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# EFFECT OF CONSTANT VERSUS FLUCTUATING TEMPERATURE REGIMES ON *BATHYPLECTES CURCULIONIS* (HYMENOPTERA: ICHNEUMONIDAE) ACTIVITY

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ABSTRACT

Individual female *Bathyplectes curculionis* parasites were exposed to either a series of constant or fluctuating temperature regimes and supplied with a new group of host *Hypera postica* larvae every day. The fluctuating temperatures were calculated from an average of weekly air temperatures during a period of actual field oviposition by the parasite. The rearing of adult parasites under a constant versus fluctuating temperature regime resulted in no significant difference in parasitism, longevity, or fecundity. The threshold for *B. curculionis* activity was estimated to be 6-8°C.

*Bathyplectes curculionis* (Thomson) is an endoparasite of the alfalfa weevil, *Hypera postica* (Gyllenhal) (Coleoptera: Curculionidae). This parasite was introduced in the United States from Europe as a biological control agent of the alfalfa weevil. Through initial releases in 1911 (Chamberlin, 1924), subsequent releases, and natural dispersal, *B. curculionis* is now established throughout the range of its host (Brunson and Coles, 1968; Dysart and Day, 1976).

Ruesink (1976) stated that data are required on several basic population processes for a systems approach to pest management. Armbrust (1978) reported that the collection of population data for the alfalfa weevil/*B. curculionis* complex modeling effort was initiated in 1974. Basic life history and biology information are needed to validate and refine the model. The objective of the present study was to determine the effects of constant versus fluctuating temperature regimes on *curculionis* activity. The fluctuating temperatures selected in this study represent the actual daily temperature changes measured in the field. Parasite activity was measured as a function of the number of parasite eggs laid per day, percent parasitism, longevity, and fecundity.

## MATERIALS AND METHODS

Alfalfa weevil larvae were field-collected in the spring and reared in the laboratory on fresh-cut alfalfa. Cocoons of *curculionis* that developed from these larvae were retrieved to establish laboratory cultures.

Adult alfalfa weevils were field-collected in the fall and reared in the laboratory on fresh-cut greenhouse alfalfa which provided food and oviposition sites for the adults. Cultures were maintained in a TWIN-cubator® (Scientific Systems Corp.) at 23°C with a 9 hr photophase alternated with a 15 hr scotophase.

Alfalfa weevil eggs were removed from the alfalfa bouquets and incubated on moistened filter paper in 10 × 2.5 cm Pyrex® petri dishes. The eggs hatched in 8 ± 1 days at 23°C with relative humidity near saturation in the petri dishes. Newly emerged larvae (less than 24 hr old) were placed on the terminal tips of alfalfa bouquets with a moistened camel hair brush. The alfalfa bouquets were held in clear plastic tubes (5.5 cm dia. × 17.0 cm length), equipped

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with six air holes covered with organdy to permit free air circulation throughout the chamber. Another opening was fitted with a rubber stopper which permitted introduction of parasites when needed.

Twenty-four hours before the introduction of parasites, five 2nd instar larvae were placed in a new chamber containing fresh alfalfa. This technique allowed for a known number and age of host larvae to become established on the alfalfa before parasite introduction.

Cocoons containing *curculionis* larvae were stored at 7°C to prevent pupation and when needed were transferred to a chamber at 23°C to induce emergence. Adult parasites emerged from these cocoons in 12 ± 2 days. A pair (one male—one female) of *curculionis* adults were immediately introduced into a plastic chamber containing five late 2nd—early 3rd instar hosts. These instars were determined to be the preferred instars of *curculionis* by Barney et al. (1978). Each parasite was provided with a new group of larvae each day and a cotton dental wick moistened with sugar water until the parasite died.

An individual female parasite was exposed to a series of either constant or fluctuating temperatures in a Percival® incubator. The temperatures used are listed in Table 1. The fluctuating temperatures were calculated from an average of weekly temperatures recorded in Washington County, Illinois, during a period of actual field oviposition by *curculionis*. The incubator operated on a cam which gradually changed the temperature between the calculated daily high and low. The parasites were exposed to the fluctuating regimes in the natural progression experienced in the field, i.e. week of 9-15 April to week of 14-20 May (Table 1). A female remained at a high-low temperature set for two days before the temperature was changed. Each female was exposed to all the temperatures in either the constant or fluctuating regimes.

Every 24 hr the five larvae were removed and dissected. The number of parasite eggs found in each larva was recorded. Fecundity, longevity, and the number of eggs laid per day were calculated for every female parasite.

A linear regression analysis was made for each set of temperatures, constant and fluctuating. Steel and Torrie's (1960) equation for calculating the difference between two regressions was used to test homogeneity of two slopes. Student's t-test was used to determine the difference between the means for longevity and fecundity.

