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Seasonal Changes of an Oligochaetous Clitellata (Annelida) Community in a Mountain Stream

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Abstract: Oligochaetous Clitellata (Annelida) were studied during the years 2003–2004 in the Morávka River, a second order stream in the Moravskoslezské Beskydy Mts. Samples were taken monthly at six sampling points situated along a 110 m river stretch, and water temperature, pH and conductivity were recorded. Altogether 1438 individuals of Annelida belonging to 13 species of oligochaetous Clitellata and one species of Aphanoneura were found. Multivariate analysis (CCA) revealed that temperature and the nominal variables winter and autumn were significant for explaining seasonal changes in the community structure. *Pristinella bilobata* (Naididae) was recorded for the first time in the Czech Republic and its seasonal dynamics were evaluated.

Key words: oligochaetous Clitellata, community structure, *Pristinella bilobata*, seasonal dynamics

INTRODUCTION

This study is focused on an invertebrate group, originally called Oligochaeta (phyllum Clitellata), which according to DNA analyses represents a paraphyletic assemblage including also leech-like taxa, and should be synonymous with Clitellata (Martin, 2001). Erséus (2005) suggested the term oligochaetous Clitellata for "clitellates bearing (few) chaetae, as opposed to branchiobdellidans and hirudinidans". This very rich group has not often been studied in mountain streams, because they are extremely poor in organic detritus, a typical oligochaete food. Only one strictly aquatic detritophagous species, *Stylodrilus heringianus*, is frequently found (Dumnicka, 2000). Other species are either grazers feeding mainly on algae (Naididae) or semi-aquatic gathering collectors utilizing also organic material from the soil (Enchytraeidae and Lumbricidae). The goal of this study is to reveal seasonal changes, species coexistence and life history of this rather untypical community of a mountain stream. Particular conditions in the Morávka River enabled the reproduction of *Pristinella bilobata*, a species new for the Czech Republic, and we present the information about its seasonal dynamics which have not yet been investigated.

MATERIAL AND METHODS

This study was carried out in a 110 m stretch of the Morávka River near the village of Morávka in the Moravskoslezské Beskydy Mts (700 m a.s.l., 18°32′52″ E, 49°30′27″ N). The bottom substratum of the river was formed by boulders and cobbles of sedimentary rocks filled with coarse gravel. Altogether, 88 quantitative samples were taken using a Surber sampler (0.3 mm mesh size) with a bottom area of 0.132 m^2. Sampling was conducted in 15 sampling events between April 2003 and July 2004 (6 samples in each event, except the first one with 4 samples). Macrozoobenthos samples were preserved by formaldehyde (4%) in the field, and oligochaetous Clitellata were sorted and stored in 70% ethanol in the laboratory. Small specimens were identified in glycerine-water solution (1:5) and large ones in Canadian Balsam, using the keys of Brinkhurst & Jamieson (1971), Hrabě (1981) and Timm (1999). Three aspects of the oligochaetous Clitellata community were evaluated:

1. Seasonal changes in the diversity and dominance. The diversity was computed by Shannon's index H' (Shannon, 1948), and changes as well as changes in dominance were compared using one-way ANOVA. The Tukey post hoc test (multiple comparison tests) was used to determine the significant differences between means in an analysis of variance. The clitellate family proportions were evaluated, and changes in abundances during the studied period were compared using the Spearman rank correlation coefficient (Zar, 1984).
2. The relationships between species assemblages and environmental variables were analysed by Canonical Correspondence Analysis (CCA, CANOCO) (ter Braak & Šmilauer, 2002). This analysis represents a direct (constrained) ordination technique for finding the biggest variability in a species data set explained by environmental variables gradients. Data were not transformed. The analysis was applied to 15 sampling events, 22 taxa, three quantitative variables (pH, temperature and conductivity) and four nominal variables (spring, summer, autumn and winter). The statistical significance of the relation between the species and environmental variables was evaluated using Monte Carlo permutation tests (9999 permutations).
3. Seasonal dynamics of *P. bilobata*. Mean abundances from 6 samples during 15 sampling events were evaluated with time series analysis. After moving average smoothing and estimating one missing value from adjacent points, autocorrelations were computed. The correlation with temperature was evaluated using the Spearman rank correlation coefficient (Zar, 1984).

Statistica 7 for Windows (StatSoft 2004) was used for all analyses.

