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Habitat selection and daily activity of *Poecilimon intermedius* (Fieber, 1853) (Orthoptera: Phaneropteridae) – autecological studies in a typical habitat of the species (Hungary)

Выбор местообитания и суточная активность *Poecilimon intermedius* (Fieber, 1853) (Orthoptera: Phaneropteridae) – аутэкологические исследования в типичном местообитании (Венгрия)

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KEY WORDS: *Poecilimon intermedius*, habitat-preference, daily activity, grassland microclimate, forest-steppe species, Central-Europe.

КЛЮЧЕВЫЕ СЛОВА: *Poecilimon intermedius*, биотопический преферендум, суточная активность, луговой микроклимат, лесо-степной вид, Центральная Европа.

ABSTRACT. *Poecilimon intermedius* reproduces parthenogenetically and is quite rare in Central Europe. The species is considered to be Eurasian forest steppe element. The paper reviews the knowledge of the spread, evaluates the arealgeographic relevance, gives new results in relation to habitat-preference, behavioral ecology, daily activity and population size of the species. Our results are based on an autecological study of a robust Hungarian population that has been discovered recently. The authors give the following statements: (1) *P. intermedius* is ranked into the Eastern European–West Asian steppe species which occurrence is probable in the natural habitat patches fragmentally remained in the forest steppe zone. (2) The species occurs in xero-mesophytic steppe grasslands of open areas. (3) The habitat-preference can be originated in the nutrition and microclimate needs of the species. The latter one is uniquely manifested in the daily activity.

РЕЗЮМЕ. Размножающийся партеногенетически *Poecilimon intermedius* довольно редок в Центральной Европе. Считается, что он является Евро-Азиатским лесо-степным видом. В статье дан обзор данных, касающихся распространения *P. intermedius*, а также приводятся результаты оригинальных исследований о выборе местообитаний, поведении, суточной активности и размерах популяции данного вида. Результаты основаны на аутэкологических исследованиях в стабильной популяции *P. intermedius*, обнаруженной недавно в Венгрии. Установлено, что (1) *P. intermedius* распространён от Восточной Европы до Западной Азии и, вероятно, встречается в естественных степных местообитаниях, фрагментарно представленных в пределах лесо-степной зоны. (2) Вид встречается в ксеро-мезофитных луговых степях. (3) Выбор местообитания может быть обусловлен особенностями питания и микроклиматическими условиями, что однозначно отражается на суточной активности вида.

Introduction

The *Poecilimon* Fischer, 1853 genus is the most species-rich Orthoptera genus of the Palearctic Region [Heller et al., 1998; Sevgili, 2001; Otte et al., 2004]. The occurrence of the majority of species is restricted to the area of South-East Europe and Anatolia. The area of certain species are mainly small, the number of wide spread species is very small [Heller et al., 2004]. In Central Asia only two species represent the ponto-caspian genus [Pravdin & Mishchenko, 1980]: *Poecilimon intermedius* (Fieber, 1853) (Fig. 1), and *P. stshelkanovtzevi* Tarbinskii, 1932. *P. stshelkanovtzevi* is described from one male and three females from the Kopet-Dagh (leg. 25.06.1927) and never reported ever since [Sergeev, 1993].

The disposition of the *Poecilimon* genus has changed many times up to now because of its confused taxonomy. The *P. intermedius* was published under the name of „*Barbitistes intermedius* (Fieber 1853)" [Type locality: Eurasia: Russia: southern Ural, Spasskoe on the Bolshoi Ik River, east of Chkalov (Orenburg); Holotype

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Fig. 1. Female *Poecilimon intermedius* (06.23.06. Hungary, Berhida, photo by Norbert Bauer).
Рис. 1. Самка *Poecilimon intermedius* (06.23.06. Венгрия, Берхида, фото Норберта Бауэра).

is in the Nat. Hist. Mus. Wien], its current name has been valid since 1878 [Brunner von Wattenwyl, 1878]. *P. intermedius* was considered as a form of *Poecilimon fussi* Brunner von Wattenwyl, 1878 by Harz [1957]. *Poecilimon intermedius* reproduces parthenogenetically has larger distribution area than sexual *Poecilimon* species [Heller & Lehmann, 2004]. The morphology of the hearing organs and the function of hearing are reduced in this species [Lehmann et al., 2007]. Earlier some male *Poecilimon* specimens were also identified as *P. intermedius* [Ramme, 1933; Maran, 1952; Bei-Bienko, 1954; Kis, 1962]. Later it was revealed that all specimens were misidentified and belong to *P. fussi* [Heller & Lehmann, 2004]. Heller & Lehmann [2004] classified the species as a member of the „*Poecilimon ampliatus*-group".

From aerological respect Sergeev [1986] classified *P. intermedius* as European-Central Siberian north-steppe species. He considered the species to be typical in the forest steppe and forest zone. Sergeev [1986] stated that the spreading centre of the insect is in West Siberia and Kazakhstan. According to Pravdin [1978] the occurrence of the species is typical in the Dzungarian-Tien San, and also in the Central Tien San region within the group of hilly and mountainous geo-botanic regions. Kis [1979] considered it a Central-Asian-Pontic species.

