Density estimates of the domestic vector of Chagas disease, *Rhodnius prolixus* Stål (Hemiptera: Reduviidae), in rural houses in Venezuela

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We report the use of the timed manual method, routinely employed as an indicator of the relative abundance of domestic triatomine bugs, to estimate their absolute density in houses. A team of six people collected Rhodnius prolixus *Stål bugs from the walls and roofs of 14 typical palm-leaf rural houses located in Cojedes, Venezuela, spending 40 minutes searching in each house. One day after these manual collections, all the houses were demolished and the number of triatomine bugs were identified by instar and counted. Linear regression analyses of the number of* R. prolixus *collected over 4 man-hours and the census counts obtained by house demolition indicated that the fit of the data by instar (stage II — adult) and place of capture (roof versus palm walls versus mud walls) was satisfactory. The slopes of the regressions were interpreted as a measure of "catchability" (probability of capture). Catchability increased with developmental stage (ranging from 11.2% in stage II to 38.7% in adults), probably reflecting the increasing size and visibility of bugs as they evolved. The catchability on palm walls was higher than that for roofs or mud walls, increasing from 1.3% and 3.0% in stage II to 13.4% and 14.0% in adults, respectively. We report, also, regression equations for converting field estimates of timed manual collections of* R. prolixus *into absolute density estimates.*

Introduction

Rhodnius prolixus Stål (Hemiptera: Reduviidae) is one of the most important domestic vectors of *Trypanosoma cruzi*, the causative agent of Chagas disease. With a wide geographical distribution, ranging from the north of South America to El Salvador in Central America, this vector occupies both sylvatic and domestic ecotopes and is especially well-adapted to palm-thatched rural dwellings, where it reaches high population densities (*1*). Of about 24 million people that were infected with *T. cruzi* in Latin America in the 1980s, more than 6 million have been attributed to the vectorial capacity of *R. prolixus* (*2*). Although currently the number of people infected has diminished to about 18 million, about 90 million (c. 20% of the total population of Latin America) are considered to be at risk of contracting *T. cruzi* infection.[a]

R. prolixus is a hemimetabolous insect, and with each moult it grows larger and probably becomes more active. These changes with the development process may seriously affect population size sampling; in addition, variations in the construction materials of rural houses and the location of the places being searched by collectors could affect the sampling outcome. Thus, consideration has to be given to these differences either for estimating the size of bug populations or for detecting infestations as part of the efforts of vector control activities.

In contrast to the relative wealth of information from laboratory studies (*3*) of domestic triatomine bugs, their population dynamics in rural dwellings have rarely been studied; Schofield (*4*) and Rabinovich et al.[b] have stated that one of the main reasons

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[a] *Strategic plan for applied field research in tropical diseases.* UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases and the Division for Control of Tropical Diseases. WHO unpublished document CTD/TDR/TDF/93.1, 1993.

[b] **Rabinovich, Leal JA, de Piñero DF.** [*Field study on the use of microhymenoptera for the biological control of the vectors of* Trypanosoma cruzi]. Technical report presented to CONICIT, Venezuela, on the first year of activities of Project S1-697. Caracas, Venezuela, 1980 (in Spanish).

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for this is the lack of adequate sampling techniques. The most widely used approach to assessing the domiciliary abundance of triatomines is timed manual capture, which provides an index of relative density expressed as the number of bugs per man-hour of search (*4–6*). The following are some of the disadvantages of this method: estimations are dependent on the experience of collectors and the length of time spent searching each house; the accuracy of the indicators of bug abundances are not known; and the indicators are biased towards higher development stages (*6*). House demolition is the only recognized method that can give reliable estimates of the age structure and absolute density of bugs in houses (*4, 7, 8*). However, because house demolition is costly and impractical on a large scale there have been no attempts to relate timed manual capture to density of triatomine bugs in houses, although some isolated estimates have been obtained from other studies (*8, 9*). Timed manual capture therefore remains an uncalibrated sampling method.

As part of a wider study on the biological control of *R. prolixus* using the pteromalid wasp *Telenomus costalimai* and *Ooencyrtus trinidadensis venatorius*, we carried out monthly capture–mark–recapture samplings of triatomine bugs in 16 houses over a 6-month period, followed by a total census of the bug populations after house demolition in order to calibrate the sampling methods employed.[c] The present article, with data based on the manual collections prior to house demolitions, provides the first statistical estimate of the "catchability" of a domestic triatomine.

Catchability estimates constitute not only a basic requisite for studies on population dynamics (rate of population growth, life-table analysis, etc.) but also contribute to the estimation of bug density, one of the key variables in the evaluation of the risk of *T. cruzi* transmission to humans (*10*). Additionally, in this article we challenge the generally accepted but rarely tested assumption of many sampling methods — that the total catch per unit effort increases linearly with population density (*11, 12*), particularly for insects (*13*).

Materials and methods

Study area

The study was carried out in the rural villages of Hacienda Vieja and Tierra Caliente located in the State of Cojedes, Venezuela, situated at approximately 10° N, 67° W. Most of this state consists of dry tropical forest (*14*); the dominant vegetation is a combination of primary and secondary dry forest mingled with savanna. The study area was located in a region of 600 metres above sea level. The mean annual temperatures lie in the range 22–29 °C; precipitation averages 1000–1800 mm per annum, showing a marked seasonality, with a dry season that can last 4–6 months, and a wet season that produces frequent floods. Two typical palm trees of the area host wild populations of *R. prolixus*: the "coroba" (*Scheelea* spp.) and the "palma llanera" (*Copernicia tectorum*) (*15, 16*); palm leaves of the former are widely used in house construction.

