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Food composition of two European groundhoppers (*Tetrix tenuicornis*, *Tetrix ceperoi*): bryophagy or detritophagy?

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INTRODUCTION

Tetrigidae (groundhoppers) are small, short-horned Orthoptera with an elongated pronotum, which covers the abdomen and hind wings. Generally, Tetrigidae belong to the least-studied groups of Orthoptera, when especially their ecological preferences and food biology is almost unknown (Ingrisch & Köhler 1998). Tetrigidae are known to feed on algae, mosses, small plants and detritus, but there is a lack of data about proportion of the above mentioned food types (Podgornaya 1983; Paranjape et al. 1987). There still remains a question what is the main food component of their diet (Kočárek et al. 2008). We studied food composition of the species *Tetrix ceperoi* (Bolivar, 1887) and *T. tenuicornis* (Sahlberg, 1893) by means of dissections and analysis of their gut contents.



Fig 3: Habitat of *T. ceperoi* in the sand pit near Bzenec-Přivoz, the Czech Republic.



Figs 4, 5: Details of the most frequently eaten mosses.

Tab. 1. Relative frequencies of the moss species at the studied locality and in the gut contents of *T. ceperoi* and *T. tenuicornis* individuals. Number of dissected specimens: *T. ceperoi* 39(18♂/21♀); *T. tenuicornis* 61(27♂/34♀).

Moss species	Relative frequency at locality (%)	Relative frequency in gut content (%)					
		<i>Tetrix ceperoi</i>			<i>Tetrix tenuicornis</i>		
		♂	♀	Σ	♂	♀	Σ
<i>Amblystegium serpens</i>	0.0	18.5	0.0	8.2	0.0	0.0	0.0
<i>Barbula</i> spp.	13.9	48.1	41.2	44.3	31.6	35.3	33.3
<i>Brachythecium</i> spp.	0.0	0.0	2.9	1.6	0.0	0.0	0.0
<i>Bryum argenteum</i>	1.3	11.1	38.2	26.2	21.1	35.3	27.8
<i>Bryum caespiticium</i>	79.7	88.9	94.1	91.8	78.9	1.0	88.9
<i>Ceratodon purpureus</i>	4.2	7.4	8.8	8.2	31.6	41.2	36.1
<i>Funaria hygrometrica</i>	0.8	0.0	0.0	0.0	0.0	0.0	0.0
<i>Plagiommium undulatum</i>	0.0	7.4	0.0	3.3	0.0	0.0	0.0



Fig 1: *Tetrix tenuicornis* is a Palaearctic species, which occupies mainly dry or semidry open locations. It is one of the most common groundhopper species in the Czech Republic.



Fig 2: *Tetrix ceperoi* is a West-Mediterranean species, which reaches the north-eastern edge of its range in Central Europe. *T. ceperoi* is restricted to damp, warm habitats, such as dune valleys, sand pits or heath ponds in the territory of the Czech Republic.

MATERIAL AND METHODS

The groundhoppers have been collected in the sand pit near Bzenec-Přivoz (Fig 3) in SE Moravia (48°55'40.67"N, 17°16'47.37"E) by sweeping and immediately stored in ethylalcohol. Together with the insects, the samples of all visually different terrestrial mosses have been collected, that were subsequently identified to species level. The dissections have been made by the cutting of the abdomen cavity by thin forceps and taking out the oesophagus, crop and proventriculus. The permanent microscopic preparations of the alimentary tract content have been made with the use of Hoyer's solution (Anderson 1954). For the comparison and determinations of the tissue fragments in alimentary tract contents, the permanent microscopic preparations of the leaves of each moss species taken from the same locality have been made by the same method. The percentage of food components within the gut content was determined from microphotographs of the microscopic preparations.

RESULTS

A dominant component of the diet of both species at each micro-locality was detritus (soil with unidentified decomposed organic matter). On average, it comprised 79.4% of the total amount of the food in *T. tenuicornis* and 89.9% in *T. ceperoi*. (Fig 7). Females of both species consumed significantly larger amount of food, as well as more detritus and more mosses particularly; but the rate of detritus vs. mosses consumption was constant in both sexes and both species.

Four moss species were found in the diet of *T. ceperoi* and five moss species in *T. tenuicornis*. The most frequent moss in the gut of both species was identified as *Bryum caespiticium* (Fig 4), which was the dominant moss species in the locality with relative coverage of 80% (Tab. 1). Altogether, the presence of at least one fragment of one moss species was detected in 90% of *T. ceperoi* specimens and 97% of *T. tenuicornis* specimens. Besides mosses and organic detritus, some fragments of vascular plants (grasses), pollen grains, algae, hyphae of Basidiomycetes, and rarely also fragments of arthropods (Arachnida, Insecta) and Tardigrada were found. The total portion of these components in the food was not higher than 1.0% in particular species.