On the basis of earlier papers we knew little about the habitat-preference and biology of *P. intermedius.* Our aim was to examine the habitat-preference and behaviour of *P. intermedius*. The population discovered in 2004 offered convenient conditions for these analyses. The occurrence in the central part of the Carpathian Basin can be found on the margin of the area, nevertheless our experiences can probably be generalized on the whole area because of the outstanding state of the studied territory's naturalness.

Review of the distribution and habitat-preferences

According to our knowledge [summarized in Heller & Lehmann, 2004] the *P. intermedius* occurs in west-east direction from the Czech-Moravian-Hills through the Carpathian Basin and the Russian steppes to the Angara table-land, and also in north-south direction from Central Ural to the Central Tien-San. We reviewed the knowledge concerning the occurrences of the species [in details see Bei-Bienko, 1954; Heller & Lehmann, 2004].

RUSSIA

It is typical orthopteran species in the steppe zone of the South, East and Central Russia [Sergeev, 1986].

Its occurrence is known from the areas of Angara table-land (Balagansk), East Saian (Krasnojarszk), Altaj Mountains, Tarbagat, Djungar-Alatau, the North Tien-San (Biskek), the Central Tien-San (Prsevalsk), Salairi table-land (Novososedovo), West Siberian Plain land (Tobolsk), Central Ural (Perm), South Ural (Natural Protected Area of Ilmensk, Orenburg), Tatarian land, the Smolensk-Moscow table-land (Moscow), the tableland along River Volga (Saratow) and the Central Russian table-land (Kurszk, Kaluga) [Bei-Bienko, 1954; Harz, 1969; Samoilov & Morozova, 2001; Laginov, 2006].

UKRAINE

The species is very rare based on its unpublished occurrence data.

ROMANIA

The species is very rare based on its occurrence data. It is known from the region of Kolozsvár (Kolozsvári-szénafüvek, Feleki-szénafüvek, Szamosfalvai-szénafüvek) [Kis, 1957, 1962].

SLOVAKIA

The species is very rare based on its occurrence data. It is known from the White Carpathians [Kocarek et al., 1999; Voigt et al., 2006].

CZECH REPUBLIC

The species is very rare based on its occurrence data. It is known from the White Carpathians [Chládek, 2003; Voigt et al., 2006] and the Czech Moravian Hills (Hustopeče) [Chládek, 1980; Kocarek et al., 1999].

HUNGARY

On the basis of its occurrence data the species is very rare. The first mentioning of the species in Hungary has to be regarded as doubtful, especially as there is confusion with occurrences of *P. fussi* [Sátoraljaújhely: Chyzer, 1897; repeated by Pungur, 1918 and Maran, 1952]. The confirmation of earlier records from the Karst of Aggtelek (Fertős-tető: 1964.VI.12., Nagy-oldal: 1964.VI.12.) [Nagy et al., 1999; Nagy, 2003], and also from the piedmont area of the Mecsek Mountains and the plain land of Pécs (Cserkút/Pellérd, 1964. VI.10.) [Nagy & Nagy, 2000] has not been affirmed for a long time [Nagy, 2003], and the population near Cserkút is considered extinct by its own explorer [Nagy, 2006]. Newly explored occurrences of *P. intermedius* are linked to the Basin of Borsod (Sajó-valley, Bódva-valley) [Garai, 2002] and the Mezőföld [Dunaföldvár, Gyűrűsi-völgy: Szövényi in Nagy, 2002 and personal communication of Gergely Szövényi]. The population published in this article, explored on 26 May 2004 (Berhida: Koldustelek) [Kenyeres & Bauer, 2005.] also belongs to the Mezőföld geographical unit.

There is little accessible information about the species' habitat preference. In connection with this we can only find small descriptions [Maran, 1952; Kis, 1962, 1976; Nagy & Szövényi, 1999; Garai, 2002], and also some allusions about the collecting circumstances (e.g. plant species were the insects found on) [Chládek, 1980].

Materials and methods

On the study area (W-Hungary: Mezőföld: Berhida: Koldustelek, 47°05'53,7"; 18°09'06,5", 150 m a.s.l.) the first larva of *P. intermedius* was found on 26 May 2004. The almost 5.5-hectare loess valley is enclosed with ploughlands (Fig. 2). Its significant botanic and zoological values became known not long ago [Bauer et. al., 2001].

After the exploration we studied the population in 2005 and 2006. During the visual detection along a line-transect we examined 10 m long, 1 m wide vegetation stripes. Based on this we defined the density of *P. intermedius* per square metre. We measured the microclimate parameters of the grassland (humidity and temperature / surface, 10, 20, 30 cm height above ground sourface) on 3 points of the line-transect at the time of the sampling (instrument: TESTO 615).

We took coenological samples using 2×2 m-quadrates and recorded the percental cover of the plant species. In favour of comparability the data are shown in Table on the basis of Braun-Blanquet [1928] system (+/– 5 scale) [see Dierschke, 1994].

We examined the daily activity of *P. intermedius*. In order to evaluate the method we watched a focal individual for two hours on 9 June 2006. Based on the collected experiences we performed ab. 12-hour long (9:20–21:00) observation of a single specimen on 20 June 2006. The specimen captured on the scene was marked with a small white unreflecting flag on its hind femur. The movements were measured with tested gauges made from light plastic and were recorded on co-ordinate paper. We documented every activity of *P. intermedius* and its point and length of time. We recorded the plant species used as the most typical habitat and food source. During the examination we recorded the humidity and temperature values of the grassland within every 10 minute.

