Detecting domestic vectors of Chagas disease: a comparative trial of six methods in north-west Argentina

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Six methods for detecting domestic infestations by triatomine bugs were compared in the rural community of Amamá, north-west Argentina. An average of three pairs (range, 2–5 pairs) of sensor boxes and sheets of pink typing-paper were tacked to the walls of human sleeping areas in 45 houses for 30 days and then inspected by a two-man team. Triatoma infestans *bugs were collected in bedrooms by a different two-man team aided by a flushing-out agent both before and after application of sensing devices. Finally, knockdown collections of bugs after application of one insecticide fumigant canister per bedroom were also made. The proportion of houses with evidence of current domestic bug infestations that were detected by the various methods were as follows: sensor boxes (95.3%), reports of householders (88.4%), knockdown (87.8%), paper-sheets (86.0%), and flushing-out (69.8–76.7%). The detectability of infestations, irrespective of the method used, increased with the density of the bugs. At low or intermediate bug densities, individual sensor boxes were more sensitive than their matched paper-sheets, but at any bug density there were no significant differences between the pooled results for all the boxes and for all the paper-sheets in the house. On average, each sensor box recorded 2.25 times more triatomine faecal smears than its matched paper-sheet, and this relation increased with the density of bugs in the house. Both sensing devices were effective at monitoring unsuccessful attempts of peridomestic triatomine populations to colonize houses.*

Introduction

Early detection of domestic infestations by triatomine bugs is an essential component of vector control campaigns. Evidence of domestic infestation can be sought using active or passive methods. Active methods involve the search for bugs by either house-dwellers (*1, 2*) or trained personnel who capture bugs during a fixed time period, generally using a "flushing-out" agent (*3, 4*). Passive methods involve use of sheets of paper (*5, 6*) or cardboard boxes, such as the Gómez–Núñez (*7*) or María boxes (*8*), which are fixed to bedroom walls for long periods. All such devices detect infestations through the characteristic faecal smears of triatomines, but the boxes may also detect exuviae, eggshells, or the bugs themselves.

Comparative field trials of the active and passive methods have yielded variable results to date, irrespective of the triatomine species being studied. While several studies have emphasized the higher sensitivity of Gómez–Núñez boxes over manual timed collections or flushing-out (*1, 7, 9, 10*), others have reported either the opposite (*4, 11, 12*) or almost no difference at all (*3*). In north-west Argentina sensor boxes have been found to be as sensitive as flushing-out and more sensitive than Gómez–Núñez boxes for detecting domestic infestations by *Triatoma infestans* (*8, 13*); however, in central Brazil, also for *T. infestans*, paper-sheets have been reported to be almost as sensitive as Gómez–Núñez boxes or flushing-out and are cheaper (*5, 14*).

Sensor boxes and paper-sheets appear to be the most sensitive and cost-effective methods of detecting domestic infestations of triatomines. However, no comparative field trial of their performance has previously been carried out, despite substantial differences in their cost and their extensive use in Argentina and Brazil. As part of a wider study on the transmission dynamics and control of Chagas disease, we compared the sensitivity of various methods for detecting domestic infestations by *T. infestans*, with particular emphasis on sensor boxes and paper-sheets.

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Materials and methods

Study area

The study was carried out in Amamá, Province of Santiago del Estero, Argentina (approximately 27°12' S, 63°02' W). The area is situated in a semi-arid plain dominated by xerophytic woods, with a mean annual rainfall of 600 mm, mainly between November and April, and a mean annual temperature of 21–22 °C (mean of the warmest month: 28.5 °C).

Amamá is a typical rural community with 48 inhabited mud-and-thatch houses that were sprayed with insecticides by official control services for the first time in 1985. Because no further control actions were undertaken, by 1989 a total of 70% of houses had become reinfested by *T. infestans*, the only bug species colonizing local homes (*15*).

Survey design and entomological methods

A comparative prospective study of matched pairs of sensor boxes and paper-sheets was carried out between February and April 1992. All houses were visited, and householders were informed about the objectives of the study, stating clearly that their house would be sprayed at the end of the study. Two houses were excluded because their residents were temporarily absent.

