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The population cycle of *Mantis religiosa* in outdoor and in laboratory conditions

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Abstract

On the basis of comparative surveys of laboratory and outdoor populations of *Mantis religiosa*, it is established that in Hungary both duration of development and lifespan differ from the optimum. Lifespan is 1.5-2 months shorter than can be expected in optimal conditions.

Density values are correlated with the ambient temperature. Mortality rates are especially affected by spring and autumn temperature anomalies.

Introduction There are few publications dealing with the dynamics of praying mantid populations (an example is BALDERAMA & MALDONADO, 1973). The main aim of the present work is to describe the population cycle of *Mantis religiosa* in outdoor and in laboratory conditions, taking into account some environmental correlates

Methods and Material The research site is a 9 ha grassland plot at Pesterzsébet (a suburb of Budapest, Hungary) In 1972,200 praying mantid cocoons were experimentally introduced and monitored for 17 years. In the first generation of the outdoor mantid population studied, 88% of the viable (3 days old) population originated from the introduced cocoons (Table 1).

Table 1.

Numbers of resident and introduced individuals in 1972

	Resident	Introduced	Total
Number of cocoons	27	200	227
Number of hatched individuals	3 494	25 244	28 738
Individuals older than 3 days	594	4 293	4 887

The exact time of hatching and the number of hatching per cocoon were established by regular checking of marked cocoons. The number of older individuals was assessed using the mark-release-recapture method (SOUTHWOOD, 1978).

The bait-stick method was used to catch mantids. Bait consisted of living insects, usually cockroaches fixed with insect pins in the dorsal position on the top of a stick higher than the herb layer.

The control population was kept in a laboratory at 23° C during the first and second larval instar and at 26° C later on. The 12/12 light/dark phase was used, with 2000 lux in daytime.

Results:

1. Components of the net reproductive rate

The 17-year average of hatched individuals per cocoon was 125. Since a female lays two sets of living eggs, the average clutch size was 250. 17.2% of the young larvae were able to reach the age of three days; of these some 65% were female. There were six moultings (in the case of males) or seven moultings (in the case of females) with a 12-day average time per instar (Fig. 1, 2). The average body lengths of males and females were 5.1 and 6.5 cm respectively (Table 2).

