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The Life History of *Triturus vittatus vittatus* (Urodela) in Various Habitats

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Abstract.- The life cycle of *Triturus v. vittatus* at localities of various altitudes in Israel, ranging from 212 to 740 m above sea level (ASL), were studied. Mature newts were observed only around winter rain pools, where they arrived before the pools filled with water. The males left the ponds after spawning, while females left after eggs were oviposited on plants and other substrata, according to the conditions of the ponds. Males (9–11 cm long, weighing 4.3–5.3 g) were slightly bigger than females (8.5–10 cm long, weighing 3.1–4.3 g) Females laid 18–68 eggs each. Fifteen to 30 days after oviposition, larvae hatched and from April to July, remained in the ponds to develop. Various anuran larvae were found in the same breeding sites, including *Hyla savignyi, Bufo viridis, Rana bedriagae* and *Pelobates syriacus*. Larval and adult *Salamandra infraimmaculata* were found to inhabit several of the rain pools simultaneously, although the period during which both stages existed together was brief. Although temperature and oxygen levels in the pools were not significantly different between breeding sites in the various habitats, development took longer to complete at the more elevated sites.

Keywords.- Newt, larvae, *Triturus v. vittatus*, winter pool, Israel, life cycle.

Introduction

The life cycle and ecological conditions necessary for the banded newt (*Triturus vittatus*) have not been well studied, although some aspects of the biology and life cycle of the subspecies *T. v. vittatus* have been documented in Israel, Europe and the Mediterranean region (Raxworthy, 1989; Olgun et al., 1997). Three subspecies of the banded newt are currently recognized: *T. v. vittatus*, found along the eastern edge of the Mediterranean, ranging from Turkey to Israel; *T. v. cilicensis*, found in areas bordering the east and northeast of the Mediterranean; and *T. v. ophryticus*, located in the Caucasus to the east and south of the Black Sea.

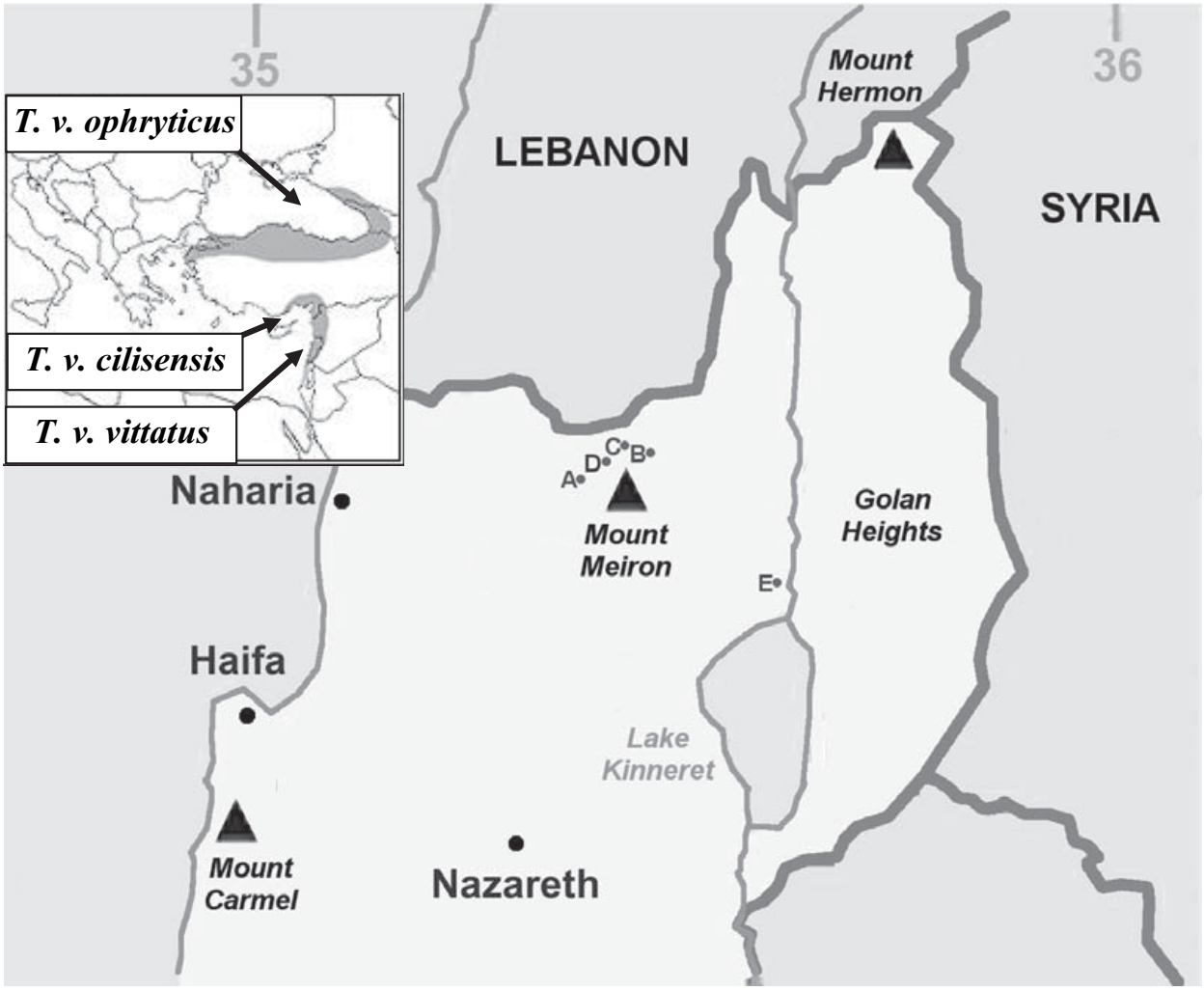
In Israel, *Triturus v. vittatus* is found from the north to the central coastal plains, where conditions are most extreme. The biology and life cycle of the populations in northern Israel and Upper Galilee have been previously described (Degani, 1986; Degani and Mendelssohn, 1983). Throughout their adult aquatic phase and larval periods, *T. v. vittatus* mainly inhabits winter pools that sometimes disappear at the beginning of summer (Degani and Kaplan, 1999). The terrestrial adults reach the pond at the beginning of the rainy season before the ponds fill with water, and when the ponds are filled, enter them for their aquatic phase.