Household interviews. One person from each household, usually the mother, was asked about the current presence and apparent density (i.e., few or many) of triatomine bugs in the sleeping quarters; adult *T. infestans* were shown to the householders to confirm the identity of the bug species being reported. Householders were asked about their nightly sleeping places as well as those of their domestic animals.

Baseline evaluation. Before installing sensing devices, a two-person team spent 10 minutes searching all the human sleeping areas of each house for live *T. infestans* (1/3 man-hour of capture effort per house). The searches employed a flushing-out agent (0.2% solution of tetramethrin) and were terminated when one *T. infestans* bug had been sighted.

Sensing devices. Subsequently, an average of three matched pairs (range, 2–5 pairs) of sensor boxes and paper-sheets were placed in each house, depending on the number and size of bedrooms (usually 1–2 bedrooms, each of 20–40 m^2 area). The sensor boxes and paper-sheets were marked with their installation date, the house and the pair number, and nailed side-by-side to walls that had triatomine faecal streaks or where bugs had been caught. They were placed 1.7 m above the ground, either beside beds in the bedrooms or in gallery areas (where people and dogs slept from October to April). The sensor boxes (Biosensor, Biocientífica de Avanzada, Buenos Aires, Argentina) had a coloured picture on the front, corrugated pink paper inside and permanent entry holes at the bottom and both sides (*8*). The paper-sheets consisted of 33 cm × 22 cm rectangles of non-absorbent pink typing-paper. House-dwellers were told not to touch or move the boxes or paper-sheets, but were instructed to replace them if they fell down. All the boxes and paper-sheets were inspected for evidence of infestation 30 days after they had been installed and the number of faecal smears, eggs, bugs, and exuviae (the last two according to instar) was recorded.

Flushing-out collections. On the day after the sensing devices had been inspected, a two-person team from the National Chagas Disease Control Service spent 30 minutes collecting bugs in the human sleeping areas of each house using a flushing-out procedure (1 man-hour per house). The team was not the same as that used for the baseline evaluation and the members were not aware of the latter results. During the initial 5 minutes, bugs were collected separately from beds and household goods. Subsequently, the walls and the roof were systematically and repeatedly sprayed with 0.2% tetramethrin solution and the bugs that emerged were collected in separate plastic vials over the next 25 minutes. All peridomestic areas, such as kitchens, storerooms and goat pens, were similarly searched for 10 minutes for bugs. Bugs collected from the different sampling locations and strata were stored separately in labelled plastic bags containing a folded piece of filter-paper and were classified by instar at the field laboratory.

Knockdown collections. About 5 days after the flushing-out collections, each bedroom was fumigated with a canister containing dichlorvos, deltamethrin, and cypermethrin (Aguvac®), aiming at the complete collection of bugs by knockdown. The procedures employed were improvements on previously published methods (*16*). Briefly, householders removed the furniture from their houses, sealed the eaves with cloth or mud to reduce ventilation, and shut the openings; the floors were then entirely covered with plastic lining to facilitate collection of the bugs. A team of two people collected all knocked-down bugs 2–3 hours after fumigation and processed them as before. Three houses were not treated because the owners refused permission, and one house was excluded from the analysis because it had been sprayed with insecticides during the trial. All houses were treated with deltamethrin in October 1992.

For flushing-out and knockdown, the terms "infested" and "positive" were taken to mean finding

live or moribund *T. infestans*; for sensor boxes these terms were taken to mean any type of evidence of infestation (i.e., triatomine faecal smears, eggs, exuviae or *T. infestans* bugs); and for paper-sheets, finding triatomine faecal smears.

Statistical analysis

Because of the paired nature of the study design, the analyses were carried out using 2 × 2 contingency tables at the level of individual pairs of sampling methods or of vigilance devices within the house. Making the assumption that different observations from the same house using a given sampling method or sensing device were completely independent, we evaluated the significance of the observed differences using the binomial test (two-tailed, assuming $P = 0.5$ for each method), if the number of pairs with discordant results was ≤25, or McNemar's χ^2 test (corrected for continuity with one degree of freedom) if the number of discordant pairs was >25 (*17*). In addition, we considered the case that all the observations made within the house using a given sensing device were perfectly dependent (*18*). Using this highly conservative approach (J.E. Cohen, personal communication, 1993), we evaluated the significance of McNemar's χ^2 test taking the number of degrees of freedom to be equal to the number of distinct houses.

