region consists of only some patches climax coniferous forests, because fire causes the formation of mixed forest in variable successional stages (Gunin *et al.*, 1999; Goldammer & Furyaer, 1996). River valley separates the hilly terrains of this region. This natural area includes grasslands (e.g. mountain dry steppe, meadow steppe, peat meadow, herb meadow and wet grassland dominated by *Carex* sp.) and the riparian woodlands (e.g. dense *Betula fusca* shrub and *Salix* sp., open riparian forests with *Larix sibirica and Betula platyphylla* with shrub layer, *Picea obovata* riparian forest, *Populus laurifolia* riparian forest) (Dulamsuren, 2004). Muehlenberg *et al*. (2000) described the following eight different vegetation types in the West Khentii: mountain taiga, mountain forest, meadow steppe, mountain dry steppe, scrublands, riparian woodland, herb meadows and wet grasslands.

Study site. The mobility of adult violet coppers surveyed in open areas of herbaceous plant meadows with shrub layers (Dulamsuren, 2004). These habitats are heterogeneous with shrubs and herb meadow on the terrace in the river valley, and with mountain dry steppe on southern slopes (Fig. 1). The size of this habitat is less than 10 ha, but it includes two different plant communities: herb meadow (e.g. *Iris sanguinea* and *Alopecurus arundinaceus* community) and *Carex*-rich wet grassland (bog area). Shrub layer contains *Salix* and *Padus asiatica* shrubs (Dulamsuren, 2004).

Mountain dry steppe has a sparse vegetation cover dominated by *Potentilla-Carex* community, often including *Potentilla acaulis, P. viscosa, Artemisia* sp., *Koeleria macrantha, Poa* sp., *Thymus* sp., *Pulsatilla* sp., *Oxytropis* sp., and *Lilium pumilium*. In contrast, the herb meadow was predominated by *Carex-Artemisia* association, including other important genera of larval food plants, such as *Bromus, Galium, Achillea, Poa, Equisetum, Dianthus, Polygonum, Sanguisorba, Vicia, Spiraea, Scutellaria, Potentilla,* and *Carum*, *Carex* are widely distributed throughout both habitats and are utilised as food plants by many species of butterflies.

Habitat occupancy of adult violet coppers. Field data on habitat occupancy of violet coppers were collected in different types of vegetation. The information was gathered on each habitat type and the number of individuals of violet copper was collected. The netting method was used for collecting the violet coppers during one

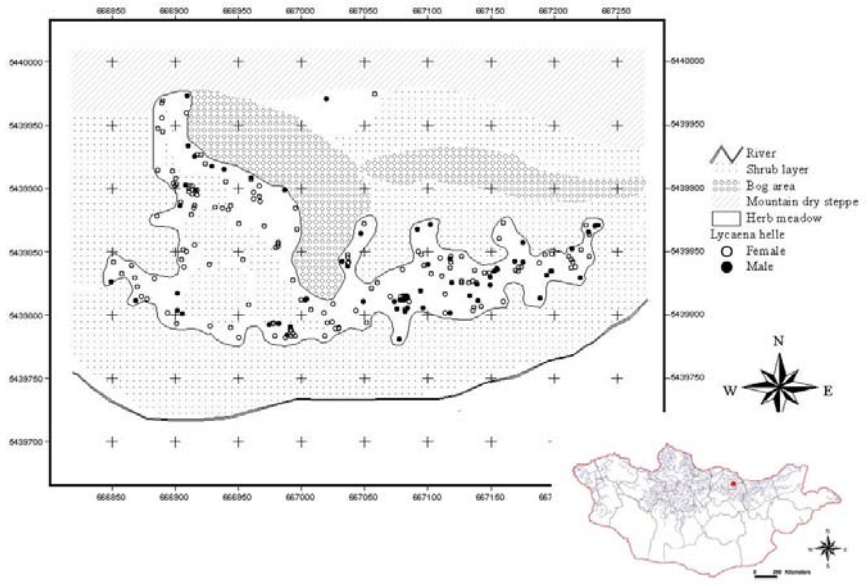

Figure 1. Heterogeneous natural habitats in West Khentii.

hour sample in different biotopes.