We made the daily microclimate diagram of the habitat (Fig. 4). The 10-minute repetitions took place in order to explore the relation between the follow up of daily fluctuation and the daily activity of the species. For this reason movement (cm), eating activity (minute) and the frequency (presence/absence) of defection was also adjusted in 10-minute intervals. We figured the daily movement pattern of the examined *P. intermedius* (using isometric axonometry) (Fig. 5).

Nomenclature of the plant species was used after Simon [2003], nomenclature of the grasshopper species was used after Heller et al. [1998]. The publications of Harz [1969] and Kis [1976] were used for the identification of *P. intermedius*.

Results

Size of the population

The population of *P. intermedius* on the examined area had the largest density in a *Stipa pennata* dominated, almost 450-m^2 vegetation patch. In the early summer period the species frequently, but very sporadically presented in the other habitat types as well.

Table. Phytocoenological samples of the examined grassland.
Таблица. Фитоценологические параметры исследованного местообитания.

Taxa / Samples	1	2	3	4	5	6	7	8	9	10	Fr.
Festuca rupicola	3	2	2	2	2	2	2	2	2	3	**V**
Teucrium chamaedrys	2	2	2	1	1	1	1	1	1	1	**V**
Euphorbia pannonica	1	1	1	1	1	2	1	1	2	1	**V**
Salvia nemorosa	0.1	1	2	0	1	1	2	2	2	2	**V**
Adonis vernalis	0.1	1	1	1	1	1	1	0	1	1	**V**
Dianthus pontederae	0.1	1	1	0	1	0.1	1	0.1	1	0.1	**V**
Chamaecytisus austriacus	1	1	2	0	1	2	0	1	1	1	**IV**
Salvia pratensis	2	1	1	1	1	1	1	1	0	0	**IV**
Eryngium campestre	2	1	1	0.1	0	0	1	1	1	0.1	**IV**
Stachys recta	1	1	1	0.1	0.1	0	0	1	1	1	**IV**
Thymus glabrescens	0.1	1	0.1	0	0	1	1	0.1	1	1	**IV**
Galium verum	0.1	0.1	0.1	1	0	0.1	0	1	1	1	**IV**
Falcaria vulgaris	0	1	0.1	0	1	1	1	0.1	0.1	0.1	**IV**
Koeleria macrantha agg.	2	1	0	1	0.1	0	1	1	1	0	**IV**
Centaurea sadleriana	1	1	1	1	1	1	1	0	0	0	**IV**
Galium glaucum	0	1	0.1	0.1	0.1	0	0.1	0.1	1	0	**IV**
Stipa pennata	3	3	3	3	2	1	0	0	0	0	**III**
Stipa pulcherrima	0	0	0	0	2	2	2	2	2	3	**III**
Inula germanica	0	0	1	1	3	3	3	0	1	0	**III**
Helictotrichon praeustum	0	1	0	0	1	2	1	0	1	1	**III**
Inula oculus-christi	0	1	1	2	0.1	0	0	1	0	1	**III**
Dorycnium germanicum	0	0	0	1	1	1	0	1	1	1	**III**
Stipa capillata	0	0	0	1	1	1	0	1	1	1	**III**
Peucedanum alsaticum	1	1	1	1	0	1	0.1	0	0	0	**III**
Poa angustifolia	1	0.1	1	1	0	1	1	0	0	0	**III**
Salvia austriaca	0.1	0.1	1	0	0.1	1	0	0	0	1	**III**
Carduus acanthoides	0	0	0.1	0.1	0	0.1	0	0.1	1	1	**III**
Sanguisorba minor	0	0.1	0.1	0.1	0	0	0.1	1	0	1	**III**
Medicago falcata	0.1	0.1	0	0	0	0.1	0.1	0	0.1	1	**III**
Achillea pannonica	0.1	0.1	0.1	0	0.1	0.1	0	0	0.1	0	**III**
Plantago media sl.	0.1	0.1	0.1	0	0.1	0	0.1	0	0.1	0	**III**
Jurinea mollis	1	0	0	0	1	1	0	1	1	0	**III**
Astragalus austriacus	0	0.1	0	0	0	0.1	0	0.1	0.1	0.1	**III**
Lotus corniculatus subsp. hirsutus	0.1	0.1	0.1	0.1	0	0	0.1	0	0	0	**III**
Chrysopogon gryllus	2	2	2	1	0	0	0	0	0	0	**II**
Brachypodium pinnatum	3	0	1	0	0	0.1	1	0	0	0	**II**
Agropyron repens	0	1	2	0	0	1	0	1	0	0	**II**
Viola ambigua	0	1	0	1	1	0.1	0	0	0	0	**II**
Carex michelii	1	1	0.1	0.1	0	0	0	0	0	0	**II**
Potentilla arenaria	0	0	0	0	0.1	0.1	1	0	0	0.1	**II**
Arabis auriculata	0	0	0	0	0.1	0.1	0.1	0	0.1	0	**II**
Asperula cynanchica	0	0	0	0	0	0.1	0	0.1	0.1	0.1	**II**
Nonea pulla	0	0.1	0	0	0.1	0.1	0	0.1	0	0	**II**
Pimpinella saxifraga	0.1	0	0.1	0.1	0	0	0.1	0	0	0	**II**
Thesium linophyllon	0.1	0.1	0	0.1	0.1	0	0	0	0	0	**II**
Melica transsilvanica	0	0	0	0	2	0	0	2	1	0	**II**
Filipendula vulgaris	0	0	0	0	1	0	2	1	0	0	**II**
Bromus inermis	0	0	0	0	1	0	1	1	0	0	**II**
Chrysanthemum corymbosum	0	0	1	0	1	1	0	0	0	0	**II**
Phleum phleoides	0	0	0	0	0	1	0	1	0	1	**II**
Helictotrichon pubescens	1	0	0	0	0	0.1	1	0	0	0	**II**
Hypericum perforatum	0	0	0	0	0	0	0	1	0.1	1	**II**
Ononis spinosa	1	0	0	0.1	0	0	0	0	0	1	**II**
Prunus spinosa	0	1	1	0	0	0.1	0	0	0	0	**II**
Verbascum phoeniceum	0	0	0.1	0	0	0	0	1	0	1	**II**
Linum austriacum	0	0	0	0	0	0	0.1	0	1	0.1	**II**
Muscari comosum	0	0	0	1	0	0	0	0.1	0.1	0	**II**
Trifolium campestre	0	0	0	0	0	0	0.1	1	0	0.1	**II**
Veronica spicata	0	0	0	0	1	0	0.1	0	0.1	0	**II**
Knautia arvensis	0	0.1	0	0	0.1	0	1	0	0	0	**II**
Vinca herbacea	0	0	0.1	0.1	0	0	1	0	0	0	**II**
Acinos arvensis	0	0	0	0	0	0	0	0.1	0.1	0.1	**II**

