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Dispersing behaviour of T.infestans: evidence from a genetical study of field populations in Bolivia.

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INTRODUCTION

Little is known about the dispersive ability of Triatoma infestans in an infested locality. This feature of the insect is important to consider in control strategy (13). Laboratory estimates indicate that flight over distances of from one to several km would be possible (7). However, it has not been possible to demonstrate it by direct field observation, where only 100 to 200 meters were scored (6,8). This physiological trait of the insect is likely to depend on various factors like external temperature (10) and nutritional status - the latter depending on the bug density relative to available hosts - (9). Blood meals identification from Argentine T.infestans shows that "movement of T.infestans between domestic and peridomestic structures is apparently minimal" (16). Does this bug spend all its lifetime in the same house, or in the same suburb ? Tibayrenc failed to demonstrate a founder effect for Trypanosoma cruzi zymodemes in the house or in the suburb when collected from vector population in Hardy-Weinberg equilibrium (15). This observation led him to suppose that "the migration of triatomine bugs from house to house is important". We propose here to use isoenzyme data of the insect in order to improve our knowledge about its dispersing behaviour during its lifespan.

MATERIAL and METHOD

Electrophoretic techniques and methods were described previously (2). Our main data are the allelic frequencies at three or four loci (the remaining loci are monomorphic) for several local populations of T.infestans from Bolivia and Peru (3). Geographical origin of bugs is classified into areas and localities (or villages). " Area ", or " region ", is defined here as a " group of localities" (see Table Comments, *). Twelve areas were compared. In Bolivia, the study areas are separated by a mean distance of 294 km, the minimum distance being 75 km between Sucre and Potosi, the maximum 645 km between the Yungas and

Tupisa. These areas show great differences in altitude, going from 800 (Camiri) to near 4,000 meters (Potosi). The local origin of the few bugs collected in the area of Potosi is unknown. Excepted for this exception, all the bugs collected were recorded according to house, suburb and village; they were also analysed for presence of parasite and if positive, the zymodeme was identified (15). In Peru, the bugs were collected in the Arequipa province (1). Four out of the study areas are subdivided into villages or localities. The distance separating them varies from 5 to more or less 20 km. In the Yungas, San Felipe, Oxomani and Coripata are very isolated villages separated by mountains.

In Cochabamba several samples were collected in both domestic and sylvatic cycles (3). In Tupisa we made a distinction between two northern villages and two southern ones, separated by more or less 10 km, because there is a geographical barrier between these two groups (15). In Vallegrande (11), Candelaria is a small group of houses each one very far from the other (200 m, sometimes with a hill making obstacle). Its nearby locality, Moro Moro, is a relatively large village with houses very close to each other. El Bello-SG is in fact a group of two nearby large villages, with well separated houses (50 to 100 m).

RESULTS and DISCUSSION

Genetic control of the isoenzyme pattern and considerations about genetic variability of _T.infestans_ were discussed before (2,3,14). A supplementary locus for the alpha glycerophosphate dehydrogenase (aGDH) is now being suspected, called here aGDH-a (Dujardin _et al._, unpublished). In the population sample as a whole, there is a strong divergence from Hardy-Weinberg equilibrium , due to the lack of heterozygotes . This deficiency in heterozygotes may indicate that the population is subdivided, with random mating presumed to occur in the subpopulations only (Wahlund effect). Using the chi-square test whenever feasible, we generally did not find indeed any departure from Hardy-Weinberg equilibrium in the areas or in the localities. In order to test the hypothesis of a local Hardy-Weinberg law, we made some comparisons between two generations of _T.infestans_ in four areas or localities. Allelic frequencies were found to be constant over two generations (Table II). Further, in 1986 and lastly in 1987, we compared in the same locality allelic frequencies of the triatomine in one house versus the other houses: we were not able to detect any significant difference (Table III). Local Hardy-

Weinberg law means that the local population of T.infestans is panmictic, allowing to assume that this species moves in its locality during its life time.

Release-recapture field tests and blood meal identification give access to only a brief episode of the insect's life. In order to know how far T.infestans is moving in a locality, the analysis of its allelic frequencies appears to be more reliable than the former techniques because it concerns one generation of these insect, say 6 months. Gene frequencies however do not allow to say that this behaviour is frequent: only a few migrants per generation could be sufficient to maintain the local genetic structure. More interesting would be the identification of the critical distance that interrupts this gene flow. A comparison between localities or group of localities separated by more than 5 km generally showed significant differences in allelic frequency for one or more locus (Table IV). Between northern and southern part of Tupisa, there is also a clear-cut difference in the zymodemes frequencies of T.cruzi (15). This parasite difference could be the consequence of the probably reduced vector circulation between the same localities (Table IV). It may be worth noting that physical and genetic (12) distances are significantly correlated: the more distant the areas, the more different the genetic structure. This situation could picture the so called "neighbourhood" or "isolation by distance" model, a dispersive process of gene frequencies based on random drift and migration (5). However, not all the loci fit within a neutral model: there might also be a selective factor accounting at least for the 6PGDH allelic differences (Table V).

CONCLUSION

Despite its poor flying ability and the results of blood meal analysis, genetical data do not agree with a non-dispersive behaviour in each study locality. The dispersive behaviour of the insect has a consequence for the control strategy: the unit target for insecticide application can not be a part of a village, nor a village, but a group of villages close to each other. Dispersion of the insect seems to be a non negligible factor which could account for the microdistribution of T.cruzi zymodemes, as showed by the association of a strong parasite founder effect with a vector population disequilibrium.

