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TEMPERATURE EFFECT UPON BLOOD CONSUMPTION IN *TRIATOMA INFESTANS*

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Different blood consumption speed was observed in Triatoma infestans *– nymphs and adults – exposed to 12 °C and 28 °C. Exposure to optimal temperature (28 °C) allows the insects to consume blood at a rate of 9% per day. Significative relationship between blood amount present in the promesenteron and consumed blood was found at 28 °C. Comsumption of blood was drastically reduced at the lowest temperature. Accordingly, lack of ovaric development, oviposition and mating behaviour was observed in insects kept at 12 °C. Relationship between laboratory and field observations are discussed.*

Key words: *Triatoma infestans* – Chagas' disease – food consumption

In haematophagous insects, temperature plays an special role acting over vectors and changing its vectorial capacity (Wood, 1976). *Triatoma infestans* is one of the main vectors of Chagas disease. Deep modifications in *T. infestans* population dynamic occur as result of seasonal temperature changes. Oviposition and moulting rate are highly favoured in spring and summer (Gorla & Schofield, 1989). Moreover, biting rate is directly dependent on temperature, with the highest values in December, January and February (Catalá, 1991).

Blood digestion speed can be modified by several environmental factors, mainly temperature (Prasad, 1987). It was shown that modifications in the amount of ingested blood and its consumption rate, affect the reproductive potentiality of *T. infestans* (Giojalas & Montenegro, 1986; Montenegro, 1989; Giojalas, 1991). Also, it could change the feeding frequency with the consequent effect upon parasite transmission (Catalá, 1991). We think that modifications in food consumption mediated by temperature would imply relevant changes in vectorial capacity through the year. The aim of this paper was to determine the effect of two different temperatures upon blood consumption in *T. infestans* looking for better comprehension of the factors involved on Chagas disease epidemiology.

MATERIALS AND METHODS

The consumption index (CI) is a measure of food consumption in a period of time (Waldbauer, 1968). Use of CI is very important in Triatominae bugs where the promesenteron (crop) acts storing and regulating the amount of blood transferred to postmesenteron to be digested. Then, real measure of consumption is not the blood meal size but the CI or amount of blood passed each day from promesenteron to postmesenteron (Montenegro & Pasina, 1984).

Two hundred and ten *T. infestans* – nymphs and adults – provided by the Servicio Nacional de Chagas (Córdoba, Argentina) were used. Experiments with nymphs – all instar – started at the fourth day after moulting. Adults were kept in couples after emergence and fed once a week up to the beginning of egg-laying. Then, couples were fasted for a period of 14 days – to standardized weight – and finally the experiment began. One preexperimental and two experimental groups were formed.

Preexperimental group – Insects in this group were killed and dissected immediately before the experiment start, in order to obtain fresh and dry crop weight. These variables represented the INITIAL BLOOD or blood amount within the insect at the start of the experiment.

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Also, fresh and dry ovaries weight was registered from females. Fifty nymphs (10 of each instar) and 20 adults (10 males and 10 females) were used in this group.

Experimental groups – Both experimental groups were fed *ad libitum* on a pigeon and INGESTED BLOOD was registered with .01 mg precision (Freitas & Guedes, 1961). Number of insects used in each experimental group was like in preexperimental group.

Experimental group 1 – The insects were kept at 28 °C during 10 days.

Experimental group 2 – The insects were kept at 12 °C during 10 days.

Previous field and laboratory observations showed that 10 days could be the best experimental period in order to prevent fast disturbance in insects kept at 28 °C. Insects from both groups were killed and dissected at the end of the 10 days period. RESIDUAL BLOOD or amount of non comsumed blood was determined by fresh and dry crop weight.

Blood Consumption Index (CI): weight (mg) of fresh and dry consumed blood per day, was estimated as follow (Montenegro & Pasina, 1984):

