

Short communication

Susceptibility to two pyrethroids in *Boophilus microplus*
(Acari: Ixodidae) populations of northwest Argentina
Preliminary results

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Abstract

Cattle are treated 6–12 times yearly to control *Boophilus microplus* ticks in the east zone of the Argentinean infested region, while 1–4 treatments are applied for tick control in the west zone. In the 1970s resistance to organo-phosphate acaricides was found in the east zone, but not in the west zone. However, a shift to synthetic pyrethroids (SP) was made through all infested regions. Currently, indications of resistance to SP in the east zone, but not in the west zone, are provoking a switch to formamidine acaricides. During 1998 a total of 147 *B. microplus* engorged females were collected from 20 beef cattle ranches from the west zone of the Argentinean infested region. Individual progenies of these ticks were tested ('larval packet test') with cypermethrin and deltamethrin, and their LC 50 and LC 90 were compared to those estimated for the Milagro susceptible strain. No evidence of resistance to these SP was found. Due to sampling restraints the results are presented as preliminary. Nevertheless, a shift away from use of SP for control of *B. microplus* in the west zone appears to be unjustified and should be independent of the resistance circumstances observed in the east zone of the Argentinean tick infested region. ©2000 Elsevier Science B.V. All rights reserved.

Keywords: *Boophilus microplus*; Cypermethrin; Deltamethrin; Susceptibility/resistance; Argentina; Cattle; Ixodidae

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1. Introduction

In northern Argentina 10 million cattle in an area of 60 million ha are infested with *Boophilus microplus* ticks (Guglielmone, 1992). In the eastern part of this region cattle are usually treated 6–12 times a year due to favourable environmental conditions for tick development. On the contrary, cattle are treated fewer times (1–4 a year) in the western part of the infested region due to less favourable conditions for *B. microplus* development (Späth et al., 1994). The latter is a mosaic of areas with high, intermediate, low and even totally unsatisfactory conditions for sustaining cattle tick populations (Guglielmone, 1992).

Chemical resistance in arthropod populations is closely related to the frequency of treatments (Sutherst and Comins, 1979; Kunz and Kemp, 1994). Therefore, *B. microplus* populations resistant to organo-phosphate (OP) acaricides developed in the east of the Argentinean infested region (Grillo Torrado and Gutiérrez, 1970; Grillo Torrado and Pérez Arrieta, 1977), while no signs of resistance were noted in tick populations from the west. However, a change from OP to synthetic pyrethroids (SP) acaricides was made through all the infested regions.

B. microplus resistance to SP has been reported in several American countries (Benavídes Ortiz, 1995; Fragoso Sánchez et al., 1995; Cardozo, 1996; Martins, 1996; Hagen, 1997), including resistance to cypermethrin in the east Argentinean tick infested region (Caracostantógolo et al., 1996). Here, farmers complained about the lack of efficacy of SP to control *B. microplus*, resulting in an incipient shift to formamidine acaricide compounds. In contrast, no complaints of SP reduced efficacy in tick control have been noted in the west of the infested region.

It is important to avoid an unnecessary switch to non-SP acaricides in the western part of the Argentinean tick infested region. *B. microplus* populations from this area were sampled to test their susceptibility to two SP. Although there were sampling restraints, preliminary results indicated no evidence of resistance to cypermethrin and deltamethrin in the tick populations tested.

2. Materials and methods

The Milagro susceptible strain was established by collecting *B. microplus* from cattle of a farm located in Manantial del Milagro (24°52'S, 65°33'W), province of Salta, Argentina, where no tick control measures are in place. Thirty engorged females, collected on December 1993 were allowed to oviposit individually in darkness at $27 \pm 1^\circ\text{C}$ and 83–86% relative humidity. The larvae (15–30 days old) were used to infest calves free of ticks under insectary conditions. This procedure has been repeated continuously during 4 years in the laboratory to maintain the Milagro strain free from any contact with acaricides. Two different generations of this strain were tested for susceptibility to several SP in independent bioassays. They were done with cyalothrin, flumethrin and cypermethrin at the Instituto de Pesquisas Veterinarias 'Desiderio Finamor', Eldorado do Sul, Brazil, and with cypermethrin and deltamethrin at the Laboratorio de Salud Animal, Instituto Nacional de Tecnología Agropecuaria, Salta, Argentina.

