Dynamics and vertical distribution of a *Hrabeiella periglandulata* (Annelida) population in South Moravia, Czech Republic

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Abstract – The objective of this work was to evaluate the density, dynamics and vertical distribution of a *Hrabeiella periglandulata* population in a forest soil at Brno, Czech Republic. From December 2003 to November 2004, two plots covered by mixed stands and two covered by coniferous stands were sampled monthly. Six soil cores per plot were taken down to 15 cm and subdivided into layers, which were subjected to wet funnel extraction. Missing in one of the coniferous stands *H. periglandulata* was abundant in the mixed stand with the highest soil pH. In this stand, monthly sampling continued until November 2005, with three additional samplings up to January 2007. Mean annual density was 2,672±1,534 individuals m⁻². Population dynamics differed from those reported from Germany. Highest densities were reached in early summer, lowest between August and December. Due to aggregated horizontal distribution, differences between monthly values were often nonsignificant. No significant correlation with climatic data was found. Nevertheless, the observed dynamics corresponded to the climatic conditions, showing particularly the negative effect of drought. The population was evenly distributed in the sampled soil profile, only avoiding the organic layer. Except for a locality in Poland, this is the easternmost record of the species.

Index terms: soil biology, soil fauna, terrestrial Polychaeta.

Introduction

*Hrabeiella periglandulata* Pižl & Chalupský, 1984, is one of the two truly soil-dwelling, non-clitellate annelids ("Polychaeta") known so far. Since its description (Pižl & Chalupský, 1984), its unclear systematic position has provoked several studies on morphology and phylogeny (Rota & Lupetti, 1996, 1997; Rota, 1998; Purschke, 1999; Purschke, 2000; Rota et al., 2001; Purschke, 2003; Jördens et al., 2004). Whereas a formerly proposed close relationship to the other truly soil-dwelling, polychaeotous annelid *Parergodrilus heideri* Reisinger, 1925, has been repeatedly dismissed, some morphological and, in particular, ultrastructural characters suggest a potential sister-group relationship with the Clitellata. However, molecular analyses have so far not supported this view.

Little is known about its ecology and area of distribution. In all cases, the species has been recorded...
in studies focusing on enchytraeids. Records have been published from Europe only, showing a range from southern Sweden in the north (Erséus & Rota, 1998), across central Europe – Germany (Jans & Römbke, 1989; Graefe, 1989, 1990, 1993a, 1993b; Purschke, 1999; Beylich & Graefe, 2007), Czechia (Pižl & Chalupský, 1984; Šídová & Schlaghamerský, 2007) and Poland (Dumnicka & Rożen, 2002) – to central Italy in the South (Rota & Lupetti, 1996). It has been found in soils of deciduous and coniferous forests, as well as of meadows and gardens. Graefe & Schmelz (1999) have characterised the species as an indicator of fresh soils (absent in wet habitats) of slight to moderate soil acidity (adapted to acidity stress), and preferring the A horizons of soils with mull to moder humus forms. According to Rota (1998), the species cannot endure a prolonged submersion in water, but is also very sensitive to drought.

This work reports on a population found in a municipal forest of the city of Brno (South Moravia, southeastern Czech Republic), during a study on enchytraeids (Clitellata: Enchytraeidae) commenced in late 2003 (Schlaghamerský & Šídová, 2007; Šídová & Schlaghamerský, 2007). Comparable ecological data on *H. periglandulata* have only been published from a few sites in southwestern Germany (Jans & Römbke, 1989), but even in that study, no proper year-round sampling was conducted.

The objective of the present study is to provide information on the density, population dynamics and vertical distribution of this population of *H. periglandulata*, based on year-round data.

### Materials and Methods

The study was conducted in the Holedná Game Park and in an adjacent forest (49°12'N, 16°32'E), both part of the municipal forest of the city of Brno, Czech Republic. The long-term annual air temperature was 9.8 °C (1987–2006), the long-term annual precipitation 533 mm (1994–2007). Four circular plots (177 m² each) were studied: two with coniferous trees only (Norwegian spruce, Scots pine, European larch), and two with mixed stands (pine, sessile oak, beech, black locust). One plot of each pair (stand type) was located within the game park, the other in the adjacent forest. The farthest distance between the plots was ca. 400 m. The soil was partially Albeluvisol, partially mesotrophic Cambisol, with a silty loam texture, and the humus form moder, tending towards mor in the coniferous stands (Šídová & Schlaghamerský, 2007) (Table 1).