Materials and Methods

In order to locate *Triturus v. vittatus,* all of the main types of aquatic habitats inhabited by amphibian larvae in northern Israel were investigated. The procedure followed was that described by Degani and Kaplan (1999).

The various *Triturus v. vittatus* populations around winter rain ponds and rock pools in northern Israel were studied during four consecutive years (2001–2005) (Fig. 1). The elevations of these habitats ranged from 212 to 740 m ASL and represented a number of extreme ecological and physical conditions. Water parameters were measured every two weeks during the time the pools were filled. *In situ* temperature and dissolved oxygen data were obtained by a hand-held oxygen meter (WTW, Oxi330 set, Germany). Water parameters were analyzed by one-way analysis of variance (ANOVA), followed by the Student–Newman–Keuls (SNK) test, for which Graph-Pad Prism software (Graph Pad, San Diego, CA) was used. The level of significance between groups was set at $p < 0.05$.

Larvae were collected with a hand net (Degani and Mendelssohn, 1983), identified to species and grouped by specific water body.



Name of pond	Longitude	Latitude	Altitude m (ASL)
Dovev pond (A)	239158	772801	740
Nahalit pond (B)	243657	776401	665
Matityahu Q. pond (C)	242783	774855	670
Pharaa pond (D)	242784	774580	682
Amiad water holes (E)	251721	757994	212

Figure 1. Various ponds in Israel colonized with newts examined in the study.

Results

The life cycle of *Triturus v. vittatus* is presented in Figure 2. Males and females arrived at the dried ponds before the beginning of the heavy rains in October and November and entered them when they were filled. Male newts (9–11 cm long and weighing 4.3–5.3 g) were found to be slightly bigger than females (8.5–10 cm long and weighing 3.1–4.3 g), with no significant difference in size detected for either sex between ponds (Fig. 3).

After mating, the males left the ponds while the females remained in the water to deposit between 18–68 eggs on plants or rock surfaces. The larvae hatched 19–29 days later and remained in the rain pool for 30 to 75 days. Hatching time and duration spent in the pool was dependent on water temperature (Fig. 4), with development being slower at higher altitudes.

Various anuran larvae were found in the same breeding sites, including *Hyla savignyi*, *Bufo viridis*, *Rana bedriagae*, and *Pelobates syriacus*. Larval and adult *Salamandra infraimmaculata* were found to inhab-

