# Effect of Ecdysterone on Food Intake of *Locusta migratoria* Hoppers

P. J. Rao* and H. Rembold

Max-Planck-Institut für Biochemie, D-8033 Martinsried, Am Klopferspitz

Z. Naturforsch. **38 c**, 878–880 (1983);
received February 3/July 11, 1983

*Dedicated* to Professor A. Butenandt *on the Occasion of His 80th Birthday*

*Locusta migratoria*, Ecdysterone, Weight Increase, Faecal Production, Feeding Inhibition

Ecdysterone administration at physiological concentrations (35 µg/hopper) on alternate days decreased the live weight gain and faecal production in both sexes of 5th instar nymphs of *Locusta migratoria*. All treated hoppers at this dose failed to moult. No such effects were observed when the hoppers were administered with half of the dose.

## Introduction

Insect growth and development are controlled by hormones [1, 2]. The hormones were also shown to control food intake and utilization in some insects [3–8]. Ecdysone is associated not only with moulting and metamorphosis but also with processes preparatory to a moult, such as cessation of feeding and the onset of the wandering stage [9]. Recently evidence for a relationship between feeding phases, ecdysone and pupariation [8] and an inverse relationship between ecdysteroid titres and total body metabolism of insects was also obtained [10]. Increased ecdysterone titres by injection were shown to lead either to reduction or cessation of feeding in the larvae of *Calliphora vicina* [8] and *Galleria mellonella* [10].

Although considerable information on prothoracic gland activity, blood titres of ecdysone and ecdysterone, its regulation and metabolism in *Locusta migratoria* is available [11–13], the effect of this hormone on food intake and weight gain of this insect was not studied. Whether it causes effects similar to those observed on feeding in holometabolous insects like *Calliphora vicina* and *Galleria mellonella* is not known. Information on this aspect becomes more essential and important in view of the recent findings that injection of azadirachtin in *Locusta migratoria* hoppers causes decreased food intake and weight gain, shifting of and decrease in ecdysterone peak during development with concomitant delay in moulting [14] and in adults azadirachtin has been shown to lead to inhibition of oogenesis and ovarian ecdysteroid synthesis [15]. Therefore the present work was undertaken to study the effect of ecdysterone on live weight gain, and faecal production, which serves as an indicator of food intake of 5th instar hoppers of *Locusta migratoria*.

## Materials and Methods

Fifth instar nymphs (less than 24 h old) of *L. migratoria* used in the present study were obtained from laboratory stock maintained according to loc. cit. [15].

Ecdysterone was a product of Calbiochem, San Diego, California, USA. It was initially dissolved in ethanol and the required volume was made up with insect saline solution prepared according to Shaaya and Levenbook [8]. The hoppers were injected with 3.5 µl (17.5 µg) and 7.0 µl (35.0 µg) ecdysterone/hopper on alternate days with a calibrated syringe using an electrically operated microapplicator (Model 234, Instrumentation Specialities Co., Nebraska, USA). Control hoppers received insect saline solution (7.0 µl) containing the same quantity of ethanol. Further injection of ecdysterone was stopped once the hoppers in control moulted to adults. After injection the hoppers were kept individually in transparent plastic beakers (9.5 × 12.5 cm) covered with a translucent plastic cap with three perforations of 1 cm diameter. Each hopper served as a replicate.

The hoppers were offered daily fresh wheat seedlings as food. Live weight of the hoppers and dry weight of faecal pellets were determined on alternate days on an analytical digital balance. For dry weight determinations, the faecal pellets were dried at 80 °C in an oven for 18 h.

The observations on ecdysterone treated hoppers continued even after the hoppers in control had moulted to adults. However, for comparison the data obtained up to the day when control hoppers

* Permanent address: Division of Entomology, Indian Agricultural Research Institute, New Delhi – 110012, India.

Reprint requests to Prof. Dr. H. Rembold.

0341-0382/83/0900-0878 $ 01.30/0

moulted to adults were utilized. The experimental conditions were the same as detailed by Rembold and Sieber [15].