CI = (initial blood + ingested blood) – residual blood/10

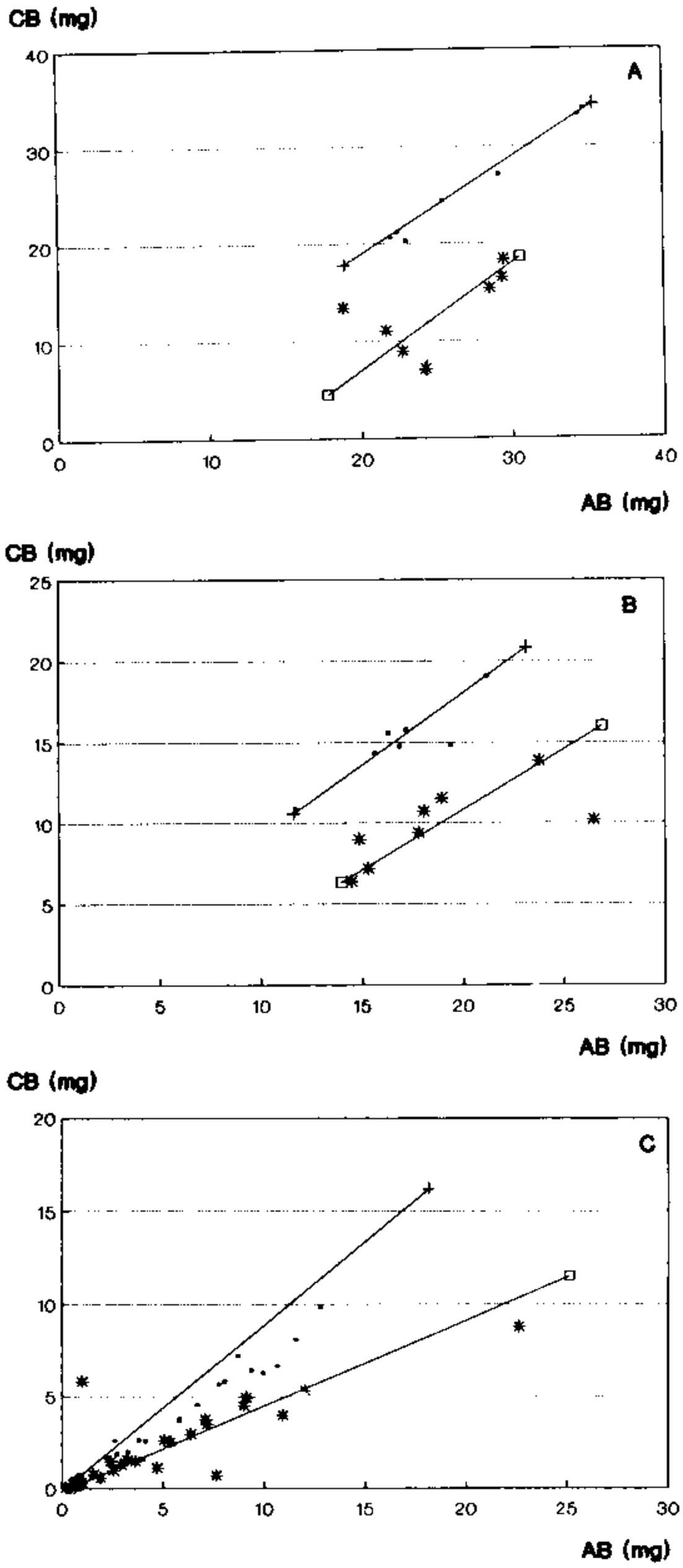
Consumption speed (CS) or percent of available blood consumed per day, was estimated as follow:

$$CS = \frac{\text{consumed blood}}{\text{available blood}} \times 100$$ where

available blood: initial blood + ingested blood/ 10

Additional variables were considered in adults: spermatophore number, eggs number and ovaric fresh and dry weight. Also, ovaric production (OP) was estimated as follow: OP = (ovaric weight at t1 + laid eggs weight) – ovaric weight at t0 (Montenegro, 1989) where t1 = end of experimental period; t0 = beginning of experiment.

Complementary microscopic observations of the ovaries were carried out to check oocyte development. The insects were kept within



Relationship between fresh consumed blood (CB) and amount of available blood (AB) at 12 °C and 28 °C in *Triatoma infestans:* A: females; B: males; C: nymphs. ■ 28 °C; * 12 °C.

chambers at 70% relative humidity and the temperature above indicated to each experiment. Before the experiment begining the insects were kept at 28 °C and 70% relative humidity. No insects died during the experiment.

Unifactorial ANOVA and Scheffée test were used in statistical analysis (Sokal & Rohlf, 1979).

TABLE I

Fresh (F) and dry (D) blood consumed (mg) and consumption speed (%) in adults and nymphs of *Triatoma infestans* at 12° and 28°

	28 °C				12 °C			
	mg		%		mg		%	
S	F	D	F	D	F	D	F	D
1	0.54	0.10	8.50	9.50	0.18	0.01	2.10	0.50
2	1.07	0.20	7.30	6.70	0.59	0.05	4.70	1.70
3	2.12	0.30	6.70	3.80	1.20	0.02	3.70	0.06
4	6.25	1.00	6.90	4.50	2.90	0.20	4.30	0.90
5	10.6	2.40	7.80	7.10	8.90	0.10	3.70	0.20
F	25.8	6.00	9.50	9.50	11.80	1.30	4.70	1.50
M	17.6	4.00	8.90	8.90	9.90	0.50	4.10	0.90

C. S: development stage: 1-5 = nymphs; F = females; M = males

RESULTS

Effect of temperature on fresh blood consumption – This variable showed a significantly relationship with the available blood amount at 28 °C, in adults and nymphs as well ($r = .99$, $p < .01$, $n = 20$ and $r = .99$, $p < .001$, $n = 50$, respectively) (Fig.).