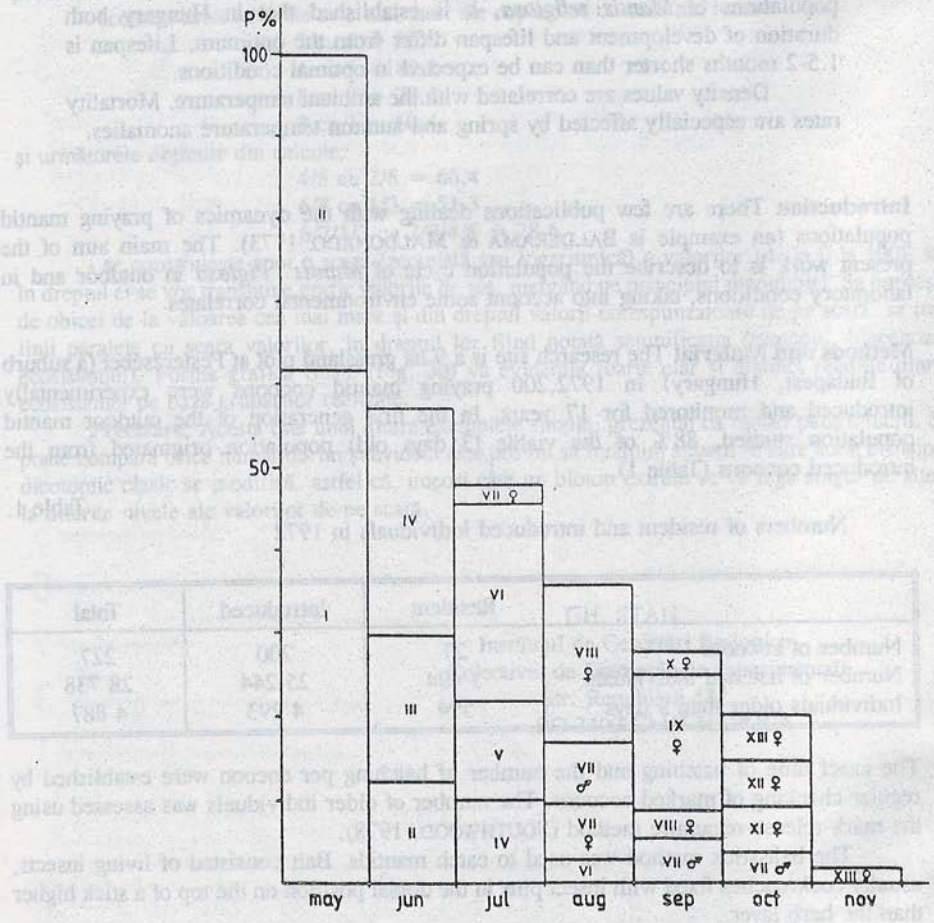

Fig. 1. 17-year average of annual trends in the ontogenesis of praying mantid; p = frequency in per cent, I-XIII = developmental stages.

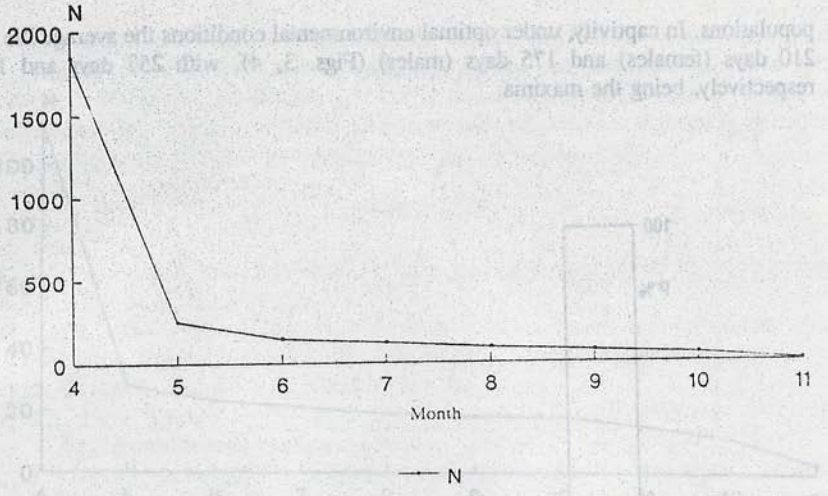

Fig.2. Intracycle survival curve of the outdoor *Mantis* population.

Table 2.

Average body size of *Mantis religiosa* in consecutive stages of development

Stage	Mean Body Length
After hatching	0.5cm
1st moulting	0.8cm
2nd moulting	1.4cm
3rd moulting	2.2cm
4th moulting	3.0cm
5th moulting	3.9cm
6th moulting	4.8cm (female)
6th moulting	5.1cm (male)
7th moulting	6.5cm (female)

In the presence of a good food supply, the first laying of eggs occurred on the 11th day after the last moulting and was repeated 5 times at intervals of 13 days. As a rule, the first two cocoons contained viable eggs. The average lifespan of females was 165 days, with a maximum of 196 days (1986). In males, these figures were 110 and 176 days respectively.

2. Interrelationships between ontogenesis and weather conditions

The embryonic ontogenal stages are usually independent of climatic anomalies because of the air compartments in the walls of the cocoons, which protect against both unfavourable temperature and moisture conditions. Postembryonic developmental stages are subject to environmental effects, as is shown by comparison of outdoor and laboratory

populations. In captivity, under optimal environmental conditions the average life span was 210 days (females) and 175 days (males) (Figs. 3, 4), with 257 days and 189 days, respectively, being the maxima.