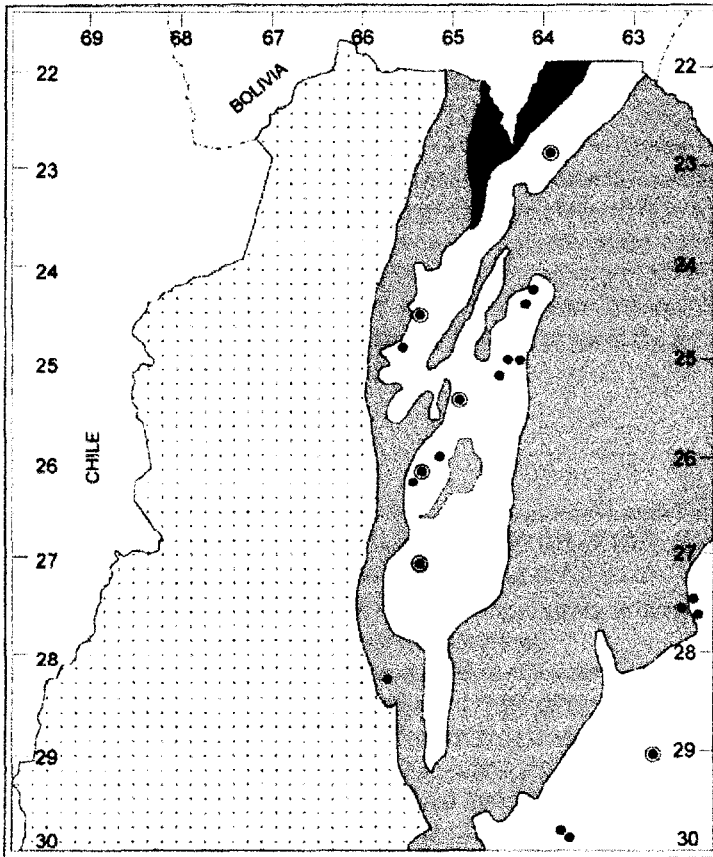


Fig. 1. Sampling sites in relation to prevalence of *Boophilus microplus* populations in northwest Argentina (partly after Guglielmo, 1992). ▨ Natural tick free area; ■ high prevalence; □ intermediate prevalence; ▩ low prevalence. ● Ticks tested only for cypermethrin resistance; ● Ticks tested for cypermethrin and deltamethrin resistance.

From January to June 1998 engorged females of *B. microplus* were obtained from 20 beef cattle ranches of north-western Argentina, 18 located in the intermediate area for tick development and prevalence and two located in the area of low prevalence for *B. microplus*. The geographical limits of tick collections were: 24°22' to 29°54'S and 62°25' to 65°42'W (Fig. 1). The female ticks were held individually to lay eggs under the above conditions and larvae (7–18 days old) were tested for susceptibility by using two duplicates of about 100 larvae each exposed for 24 h to filter papers impregnated with several concentrations of technical grade cypermethrin (96.2%) and deltamethrin (99.5%) obtained by serial dilution of 50% stock (Stone and Haydock, 1962). For this technique, commonly known as the 'larval packet test', we used the following concentrations of cypermethrin (w/v): 0% (controls, filter papers impregnated only with the diluent); 0.0062%; 0.0125%; 0.025%; 0.05%; 0.1%; 0.2% and deltamethrin (w/v): 0%; 0.0015%; 0.003%; 0.006%; 0.012%; 0.024%; 0.048%. All tests

where larvae mortality in the controls was higher than 10% were excluded from the analysis. All ticks were tested with cypermethrin and ticks from six properties were additionally tested with deltamethrin (details of origins of *B. microplus* ticks tested with cypermethrin or with cypermethrin and deltamethrin are presented in Fig. 1).

