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Autor: Hadani, A. / Ziv, M.

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Kimron Veterinary Institute, Bet Dagan, Israel,
affiliated to the University of Tel-Aviv

Tick-Host Relationships.
III. The Effect of Photoperiodic Pre-conditioning on the Circadian Rhythm of "Drop-off" of Engorged Pre-imaginal Stages of the Tick *Hyalomma excavatum* (Koch, 1844) from the Gerbil – *Meriones tristrami* *

A. HADANI and M. ZIV

Abstract

The effect of regimes of constant light or darkness on the eventual "drop-off" of engorged larvae and nymphs of *Hyalomma excavatum* from its gerbil host, *Meriones tristrami* was studied. Photoperiodic pre-conditioning could not basically modifiy the circadian rhythm of "drop-off".

The existence of a circadian rhythm in the "drop-off" of engorged stages of *Hyalomma excavatum* (KOCH, 1844) and *Rhipicephalus sanguineus* (LATREILLE, 1806) from the gerbil host has been demonstrated (HADANI & RECHAV, 1969). Later, some factors affecting this rhythm, particularly different photoperiodical regimes and host reactions, were examined (HADANI & RECHAV, 1970). In these studies the circadian rhythm of "drop-off" was believed to be essentially endogenous.

Similar observations were reported for other species of ticks (BALASHOV, 1954, KITAOKA, 1962, and GEORGE, 1963). Recently, AMIN (1970) and particularly GEORGE (1971) published their results, indicating the possible effect of exogenous factors such as light and host activity on the circadian rhythm of "drop-off" of engorged ticks from their hosts. Light is considered by SOLLBERGER (1965) to be a dominant synchronizer affecting endogenous biological rhythms.

The effect of photoperiodic pre-conditioning of the free and parasitic stages on the eventual behaviour of the ticks attached to their hosts has hardly been studied.

In the present report the circadian rhythm of "drop-off" of engorged larvae and nymphs of *Hyalomma excavatum* which were exposed to different photoperiodic regimes during their free and parasitic stages has been studied.

Materials and Methods

Laboratory bred *H. excavatum* ticks were used throughout the experiments. Methods of tick breeding and infestation have been previously described (HADANI & RECHAV, 1969). Engorged female ticks were kept individually in test tubes either in constant light or darkness at 28 °C and 80 % R.H. for oviposition and larval hatching.

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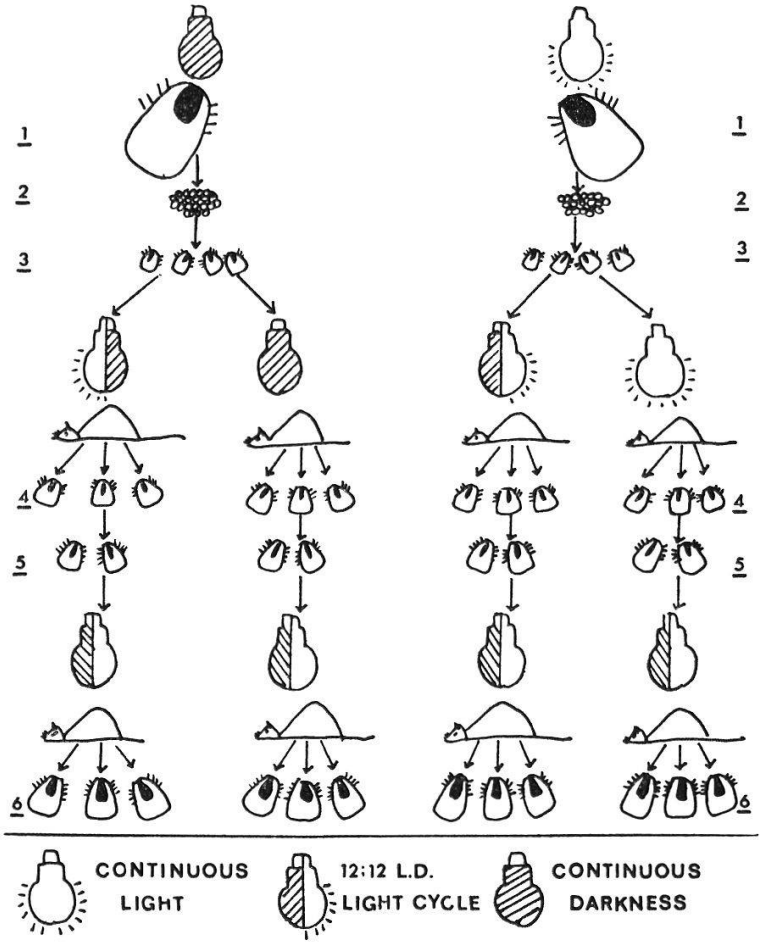

Fig. 1. Photoperiodic pre-conditioning of *H. excavatum* ticks during the parasitic and free stages – experimental design.
1. engorged female; 2. eggs; 3. unfed larvae; 4. engorged larvae; 5. unfed nymphs; 6. engorged nymphs.

