OBSERVATIONS ON THE FEEDING ACTIVITY OF THE AUSTRALIAN PLAGUE LOCUST CHORTOICETES TERMINIFERA (WALKER) IN FIELD POPULATIONS IN EASTERN AUSTRALIA

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INTRODUCTION

Flight activity in the Australian plague locust, Chortoicetes terminifera (Walker), is influenced by feeding activity (Clark 1971; Lambert 1972) and an understanding of the normal feeding behaviour of the insect is necessary for a full appreciation of flight activity. The observations on feeding presented here are the results of investigations made mostly in the field in Australia with this in view.

MATERIAL AND METHODS

Field work was carried out initially in the Bogan-Macquarie outbreak areas of Chortoicetes terminifera in western central New South Wales from late October to mid-December 1969, during a joint C.S.I.R.O.*/A-L.R.C.† investigation into the flight activity of C. terminifera on which further data will be published separately. Observations were made in several localities in the region of Trangie (listed in Lambert 1972) on concentrations (referred to as 'swarms') whose density varied and whose morphometric parameters were characteristic of the transiens, transiens/gregaria and gregaria phases (Key 1954). A further investigation was carried out from November to March 1971/1972 on populations in New South Wales, Queensland and South Australia at the following localities, listed in relation to the nearest township.

New South Wales (N.S.W.)

‘Benerembah’, lat. 34°30'S long. 145°45'E, 16 miles (26 km) west of Darlington Point.
‘Brindingabba’, lat. 29°07’S long. 144°48'E, 26 miles (41 km) east-south-east of Hungerford.
‘Coally’, lat. 29°55’S long. 142°01'E, 15 miles (24 km) south-south-east of Milparinka.
‘Corynnia’, lat. 34°00’S long. 145°30'E, 16 miles (26 km) north of Carathool.
N. ‘Corynnia’, lat. 33°53’S long. 145°30'E, 20 miles (32 km) north of Carathool.
‘Milpa’, lat. 30°21’S long. 142°02'E, 54 miles (87 km) south-south-east of Milparinka.
‘Warri House’, lat. 29°02’S long. 141°56'E, 32 miles (51 km) north of Tibooburra.
‘Warroo’, lat. 29°05’S long. 144°41'E, 18 miles (29 km) east-south-east of Hungerford.

Queensland (Qld)

‘Kihee’, lat. 27°15’S long. 142°32'E, 5 miles (8 km) west of homestead, S-W. Qld.
Four miles (6 km) south of Quilpie, lat. 26°40’S long. 144°14'E.
Four miles (6 km) east of St. George, lat. 28°03’S long. 148°37'E.

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Feeding activity in the Australian plague locust

‘Westland’, lat. 24°46′S long. 143°48′E, 49 miles (79 km) south-south-west of Longreach.

‘Whitehill’, lat. 23°35′S long. 144°01′E, 20 miles (32 km) south-west of Longreach.

South Australia (S.A.)

‘Pine Creek’, lat. 32°07′S long. 140°56′E, 24 miles (39 km) north of ‘Mutooroo’ (38 miles (61 km) west of Broken Hill, N.S.W.).

Pinery, ‘Pine Creek’, lat. 32°12′S long. 140°56′E, 17 miles (27 km) north of ‘Mutooroo’ (38 miles (61 km) west of Broken Hill, N.S.W.).

The proportion of insects actively feeding at any one time was determined by observing individual insects through binoculars and recording their activity. The binoculars covered a viewing angle of 180° and at minimum focus covered a strip 3·3–4·5 m from the observer giving a total area of approximately 14·7 m². Recordings were made intermittently during daylight hours on six daily occasions for four different populations in three separate areas. Observations were carried out where possible when the ground vegetation was not too dense since otherwise the field of view was interrupted. Frequently locusts were inverted at the base of grass hummocks seeking out green material when the vegetation was dry. On these occasions the head was not visible, but feeding could be detected in this posture when rhythmical movements of the biting action could be seen. Care was taken not to disturb the locusts before observation, for re-settling may stimulate feeding to take place. The number of locusts counted depended on the density of the ground population.

The feeding state was estimated by examining the quantity of food in the foregut in locusts dissected ventrally. This was classified as being ‘full’ if it was from 60% filled to distended; ‘half-full’, up to 60% full; or empty. This was based on the technique used by Ellis (1951), Chapman (1957) and Lambert (1972).

