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The habitat requirements of *Poecilimon brunneri* Frivaldszky, 1867 (Orthoptera: Phaneropteridae) and its Hungarian occurrence

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Abstract. *Poecilimon brunneri* Frivaldszky, 1867, a bushcricket species about to be declared protected, has been known only from one place in the hilly area of Gödöllő from within the Carpathian Basin. The present study was conducted on this population in Hungary in order to gain knowledge of the species´ habitat requirements, as well as to discover more occurrences within the area. Looking at the habitat´s vegetation structure and species composition at different scales, it proved to be rather patchy, especially on a finer scale. We found patches of lower (cca. 10 cm), sparser vegetation alternating with patches of denser and higher vegetation. The distribution of *P. brunneri* between these two patch types changed during the season and with the larval development of the bush crickets. First instar larvae and females prefer more open soil surfaces (the latter for laying their eggs), whereas for older larvae and imagines it is the more densely and higher covered areas that play a leading role. For assessing the situation of the species in Hungary, it is necessary to know the extent of the populated area. In the course of exploring the terrain further around the already known place near Pécel we found the species on several smaller, more or less seperated habitat patches on the surrounding hills as well as on the Mountain of Küdő, lying somewhat further.

INTRODUCTION

As a representative of the *Poecilimon* genus of which the distributional centre lies mostly in the Aegean, Caucasian and Crimean areas, *P. brunneri* (Orthoptera: Phaneropteridae) is typically of a SE-European and a southern E-European distribution (Kis 1962, Heller 1984); it can be found both to the south and to the east of the range of the Carpathians. The only occurrence known from within the Carpathian Basin lies in the hilly area around Gödöllő, north of the town Pécel, where it was found in 2003 (Nagy 2003). Although there was given a short preliminary description of the habitat, for effective protection measures more detailed data is needed. The population first detected here consists of a very small number of individuals and regarding the distribution of the species as a whole, it is extremely isolated. Thus, it is seriously threatened by local extinction, as isolated populations in general are, where there are no nearby areas from which recolonization could take place (Boer 1981). It is essential for taking the appropriate measures that we are sufficiently well informed on the requirements of the target species. In order to achieve this, in 2005 we tried to reveal the ecological requirements of this species´ Hungarian population by examining vegetation structures of inhabited areas, along with the size of the population and its dispersal potential (Vári & Szövényi 2007). The importance of spatial structures has already been recognized by Sänger (1977), newer research promotes this idea, too (e.g. Behrens & Fahrtmann 2004, Krätzel *et al*. 2002, Schuhmacher 2002) and emphasizes their effect on the resulting microclimate, which is ultimately the determining agent in the occurrence of most orthopterans (Ingrisch 1979, Fartmann 1997).

Besides the area where the species was first found by Barnabás Nagy (2003), an estimated 1-2 ha, another place inhabited by *P. brunneri* in an adjacent valley became known. Our research was conducted on this latter site, which was about 12 ha, but we also aimed at the detection of further habitat patches of the species.

MATERIALS AND METHODS

The researched area lies at the southwestern edge of the Hilly Area of Gödöllő, which joins the plain of Pest. The Hilly Area consists mostly of sandy-gravel fluvial deposits on top of which pleistocene loess has settled (Marosi & Somogyi 1990). The researched site lies northeast of the

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town Pécel, on Látó Hill. At the present there is a degraded Pannonic loess steppe (*Festucetum rupicolae* Zólyomi ex Soó, 1964) which is sheep-run (Nagy *et al*. 2005).

The vegetation structure was assessed at different spatial scales (in sampling squares of 0.25 m^2 and of 25 m^2). In these estimates we used the structural growth-types and measured the horizontal structure at different heights as described by Fartmann (1997).