The densities of triatomine faecal smears (x) recorded using the matched pairs of sensor boxes and paper-sheets were transformed to $\log(x + 1)$ to normalize the distribution.

Results

The proportion of houses infested by *T. infestans* lay in the range 66.7–73.3%, as determined by both types of flushing-out, to 91.1%, as assessed by sensor boxes (Table 1). All the methods combined detected domestic infestations in 43 (95.6%) of the 45 study houses; established *T. infestans* colonies with nymphs were observed in 36 (80%) houses. Also, *T. infestans* were collected in the peridomestic areas of 24 (53.3%) houses. Among houses with any evidence of current infestation, sensitivity increased from 69.8–76.7%, for both types of flushing-out, to 95.3%, for sensor boxes. When houses were defined as infested through finding live or moribund *T. infestans* by any method, the sensitivity estimates were similar to those based on finding any evidence of infestation (see footnote *a*, Table 1).

Table 2 shows the paired results of infestations determined by each sampling method, relative to the standard flushing-out procedure with 1 man-hour of capture effort per house. Only sensor boxes detected a significantly greater number of infested houses than the standard flushing-out method. Although the latter method was more sensitive than the 10-minute flushing-out search, the standard method also failed to identify some low-density infestations that were detected by the 10-minute search. Among houses that were negative in the standard flushing-out procedure but positive in passive methods, bugs were collected from bedrooms or peridomestic structures in almost all cases (see footnotes *c* and *d*, Table 2).

Evidence of persistent infestation was identified in 36 of the 39 houses where bugs were collected, through finding live bugs before and after exposure (in 29 houses) or third-instar or larger nymphs at the end of exposure (in 7 houses, data not shown). This last-mentioned finding is indicative of a previous infestation that was undetected by flushing-out (1/3 man-hour) because third-instar or larger nymphs take significantly longer than 1 month to develop from eggs. In addition, one house that was negative at the beginning of the study became infested (as shown by the presence of a few adult bugs at the end of the exposure period), and one house that was positive at the start was negative both by flushing-out and knockdown at the end. Both these houses (positive by sensor boxes and paper-sheets) were included under the density category of 1–20 bugs in Tables 3 and 4. In total, 38 of the houses could be considered to have been persistently infested during the study.

Table 1: **Prevalence of domestic infestations by *Triatoma infestans* in the study houses and the sensitivity of six detection methods, Amamá, Argentina, 1992**

Detection procedure	% of houses infested	Sensitivity (%)[a]
Active methods		
Flushing-out (1/3 man-hour)	66.7 (30/45)[b]	69.8
Flushing-out (1 man-hour)	73.3 (33/45)	76.7
Knockdown	83.7 (36/43)[c]	87.8
Passive methods		
Paper-sheets	84.4 (38/45)	86.0
Reports from householders	86.7 (39/45)	88.4
Sensor boxes	91.1 (41/45)	95.3
All methods combined	95.6 (43/45)	100

[a] Calculated for 43 houses that were classified as infested, based on finding any evidence of infestation, except for knockdown, which was calculated for 41 houses. For 39 houses defined as infested because live *T. infestans* were found by any method, the sensitivities were as follows: flushing-out (1/3 man-hour), 74.4%; flushing-out (1 man-hour), 84.6%; paper-sheets, 87.2%; reports of householders, 89.7%; knockdown, 94.7% (38 houses); and sensor boxes, 94.9%.

[b] Figures in parentheses are No. of infested houses/No. tested.

[c] Houses No. 14 and No. 34, which were not tested by knockdown, are included in the other categories.

