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PHENOTYPIC ANOMALIES IN A COLLECTION OF NEOTROPICAL TICKS (IXODIDAE)

by A. A. GUGLIELMONE 1, J. CASTELLA 2, A. J. MANGOLD 1, A. ESTRADA-PEÑA 3 and A. E. VIÑABAL 4

SUMMARY: A total of 62 (1%) ticks with phenotypic anomalies was found amongst 64,473 Ixodoidea collected from March 1976 to March 1997 in mainland Argentina (Neotropical). No anomalies were detected in the few individuals of the subfamilies Haemaphysalinae and Ixodinae collected. Thirty-eight (1.8%) of the 20,626 ticks of the subfamily Amblyomminae had anomalies, as did 24 (0.5%) of the 43,651 ticks of the subfamily Rhipicephalinae (P<0.001, χ²). Anomalies in Amblyomminae were more frequent in females than in males (P<0.001) or nymphs (P<0.01), while no statistical differences were found between the stages of Rhipicephalinae. In agreement with previous authors, gynandromorphism was more frequent in Amblyomminae (3 Amblyomma neumanni gynandromorphs) than in Rhipicephalinae (1 gynander of Boophilus microplus).

RESUME: Sur 64 473 Ixodoidea recoltes de mars 1976 a mars 1997 dans les regions continentales d'Argentine (Neotropical), 62 (1%) presentent des anomalies phenotypiques et aucune parmi les quelques d'individus appartenant aux Haemaphysalinae et Ixodinae. Trente-huit (1,8%) des 20 626 tiques de la sous-famille Amblyomminae presentent des anomalies, ainsi que 24 (0,5%) des 43 651 tiques de la sous-famille Rhipicephalinae (P<0,001, χ²). Les anomalies des Amblyomminae sont plus frequentes chez les femelles que chez les males (P<0,001) ou les nymphes (P<0,01). Il n'y a pas de differences significatives entre les stades des Rhipicephalinae. En accord avec les auteurs precedents, le gynandromorphisme est aussi plus frequents parmi les Amblyomminae (3 gynandromorphes d'Amblyomma neumanni) que parmi les Rhipicephalinae (1 gynandromorphe de Boophilus microplus).

RESUMEN: Se detectó un total de 62 (1%) garrapatas con anomalías fenotípicas entre 64 473 Ixodoidea coleccionadas entre marzo 1976 y marzo 1997 en el territorio continental argentino (Neotrópico). No se detectaron anomalías en los pocos individuos obtenidos de las subfamilias Haemaphysalinae e Ixodinae. Treinta y ocho (1.8%) de las 20 626 garrapatas de la subfamilia Amblyomminae presentaron anomalías y 24 (0.5%) de las 43 651 garrapatas de la subfamilia Rhipicephalinae mostraron igual condición (P<0,001, χ²). Las anomalías en Amblyomminae fueron más frecuentes en las hembras que en los machos (P<0,001) o las ninfas (P<0,01), mientras que no se detectaron diferencias estadísticas significativas entre los estadios de Rhipicephalinae. En concordancia con autores previos, el ginandromorfismo fue, aparentemente, también más frecuente en Amblyomminae (3 ginandromorfos de Amblyomma neumanni) que en Rhipicephalinae (1 ginandro de Boophilus microplus).

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INTRODUCTION

Reports of phenotypic anomalies in ticks are relatively frequent, especially for gynandromorphs (Viñabal et al., 1994). Several authors have stated that tick malformations occur at relative low frequencies in nature (Neumann, 1899; Warburton & Nuttall, 1909; Nuttall, 1914; Brumpt, 1934; Delfy, 1936; Sakla et al., 1980). Senevet (1922) found 0.7% of anomalous specimens from different species of the genus Hyalomma; Tovornik (1987) reported 0.2% of anomalous specimens from the subfamily Ixodinae and 1% from the subfamily Haemaphysalinae, while Cerny (1957) recorded 1.3% abnormal specimens in 15,000 ticks of the genera Ixodes, Dermacentor and Haemaphysalis. No previous accounts of tick anomalies based on extensive tick collection are available for Neotropical areas. In this article, we present the results of a study of anomalies in ixodid ticks, based on a 21 year collection period on the Argentinean mainland, which is located in toto in the Neotropical region. Information is also provided about abnormal ticks in the subfamilies of Ixodidae and in the different tick stages.

MATERIALS AND METHODS

The ticks were mainly collected during fieldwork on the ecology of cattle ticks in northern Argentina, and, to a lesser extent, those sent to us by collaborators in other Argentinean regions from March 1976 to March 1997. In addition, ticks were collected from other domestic hosts and small numbers from wild hosts. They are deposited in the tick collection of the Instituto Nacional de Tecnología Agropecuaria, Estación Experimental Agropecuaria Rafaela, Rafaela, Province of Santa Fe, Argentina. Because there are few collections of anomalous ticks, the specimens used in this study are available upon request to any scientist interested in carrying out further studies.