The study villages were sprayed with dieldrin or γ-BHC for the first time in 1968 and were regularly sprayed until 1971. By 1976 a total of 62% of the houses in Hacienda Vieja were infested by *R. prolixus* and 48% of humans were seropositive to *T. cruzi* (*17*). In March 1976 we preselected 128 houses satisfying the following criteria: *Construction*—representative of the commonest dwellings that harbour *R. prolixus* (*18*) (coroba palm-thatched roofs and walls of mud or palm, approximately standard in size (one bedroom and one contiguous room) and floors of beaten earth) (Fig. 1); and *Accessibility*—accessible during the rainy season. In addition, a third criterion was imposed: infestations of at least 30 bugs per house. For this purpose 22 houses that satisfied the first two criteria were sampled using the Lincoln method and a 4-man–hour sampling effort. From these houses, 16 were selected that had bedrooms infested with *R. prolixus*, with a wide range of bug densities (30–1700 bugs per house).

Sampling design

Each house was sampled by six people divided into two teams who systematically searched bedrooms for *R. prolixus* for 40 minutes, i.e., 4 man–hours of capture effort per house.

The sampling effort was divided into six strata: upper wall, including a 50-cm-wide strip below the eaves; lower wall, up to 60 cm above the ground; middle wall (the space between the lower and upper walls); upper roof, including the crest and a 2-m-wide strip at each side; lower roof, including a 1-m-wide strip above the eaves; and middle roof, the intermediate space between the lower and upper roof. To prevent them from becoming tired or bored, the two teams were successively rotated between the roof and wall strata.

Bugs were collected from palm fronds and from the cracks in mud–stick walls using a pair of tweezers made of soft clock-springs or, in the case of the smaller nymphs using a microcollecting device. The

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[c] See footnote *b*, p. 347.

Fig. 1. **Typical rural house used for the study showing the ladder employed to collect bugs on the roof.**

collected bugs were stored in labelled jars according to stratum and collector for subsequent counting and identification by instar. The bugs were not returned to the houses, which were scheduled for demolition 24 hours later.

House demolition

Detailed procedures for house demolition have been described by Rabinovich et al. (*1*) and only the main features are given here. A group of 15–20 people equipped with different tools completed the demolition and bug collection of each house in about 9 hours, using the following procedure: all furniture and household goods were removed from the house and carefully searched for bugs; a piece of white canvas was laid on the ground near the external walls, and the palm leaves were removed individually, shaken vigorously over the canvas, and examined section by section to collect all the bugs; the thatched roof was dismantled following a similar procedure to that employed for the palm walls; and the frame of the house (made of bamboo or lumber) was removed and also inspected for bugs. After burning all the rubbish, a new house with a metal roof was built with the aid of members of the community. Three houses (No. 1, 8, and 11) were not dismantled because the occupants refused and hence were not included in the analysis; inexplicably, almost no bugs were collected from house No. 10 before it was demolished; we considered this to be an anomalous case and it was therefore also excluded from further analysis. Data from 12 houses were included in the final analysis.

After the last house had been demolished, an additional house (No. 17) was included to test the bug removal method described by Leslie (*19*) and to estimate the bug biting frequency (*1*). Leslie's method was used only on the roof by five people who collected bugs over eight successive periods of 12 minutes each with a 10-minute rest between each period. The findings were used to check whether the probability of bug capture was related to population density. Although house No. 17 was later demolished, it was not included in the catchability analyses.

Data analysis

In the analysis, *timed collection* represents the number of bugs captured during a 4-man-hour manual collection carried out prior to the house demolition, and *census* applies to the total population of bugs counted during the house demolition. Catchability is defined as the fraction (or percentage) of the census that was captured during the timed collection. We assumed that demographic changes due to the death, birth, or migration of bugs during the 24-hour period between the timed collection and demolition were negligible, both among and within strata. Since the number of bugs obtained in the timed collection is expected to increase with bug density, we carried out linear and non-linear regression analyses using bug census as the independent variable and timed collection as the dependent variable. Because bug census implies collection of all bugs, our regressions follow the model with no error in the independent variable (*20*). For the linear regressions, the slope of the regression plot represents a simple and direct estimate of catchability, while for the nonlinear regressions the coefficients cannot be interpreted so straightforwardly. A symmetrical distribution of regression residuals was considered an acceptable indicator that they were normally distributed.

The data used in the regression analyses were stratified by the development stage of the bugs; the place of capture (roof or walls); and the structure of the walls (mud–stick or palm-leaves). Subdivisions of the roof and wall strata were not used in the analyses because they frequently resulted in too few or no bugs.

We tested the premise that the total catch per unit effort increased linearly with the bug population density by using the roof collection data for house No. 17, employing Leslie's removal method. This procedure implied taking the census of bugs from the roof to be the true initial number of bugs, and then subtracting the value of the first timed collection from this to generate a total hypothetical bug population for the second collection, and repeating the procedure for subsequent collections. The ratio of the number of bugs captured to the total hypothetical bug population prior to each collection was considered to be a reasonable estimate of the probability of capture for each successive collection period. Thus, successive reductions of the actual population in each subsampling using Leslie's removal method permitted us to test for a possible relationship between catchability (as a measure of the probability of capture) and population density.

