OBSERVATIONS ON THE FOOD PREFERENCES AND REPRODUCTIVE POTENTIALITY OF THE SPINY RAT MITE, ECHINOLAELAPS ECHIDNINUS

A THESIS

IN BIOLOGY

by

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Approved

Texas Technological College

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TABLE OF CONTENTS

I. Introduction..... 1

II. Blood Preference Tests..... 3

A. Materials and Methods..... 3

B. Results..... 4

III. Reproductive Potentiality Test..... 7

A. Materials and Methods..... 7

B. Results..... 9

IV. Conclusions and Discussion.....15

V. Summary.....17

References.....18

I. INTRODUCTION

Echinolaelaps echidninus (Berlese) 1887 is a parasitic mite belonging to the suborder Mesostigmata and to the family Laelaptidae Berlese 1892. It is found on nearly all species of the genus Rattus, the so-called domestic rats.

These mites are viviparous and have four stages in their life cycle: larva, protonymph, deutonymph, and adult. It is thought that they feed on blood or lymph tissue. The larval stage is the only stage that does not feed. The mites feed daily and do not swell from engorgement as do some mites.

Owen (1955) showed in his study on the life history of Echinolaelaps echidninus that these mites could be reared by artificial feeding in the laboratory.

Virginia Landwer (1955) experimented with a method of artificial feeding suggested by Dr. Dorald Allred (personal communication) of the University of Utah and found the method satisfactory. Dr. Allred's method of feeding was used in this study. Landwer also ran tests for food preferences using rat, sheep, and citrated human bloods and concluded that the mites preferred the rat blood.

W. W. Miller (1908) proved that this mite transmits the haemogregarine, Hepatozoon perniciosus, in rats.

Since, in nature, these mites are strictly specific for rats of the genus Rattus, even though the opportunity to feed on other hosts undoubtedly presents itself, some physical or physiological

factor, or factors, which influence this specificity must be present. The purpose of this project is to explore two of the possible causes of specificity: One, is the blood of other hosts unattractive; and two, if the bloods of other hosts are acceptable, what is their effect on the reproductive potentiality of the mite?

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II. FOOD PREFERENCE

A total of 525 mites of all feeding stages was tested to see if the mites indicated a preference among four kinds of vertebrate bloods: rat, human, pigeon, and sheep.

MATERIALS AND METHODS

A colony of mites was cultured on the ordinary laboratory rat, Rattus norvegicus albinus. Wood shavings from the rat cages were placed in a Berlese funnel for 24 hours, and the mites were caught in a Mason jar. This amount of time was sufficient to insure the mites' being hungry. By means of an aspirator the mites were drawn from the jar into a plastic vial 3.5 cm in diameter and 5 cm deep.

A plastic sandwich box, 11.5 cm long, 10.5 cm wide, and 3.5 cm deep, was used as the arena. Rat, human, pigeon, and sheep bloods were obtained from the respective animals and were kept frozen when not in use. A drop of rat blood was placed in one corner, a drop of human blood in another corner, a drop of pigeon blood in a third corner, and a drop of sheep blood in the last corner.

At each of 29 runs 10 to 20 mites were placed in the center of the box, the lid was placed on top, and the number of mites at each drop of blood was counted at the end of 15 seconds, 30 seconds, 45 seconds, 60 seconds, 120 seconds, and 300 seconds. All tests were performed at a room temperature of approximately 25° C., at a relative humidity of approximately 25 per cent, and under overhead flourescent lighting of approximately 30 foot-candles of light.

At the conclusion of the 29 runs, the total number of mites feeding at each type of blood at the various time intervals was calculated.

RESULTS

At the end of 15 seconds, 38 mites were feeding on rat blood, 78 mites were feeding on human blood, 49 mites were feeding on pigeon blood, and 51 mites were feeding on sheep blood.

At the end of 30 seconds, 57 mites were feeding on rat blood, 89 on human blood, 67 on pigeon blood, and 74 on sheep blood.

At the end of 45 seconds, 57 mites were feeding on rat blood, 88 on human blood, 53 on pigeon blood, and 64 on sheep blood.

At the end of 60 seconds, 52 mites were feeding on rat blood, 78 on human blood, 41 on pigeon blood, and 57 on sheep blood.

At the end of 120 seconds, 42 mites were feeding on rat blood, 59 on human blood, 24 on pigeon blood, and 31 on sheep blood.

At the end of 300 seconds, 14 mites were feeding on rat blood, 18 mites were feeding on human blood, 10 mites were feeding on pigeon blood, and 5 mites were feeding on sheep blood.

After 30 seconds there was a sharp drop in the number of mites found on sheep and pigeon bloods. A leveling off and then a gradual drop was shown in the number feeding on the rat and human bloods until at the end of 300 seconds very few were feeding.

