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Teresa Cristina M Gonçalves[a], Dayse S Rocha[a] and Rodolfo A Cunha[b]

[a]*Departamento de Entomologia do Instituto Oswaldo Cruz. Fiocruz. Rio de Janeiro, RJ, Brasil.*
[b]*Departamento de Biologia do Instituto Oswaldo Cruz. Fiocruz. Rio de Janeiro, RJ, Brasil*

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Teresa Cristina M Gonçalves[a], Dayse S Rocha[a] and Rodolfo A Cunha[b]

[a]*Departamento de Entomologia do Instituto Oswaldo Cruz. Fiocruz. Rio de Janeiro, RJ, Brasil.*
[b]*Departamento de Biologia do Instituto Oswaldo Cruz. Fiocruz. Rio de Janeiro, RJ, Brasil*

Keywords
Food habits#. Triatoma, parasitology#. *Trypanosoma cruzi*, isolation and purification#. Insect vectors. Ecology of vectors. – *Triatoma vitticeps*.

Abstract

Objective
Feeding patterns of triatomines have contributed to elucidate its biology. *Triatoma vitticeps*, naturally infected with *T. cruzi*, has been found in domiciles. Its behavior and epidemiological patterns were investigated.

Methods
One-hundred and twenty two specimens of *T. vitticeps* were captured from February 1989 to April 1993 in two areas of Triunfo municipality, a subdistrict of Santa Maria Madalena municipal district, State of Rio de Janeiro, Brazil. The insects were dissected and their intestinal contents were removed and tested. It was used antisera from: man, cow, horse, dog, pig, armadillo, opossum, rodent, and bird.

Results
From the total analyzed, 79 were positive and 43 were negative to the nine antisera tested: armadillo (30.3%) > human and pig (13.1%) > bird and dog (11.5%) > horse (5.7%) > opossum (4.9%) > rodent (4.1%) > cow (3.3%). Blood meals ranged from 0 to 4 and 6 in the following distribution: 0 = 25.41%; 1 = 45.08%; 2 = 10.66%; 3 = 6.56%; 4 = 1.64%, and 6 = 0.82%. Nine of the 122 insects captured were not examined, 74 (65.54%) were positive for *T. cruzi* infection and 39 (34.51%) were negative.

Conclusions
These results identified the *T. vitticeps* as being a sylvatic species and trypanosomiasis as being an enzootic disease. Epidemiological vigilance will be important to provide more information regarding the behavior of the species.

Descritores
Hábitos alimentares#. Triatoma, parasitologia#. Trypanosoma cruzi, *isolamento e purificação. Insetos vetores. Ecologia de vetores. –* Triatoma vitticeps.

Resumo

Objetivo
O estudo do hábito alimentar dos triatomíneos tem contribuído para o conhecimento da sua biologia no habitat natural. Triatoma vitticeps, *espécie que vem invadindo freqüentemente o domicílio apresentando-se infectado por* T. cruzi, *foi analisado sob esse aspecto, possibilitando conhecer a situação epidemiológica da área.*

Métodos
De fevereiro de 1989 a abril de 1993, 122 espécimes de T. vitticeps *foram capturados em duas áreas da localidade de Triunfo, 2° Distrito do Município de Santa Maria Madalena (RJ). Os insetos foram dissecados para a retirada do conteúdo estomacal. Os anti-soros utilizados foram: homem, vaca, cavalo, cão, porco, tatu, gambá, roedor e ave.*

Correspondence to:
Teresa Cristina M. Gonçalves
Av. Brasil, 4365
021045-900 Rio de Janeiro, RJ, Brasil
E-mail: tcmonte@gene.dbbm.fiocruz.br

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Resultados

Do total analisado, 79 estavam positivos e 43 negativos para os anti-soros testados: tatu (30,3%) > homem e porco (13,1%) > ave e cão (11,5%) > cavalo (5,7%) > gambá (4,9%) > roedor (4,1%) > boi (3,3%). As fontes alimentares identificadas variaram de 1 a 4 e 6: 0 - 25,41%; 1 - 45,08%; 2 - 10,66%; 3 - 6,56%; 4 - 1,64% e 6 - 0,82%. Quanto à infecção por T. cruzi, *74 espécimes (65,54%) estavam positivos, 39 (34,51%) negativos e 9 não foram examinados.*

Conclusões

Os resultados caracterizam o hábito silvestre de T. vitticeps *e a tripanosomíase como uma enzootia. A vigilância epidemiológica se faz necessária para o acompanhamento do comportamento dessa espécie.*

INTRODUCTION

Studies on blood meal sources for Hemiptera insects were carried out specifically with reduviids (Romaña,[9] 1939) and triatomines (Corrêa,[2] 1951). Since then, this method has been used not only to elucidate the biology of insects of medical importance but also to identify the potential reservoirs of some other pathogenic agents. Assessments of triatomine feeding patterns have become a valuable tool in clarifying vectors' biology and possible vector/host interactions in the epidemiology of Chagas disease (Wisnivesky-Colli,[12] 1987).