Results

The numbers of *R. prolixus* bugs caught by timed collection and during each house demolition according to house number, bug developmental stage, place of capture, and type of wall material are shown in the Annex.

The results of linear and nonlinear regression analyses for each stratum are shown in Table 1. The determination coefficients (R^2) of both models fitted the data well. In some cases linear regression produced a better fit than power regression, but in other cases the converse was true. The overall number of significant regression coefficients for each stratum was also very similar for both models.

The estimated catchability determined using Leslie's removal sampling method showed no consistent trend with population density (Fig. 2), suggesting that no nonlinearity is involved. We therefore used the linear model since it was simpler; the slope of the linear regression equation can be intuitively interpreted in terms of catchability; and the results shown in Fig. 2 indicate that the probability of capture is stable over a wide range of bug densities.

Since the intercepts of the complete linear regression were not significant (Table 1), we recalculated the linear regressions forced through the origin, with slopes representing catchability as defined above (Fig. 3–5 for roof, palm wall and mud wall, resp.). All the catchabilities were statistically significant at the $P < 0.01$ level, except for stage I of the palm-leaf wall ($0.01 < P < 0.05$) and for stages I and V of the mud wall ($P < 0.05$). The distribution of regression residuals had acceptable symmetry in 15 of the 18 regressions (only stage III, adult bugs in

Table 1: **Regression and determination coefficients for complete linear regressions and power regressions for development stages and house strata**

	Linear regression[a]			Power regression[b]		
Stage	*a*	*b*	R^2	*a*	*b*	R^2
Stratum: roof (n = *12)*						
I	0.787	0.009	0.188	0.0125	0.293	0.224
II	0.237	0.011[c]	0.371	0.0575	0.153	0.207
III	–0.085	0.035[d]	0.487	0.0679	0.361[c]	0.462
IV	1.087	0.034[d]	0.558	0.7295	0.441[d]	0.732
V	0.059	0.104[d]	0.683	0.0667	0.603[d]	0.822
Adult	–1.274	0.140[d]	0.849	0.1531	0.960[d]	0.880
Stratum: palm walls (n = *7)*						
I	1.660	0.019	0.141	1.0520	0.310	0.181
II	0.581	0.104[d]	0.884	0.6310	0.595[d]	0.797
III	0.159	0.137[d]	0.987	0.0141	0.616[d]	0.932
IV	0.160	0.279[c]	0.582	0.7943	0.637[c]	0.589
V	0.531	0.392[d]	0.882	0.7345	0.826[d]	0.800
Adult	0.921	0.354[d]	0.844	0.9016	0.752[c]	0.760
Stratum: mud walls (n = *5)*						
I	3.899	–0.032	0.129	2.8510	–0.072	0.001
II	0.196	0.029[c]	0.901	0.7211	0.377[c]	0.874
III	0.279	0.022[c]	0.892	1.0691	0.261[d]	0.947
IV	–0.037	0.090[d]	0.999	0.8974	0.443[d]	0.956
V	0.654	0.058	0.420	0.9572	0.403[c]	0.860
Adult	–0.234	0.147[d]	0.972	0.6412	0.585[c]	0.866

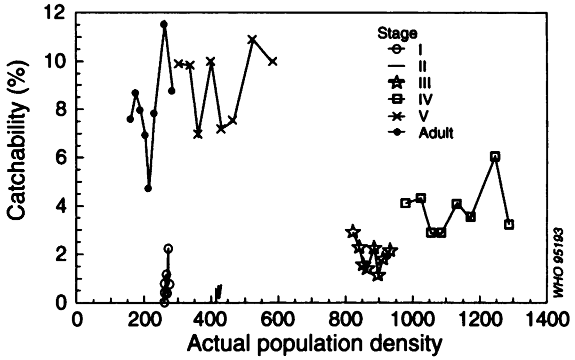
[a] $Y = a + bX$: R^2 = determination coefficient; X = bug census; Y = bug collection. Unless otherwise stated, regression coefficients were not statistically significant ($P > 0.05$).

[b] $Y = aX^b$; R^2 = determination coefficient; X = bug census; Y = bug collection. Unless otherwise stated, regression coefficients were not statistically significant ($P > 0.05$).

[c] $0.001 < P < 0.05$.

[d] $P < 0.01$.

Fig. 2. **Illustration of the use of Leslie's removal method to verify the relationship between bug catchability and the house population density of *Rhodnius prolixus*.** For each developmental stage, the symbols from right to left indicate how the numbers were reduced with each subsampling (in total eight subsamples of 12 minutes each were taken). Density reduction was less for the lower stages — even for the same range of densities — since they have lower catchabilities. See text for details.



the roof, and stage I in mud walls exhibited a degree of asymmetry).