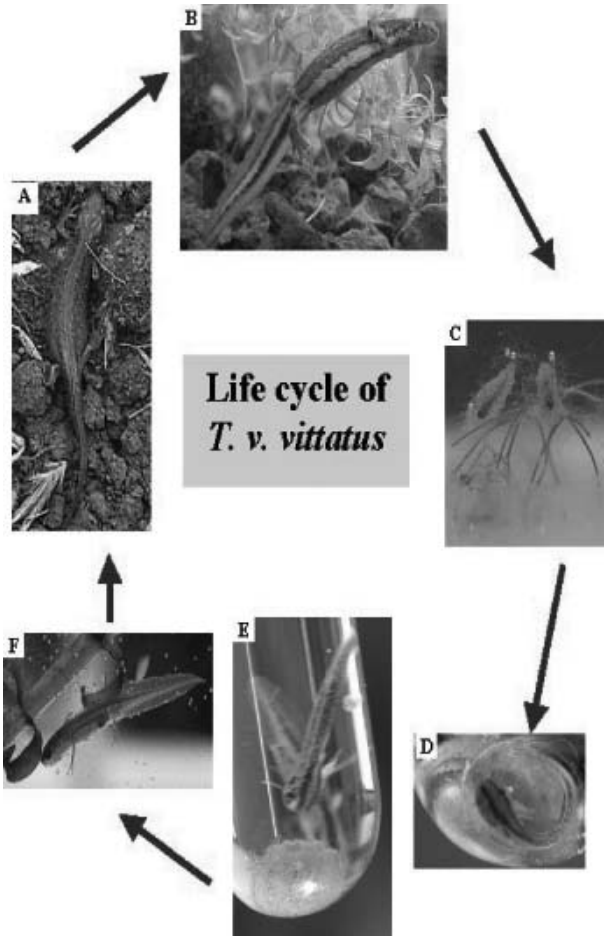


Figure 2. Life cycle of *T. v. vittatus*: Terrestrial (A) and aquatic females (B), eggs on plants in the pond few days after spawning (C), larvae one day before hatching (D) and 2 days after hatching (E), and developing larvae (F).

it several of the rain pools simultaneously, although the period during which both stages existed together was brief. The eggs and larvae developed in the ponds only when temperatures rose above 18°C, the threshold temperature also necessary for metamorphosis in *S. infraimmaculata*.

From winter to spring temperatures rose from 5°C to 30°C (Fig. 4). No significant differences in temperature were observed between the various ponds ($p > 0.05$, F-value = 0.1766–1.186) during the periods when the newt larvae were present, although temperatures in Dovev pond were lower at the beginning of the growth period during the years 2001–2002, 2003–2004 and most of the growth period in 2004–2005. Dissolved oxygen concentrations did not vary between sites ($p > 0.05$, F-value = 0.3489–2.326), ranging between 2–27 mg/L; concentrations stayed between 5–10 mg/L for most of the growth period. High oxygen concentrations were detected during the larval growth period and during completion of metamorphosis (Fig. 4).

Discussion

Since newt larval development is dependent on an aquatic habitat, the locations of breeding sites changed from year to year depending on water availability. This site flexibility is an important environmental adaptation in a semi-arid country such as Israel. The data obtained from the five different newt populations examined in this study were consistent with those data obtained in previous studies on the same subspecies in Upper Galilee (Degani and Kaplan, 1999; Degani and Mendelssohn, 1983) and the coastal plains of Israel (Geffen et al., 1987), supporting observations that *T. v. vittatus* is present in water in Israel between December and April. Adults of *T. v. ophryticus* in northern Turkey differ in that they are usually found in the water from

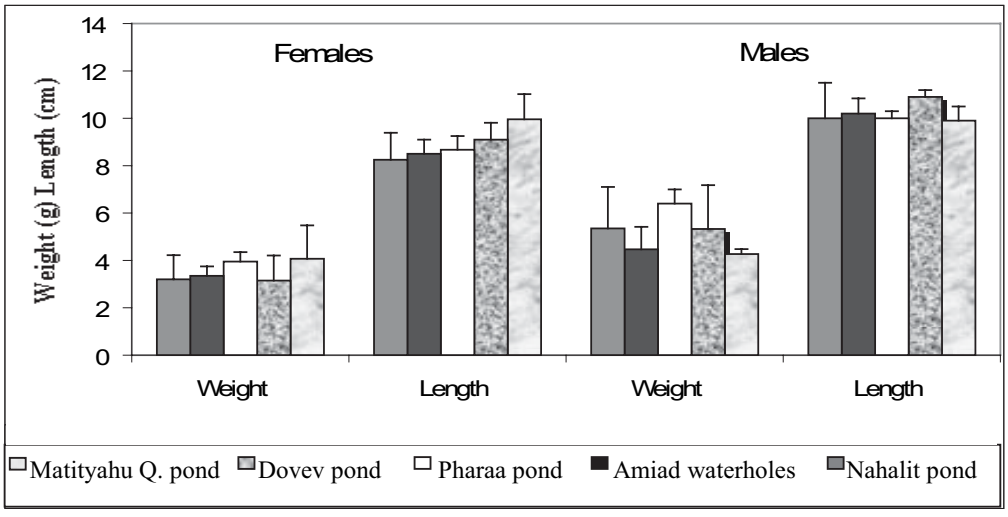


Figure 3. The measurements of mature females (N = 27) and males (N =15) from various populations.

