Resistance to Starvation of *Rhodnius neivai* Lent, 1953 (Hemiptera: Reduviidae: Triatominae) under Experimental Conditions

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The period of resistance to starvation and the loss of weight until death of Rhodnius neivai *in all stages of development were studied. Work was based on experiments conducted under controlled laboratory conditions. One hundred specimens of each nymphal instar were observed: 50 were fed on chicken and 50 on rabbit. Adult females and males were kept together and fed on each host. All bugs were weighed weekly until death. Laid eggs were collected weekly and observed during five weeks to obtain hatchability. Resistance to starvation was similar with both hosts and increased with the evolutionary stage, excepting the 5th nymphal instar and adults. With both hosts, loss of weight was abrupt in the first week and steady in the following weeks. In adults, on the first weeks after eating, there was little or no mortality, after which mortality increased rapidly with the starving time. Reproductive output was higher in the bugs fed on rabbit.* R. neivai *is among the least resistant triatomine species.*

Key words: resistance to starvation - Triatominae - *Rhodnius neivai* - Venezuela

Rhodnius neivai Lent, 1953 has a restricted geographic distribution, limited to arid areas in center western Venezuela (Machado-Allison & Ramírez-Pérez 1967) and northeastern Colombia (Lent & Wygodzinsky 1979), usually in human dwelling (Lent & Jurberg 1969). Carcavallo et al. (1976) collected this species from the palm *Copernicia tectorum* after intensive sampling in central Venezuela.

R. neivai is partially domiciliated (Zeledón 1983) being sylvatic, it has started the adaptation process to human domicile facilitated by the socioeconomic factors existing in many Latin American countries. Actually, some small groups, including nymphs and adults, are found in houses.

In triatomines, resistance to starvation is of epidemiological importance and affects population survival, since it determines capacity to stand long periods of food deprivation (Pellegrino 1952). Resistance allows insects to get refugee in deep holes on houses walls, for time enough to escape from residual insecticides (Dias 1965, Viera 1990). Besides, it helps to keep environmental infestation in habitats temporarily abandoned (Feliciangelli et al. 1980) and changes population age structure, which should be considered to apply control actions (Rabinovich 1972).

Lent and Wygodzinsky (1979) indicated that nymphal instars tolerate starving longer periods than adults. However, as adults disperse easier than instars, can partially compensate this lower resistance and are relatively abundant (Feliciangelli et al. 1980).

Up to the present, *R. neivai* has not been considered a risk to human health. Nevertheless, the Ministerio de Salud from Venezuela has recently reported an outbreak of Chagas disease in some areas from central states where it is one of the most abundant triatomine species. Therefore some aspects of its behavior, as resistance to fast, should be studied.

The objective of this study is to learn about the resistance capacity to starvation of *R. neivai*, fed in two different hosts, in the period between molting and death in its nymphal and adult stages, and to analyze the differences in chicken or rabbit blood utilization for survival and reproduction, contributing to the comprehension of its behavior and the planning of control actions.

MATERIALS AND METHODS

The insects used in this study derived from a laboratory colony founded by 50 couples reared in the Instituto "Herman Lent", Facultad de Ciencias, Universidad de Los Andes, Mérida, Venezuela, where they have been kept during ten years after coming from field collected bugs.

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During experiments, triatomines were kept in a climatic chamber at 28±2ºC, 75±10% RH and 12 h photoperiod. Just after hatching, nymphs were placed in 3,785 l broad mouth jars, covered with nylon mesh and provided with vertically placed strips of paper folded several times to enlarge the surface of contact and give the insects resting places.

This process was repeated when insects molted to next stage and started the starvation. One hundred specimens of each nymphal instar were observed: 50 were fed on chicken and 50 on rabbit. Blood meal was offered twice a week until insects got replete, using animals placed on a wooden box with holes at the bottom, through which the top jars could be inserted (Gómez-Núñez & Fernández 1963). Bugs climbed to the top and fed through nylon mesh.

Initial weight was taken the day of molting. The three first instars were weighed three times a week to register gradual weight loss until death. In the 4th and 5th nymphal stages, the weighing was taken at four-days intervals because of their lower weight losses.

Fifty females and 50 males were kept together and fed on each host. These adults were fed until repletion, three weeks after ecdysis, this time was waited to avoid autogeny (Patterson 1979); after that bugs were weighed weekly until death. Eggs were collected weekly, computed and maintained during five weeks; then number of 1st instar nymphs alive was counted to obtain egg-hatchability.

The Wilcoxon matched-pairs signed-ranks test (Siegel 1956) was used to compare resistance to starvation, loss of weight and reproductive characteristics between hosts. Besides, the Spearman rank correlation coefficient (Siegel 1956) was used to evaluate each group in relation to the correlation between the time of experiment and the loss of weight. The significance level considered was 0.05.