RESULTS

In the Morávka River, 1438 individuals of oligochaetous Clitellata (Annelida) belonging to 13 species of five families, three genera of the family Enchytraeidae not further identified, and one species of Aphanoneura (Annelida) were recorded (Tab. 1). *P. bilobata* and *S. heringianus* were the eudominant species.

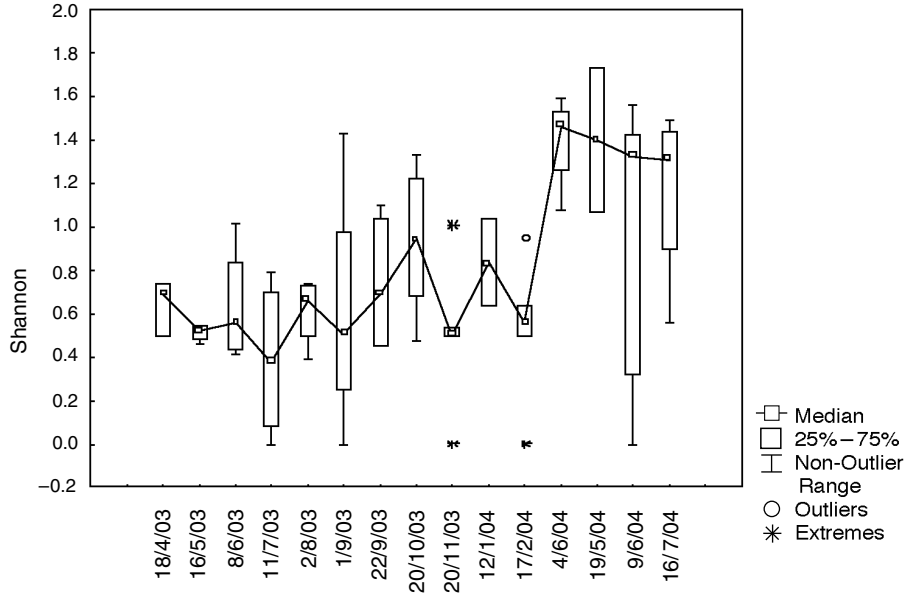

Fig. 1: Seasonal changes of the Shannon diversity index of the oligochaetous Clitellata community.

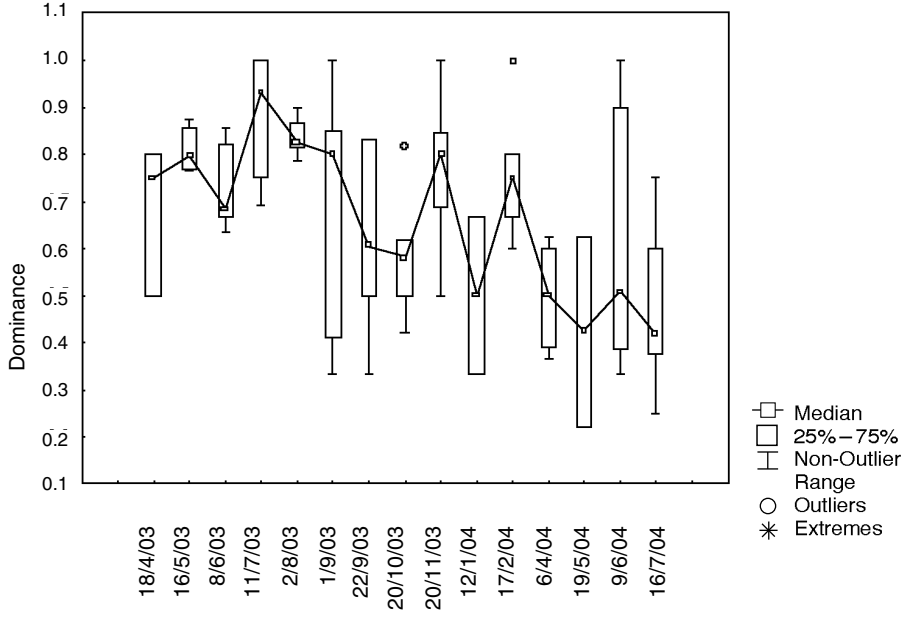

Fig. 2: Seasonal changes of dominance in the oligochaetous Clitellata community.