We compared the differences between the slopes of the linear regressions through the origin for each developmental stage (*21*). Inspection of Fig. 3–5 shows that there was usually a marked difference in the determination coefficient between stages III and IV; differences within stages I–III and within IV–adults were therefore analysed separately. For mud walls there were no statistically significant differences ($P > 0.05$) among stages I–III and among stages IV–adults. For the roof, differences among stages I–III were not statistically significant ($P > 0.05$) but those among stages IV–adult were significant ($0.01 < P < 0.05$). For the palm-leaf walls differences were statistically significant for stages I–III ($0.01 < P < 0.05$) but not for stages IV–adult ($P > 0.05$). We therefore maintained the catchability value of each stage independently.

Catchabilities generally increased with developmental stage (Fig. 6). This may reflect the increasing size of the bugs as they evolve from the first to the adult stage. We tested this hypothesis using weights as an indicator of size; the following are the average weights in mg ± standard deviations for a sample of unfed *R. prolixus* (20 bugs at each stage) (Rabinovich, unpublished data): stage I, 0.446 ± 0.065 mg; stage II, 1.465 ± 0.0287 mg; stage III, 5.504 ± 0.0762 mg; stage IV, 17.921 ± 0.2544 mg; stage V, 42.729 ± 0.4130 mg; adult, 73.913 ± 1.1124 mg. Fig. 7 shows the fit of linear regressions forced through the origin of the average catchability as a function of the average weight of bugs caught on the roof, palm walls, and mud walls, separately. In all cases, the regression coefficients were statistically significant ($0.01 < P < 0.05$), with similar slopes (about 0.2) for roofs and mud walls, but a considerably greater slope (0.68) for palm walls. Comparisons of the slopes for roofs and mud walls using a procedure described by Steele & Torrie (*21*) indicated that there was no statistically significant difference among stages.

To facilitate the conversion from field timed collections to absolute bug densities, we recalculated all regressions through the origin, by transposing the variables (i.e., bug census as the dependent and timed collection as the independent variable). Thus if a new 4-man-hour timed collection of *R. prolixus* in a rural house were carried out, the following expressions would provide an estimate of the actual density of bugs and the confidence intervals of the prediction (*21*), for roof (D_r), palm walls (D_p), and mud walls (D_m), respectively:

$$D_r = V1 + V2.FV \pm 2.201V3\sqrt{1.0833 + \frac{FV^2}{V4}}$$

$$D_p = V1 + V2.FV \pm 2.447V3\sqrt{1.1429 + \frac{FV^2}{V4}}$$

$$D_m = V1 + V2.FV \pm 2.776V3\sqrt{1.20 + \frac{FV^2}{V4}}$$

where $V1$, $V2$, $V3$ and $V4$ are the specific values for each stratum and insect stage given in Table 2, and FV is the new field value obtained by timed collection and for which an estimation of the actual bug density is sought.

Discussion

In fishery science, catchability is a proportionality constant and is calculated as the ratio of fishing mortality to a particular unit of fishing intensity or effort (*22, 23*). However, by definition, this constant also relates the catch per unit effort to the true fish density (*24*), i.e., the catchability coefficient is an indicator of abundance.

Using catchability in this sense, we examined two regression models for manual collection (catch per unit effort) and house demolition (true density) values, and found that the linear and power regression models had similar goodness of fit. This is not

Table 2: **Results of transposed linear regressions forced through the origin, according to stratum**

	Stratum											
	Roof:[a]				Palm wall:[a]				Mud wall:[a]			
Stage	*V1* (m_y)	*V2* (b)	*V3* ($s_{y,x}$)	*V4* (Σx^2)	*V1* (m_y)	*V2* (b)	*V3* ($s_{y,x}$)	*V4* (Σx^2)	*V1* (m_y)	*V2* (b)	*V3* ($s_{y,x}$)	*V4* (Σx^2)
I	149.4	41.2	114.9	130	54.0	14.0	53.7	97	—	—	—	—
II	52.2	43.9	49.4	22	31.6	8.4	14.9	221	35.0	30.6	21.5	20
III	76.7	21.1	44.7	177	19.7	7.1	3.3	140	42.6	38.3	21.6	14
IV	53.2	17.4	40.0	179	9.1	2.8	5.1	93	18.2	11.2	0.5	40
V	78.5	7.6	48.1	2 071	12.1	2.3	5.0	381	—	—	—	—
Adult	142.4	6.8	56.3	8 855	17.6	2.4	6.4	552	15.2	7.0	3.6	50

[a] m_y = Mean of the dependent variable (censuses); b = regression coefficients; $s_{y,x}$ = standard errors of linear regressions forced through the origin, and Σx^2 = sum of the coded independent variable (collections), for all house strata and all bug stages. All regressions were statistically significant ($P < 0.05$) except stages I and V in the mud-wall stratum.

Fig. 3. **Linear regressions forced through the origin (solid lines), typical of the roof, for all developmental stages of *Rhodnius prolixus*.** In all cases n = 12 houses and the field data are represented by open squares (one per house). Catchability is the slope of the regression in percent.