The ticks were identified using the keys and descriptions of Boero (1957), Jones et al. (1972), Keirans et al. (1985) and Guglielmone & Viñabal (1994). Subfamilies of Ixodidae follow Hoogstraal & Aeschlimann (1982). The malformations were classified as general and local anomalies, following Campana-Rouget (1959a, b) and Buczek (1995, 1997). General malformations included asymmetries (here defined as defects in the expected left-right bilateral disposition of apparently normal structures), changes in shape and gynandromorphs. Local anomalies were classified as structural abnormalities (fusion, lacking, supernumerary, protuberances), leg/coxa malformations and scars on the notum.

Chi-square tests were used to determine statistically significant (P<0.05) differences in the proportion of abnormal specimens in the subfamilies of Ixodidae. Additionally, the prevalence of external malformations in males, females, nymphs and larvae were evaluated. Expected values less than 1 were not considering in the statistical analysis.

RESULTS

A total of 20,626, 49, 147 and 43,651 ticks of the subfamilies Amblyomminae, Haemaphysalinae, Ixodinae and Rhipicephalinae were collected, respectively. No anomalies were detected in Haemaphysalis juxtakochi, the only representative of Haemaphysalinae collected, or in the two species of Ixodinae (Ixodes loricatus and Ixodes pararicinus) found during the study period. Therefore, further analyses were only carried out for the remaining subfamilies.

Sixty-two (1%) Amblyomminae and Rhipicephalinae showed anomalies: 1.8% (38 ticks) of the Amblyomminae and 0.5% (24 ticks) of Rhipicephalinae were anomalous ($\chi^2 = 20.77, P<0.001$). Thirty-nine ticks had general anomalies (63.0% of all abnormal ticks) and 23 (37.0% of all anomalous ticks) had local malformations.

The anomalies of Amblyomminae were found in Amblyomma cajennense (13 abnormal ticks from a total of 10,284 ticks), A. neumanni (17 abnormal ticks out of 7,434 ticks), A. parvum (6 out of 1,903 ticks), A. testudinis (1 out of 151) and A. tigrinum (1 of 483 ticks). Anomalous Rhipicephalinae were represented by Boophilus microplus (23 malformed ticks out of 42,642) and Rhipicephalus sanguineus group (1 out of 511 ticks). No abnormalities were found in the Rhipicephalinae (Anocentor nitens, 408 ticks) and the fol-
### Table 1: General and local anomalies in Ixodidae from Argentina.

* Normally 2 spurs in metatarsi II-IV in males and females of *A. neu111onni*.
** Normally 1 caudal appendage in *B. microp/us* males.
*** Only found in female ticks and may be related to traumatic lesions.

<table>
<thead>
<tr>
<th>GENERAL ANOMALIES</th>
<th>n</th>
<th>% of total</th>
<th>Number of affected specimens of each tick species (host in brackets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gynandromorphs</td>
<td>4</td>
<td>6</td>
<td>3 <em>A. neu111onni</em> (cattle), 1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>Asymmetries</td>
<td>19</td>
<td>31</td>
<td>4 <em>A. cajennense</em> (cattle), 3 <em>A. neu111onni</em> (cattle), 4 <em>A. parvum</em> (goat), 1 <em>A. tigrinum</em> (dog), 7 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>External outline</td>
<td>16</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Constriction</td>
<td>2</td>
<td>3</td>
<td>2 <em>A. cajennense</em> (cattle), 1 <em>A. parvum</em> (cattle)</td>
</tr>
<tr>
<td>Elongation</td>
<td>1</td>
<td>2</td>
<td>1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>Cleft in posterior border</td>
<td>3</td>
<td>3</td>
<td>3 <em>A. neu111onni</em> (cattle), 2 <em>A. cajennense</em> (cattle), 6 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>LOCAL ANOMALIES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fusion of structures</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Porose areas</td>
<td>1</td>
<td>5</td>
<td>1 <em>A. neu111onni</em> (unknown)</td>
</tr>
<tr>
<td>Paipi</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. neu111onni</em> (cattle)</td>
</tr>
<tr>
<td>Lack of structures</td>
<td>13</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>One leg</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. neu111onni</em> (cattle), 1 <em>A. cajennense</em> (horse), 1 <em>R. sanguineus</em> (dog),</td>
</tr>
<tr>
<td>Two legs</td>
<td>2</td>
<td>3</td>
<td>2 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>One spur in a coxa IV</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. neu111onni</em> (horse)</td>
</tr>
<tr>
<td>One porose area</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. parvum</em> (goat)</td>
</tr>
<tr>
<td>One spiracular plate</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. testudinis</em> (Chelomoides chilensis)</td>
</tr>
<tr>
<td>One adanal plate</td>
<td>1</td>
<td>1</td>
<td>1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>The anus</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. cajennense</em> (cattle)</td>
</tr>
<tr>
<td>The caudal appendage</td>
<td>1</td>
<td>1</td>
<td>1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>Supernumerary structure</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Three spurs on a metatarsi III**</td>
<td>1</td>
<td>1</td>
<td>1 <em>A. neu111onni</em> (human)</td>
</tr>
<tr>
<td>Two caudal appendages**</td>
<td>1</td>
<td>1</td>
<td>1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>Protuberance in posterior border</td>
<td>1</td>
<td>1</td>
<td>1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>Scars on notum***</td>
<td>5</td>
<td>8</td>
<td>2 <em>A. neu111onni</em> (1 cattle, 1 horse), 2 <em>A. cajennense</em> (cattle), 1 <em>B. microp/us</em> (cattle)</td>
</tr>
<tr>
<td>Malformation of legs and coxae</td>
<td>1</td>
<td>2</td>
<td>1 <em>A. neu111onni</em> (cattle)</td>
</tr>
</tbody>
</table>

Table 2: Anomalies (gynandromorphs excluded) in different stages of Amblyomminae and Rhipicephalinae from Argentina.