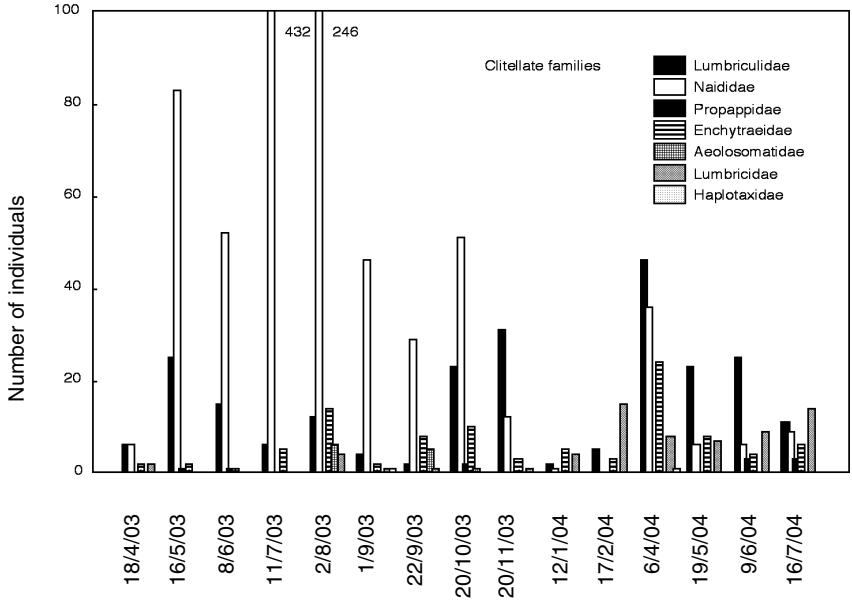

Fig. 3: Seasonal changes in clitellate family proportions.

1. Seasonal changes in the values of Shannon's index H' (Fig. 1) and dominance (Fig. 2) were significant; the null hypothesis of equality of means was rejected for the Shannon's index ($F = 3.49$, $p = 0.0004$), as well as for dominance ($F = 3.05$, $p = 0.0015$) (one-way ANOVA). The multiple comparisons by the Tukey test revealed pairs of sampling events which differed significantly in the Shannon index: 16. 5. 03 and 6. 4. 04 ($p = 0.0096$), 11. 7. 03 and 6. 4. 04 ($p = 0.0142$); in dominance 2. 8. 03 and 6. 4. 04 ($p = 0.0297$). The seasonal changes in clitellate family proportions were evaluated (Fig. 3). A negative correlation of abundances in the family Naididae and Lumbricidae ($r_s = -0.534$), and a positive correlation of abundances in the family Enchytraeidae and Aeolosomatidae ($r_s = 0.563$) were found ($p < 0.05$).
2. Canonical Correspondence Analysis. Fig. 4 shows the position of species in the ordination space of the first and second axes. The first axis explained 51.0% of the variability in species-environment data, the second axis 24.8% and the third 13.4%. Three environmental variables were significant (Monte Carlo permutation test) for oligochaetous Clitellata community structure: water temperature ($p = 0.0001$, negatively correlated with the first axis), and the nominal variables winter ($p = 0.0001$, positively correlated with the second axis) and autumn ($p = 0.0043$, negatively with the second axis). Conductivity and pH were positively correlated with temperature. The first ordination axis separated species prevailing in warmer parts of the year from those occurring in colder months. Species were further divided along the second axis to "autumn" and "winter" species.

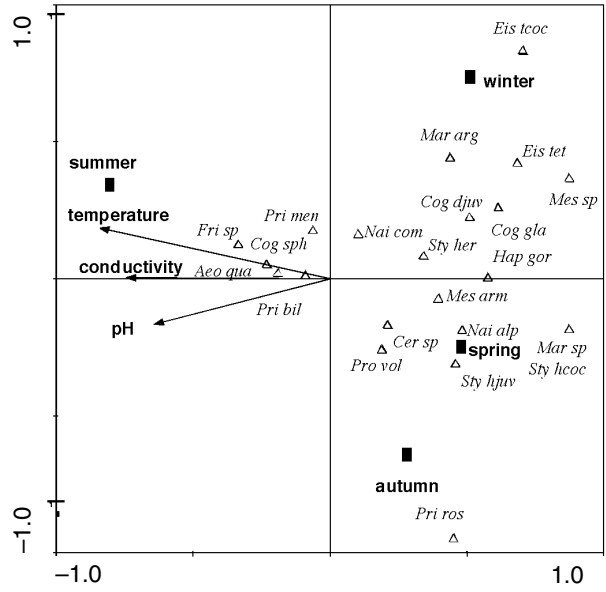

Fig. 4: CCA of oligochaetous Clitellata and Aphanoneura species and environmental variables in the ordination space of the first and the second axes; for abbreviations see Table 1.