*Hrabeiella periglandulata* was studied at this site from December 2003 to January 2007. From December 2003 to December 2004, six randomly positioned soil cores (17 cm² area, depth mostly 12 cm or more) were taken at the beginning of each month, in each of the four above mentioned plots. Monthly sampling continued till November 2005 in one of the plots (mixed stand within the game park, with the highest density of *H. periglandulata*). In March and May 2006, and January 2007, further 6 or 8 cores per date were taken in this plot. All soil cores were cut into layers according to soil horizons (3 cm layers, when horizons were thicker or not well distinguishable). All the subsamples were subjected to wet funnel extraction: 12-hour exposure without heating, then heating of the soil surface up to 43 °C within 3 hours. Extracted specimens were stored in water at 8 °C and, subsequently, counted under a binocular preparation microscope. During 2004, further soil samples were taken for analysis of soil chemistry and texture.

### Results and Discussion

Except for a locality in southeastern Poland (Dumnicka & Rożen, 2002), the study site presents

<table>
<thead>
<tr>
<th>Plot</th>
<th>Soil layer (cm)</th>
<th>pH (H₂O)</th>
<th>pH (KCl)</th>
<th>pH (H₂O)</th>
<th>pH (KCl)</th>
<th>pH (H₂O)</th>
<th>pH (KCl)</th>
<th>pH (H₂O)</th>
<th>pH (KCl)</th>
<th>Cₐ (g kg⁻¹)</th>
<th>N (g kg⁻¹)</th>
<th>Na (mg kg⁻¹)</th>
<th>K (mg kg⁻¹)</th>
<th>Ca (mg kg⁻¹)</th>
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<td>4.3</td>
<td>3.3</td>
<td>714</td>
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<td>6</td>
<td>32</td>
<td>136</td>
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</table>

| Note: OC, outside the Holedná Game Park; IC, inside the game park; C, coniferous stand; D, mixed stand dominated by deciduous trees; 0–3 cm soil layer = organic layer, thickness variable; 3–12 cm soil layer = mineral layer, below organic layer (ca. 3 cm thick). |
Dynamics and vertical distribution of *Hrabeiella periglandulata*

the easternmost published record of the species, thus
shifting the border of the known range further to the
southeast, and by large closing the gap between known
localities in the southwest, South Bohemia (Pižl &
Chalupský, 1984) and northwest (North Bohemia) of
the Czech Republic, and the above mentioned Polish
site (Figure 1). While the lack of records from most of
Scandinavia, the Netherlands and the British Isles might
represent a biological fact, the same is probably not true
for further parts of western Europe, where a lack of soil
mesofauna studies based on wet extraction techniques
(usually used to study enchytraeids) might be responsible
for missing records. The same is true for other parts of
central, southern and eastern Europe, except for Austria
and Hungary, where enchytraeids have been studied
rather extensively, but *H. periglandulata* has not been
recorded so far.

From December 2003 to December 2004, *H. periglandulata* was found in three of the four
study plots: mixed forest stand inside Holedná Game
Park (344 specimens); mixed forest stand outside
Holedná Game Park (31 specimens); coniferous
forest stand inside Holedná Game Park (3 specimens).

Densities differed substantially along a transect of only ca.
400 m (distance between the most remote plots). Over the
entire study period until January 2007, 758 specimens were
collected in the first plot (characterised by the highest soil
pH) (Table 1). The mean annual density, based on two years
of monthly sampling, was 2,672±1,534 individuals m⁻².