Table 2: **Comparison of the detection of domestic infestations by *Triatoma infestans* in houses (n = 45; for knockdown, n = 43) by various alternative methods relative to the standard flushing-out method,[a] Amamá, Argentina, 1992**

Alternative method	No. positive: By both methods[b]	Only by standard method	Only by alternative method	No. negative by both methods	Binomial test
Flushing-out (1/3 man-hour)	27	6	3	9	P >0.05
Knockdown	32	0	4	7	P = 0.125
Paper-sheets	31	2	7[c]	5	P = 0.180
Householders' reports	32	1	7[d]	5	P = 0.070
Sensor boxes	32	1	9[c]	3	P = 0.022

[a] 1 man-hour of capture effort per house.
[b] Here, positive means the following: for sensor boxes — any type of evidence of infestation (faecal smears, eggs, exuviae or bugs); and for paper-sheets — finding faecal smears.
[c] Bugs were found in the bedrooms or peridomestic sites of all these houses.
[d] Bugs were found in the bedrooms or peridomestic sites of all these houses except one.

The data in Table 3 show that the detectability of infestations by each sampling method increased with the density of *T. infestans* in human sleeping places. While among the most infested houses (≥100 bugs) all methods worked well, for those with low-density infestations (1–20 bugs) flushing-out (both types) was the least sensitive of the methods employed. In addition, among the seven houses where flushing-out or knockdown failed to collect bugs in bedrooms, sensor boxes and paper-sheets revealed infestations in five and four of them, respectively; five of these seven houses had peridomestic colonies of *T. infestans*.

We studied the relation between householders' reports of bug infestations and whether active or passive methods whether found any evidence for current infestations (data not shown). Five of the six houses considered to be negative by their occupants were found to have low-density infestations. With one exception, houses that were reported by their occupants to be infested were found to be so also by the active or passive methods. Thus, the predictive value of a negative report was 16.7% (1/6) and that of a positive report, 97.4% (38/39).

Table 4 shows the paired results obtained with sensor boxes and paper-sheets, according to the domiciliary density of *T. infestans*. Three paper-sheets were lost during the study, and in these instances data for the paired sets of devices involved were excluded from the analyses. In addition, in several houses the action of silverfish reduced the surface area of the paper-sheets by 20–30%. Sensor boxes were consistently more sensitive than paper-sheets at all bug densities, even when the criterion of positivity for sensor boxes relied only on faecal smears (see footnote *d*, Table 4). Differences were statistically significant only for houses with low (1–20) or intermediate (21–99) bug densities, when

Table 3: **Detection of domestic infestations of *Triatoma infestans*, by flushing-out, knockdown, sensor boxes, paper-sheets, and the reports of householders, according to the density of bugs in bedrooms, Amamá, Argentina, 1992**

Density of bugs[a]	No. of houses	% of houses infested by: Flushing-out: (1/3 man-hour)	Flushing-out: (1 man-hour)	Knockdown	Paper-sheets	Householder's reports	Sensor boxes
0	7	0	0	0[b]	57	57	71
1–20	14	57	64	92[c]	71	86	86
21–99	10	80	100	100	90	90	100
100–644	14	100	100	100	100	100	100
Total	45	67	73	84[d]	84	87	91

[a] Expressed as the total number of bugs collected by flushing-out (1 man-hour) plus knockdown at the end of the exposure period. Two houses not tested by knockdown are included in the 0 and 1–20 bug categories.
[b] % calculated over 6 houses.
[c] % calculated over 13 houses.
[d] % calculated over 43 houses.

Table 4: **Detection of domestic infestations by *Triatoma infestans*, using matched pairs of sensor boxes and paper-sheets, according to the density of *T. infestans* in bedrooms, Amamá, Argentina, 1992**[a]

Density of bugs	No. of houses	No. positive:[b] Both methods	Only boxes	Only paper-sheets	Negative by both methods	Binomial test
0[c]	7	4[d]	7	1	9	$P = 0.070$
1–20	14	17	12	3	9	$P = 0.036$
21–99	10	13	14[d]	2	1	$P = 0.004$
100–644	14	34	3	0	0	$P = 0.250$
Total	45	68	36	6	19	$P < 0.001$[e]