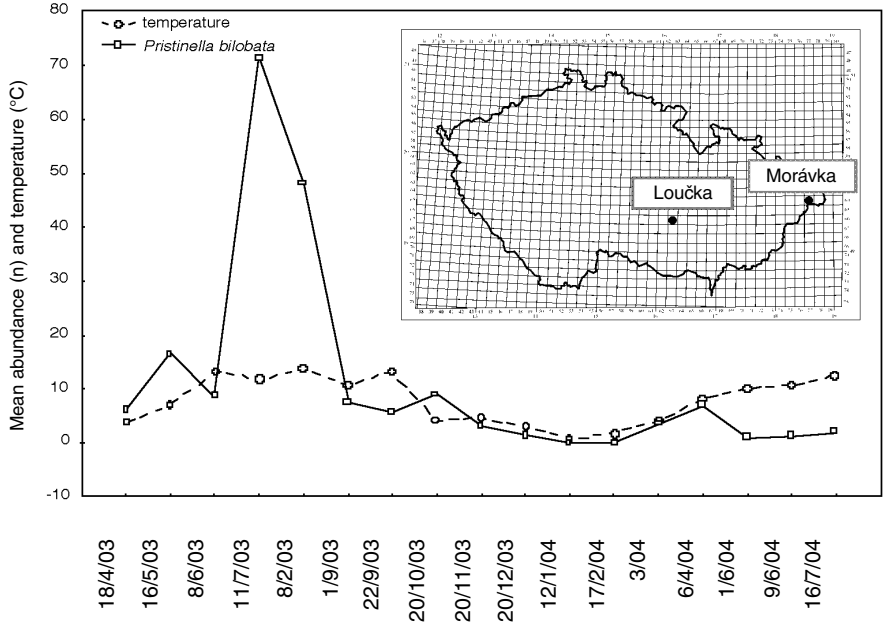

Fig. 5: Seasonal changes of *P. bilobata* abundance and water temperature. In the upper right corner is a map of the Czech Republic with the location of streams where *P. bilobata* was recorded.

3. The life history of *P. bilobata*. The species *P. bilobata* was recorded for the first time in the Czech Republic in the Morávka River. This species was also recorded sporadically in the Loučka River near Skryje (16°19′36″ E, 49°22′30″ N) at 300 m a.s.l. (leg. Opravilová, det. Schenková, 2000) (Fig. 5), but this finding has not yet been published. The seasonal dynamics of *P. bilobata* was visualised after smoothing and estimating one missing value (Fig. 5). A significant correlation of mean abundance with water temperature was found ($r_s = 0.514$, $p < 0.05$). Autocorrelations were computed, but no cyclic trend was found.

Table 1: List of oligochaetous Clitellata and Aphanoneura recorded.

Family	Species/genus	Author	Abbreviation	Abundance (n)	Dominance (%)
Aeolosomatidae	*Aelosoma quaternarium*	Ehrenberg, 1931	Aeo qua	12	0.83
Enchytraeidae	*Cernosvitoviella* sp.		Cer sp	26	1.81
	Cognettia glandulosa	(Michaelsen, 1888)	Cog gla	18	1.25
	Cognettia sphagnetorum	(Vejdovský, 1877)	Cog sph	9	0.63
	Cognettia sp. div juv.		Cog djuv	6	0.42
	Fridericia sp.		Fri sp	3	0.21
	Marionina argentea	(Michaelsen, 1889)	Mar arg	5	0.35
	Marionina sp.		Mar sp	6	0.42
	Mesenchytraeus armatus	Levinsen, 1884	Mes arm	17	1.18
	Mesenchytraeus sp.		Mes sp	7	0.49
Haplotaxidae	*Haplotaxis gordioides*	(Hartmann, 1821)	Hap gor	2	0.14
Lumbricidae	*Eiseniella tetraedra*	(Savigny, 1826)	Eis tet	20	1.39
	Eiseniella tetraedra (cocoon)		Eis tcoc	44	3.06
Lumbriculidae	*Stylodrilus heringianus*	Claparede, 1862	Sty her	43	2.99
	Stylodrilus heringianus juv.		Sty hjuv	187	13.00
	Stylodrilus heringianus (cocoon)		Sty hcoc	6	0.42
Naididae	*Nais alpina*	Sperber, 1948	Nai alp	2	0.14
	Nais communis	Piguet, 1906	Nai com	22	1.53
	Pristina menoni		Pri men	2	0.14
	Pristinella bilobata	(Bretscher, 1903)	Pri bil	980	68.15
	Pristinella rosea	(Piguet, 1906)	Pri ros	10	0.70
Propappidae	*Propappus volki*	Michaelsen, 1916	Pro vol	11	0.76
Total				1438	100.00