During the day, samples of settled locusts were taken from ground populations by sweeping the insects with a small hand-net. In the early morning just before or at about the time of sunrise (c. 05.00 hours E.S.T., Aust.) or sometimes in the evening at or after sunset (c. 19.00 hours), when the temperature was often too low for take-off on disturbance, the locusts were picked off the ground by hand. Finally, during the earlier hours of darkness (19.45–24.00 hours), locusts were caught at a mercury-vapour light trap at the Trangie Agricultural Research Station, New South Wales Department of Agriculture (Experiment Station), 4 miles (7 km) north-west of Trangie on the Mitchell Highway; or, when far from built-up areas, by means of a mercury-vapour lamp bulb suspended above a sheet with an electrical supply from a motor generator. Immediately they were caught, the insects were fixed in a preservative mixture of ninety-five parts of 70% alcohol and glycerine (95:5) for later examination.

The rate of passage of food from the foregut was estimated by sweeping actively feeding locusts off the ground at different times of the day and keeping them deprived of food in well-aerated gauze cages somewhat shaded by vegetation within the ground population. Samples of locusts were extracted at intervals over a period of several hours and immediately fixed in alcohol for later examination.

The age (number of days after the imaginal ecdysis) was determined by counting the growth layers in the cuticle of hand-cut sections of the hind tibia examined with a polarizing light microscope (Neville 1963). It was possible to estimate age up to 10 days after the imaginal ecdysis in C. terminifera, as shown by Lambert (1972), but in older locusts deposition of growth layers in a daily cycle became irregular; often no further
layers were laid down. The deposition of growth layers was not affected by extreme conditions. It was still possible to determine the age of laboratory locusts up to 10 days when kept in a day/night regime in cool, damp conditions (14–30.5° C) with much green grass-food or in hot, dry conditions (27–39° C) with little food. Mortality in the latter conditions was much increased.

The state of sexual maturity in female locusts was estimated from the mean lengths of terminal oocytes (those nearest the oviduct) in the ovaries. The mean was based on three oocytes per insect, the measurements being made under a binocular microscope with a calibrated eyepiece. Clark (1965) classified the lengths of oocytes into classes: class I, oocytes less than 0.96 mm; class II, 0.96–1.89 mm; class III, 1.90–2.85 mm; class IV, 2.86–3.81 mm; class V, 3.82–4.57 mm; and class VI, greater than 4.57 mm.

Laboratory observations in London were made on a stock of C. terminifera obtained as eggs from Australia in 1966. The insects were maintained according to the method described by Hunter-Jones (1966), with some modification described by Osborne, Carlisle & Ellis (1968), and reared at the rate of seven and a half generations per year. For feeding studies, locusts were placed individually into litre jars with perforated zinc lids and with bundles of grass supported to one side by small galvanized-mesh ladders. The jars (ten in all at any one time) were placed at a distance of approximately 0.15 m from a 60-W bulb at a light intensity of about 2000 lx in an illuminated room at 30–32° C. Observations began at 10.30 hours B.S.T. after giving the insects an hour to acclimatize, and continued for 6 h. Feeding periods were generally recorded to the nearest 30 s unless below 15 s duration in which case actual values were noted. The time period commenced with the first bite and was concluded when mastication was completed with associated cessation of feeding. Altogether observations were made individually on twenty-five males and twenty-five females.

RESULTS

Measurement of feeding activity

In this paper, foregut fullness is used as a measure of recent feeding, but the degree of fullness at any one time is a balance between the rate of food ingestion and the rate at which food is passed back to the midgut. There is a possibility that no feeding takes place when the foregut is full, but the pattern of feeding activity in the field and behaviour in the laboratory indicate that feeding occurs continually at intervals during the day. Thus a full foregut may arise from recent feeding or it may arise from earlier feeding followed by retention of the food for a prolonged period of time, as is known to occur, for instance, in morabine grasshoppers (Blackith & Blackith 1966). The possibility of this occurring in Chortoicetes terminifera was investigated in a number of observations.