## RESULTS AND DISCUSSION

The number of eggs laid in a 24 hr period by female *curculionis* was directly proportional to temperature, regardless of the temperature regime (constant or fluctuating) under which the parasites were maintained (Fig. 1). Under the constant regime, oviposition was quite low at 7.2°C (1.73 eggs/day) and gradually increased to 19.00 eggs/day at 25.8°C. Extrapolation of Figure 1 would indicate the threshold of activity for *curculionis* to be about 6-8°C. Tempera-

Table 1. Constant and fluctuating temperature regimes (°C) used to determine effect of temperaure on *B. curculionis* oviposition.

| Temperature (°C) | | | | |
|---|---|---|---|---|
| | fluctuating | | | |
| constant | high | low | ave. | week |
| 7.2 | | | | |
| 10.0 | 13.3 | 6.1 | 9.7 | 9-15 April |
| 12.8 | 16.9 | 9.7 | 13.3 | 23-29 April |
| 15.5 | 18.9 | 11.7 | 15.3 | 30 April-6 May |
| 18.0 | 22.2 | 15.0 | 18.6 | 14-20 May |
| 23.0 | | | | |
| 25.8 | | | | |

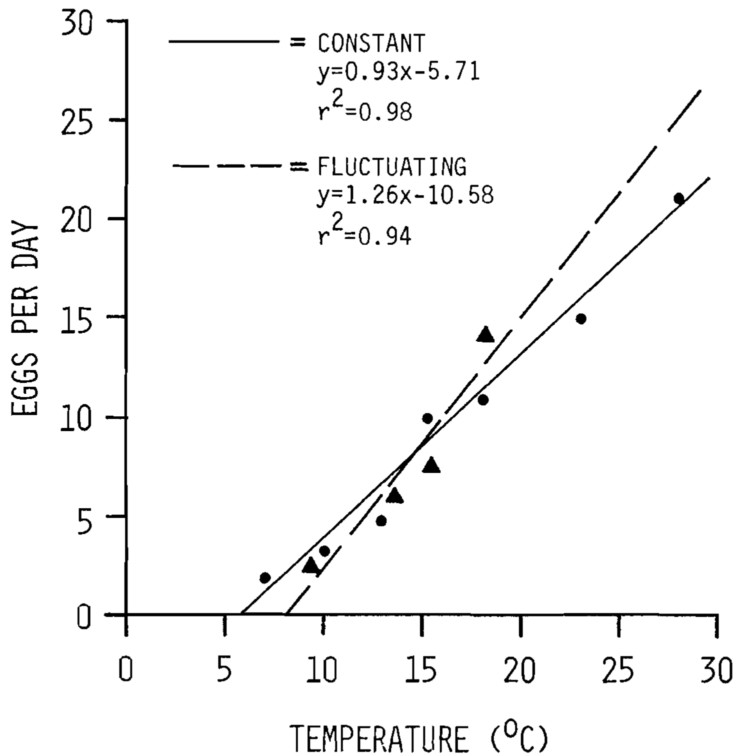


Fig. 1. Relationship between the number of eggs laid per day by *B. curculionis* and constant and fluctuatng temperatures.

tures exceeding those tested in this study are required to determine at what temperature peak oviposition is reached and subsequently inhibited by excessive temperature. Yeargan and Latheef (1977) found *B. anurus* females to oviposit more than 70 eggs/day when supplied with 40 hosts. The use of only five hosts in our experiment limited the total number of eggs laid, but was sufficient to indicate relative differences in parasite activity and oviposition at different temperatures. We did have one instance of 49 eggs laid in five hosts during a 24 hr period.

Parasitism reached 91.3% at 25.8°C and dropped to 26.7% at 7.2°C (Fig. 2). Again it must be remembered that only five hosts were available during a 24 hr period which gives a relative indication of parasite activity, oviposition, and searching ability. The low parasitism at decreased temperatures indicates a reduction in activity, searching ability, and consequently oviposition. The increased parasitism at greater temperatures reveals that *curculionis* was capable of locating and parasitizing the five host larvae given a sufficient temperature. Both constant and fluctuating temperature regimes elicited a directly proportional response in parasitism and there was no significant difference in percentage parasitism between the constant and fluctuating regimes ($P < .01$). This indicates that the same degree of parasite activity results from a constant temperature as from a temperature regime fluctuating around a mean equal to the constant temperature.

Longevity and fecundity of *curculionis* are shown in Table 2. Constant and fluctuating regimes caused no significant difference in longevity or fecundity ($P < .01$). Dowell and Horn (1977) also found *curculionis* laboratory longevity to average 14 days.