The photoperiodic treatments consisted of constant light, continuous darkness and a L.D. 12:12 light cycle, with the photoperiod extending from 06.00 to 18.00. Light was supplied by fluorescent lamps. The experimental design is described in Figure 1.

Groups of gerbils were infested with larvae which had hatched in constant light or darkness, the animals being maintained either in the same regime or in 12:12 L.D. light cycle, all at 20–25 °C and 50–70% R.H. The engorged detaching larvae in the 12:12 L.D. light cycle were collected and counted every 2 hours. Those of the 2 other regimes were collected daily.

The issuing nymphs were fed on gerbils which were kept in 12:12 L.D. light cycle. The engorged nymphs were collected and counted every 2 hours and the rhythm of "drop-off" was recorded.

Results and Discussion

The circadian rhythm of "drop-off" of engorged larvae, from the gerbils maintained at 12:12 L.D. light cycle is given in Table 1 and Figure 2.

It can be seen that the circadian rhythms of "drop-off" of engorged larvae, recorded for both photo-periodical preconditioning treatments are similar with

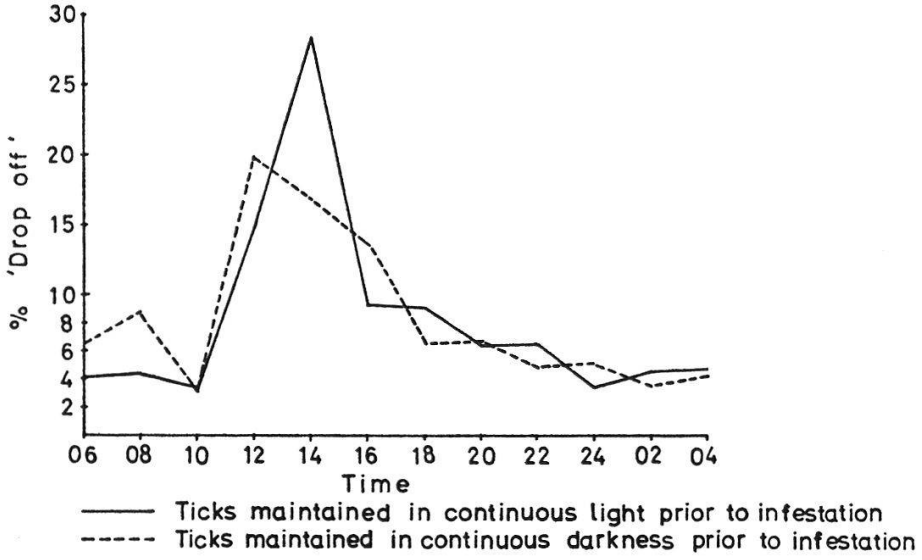

Fig. 2. Effect of photoperiodic pre-conditioning on the pattern of circadian "drop-off" of *H. excavatum* engorged larvae from gerbils kept in a 12 : 12 L.D. light cycle.

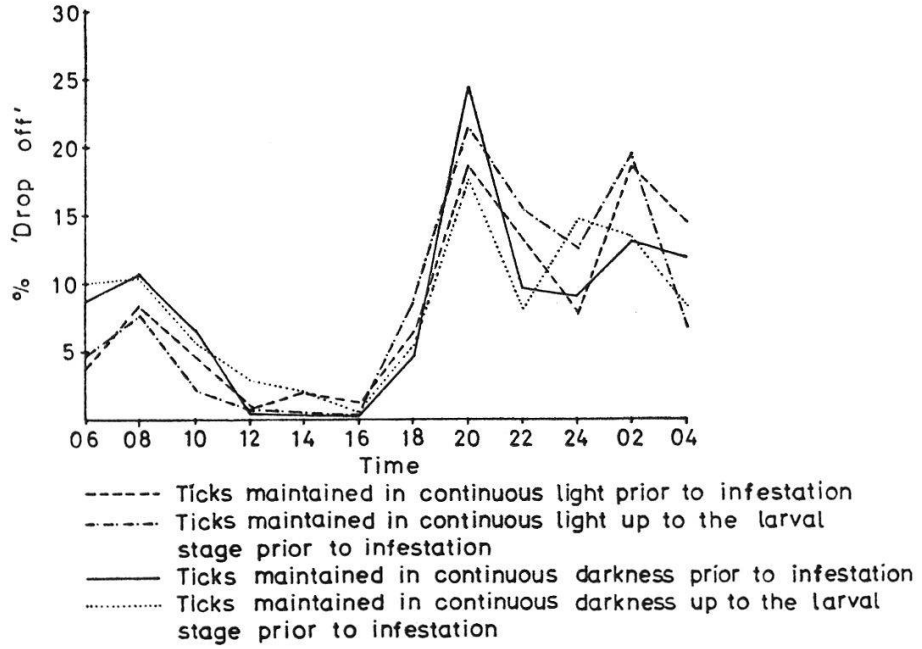

Fig. 3. Effect of photoperiodic pre-conditioning on the pattern of circadian "drop-off" of *H. excavatum* engorged nymphs from gerbils kept in a 12 : 12 L.D. light cycle.