The rate at which food passed back from the foregut was investigated in insects collected in the field during periods of active feeding, and then deprived of further food. Of these, some will have ceased feeding just before capture and others will be about to start feeding. The foreguts of the latter will empty relatively quickly with further food deprivation while the longest time to empty will be taken by those that have fed just before capture. Hence the figures quoted are times at which the insects in samples no longer contained ‘full’ foreguts, and at which 90% and 100% of locusts had empty foreguts (Table 1). In 1969 (collections 1–3), insects were feeding on abundant green grass, while in 1972 (collections 4–6), there was little green grass and locusts were probably eating dry food material. The foregut generally emptied completely after 3–4 h, taking
Table 1. The rate of passage of food from the foregut: times (min) at which no 'full' foreguts were recorded and 90% and 100% became empty (actively feeding locusts collected from field populations were deprived of food during the day)

<table>
<thead>
<tr>
<th>Locality</th>
<th>Date</th>
<th>Time of collection (E.S.T., Aust.)</th>
<th>Foreguts full at start (%)</th>
<th>Air temperature range (°C) over period of food-deprivation</th>
<th>Period of food deprivation (min)</th>
<th>No. of locusts per extraction</th>
<th>Time at which foreguts are: not 'full'</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 'Methalibah', N.S.W.</td>
<td>3 Dec. 1969</td>
<td>07.20</td>
<td>60</td>
<td>17–23</td>
<td>220</td>
<td>25</td>
<td>100</td>
<td>124</td>
<td>160</td>
</tr>
<tr>
<td>2. 'Methalibah', N.S.W.</td>
<td>3 Dec. 1969</td>
<td>10.00</td>
<td>72</td>
<td>21–26</td>
<td>300</td>
<td>25</td>
<td>90</td>
<td>117</td>
<td>180</td>
</tr>
<tr>
<td>3. 'Hillside', N.S.W.</td>
<td>2 Dec. 1969</td>
<td>15.30</td>
<td>73</td>
<td>25–22</td>
<td>240</td>
<td>15</td>
<td>120</td>
<td>166</td>
<td>240</td>
</tr>
<tr>
<td>4. 'Benerambah', N.S.W.</td>
<td>12 Feb. 1972</td>
<td>11.00</td>
<td>80</td>
<td>30–34</td>
<td>325</td>
<td>20</td>
<td>165</td>
<td>180</td>
<td>220</td>
</tr>
<tr>
<td>5. 'Whitehill', Qld</td>
<td>23 Feb. 1972</td>
<td>13.00</td>
<td>53</td>
<td>33–36</td>
<td>200</td>
<td>20</td>
<td>150</td>
<td>216*</td>
<td>270*</td>
</tr>
<tr>
<td>6. 'Whitehill', Qld</td>
<td>23 Feb. 1972</td>
<td>16.00</td>
<td>70</td>
<td>36–32</td>
<td>180</td>
<td>20</td>
<td>180</td>
<td>175</td>
<td>210*</td>
</tr>
</tbody>
</table>

* When final values were not obtained, values were extrapolated from trends shown during the period of food-deprivation.
longer with drier food material although temperatures were higher (Husain, Mathur & Roonwal 1949). The rate of emptying of the alimentary canal in serial collections taken at a light trap during night flight was apparently no greater than in locusts deprived of food and kept inactive in cages at similar or higher temperatures during the day (M. R. K. Lambert, unpublished). Hence the presence of any food in the foregut indicates that feeding almost certainly occurred in the previous 4 h, while insects with full foreguts will probably have fed within 2 h.

Table 2. The feeding state (percentage foreguts full) when locusts were observed feeding actively (figures indicate number of observations made at the same time, each containing samples of at least seventeen insects)

<table>
<thead>
<tr>
<th>Observed feeding</th>
<th>Feeding state (% full foreguts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a) Before 13.00 hours</td>
</tr>
<tr>
<td></td>
<td>0-24 25-49 50 and above</td>
</tr>
<tr>
<td>None</td>
<td>2 1 0</td>
</tr>
<tr>
<td>Active</td>
<td>1 2 10</td>
</tr>
</tbody>
</table>

Further evidence on the validity of using fullness as a measure of recent feeding was obtained by comparing the percentage of insects with full foreguts in a sample with the proportion of insects observed feeding at the same time. In observations made before 13.00 hours, it was found that, when no feeding was observed, the foreguts of insects collected at the same time were empty or almost empty, whereas when active feeding was observed most of the insects had full foreguts (Table 2a). In observations made later
in the day, however, there was no obvious relationship (Table 2b), probably because in this case the insects were already full from earlier feeding whereas during the morning this was not the case (Fig. 1).

On the basis of these observations, it appears that foregut fullness can justifiably be used as an indication of feeding within the previous 2 h. There was no evidence whatsoever that in adult C. terminifera food was retained for an extended time period in normal conditions in all regions of the alimentary canal. Not only did the foreguts of caged insects empty within 4 h, but field collections before and around sunrise invariably included a large number of insects with empty foreguts (Fig. 1). The proportion could be as high as 90%. It gradually decreased to nil towards mid-day as feeding took place.