[a] Data are for 2–5 matched pairs exposed for 30 days.
[b] Positive was defined as follows: for sensor boxes — any type of evidence of infestation (faecal smears, eggs, exuviae or bugs); for paper-sheets — finding faecal smears.
[c] Expressed as the total number of bugs collected by flushing-out (1 man-hour) plus knockdown at the end of the exposure period. The two houses not tested by knockdown are included in the 0 and 1–20 bug densities categories.
[d] One reversion from positive to negative by sensor boxes occurred if only faecal smears were considered to be diagnostic.
[e] McNemar's test, one degree of freedom, χ^2 test = 20.02.

repeated observations within the same house were assumed to be independent. In contrast, if the observations were dependent, there were no significant differences at these bug density levels ($P > 0.2$). In addition, the pooled results obtained with all the paper-sheets in the house compared with those with any one or all the sensor boxes revealed no significant differences at any level of bug density (data not shown).

Fig. 1 shows that the densities of triatomine faecal smears recorded by the matched pairs of sensor boxes and paper-sheets were significantly correlated ($r = 0.659$, $n = 129$, $P < 0.0001$).

The log-transformed ratios of the density of smears in sensor boxes to those on paper-sheets was taken as a measure of the relative sampling efficiency of the two methods (*19*). The mean log ratio was 0.3529 (SE = 0.03869); the antilog is the geometric mean ratio, 2.25 (95% confidence interval: 1.89–2.68). Thus, on average, the sensor boxes recorded 2.25 times more smears than the matched paper-sheets. This relation was significantly correlated with total bug density ($r = 0.404$, $n = 129$, $P < 0.01$), indicating an increase in the relative efficiency of sensor boxes the more bugs there were in the house.

Table 5 shows the paired results of the various types of evidence of bug infestation for the sensor boxes. Triatomine faecal smears were the most frequently found (in 79.1% of boxes), followed by the presence of bugs (40.3%; 130 bugs in total), and nymphal exuviae (13.2%); triatomine eggs (1.6%) were rarely collected. Nearly all the boxes that were positive for bugs or exuviae also contained faecal smears. Other insects found in the boxes included silverfish (sometimes in large numbers) and spiders; however, there were no cockroaches or their egg cases.

Fig. 1. **Linear regression of the densities of triatomine faecal smears recorded by matched pairs of sensor boxes (x) and paper-sheets (y) after 30 days of exposure in bedrooms of the study houses, Amamá, Argentina, 1992** (log-transformed data + 1); $y = 0.0356 + 0.4756x$; SE of intercept = 0.04531; SE of slope = 0.04814; $r = 0.659$; $n = 129$; $P < 0.0001$.

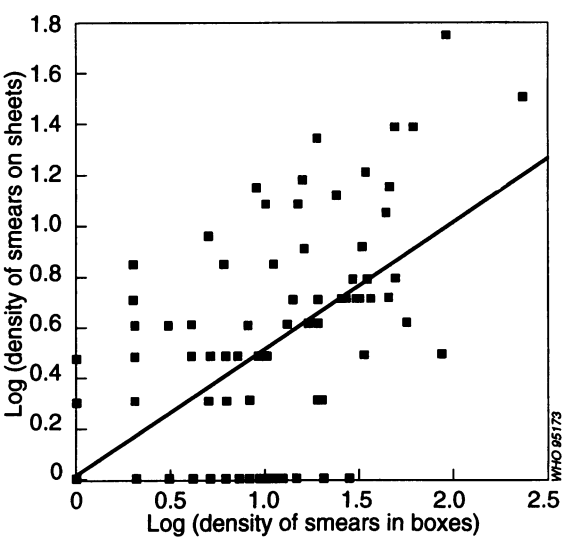

Table 5: **Concurrent detection of different types of evidence of domestic infestation by *Triatoma infestans* in sensor boxes, Amamá, Argentina, 1992**

	Bugs:		Exuviae:		
Faecal smears	No. positive	No. negative	No. positive	No. negative	Total
No. positive	50	52	17	85	102 (79.1)[a]
No. negative	2	25	0	27	27
Total	52 (40.3)	77[b]	17 (13.2)	112[c]	129

[a] Figures in parentheses are percentages
[b] McNemar's test, one degree of freedom, χ^2 test = 46.0, P <0.001.
[c] McNemar's test, one degree of freedom, χ^2 test = 83.01, P <0.001.