Mobility of adult violet coppers. The observations on mobility of the violet coppers were repeatedly made during 06 to 26 June, 2004 and 2005 at the Eroo river valley on the terrace. The survey started at about 11.00 AM., and continued until 2.00 PM., with careful search for adult coppers in all open areas including the bush layers when it was sunny. During the survey we searched about 50 square meter area on the site and netted all individuals encountered. One person marked the individuals and subsequently released it. The exact GPS position of all individuals captured during the mark-release-recapture study was plotted on a map, in order to get measures of movement distances between captures. Distances moved by coppers were estimated by a straight line between the places released and recaptured points.

Results

Habitat occupancy of adult violet coppers. Gained data based on standardised counts indicate that the violet coppers occupy the most of habitat types of West Khentii (Table 1).

The violet coppers predominantly found in the herb meadows and wet, mesophilous grassland (ANOVA, $F_{6,28}$=3.54, P<0.01), but it is also found in the riparian woodland in the birch forests of the valley, as well as in the mixed forests. No constant occurrences of violet coppers were observed in the mountain dry steppe and meadow steppe.

Table 1. Habitat types and number of individuals of *Lycaena helle* encountered in West Khentii (ANOVA, $F_{6,28}$=3.54, P<0.01)

Habitat types	Standardised 1 hour sample	
	Number of individuals ± Standard deviation	Percent (%)
Birch forests in the valley	5.19 ± 5.84	13
Mesophile grassland	11.0 ± 6.7	27.5
Mixed forest	2.2 ± 0.83	5.5
Riparian woodland	4.8 ± 5.67	12
Moist clearings in forest	3.79 ± 2.40	9.5
Herb meadow with shrubs	11.3 ± 7.5	28.5
Mountain dry steppe	1.6 ± 0.89	4

Capture-mark-recapture data. Overall 392 individuals of violet coppers (205 females and 187 males) were captured and marked during the survey period. 21% of total marked individuals were recaptured at least once within 20 days of survey, and 26% of males and 17% of females were recaptured at least once (Table 2). The maximum time interval between mark and recapture was 18 days for males and 13 days for females.

Males were recaptured more than females. 24.5% of total recaptured individuals were encountered three times, but only 4.6% more than 4 times.

Mobility of adult violet coppers. Recapture results show great differences between mean distances moved by males and females (Table3). The mean distances between the first and subsequent capture were greater for both sexes (107 ± 76 and 44 ± 41 meters for females and males, respectively) than reported in other studies (Fischer *et al*., 1999).

Actually 42.5% of the linear distances between recaptures of violet coppers was less than 40 meters, 22% was less than 100 meters and 35.5% less than 200 meters. The single greatest movement between recaptures was 386 m for females and 163 m for males. Mean distances moved between recaptures were significantly different for both sexes (for male 44 ± 41 m, female 181 ± 74 m;

Table 2. Recapture rate and mean movement distance of violet copper.

Capture-mark-recapture results	Number of individuals		
	Male (m)	Female (f)	Total (m+f)
Marked individuals	187	205	392
Recaptured individuals	49	35	84
Recapture rate	26%	17%	21%

Table 3. Mean distance of movement of violet coppers (ANOVA; $F_{1,82}$=16.25, P<0.001).

Mobility parameters	Male (m)	Female (f)	Total (m+f)
Mean distance between first and subsequent captures	44 ± 41	107 ± 70	79 ± 71
Mean distance ± SD (meters)	59 ± 41	181 ± 74	109 ± 83
Mean distance ± SD (meters) between marginal two points for multiple recaptures	63 ± 33	211 ± 54	116 ± 83
Mean distance between first and last captures ± SD (meters)	53 ± 32	144 ± 69	92 ± 68
Maximum distance (meters)	163	386	386

(ANOVA, $F_{1,82}$=16.25, P<0.001 (Table 3). For the case of multiple recaptures, if we connect the marginal two points covered by each individual, the average restricted movement were significantly different for both sexes (ANOVA, $F_{1,26}$=83.16, P<0.001). Most of marked adults were recaptured nearby previous place.

Habitat characteristics. The total number of observed visits to flowers was 455 during the mark-release-recapture study, and they visited in total 21 plant species (Table 4). The females and males visited 19 and 15 plant species, respectively. This species of violet copper feeds on nectar of seven plant species, among which most frequently two species with white flowers: *Anemone crinita* (18% of all visits) and *Callianthemum isophoides* (12%).

Both the sexes of violet coppers visited most often the leaves of *Polygonum viviparum* and *Filipendula palmate*. It must be added that both these plant species were less abundant in this area.