Continue of Table.
Продолжение таблицы.

Taxa / Samples	1	2	3	4	5	6	7	8	9	10	Fr.
Betonica officinalis	0	0.1	0	0	0.1	0.1	0	0	0	0	**II**
Erophila verna	0	0	0	0	0	0	0.1	0.1	0.1	0	**II**
Fragaria viridis	0.1	0.1	0	0	0.1	0	0	0	0	0	**II**
Muscari racemosum	0	0	0	0	0.1	0	0	0	0.1	0.1	**II**
Seseli annuum	0	0	0	0	0.1	0	0.1	0	0	0.1	**II**
Veronica austriaca	0	0	0	0	0	0	0.1	0.1	0	0.1	**II**
Vincetoxicum hirundinaria	0	0	0	0.1	0	0	0.1	0	0.1	0	**II**
Artemisia campestris	0	0	0	0	0	0	1	0	1	0	**I**
Peucedanum cervaria	0	0	0	0	0	0	1	1	0	0	**I**
Rapistrum perenne	0	0	0	0	1	0	1	0	0	0	**I**
Vicia tenuifolia	0	1	1	0	0	0	0	0	0	0	**I**
Ajuga laxmannii	1	0	0.1	0	0	0	0	0	0	0	**I**
Anthyllis vulneraria	0	0	0	0	0	0.1	1	0	0	0	**I**
Euphorbia virgata	0	0	0	0	0.1	0	1	0	0	0	**I**
Inula ensifolia	0	0	1	0	0	0	0	0	0.1	0	**I**
Pulsatilla nigricans	0	0	1	0	0.1	0	0	0	0	0	**I**
Seseli varium	0	0.1	0	0	1	0	0	0	0	0	**I**
Silene bupleuroides	0	0.1	1	0	0	0	0	0	0	0	**I**
Taraxacum serotinum	0	0	0	0	0.1	0	0	1	0	0	**I**
Vicia hirsuta	0	0	1	0	0	0.1	0	0	0	0	**I**
Arenaria serpyllifolia	0	0	0	0	0	0.1	0	0.1	0	0	**I**
Astragalus cicer	0	0	0	0.1	0	0.1	0	0	0	0	**I**
Carex caryophyllea	0.1	0	0	0.1	0	0	0	0	0	0	**I**
Euphorbia cyparissias	0	0	0	0	0	0	0.1	0.1	0	0	**I**
Myosotis arvensis	0	0	0	0	0	0	0	0	0.1	0.1	**I**
Scabiosa ochroleuca	0	0	0	0	0	0	0.1	0	0	0.1	**I**
Thlaspi perfoliatum	0	0	0	0	0	0.1	0	0.1	0	0	**I**
Tragopogon dubius	0	0	0	0	0	0	0	0.1	0	0.1	**I**
Trifolium montanum	0.1	0	0	0	0.1	0	0	0	0	0	**I**
Viola hirta	0.1	0	0	0	0.1	0	0	0	0	0	**I**
Bromus erectus	0	0	0	0	0	0	1	0	0	0	**I**
Campanula bononiensis	0	0	0	0	0	0	0	0	1	0	**I**
Carduus nutans	0	0	0	1	0	0	0	0	0	0	**I**
Carex humilis	0	0	0	0	0	0	1	0	0	0	**I**
Iris pumila	0	0	0	0	1	0	0	0	0	0	**I**
Iris variegata	0	0	1	0	0	0	0	0	0	0	**I**
Lathyrus pannonicus	0	0	0	1	0	0	0	0	0	0	**I**
Linaria genistifolia	0	0	0	0	0	0	0	0	1	0	**I**
Potentilla recta	0	0	0	0	0	0	0	0	0	1	**I**
Pulsatilla grandis	0	0	0	0	0	0	1	0	0	0	**I**
Reseda lutea	0	0	0	0	0	0	0	0	0	1	**I**
Thalictrum minus	0	0	0	0	1	0	0	0	0	0	**I**
Agrimonia eupatoria	0	0	0	0.1	0	0	0	0	0	0	**I**
Alyssum alyssoides	0	0	0	0	0	0	0	0	0	0.1	**I**
Asparagus officinalis	0	0	0	0	0	0	0	0.1	0	0	**I**
Camelina microcarpa	0	0	0	0	0	0	0	0.1	0	0	**I**
Lathyrus tuberosus	0	0	0.1	0	0	0	0	0	0	0	**I**
Onobrychis viciifolia	0	0	0	0	0	0.1	0	0	0	0	**I**
Orchis tridentata	0	0	0	0	0	0	0.1	0	0	0	**I**
Ranunculus polyanthemos	0	0	0	0	0.1	0	0	0	0	0	**I**
Vicia angustifolia	0	0	0	0	0	0	0.1	0	0	0	**I**

