THE INFLUENCE OF FOOD ON LONGEVITY AND OVIPOSITION IN *RHYSSA PERSUASORIA* (L.) (HYMENOPTERA: ICHNEUMONIDAE)

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Abstract

A study was made of the effect of carbohydrate food on the longevity and oviposition of *Rhyssa persuasoria* (L.). The adult life span was 9 days without food and approximately 45-55 days on a carbohydrate diet. When females were starved, searching and egg-laying activity were reduced. Aphid honeydew was found to be as effective as honey solution in promoting longevity and oviposition. Some aspects of the availability of honeydew in Australian pine plantations and its importance in the establishment of rhyssines are discussed.

INTRODUCTION

Various species of the tribe Rhyssini (family Ichneumonidae) have been introduced from the northern hemisphere to control *Sirex noctilio* F., an exotic pest of pine forests in Australia and New Zealand. Feeding by rhyssines in their native habitats has not been observed, but it is known that many ichneumonids require a carbohydrate food supply in order to live and reproduce successfully (Townes 1958, Leius 1960, Gyorfi 1963, Johannson 1964). *Rhyssa* spp. have the chewing-lapping type of mouthparts and they feed by licking liquid material from a flat surface by means of the hairy labial plate. This mechanism excludes most floral nectar as a food source for these insects. Chrystal and Myers (1928) observed *R. persuasoria* (L.) feeding readily in the insectary on the honeydew deposited by aphids on hawthorn (*Crataegus oxyacantha* L.). Under similar conditions *Rhyssa* will also feed readily on honey solution soaked into filter paper, but deprived of food the insects soon die.

In the present study, the effect of artificial food on longevity and ovipositional activity was examined and, in addition, the efficacy of a natural source of food, in the form of honeydew on oak leaves, was tested.

MATERIALS AND METHODS

Longevity

Three insectary cages (1 ft 9 in. × 1 ft 9 in. × 1 ft 9 in.) were set up and a *Sirex*-infested log placed in each. Unfed *Rhyssa persuasoria* which had emerged within 2 days of each other were then placed in the cages. The experiment commenced on 30.x.64. Each cage contained 25 (12 ♂, 13 ♀) insects and a replicate set of larger cages (2 ft × 2 ft × 3 ft) containing 13 (8 ♂, 5 ♀) insects was also set up. The insects in each batch varied in size. The cages were placed out of doors and the upper and windward sides were covered with transparent polythene sheet to exclude rainwater. The insects were subjected to normal late spring temperatures and received approximately six hours of direct sunlight per day. The mean maximum temperature for the duration of the experiment was 18.3°C (range 10.4° to 30.7°) and the mean minimum temperature 8.7°C (range 3.9° to 16.7°). Humidity readings mostly fell within the range 50-70 per cent. In one cage no food or water was available, the second had only water, and the third contained both water and dilute honey as food supply. The liquids were fed continuously on to filter paper and renewed regularly to provide a constant supply. Daily mortality was counted and egg-laying activity observed.

Later another series of cages was set up in a similar manner (commencing 23.xi.64). These contained 14 (7 ♂, 7 ♀) insects and the food tested was honeydew. One cage contained a branch of oak leaves (*Quercus robur* L.) with heavy aphid (*Myzocallis* sp.) infestation, the second contained oak leaves free from aphids, and the third, branches of wattle (*Acacia* sp.), with a few honeydew-producing insects (not aphids), together with other native plants found in the Pittwater plantation.

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Each cage was also provided with water. These were set up in the open and examined daily for mortality and egg-laying activity of *Rhyssa*. The leaves were renewed as they withered.

