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CANNIBALISM AMONG *SALAMANDRA SALAMANDRA* (L.) LARVAE

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ABSTRACT

Two populations of *Salamandra salamandra* (L.) larvae from Galilee were studied: a cannibalistic population from Hammama Spring, and a non-cannibalistic population from Tel Dan.The cannibalistic larvae grew faster than the non-cannibalistic ones. The habitat at Tel Dan contained an ample supply of food (invertebrates) for the larvae. A shortage of food in the Hammama Spring population, while not affecting the rate of growth, caused an increase in cannibalism. Five large cannibalistic larvae consumed 116 small larvae during the three months required to complete metamorphosis. There was no incidence of cannibalism among large larvae of roughly equal size. The phenomenon of cannibalism as an aspect of adaptation to different habitats is discussed.

INTRODUCTION

The urodelan, *Salamandra salamandra* (L.) is widely distributed in the palestrotic region (Eiselt, 1958; Klewen, 1991). In northern Israel, the native salamander belongs to the subspecies *S. s. infraimmaculata* (Degani, 1986a). Its food consists mainly of a variety of invertebrates (Degani and Mendelssohn, 1979). This subspecies is found in a variety of habitats, under different limnological and environmental conditions. The larvae are found in permanent streams, such as Tel Dan, where the water temperature (15–17 °C) is relatively constant throughout the year (Degani and Mendelssohn, 1979, 1982), but food is not always abundant. The larvae also grow in rain pools, where food supply is unlimited, but water is available for only a few months of the year, with water temperatures ranging widely, from 0 to 25 °C, during the growth period (Warburg et al., 1979). Salamander larvae are also found in winter ponds, where water is available from winter to early summer. In this habitat, other amphibian larvae interact with salamander larvae during their growth period (Degani, 1982, 1986b).

Salamander larvae also grow and metamorphose in rock pools (such as Sasa) or in caves (Hammama Spring) where food supplies are limited (Warburg et al., 1979). Under these conditions, salamander larvae may become cannibalistic, the larger larvae consuming smaller ones (Degani and Mendelssohn, 1979).

Cannibalism among salamander larvae was studied under experimental conditions by Degani et al. (1980). In the present study, an attempt was made to analyze the effect of

environmental conditions (water temperature and food supply) on the development and incidence of cannibalism in two larvae populations.

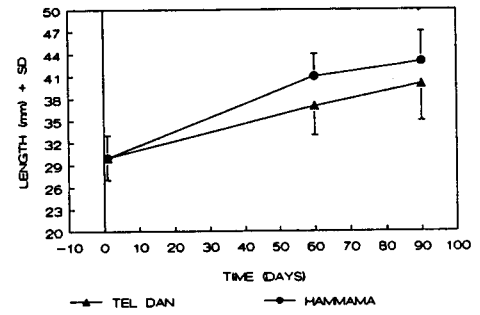
MATERIALS AND METHODS

EFFECT OF HABITAT

Eighteen larvae from a single egg-clutch were taken from each of two Galilee populations: Hammama Spring, where cannibalism had been observed, and Tel Dan, a non-cannibalistic population (Degani and Mendelssohn, 1979). The larvae were maintained in aquaria, measuring 25×20×15 cm, at room temperature (25±3 °C). Both groups were provided ad libidum with aquatic invertebrates. Growth (weight and length) was monitored monthly.

EFFECT OF DENSITY

Sixty larvae were taken from the same Hammama Spring egg-clutch, and divided equally into three aquaria, measuring 60×25×32 cm, 35×25×30 cm, and 15×10×15 cm. Water temperature was maintained at 25±3 °C. They were fed aquatic invertebrates ad libidum, and measured monthly, as above.



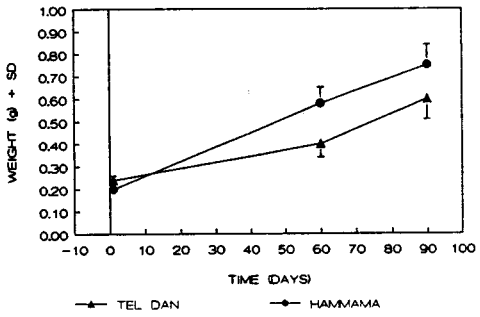
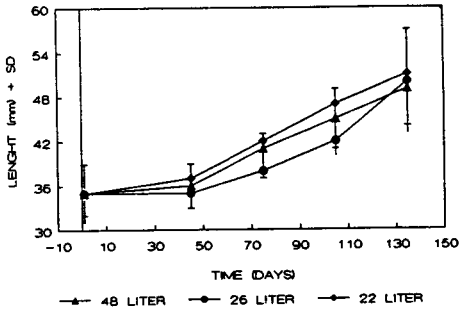


Fig. 1. Rate of growth and degree of cannibalism of larvae from Hammama Spring (cannibalisitic) and Tel Dan (non-cannibalistic).



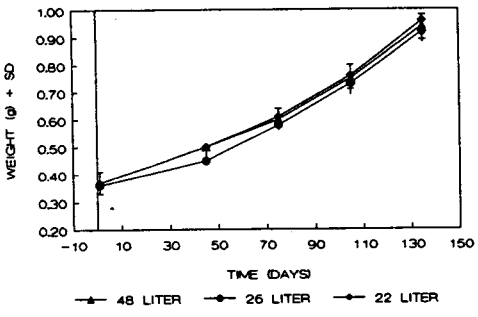
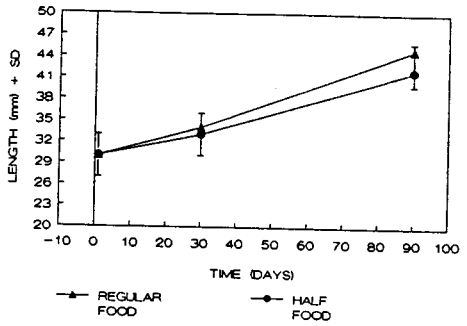


Fig. 2. Effect of density on growth and cannibalism of larvae from Hammama Spring.



