Morphological Antipredator Adaptations in Water Fleas

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Abstract

Some *Bosmina* and *Daphnia* species have the ability to develop extreme morphological antipredator defences, such as long antennules, high carapaces and helmets. The relative sizes of these plastic traits may differ substantially between populations, and also between individuals within a population, between sexes and during ontogeny. In this thesis I examine how abiotic factors (trophic levels and temperature) and biotic factors (fish and invertebrate predators) affect the size and shape of these traits.

In the first two studies, calculations based on experimental results using physical morphological models sinking in glycerine, were used to estimate body drag and energy consumption in *Bosmina*. *Eubosmina longispina*, with a low carapace and short antennules, and *Eubosmina coregoni gibbera*, with a very high carapace and long antennules, were examined. At 5°C, *E. c. gibbera* had 32-45 % higher body drag than *E. longispina*. At 20°C the difference was 20-45 %. A model of swimming predicted that, all else being equal, this difference should result in 18-20 % (at 5°C) or 14-16 % (at 20°C) lower swimming speed for *E. c. gibbera* than for *E. longispina*. This indicates substantial hydrodynamic costs of the morphological antipredator defences, particularly in low temperatures.

The morphological antipredator defences in *E. c. gibbera* are larger and more variable in females than in males. Male models had lower body drag than models of asexual and sexual females, suggesting that males can swim 14-28 % faster with the same energy consumption. High speed video documentation of swimming *E. c. gibbera* showed that males advanced 55-73 % further than females in each swimming stroke. Hydrodynamic body drag may therefore have significant implications for swimming and evolution of sexual dimorphism in water fleas. Males may lack the defensive, but hydrodynamically expensive, high carapace of female *E. c. gibbera* probably because competition over mates favours low body drag.

The morphology and size of heads and trunks in *Daphnia cristata* individuals were studied in twenty lakes in the same drainage basin. The lakes showed a variation in lake total phosphorus and in densities of invertebrate predators and fish. In the end of the summer *D. cristata* had varying shape and size of their heads. Our results indicate that *D. cristata*, in nutrient rich lakes, show adaptive morphological defences against both visually hunting and size limited predators.

Female *D. cristata* head shape, in the examined lakes, varied from small and rounded to large and curved. A significant positive correlation between lake total phosphorus and the allometric head coefficients was found, suggesting that the most extremely shaped heads are found in nutrient-rich lakes.

Keywords: Body drag, Reynolds number, viscosity, zooplankton, *Bosmina*, swimming velocity, cyclomorphosis, sexual dimorphism.
Daphnia cristata, head area, helmet angle, trophic condition, allometry, invertebrate predator, fish.