Data from the 25 m^2 plots was taken every 2-3 weeks starting in April 2005, altogether six times at 19 sites (at the grid-points of a 70 x 70 m grid-square). Apart from individual-countings (Vári & Szövényi 2007) we assessed different abiotic and biotic environmental parameters. Among the previous ones was the steepness of the plot (flat: 0-5°, gently sloping: 5-20°, steep: >20°) and its orientation, among the latter ones parameters characterizing the vegetation structure were recorded (the total vegetation cover, the cover of litter and the percentage of open ground, as well as the horizontally seen density of vegetation at a height of 10 cm and of 30 cm and the vegetation composition according to structural growth-types: the coverage of sward forming grasses, tussock grasses, rosette forming plants and wooden plants in percent).

The smaller plots (0.25 m^2) were examined on 15th July 2005 along three (50 x 0.5 m) transects. The vegetation cover (in percent), the mean vegetation height and the number of *P. brunneri* individuals found in the respective squares, as well as the height of each bushcricket´s position were noted. At the time of this examination about 23% were imagines (Vári 2005).

Developmental stages of the nymphs at the time of each counting were determined by measuring the length of their femura (Vári unpublished), thus gaining five distinctly seperable groups. This way we found on 23rd April and on 29th April solely 1st instars, on 13th May 2nd and 3rd instars, on 28th and 29th May mainly 4th instars, but also few 5th instars, on 13th and 14th June mainly 5th instars and few imagines were caught, whereas from 25th June all were imagines.

For data assessment Excel and STATISTICA (StatSoft) software was used: Spearman rank correlation for vegetation parameters and chi-square test for goodness of fit.

The surroundings of the known population were searched several times during 2005 and 2006. Samples were taken by sweep netting (at least 300 sweeps) on sites chosen according to different aspects like closeness to the known habitat patch or similarity of vegetation.

RESULTS

Big plots. The distribution of *P. brunneri* changed with the vegetation coverage during the season (Fig. 1). For first instar larvae an optimum curve is discernible, with an optimum at about 50 % coverage. Such a more densely inhabited range is also detectable for second instars, whereas with the progress of the season this range gets broader until the occurrences are more or less evenly distributed in plots covered about 60 to 90 %. Some sort of a preference for steepness could similarly only be shown at the first counting. At this time half of the first instar larvae inhabited „steep" squares, 30 % „gently sloping" ones and only 20 % were to be found in „flat" squares.

There was no difference in individuals´ distribution between the plots of the SE and of the SW hillsides. We couldn´t find any significant correlation between all the other measured environmental parameters and animal abundance, except one: the correlation with low herbaceous plants at the second counting (2nd and 3rd instars) was significantly correlated ($p<0.05$) according to Spearman rank correlation ($r = 0.73$, $n = 19$). Correlations with all other parameters were weaker than this and/or not significant.