![Graph showing feeding state of locusts in relation to air temperature]

Further evidence that the foregut (as well as the midgut and even the hindgut) can empty is provided by the total emptiness of over 95% of locusts caught at light traps during night flight (see also Clark 1971; Lambert 1972).

**Factors affecting feeding**

**Air temperature and radiation**

In the early morning there was little indication that the body temperature of the locusts was not approximately the same as the air temperature for the insects would have had little opportunity to raise their body temperatures by basking. Under these conditions, foreguts were not full below 13.5° C. Above this, the percentage of insects with full
foreguts increased with temperature (more than 75% in one sample was full at 17°C); and above 30°C the majority of insects in samples had full foreguts (Fig. 2). Invariably more than 50% of locusts contained at least some food in the foregut above 25°C.

The body temperature, which is influenced by radiant heat from the sun, may be raised above that of the air by basking. During the morning, there is a positive correlation between the percentage of full foreguts and increasing total radiation ($r = 0.74$, $n = 38$, $P < 0.001$), but after 13.00 hours there is no clear relationship (Fig. 3). At this time when radiation decreases, the air temperature is higher than with rising radiation in the morning and temperature is not therefore limiting feeding. In addition, the insects are already full from previous feeding so that no direct correlation would be expected.

Age and sex

The results of foregut analysis in relation to age on seventy-nine collections (2418 locusts) made from 10.00 to 16.30 hours when temperatures were invariably suitable for active feeding, were pooled (Fig. 4). During the first day after the imaginal ecdysis, before the cuticle had hardened fully, the insects were already feeding actively with significantly more females than males having full foreguts ($\chi^2 = 5.32$, $0.02 < P > 0.01$). The percentage with full foreguts increased to a maximum in both sexes by the fifth day, but then declined sharply. There was little indication that locusts of any particular age commenced feeding earlier in the day (Fig. 5). Those 4–6 days of age had on average more than 50% foreguts full by 08.00 hours while the insects of other ages were less full, but this was probably due to the higher rate of feeding of insects in this age range. There was little variation from the basic pattern (Fig. 4) from hour to hour, but just before and
FIG. 4. The feeding state of *Chortoicetes terminifera* during a period of high feeding activity (10.00–16.30 hours), in relation to age and sex. Males (filled circles) and females (open circles) with figures above indicating the number of locusts examined.

FIG. 5. The feeding state at different times of the day of locusts of different ages (days after the imaginal ecdisis). Figures above indicate numbers of locusts examined.
by about the time of sunset the older locusts tended to be emptier than the younger ones (see also Lambert 1972) and the females less full than the males. When the air was very warm after sunset and during the first few hours of darkness, a high proportion of younger insects in particular were still registered as having full foreguts (M. R. K. Lambert, unpublished).

The feeding activity of female locusts of 10 and more days after the imaginal ecdysis was correlated with the state of sexual maturity. In *C. terminifera* in field conditions, the feeding level was higher at the start of the ovarian cycle and decreased to a minimum when the eggs were well developed and oviposition about to take place (Fig. 6). The

![Diagram](attachment:image.png)

**Fig. 6.** The feeding state in relation to the ovarian cycle (oocyte length-class) of females 10 and more days after the imaginal ecdysis during a period of active feeding (10.00–16.30 hours). Figures above indicate numbers of locusts examined.

The differences of levels between the maximum and minimum values of per cent foregut fullness in relation to oocyte length-class is very highly significant ($\chi^2 = 89.13$, 3 d.f., $P<0.001$).

**The pattern of feeding behaviour**

**Field populations**

Locusts were observed feeding as early as 07.28 hours when the temperature was suitable, but maximum numbers (up to 15%) were observed usually at around 11.00 hours. None was seen actively feeding after 17.10 hours in populations in the three separate areas investigated (Table 3). The percentage of locusts with the foregut full was determined in collections swept off the ground on separate occasions at all hours of the day.
Table 3. The percentages of locusts observed feeding in different localities during daylight hours (air temperatures are indicated)