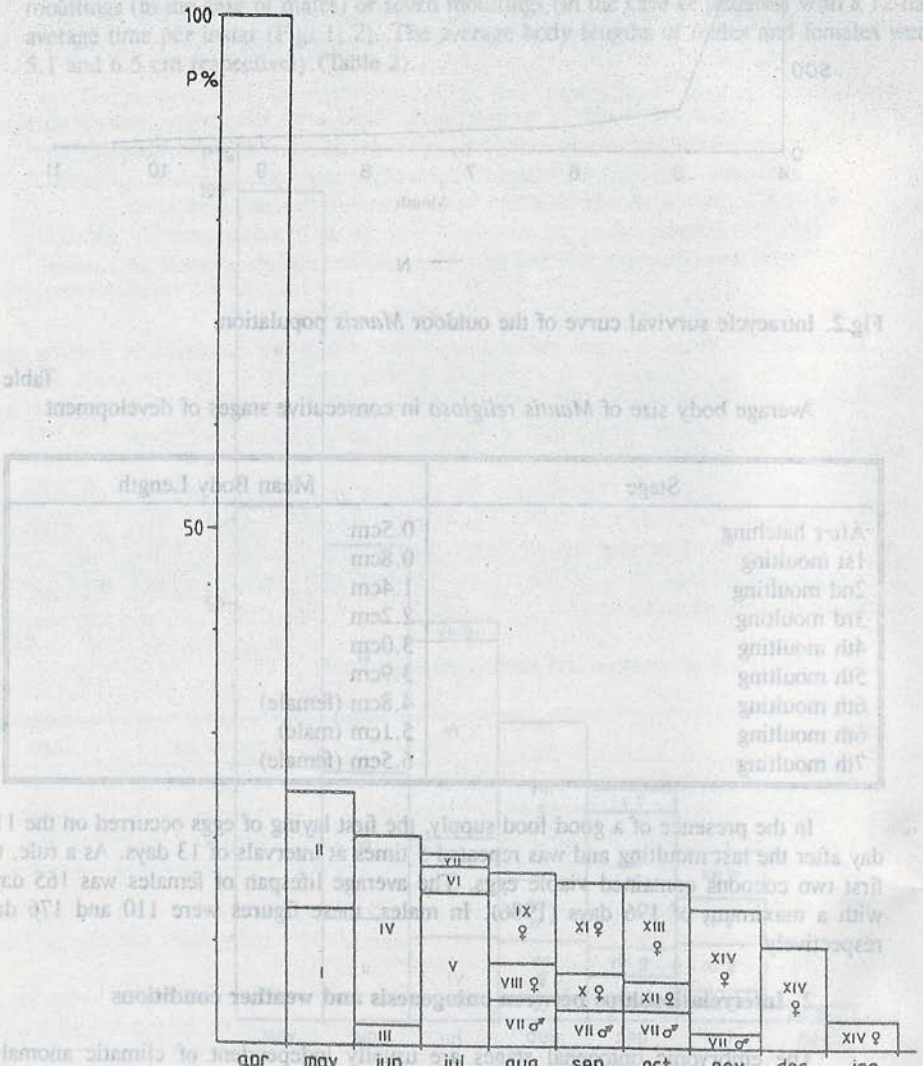

Fig 3. Annual trends in the ontogenesis of the laboratory praying mantid population]

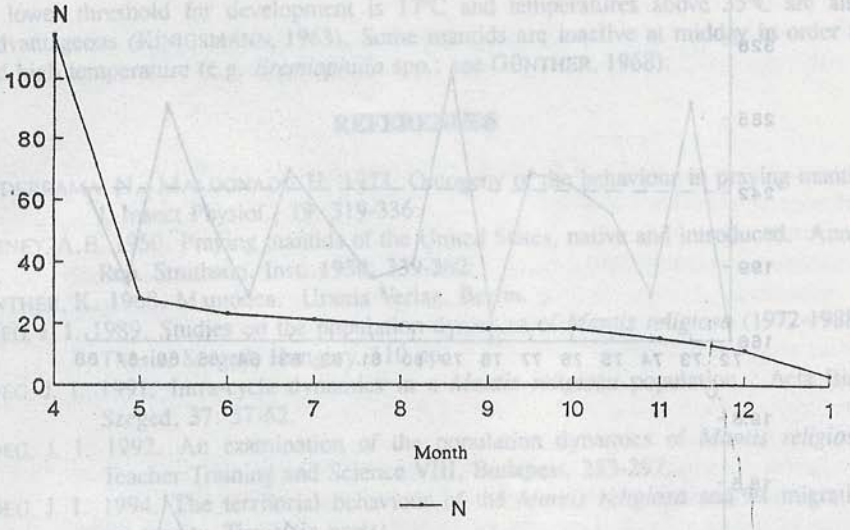

Fig. 4. Intracycle survival curve of the laboratory praying mantid population

In the outdoor population a significant relationship was found between temperature and survival during postembyonic development (see Fig. 5). In the first years following introduction, the population was smaller than expected at given temperatures. By 1976 this difference was completely made up by the high hatching rate of cocoons. The cold weather in April resulted in fewer surviving individuals in 1980 and 1982, when temperatures differed from the average by -2.2°C and -2°C respectively. The correlation was also clear in 1976 and 1983, when higher temperatures (+0.9°C and +2.2°C above the average) led to higher survival rates. In November the sole mortality factor is the temperature. If the November average is below zero, survival expectancy is negligible (as in 1983).