Samples taken by N. Bauer; Locality — Hungary, Mezőföld Region, Settlement — Berhida, name of the location — Koldustelek; Plant association — *Salvio-Festucetum rupicolae* Zólyomi ex Soó 1964; Bedrock — calciferous pleistocene loess; Size of the quadrates — 2×2 m; Date of the samplings: 1–7— 18.VI.2005., 8–10 — 09.IV.2006.; Altitude (above sea level) ~ 155 m; Exposure: 1., 2., 5. — S; 3., 4., 7. — S–W; 6., 8., 9., 10. — W; Angle of slope— 20–35°; Cover values: 0,1 — less than 1%; 1 — 1–5%; 2 — 6–25%; 3 — above 25%; Fr — Frequency: V — taxa are in 80–100% of the samples, IV — taxa are in 60–79% of the samples, III — taxa are in 40–59% of the samples, II — taxa are in 20–39% of the samples, I — taxa are in 1–19% of the samples.

Площадки описаны Норбертом Бауэром; местоположение — Венгрия, окрестности Мезёфолда, поселение Берхида, локалитет Колдуштелек; растительная ассоциация — *Salvio-Festucetum rupicolae* Zólyomi ex Soó 1964; коренная подстилающая порода — известковые плейстоценовые лёссы; размер площадок — 2×2 м; даты описания площадок: 1–7 — 18.VI.2005; 8–10 — 09.VI.2006; высота над уровнем моря ~ 155 m; экспозиция: 1, 2, 5 — S; 3, 4, 7 — S–W; 6, 8, 9, 1. — W; склон — 20–35°; проективное покрытие: 0,1 — менее 1%; 1 — 1–5%; 2 — 6–25%; 3 — более 25%; Fr. — частота встречаемости видов: V — в 80–100% случаев, IV — в 60–79% случаев, III — в 40–59% случаев, II — в 20–39% случаев, I — в 1–19% случаев.

Fig 2. The loess valley near Mezőföld (Hungary, Berhida) preserves many significant steppe elements (photo by Norbert Bauer).
Рис. 2. Лёссовая долина в окрестностях Мезёфолда (Венгрия, Берхида), где сохранились степные ландшафты (фото Норберта Бауэра).

Fig. 3. Examined habitat of *Poecilimon intermedius* (photo by Norbert Bauer).
Рис. 3. Исследованное местообитание *Poecilimon intermedius* (фото Норберта Бауэра).

The following individual numbers and density values projected on square metre were documented: 05.26.04: 4 L_2 (D: 0.4); 08.10.04: –; 06.18.05: 15 ♀ (D:1.5); 07.21.05: –; 05.18.06: 1 L_2 (D:0.1); 06.09.06: 5 L_4 (D:0.5); 06.20.06: 3 ♀ (D:0.3); 06.23.06: 1 ♀ (D:0.1); 07.25.06: –.

The earliest presence data of the year was on 18 May, the latest on 23 June. In case of positive data the species density on a square metre ranged from 0.1 to 1.5. Calculating with the average value the examined population could be estimated to 200–250 individuals, with large differences between the years (the eggs placed