<table>
<thead>
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<tbody>
<tr>
<td>(E.S.T., Aust.)</td>
<td>No. of samples</td>
<td>No. of insects</td>
<td>Mean % feeding</td>
</tr>
<tr>
<td>06.00/07.00</td>
<td>1</td>
<td>113</td>
<td>6.19</td>
</tr>
<tr>
<td>08.00/09.00</td>
<td>2</td>
<td>227</td>
<td>3.58</td>
</tr>
<tr>
<td>10.00/11.00</td>
<td>1</td>
<td>103</td>
<td>5.83</td>
</tr>
<tr>
<td>12.00/13.00</td>
<td>1</td>
<td>320</td>
<td>2.50</td>
</tr>
<tr>
<td>14.00/15.00</td>
<td>1</td>
<td>34</td>
<td>5.88</td>
</tr>
<tr>
<td>16.00/17.00</td>
<td>1</td>
<td>19</td>
<td>5.26</td>
</tr>
</tbody>
</table>
(Fig. 7). Feeding had commenced as early as 07.00 hours in five collections when there was radiant heat from the sun and, provided temperatures remained high, well over 50% of the insects had full foreguts throughout the remaining daylight hours when temperatures were suitable, reaching a maximum between 10.00 and 12.00 hours. From 17.00 hours on, however, many of the collections consisted of locusts with foreguts less than 50% full, suggesting that there could be a reduction in feeding despite the persistence of relatively high temperatures. In some cases, especially in younger populations, and particularly after much flight activity during the day when the level of feeding may be depressed (see also Lambert 1972; unpublished), there was an increase in feeding during the later hours of the afternoon until the earlier hours of darkness. Feeding may then be maintained in darkness even in the absence of radiant heat from the sun, provided air temperatures remain around 30°C.

**Laboratory conditions**

These field observations suggest that feeding could be maintained regularly during the daylight hours and experiments were performed in the constant conditions (30-32°C) of the laboratory to determine whether this was so in individuals kept under continuous observation. The time spent feeding by individual locusts of both sexes fluctuated from a few seconds up to 7 min over successive half-hour periods in males and up to 10 min in females, but the overall differences in the proportions of time spent feeding were not outstanding in a 6-hour period of observation (Fig. 8). However, the percentage of time spent feeding by males was lower during the last hour of the period of observation. The mean proportion of time spent in active feeding was low; in males only 3-9% (range 1-25-6-5%) and in females 6-5% (range 3-8-8-5%) for a half-hour period.
Thus laboratory observations showed that active feeding is maintained throughout at least 6 h of a total of 14 h of illumination and support the evidence of observations in the field that, given suitable environmental conditions, feeding is maintained regularly and does not occur briefly for a period of time during the earlier part of the day.

**DISCUSSION**

The quantity of food in the foregut represents a balance between the amount taken in and the rate of passage of food through the alimentary canal. The rate of passage of food through the alimentary canal in *Chortoicetes terminifera* is apparently influenced by the type and quality of the food-plant material and is lower for drier material. Goodhue (1962), by means of a radiographic X-ray technique, recorded a slower rate through the gut when third- to fifth-instar nymphs of the desert locust, *Schistocerca gregaria* (Forskål), were fed dry bran instead of fresh grass. The rate of passage is related to temperature, and Husain, Mathur & Roonwal (1949) also showed in first- to fifth-instar nymphs of *S. gregaria* that the time taken increased with the instar and decreased with temperature over the range from 18° to 38° C.

The data presented here indicate that feeding by *Chortoicetes terminifera* normally continues all day provided air temperatures are suitable, but with minor variations depending on the age and state of maturity of the insects.

No feeding occurs when the body temperature is below 13·5° C, but with increasing temperature feeding becomes general until, above 25° C, it can be presumed that temperature is no longer limiting. Overnight body temperature approximates to air temperature,
but during the day it is dependent on total radiation (radiant heat from the sun together with convective heat and heat radiated from the ground after warming). This steadily increases on clear days after sunrise to reach a maximum and then steadily declines with the sun's passage across the horizon. The air temperature remains high during the afternoon, as solar radiation becomes lower, from heat transferred by convection and radiation from the sun-warmed ground and thus internal body temperatures of locusts remain high enough still for feeding to occur. Nevertheless, from 17.00 hours until sunset, feeding may decrease, especially in older insects, despite the fact that temperatures are suitable.

The numbers seen feeding at any one time will depend on the physiological state of the insects, which influences the proportion of time spent feeding and the time period for each meal. The food eaten depends on the acceptability and availability of the food-plant material as shown by Bernays & Chapman (1970) in the British grasshopper, Chorthippus parallelus (Zetterstedt). Biting is influenced by the size, hardness and chemical components of the food material and, thus, numbers of locusts to be observed feeding on any occasion are likely to vary.

