Israel Journal of Entomology Vol. V - 1970

A METHOD FOR STUDYING THE BEHAVIOUR OF SOFT TICKS

A. Avivi*
Israel Institute for Biological Research
Ness-Ziona

Abstract

An apparatus is described, which is basically a funnel into which ticks moving towards a host are collected. The effect of various hosts and various ambient conditions can be tested in this apparatus.

The precautions to be taken with Ornithodoros tholozani and O. mouhata. in order to minimize artifacts, are discussed.

The behaviour of ticks (Ixodidae) had not been sufficiently explored, as compared with insects. Most of the work done was confined to the ticks' sensory physiology and did not deal with more complex behaviour.

Such work has been performed by Schultze and Schroeder (1949) on phototaxis, thermotaxis and hygrotaxis in Argas columbarum; by Hindle and Merriman (1912) on phototaxis and thigmotaxis in Argas persicus ; by Krijgsman (1937) on phototaxis, geotaxis, hygro- taxis, thigmotaxis and chemotaxis in Boophilus annulatus ; by Wilkinson (1953) on photo- taxis, geotaxis and chemotaxis in B. microplus ; and by Totze (1933) on phototaxis and thermotaxis in Hyaloma marginatum.

More comprehensive work was done by Totze (1933), Macleod (1935) and Lees (1948) on phototaxis, thermotaxis, hygrotaxis, anemotaxis, geotaxis and chemotaxis in Ixodes

* deceased on 23 January 1970

ricinus; by Mironov (1939) on phototaxis, geotaxis and chemotaxis in I. persuccatus; and by Krijgsman (1937) on hygrotaxis, thigmotaxis and chemotaxis in Rhipicephalus sanguineus, while only one publication exists on Ornithodoros (Samira El-Ziady, 1958).

There is a fundamental difference between the two sub-families of the Ixodidae. The Ixodidae are ectoparasite ticks that stay constantly, or for long periods, on their hosts. The main elements of their behaviour, according to Lees (1948), are climbing on vegetation when they are hungry (negative geotaxis), descending from the vegetation after feeding (positive geotaxis and negative phototaxis), and attraction to the host by his presence (chemotaxis, thermotaxis).

On the other hand, the Argasinae ticks are ectoparasites found mostly in the burrows of their hosts and it seems likely that all their responses have a different character. On the basis of observations, it appears that anemotaxis, chemotaxis and thermotaxis are similar in both groups, but that phototaxis here has a more constant, negative character enabling the ticks to remain always in their burrows. Geotaxis is not so distinct, especially among the mature stages and hygrotaxis, like phototaxis, helps the ticks to remain constantly in humid places.

This paper describes a method developed for the study of behaviour of Ornithodoros tholozani and O. moubata. The stages that can be used in the apparatus described are older nymphs and adults following various periods of starvation. Larvae and nymphs of the first and second stage were not used since they are more complicated to work with, and a different technique would have to be devised for the study of their behaviour. However, after several years of observation in the laboratory it can be said that their behaviour, in general, resembles that of the adult stages although they are more sensitive and react quicker to many stimuli.

O. tholozani: The ticks were collected from caves in this country and propagated in the laboratory. This tick seems to be sensitive to low humidities since it is found mostly in humid places (caves, burrows, ruins, etc.).

When the relative humidity in the room drops, the ticks begin to move nervously and try to climb out of their containers. When the humidity is increased they stop such nervous movements and return to their normal activity, i. e. they settle down or dig into the sand. Their phototaxis is less negative than that of O. moubata and experiments can be conducted in full light.

The sensitivity of the ticks to stimuli is dependent on starvation time. Starvation periods of six to eight months were found to be optimal for attraction experiments, while with shorter starvation periods they are not responsive enough to stimuli and are not active in significant numbers. On the other hand, after a long starvation (1 - 2 years) they are less resistant to low relative humidity and die in large numbers. They do not show as strong a thigmotaxis as O. moubata or A. persicus, and dig themselves into the sand in a random dispersal.

O. moubata: This tick is much more tolerant to low humidities and less sensitive to humidity changes in the laboratory, but its negative phototaxis is much more pronounced and occasionally it is impossible to experiment with these ticks under full light. This tick has a very strong thigmotaxis and it will try to crawl into any crevices found in the apparatus, a factor that can interfere with experiments and should be considered when constructing the apparatus.

In preparing a stock of ticks for experiments, it is important to feed all ticks on the same day to ensure homogenous physiological conditions. However, even under this procedure, there is a dispersal of their activities, not all the ticks being responsive on the same day, a phenomenon which may have its survival value in nature by putting less pressure on the host.

The Attractometer: (Fig. 1). An aluminum bowl having a hole in the centre of its floor and a cone made of celluloid fixed in this hole by a metal rod is filled with sand to the rim of the cone. A circular tin sheet which can be opened in the centre by a cover is placed on the rim of the cone. A ring of sticky material (a mixture of Tanglefoot -

a commercial sticky paste for application on trees to prevent climbing of insects, with the repellent dimethylphthalate) is applied to the rim of the bowl. An animal host or some other source of attraction is placed in the centre of the cone. A live host (rat, mouse, etc.) is placed in a narrow cone-shaped cage, closed at the bottom with a rubber stopper. After numerous experiments, the cone form proved to be the best since the same cage can be used for animals of various sizes. The ticks which are attracted to the host, approach the cone and slide down into the glass tubes which are placed under the bowl (Fig. 1).