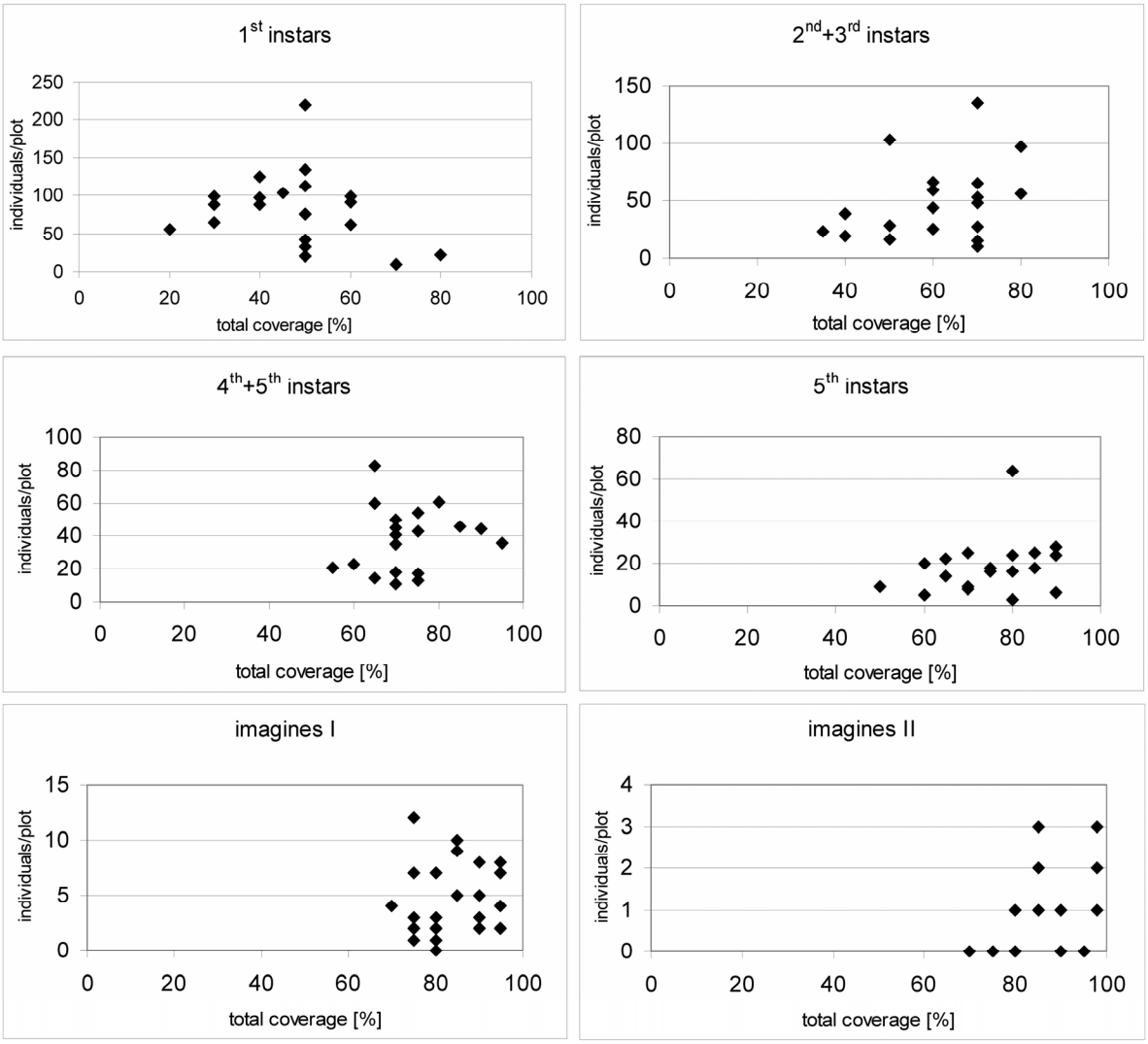

Figure 1. Number of individuals per plot and the plots´ total vegetation cover during the season: 29/04/05 (1st instars), 13/05/05 (2nd+3rd instars), 28/05/05 (4th+5th instars), 13/06/05 (5th instars),01/07/05 and 24/07/05 (imagines)

Small plots. In the smaller scale investigations we succeeded in showing up more definite correlations such as the (adult and 5th instar) bushcrickets´ predominantly sitting on plants protruding from the vegetation (Fig. 2). Their distribution, divided into three categories (higher than avarage vegetation height, at the same height or lower) deviated from an even distribution significantly (X^2=18,553 > $X^2_{(2,\ 0,005)}$ = 10,597). This was confirmed by nighttime investigations on imagines, too (Vári 2005).

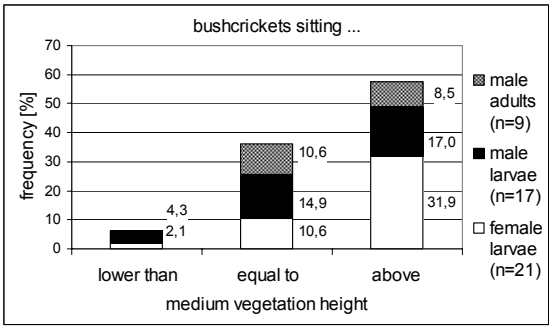

Figure 2. Height of the animals´ sitting places in relation to the surrounding vegetation

Exploring the surrounding hills, we searched an area of about 60 ha (Fig. 3) thoroughly around the investigated population, where, apart from the patch where *P. brunneri* was first recorded from in Hungary, we detected several other habitat patches of different size. Trespassing between these patches is uncertain, even though, physically, it cannot be excluded.