The analyses were carried out using the POLO-PC software to obtain the estimated concentrations necessary to kill 50% (LC 50) and 90% (LC 90) of the larvae derived from the dose-mortality responses obtained by probit analysis (Russell et al., 1977). A *B. microplus* progeny was considered statistically different from the reference strain when the fiducial limits (95%) did not overlap (Savin et al., 1977). Relative resistance (RR) factors were calculated as the quotient between LC 50 or LC 90 of the unknown individual progenies in relation to LC 50 or LC 90 estimates obtained for the Milagro strain at the Salta laboratory.

3. Results

The LC 50, LC 90 and fiducial limits of the Milagro strain tested with cypermethrin at the Salta laboratory were: 0.053 (0.050–0.057) and 0.112 (0.103–0.125), respectively. For deltamethrin these estimates were 0.012 (0.010–0.013) and 0.022 (0.019–0.026), respectively. The LC 50 estimate with cypermethrin for the Milagro strain at the Eldorado do Sul laboratory was 0.021 (J.R. Martins, personal communication).

A total of 147 engorged female ticks were collected (4–10 ticks per sampling site) and their progenies were tested individually. Twenty five (17%) of these tests were discarded from further analyses due to mortality in the controls higher than 10%. The highest RR for any tick was 1.2 for LC 50 and 1.0 for LC 90 of cypermethrin and deltamethrin. Furthermore, when statistical differences were found, they showed that LC 50 and LC 90 estimates for both pyrethroids were lower for the progenies of field *B. microplus* engorged ticks than for the reference strain.

4. Discussion

The LC 50 estimates of the Milagro strain obtained at the Salta laboratory were slightly higher than the LC 50 estimates of the Australian Yeerongpilly strain (0.037 and 0.004 for cypermethrin and deltamethrin, respectively) (Nolan et al., 1989). The LC 50 to cypermethrin for the Milagro strain at the Eldorado do Sul laboratory was lower than the same estimate for the Brazilian Porto Alegre susceptible strain (0.040) (J.R. Martins, personal communication). Therefore, the Milagro strain appears to be useful as a susceptible reference strain.

Although the total number of *B. microplus* engorged females collected in field was lower than expected, these preliminary results showed no evidence of resistance to cypermethrin and deltamethrin. Commonly, compounds with a shared target site are involved in the susceptibility/resistance status of an arthropod population. However, the Lamington strain of *B. microplus* from Australia was resistant to flumethrin (RR of 29.0), but not to cypermethrin or to deltamethrin (RR of 3.2 and 3.0, respectively) (Nolan et al., 1989). Notwithstanding,

this phenomenon appears to be uncommon since, to our knowledge, no other strain with a similar resistance profile has been found later in Australia or elsewhere.

Further studies are needed to safely conclude that resistance to SP is not present in *B. microplus* populations of the western infested zone of Argentina. Nevertheless, the lack of complaints about efficacy of SP for tick control, plus the susceptibility of all ticks actually tested to cypermethrin and deltamethrin are strong indications that *B. microplus* resistance to SP is not yet a problem in northwest Argentina. This appears to indicate, as expected, that the situation for cattle tick control with SP differs between the east and the west zones of the Argentinean infested region, probably as a result of an unequal treatment frequency. Therefore, there are no rational grounds to change to non-SP chemicals to control *B. microplus* within the area of the present study.