Dias et al[3] (1989), while studying feeding patterns of *Triatoma vitticeps* in Espírito Santo state, concluded that this species does not seem to be a good vector of human infection.

In the municipality of Triunfo, subdistrict of Santa Maria Madalena municipal district, the invasion of the domicile has not yet been followed by domiciliation, which suggests that the antropic modification was not high enough to modify the species' behavior. It seems that the acting selective pressures were not strong enough to determine the selection of genotypes and/or there has not been enough time to evidence any behavior change. Another hypothesis which may justify this sylvatic behavior is the low selective coefficient resulting from high Darwinian coefficient of these eclectics genotypes. However, the high indexes of triatomines infected with *T. cruzi* suggest that this agent is circulating in the sylvatic environment and maybe the synantropic vertebrates could be responsible for the closer contact between parasites and humans.

Based on a previous study on the ecology of *T. vitticeps* (Gonçalves et al,[7] 1998), the aim of the study was to identify the possible reservoir hosts for *T. cruzi.* This information could help improve the understanding of the epidemiological scenario as well as provide support to vigilance and control programs in the study areas.

METHODS

The 122 specimens of *T. vitticeps* analyzed were captured in households of two Triunfo areas: area A (two houses) – 250 m of altitude, 3.5 km away from the village, an deforested area due to banana plantation; and area B (one house) – 130 m of altitude, 4 km away from the village, in a valley with preserved vegetation (a reforested area). These areas are located 2 km far from each other, separated by a geographical barrier (a rocky mountain) with an altitude of 400 m to 900 m (Gonçalves et al,[7] 1998).

The insect abdomen was dissected and its intestinal contents were spread on a filter paper disc. For the testing, antisera preparation and titers determination and specificity were performed according to Siqueira[10] (1960).

It was used the following antisera: human (*Homo*), cow (*Bos*), horse (*Equus*), dog (*Canis*), pig (*Sus*), armadillo (*Dasypus*), opossum (*Didelphis*), rodent (*Rattus*), and bird (*Gallus*). The antisera titres were: armadillo (1:10,000), bird (1:10,000), human (1:10,000), opossum (1:10,000), cow or goat (1:15,000), dog (1:15,000), horse (1:15,000), pig (1:15,000), and rodent (1:15,000). As there were no goats in the study areas, they will not be mentioned from now on, only cows.

The specificity of each antiserum was determined using both homologous (controls) and heterologous antisera and from specimens of *T. vitticeps* which were kept under laboratory conditions and fed on the same vertebrates used in the precipitin test.

The statistical tests used were t-Student, ANOVA and DMS.

Some teaching took place to make the local population able to identify the species, provide information about the insects, to be aware of the increased number of insects in their households, and to know

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how to avoid insect colonization, all of that with the purpose of starting epidemiological vigilance in the locality.

RESULTS

The presence of *T. cruzi* was ≥ 50% for both female and male insects in the two areas. Using the statistical test t-Student, ANOVA and DMS the difference between infection rates among both genders (p=0.11) and in both areas (p=0.62) was not significant (Table 1).

The results of blood meal identification were based on the 122 specimens (85 alive and 37 dead) despite the fact that only 79 specimens (65%) were reactive to the antisera, as follows: armadillo > human and pig > bird and dog > horse > opossum > rodent > cow. There were no results for 43 (35.2%) of them. The predominance of armadillo blood meal source was observed in both genders. The statistical tests ANOVA and DMS showed a statistical difference to the armadillo antiserum when compared to other antisera. Regarding the 43 insects mentioned above, 31 (72%), including nine dead, were no reactive to the antisera, and in 12 (28%), including the three dead, there was not enough material to be tested (Table 1).