In the summer of 2006 a part of the investigated area (cca. 1 ha) and an adjacent area also populated with *P. brunneri* (cca. 4 ha) was ploughed and planted with oak saplings.

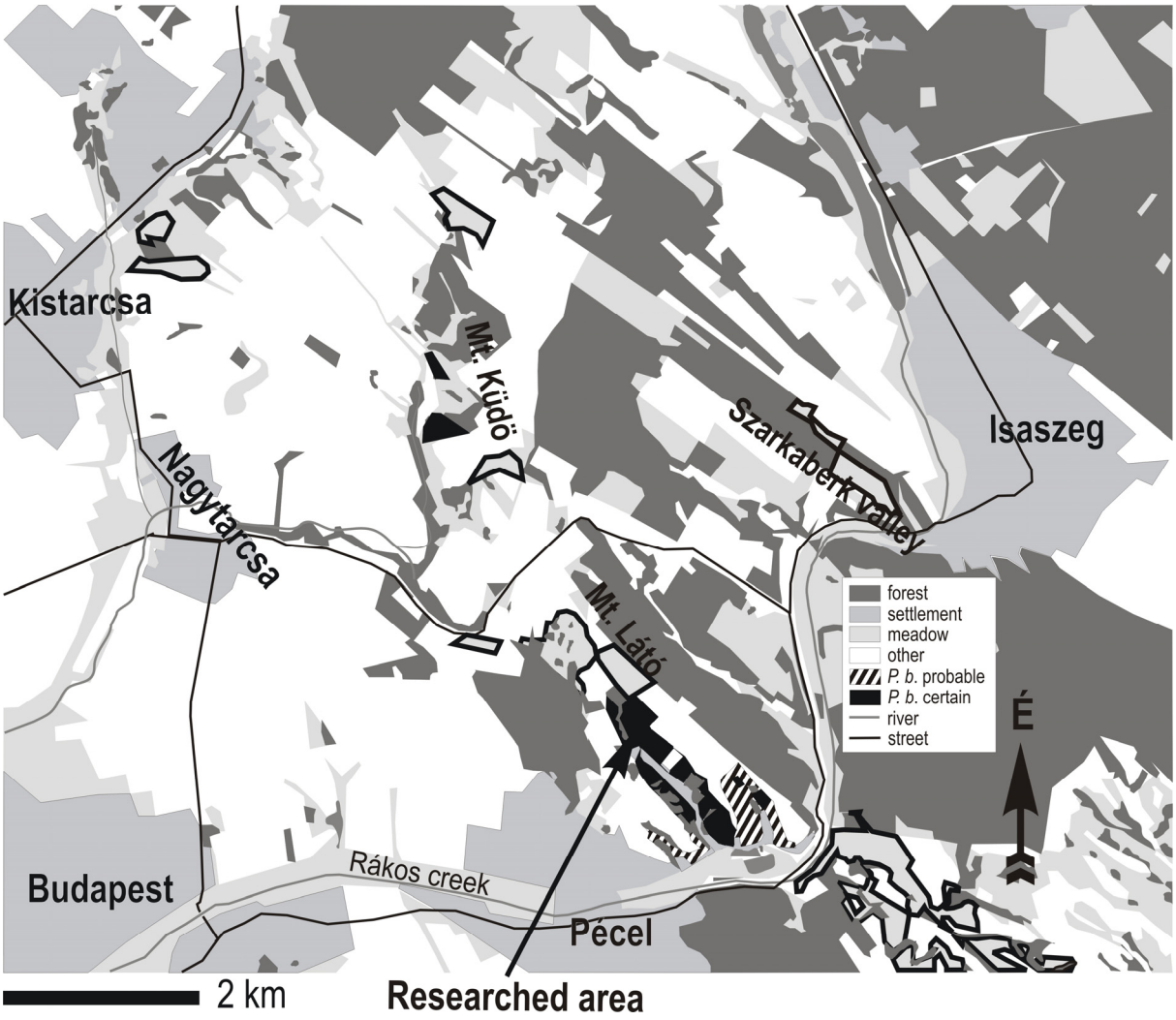

Figure 3. The occurrence of *P. brunneri* in the hilly area of Gödöllő. Areas with proved occurrence of *P. brunneri* are filled black. Areas searched but *P. brunneri* not found are framed with thick black line

