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VARIATION IN BROOD SIZE OF THE AMPHIPOD *GAMMARUS MINUS* ALONG THE LENGTH OF WARM SPRING

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ABSTRACT

Gammarus minus is a freshwater amphipod crustacean that lives primarily in alkaline springs and headwaters in the mid-Appalachian region of North America. The goal of this study was to determine whether brood size (number of eggs/embryos per brood) varied significantly along the length of Warm Spring (Huntingdon, Pennsylvania). No such variation was found, possibly because of extensive amphipod dispersal throughout the springbrook, which also exhibited little longitudinal temperature differences. The only differences that were found were that midway along the springbrook (200 m from the source) brood size and body mass were significantly correlated with body length, whereas this was not observed at the source and 400 m downstream. Further work is necessary to determine whether actual reproductive differences exist in *G. minus* along the length of Warm Spring and other springs showing greater longitudinal changes in temperature.

Key words: Amphipod, body size, brood size, Gammarus minus, *reproduction, spring, temperature*

INTRODUCTION

The amphipod *Gammarus minus* is a common crustacean in hard water springs, streams, and caves of the montane eastern United States. It ranges from southern Pennsylvania to western Kentucky and southern Indiana (Holsinger 1972). Much is known about the reproduction of gammarid amphipods, but we are unaware of any comparative studies of the reproductive ecology of these animals along the length of a stream. Therefore, we tested whether brood size of *G. minus*, in relation to body size, varies along the length of a springbrook.

FIELD SITE

G. minus were collected from three 6-m long sampling areas along Warm Spring (Huntingdon, Pennsylvania): the source and 200 and 400 m downstream. During the study period (April 3-10, 2001), the springwater pH was nearly neutral, and the water temperature was a constant 15 $^{\circ}$ C at the source, and varied from 14-17 $^{\circ}$ C at the downstream sites (estimated with max-min thermometers). The average water depth ranged from 7.9cm at the 200-m site to 11.7 cm at the 400-m site. The springbrook was widest at the source (4.62 m) narrowing to 2.13 m at the 400-m site. The substrate consisted largely of sand and cobbles at the source, sand at the 200 m site, and mostly silt and decaying plant matter at the 400-m site.

MATERIALS AND METHODS

For population-density estimates, 10 random samples of amphipods were collected at each site with a small Surber-type sampler (area = 154 cm^2) on April 3, 2001. Additional samples of brooding females (for a total of 30 per site) were also collected using nets on April 10, 2001. For each brooding female, body length and mass were measured and the eggs or embryos in the brood pouch were removed and counted. Debrooding was carried out by flushing water into the brood pouch of females pinned to a wax platform. Debrooded females were frozen at –75° C, freeze or oven-dried, and weighed on a Cahn electrobalance. Differences in brood size (number of eggs/embryos per brood pouch) among sites were tested by using ANOVA and ANCOVA (with body length and body mass as covariates). Relationships between brood size and body length, body mass and body mass per length were examined using linear regression analyses.

RESULTS

Mean brood size did not differ significantly among the three sites ($F = 0.242$, df = 89, $P = 0.389$) even after correcting for the effects of body length ($F = 0.238$, df = 89, $P = 0.249$) (Table 1). Brood size was significantly correlated with female body length at the 200-m site ($r = 0.287$, df = 29, $P = 0.002$), but not at the source ($r = 0.002$, df = 29, $P = 0.815$) or 400-m site ($r = 0.009$, df = 29, $P = 0.614$). For all samples together, brood size was marginally significantly related to body length ($F = 9.56$, df = 89, $P = 0.062$).

Table 1. Mean population density and mean brooding female body length, brood size, and body mass of the freshwater amphipod Gammarus minus *at three different sampling sites in Warm Spring (Huntingdon, Pennsylvania).*

	Source	200 m downstream	400 m downstream
Mean maternal body length (mm) (± SD)	5.35 ± 0.872	5.67 ± 0.997	5.65 ± 0.778
Mean brood size (number of eggs) (± SD)	5.80 ± 2.12	6.50 ± 2.21	6.00 ± 3.46
Mean maternal body mass (mg) (± SD)	1.00 ± 0.32	0.98 ± 0.26	0.78 ± 0.29
Population density (amphipods/m^2)	110	715	156

Similarly, body mass was significantly correlated with body length at the 200-m site ($r = 0.267$, df = 29, $P = 0.003$), but not at the source ($r = 0.034$, df = 29, $P = 0.328$) or 400-m site ($r = 0.000$, df = 29, $P = 0.930$). For all samples together, body mass was also marginally significantly related to body length ($F = 8.78$, df = 89, $P = 0.083$).

DISCUSSION

We found no significant differences in mean brood size of *Gammarus minus* along the length of Warm Spring, even after adjusting for the effects of body size. We expected to find some differences due to temperature differences along the length of this springbrook. Perhaps, we did not find any differences because temperature actually varied little (14-17° C) among our three sampling sites during the time of this

study. Another reason may be that amphipods were able to freely disperse throughout the springbrook, thus preventing the establishment of any longitudinal differences in brood size.

Some differences among sampling sites were noted, however. For example significant correlations between brood size and body length and between maternal body mass and body length were only found at the 200 m downstream site. Coincidentally this site also appeared to have the highest density of amphipods(Table 1). Further research is needed to determine whether this was a sampling artifact or the result of environmental differences at this site.

In addition, further research at other times of the year and in other springs with greater temperature differences is needed to determine whether the reproduction of *G. minus* is sensitive to changes in temperature along the length of a springbrook.

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LITERATURE CITED

Holsinger, J.R. 1972. The freshwater amphipod crustaceans (Gammaridae) of North America. United State Environmental Protection Agency, Cincinnati, Ohio, USA.