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A Quantitative Food Web Model for the Macroinvertebrate Community of a Northern German Lowland Stream

key words: network analysis, consumption, connectance, mass-balance, trophic interactions

Abstract

Trophic interactions and cycling of organic carbon within the macroinvertebrate community of a Northern German lowland stream were analyzed based on a compartment model. The network model describes the structure of the food web quantifying biomass, production, and consumption of their elements, of the entire system and between trophic levels. System primary production is 153.7 g C m^{-2} yr^{-1} and invertebrate production 53.3 g C m^{-2} yr^{-1}. Invertebrate consumption amounts to 702.6 g C m^{-2} yr^{-1}. Main flows are identified between trophic level 1 and 2 and are connected with highly productive compartments. '*Anodonta* and *Pseudanodonta*' and *Dreissena polymorpha* show the highest consumption of all groups with 269.9 g C m^{-2} yr^{-1} and 114.1 g C m^{-2} yr^{-1}, respectively. System consumption is highest on the import from the upstream lake with 532.5 g C m^{-2} yr^{-1}, sediment detritus with 135.5 g C m^{-2} yr^{-1}, and primary producers with 25.7 g C m^{-2} yr^{-1}. The lowest predation pressure is observed for Bivalvia with an ecotrophic efficiency of <10% and highest for Chironomidae with 91%. Approximately 20% of organic matter entering the detritus pool are recycled to the living groups of the system. Transfer efficiencies between discrete trophic levels are generally low except for transfer of detrital material between level I and II.

1. Introduction

Few studies deal with the question, what a share imported material has in the total consumption of macroinvertebrate communities in streams (SCHÖNBORN, 1992; SCHWOERBEL, 1972, 1987; STATZNER, 1979). Lakes may supply large quantities of suspended particulate material to the outlet streams (ARMITAGE, 1977; CUSHING, 1963; GIBSON and GALBRAITH, 1975; ULFSTRAND, 1968) and therefore they may be responsible for high densities of filter feeding invertebrates (ARMITAGE, 1976; HYNES, 1970; ILLIES, 1956; OSWOOD, 1979; SHELDON and OSWOOD, 1977; SPENCE and HYNES, 1971; WOTTON, 1988). Compared to other studies (see BENKE, 1993; IVERSEN, 1988; SMOCK *et al.,* 1985, 1992) POEPPERL (1996) determined a very high secondary production for the investigated stream and the abundance, biomass, and secondary production of filter feeders decrease with increasing distance from the lake (POEPPERL, 1999). The study presented here investigated how much material was being consumed by the macroinvertebrate community of a northern German lowland stream.

The food web, presented here as a carbon mass-balance model, describes the trophic interactions and trophic impact of invertebrate groups. Along with the general objective to gain a more holistic understanding of structure and functioning of the community (comp. TOWNSEND *et al*., 1998; POWER and DIETRICH, 2002) by quantitatively describing how matter and energy propagate along pathways of the food web (comp. OKEY and PAULY, 1999; THOMPSON and TOWNSEND, 2000; MOREAU *et al*., 2001), the model was intended to yield the fol-

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