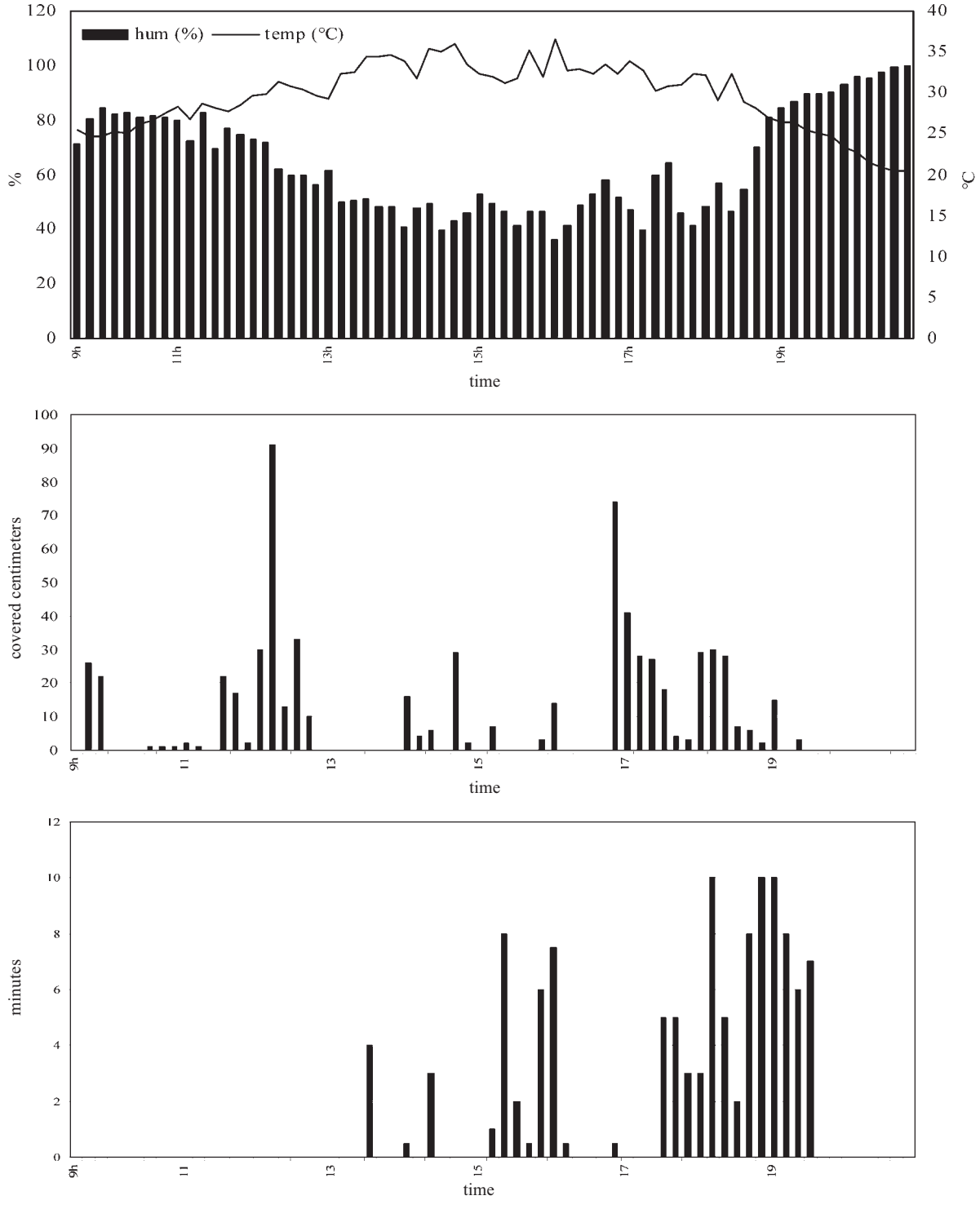

Fig. 4. Motional and feeding activities of *P. intermedius* in connection with the daily changing of microclimate.
Рис. 4. Зависимость двигательной и пищевой активности *P. intermedius* от суточных изменений микроклимата.

in soil of *Poecilimon* species can hibernate for 2 years [Nagy, 2003]).

Behaviour, daily activities

The analyzed single specimen covered 668 cm during the examined period of 11.5 hours (creeping and skipping together). As a thamnobiont species [Rácz, 1998] it was continuously in the upper third of the grassland. This is a significantly different behaviour from grass-dweller *Isophya* species dwelling in the lower regions of the grassland. Movements bigger than 1 cm during 10-minute intervals were between 1 and 91 cm. The average cover was 17.5 cm within a 10-minute interval. There were two activity peaks between 11:30–12:30 and 16:50–18:30 (compare Fig. 4). These two peaks concurred with the phase showing two same temperature and humidity correlation on the climate diagram (~27°C temperature, 80% humidity). The peaks manifesting in the moving activity also coincided with the tops showing the time expended on nutrition. On the basis of these the animal responded to more extreme periods revealing the daily fluctuation of both the temperature and humidity with smaller activity. The need for a tempered microclimate could be one of the autecological bases for the attachment for forest steppe habitats.

During nutrition the animal consumed the following plants and parts of plant in 98%: *Euphorbia pannonica* Host. (different parts of the inflorescence), *Carduus acanthoides* L. (leaf, spear), *Chamaecytisus austriacus* L. (epipetalous, leaf), *Salvia nemorosa* L. (flower, leaf, spear), *Eryngium campestre* L. (leaf). The intensity of nutrition and the frequency of defecation revealed contradictory tendency. Defecation generally took place in the morning period, and the intensive nutrition mainly occurred in the afternoon (Fig. 4).

During the period of the analysis the *P. intermedius* got in touch with two other insects, first with a *Leptophyes albovittata* (Kollar, 1833), and then with another individual of *P. intermedius*. In both cases defending movements and avoiding behaviour could be seen. The observed individual ignored other *P. intermedius* individuals being near (may as well sitting on the same plant), and also individuals of other species (e.g. loudly chirping *Isophya costata* Brunner von Wattenwyl, 1878 males). The daily activity of the examined specimen was figured on Fig. 5.