Egg-laying activity

To determine the effect of food on egg-laying activity, batches of 7 ♂ and 10 ♀ *R. persuasoria* of unknown age which had been stored at 5°C since emergence, were placed in each of two cages of equal size (1 ft 9 in. × 1 ft 9 in. × 1 ft 9 in.). The insects in one cage were provided with honey and water, and those in the other had water only. As females in either cage died they were replaced to maintain constant numbers ovipositing. A fresh log was introduced to each cage at intervals of one or two days and the log previously exposed was weighed, measured, and dissected to assess the total number of *Sirex* individuals and the number of *Rhyssa* eggs laid. The logs were from regrowth trees ranging in diameter from 1.5 in. to 4 in., adjacent logs being presented in each cage during the same period to minimize variations in diameter, moisture content, and density of larvae. A total of eighteen logs for each of the fed and unfed groups of insects was sampled.

Food source

Various flowers found in the Pittwater plantation, near Hobart, Tasmania, including vetches, a tree lupin, and species of Compositae were suspended randomly in a cubicle containing starved *R. persuasoria*.

Since honeydew on deciduous trees had been found to be a suitable food source, pine and eucalypt were also tested. Branches of pine and eucalypt from the Pittwater plantation were treated by dipping in a dilute honey solution and then drying to simulate honeydew. "Untreated" branches were dipped in water only. Several untreated and treated branches of both species, together with branches of oak coated with natural honeydew, were offered to *Rhyssa* in the same way.

RESULTS

Longevity

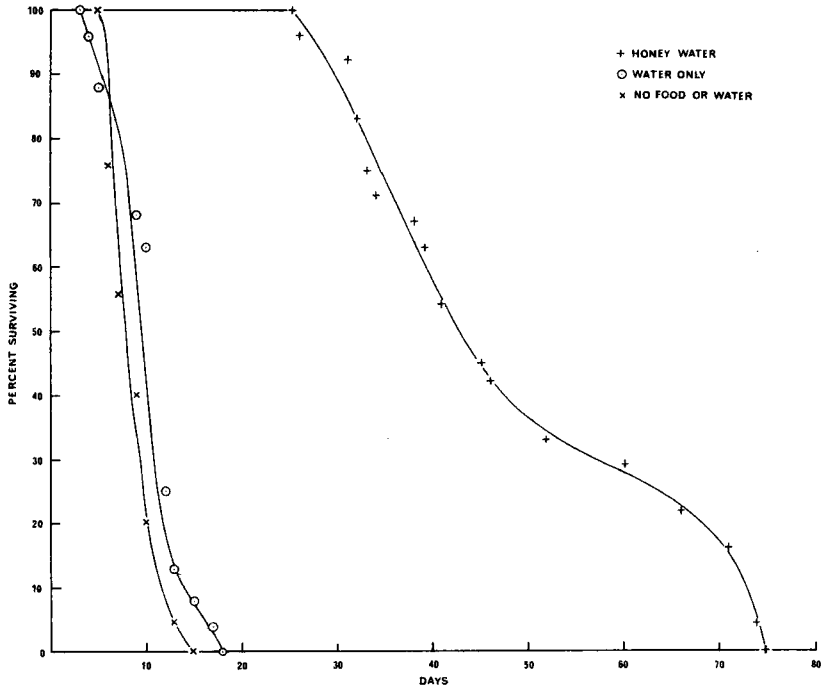
The mortality curves were plotted from means of the two replicates, representing the percentage of original numbers still surviving (Figs. 1, 2). There was no appreciable difference in the mortality rates between groups presented with water only, no water, wattle and leaves without honeydew. The curves indicate a slightly higher death rate in the two latter batches (Fig. 2) but this can be attributed to the effects of weather. A warm, dry spell occurred soon after the commencement of the experiment (see Table 1).