The results from this experiment are given in Table I and Chart I.

TABLE I

FOOD PREFERENCE DATA

NUMBER OF MITES RECORDED AT EACH TYPE OF BLOOD

Blood	Seconds 15	30	45	60	120	300
Rat	38	57	57	52	42	14
Human	78	89	88	78	59	18
Pigeon	49	67	53	41	24	10
Sheep	51	74	64	57	31	5

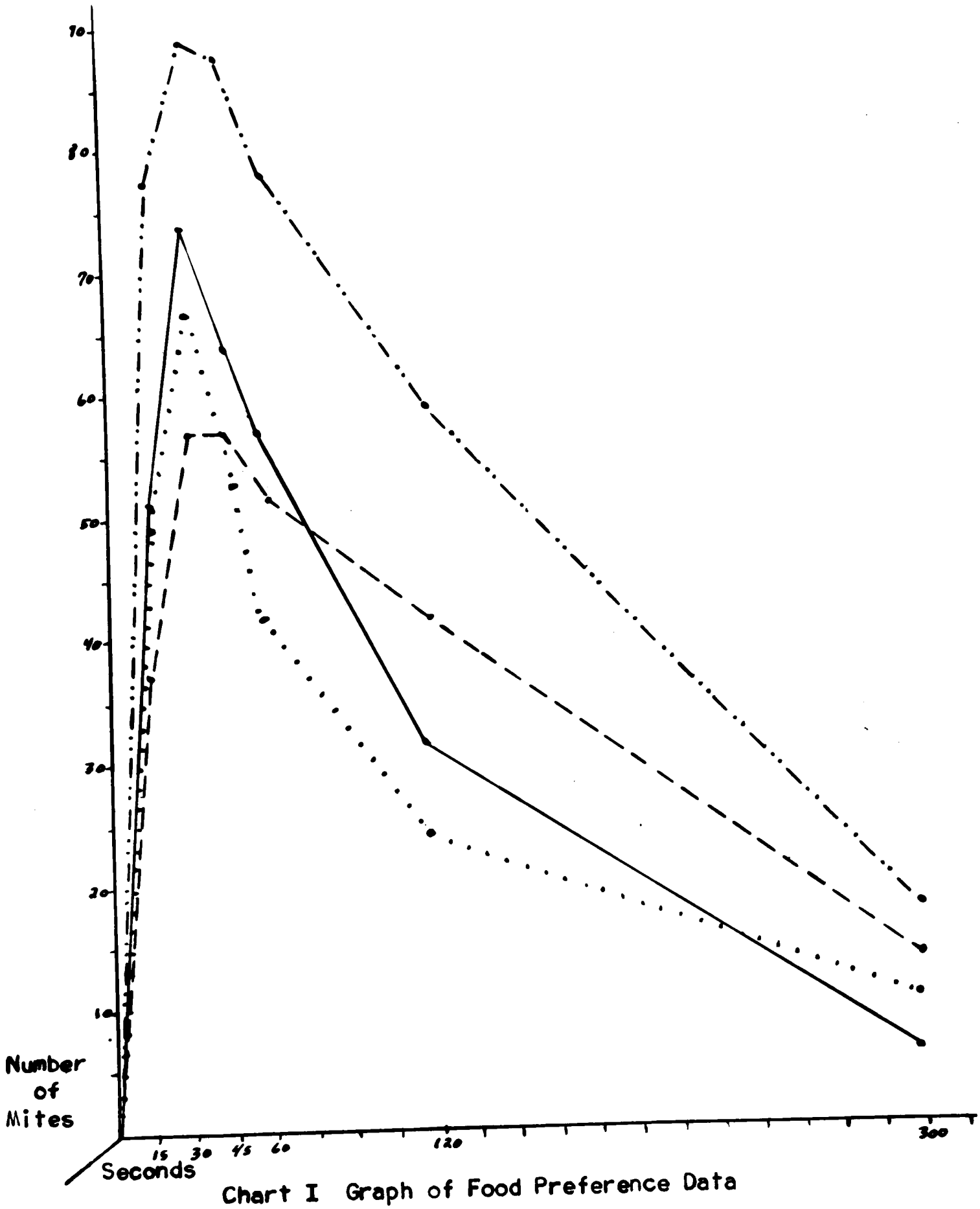

Chart I Graph of Food Preference Data

Key to chart:

Mites feeding on rat blood — — —

Mites feeding on human blood —··—··

Mites feeding on sheep blood ————

Mites feeding on pigeon blood ·····

III. REPRODUCTIVE POTENTIALITY

Since Echinolaelaps echidninus is found almost exclusively on rats, the following experiment was carried out to determine if vertebrate bloods other than rat blood would have an effect on its reproductive potentiality and, if so, what that effect would be. The same four bloods as those in the preceding experiment were used: rat, human, pigeon, and sheep.