RESULTS

Resistance to starvation was similar with both hosts, although 3rd and 4th nymphal instars fed on chicken were more resistant than those fed on rabbit (z=1.79 and z=1.71 respectively; P<0.05). In general, resistance increased in agreement with the evolutionary stage, excepting the 5th nymphal instar and the adult bugs whose resistance was higher than the 2nd stage nymphs, but lower than the 3rd stage. The lowest resistance was registered in the 1st stage and the highest in the 4th stage. Dispersion also tended to increase with the development stage, except for the 5th stage nymphs and the adults fed on chicken (Table I).

TABLE I

Resistance to starvation (days) of *Rhodnius neivai*

Developmental stage	Range: Fed on chicken	Range: Fed on rabbit	Mean±SD: Fed on chicken	Mean±SD: Fed on rabbit
1st instar	25-51	19-48	41.9±10.7	37.6± 8.4
2nd instar	61-99	58-96	84.6±15.7	79.4±13.8
3rd instar	105-159	93-139	142.3±17.6	124.9±18.5[a]
4th instar	113-166	102-144	149.7±21.8	131.6±17.2[a]
5th instar	39-142	41-127	106.3±19.5	99.1±20.1
Adults				
Females	52-128	22-119	86.5±19.8	83.9±24.7
Males	65-109	43-105	84.3±16.6	79.5±21.4

SD = Standard Deviation; n = 50 individuals for each instar, sex and host; *a*: significant difference (P<0.05)

With both hosts, loss of weight was gradual, according to the stage of development; the smallest was observed in the 1st instar and the greatest in the adults (Table II). A positive correlation (r_s=0.79; t=2.03; P<0.05 in the insects fed on chicken and r_s=0.85; t=2.17; P<0.05 in those fed on rabbit) was registered between the starvation time and the loss of weight. In any instar, there were no significant differences in loss of weight between nymphs fed on chicken or rabbit (z<1.64 in all instars; P>0.05). In all instars there was a sharp weight loss in the first week followed by a steady loss until death. However some fluctuations in the amount of weight loss were registered in the 2nd nymphal instar and adult insects. Females lost slightly more weight than males, but differences were not significant (z=1.46; P>0.05).

In female adults, on the first eight (fed on rabbit) to ten (fed on chicken) weeks after eating there was little or no mortality, after that mortality increased rapidly with the starving time (Fig. 1).

TABLE II

Loss of weight (mg) during starvation of *Rhodnius neivai*

Developmental stage	Range: Fed on chicken	Range: Fed on rabbit	Mean±SD: Fed on chicken	Mean±SD: Fed on rabbit
1st instar	0.2- 0.6	0.2- 0.7	0.4± 0.1	0.5± 0.1
2nd instar	0.9- 3.5	1.2- 3.6	1.9± 0.4	1.9± 0.4
3rd instar	3.5- 6.7	3.9- 7.5	5.5± 1.2	6.1± 1.4
4th instar	6.8-18.6	7.2-21.4	13.5± 3.7	15.2± 4.0
5th instar	11.1-26.7	12.7-28.1	19.2± 6.9	21.7± 7.5
Adults				
Females	17.4-51.0	19.0-53.7	32.7±13.5	33.1±14.8
Males	16.5-49.3	17.8-51.2	30.8±12.6	31.4±13.3

SD = Standard Deviation; n = 50 individuals for each instar, sex and host

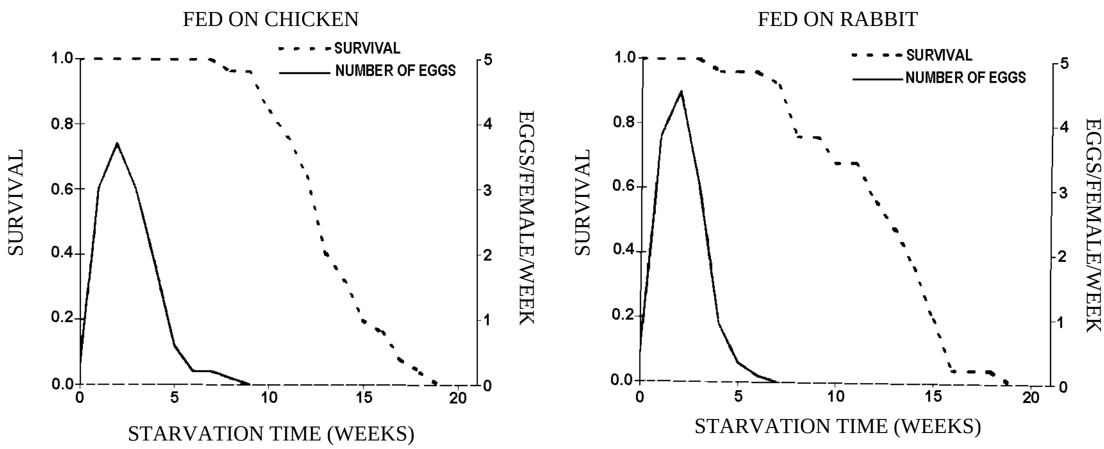

Fig. 1: survivorship curves and number of eggs/females/week of *Rhodnius neivai* fed once as adults.

