THE ECOLOGY OF THE KANGAROO TICK ORNITHODESORNIS JUNAPTUS

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Summary

This study is an attempt to elucidate some of the behavioural and physiological mechanisms which enable the kangaroo tick, Orothodoxus (Powyskyella) curvati (Warburton), to persist in some of Australia's most inhospitable country. In nature, when the tick is not feeding, it lies buried in the soil at the base of trees where its host, the red kangaroo, Macropus rufus (Temescum), is wont to lie in the shade during the heat of a summer's day. The kangaroo scrapes out a "wallow" in which it lies, and because of the kangaroo's movements, the soil in a wallow is usually soft and friable. Into this soil the tick can burrow easily.

The life-cycle stages are eggs, larvae, between three and five nymphal instars and adults. All stages except the egg feed, and females may feed and oviposit as many as six times. Mating and oviposition all take place in the soil.

Adults and late-instar nymphs remain attached to their host for 20 min. to 2 hrs before detaching engorged. In contrast, early-instar nymphs may remain attached for several days, and larvae for up to twelve days before engorging and detaching. The timing of detachment in such ticks is regulated by a circadian rhythm within the tick, the phase of which can be set before or during attachment. This rhythm ensures that the engorged ticks detach during the middle
of the photo-phase. Because kangaroos are nocturnal and range widely, feeding at night but resting under shady trees by day, there is a high probability that the engorged ticks will detach while the kangaroo is resting and so will be in a place where the probability of finding another meal is relatively high. Because kangaroos are semi-nomadic, the prolonged period of attachment serves as a dispersal mechanism, possibly the only one.

Morphogenesis begins at temperatures between 15 and 20°C, depending on the instar. The earlier instars have lower developmental thresholds. The temperature thresholds for molting are several degrees above the developmental threshold for each instar. High temperatures (40°C) inhibit morphogenesis; several days at 45°C is lethal. Observations on the rate of development in the field showed that laboratory data, in conjunction with meteorological records, could be used to predict the amount of development that would occur in the field during a particular period. The amount of development which could occur during each month of an average year was calculated. Most development occurs during the summer months and very little occurs during winter. If food were abundant, then the mean duration of the life-cycle in the field would be between four and ten months, depending on the season of the year. However in nature food is so scarce that the rate of development rarely, if ever, limits the rate of growth of
the population. Humidity had only a slight effect on the rate of morphogenesis.

An examination of the susceptibility to desiccation of the different developmental stages showed that solitary larvae died after only a few days' exposure to high saturation deficit, whereas nymphs and adults were very resistant and could survive at least several months of similar conditions. The longevity of larvae was enhanced when the eggs and subsequent larvae were "cooed" by their mother, but they were still very vulnerable. Larvae can rehydrate, but this ability did not increase their chance of survival. Nymphs and adults, on the other hand are very tolerant of dry conditions. They dehydrate very slowly, can tolerate the loss of a relatively high proportion of their body weight and they can rehydrate by extracting water from unsaturated air. These abilities enable the tick, when occasionally rehydrated, to survive several years without feeding.

Examination of the climatological data for the inland areas studied suggest that if ticks do not find a meal, the larvae will die from desiccation, as will a proportion of the early-instar nymphs, while the late-instar nymphs and adults are so resistant that very few perish in this way. The ticks which survive desiccation may die from starvation over a period of several years.

Most eggs are laid in spring and early summer and few at other times of the year. This was shown to be due to the occurrence of a
diapause in the adult during which oogenesis did not occur. There is a seasonal cycle in the incidence of imaginal disease in which most females are in diapause between mid-summer (December) and mid-winter (July). High temperatures during early summer induce diapause in the late-instar nymphs and in a proportion of the imagos. The factors inducing diapause in the rest of the adult female population are enigmatic. Diapause development occurs at temperatures between 10 and 20°C and in nature, occurs during autumn and winter.

Kangaroos do not begin to spend most of the day in wallows until late spring, and so during early spring ticks are unlikely to find a meal. However, even if a female engorges in early spring, the amount of effective temperature is so small that little oogenesis occurs. In late spring and early summer (before diapause becomes manifest) kangaroos visit wallows more frequently, and temperatures are relatively high. This results in a flush of larvae at these times. Kangaroos continue to visit wallows until early autumn and so the larvae give rise to a flush of first instar nymphs from January to March; these may give rise to second instar nymphs from February to April.

January and February are the hottest and driest months of the year. Reproductive diapause entails egg production at a time when eggs and larvae are most likely to perish from desiccation and so is of obvious adaptive value.
The density of kangaroos in the area that was studied appears to be about 4 to 8 per sq. mile (1.5 to 3 per square kilometre). During summer kangaroos do not, as a rule, lie under trees which provide sparse shade; those trees providing denser shade were visited, on the average, about once a month during summer.