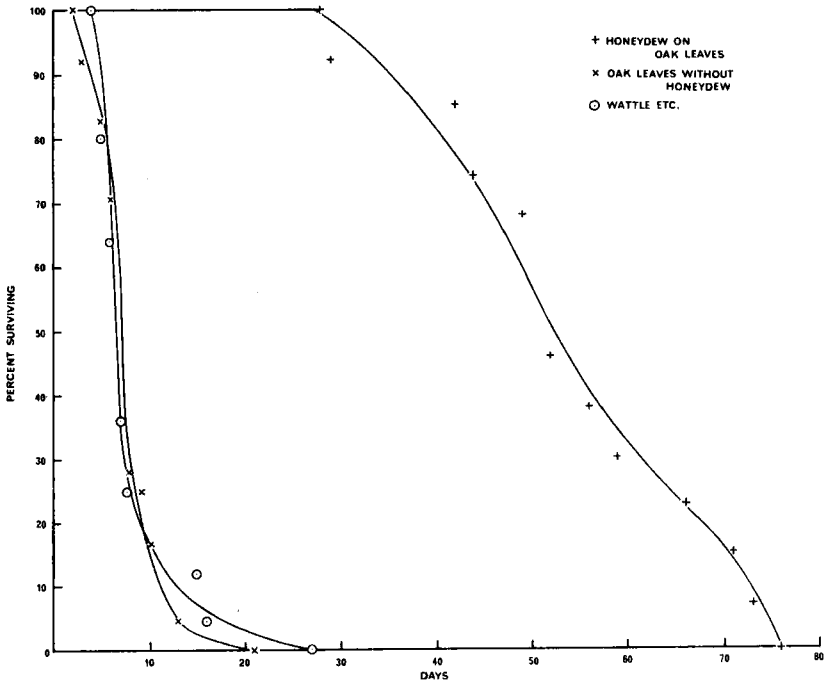
TABLE 1

DAILY TEMPERATURE AND HUMIDITY READINGS FOR PERIOD 21.xi.64-2.xii.64

DATE	MAXIMUM TEMPERATURE (° Centigrade)	MINIMUM TEMPERATURE (° Centigrade)	RELATIVE HUMIDITY (3 p.m.) (per cent)
23.xi.64	20.5	6.1	46.0
24.xi.64	24.0	8.1	71.0
25.xi.64	24.4	16.7	40.0
26.xi.64	23.5	12.4	45.0
27.xi.64	17.6	7.0	74.0
28.xi.64	17.8	7.0	47.0
29.xi.64	18.9	7.2	39.0
30.xi.64	30.7	8.3	31.0
1.xii.64	20.1	15.3	36.0
2.xii.64	18.2	6.8	45.0

The marked increase in mortality rate at about 30 days in the batch with honey and water (Fig. 1) was a result of the same prevailing weather conditions.





FIGS. 1, 2.—The survival of *Rhyssa persuasoria* L. on different diets.

The presence of carbohydrate food, either in honey water, or in natural honeydew, increased the mean longevity four to five times (Table 2).

TABLE 2

SURVIVAL OF *Rhyssa persuasoria* ON DIFFERENT DIETS

Diet	Mean Longevity of *Rhyssa* in days	
	♂♂	♀♀
No food or water	8	9
Water only	10	12
Honey and water	54	42
Leaves without honeydew	7	8
Leaves with honeydew	62	52

The mean longevity of the males exceeded that of the females by about 10 days when food was available. Either the few insects present on the wattle were inadequate to produce honeydew in appreciable quantities or it was unavailable to *Rhyssa* on the finely divided leaves. The greater longevity of insects fed on honeydew compared with those fed on honey and water is attributed to variation in ambient temperatures between experiments and these data do not indicate any real difference.

Egg-laying activity

The *Rhyssa* females deprived of food in the longevity experiments were observed to rest on the walls of the cage and generally showed less interest in the logs than did the fed females. Frequent observations indicated that at any time three or four of the fed females were searching and ovipositing on the logs to one of the starved females. Thus the presence of food probably influenced the number of eggs laid not only by increasing the longevity but also by increasing egg-laying activity.

In the experiment designed to test egg-laying activity the parasitism of *Sirex* larvae among the eighteen logs for each of the fed and unfed insect samples showed great variation (Table 3).