The average number of moss species detected simultaneously in gut contents of one specimen of *T. ceperoi* was 1.47 (SD ± 1.03) in males and 2.00 (SD ± 0.84) in females, when the maximal number was four moss species (Fig 6). The average number of moss species detected in gut content of one specimen of *T. tenuicornis* was 1.85 (SD ± 0.82) in males and 2.09 (SD ± 1.05) in females, when the maximal number was also four moss species. Differences in numbers of moss species between sexes were not significant.

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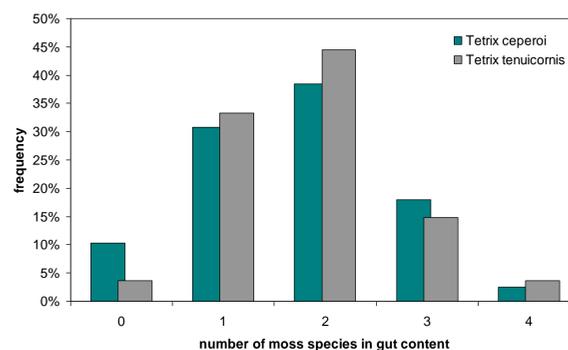


Fig 6: Numbers of moss species simultaneously detected in gut contents of *T. ceperoi* and *T. tenuicornis*

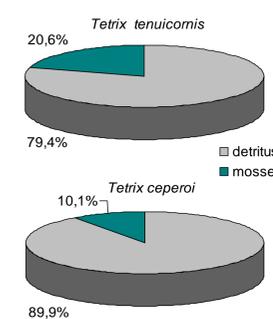


Fig 7: Average relative composition of food in *T. tenuicornis* and *T. ceperoi*

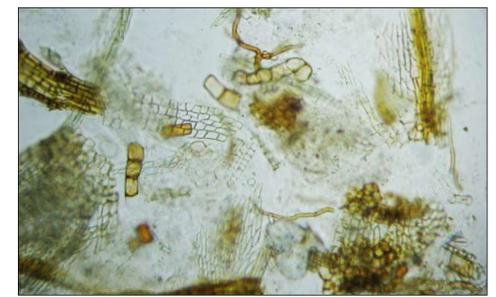


Fig 8: Fragments of mosses *Bryum caespiticium* and *Amblystegium serpens* in preparation from alimentary tract of *T. ceperoi*

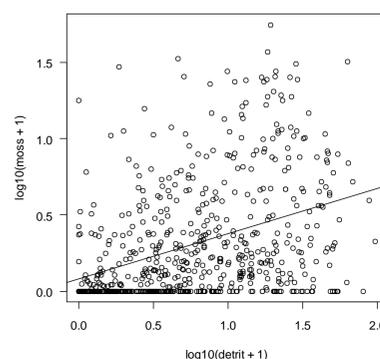
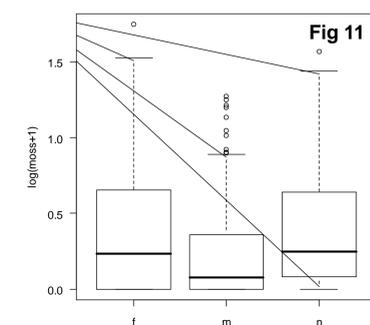
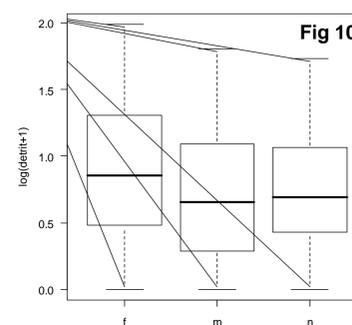


Fig 9: Correlation between relative quantity of moss and detritus in individual samples of gut contents of *T. tenuicornis* ($p < 2.2 \cdot 10^{-16}$, $r = 0.38$).



Figs 10,11: Comparison of quantity of detritus (Fig 10) and moss (Fig 11) in guts of females, males and nymphs of *T. tenuicornis*.

f - females
m - males
n - nymphs

CONCLUSION

The main component of the diet of groundhoppers *Tetrix tenuicornis* and *T. ceperoi* is detritus complemented by the regular eating of mosses and other accessible organic matter. The composition of not-detritus diet is probably dependent on its availability at each locality. The results suggest that the individuals not searching for a specific moss species, but eating away the leaves of randomly found mosses.

There remains the question what is the reason of mosses consumption, if the caloric values of mosses are noticeably lower than that of detritus (Forman 1968). This question is the subject of our current investigations.

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