MATERIALS AND METHODS

Wood shavings from the rat cages were placed in a Berlese funnel and the mites, which were caught in the jar attached to the funnel, were placed in glass tubes 5 cm in length with an outside diameter of 10 mm and an inside diameter of 7 mm. The ends of the glass cylinders were closed by placing a piece of silk bolting cloth over each end and by pushing the cloth into the tube with a piece of rubber tubing 9 mm in length with an inside diameter of 4 mm.

Since the female mite will devour the larvae, efforts were made to reduce this infanticide. One method was to place a small trap consisting of a piece of nylon organdy pushed into the lower one-third of the tube with a piece of rubber tubing 5 mm long. A small hole just large enough to allow for passage of the larva was made in the cloth. Ten of the twenty tubes were provided with traps, and more live larvae were obtained from them than from the tubes in which no traps were provided.

Another method was to place two mites rather than one mite in a tube, as previous observations had showed that this particular type of mite tended to become akinetic when in contact with other mites. The two females would place their gnathosomas close together, and they would remain quiet for a longer length of time than would one female mite by herself. This longer length of time gave the larvae a chance to escape through the trap or to molt before being devoured. As soon as the larvae or nymphs were found in the traps, they were placed into separate tubes.

The tubes were placed in 150 mm desiccator jars. A solution of glycerol and distilled water mixed in proportions to produce a relative humidity of 80 per cent was kept in the bottom of the jar. The desiccator jars were kept in an incubator at a temperature of 28° to 30° C.

The adult mites were fed by a simple method. A small amount of whole blood was placed in a medicine dropper, a washer of rubber tubing was placed over the dropper end, the silk bolting cloth was removed from one end of the rearing tube, and the medicine dropper was inserted into the mite tube. This method was suggested by Dorald Allred. Five tubes of mites were fed on rat blood; 5 tubes of mites were fed on human blood; 5 tubes of mites were fed on pigeon blood, and 5 tubes of mites were fed on sheep blood.

The nymphs were fed by placing a drop of blood on the silk cloth, as described by H. F. Cross (1954). This method of feeding was used because the nymphs had a tendency to fall into the dropper and drown.

The larvae do not feed. The mature mites and the deutonymphs were fed once a day; the protonymphs were fed twice a day.

RESULTS

A total of 36 live larvae or protonymphs were obtained from the rearing tubes. Of these 36 mites, 13 were from those fed on rat blood, 13 from those fed on human blood, and 9 from those fed on pigeon blood.

No larvae or protonymphs were recovered from mites fed on sheep blood, but one protonymph which had been recovered from a mite fed on rat blood was reared to adulthood on sheep blood. This single second generation mite became a male adult.

Of the 9 second generation mites reared on pigeon blood, one became a male, 2 died as deutonymphs, and 5 died as protonymphs. One larva died before molting.

One of the 13 second generation mites reared on human blood was mounted in the larval stage, one larva died before molting, 2 died as protonymphs, 8 died as deutonymphs, and one became a male adult.

Of the 13 second generation mites reared on rat blood, 3 died as protonymphs, 3 died as deutonymphs, and 7 became adults. Of the adults 4 were males and 3 were females.

Most of the mites other than those fed on rat blood became packed with a white substance which they seemed unable to void. The substance was even packed into the legs. This condition was particularly true of the protonymphs fed on pigeon blood. A few of the mites fed on rat blood became filled with this substance, but this condition was the exception and not the rule.

Table II shows the second generation mites fed on rat blood.

TABLE II

SECOND GENERATION MITES FED ON RAT BLOOD

Mite	Date found	Larva	Proto-nymph	Deuto-nymph	Adult	Sex	Death
5R	10-5		10-5				10-7
3R	10-9		10-9				10-17
5R-1	10-21	10-21	10-22	10-26	10-29	female	2-7
5R-2	10-31	10-31	10-31	11-5	11-7	female	11-9
RN	10-6		10-6	10-18	?	male	12-6
RN	10-6		10-6				10-17
5R-3	11-8	11-8	11-9	11-13			1-30
2R-1	11-13		11-13	11-15	11-21	male	1-2
5R-4	11-13		11-13	11-18			12-24
4R-1	11-19		11-19	11-22	11-29	male	2-20
2R-2	11-22		11-22	11-26	12-4	female	3-17
4R-2	11-24	11-24	11-25	11-29			1-1
4R-3	12-2		12-2	12-9	1-29	male	1-30

Given in the table is the code number of each mite, the stage in which the mite was found, the length of each stage, the date of molting, the date of death, and the sex of each adult.

Table III shows the second generation mites fed on sheep blood. Given in the table is the code number of each mite, the stage in which the mite was found, the length of each stage, the date of molting, the date of death, and the sex of each adult.