Multiple blood meals identified by precipitin test ranged between 0 (non-reactive) to 4 and 6, as follows: non-reactive (25.41%), one (45.08%), two (10.66%), three (6.56%), four (1.64%) and six (0.82%). Single blood meal sources were the prevalent (20 specimens positive to armadillo, 9 to human, 9 to dog, 8 to pig, 5 to bird, 2 to opossum, 1 to horse and 1 to rodent). Multiple blood meals (two or more host sources identified per insect) were seen in 24 specimens (Table 2).

Nine insects (16.36%) among the positive to human antiserum were included in the group of one blood meal and seven insects (29.16%) with two, three and six blood meal sources. The nymphs were positive only to human (2nd and 3rd instar) and dog (5th instar) antisera.

The infectivity blood meal index (IBMI) was ≥ 50% to all antisera tested (Table 3). It was observed that all specimens reactive to bird and horse antisera were 100% positive to *T. cruzi*, followed by rodent, cow, opossum, human and pig, armadillo and dog. In regard to the specimens non-reactive to the antisera, 58.14% were infected by *T. cruzi*.

The population teaching proved effective as local people captured most triatomines.

Table 2 - Multiple blood-meals identified by precipitin test in the 122 specimens of *Triatoma vitticeps*.

Blood-meals	N	%
Bird/horse	1	4.2
Bird/armadillo	1	4.2
Dog/armadillo	3	12.5
Horse/armadillo	1	4.2
Opossum/armadillo	1	4.2
Human/bird	1	4.2
Human/pig	1	4.2
Human/armadillo	1	4.2
Pig/armadillo	3	12.5
Bird/cow/armadillo	1	4.2
Bird/pig/armadillo	1	4.2
Cow/opossum/armadillo	1	4.2
Horse/pig/armadillo	1	4.2
Human/bird/horse	1	4.2
Human/opossum/rodent	1	4.2
Human/opossum/armadillo	1	4.2
Rodent/pig/armadillo	1	4.2
Bird/cow/dog/rodent	1	4.2
Bird/horse/pig/armadillo	1	4.2
Human/bird/dog/cow/horse/rodent	1	4.2

DISCUSSION

Among many other biological aspects, trophic resources should be used to understand this species behavior. The multiple feeding sources seen for *T. vitticeps* emphasize the broad ecological valence previously noted by Gonçalves et al[7] (1998).

The diversity of blood meals may be associated with the low aggressiveness to feeding (Diotaiuti et al[4] 1987, Gonçalves et al,[6] 1988) which forces the insect out to find another host to feed itself.

The nymphs' positivity for human and dog antisera

Table 1 - Blood meals identification according developmental stage and sex.

Evolutive stage	Area A	Area B	Number and percentage of triatomines positive to different antisera: Infected	No result	Armadillo	Human	Pig	Bird	Dog	Horse	Opossum	Rodent	Cow
Female	59	20	55(69.6)	29(36.7)	26(32.9)	9(11.4)	11(13.9)	9(11.4)	7(8.9)	7(8.9)	4(5.1)	2(2.5)	3(3.8)
Male	18	17	19(54.2)	10(28.5)	11(31.4)	4(11.4)	5(14.3)	5(14.3)	6(17.1)	-	2(5.7)	3(8.6)	1(2.9)
Nymphs	3	-	-	-	-	2(66.7)	-	-	1(33.3)	-	-	-	-
Sex not identified	5	-	-	4(80.0)	-	1(20.0)	-	-	-	-	-	-	-
Total	85	37	74	43(35.2)	37(30.3)	16(13.1)	16(13.1)	14(11.5)	14(11.5)	7(5.7)	6(4.9)	5(4.1)	4(3.3)

Percentage in parenthesis; total >100% because of multiple feeds

Table 3 - Identification of *T. vitticeps* blood-meal sources x infection by *T. cruzi.*

		Antisera									
T. cruzi	Total exam.	Bird	Horse	Rodent	Cow	Opossum	Human	Pig	Armadillo	Dog	Non reagent
Positive	74	14(18.9)	7(9.5)	4(5.4)	3(4.1)	4(5.4)	10(13.5)	10(13.5)	23(31.1)	7(9.5)	25(33.8)
Negative	39	-	-	1(2.6)	1(2.6)	1(2.6)	5(12.8)	4(10.3)	14 (35.9)	6(15.4)	14(35.9)
Non exam.	9	-	-	-	-	1(11.1)	1(11.1)	2(22.2)	-	1(11.1)	4(44.4)
Total positive		14(11.5)	7(5.7)	4(3.3)	3(2.5)	4(3.3)	10(8.2)	10(8.2)	23 (18.9)	7(5.7)	25(20.5)
IBMI *		14/14(100.0)	7/7(100,0)	4/5(80,0)	3/4(75.0)	4/6(66.67)	10/16(62.50)	10/16(62.50)	23(62.16)	7/14(50)	25/43(58.14)