TABLE I. Allelic frequency distribution in the total study area; confidence variation is given between brackets (aGDH-a is a phenotype proportion, not an allelic frequency).

*	PGM-1	6PGDH-1	aGDH-1	aGDH-2	aGDH-a
1a	.91(.04)	N	N	N	N
1b	.83(.05)	.36(.07)	0(0)	1(0)	.39(.08)
2	.41(.06)	.15(.04)	0(0)	1(0)	.44(.08)
3	.44(.03)	.14(.02)	0(0)	1(0)	0(0)
4	.90(.05)	.47(.08)	0(0)	1(0)	0(0)
5a	0(0)	0(0)	0(0)	1(0)	0(0)
5b	0(0)	0(0)	0(0)	1(0)	.64(.10)
5c	.06(.0)	.31(.0)	0(0)	1(0)	.35(.06)
6a	.17(.08)	.33(.10)	0(0)	1(0)	0(0)
6b	.07(.03)	.21(.05)	0(0)	1(0)	0(0)
6c	.28(.06)	.40(.07)	0(0)	1(0)	0(0)
6d	.22(.05)	.31(.06)	0(0)	1(0)	0(0)
7	.82(.06)	.58(.08)	0(0)	1(0)	0(0)
8a	.87(.04)	.52(.06)	0(0)	1(0)	0(0)
8b	.95(.03)	.64(.06)	0(0	1(0)	0(0)
9	.74(.04)	.22(.04)	0(0)	.92(.02)	0(0)
10	.73(.07)	.15(.08)	0(0)	.78(.06)	0(0)
11a	.87(.03)	.25(.04)	.09(.03)	.92(.03)	.02(.01)
11b	.87(.03)	.26(.04)	.05(.02)	.95(.02)	.01(.01)
11c	.97(.02)	.32(.05)	.03(.02)	.97(.02)	0(0)
11e	.93(.04)	.31(.07)	.05(.03)	.96(.03)	0(0)
12	.24(.05)	1(0)	0(0)	0(0)	0(0)

TABLE II. Level of significance of allelic frequency comparisons between two generations of T.infestans.

*	PGM-1	6PGDH-1	aGDH-2
1a and 1b	> .05	N	N
8a and 8b	> .05	> .05	/
11a and 11b	> .05	> .05	> .05
11d and 11e	/	> .05	/

TABLE III. Comparison of allelic frequencies between one house (H) and the rest of the village (V) at two different times in Moro Moro (P is the level of significance).

		PGM-1	6PGDH-1	aGDH-1
1986	H	33/34 (.97)	11/28 (.39)	0/30 (.00)
	V	97/114 (.85)	27/122 (.22)	10/98 (.10)
P		/	> .05	/
1987	H	77/90 (.86)	24/92 (.26)	6/90 (.07)
	V	38/44 (.86)	12/48 (.25)	2/44 (.05)
P		> .05	> .05	/

TABLE IV. Level of significance of allelic frequency comparisons between localities.

*	PGM-1	6PGDH-1	aGDH-2
5a, 5b and 5c **	/	/	/
6b and 6d+c ***	<.001	<.02	/
3a and 3b ****			
(a) and (b)	> .05	<.001	/
north and south (c)	> .05	<.02	/
11a,b and 11c	< .02	<.001	/
11a,b and 11d,e	= .05	> .05	= .05
11d,e and 11c	/	> .05	/

TABLE V. Correlation coefficient between allelic frequencies of *T.infestans* from Bolivia and some climatic parameters. (a)= maximum annual temperature variation (b)= mean relative humidity (c)= in mm/year. Underlined scores are significant values.

climatic parameters	PGM-1	6PGDH-1	aGDH-2
LATITUDE	+.329	-.830	-.014
LONGITUDE	-.849	+.184	-.005
ALTITUDE	-.252	-.527	-.407
MEAN TEMPERATURE	+.089	+.506	+.467
MIN. "	-.044	+.829	+.171
MAX. "	+.239	-.159	+.410
M.A.T.V. (a)	+.007	-.960	-.395
MEAN R.H. (b)	+.015	+.842	+.213
PRECIPITATIONS (c)	+.030	+.578	-.059

TABLE COMMENTS

N no information available; / theoretical effectives below 5; * 1a Camiri, 1980; 1b Camiri, 1981; 2 Tarija, 1981; 3a Tupisa North, 1981; 3b Tupisa South, 1981; 4 Comarapa, 1981; 5 Yungas, 1981; 5a San Felipe; 5b Oxomani; 5c Coripata; 6 Cochabamba; 6a San Miguel, 1982; 6b Maica, 1984; 6c Angostora, 1984; 6d wild focus, 1984; 7 Huaricana; 8a Chiwisiwi, 1981; 8b Chiwisiwi, 1982; 9 Sucre, 1981; 10 Potosi, 1983; 11 Vallegrande; 11a Moro Moro, 1986; 11b Moro Moro, 1987; 11c Candelaria, 1986; 11d El Bello.sg, 1986; 11e El Bello.sg, 1987; 12 Peru (Arequipa), 1983; ** See Table I, localities 5a,5b and 5c, which present each a particular isoenzymic pattern for aGDH-a phenotypes frequencies; *** for map and more comparisons, see (4); **** for map of Tupisa region see (15): (a) North: 48 bugs from Zona Bolivar and Villa Remedios (b) South: 47 bugs from Suycuchacra and Chacopampa (c) Allelic frequency in northern and southern sample of

T.infestans from which parasite stocks have been isolated in Tupisa (15).

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