The mean annual density of all enchytraeid species (based
on one year of monthly sampling), in the first plot, was
14,500±4,900 individuals m⁻² (Šídová & Schlaghamerský,
2007). This shows that *H. periglandulata* can be
a quantitatively important member of the annelid
assemblage in soils (with individuals reaching up to
1.5 mm in body length, the biomass of an individual or
of a given population will of course stay below that of
most enchytraeid species). Annual density maxima were
found in May 2004 and June 2005, and low densities
from late summer till October or even into the winter
as in December 2003 or November 2005 (Figure 2).

The lowest mean density recorded in this plot was
196 individuals m⁻² in September 2005, and the highest
one was 11,863 individuals m⁻² in June 2005. Due to the
highly aggregated horizontal distribution (also indicated
by the high standard errors of the mean), many of the
monthly values did not differ significantly. However, the
observed trend in population dynamics corresponded
to the climatic development during the study period
– with low densities at times of low precipitation and
partially also low temperatures. This trend showed,
particularly, the negative effect of the droughts at the
end of the summer. The observed population dynamics
differed from those at sites in southwestern Germany,
where minima occurred in early summer, and maxima
in winter (Jans & Römbke, 1989). This is in rather
good agreement with the differences between the
more Atlantic climate in southwestern Germany and
the more continental climate in southeastern Czech
Republic, and shows that one has to be careful in
drawing general conclusions on a species' biology
based on local phenological data.

The studied population had a very even distribution
in the upper soil profile down to ca. 15 cm, only
avoiding the organic layer (Figure 3). Particularly
during the winter months (frozen soil), we were not
always able to sample into greater depth than 9 cm. To
compensate for the underrepresented layers below this
depth, the presented data for the individual layers have
been weighted. The organic horizon in the study plots

**Figure 1.** Records (●) of *Hrabeiella periglandulata* in Europe
(Pižl & Chalupský, 1984; Jans & Römbke, 1989; Graefe, 1989,
1990, 1993a, 1993b; Rota & Lupetti, 1996; Erséus & Rota,
1998; Purschke, 1999; Dumnicka & Rožen, 2002; Beylich &
Graefe, 2007; Šídová & Schlaghamerský, 2007); (▲) our record
from Brno, Czech Republic; (■) new record of first author from
North Bohemia, Czech Republic (October 2008).
was often very dry during samplings. This might have contributed to the low percentage of *H. periglandulata* in this layer, as observed to some degree also in the case of enchytraeids (Schlaghamerský & Šídová, 2007; Šídová & Schlaghamerský, 2007). However, avoidance of the uppermost organic soil layer by *H. periglandulata* was also observed elsewhere within its known range (Jans & Römbke, 1989; Graefe & Schmelz, 1999). The high percentage of specimens found in the sampled part of the B-horizon at our site (depending on the soil core these were 12–15 cm and, partially, also 9–12 cm layers) was remarkable, as this consisted of very fine, silty mineral soil with very little organic matter. Thus, although the soil at our site seemed rather special, the vertical distribution of *H. periglandulata* found here was in agreement with that observed by other authors (Jans & Römbke, 1989; Graefe & Schmelz, 1999). It is possible that the proportions of

**Figure 2.** Population dynamics (mean monthly densities±SE) of *Hrabeiella periglandulata* in the most studied plot (mixed forest stand, inside Holedná Game Park) from December 2003 to January 2007; monthly mean air temperatures and precipitation sums from October 2003 to January 2007 from the closest meteorological station; note that abundance data were collected at the beginning of each month.

**Figure 3.** Vertical distribution (mean percentages of individuals present in individual soil layers) of *Hrabeiella periglandulata* in the most studied plot (mixed forest stand, inside Holedná Game Park).
individuals dwelling in greater depths than the sampled ones were not negligible, and the true population densities might be, therefore, higher than those presented.

Conclusions

1. *Hrabeiella periglandulata* can reach densities of several thousand individuals per square metre, comparable to the densities of other small soil annelids – in particular enchytraeids – in the same soils.

2. The population of *H. periglandulata* in Brno reaches maximal densities in late spring to early summer and minimal densities in late summer to autumn.

3. At the study site, *H. periglandulata* is rather evenly distributed in the upper 15 cm of soil, only avoiding the litter layer.

4. The range of *H. periglandulata* reaches further to the southeast than previously reported.

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References


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