Table IV shows the second generation mites fed on human blood. Given in the table is the code number of each mite, the stage in which the mite was found, the length of each stage, the date of molting, the date of death, and the sex of each adult.

Table V shows the second generation mites fed on pigeon blood. Given in the table is the code number of each mite, the stage in which the mite was found, the length of each stage, the date of molting, the date of death, and the sex of each adult.

Code for mite numbers and letters:

The first number is the number given to the parent from which the young was recovered.

"R" refers to mites fed on rat blood.

"S" refers to mite fed on sheep blood.

"H" refers to mites fed on human blood.

Dash plus a number is the specific number of the mite.

"N" refers to nymphal stage in which it was found.

"RN" is a mite taken from the rat cage culture.

TABLE III

SECOND GENERATION MITE FED ON SHEEP BLOOD

Mite	Date found	Larva	Proto-nymph	Deuto-nymph	Adult	Sex	Death
Sm	10-7		10-7	10-23	?	male	12-15

TABLE IV

SECOND GENERATION MITES FED ON HUMAN BLOOD

Mite	Date found	Larva	Proto-nymph	Deuto-nymph	Adult	Sex	Death
H1-1	11-2	11-2	11-3	11-8			12-2
H4-1	11-11		11-11	11-17			12-10
H4-2	11-11		11-11	11-16			11-24
H5-1	11-2	11-2	11-3	11-10	11-22	male	12-1
H2-1	11-3	11-3	11-4	11-8			12-9
H5-2	11-9	11-9	11-9	11-15			12-9
H3-1	11-16	11-16	11-23				12-5
H3-2	11-18	11-18	11-18	11-25			12-26
5H-5	11-22	mounted					11-22
H1-2	11-23	11-23	11-24	12-2			12-9
H4-3	11-29		11-29				12-15
H1-3	12-4		12-4	12-9			12-26
H3-3	12-2	12-2					12-3

TABLE V

SECOND GENERATION MITES FED ON PIGEON BLOOD

Mite	Date found	Larva	Proto-nymph	Deuto-nymph	Adult	Sex	Death
1-1	10-7		10-7				10-14
3-1	10-21	10-11					10-12
4-1	10-10	10-10	10-11	10-21	10-30	male	12-9
4-2	10-13	10-13	10-14	10-23			10-28
3-2	10-17	10-17	10-18				10-18
5-2	11-5	11-5	11-6				11-13
1-2	11-10	11-10	11-11				11-13
2-1	11-13		11-13	11-18			11-21
4-3	11-21	11-21	11-22				12-10

IV. CONCLUSIONS AND DISCUSSION

From the results of the food preference tests, the author concluded that the vertebrate bloods used were not unattractive to this mite. The results showed that the spiny rat mite fed on rat, human, pigeon, and sheep bloods with no sharply defined preference for any of these bloods, although human blood seemed to be slightly favored.

These tests are admittedly inconclusive and the data obtained are not adapted to statistical analysis. More refined testing methods need to be used, but the author was unable to get results by other means tried, including aspiration through a "Y" tube with pairs of bloods. Perhaps a shorter period of time between the placing of the wood shavings in the funnel and the actual running of the test should be used, as it is possible that the mites were too hungry after 24 hours and would stop to feed at the first food they found.

Since the mite did feed on bloods other than rat blood, and showed no sharply defined preference, the reason for host specificity cannot be attributed to unattractiveness of the bloods of non-host animals.

The results of the reproductive potentiality test indicated that the mites had a lower reproductive potentiality when fed on human, sheep, or pigeon bloods than when fed on rat blood, less than 12 per cent reaching maturity.

Over 50 per cent of the second generation mites fed on rat blood reached adulthood. Evidently constituents are found in rat blood

that are lacking in the other three bloods or else substances in the other three bloods are indigestible or toxic to the mites.

Since a few of the mites fed on rat blood became filled with a white substance, perhaps certain constituents are present in larger amounts in the whole blood as fed in this experiment than are present when the mite feeds on the rat directly and these substances cannot be eliminated when taken in greater quantity. These materials might be found in larger amounts in sheep, pigeon, or human bloods, thus causing the death of the mites.

The very low reproductive potential on non-rat blood may very well be the reason for host specificity.

Tests to show the reproductive potentiality on serum, whole blood, and red blood cells of rat are now underway but results are not yet available.

V. SUMMARY

This project explored two of the possible causes of host specificity of the spiny rat mite, Echinolaelaps echidninus: (1) Are the bloods of hosts other than rat unattractive to this mite, and (2) if bloods of other vertebrates are available, what is their effect on the reproductive potentiality?

The results indicated that rat, human, pigeon, and sheep bloods were about equally well liked, but that mites fed on rat blood had a higher reproductive potentiality than had those fed on the other bloods.

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