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References

- Benavides Ortiz, E., 1995. Resistencia de la garrapata *Boophilus microplus* a los acaricidas en Colombia. Un resumen de la situación actual. Mem. III Sem. Int. Parasitol. Anim. 'Resistencia y control en garrapatas y moscas de importancia veterinaria'. Acapulco, México, Octubre 1995, pp. 153–163.
- Caracostantógolo, J., Muñoz Cobeñas, M.E., Eddi, C., Ambrústolo, R.R., Bulman, G.M., Marangunich, L., 1996. Primera determinación en la República Argentina de una población de *Boophilus microplus* (Can.) resistente al piretroide sintético alfacipermetrina caracterizada mediante pruebas preliminares. Vet. Arg. 13, 575–582.
- Cardozo, H., 1996. Situación de la resistencia del *Boophilus microplus* en Uruguay. Medidas para controlarla. Veterinaria (Montevideo) 32, 15–18.
- Fragoso Sánchez, H., Soberanes Céspedes, N., Ortiz Estrada, M., Santamarina Vargas, M., Ortiz Nájera, A., 1995. Epidemiología de la resistencia a ixodicidas piretroides en garrapatas *Boophilus microplus* en la República Mexicana. Mem. III Sem. Int. Parasitol. Anim. 'Resistencia y control en garrapatas y moscas de importancia veterinaria'. Acapulco, México, Octubre 1995, pp. 45–57.
- Grillo Torrado, J.M., Gutiérrez, R.O., 1970. Fósforo-resistencia de una cepa argentina de garrapata *Boophilus microplus*. Su medición. Rev. Med. Vet. (Buenos Aires) 51, 3–12.
- Grillo Torrado, J.M., Pérez Arrieta, A., 1977. Nuevo tipo de fósforo-resistencia en la garrapata común del ganado bovino (*Boophilus microplus*) en la República Argentina. Rev. Med. Vet. (Buenos Aires) 58, 101–105.
- Guglielmo, A.A., 1992. The level of infestation with the vector of cattle babesiosis in Argentina. Mem. Inst. Oswaldo Cruz 87 (Suppl. 3), 133–137.
- Hagen, S., 1997. Akarizidresistenz der veterinärmedizinisch bedeutenden Zeckenspezies *Boophilus microplus* an ausgesuchten Standorten Zentralamerikas. Dissertation, Doctor Medicinae Veterinariae, Tierärztliche Hochschule, Hannover, 137 pp.
- Kunz, S.E., Kemp, D.H., 1994. Insecticides and acaricides: resistance and environmental impact. Rev. Sci. Tech. Off. Int. Epiz. 13, 1249–1286.
- Martins, J.R., 1996. Resistência a carrapaticidas no estado do Rio Grande do Sul: relato de situação. Veterinaria (Montevideo) 32, 12–14.

- Nolan, J., Wilson, J.T., Green, P.E., Bird, P., 1989. Synthetic pyrethroid resistance in field samples in the cattle tick (*Boophilus microplus*). *Aust. Vet. J.* 66, 179–182.
- Russell, R.M., Robertson, J.L., Savin, N.E., 1977. POLO: a new computer program for probit analysis. *Bull. Entomol. Soc. Am.* 23, 209–213.
- Savin, N.E., Robertson, J.L., Russell, R.M., 1977. A critical evaluation of bioassay in insecticide research: likelihood ratio tests of dose-mortality regression. *Bull. Entomol. Soc. Am.* 23, 257–266.
- Späth, E.J.A., Guglielmone, A.A., Signorini, A.R., Mangold, A.J., 1994. Estimación de las pérdidas económicas directas producidas por la garrapata *Boophilus microplus* y las enfermedades asociadas en la Argentina (4a. parte). *Therios* (Buenos Aires) 23, 524–538.
- Stone, B.F., Haydock, K.P., 1962. A method for measuring the acaricide susceptibility of the cattle tick, *Boophilus microplus* (Can.). *Bull. Entomol. Res.* 53, 563–578.
- Sutherst, R.W., Comins, H.N., 1979. The management of acaricide resistance in the cattle tick, *Boophilus microplus* (Canestrini) (Acari: Ixodidae), in Australia. *Bull. Entomol. Res.* 69, 519–537.