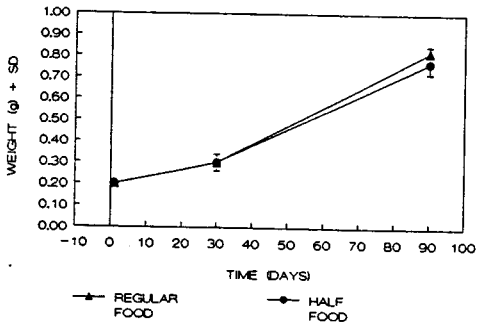
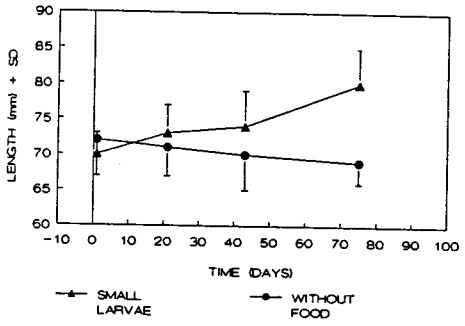


Fig. 3. Growth rate and cannibalism under limited food supply.



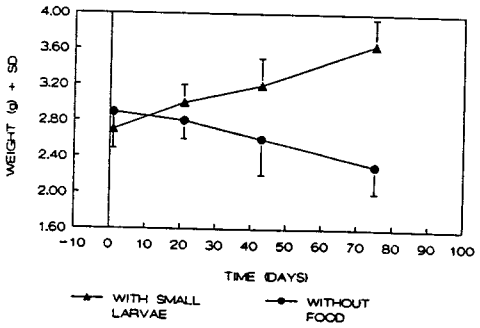


Fig. 4. Growth and cannibalism of larvae from Hammama Spring when no alternative food is available.

GROWTH UNDER LACK OF FOOD

Thirty larvae from Hammama Spring were divided equally into two aquaria, where one group was fed twice as much aquatic invertebrates as the other.

GROWTH OF CANNIBALISTIC LARVAE

Ten large cannibalisitic larvae (weight: 2.8 ± 0.5 g; length: 70 ± 10 mm) were divided equally into two aquaria (15 × 10 × 15 cm), and maintained at room temperature (25 ± 3 °C). The first group was maintained together with 10 small salamander larvae (0.25 ± 0.5 g, 29.3 ± 0.5 mm); the second group was maintained without additional larvae or food. The larvae that had been eaten were replaced daily.

RESULTS

The larvae of salamanders from the cannibalistic population grew faster than those from the non-cannibalistic population (Fig. 1). In the second experiment, in which food was available in unlimited quantities, there was no evidence for an effect of density on cannibalism in either population (Fig. 2). However, cannibalism developed in the group that was fed less, and the larvae grew at the same rate as in the group fed at double the rate (Fig. 3).

The five large, cannibalistic larvae from Hammama Spring consumed 116 small larvae during the three-month period of growth required to complete metamorphosis (Fig. 4). No cannibalism developed in the group which was not provided with small larvae, and these larvae lost weight.

DISCUSSION

Intra-uterine cannibalism was observed in European subspecies of *S. salamandra* by Joly (1968). Degani et al. (1980) studied the effect of environmental factors (e.g., temperature and ions in water) on cannibalism. This and previous studies (Warburg et al., 1979; Degani and Mendelssohn, 1979) support the hypothesis that the phenomenon of cannibalism develops when food is in limited supply or unavailable.

The present study provides additional data which may improve our understanding of the adaptation of salamander larvae to different habitats. It appears that larvae from the Hammama Spring population grow faster than those from Tel Dan, even under identical experimental conditions. For this, they require more food; and where food is limited, they supplement their diet by cannibalism.

The effect of ponds drying up as a result of the cessation of rain in Mount Carmel (xeric habitat) on breeding patterns has been discussed by Warburg (1992). On the basis of 10 years of observation, he concluded that a female salamander produces a total of approximately 400 larvae during her life. Only about 33% of the larvae deposited in November survive, since ponds generally dry up before the larvae reach metamorphosis. Larvae deposited during a wet November have a better chance of survival because they can grow to become cannibals preying on the December batches.

The larvae from Tel Dan grew more slowly in their natural environment than those from Hammama Spring (Degani and Mendelssohn, 1979, 1982a). The latter showed the same behavior as the Mount Carmel population described by Warburg et al. (1979). When food was available, cannibalism did not develop. Density, in itself, does not affect the propensity of a population to develop cannibalism. This is also the case among larvae in winter pools which dry up in the summer, as long as large quantities of food are available (Warburg et al., 1979).

In habitats where food is not found or is very limited, cannibalism develops, enabling the cannibalistic larvae to grow and reach metamorphosis (Degani and Mendelssohn, 1979). The results of the present study show that large larvae cannibalize small ones, but there is no cannibalism among large larvae of approximately the same size. This pattern of behavior is found in Hammama Spring.

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