In the early and mid-summer, the temperature is a conditioning factor without causing mortality. Development is completed by the end of August; therefore mantids are not sensitive to moderately low temperatures in early autumn (see HIDEG, 1989 for details).

Discussion It is clear from the results (low hatching rates and the survival of young larvae in April, high mortality rates in November) that the climate in Hungary is suboptimal for mantids of subtropical origin. Only 150 of the 2000 known mantid species live in temperate regions within the limits of the 46° lines of latitude (GÜNTHER, 1968).

Several authors (BALDERRAMA & MALDONADO, 1973; GURNEY, 1950) emphasize the need for high temperature and wide limits to tolerance of rainfall. These are in line with the findings of the present paper.

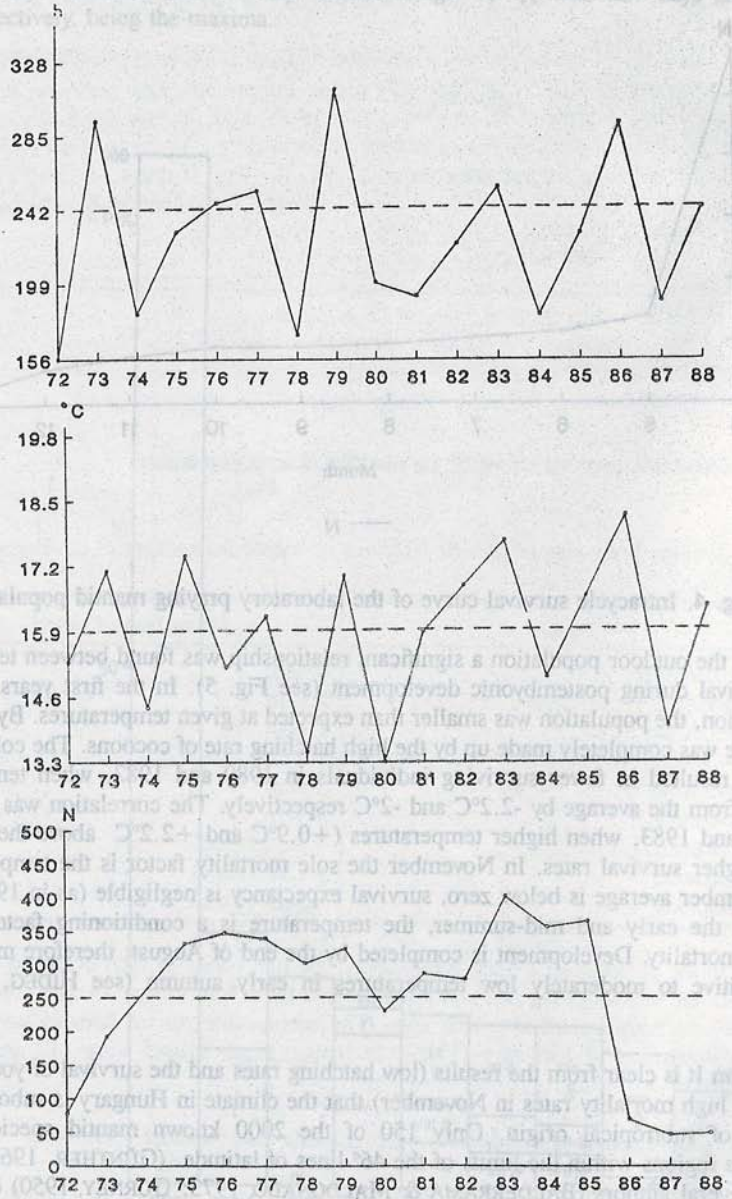

Fig. 5. Hypercyclic trends in two weather components (h = number of sunny days; °C = temperature), and the number of individuals in the early stages of postembryonic development.

Sphodromantis viridis, a Mediterranean mantid, exhibits environmental deamds similar to those exhibited by *Mantis religiosa*. Its optimal temperature range is 25-30° C. The lower threshold for development is 17°C and temperatures above 35°C are also disadvantageous (KÍNIGSMANN, 1963). Some mantids are inactive at midday in order to avoid high temperature (e.g. *Eremiaphilia* spp.; see GÜNTHER, 1968).

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