peaks of detachment at 14.00 and 12.00 for the ticks maintained in continuous light and permanent darkness respectively. A slight "shift to the left" might have occurred in the circadian "drop-off" of engorged larvae kept in continuous darkness with a less well defined peak. This latter tendency was observed when studying the pattern of "drop-off" of *H. excavatum* engorged larvae from gerbils kept in continuous darkness as compared to those maintained at 12:12 L.D. light cycle (HADANI & RECHAV, 1970).

The pattern of "drop-off" of engorged nymphs is presented in Table 1 and Figure 3.

Table 1. Circadian rhythm of "drop-off" of photoperiodically pre-conditioned engorged larvae and nymphs of *H. excavatum* from gerbils kept in 12:12 L.D. light cycle.

Stage	Photoperiodic pre-conditioning	No. of animals in trial	Total No. of engorged ticks collected	Time of collection											
				Light						Darkness					
				06–08	08–10	10–12	12–14	14–16	16–18	18–20	20–22	22–24	24–02	02–04	04–06
Larvae	Continuous light	6	9,397	4.9 *	3.4	15.1	28.1	9.4	9.1	6.2	6.5	3.6	4.6	4.7	4.1
	Continuous darkness	6	13,307	8.6	3.2	19.7	16.8	13.7	6.5	6.7	5.0	5.1	3.7	4.3	6.7
Nymphs	Continuous light	4	537	8.1	4.7	0.9	2.0	1.1	6.2	18.6	13.5	7.8	18.7	14.6	3.7
	Continuous light up to the larval stage	6	422	7.6	2.2	0.4	0.2	0	8.9	21.4	15.0	12.8	19.4	7.0	4.6
	Continuous darkness	4	818	10.6	6.7	0.4	0.5	0.4	4.9	24.2	9.8	9.1	12.5	12.0	8.8
	Continuous darkness up to the larval stage	6	392	10.7	5.8	2.9	2.1	0.4	5.2	17.7	8.1	14.9	13.8	8.3	10.0

* Expressed in %, each value representing the mean percentage of "drop-off" as related to the total number of ticks collected from the lot of gerbils.

It can be seen that similar diurnal rhythms of "drop-off" of engorged nymphs were obtained in all 4 groups, showing two peaks extending over most hours of the night i.e. 20.00–02.00 with a small additional increase at 08.00. These findings remarkably overlap those obtained for the "drop-off" of engorged nymphs from infested gerbils maintained in continuous light and darkness (HADANI & RECHAV, 1970). In that case several less well defined peaks of "drop-off" of engorged nymphs were obtained as compared to the sharply defined peak at 22.00–24.00 recorded when the gerbils, infested with non-preconditioned nymphs were kept under similar conditions.

From the results described above it can be seen that photoperiodical pre-conditioning of the ticks might slightly modify the endogenous, well regulated, circadian rhythm of "drop-off" of engorged larvae and nymphs of *H. excavatum* from the gerbil host without, however, changing the overall typical pattern.

BELOZEROV (1966), working with *Ixodes ricinus,* found that diapause with regard to moulting and aggressiveness was regulated by pre-feeding photoperiodic regimes. BATEMAN (1955) has shown that the diurnal rhythm of eclosion in the fruit fly *Dacus tryoni* "can be reset in the larval stage by new light: darkness conditions", the pupae being insensitive to such changes. Furthermore, the rhythm of ecdysis was shown to be reversed by reversing the exposure periods to light and darkness of the adults of the previous generation. On the other hand, the rhythm of ecdysis was found to be entirely independent of the conditions of illumination during the pupal stage.

AMIN (1970) and particularly GEORGE (1971) consider the circadian rhythm of "drop-off" of engorged ticks from their hosts to be endogenous, and at the same time influenced by exogenous factors such as host reactions and light intensity. According to GEORGE (1971) entrainment of the circadian rhythm does not occur until the ticks are attached to the host.

From the results obtained it seems that the circadian rhythm of "drop-off" of engorged pre-imaginal stages of ticks from the gerbil host is essentially endogenous. As shown previously exogenous factors such as light might modify the pattern of "drop-off" to a certain extent. Furthermore as shown in the present report, photoperiodic pre-conditioning might also cause slight changes in the pattern of the circadian "drop-off" of engorged ticks.

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