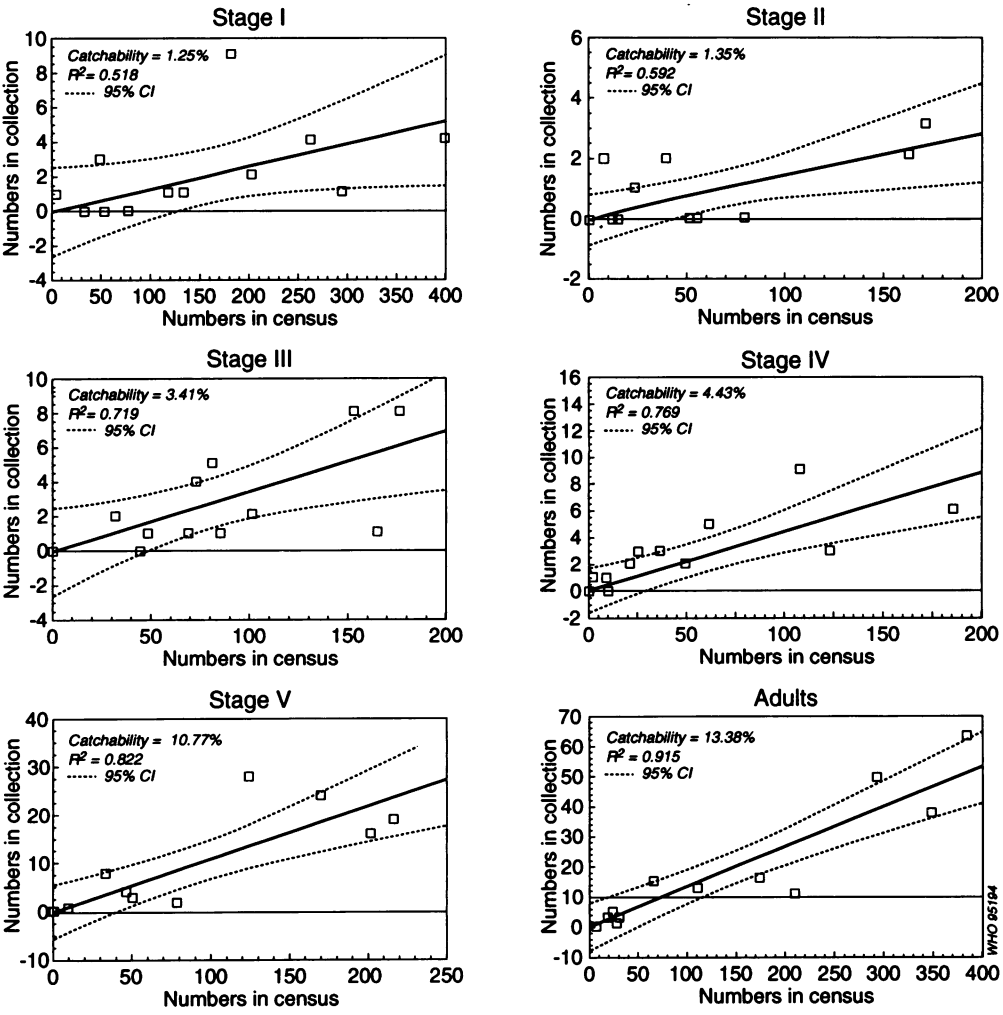
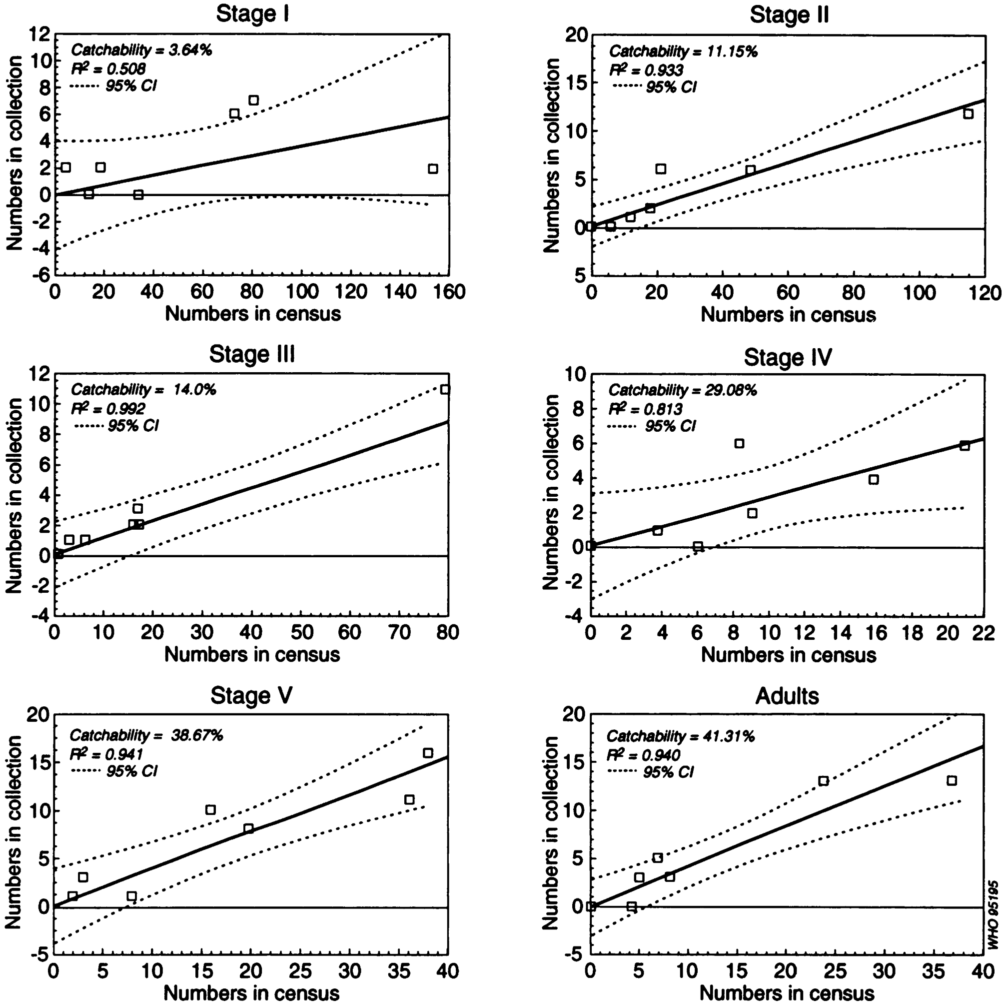