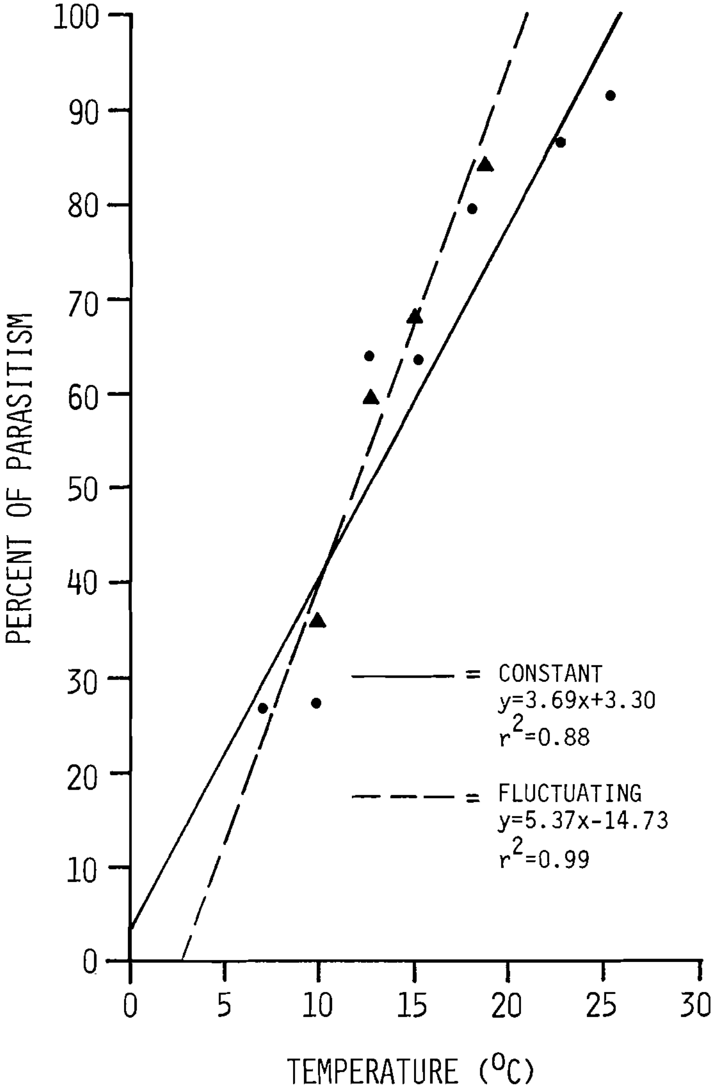


Fig. 2. Relationship between percent parasitism by *B. curculionis* and constant and fluctuating temperatures.

Table 2. Longevity and fecundity of *B. curculionis* under constant or fluctuating temperature regimes.

| Temperature regime | $\bar{x}$ longevity ± SE | $\bar{x}$ fecundity ± SE |
|---|---|---|
| constant | 14.37 ± 1.41 days[a] | 94.25 ± 22.2 eggs[a] |
| fluctuating | 12.46 ± 1.30 days[a] | 95.25 ± 16.4 eggs[a] |

[a]Not significantly different ($P < .01$)

In summary, the rearing of *curculionis* adults under a constant versus fluctuating temperature regime resulted in no significant difference in parasitism, longevity, or fecundity. Extrapolation shows the threshold for *curculionis* activity to be about 6-8°C.

## LITERATURE CITED

Armbrust, E. J. 1978. Alfalfa weevil pest management system for alfalfa. p. 85-99, in: Pest control strategies. E. H. Smith and D. Pimentel, eds. Academic Press.

Barney, R. J., E. J. Armbrust, D. P. Bartell, and M. A. Goodrich. 1978. Distribution of *Bathyplectes curculionis* within *Hypera postica* larvae in Illinois. Environ. Entomol. 7:241-245.

Brunson, M. H., and L. W. Coles. 1968. The introduction, release, and recovery of parasites of the alfalfa weevil in the eastern United States. U.S.D.A. Res. Serv. Prod. Res. Rep. 101.

Chamberlin, T. R. 1924. Introduction of parasites of the alfalfa weevil into the United States. U.S.D.A. Dep. Circ. 301.

Dowell, R. V., and D. J. Horn. 1977. Adaptive strategies of larval parasitoids of the alfalfa weevil (Coleoptera: Curculionidae). Can. Entomol. 109:641-648.

Dysart, R. J., and W. H. Day. 1976. Release and recovery of introduced parasites of the alfalfa weevil in eastern North America. U.S.D.A. Agr. Res. Ser. Prod. Res. Rep. No. 167.

Ruesink, W. G. 1976. Status of the systems approach to pest management. Annu. Rev. Entomol. 21:27-44.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc. N.Y.

Yeargan, K. V., and M. A. Latheef. 1977. Ovipositional rate, fecundity, and longevity of *Bathyplectes anurus*, a parasite of the alfalfa weevil. Environ. Entomol. 6:31-34.