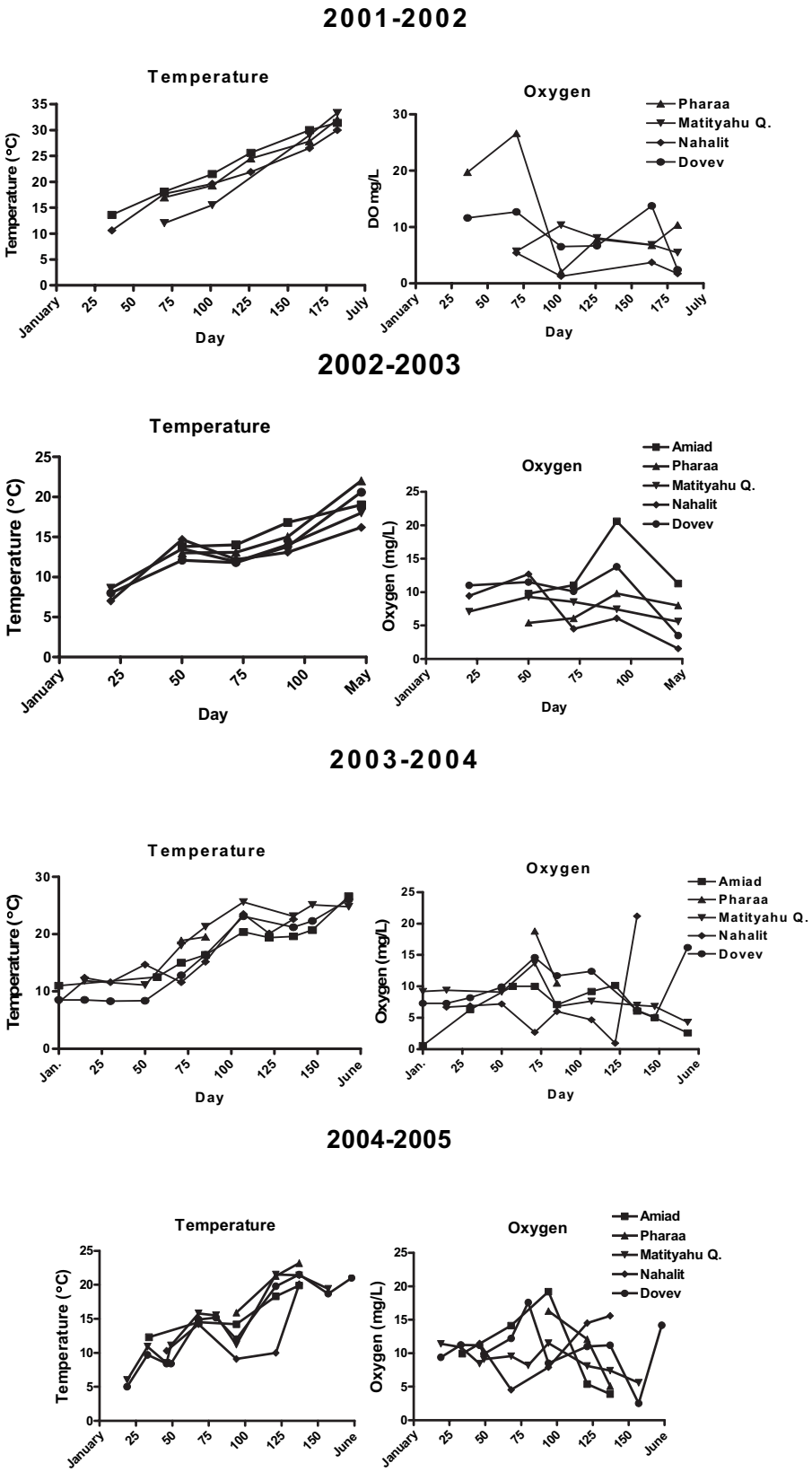


Figure 4. Water temperatures and oxygen concentration of various breeding sites where *T. v. vittatus* newts were present during winter and spring 2001 to 2005.

early March to late Octoberor November, depending on the climate and altitude (Kutrup, 2005b). We suggest that the differences between the two subspecies are due to regional climate differences.

Kutrup et al. (2005a) studied the food of the banded newt, *Triturus v. ophryticus*, at different sites in Trabzon in northern Turkey and discovered that the newts consume a wide variety of invertebrates during their aquatic phase. In Israel, the *Salamandra infraimmaculata* and *T. v. vittatus* have a very similar diet, composed of various invertebrates (Degani and Mendelssohn, 1978; Geffen et al., 1987).

In summary, the present study examined the life cycle of *Triturus v. vittatus* in northern Israel, which was found to vary depending on the unpredictable presence of rain pools necessary for juvenile development. Among the different ponds, large variations were found in the length of the larval growth period, as well as in the time required for completion of metamorphosis. In contrast, no differences were observed in the ecological parameters and water quality of the ponds during the larval growth period.

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