Daily consumption speed of fresh blood was 9.5% (females), 8.9% (males) and 7.4% (nymphs, all instar). All the differences were significative ($p < .01$).

Fresh blood consumption was reduced about 50% both in nymphs and adults when the experiment was carried out at 12 °C. Like at 28 °C, fresh blood consumption was related to available blood amount (nymphs: $r = .98$, $p < .01$, $n = 50$; females: $r = .65$, $p < .05$, $n = 10$; males: $r = .86$, $p < .01$, $n = 10$) (Fig.).

Daily consumption speed obtained from low temperature was 4.7%, 4.1% and 3.7% for females, males and nymphs respectively. There were no differences among nymphal instar and adults.

Statistical analysis (ANOVA) of fresh blood consumption as well as consumption speed, showed very significative differences ($p < .001$) between both temperatures.

Effect of temperature on dry material consumption – When the insects were kept at 28 °C consumption of dry material was correlated with the amount of available blood within the crop (nymphs: $r = .94$, $p < .01$, $n = 50$; females: $r = .99$, $p < .01$, $n = 10$; males: $r = .99$, $p < .01$, $n = 10$). Dry blood material was consumed at 9.5% (females), 8.9% (males) and 6.35% (nymphs) per day. Statistical analysis revealed that first nymphal stage, females and males differed significantly with the other nymphal instar ($p < .001$) (Table I).

Dry material consumption was significantly reduced in nymphs and adults kept at 12 °C. This variable was not related to the amount of available dry material. Daily consumption speed at 12 °C was 1.5%, 0.9% and 0.6% per day in females, males and nymphs respectively. The lowest consumption speed was registered for third nymphal stage ($p < .001$).

Effect of temperature on reproduction (Table II) – Females submitted to 12 °C showed reduced ovaric development with atresic oocyte and lack of egg laying. Females exposed at 28 °C laid eggs and had normal ovaric development.

TABLE II

Ovaric production, number of laid eggs and spermatophores, at 12° and 28 °C

Temperature	Ovaric production	Eggs	Spermatophores
28	45.9 ± 20.38	0.5 ± 8.9	2.5 ± 1.1
12	4.1 ± 5.32	0	0

Spermatophore production was absent in males kept at 12 °C while males submitted to optimal temperature produced 2.5 spermatophore during the 10 days period.

DISCUSSION

Blood ingested by Triatominae bugs is primarily kept within the spacious crop where water absorbtion occurs quickly. Major digestion and absorbtion process are relegated to postmesenteron. The crop acts as a storage organ and its evacuation speed is modified by sex and physiological stage. Females consume food faster than males (Montenegro & Pasina, 1984) and mated females do it faster than virgin females (Montenegro, 1989). Our results show that blood consumption speed can be also modified by external factors as temperature.

Dry blood consumption was more drastically reduced at low temperature than fresh blood consumption. Then, water absorbtion is less affected than solid components absorbtion. Nevertheless as was pointed by Waldbauer (1968) dry materials bear the essential nutrients that allows the insect to grow and reproduce.

Reduced blood consumption affect male accessory glands production in fasted males at optimal temperature (Giojalas & Montenegro, 1986) as well as in fed insects submitted to low temperature (Giojalas, 1991). As accessory glands are responsible for spermatophore production we suppose that the same phenomenon leads to a lack of spermatophore in present experiment at 12 °C.

Reduced or absent oviposition is very common at low temperature both in laboratory (Joerg, 1964) and field (Gorla & Schofield, 1985). It was shown that it is necessary a minimum of 150 mg of blood consumption to start egg laying. Moreover, each laid egg means 12 mg of consumed blood (Montenegro, 1989). Fifty percent reduction on fresh blood consumption and eighty four percent reduction on dry material consumption could easily explain the lack of egg laying in females at low temperature.

Looking at natural field conditions, this drastic decrease of blood consumption speed at low temperature, could explain the strong effect of winter upon population density (Gorla & Scofield, 1989). Even with available food within the crop low temperatures break down blood consumption and – as in fasted insects – disrupt reproduction and moulting process. Moreover, direct relationship between blood consumption and available blood within the crop – seems to show an adjusted mechanism to survive when few blood is available at optimal temperature.

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