Whether a population persists in an area will depend on the balance between the ability of the tick to survive protracted periods without feeding and the frequency with which kangaroos visit wallows. The way in which the density of kangaroos and the density of shade-trees affects the probability of survival of a local population is discussed.
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2.1</td>
<td>The Life History of the Tick</td>
<td>11</td>
</tr>
<tr>
<td>2.2</td>
<td>Laboratory Feeding and Breeding Methods</td>
<td>12</td>
</tr>
<tr>
<td>2.3</td>
<td>Feeding</td>
<td>13</td>
</tr>
<tr>
<td>2.4</td>
<td>Hatching and Moulting</td>
<td>17</td>
</tr>
<tr>
<td>2.5</td>
<td>Matings and Oviposition</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>A Circadian Rhythm of Feeding and Detachment</td>
<td>22</td>
</tr>
<tr>
<td>3.1</td>
<td>Introduction</td>
<td>22</td>
</tr>
<tr>
<td>3.2</td>
<td>Materials and Methods</td>
<td>24</td>
</tr>
<tr>
<td>3.3</td>
<td>The Rhythms of Detachment of Engorged Larvae</td>
<td>26</td>
</tr>
<tr>
<td>3.4</td>
<td>The Rhythms of Detachment of Engorged Nymphs</td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td>The Rate of Development</td>
<td>42</td>
</tr>
<tr>
<td>4.1</td>
<td>Summary</td>
<td>42</td>
</tr>
<tr>
<td>4.2</td>
<td>Literature Review</td>
<td>43</td>
</tr>
<tr>
<td>4.3</td>
<td>Introduction</td>
<td>49</td>
</tr>
<tr>
<td>4.4</td>
<td>Larval and Nymphal Development</td>
<td>49</td>
</tr>
<tr>
<td>4.4.1</td>
<td>The Effect of Temperature on the Rate of Development</td>
<td>50</td>
</tr>
<tr>
<td>4.4.2</td>
<td>The Effect of Sub-lethal Doses of High Temperature on Development</td>
<td>52</td>
</tr>
<tr>
<td>4.4.2.1</td>
<td>The Failure of Engorged Juveniles to Hold at Constant Temperatures</td>
<td>94</td>
</tr>
</tbody>
</table>
4.4.2.3 Moulting Behaviour in Changing Temperatures

4.4.2.3.1 The Influence of High Temperature on Adult Ticks

4.4.2.4 How Moulting Disperses

4.4.3 Temperature Thresholds for Moulting

4.4.4 Effect of Humidity on Moulting Development

4.4.5 Day-Degree and Moulting Behaviour

4.4.6 Field Experiments on the Rate of Development

4.5 Incubation Period

4.6 The Rate of Oogenesis

4.6.2 The Effect of Relative Humidity on the Rate of Oogenesis

4.7 Discussion

5. Longevity of O. gurneyi

5.1 Summary

5.2 Literature Review

5.3 Introduction

5.4 Survival: Starvation, Humidity and Temperatures

5.4.1 Survival of Eggs

5.4.2 Longevity of Larvae

5.5 Regulation of the Water Content of nymphs and Adults, and Survival under Dry Conditions

5.5.1 How Dry is too Dry?
5.5.2 The Rate of Weight Loss at Different Humidities

5.5.3 The Rate of Absorption of Water Vapour

5.6 The Survival of Ticks in the Field

5.6.1 How Dry are the Rainless Periods?

5.6.2 How Long do the Dry Periods Last?

5.6.3 How Quickly does the Soil Dry Out?

5.6.4 The Longevity of Ticks under Field Conditions

6. The Regulation of Diapause

6.1 Summary

6.2 Literature Review

6.3 How to Recognise Diapause

6.4 Field Observations and Experiments

6.4.1 The Occurrence of Diapause in Field Populations

6.4.2 When is Diapause Induced

6.4.3 The Induction of Diapause in the Field

6.5 Laboratory Experiments

6.6 The Induction of Diapause by Temperature

6.6.1 The Sensitivity to Temperature of Unfed Females

6.6.2 The Sensitivity to High Temperature of Unfed Females

6.6.3 The Sensitivity to Temperature During and after Oogenesis and Oviposition
6.6.4 The Sensitivity to Temperature of Engorged Females
6.6.5 The Effect of Short Periods of Exposure to High Temperature
6.7 How Humidity had but a Slight Influence on the Incidence of Diapause in Adults
6.7.1 The Effect of Relative Humidity on Engorged Females
6.7.2 The Reaction of Engorged Diapausing Females
6.8 The Induction of Imaginal Diapause in the Nymphal Stage
6.8.1 The Sensitivity of Engorged Third-, and Unengorged Fourth Instar Nymphs
6.8.2 The Sensitivity of Unengorged Nymphs
6.8.3 The Sensitivity of the Engorged Nymph
6.9 Diapause Development
6.10 Discussion

7. The Behaviour of Kangaroos and the Annual Breeding Cycle of the Tick
7.1 Seasonal Changes in the Use of Wallows
7.2 The Relative Density of Ticks in Wallows
7.3 What is the Density of Kangaroos?
7.3.1 How Frequently are Wallows Visited?
7.3.2 What is the Chance of Finding a Meal?
7.4 The Instar Distribution