Discussion

Adults of violet copper prefer wet, mesophilous grassland, moist clearings in the forest and the habitats along streams, springs and bogs with abundance of foodplants (Van Swaay & Warren, 1999). However, in case of northern Mongolia, violet coppers are predominantly found in the wet, mesophilous grassland and herb meadows, but it is also found in the riparian woodland, in the birch forests of the valley as well as in mixed forests. The species is not often found in the mountain dry steppes and meadow steppes of West Khentii. However, the food plant of violet copper is still not clear in northern Mongolia. A species, *Polygonum bistorta* and its relatives (e.g. *Polygonum viviparum*) are reported as larval food

Table 4. Percentage of visits of the violet coppers to different plant species.

Plants	Female (%)	Male (%)	Total %
Anemone crinita	20	14	18
Polygonum viviparum	16	14	16
Callianthemum isophoides	13	8	12
Filipendula palmata	10	11	11
Ranunculus acer	8	13	9
Thalictrum sp.	6	6	6
Iris sanguinea	3	13	6
Carex	4	2	4
Spiraea salicifolia	4	2	3
Rosa acicularis	2	6	3
Galium boreale	4		3
Rumex acetosella	2	2	2
Spiraea media	1	5	2
Trollius asiaticus	2	2	2
Rumex acetosa	1		1
Galium verum	1		0.4
Phlomis tuberosa	1		0.4
Potentilla anserina	1		0.4
Rheum undulatum	1		0.4
Sanguisorba officinalis		2	0.4
Vicia unijuga		2	0.4

plants in Europe (Van Swaay & Warren, 1999).

This study suggests a higher recapture rate of male butterflies than females. The males were more active than females, and they tend to stay in a habitat patch for longer time of period than females. The mean distance between first and subsequent captures of violet copper were greater than those reported in other studies (e.g. Fischer *et al*., 1999), but it was shorter than that of the scarce copper (*Lycaena virgaureae*) (Schneider *et al*., 2003; Gantigmaa, 2005).

In the open habitats, where individuals find their resources, they could travel everywhere. On one hand, in natural landscape, which contains higher plant diversity, the individuals have enough resources, it is not necessary to move far searching next suitable habitats, like other butterfly species that live in fragmented habitats (Schneider *et al.*, 2003).

Therefore, vast nature reserve and wilderness of West Khentii forest steppe ecosystem supports the full complement of native vegetation for butterflies (Dulamsuren, 2004; Gantigmaa, 2005) in North Mongolia. Hence, mosaic structure of this natural landscape plays an important role for habitat requirements of violet copper. The violet copper is restricted to sheltered locations in the vicinity of scrubs and trees (Schurian & Fiedler, 1999) instead of moist meadows (Van Swaay & Warren, 1999).

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Хураангуй

Цэнхэр эрвээхэйн овгийн *Lycaena helle* Denis et Schiff. зүйлийн Баруун Умард Хэнтийн популяцид барих-тэмдэглэх-дахин барих аргыг ашиглан түүний шилжилт хөдөлгөөнийг судалсан дүнг нэгтгэн энэхүү өгүүлэлд тусгав. Уг эрвээхэйн зүйл хамгийн түгээмэл тохиолдоц бүхий биотопыг илрүүлэх зорилгоор ургамалжилтын янз бүрийн эвшилд ижил хугацаанд ажиглалт хийж, эрвээхэйн бүх бодгалийг барьж давтамжийг тооцов. Энэхүү зүйл эрвээхэй Баруун Умард Хэнтийн ойт хээрийн бүсэд гол төлөв чийг, намгархаг газрын ургамлын бүлгэмдэлд илүү түгээмэл тархалттай байсан хэдий ч хусан ой, голын татмын бүсэд орших шинэс, хус (*Larix sibirica*, *Betula platyphylla*) зонхилсон холимог ойд тохиолдож байв. Энэ зүйл эрвээхэйн тархалт, шилжилт хөдөлгөөний эрчмийг судлаж үзэхэд дахин баригдалт хоорондын зай нь эмэгчин эрвээхэйн хувьд 107±76 м, эрэгчин эрвээхэйн хувьд 44±41 м байв. Хамгийн хол зайд шилжилт хийсэн эрвээхэйн тохиолдол эмэгчин эрвээхэйд 386 м, эрэгчинд 163 м болох нь тэмдэглэгдэв.

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