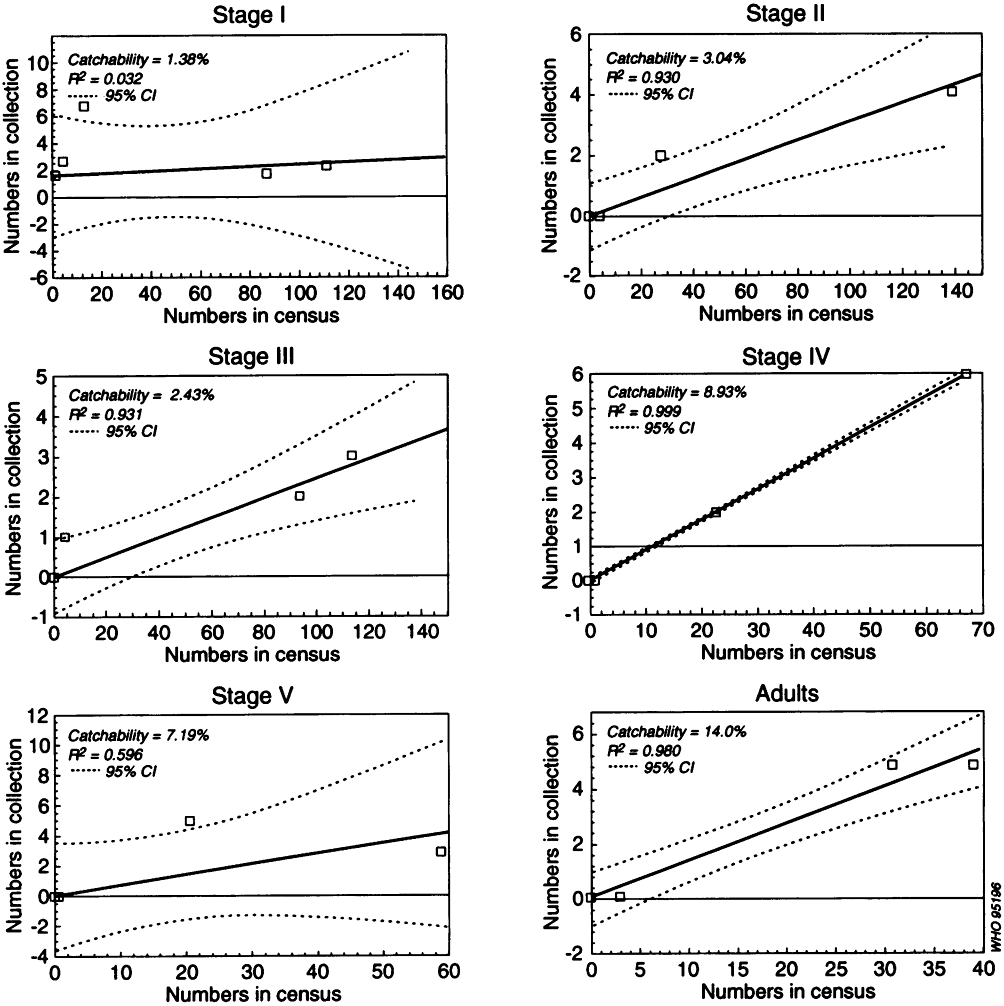
Fig. 4. **Linear regressions forced through the origin (solid lines) typical of mud walls, for all developmental stages of *Rhodnius prolixus*.** In all cases n = 7 houses and the field data are represented by open squares (one per house). Catchability is the slope of the regression in percent.



surprising because the observed points usually fell in the most linear segment of the power function. Also, we showed that the *a priori* probability of capture, i.e., catchability, is not related to the actual bug density in the house, a relationship implicit in nonlinear regressions between catch per unit effort and true density. We therefore consider that linear regression is more appropriate for our data.

Our linear regression model had errors that affected only the dependent variable (the collection of bugs); this could reduce the correlation and increase the standard error of the estimate but does not alter the slope of the regression line (*20*), i.e., our estimate of catchability. Since the regression constants for the ordinate intercept were not statistically significant, the linear regression forced through the origin is a satisfactory representation of our data because, in addition to its goodness of fit, it permits a straightforward interpretation of the slope as catchability. This approach was adopted although a minimum number of bugs at a given stage is probably necessary (a threshold value represented by the ordinate intercept in the linear regression) in order to collect them by hand.

Fig. 5. **Linear regressions forced through the origin (solid lines) typical of palm walls, for all developmental stages of *Rhodnius prolixus*.** In all cases *n* = 5 houses and the field data are represented by open squares (one per house). Catchability is the slope of the regression in percent.