TABLE 3

NUMBERS OF *Sirex* LARVAE AND PARASITE EGGS DISSECTED FROM LOGS EXPOSED TO FED AND STARVED FEMALES OF *Rhyssa persuasoria*

Date	Diameter of Log in inches	Exposed to Fed Females		Exposed to Starved Females	
		No. of *Sirex* Immatures	No. of *Rhyssa* Eggs	No. of *Sirex* Immatures	No. of *Rhyssa* Eggs
25.xi.64	(a) 1.6	6	0	3	0
	(b) 3.35	5	0	5	0
26.xi.64	(a) 1.69	6	2	5	0
	(b) 2.9	16	1	14	0
27.xi.64	(a) 1.5	5	0	3	0
	(b) 2.6	26	0	31	0
28-29.xi.64	(a) 1.4	3	1	9	0
	(b) 2.75	14	7	8	1
30.xi.64	(a) 1.25	2	0	4	0
	(b) 2.5	15	0	6	0
1.xii.64	(a) 1.4	9	0	6	0
	(b) 2.3	4	0	8	0
2.xii.64	(a) 3.25	6	0	10	0
3.xii.64	(a) 1.3	4	0	5	0
	(b) 2.4	3	0	1	0
4-6.xii.64	(a) 3.75	29	11	19	0
7-8.xii.64	(a) 4.0	56	15	45	3
9-10.xii.64	(a) 2.6	28	0	36	0
TOTAL		237	37	242	4

Frequently no *Rhyssa* eggs were found where numbers of *Sirex* were low or the *Sirex* larvae were small in size. The overall parasitism was 16 per cent. for fed females (237 *Sirex*, 37 *Rhyssa*), and 1.6 per cent. for unfed females (242 *Sirex*, 4 *Rhyssa*). Wherever any parasitism occurred in a pair of logs, the values for females which had had food were always higher than those for starved females. As many of the logs presented were unattractive to *Rhyssa*, these data on degree of parasitism only serve to illustrate the broad effect of food on number of eggs laid.

Food source

Rhyssa showed no interest in the various flowers collected from the Pittwater plantation.

The insects fed readily from the treated branches of both pine and eucalypt, as well as from the honeydew. If an insect alighted on an untreated branch, after testing briefly and finding no food, it would fly off. As the insects could feed from the pine needles and from the native eucalypt when the foliage was artificially coated with food, these trees could be a source of carbohydrates if naturally infested by honeydew-producing insects.

Discussion

It has been shown that when females of *Rhyssa persuasoria* are given carbohydrate food they live four or five times as long as they do without it. Also, starved females are less active and lay fewer eggs in a given time than females with adequate food. Thus a source of suitable food is a major factor influencing the efficiency and distribution of this parasite. The natural sources of food of *R. persuasoria* in its native habitats in the northern hemisphere are not fully known, but the Australian pine plantations with their paucity of other plant species must present a very different environment. To be available to *Rhyssa*, food must occur on an exposed surface, and many of such carbohydrate deposits may be suitable. The occasional eucalypts occurring in the Pittwater plantation may supply some food in this way, though infestation by insects producing honeydew was found to be very low, and this source is probably inadequate for the population of *Rhyssa*. Also, if *Rhyssa* is to obtain food, its emergence season must coincide with that of the honeydew-producing insects and this factor may be particularly affected by prevailing weather conditions. The flight capacity of this parasite and its ability to locate suitable food sources are unknown, and *Rhyssa* may be restricted to feeding within the forest cover. While carbohydrate alone promotes longevity, other foods may be required by rhyssines for a complete diet.

Some specimens of *Rhyssa himalayensis* Wilk., which had been collected in the field in India, but died in transit due to excessive heat, were found to contain pollen grains of a conifer in the foregut. These were identified as pollen from a member of the Pinaceae, probably a species of *Pinus*. In the natural habitat these may be supplying protein which increases the oviposition potential of the females; the lack of such protein may have contributed to the limited success achieved in culturing *R. himalayensis* at the Hobart insectaries. The pollen may have been ingested accidentally whilst the insect was drinking dew from the pine needles, but the absence of entire grains from the stomach and hind-gut suggested that some digestion had occurred or that ingestion was very recent.

It is clear that the availability of suitable food influences the effectiveness of *Rhyssa* spp. and that this is important if efficient and widespread biological control of *Sirex* by its parasite complex is to be made possible.

Acknowledgements

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