## Results and Discussion

*Experiment I:* In this experiment hoppers of both sexes were treated with 35 µg ecdysterone/hopper on alternate days and insect saline treated hoppers only served as control.

The data on live weight of hoppers and dry weight of faecal pellets are presented in Figs. 1 and 2. Although there was continuous increase in weight of hoppers of both treatment and control, the rate of increase in control hoppers was far higher. The faecal output was the maximum on 4th day and minimum on 8th day, *i.e.*, the day before moulting in control hoppers. In contrast to these fluctuations, the difference in faecal content of treated hoppers during 8 days period was not much.

In case of control female hoppers, the total live weight gain during 8 days period was 869 mg as compared to only 342 mg by ecdysterone treated hoppers. Similarly, the saline treated males showed a weight gain of 655 mg in comparison to 235 mg by ecdysterone treated male hoppers. The differences

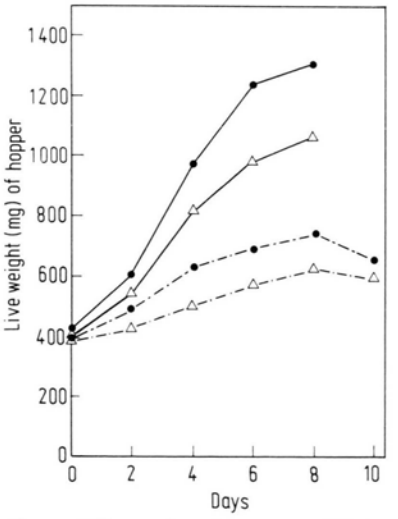


Fig. 1. Effect of ecdysterone (35.0 µg/hopper) on the weight increase of 5th instar hoppers of *Locusta migratoria.* ●—● control female; ●---● treated female; △—△ control male; △---△ treated male. The values presented are the average of four replications.

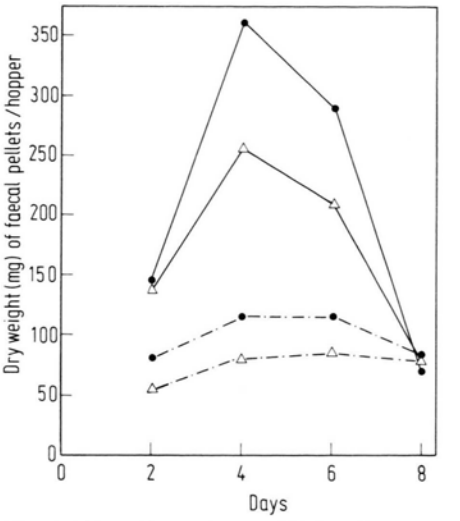


Fig. 2. Effect of ecdysterone (35.0 µg/hopper) on the faecal production of 5th instar hoppers of *Locusta migratoria.* ●—● control female; ●---● treated female; △—△ control male; △---△ treated male. The values presented are the average of four replications.

in the quantity of faecal production between saline treated and ecdysterone treated hoppers reflected the differences in live weight gain.

All the saline treated hoppers moulted to adults either on 9th or 10th day after the first application. However, ecdysterone treated female hoppers died on 11th day without moulting. It is of interest to note that one of the treated male hoppers survived as long as 28 days without moulting while the remaining hoppers died on 13th day from the start of the treatment. Since the present study is of a preliminary nature it is difficult to suggest any sex specific effects of ecdysterone.

*Experiment II:* Only male hoppers were used for this experiment. Besides insect saline treatment, untreated hoppers were also kept as an additional control to find out whether insect saline has any effect on weight gain and faecal production. Furthermore, the effect of a lower dose (17.5 µg/hopper) was also studied.

The consolidated data for the period on weight gain and faecal production of normal, saline treated, and of ecdysterone treatments (17.5 µg and 35.0 µg/hopper) are presented in Table I. The data confirm the results from experiment I and also point out that insect saline solution has no adverse effect on weight gain and faecal production.