Habitat-preferences

The majority of the individuals of *P. intermedius* can be found in the patches of closed loess grassland association (Fig. 3) named: *Salvio nemorosae-Festucetum rupicolae* Zólyomi et Soó 1964 [Zólyomi, 1958; Borhidi, 1996]. This vegetation type is the most typical Carpathian Basin representative of the Ukraine-Russian steppe grasslands (see Table). The natural status of the grassland is outstandingly excellent. Its physiognomy is typical. The grassland has specific microclimate typical of multi-levelled steppe grassland associations [Bauer & Kenyeres, 2006a]. Besides the dominant grass species (*Stipa pennata* L., *S. pulcherrima* C. Koch, *Festuca rupicola* Heuff.) the proportion of the dicotyledons is marked. It is a proven considerable habitat factor for several sensitive grasshopper species [e.g. Berg et al., 1996; Nagy & Szövényi, 1999; Kenyeres et al., 2004; Kenyeres & Bauer, 2005; Bauer & Kenyeres, 2006b]. The characteristic plant species (typical in the valley: *Salvia nemorosa* L., *Euphorbia pannonica* Host., *Silene bupleuroides* L., *Taraxacum serotinum* (W. et K.) Poir., *Chamaecytisus austriacus* (L.) Link., *Seseli varium* Trev., *Ajuga laxmannii* (L.) Benth., *Inula germanica* L., *Vinca herbacea* W. et K., *Viola ambigua* W. et K.) are mainly Eurasian, Pontic-Pannonian forest steppe elements. These refer to the close biogeographical connection with the steppe and forest steppe zone. In the flora of the valley, the proportion of Eurasian (28%) and Continental (24%) flora elements is outstandingly high, together it is above 50 % (Bauer et al., 2001). The zonal vegetation type is the *Aceri tatarici-Quercetum roboris* [Zólyomi, 1957], and probably similar piedmont and hilly oak forests. The arboraceous component of the forest steppe is only fragmented in this valley. Old seed-trees (*Quercus robur* L., *Quercus pubescens* Willd.), steppe shrubs (*Prunus fruticosa* Pall., *Prunus spinosa* L., *Crataegus monogyna* Jacq.), and dry forested herb species refer to the original, more mosaic-like structure where originally steppe meadows formed smaller and bigger clearings.

Discussion

On the basis of the Central European occurrences the statement of Sergeev [1986] (the *P. intermedius* is Eurasian-Continental forest steppe species) can be confirmed. From macroclimatic reasons the Eurasian forest steppe zone reaches its western border in the Carpathian Basin, and it adjoins here and also creates transition zone with the European mild foliage forest zone. In this respect the relatively closed, but significantly large plain-collin region (~ biogeographical „Pannonicum") of the Carpathian Basin is extremely important. In this area the natural vegetation was once forest steppe forests closed to different extents [Zólyomi, 1957; Wendelberger, 1959; Varga, 1989; Zólyomi & Fekete, 1994; Bohn et al., 2003], and on this region exploited nowadays mainly as an agricultural area. The natural states can be reconstructed with island-like natural vegetation relicts. On the margins of the Great Hungarian Plain (especially on its western part, on Mezőföld) we can find the valuable remains of the forest steppe vegetation (the valley being the habitat of *P. intermedius* belongs to it as well). Many forest steppe plant species occurring in Mezőföld and the other Hungarian *P. intermedius*-habitats (*Stipa capillata* L., *Astragalus austriacus* Jacq., *Anemone sylvestris* L., *Oxytropis pilosa* (L.) DC., *Phlomis tuberosa* L., *Brachypodium pinnatum* (Host) Roem. et Schult. [Meusel et al., 1965]) have similar area to the examined grasshopper species. It has a biogeographical, flora and fauna historical signifi-

