

# SALAMANDER PREDATION ON AQUATIC MACROINVERTEBRATES

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*REFERENCE:* *Proceedings of the 2003 Georgia Water Resources Conference*, held April 23-24, 2005, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

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**Abstract.** In fishless habitats, salamanders often compete with and are predators of macroinvertebrates. Studies on the effects of these interactions, however, are limited. Much of the research has instead been focused on microinvertebrate prey, or has been focused within a single family of salamanders. Although results are mixed, some studies suggest that these interactions can significantly affect macroinvertebrate communities.

## BACKGROUND

In their paper on aquatic community structure, Wellborn et al. 1996 proposed that vertebrate predation and hydrology were the two components responsible for maintaining gradients in community structure. Although their model focused on fish predation, a logical next step would be applying the same theory to amphibian predation in habitats that lack fish. The goal of this paper is to review existing research on salamander predation on macroinvertebrate communities, and draw conclusions about the importance of this predation in wetland communities.

There has been extensive research on the diet of salamanders (see Table 1). This work suggests that the aquatic stages typically feed on aquatic invertebrates, as well as other amphibians. Most taxa rely on microcrustaceans in early larval stages and then shift to larger macroinvertebrates and to some degree vertebrates. Suspected reasons for this ontogenetic shift include gape limitations in early larval periods, as well as a change in feeding technique as limb buds form into usable appendages (McWilliams and Bachmann 1989). Although there has been much research on competition and cannibalism between amphibian species (see Morin 1981), little attention has been paid to the interactions between salamanders and their invertebrate prey.

Existing work has focused primarily on microcrustacean prey species. This focus is due to intense predation on these species by early larval stages of most salamanders. Salamander predation and competition can increase or decrease prey species richness (Dodson and Dodson 1971, Sprules 1972), and can dramatically affect prey density (Sprules 1972,

Taylor et al. 1988). Much of this work, however, has been limited to the family Ambystomatidae.

Like microcrustaceans, research on macroinvertebrate-salamander interactions has also focused on Ambystomatidae. Within this family, macroinvertebrate responses are variable. Studies with *Ambystoma tigrinum* (tiger salamander) suggest patterns similar to microcrustaceans. For example, Wissinger et al. (1999) found that tiger salamander presence mediated the macroinvertebrate community composition, and suggested that *A. tigrinum* is a keystone predator in that system. In the prairie pothole region of the US, Benoy et al. (2002) found that tiger salamanders were strong competitors with dabbling duck species for macroinvertebrates, and indirectly deter wetland use by some migrating waterfowl. Holomuzki and Collins (1987) suggested strong interactions by *Ambystoma tigrinum* on multiple trophic levels in a system of montane ponds in east-central Arizona. Ontogenetic shifts in diet, however, make quantifying effects on the invertebrate community difficult.

Leeper and Taylor (1998) speculated that *Ambystoma talpoideum* (mole salamander) may have suppressed the population of chironomids in a temporary wetland in South Carolina. Their hypothesis was supported when, after a low recruitment year for the salamander, the chironomid population increased. In a similar study (Taylor et al. 1988), however, *A. talpoideum*, as well as two non-ambystomatids, *Eurycea quadridigitata* (dwarf salamander) and *Notophthalmus viridescens* (eastern newt) consumed mainly chironomid larvae for a large part of the year, but had no visible impacts on the chironomid community.