The pattern of feeding behaviour is similar to that observed in other tropical acridids. For instance, feeding in a population of Schistocerca gregaria nymphs was maintained regularly at various temperatures throughout the 24-h period, although less food was taken in during the 6-h period from sunrise to noon (Ellis & Ashall 1957). Similarly, in nymphs of the red locust, Nomadacris septemfasciata (Serville), Chapman (1959) showed that there was a general tendency for feeding to continue all day, but with definite peaks in the morning (at 11.00 hours) and in the evening, just after darkness. Feeding in the adults (Chapman 1957) varied during the year and from April to July feeding was regularly maintained daily, increasing steadily all day to reach a maximum in the late afternoon. This was comparable to feeding in Chortoicetes terminifera, although it was maximal earlier at around mid-day when there were suitable temperature conditions (above 17° C). In Nomadacris septemfasciata, maximum feeding took place over the range from 26° to 34° C and, during the earlier months of the year, there was a reduction in feeding rate in the late afternoon as in the Australian species, although temperatures were still favourable.

Feeding is affected by age, and Norris (1961) showed that in both isolated and crowded males of Schistocerca gregaria a feeding peak, as measured by the mean dry weight of faeces produced, was reached 7 or 8 days after the imaginal ecdysis. After this time, it was maintained at a lower level. A similar pattern was recorded for females in the laboratory (Hill, Mordue & Highnam 1966; Hill, Luntz & Steele 1968) and in both sexes of the migratory locust, Locusta migratoria migratorioides (R. & F.) (Strong 1967). Similar observations, varying seasonally, were also made in the field on Nomadacris septemfasciata by Chapman (1957). During the first day after the imaginal ecdysis in Chortoicetes terminifera, feeding is less than in older insects (and in males less than in females) in field conditions. It reaches a peak on the fourth and fifth days and in both sexes the feeding rate during the day (10.00–16.30 hours) is reduced after 10 days. This differed a little from the observations of F. T. Bullen (unpublished) who showed that in the laboratory, a feeding peak was reached in C. terminifera adults 6 to 10 days after the imaginal ecdysis. A fairly stable level of feeding rate is maintained in the laboratory after maximum adult live weight has been reached at about the eleventh day (see also Norris (1954 for Schistocerca gregaria).

As in S. gregaria (Hill et al. 1966; Hill et al. 1948) and Locusta m. migratorioides
Feeding activity in the Australian plague locust

(Strong 1967) feeding activity of mature females varies rhythmically reaching a maximum early in each ovarian cycle.

The daily pattern of feeding in the field is not in general affected by age; both old and young locusts commence feeding in the early morning provided temperatures are suitable. The feeding rate is generally lower in older insects and towards sunset a higher proportion of the older insects have empty foreguts than during the day. The older insects may cease feeding earlier in the afternoon than the younger ones and there is a greater tendency for them to be involved in prolonged migratory flight at night when no feeding occurs (see also Clark 1971; Lambert 1972; unpublished).

The percentage of time spent feeding by *Chortoicetes terminifera* adults in laboratory conditions is low in contrast to the situation in nymphs of *Nomadacris septemfasciata*, where the percentage of time feeding rises steadily with temperature up to about 23° C and thereafter remains steady at about 20% (Chapman 1959).

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SUMMARY

(1) The feeding state (percentage of foreguts full) in field populations of the Australian plague locust, *Chortoicetes terminifera* (Walker), generally reflects the feeding activity at that time, although locusts may still be full for a time after they have ceased to feed.

(2) The foregut empties after 2–4 h, the time varying with the food-plant material and temperature at different times of the day.

(3) No food was retained in the foregut for an extended period of time when locusts were deprived of food or failed to feed.

(4) Feeding commences at 13·5° C, increasing during the morning with air temperature and total radiation, to reach a peak at around mid-day when up to 15% of insects may be observed feeding.

(5) Feeding then remains high for the remaining day-light hours in young adults, but in older insects feeding may be reduced for 2 or 3 h before sunset. Younger insects in particular may continue feeding for the first few hours of darkness when the air is warm.

(6) Feeding is reduced in adults of more than 10 days after the imaginal ecdysis, while in females it is dependent on the stage of the ovarian cycle.

(7) The percentage of time spent feeding in the laboratory, which was low, showed a constant pattern which supported the observations made in the field.

REFERENCES


(Received 5 July 1973)