* Excluded from the analysis due to expected value less than 1.
** Proportion of anomalous females significantly different to males (P= 0.0007) and nymphs (P= 0.0082).
Following *Amblyomma* species: *A. auricularium* (27 ticks), *A. coelebs* (9 ticks), *A. cooperi* (14 ticks), *A. ovale* (8 ticks), *A. parvitarsum* (9 ticks), *A. pseudonconcolor* (31 ticks), *A. pseudoparvum* (267 ticks) and *A. rotundatum* (6 ticks).

Classification of the anomalies, including the tick species and the number showing a particular abnormality, are presented in Table 1. An analysis of the proportion of anomalous ticks (excluding gynandromorphs) of Amblyomminae and Rhipicephalinae, according to the stage, is presented in Table 2.

### Discussion

The frequency of abnormal ticks from field hosts found in this study was similar to those found by Sénévet (1922) and Cerny (1957), and in the Haemaphysaliniae studied by Tovornik (1987), but it is substantially higher than the frequency found by Tovornik (1987) in the subfamily Ixodinae. On the other hand, the frequency of abnormal ticks found in this study was lower than that observed by Latif et al. (1988b) after rearing *Amblyomma variegatum* on unusual hosts (rabbits) with resistance to this tick species. Under these conditions, Latif et al. (1988b) found 70% of males with abnormal pattern of scutal ornamentation and 4-8% small adults. Warburton & Nuttall (1909) stated that tick anomalies are usually slight, which is supported by the present study. However minor deviations of the expected phenotype may be associated with genotype and fitness (Markov, 1995), making it difficult to speculate on the significance of anomalies like asymmetries, clefts in the posterior borders or lack of appendages.

The failure to find abnormal Ixodinae and Haemaphysaliniae was probably a consequence of the low number of ticks collected for these subfamilies. The higher rate of anomalies in Amblyomminae in comparison with Rhipicephalinae, and the higher prevalence of abnormal females in the former, are interesting phenomena. The relationship of *Boophilus* to cattle in the Americas can be considered a normal parasitic association, introduced to the Neotropical region by anthropic activities. However, the current parasitic life cycle of Neotropical ticks species like *A. neumanni*, *A. cajennense* and *A. parvum* on cattle and other domesticated hosts introduced by man into the Neotropical region (Guglielmone et al., 1990a, b), constitutes “surrogate host-parasite relationship”, according to the definition of Hoogstraal & Aeschlimann (1982). Latif et al. (1988a, b) linked anomalies in *A. variegatum* to feeding on unusual hosts, and Dubinina & Alekseev (1994) found a probable connection between environmental pollution and abnormalities in ticks of the genus *Ixodes* in Russia. There is no evidence to associate environmental stress and/or feeding on introduced hosts with the higher rate of phenotypic anomalies found in Neotropical Amblyomminae. Nevertheless, it would be of interest to know whether the incidence of anomalous Amblyomminae in areas where the primeval host-tick relationship has undergone less alteration, is similar to that found in the present study.

Gynandromorphism—a major defect associated with the unequal distribution of sex-linked chromosomes (Homsjer & Yunker, 1981)—was found at a general rate of 1 gynandromorph per 13,900 adult ticks. Palmgren (1979), studying gynandromorphism in spiders of the subfamily Micryphantinae, found a rate of gynandromorphism similar to that found in the Ixodidae studied here. Palmgren (1979) noted that a disproportionate great number of gynandromorphs were detected in the genus *Oedothorax*. A similar case appears to occur in Ixodidae, since more than 40% of gynanders are consistently found in the genus *Amblyomma* (Travassos Santos Dias, 1953; Rechav, 1977; Viñabal et al., 1994). Amblyomminae represented 32% of the total numbers of ticks collected in this study, yet 3 of the 4 gynandromorphs belonged to the genus *Amblyomma*. Notably, these 3 gynandromorphs were *A. neumanni*. The first description of a gynander tick was in *A. neumanni* (Joan, 1919) and recently Aguirre et al. (1999) found two additional gynandromorphs of this species during a study of its life cycle under laboratory conditions. *A. neumanni* is mainly restricted to a relatively small ecological region in northwestern Argentina (Guglielmone & Hadani, 1982; Guglielmone & Viñabal, 1994). It is unknown if this high rate of gynandromorphs in *A. neumanni* is intrinsic to this tick species or the result of chance.
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