Percentage in parenthesis; total >100% because of multiple feeds; non reagent includes also insuficient material.
*Infectivity blood meal index = (number of bugs positive for *T. cruzi* fed on host X/ n° of bugs examined for *T. cruzi f*ed on host X) x 100.

suggests little or no motility at this developmental stage, implying that the postures were realized within the domicile. The finding of nymphs with human blood may be an epidemiological indication of a colonization process. But considering the long duration of the study, two nymphs seem not enough to draw conclusions on colonization. There is an evident risk of transmission, though *T. vitticeps* has been considered as a not very effective vector. In regard to adult forms, the positivity to human antiserum was high, though it was expected to be higher given that all insects were captured indoors, behind the furniture (bed, sofa), and many times engorged. In addition, based on the Weitz[11] (1956) results, it was difficult to determine the origin of blood meals to human and dog antisera due to the presence of primates and wild canids in the study areas and/or because the intestinal contents were exiguous in some insects.

The high incidence to armadillo blood meal (single or multiple) and pig blood meal (probably a sylvatic artiodactylus since there were no pigsties near the households) emphasizes the sylvatic habitats of *T. vitticeps* in Triunfo. These results confront with those observed in Espírito Santo (Dias et al,[3] 1989), where most samples were reactive to human antisera, indicating a close contact between humans and insects. It also suggests that domicile infestation is more frequently seen in that state. The difference in behavior seen in Triunfo and Espírito Santo populations may have resulted from a selective pressure, which could establish different gene pools in allopatric populations.

Taking all these into account, it is difficult to accurately assess the actual feeding frequency and degree of motility of sylvatic specimens. Although the precipitin test results showed the presence of a specific vertebrate in the area, it must be considered that host vicinity is probably the most important factor in host selection.

The relationship between gender and number of hosts revealed the tendency of male insects to be associated with more blood meal sources than females, which is in agreement with of Dias et al[3] (1989) observations. This may be explained by the fact that female insects generally ingest a greater volume of blood to guarantee the posture.

Also, opossums, known as a common host source for several other triatomines species (Zeledón et al,[14] 1974, Barreto,[1] 1979), represented only a small percentage (4.9%) of the blood meal sources for *T. vitticeps.*

The high incidence of armadillo, bird, human and pig blood meals infected with *T. cruzi*, associated with the absence of human and domestic animal trypanosomiasis (Gonçalves et al,[7] 1998), suggests that *T. cruzi* infection remains an enzootic disease in the study areas. However, it is not possible to prove that the armadillo is an important reservoir. Not only due to the IBMI, but because *T. cruzi* infection was observed only in marsupials (Gonçalves et al,[7] 1998), which were one of the least preferred food sources for *T. vitticeps* (5%). On the other hand, birds, refractory to *T. cruzi* infection, were the second food source of choice for triatomines with a high infection index. Both results demonstrate the difficulty in determining the predominant reservoir for *T. cruzi* using blood meal identification procedures (Zárate et al,[13] 1980).

The human infectivity blood meal index (62.50%) and the negative human serology (Gonçalves et al,[7] 1998) also confirm that *T. vitticeps* is not a good vector in human infection (Dias et al,[3] 1989; Diotaiuti et al,[4] 1987; Gonçalves et al,[6] 1988). This suggests an opportunist behavior since the vicinity of a certain type of host is generally more important than preference for a specific host (Minter,[8] 1976).

The results' analyses corroborate that in the two study areas *T. vitticeps*, though capable of occasionally infesting the domicile, still remain in the sylvatic habitat, which reinforce Gonçalves et al[7] (1998) findings.

The population teaching was effective for both children and adults, who learned how to identify the

triatomines, making it possible their capture indoors. It should be emphasized that they themselves captured most insects used in the study. Teaching also contributed to the surveillance and could be responsible for the low predominance of human antiserum. It can be then characterized as opportunist behavior of the insect, according to Forattini et al[5] (1974) who stated that humans have been playing the role of hosts for the insects' survival and dispersion. Continuing surveillance will be necessary to help maintain this situation in Triunfo for the future.

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