Table I. Experiment II. Effect of ecdysterone on 5th instar *Locusta migratoria* males. The values are on hopper basis for the 5th instar period and represent the average of 4 replications.

| Treatment | Live weight gain [mg] | Faeces produced (dry weight) [mg] |
|---|---|---|
| Untreated | 649 | 577 |
| Insect saline | 695 | 600 |
| *Ecdysterone* | | |
| (a) 17.5 µg/hopper | 718 | 663 |
| (b) 35.0 µg/hopper | 184 | 176 |

The foregoing results clearly show that ecdysterone titres at peak levels [14] affect weight gain, faecal output and moulting. Since faecal production is directly related to food intake, it could be presumed that the food intake was also affected by ecdysterone treatment. However, lack of any adverse effect in 17.5 µg treated hoppers is an indication that high ecdysterone titre may be required for the expression. Indeed it was shown in *Calliphora vicina* that the extent of larval feeeding was inversely related to those of 20-hydroxyecdysone administered and also the hormonal effect was dependent on the period of starvation subsequent to administration of the hormone [8]. Recently Slama [10] has shown an inverse relationship between ecdysterone titres and total body metabolism in insects. He was of the opinion that the presence of a relatively large ecdysteroid concentration in the body would not be compatible with the extremely high metabolic rates of the feeding and rapidly growing larvae. It was pointed out that metabolic inhibition at high ecdysteroid titre was due to a side effect caused by starvation and immobilisation in *Galleria mellonella*.

The lack of moulting in ecdysterone treated hoppers (35 µg/hopper) in the present study could be due to lack of sufficient body reserves for the moult. In this connection it is of interest to note the findings of Fourche [16, 17] who showed that exogenous ecdysone was required for starved 2nd instar *Drosophila* larvae to moult to 3rd instars. But also adequate feeding was necessary for the larvae to become "competent" to react to ecdysone. Since the moulting is governed by both juvenile hormone and moulting hormone titres, studies are in progress to determine the juvenile hormone titres under ecdysterone treatment.

*Acknowledgement*

P. J. Rao is grateful to Max-Planck-Gesellschaft for a fellowship.

[1] L. I. Gilbert, Recent Prog. Horm. Res. **30,** 347–390 (1974).
[2] L. I. Gilbert, W. E. Bollenbacher, W. Goodman, S. L. Smith, A. Agui, N. Granger, and B. I. Sedlak. Recent Prog. Horm. Res. **36,** 401–449 (1980).
[3] L. Hill, W. Mordue, and K. C. Highnam, J. Insect. Physiol. **12,** 1197–1208 (1966).
[4] L. Strong, J. Insect Physiol. **13,** 495–507 (1967).
[5] P. R. Walker and E. Bailey, J. Insect Physiol. **17,** 1125–1137 (1971).
[6] A. M. Th. Beenakkers and A. Th. M. Van Den Broek, J. Insect Physiol. **20,** 1131–1142 (1974).
[7] T. Srihari and R. T. Gahukar, Bull. Soc. Zool. Fr. **100,** 327–333 (1975).
[8] E. Shaaya and L. Levenbook, J. Insect Physiol. **28,** 683–688 (1982).
[9] P. Karlson. Prog. Ecdy. Res., Elsevier North Holland 1–11 (1980).
[10] K. Slama, Z. Naturforsch. **37c,** 839–844 (1982).
[11] J. A. Hoffmann, J. Koolman, P. Karlson, and P. Joly, Gen. Comp. Endocrinol. **22,** 90–97 (1974).
[12] J. Koolman, J. A. Hoffmann, and M. Dreyer, Experientia **31,** 247–249 (1975).
[13] M. Hirn, C. Hetru, M. Lagueux, and J. A. Hoffmann, J. Insect Physiol. **25,** 255–261 (1979).
[14] K.-P. Sieber and H. Rembold, J. Insect Physiol. **29,** 523–527 (1983).
[15] H. Rembold and K.-P. Sieber, Z. Naturforsch. **36c,** 466–469 (1981).
[16] J. Fourche, C. R. Hebd. Seanc. Acad. Sci. Paris, Ser. D **264,** 2398–2400 (1967a).
[17] J. Fourche, Archs. Anat. Microsc. Morph. Exp. **56,** 141–152 (1967b).