Apart from the described patches, we found the species at another hill somewhat further (cca. 3.5 km, Mountain of Küdő). On other nearby places, even with similar vegetation composition, no *P. brunneri* could be detected. In all these inhabited patches the vegetation is denser than at the researched population´s place, probably due to a missing, regular grazing. The density of *P. brunneri* in all these habitat patches seems to be far less than at the researched site.

DISCUSSION

Knowing the dispersal capacity of first instar larvae (Vári & Szövényi 2007), it can be assumed that their observed distribution, according to which they were in greater numbers on plots covered to a certain degree with vegetation, does not result from their actively choosing these places. The clustering of the larvae on rather thinly covered spots could be ascribed on one side to the females preference of laying their eggs into rather open ground patches (own field observation) but also to the different survival chances for eggs and larvae, as both develop better in sparsely covered and in steeper places which warm up more easily (Bruckhaus 1992).

In contrast to other research´s results (Schuhmacher 2002, Walter 1994) we did not find the highest densities of larvae on the least covered patches, but somewhere in the middle of the range of all densities recorded at one time. Looking at the absolute numbers of recorded vegetation cover this can be easily explained as the lowest percentages of cover still reached about 80 to 90 % in the cited investigations, whereas we had up to 20-70 % uncovered ground (depending on the time of the year). As the vegetation provides also food and shelter, it seems logical that a certain minimum of vegetation is beneficial for their development. The correlation between bushcricket densities and lower herbaceous plants at the second counting seems plausible, as according to our knowledge of *P. brunneri´*s feeding habits it only eats various herbaceous dicotyledonous, but no monocotyledonous plants at all (Nagy 2003, Vári 2005). In the light of the above, it should be rather more the lack of other connections that is harder to interpret. It might be explained by a blurring effect of vegetation growth in other structural types later on, which were not present at the time of the second countings. Furthermore, we suppose that the lack of significant correlations between vegetation parameters and bushcricket abundance taken at the bigger scale is related to the fineness of the patchy pattern for which the 5 x 5 m squares were too rough to detect otherwise existing differences.

Regarding the preference of high sitting places, we have to take several facts into account, as we have seen *P. brunneri* exhibiting this behaviour during the day just as well as in the night. We might assume that during the day it is the insolation that influences the animals´ behaviour as in sunny weather protruding places are the thermally most beneficial ones and this is sought actively by some orthopterans (Samietz 1998, Chappell 1983) as it has been proven to have a positive influence on physiological processes like maturing of the eggs (Samietz 1998). In contrast to this, in the night, the search for mating partners is a more probable explanation, during which the bush crickets stridulate (as well as listen to others stridulating) preferably from acoustically advantageous places (Kalmring 1990). But other, microclimatic components of the observed behaviour cannot be excluded either.

Looking at the mapped occurrences of *P. brunneri* in the surroundings we can see a rather large area of altogether 70 ha inhabited patchily. In evaluating this, it is important to see the degree of fragmentation of these patches, also in relation to the rather poor dispersal abilities of the animals (Vári & Szövényi 2007). For this reason, even relatively small distances present serious obstacles, so there is actually not one big area that can be populated evenly, but several smaller spots and one bigger patch, which is threatened by being ploughed or built up.

The present study shows that there is not one single parameter that defines the habitat requirements of *P. brunneri* but rather more the complex structural diversity of the vegetation, the patchiness of the habitat that is of basic importance to the species. This structure of alternating sparsely and densely vegetated patches can be maintained by keeping up sheep grazing or by the early spring burnings.

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