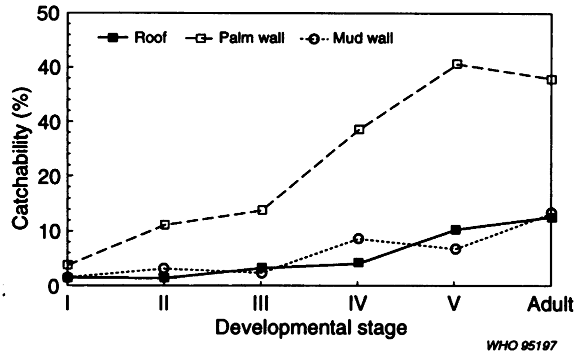


Using the linear regression forced through the origin, we demonstrate that, under the conditions of our study, catchability estimates are affected by development stage, house section, and house construction material.

Catchability escalates tenfold (from about 4% to about 40% on palm walls, and from about 1% to >10% on roofs and mud walls) as the size of the bugs increases. Because of the highly significant correlation between catchability and weight (as an indicator of size), and because there was no evident behavioural difference among stages, this effect probably responds to the higher visibility of the nymphal stages as they become larger. This conclusion is reinforced by the fact that all stages are pale brown, very similar to the mud walls and the palm leaves.

This trend of increasing catchability with stage appears to be independent of the house material, since roofs were made of palm leaves and had catchability values closer to those of mud walls than of palm walls. However, it cannot be concluded that catchability was completely independent of house material; the similar catchabilities of bugs collected

Fig. 6. **% Catchability for all developmental stages of *Rhodnius prolixus* according to house sector and materials.**

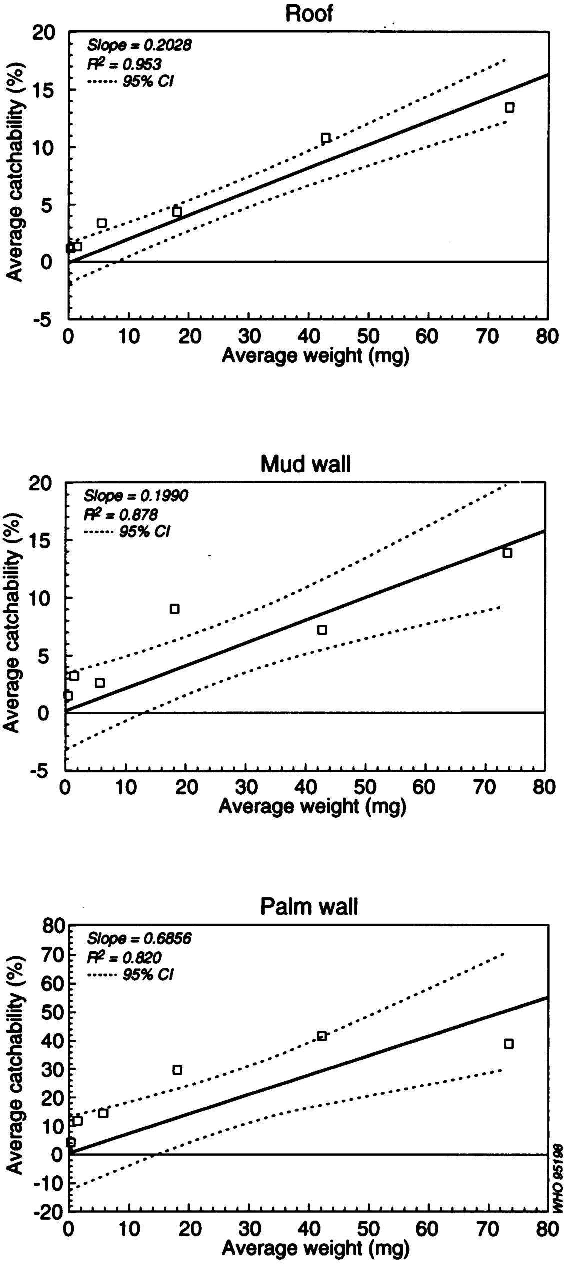


from mud walls and roofs might indicate that the roofs were more difficult to sample (collectors had to balance on a ladder) and that the bugs can hide more easily in the cracks of the mud walls.

The transposed linear regression forced through the origin can be used to estimate the actual number of bugs per house. However, its use should be restricted to a given house stratum and bug development stage and only be applied under situations analogous to our study, i.e., tropical rural houses similar in construction characteristics and infested with *R. prolixus*. This is reinforced by the fact that confidence intervals were relatively wide, e.g., for an observed collection of five adult bugs on palm walls, the transposed regression equation predicted a total adult population of 29.6 ± 17.1 bugs, i.e., the 95% confidence interval (CI) is 57.8% of the estimated density. In other cases, however, the CIs were relatively narrow: an observed collection of three stage V nymphs on palm walls predicted a total stage V population in that sector of 83.5 ± 13.2, i.e., the 95% CI is only 15.8% of the estimated density.