Studies outside of Ambystomatidae are lacking. However, from the diet analyses that are available, we can predict that the numerous taxa that have a large portion of their diet made up by macroinvertebrates could potentially affect these communities (Table 1). Further, we can hypothesize which conditions might promote strong salamander interaction with macroinvertebrates. Because gape limit often restricts macroinvertebrate consumption to later stages of development, extended larval periods will likely increase effects on

macroinvertebrate prey. The presence of large, paedomorphic (sexually mature animals with the larval body form) individuals is a good example of these particularly strong predation pressures. Paedomorphic salamanders forgo metamorphosis into the terrestrial form, instead staying in the aquatic habitat and feeding primarily on macroinvertebrates and conspecifics. Whiteman et al. (1996) provided an excellent example of the effects of this condition in a Colorado wetland complex. These conditions, however, are only common in wetlands with semi-permanent to permanent hydroperiods. The constraint of drying on larval development time and the often changing invertebrate community in temporary habitats (see Batzer and Wissinger 1996) probably makes a generalist feeding pattern necessary for salamander larvae in wetlands with shorter hydroperiods.

### CONCLUSIONS AND RECOMMENDATIONS

Although research is lacking, existing work suggests salamander predations may significantly affect macroinvertebrate communities. To expand our knowledge on these interactions, research needs to be completed outside of the family Ambystomatidae, as well as further research to detect what causes patterns within the family. Comparisons of predation pressures in wetlands over a hydrologic gradient, as well as yearly variations in hydrology within one habitat may provide valuable insight. Overall, however, it is clear that the effects of salamander predation and competition on macroinvertebrates are variable. The lack of research in this area makes it difficult to generalize. However, the abundance of macroinvertebrates in salamander diets, as well as strong keystone interactions observed in some habitats, suggests that further research in this area is warranted. Findings from these studies will expand our knowledge on predator-prey interactions, as well as provide insight into the importance of sensitive amphibian fauna in wetland ecosystems.

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**Table 1. Diet analysis of salamanders indicating significant macroinvertebrate consumption**

\* denotes studies finding over 20% of stomach content or over 75% occurrence of macroinvertebrates (diet information for larvae unless indicated)

<b>Taxa</b>	<b>Citation</b>
<b>Cryptobranchidea</b>	
<i>Cryptobranchus alleganiensis</i>	Netting 1929 (Adult)
<b>Sirenidae</b>	
<i>Siren lacertina</i>	Halin 1978* (Adult)
<i>Siren intermedia</i>	Altig 1967* (Adult)
<b>Salamandridae</b>	
<i>Notophthalmus perstriatus</i>	Christman and Franz 1973* (Adult)
<i>Notophthalmus viridescens</i>	Brophy 1980, Ries and Bellis 1966*(Adult), Taylor et al. 1988*
<b>Proteidae</b>	
<i>Necturus maculosus</i>	Hamilton 1932*( Adult)
<b>Amphiumidae</b>	
<i>Amphiuma tridactylum</i>	Chaney 1951 (Adult)
<b>Ambystomatidae</b>	
<i>Ambystoma gracile</i>	Henderson 1973*
<i>Ambystoma jeffersonianum</i>	Smith and Petranka 1987*
<i>Ambystoma macrodactylum</i>	Anderson 1968* (Larvae and Adult)
<i>Ambystoma maculatum</i>	Freda 1983*, Lannoo 1986
<i>Ambystoma opacum</i>	Petranka and Petranka 1980*
<i>Ambystoma texanum</i>	McWilliams and Bachmann 1989, Smith and Petranka 1987*
<i>Ambystoma talpoideum</i>	Mcallister and Trauth 1996*, Taylor et al. 1988*
<i>Ambystoma tigrinum</i>	Anderson 1968*, Benoy et al 2002* (Larvae and Adult), Brophy 1980*, Christman and Franz 1973, Collins and Holomuzki 1984*, Dineen 1955*, Dodson and Dodson 1971*, Holomuzki and Collins 1987*, Lannoo and Bachmann 1984*, Whiteman et al. 1996, Zerba and Collins 1992*
<b>Plethodontidae</b>	
<i>Gyrinophilus porphyriticus</i>	Hamilton 1932* (Adult)
<i>Desmognathus fuscus</i>	Hamilton 1932* (Adult)
<i>Eurycea bislineata</i>	Hamilton 1932* (Adult)
<i>Eurycea quadridigitata</i>	Taylor et al 1988*