Survivorship curves showed a similar pattern with both hosts, resembling type I curves (Deevey 1947). The number of eggs/female/week reached its maximum value at about three weeks of fast, and then oviposition dropped off abruptly and almost stopped after five weeks.

Some reproductive output indicators as: mean number of eggs/female/week and mean number of eggs/female/week at the age of maximum reproduction (Table III) were higher (z=2.01 and z=1.67 respectively; P<0.05) in the insects fed on rabbit.

In the insects fed on rabbit, egg-hatching percentage decreased abruptly six weeks after feeding (Fig. 2), while in the animals fed on chicken it dropped off with some irregular oscillations since fifth week reaching zero at the tenth week of starving, however number of laid egg was very low.

DISCUSSION

It has been indicated that different conditions (temperature, relative humidity and food source) make it difficult to compare results (Rabinovich 1972, Jurberg & Costa 1989, Cortéz & Gonçalves 1998), however conditions in this study are close to those of most authors.

TABLE III

Some reproductive characteristics of *Rhodnius neivai*

Characteristic	Fed on chicken	Fed on rabbit
Total number of eggs	358	380
Mean number of egg/female	32.3±2.3	35.4±2.5
Mean number of egg/week	14.3±2.8	15.4±2.7
Mean number of egg/female/week	1.9±0.4	3.1±0.4[a]
Mean number of egg/female/week at age of maximum reproduction	3.9±0.8	5.1±1.5[a]
Total number of reproductive weeks	10	8
% egg-hatching average	73.3	72.7

Mean ± standar error; *a*: significant difference (P<0.05)

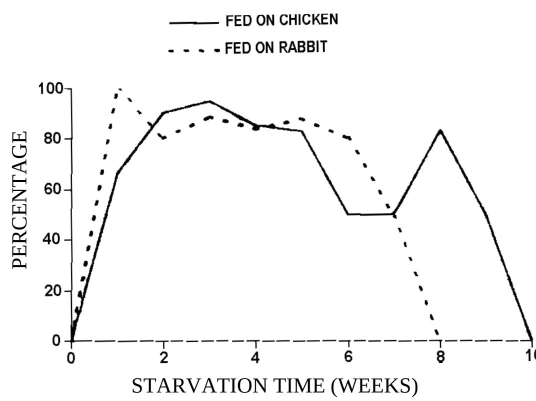

Fig.2: average egg-hatching percentage of females *Rhodnius neivai* fed once as adults.

Resistance to starvation in *R. neivai* was lower than *R. prolixus* in all instars (Feliciangelli et al. 1980), and higher than *R. neglectus* (Costa et al. 1967) in nymphal stages and adults. In the latter the results among the adult insects were similar for females that were more resistant than males. In general, resistance to fast in *R. neivai* was in agreement with the reported by other authors with *R. prolixus* (Uribe 1926, Buxton 1930, Feliciangelli et al. 1980), the 3rd and 4th instar nymphs could withstand starvation for longer periods than 5th nymphal stages and adults. However, *R. neivai* is one of the triatomine species less resistant to starvation.

The finding that the 3rd, 4th and 5th instar nymphs were more resistant to fast than 1st and 2nd instar nymphs and adults might explain the age pyramid frequently observed in both sylvatic and domestic populations, with a typically enlarged middle section.

The great weight reduction registered, with both hosts, in the first week after molting is consistent with the observations of Costa and Perondini (1973) in *Triatoma brasiliensis* and Cortéz and Gonçalves (1998) in *T. rubrofasciata*.

Cannibalism was also observed in this study, 2nd and 3rd instar nymphs fed on 5th stage nymphs and adult bugs. It supports Schaub's (1988) conclusions, which indicated that this behavior could contribute to nymph survival, helping to keep infection by *Trypanosoma cruzi* in natural conditions.There is not enough available information on different blood sources utilization by triatomines. Nevertheless, in other insect groups, total amount of ingested proteins has been related to egg production in phlebotomines (Ready 1979) and plasmatic protein concentration linked to egg production in *Aedes aegypti* (Greemberg 1951). Blood rabbit protein concentration higher than chicken blood concentration (Sturkie 1965, Swenson 1975) could explain the highest reproductive output in triatomines fed on rabbit.

Longer reproductive periods and slightly bigger egg hatching percentage in the insects fed on chicken could be due to the higher nutrient concentration in bird nuclei red cells (Downe & Archer 1975) and higher chicken blood digestibility letting more nutrient availability for egg production (Wigglesworth 1974, Nayar & Sauerman 1977). In spite of this, *R. neivai* seems to utilize rabbit blood more efficiently.

The ability of triatomines to tolerate starvation for long periods favors their capacity to undergo severe times of food shortage, and to take shelter in holes on walls, to escape from residual insecticides, increasing their survival. As *R. neivai* is one of the species that shows lower resistance to fast, it is concluded that there are good perspectives in controlling this species, since effectiveness of control campaigns against triatomine bugs is affected by their resistance to fast (Dias 1965, Perlowagora-Szumlewicz 1969, Cortéz & Gonçalves 1998).

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