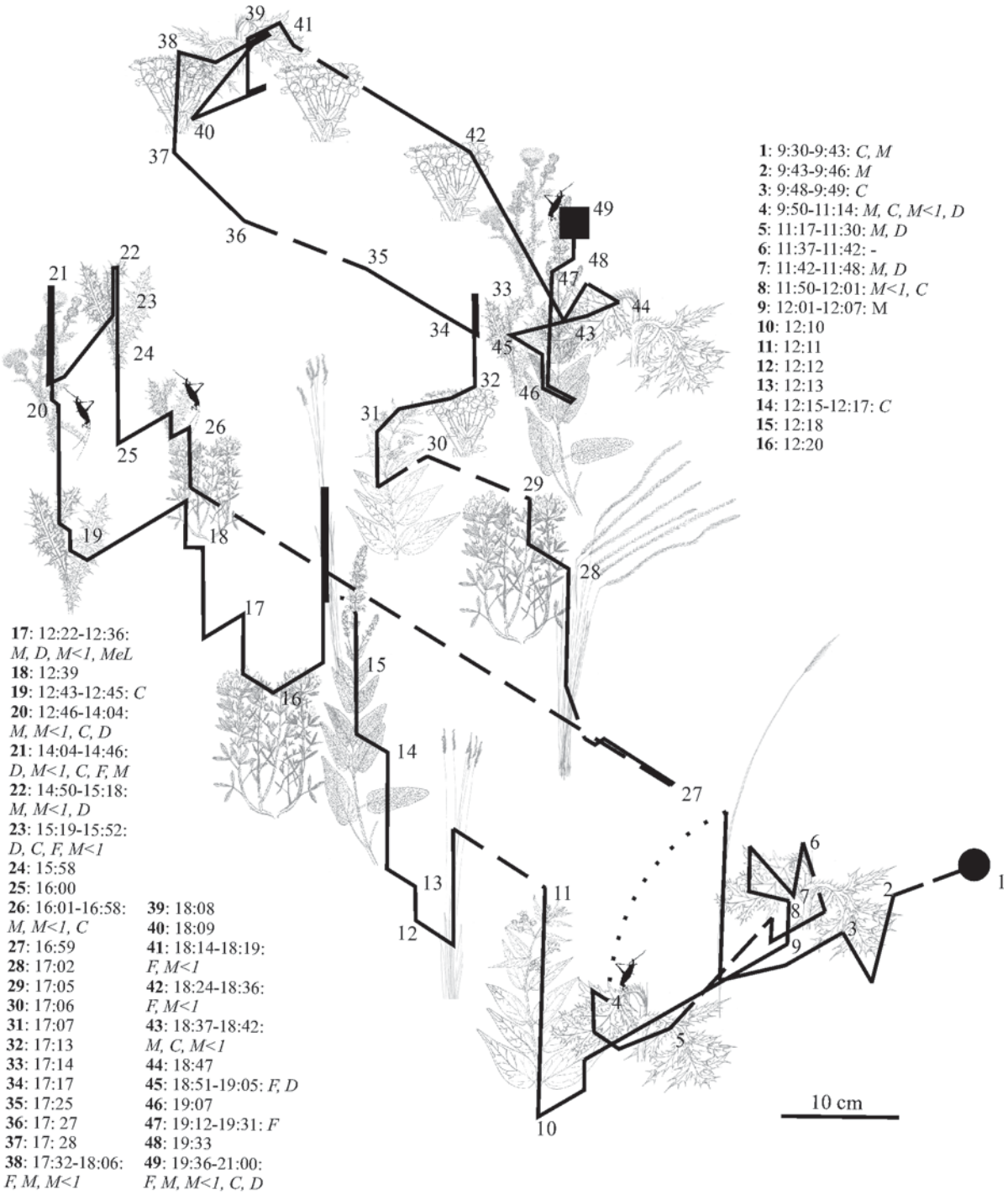

Fig. 5. Daily activity of *P. intermedius* (23.VI.2006. Hungary, Berhida): black circle — start point; black square — finish point; continuous line — climb; broken line — jump; dotted-line — passive moving; Arabic numerals — important stages; *P. intermedius* icons — standing place equal or more than an hour; block-capitals — types of activities (F — feeding; M — moving without progression; M<1 — moving with progression under 1 cm; D — defecation; MeL — meet with a *Leptophyes albovittata* specimen; C — cleaning).

Рис. 5. Суточная активность *P. intermedius* (23.VI.2006. Венгрия, Берхида): чёрный кружок — точка старта; чёрный квадрат — точка финиша; сплошная линия — лазанье по растениям; пунктирная линия — прыжки; точечная линия — пассивное перемещение; арабские цифры — важнейшие временные интервалы; силуэт *P. intermedius* — места остановки на час и более; прописные буквы — тип активности (F — питание; M — движение без продвижения вперёд; M<1 — движение с продвижением вниз на 1 см; D — дефекация; MeL — встречается вместе с *Leptophyes albovittata*; C — чистка).

cance and seems to establish the area-type classification [Sergeev, 1986; Rácz, 1998].

Based on the information in connection with the size of populations in Hungary the data from the region of Sátoraljaújhely should be treated uncertain, the confirmation of occurrences from the Karst of Aggtelek has not been known for a long time, the population from the flatland of Pécs is considered extinct, the size of the biggest Sajó-valley population is estimated to 100 by its explorer (personal communication of Adrienne Garai), the population size near Dunaföldvár (Gyűrűsi-völgy) is very robust (personal communication of Gergely Szövényi). Therefore the population described near Berhida should be considered one of the most robust known population of the species in Hungary.

Reckoning the population size, the habitat-preference and the daily activity *P. intermedius* has to be counted as a specialist, sensitive species. Considering the natural status the insect is one of the most important indicator species of Eastern European habitats [Samways et al., 1995].

Conclusions

We had insufficient information about the habitat preference of *P. intermedius* before our study. Earlier examination relating the behaviour biology of the species is unknown. On the basis of reviewing literature and an autecological analysis of one of the most robust known Hungarian population the following can be stated:

— Agreeing with Rácz [1998] and slightly modifying the statement of Sergeev [1986] the species should be ranked into the Eastern European–Western Asian steppe species; its occurrence is the most typical in the forest steppe zone.
— The habitat preference in Hungary similarly to the descriptions from the Transylvanian Mountains is characterized by attachment to xero-mesophytic grasslands, and steppe grasslands of the open areas [Kis, 1962].
— The habitat-choice of the species can be deduced both to its nutriment preference (in the period of analysis it consumed mainly herb dicotyledons) and microclimate needs. The two most intensive period of its activity in a day coincides with tempered microclimate values. It responds to the extremes of grassland's daily temperature and humidity values with low activity.
— The species is characterized by small mobility (within the 12 hours of the analysing period it covered 668 cm altogether), so it is intensively liable to isolation, it should have the honour of the most outstanding conservation biological status.
— Its settlement to parthenogenetic lifestyle is justified by the fact that considering the aim of moving activity, the nutrition, moving into penumbra state and avoiding other individuals could be observed. Behaviour similar to pairing could not be revealed, despite the fact that *P. intermedius* females easily accept males of the sister species *P. ampliatus* for mating [Lehmann & Lehmann, 2005].

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