Preliminary experiments have shown that ticks behave nervously and move ceaselessly when placed on an exposed surface. By placing a population of ticks on sand and allowing them to dig in, the conditions become similar to those in nature where the ticks stay in the sand of burrows. By this method a large number of ticks can be concentrated in the vicinity of the host. Experiments with O. moubata females have shown that they lay more eggs in sand than when sand is not available.

The circular plate with the cover which prevents the ticks from falling through the open cone during the conditioning stage, is closed and then the ticks are introduced into the apparatus in the required numbers (200 - 500 - 1000) the day before starting the experiment in order to condition them to the new surroundings. An experiment which begins too soon after introducing the ticks may produce wrong results as many ticks will fall into the cone owing to random movement before burrowing into the sand and not as a result of direct attraction.

The experiment begins when all the ticks are dug in or resting. For O. tholozani this condition is further facilitated by providing a light that is left on during the night, thus causing the ticks to dig in more rapidly.

In starting an experiment, the animal within its cage is placed in the centre resting on the iron bar and fastened by rubber strings. While placing the animals in their places care should be taken for the cage not to touch the rim of the covers as this would enable ticks to climb on the animal and suck blood.

All the preparations of introducing the animals into their cages etc. are performed away from the attractometer or in another room in order to avoid stimulation of the tick by the presence of the experimentator. This is especially important in dealing with very hungry ticks. When the behaviour of the ticks is to be watched, the observer is isolated from the attractometer by a cover of celluloid or other transparent material, but it should be understood that by isolating the attractometers, the conditions inside change drastically as there is a concentration of attraction factors (CO_2, warmth, vapours, etc.) that do not disperse. However, this is not an artificial condition since similar conditions exist in small burrows of rodents. The attractometer can also be isolated by a cylinder which is open at the top.

Duration of the experiments: In general, six hours are necessary to give significant results. In experiments lasting several days (day and night) without interruption, the host is changed every day as it may die after being confined to its cone for over 24 hours, especially at low temperatures. In order to study the behaviour cycles for longer periods (month or more) the experiment is conducted during the day and it is interrupted towards night when the host is removed and then replaced on the following day. This, again, is not such an artificial procedure as it seems, since the same occurs in nature in the burrows of rodents: the rodents are out during the night and stay in during the day.

At the end of the experiment, the animal is removed, the cone is closed with the cover and the ticks in the glass tubes are counted. To remove the remaining ticks from the sand, the cork is opened and the sand is allowed to fall through silk netting which retains the ticks. It is recommended to conduct the experiments at relative humidity of 80 - 90% and temperature of 24 - 26^{o}C, unless the effects of temperature or relative humidity are studied.

As mentioned before, high humidities are essential for O. tholozani. In order to produce these humidities, a jet of air from a fan is directed towards wet towels.

This apparatus was found suitable for studying the effect of various hosts, and the effects of external conditions such as temperature, humidity, light and darkness on the activity cycles of the ticks.

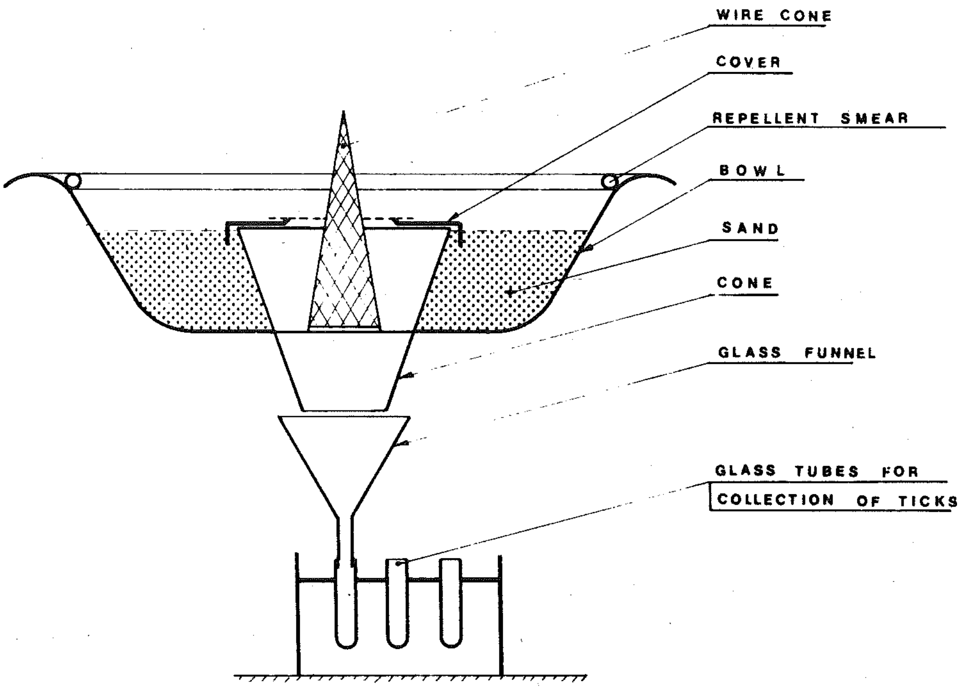

Fig. 1. Tick's Attractometer

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