Discussion

Study design

We believe that the present study is the first to compare prospectively several methods for detecting domestic triatomines in a community-wide setting. In the only other similar study (*14*), bug densities were not assessed and the data were not paired for analysis. Our study design enabled us to perform the following: identify houses with a defined domestic infestation during the study; cross-check the outcome of each method against the others; and assess the presence and density of bugs in a house, as measured by an improved knockdown collection method.

Calculation of the sensitivities of the methods used in the study requires accurate determination of whether or not a house is infested. Because no one sampling method is 100% effective in detecting domestic bug infestations (*3, 4, 14, 16*), multiple procedures are indicated. In addition, under the two criteria employed for defining the bug-infested houses (finding any evidence of current bug infestation or of live or moribund *T. infestans*), the sensitivity estimates were similar in every case.

The main findings

When the densities of bugs in houses were low our results show that the sensor boxes and paper-sheets were more sensitive than time-limited manual searches by flushing-out. Although the study community had high bug densities, flushing out failed to detect 23–30% of the infestations. Sensor boxes and 1 man-hour of flushing-out have previously been found to have similar sensitivities before (*8*) or after application of insecticides (*13*), but our results showed that there were significant differences between the two methods. These previous studies (*8, 13*) were made in the same region as our investigation, but were not carried out at the same time of the year and encountered different densities of bugs, and this could explain the discrepancies observed. Also it is of importance that the paper-sheets were slightly more sensitive than the flushing-out procedure, as has previously been observed in Brazil (*5, 14*).

Both sensor boxes and paper-sheets gave positive results in houses with bedrooms found to be negative by flushing-out and knockdown but whose peridomestic areas were infested with bugs. This suggests that the sensing devices might be monitoring the unsuccessful attempts of peridomestic *T. infestans* or other sylvatic triatomine populations to invade houses. Although in the study area, sylvatic triatomines such as *T. sordida* and *T. guasayana* are frequently captured near and sometimes in sleeping quarters, flushing-out and knockdown collections show that they do not colonize bedrooms in the presence or absence of *T. infestans* (*15*).

Individually, the sensor boxes were more sensitive than the paired paper-sheets in recording evidence of infestation, even when both devices were compared only on the basis of faecal smears. The increased sensitivity of the boxes could be due to their greater surface area and because they provide a refuge for the bugs. Also, the labyrinthine structure of the sensor boxes might prolong the time bugs spend inside them, thus increasing the chance that any sign of infestation is left by an individual bug (D. Salomón, personal communication, 1993). In contrast, the paper-sheets probably detect triatomine excrement produced by different bugs on their route back to their refuges. Both devices had similar sensitivities when the pooled result for the 2–5 sensor boxes per house was compared with that for all the paper-sheets, which suggests that the sensitivity of the sheets could be increased by using more per house.

The commonest evidence of bug infestation in sensor boxes was triatomine faecal smears. Although these can be confused with those of cockroaches (*1*), ticks or bedbugs, in most cases a reliable differentiation would be possible (*20*). Moreover, in our study area neither bedbugs nor ticks were observed during repeated searches for domestic *T. infestans*, and

cockroaches were rare in bedrooms, as shown by the flushing-out and knockdown collections. Therefore, the likelihood of "false-positive" faecal smears caused by other insects was probably too low to be of significance.

The knockdown procedures that we have described previously (*16*) were improved in the present study through the use of stronger knockdown agents and plastic sheets on the floor to permit complete recovery of the fallen bugs. The higher sensitivity of knockdown over the 1 man-hour flushing-out procedure that we observed in the present study, which contrasts with our previous results, could have arisen because of the improved technique. Several advantages of knockdown over flushing-out (*16*) make the former the first choice if either large collections of bugs or a more accurate point assessment of bug presence is needed, especially after insecticide applications.

Householders' reports of domestic infestations are unreliable when the densities of bugs in bedrooms are low.[a] In agreement with this, our study found that householders' denials of infestations had poor predictive value but that of positive statements was excellent. This suggests that properly designed and executed interviews of householders might be used for the rapid assessment of the prevalence of domestic infestations of bugs in untreated communities, although little reliance can be placed on such interviews after insecticide spraying.