Our study shows clearly that the catchability of *R. prolixus* is affected by developmental stage, house section, and construction material; this relationship may hold also for other species of bugs. For example, Schofield has reported a similar bias towards large stages for hand collections of *T. infestans* (*9*). Although our numerical catchability values should not be extrapolated to other triatomine species, the functional relationship obtained and some of the factors that affect sampling efficiency may be generally applicable. Furthermore, if capture–mark–recapture samplings are used with triatomine species, our results reinforce Seber's suggestion that "if the catchability is constant between certain well-defined subgroups and there are sufficient recaptures from each subgroup, the numbers in each subgroup should be estimated separately" (*19*).

Fig. 7. **Linear regressions forced through the origin (solid lines) for average % catchability as a function of average weight for all developmental stages of *Rhodnius prolixus*.** Fit is shown for roof, mud walls, and palm walls separately. In all cases *n* = 6 houses (one observation per developmental stage; open squares). All regressions were statistically significant.



Résumé

Estimations de la densité de *Rhodnius prolixus* Stål (Hemiptera: Reduviidae), vecteur domestique de la maladie de Chagas, dans des habitations rurales au Venezuela

La capture manuelle en temps limité est une méthode couramment employée pour déterminer l'abondance relative des punaises domestiques, mais elle doit être étalonnée pour permettre la détermination de la densité absolue de ces insectes. Pour effectuer un tel étalonnage, une équipe de six personnes a capturé *Rhodnius prolixus* Stål sur les murs et le toit de 14 habitations rurales typiques en feuilles de palmiers à Cojedes (Venezuela). La capture durait 40 minutes par habitation. Le lendemain de cette collecte manuelle, les habitations ont été démolies et les punaises collectées, classées et dénombrées par stade de développement. Le nombre de punaises capturées en 4 hommes-heures (variable dépendante) et les nombres obtenus après démolition (variable indépendante) ont été analysés par régression linéaire et non linéaire. Ces deux méthodes donnaient un bon ajustement aux données réparties par stade (stade II à adultes) et par lieu de capture (toit/murs en palmes/murs en terre). Toutefois, en utilisant la méthode de capture de Leslie, nous avons montré que la probabilité de capture *a priori* n'est pas liée à la densité réelle des punaises dans l'habitation, relation qui apparaît dans la régression non linéaire. L'analyse par régression linéaire semblait donc plus adaptée à nos données. Comme l'ordonnée à l'origine des droites de régression linéaire n'était pas statistiquement significative, nous avons refait les calculs en passant par l'origine et interprété les pentes des droites comme mesure de la probabilité de capture. Pour les murs en palmes, cette probabilité augmentait avec le stade de développement des insectes (11,2%, 14%, 29,1%, 41,3% et 38,7% respectivement pour les stades II, III, IV, V et adultes), ce qui est vraisemblablement dû au fait qu'à mesure de leur développement, les punaises deviennent plus grosses et plus visibles. Ces pourcentages sont plus élevés que les valeurs correspondantes obtenues pour les toits (1,4%, 3,4%, 4,4%, 10,8% et 13,4% respectivement) et les murs en terre (3%, 2,4%, 8,9%, 7,2% et 14%). Les équations des droites de régression peuvent être utilisées pour convertir les chiffres de la collecte manuelle de *R. prolixus* en temps limité en estimations absolues de la densité de ces insectes pour chaque stade de développement et chaque secteur de l'habitation.

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Annex

Number of *Rhodnius prolixus* bugs collected by 4-man-hours of effort (C) and according to census during house demolition (D), by roof (R) and wall (W) stratum

		Triatomine developmental stage:											
		I		II		III		IV		V		Adults	
House	Stratum[a]	C	D	C	D	C	D	C	D	C	D	C	D
2	R	1	295	3	175	8	161	9	117	24	195	64	450
	W/P	2	156	12	127	2	18	4	20	3	11	11	47
3	R	2	202	0	55	1	86	3	29	4	51	15	82
	W/M	1	105	4	143	2	97	2	25	5	26	5	36
4	R	4	263	2	41	2	33	1	11	1	11	5	30
	W/P	2	20	6	27	1	7	1	5	3	8	1	3
5	R	0	31	0	0	0	1	1	4	0	1	3	23
	W/P	7	88	1	13	3	19	0	6	0	4	1	9
6	R	9	193	0	53	4	74	5	67	28	153	50	344
	W/P	0	34	2	20	2	19	2	11	13	37	16	54
7	R	4	405	2	166	8	183	6	191	16	220	38	388
	W/M	0	82	2	30	3	117	6	73	3	62	5	44
9	R	3	50	0	17	1	68	2	52	2	81	3	35
	W/M	2	7	0	4	1	5	0	1	0	1	0	3
12	R	1	116	1	24	5	86	2	24	8	42	13	125
	W/M	10	23	0	4	0	0	0	0	0	0	0	3
13	R	1	134	0	81	1	166	3	126	19	238	11	222
	W/P	6	78	6	55	11	90	6	27	13	50	8	28
14	R	1	6	0	0	0	1	0	1	0	0	0	8
	W/M	0	2	0	0	0	0	0	0	0	0	0	0
15	R	0	49	0	12	0	45	0	11	0	1	1	30
	W/P	0	14	0	6	0	1	0	0	0	0	3	6
16	R	0	75	2	12	1	47	3	40	3	54	16	191
	W/P	2	7	0	0	1	4	6	14	5	12	10	26

[a] W/P = palm walls; W/M = mud walls.