DISCUSSION

In some aspects, the composition of the oligochaetous Clitellata community studied represented a typical mountain stream community. A high diversity of the family Enchytraeidae, with the taxa *Cernosvitoviella*, *Mesenchytraeus armatus*, *Cognettia glandulosa* and *C. sphagnetorum*, is consistent with characteristics of such streams, especially those which originate from rheo- and helocrene springs (Dumnicka, 2000). Also, the species *S. heringianus* (family Lumbriculidae) is typical for upper-middle water courses (Martínez-Ansemil & Collado, 1996). On the other hand, the massive occurrence of the family Naididae with the eudominant *P. bilobata* is unique; usually, the genus

Pristinella can be found only in floating sand habitats (Schwank 1985). In several studies concerning mountain streams (Dumnicka, 1982, Dumnicka & Kukuła, 1990, Šporka, 1996), in spite of similar species compositions (about 60% of species), the genus *Pristinella* was not recorded. Another genus of this family, *Nais*, is typical for either upper courses with no shading in open areas (Dumnicka, 1994), or for high mountain streams originating from lakes (Dumnicka, 2000).

Seasonal changes in the species diversity and dominance were most distinct between the sampling events in spring of the first and in spring of the second years. The differences can either be explained by very high regular fluctuations in the community composition within this time, or by the impact of an exceptionally dry (climatically anomalous) year 2003 on the worm community. While the abundance of *S. heringianus* was well-balanced, enormous reproduction of *P. bilobata* in the first year, especially during the hot July and August, resulted in a striking difference between its abundance in 2003 and 2004. In the second year of research, *P. bilobata* was replaced by *E. tetraedra* (Lumbricidae), another upper-courses inhabitant (Martínez-Ansemil & Collado, 1996). The correlation of development between Enchytraeidae and the infrequent Aeolosomatidae can be explained by their similar reaction to the climatic change, i.e., improving conditions after a very dry year. Our data correspond to the scarce information about habitat preferences of the genus *Aeolosoma*; worms of this genus are common on algae, sludge on stones in brooks, and in colonies of bryozoas; they represent another dominant species in floating sand communities (Schwank, 1985).

Multicriterial analysis (CCA) brought the expected result that seasonal changes in the community structure are strongly influenced by water temperature. Moreover, great differences were found between the autumn and winter communities, which can be explained by various life strategies for overwintering in particular species, e.g. differences in depth of survival in the river bottom.

The new species for the Czech Republic, *P. bilobata*, is an "imperfectly known, somewhat dubious species" (Sperber, 1950). Its main identification characters are needle setae with teeth equally long and stomachal dilatation in VII or VIII, and the distribution in central Europe. The very similar species *Pristinella jenkinae* (Stephenson, 1931) (syn. *P. idrensis*), has longer proximal teeth and stomachal dilatation in VI, and is known only from Sweden, Poland and Great Britain. Our specimens match the description of *P. bilobata* in these features as well as in the length of setae described by Sperber (1950). The saprobic evaluation of *Pristinella* species by Uzunov et al. (1988) is a bit confusion: *P. bilobata* is an alpha- and betasaprobic species, while *P. idrensis* is a xeno- and oligosaprobic species. We found *P. bilobata* in well oxygenated oligosaprobic mountain water, and Timm and Veldhijzen van Zanten (2002) also describe it as a freshwater species.

The reproduction of *P. bilobata* is mostly asexual by paratomy; sexual reproduction is rare or seasonal (Timm & Veldhijzen van Zanten, 2002). In the mountain stream under study, only asexual reproduction was observed and no mature individuals were found. The dry summer of the first year of our study seems to have been optimal for its reproduction, and *P. bilobata* probably reproduced in 2–3 months intervals. However, due to the short time of research, no cyclic trend of reproduction in *P. bilobata* could be observed. Future study of the Morávka River can reveal more about the behaviour and ecology of this species, as well as about the exceptionality of this whole oligochaetous Clitellata community.

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