The selection of an appropriate device for the large-scale monitoring of domestic infestations of bugs must be based on a cost-effectiveness analysis, which includes the social acceptability of the proposed tool. Such an approach usually favours passive methods over flushing-out (*5, 8, 13*). In our study, sensor boxes were individually more sensitive than paper-sheets but were also more costly (US$ 2 per box versus US$ 0.01 per paper-sheet). Another disadvantage of sensor boxes, as with Gómez–Núñez boxes (*12*), is the expense and labour required to mount and inspect them, but these aspects can be tackled through community participation (*13*). The durability of each vigilance device must also be taken into consideration because vector surveillance is a long-term procedure. We used sensor boxes effectively for 2 years after insecticide applications (*15*), but in our experience paper-sheets are frequently lost and would not last for such long periods, thus decreasing their effectiveness.

The results we obtained in houses with low densities of bugs could be taken to approximate to post-spraying conditions, when bug reinfestations occur. Our study shows that at this stage, sensor boxes are individually more sensitive and durable than paper-sheets, although costlier, and that both are to be preferred to flushing-out as low-cost methods for monitoring house reinfestation at the district level.

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Résumé

Détection des vecteurs domestiques de la maladie de Chagas

Six méthodes de détection des infestations domestiques par des triatomes ont été comparées dans la communauté rurale d'Amamá, dans le nord-ouest de l'Argentine. En moyenne, 3 paires (intervalle 2–5 paires) consistant en une boîte détectrice et une feuille de papier machine rose ont été posées sur les murs des chambres à coucher de 45 habitations pendant 30 jours, puis inspectées par deux personnes à la recherche d'infestations par *Triatoma infestans*. Les punaises ont été capturées par une autre équipe de deux personnes au moyen d'un agent répulsif utilisé comme débusquant (tétraméthrine 0,2%) immédiatement avant (1/3 homme-heure) et après (1 homme-heure) la période d'exposition. Enfin, des collectes de punaises ont été réalisées après immobilisation (*knock-down*) au moyen d'une cartouche fumigante d'insecticide par chambre.

Les boîtes ont permis de détecter 95,3% des habitations présentant des signes d'infestation actuelle par des punaises; elles étaient suivies, dans l'ordre d'efficacité, par les indications des

[a] **Chuit R.** [*Epidemiology of Chagas disease in rural areas of Argentina*]. Doctoral thesis, Universidad Nacional de Córdoba, 1989 (in Spanish).

habitants (88,4%), la collecte après immobilisation (87,8%), les feuilles de papier (86,0%) et les deux types de débusquage (69,8–76,7%). Quelle que soit la méthode, les infestations étaient d'autant mieux détectées que la densité de punaises dans l'habitation était élevée. Individuellement, les boîtes étaient plus sensibles que les feuilles de papier appariées lorsque la densité de punaises était faible ou moyenne mais, quelle que soit la densité de punaises, il n'y avait pas de différence significative entre les résultats groupés de l'ensemble des boîtes et de l'ensemble des feuilles à l'intérieur d'une même habitation. La présence d'excréments de triatomes était le signe le plus fréquent d'infestation dans les boîtes. En moyenne, chaque boîte enregistrait 2,25 fois plus de traces d'excréments que la feuille de papier appariée, relation qui augmentait avec la densité de punaises dans l'habitation. Les deux types de systèmes de détection ont semblé efficaces pour contrôler l'invasion de triatomes péridomestiques qui ne réunissaient pas à coloniser l'habitation.

Les résultats obtenus dans les habitations à faible densité de punaises peuvent être extrapolés aux conditions régnant après pulvérisation d'insecticide, lorsque les réinfestations se produisent. Notre étude montre que les boîtes détectrices sont plus sensibles et plus durables que les feuilles de papier, bien que plus coûteuses, et que ces deux systèmes sont préférables au débusquage comme méthode à faible coût de surveillance au niveau du district de la réinfestation des habitations par les punaises.

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