SHORT COMMUNICATION

Sex chromosome variation and cytotaxonomy of the onchocerciasis vector Simulium squamosum in Cameroon and Nigeria

M. TRAORE-LAMIZANA, S. SOMIARI*, H. B. MAFUYAI†, C. G. VAJIME‡ and R. J. POST§
Institute Pierre Richet, Bouaké, Côte d'Ivoire, *Department of Zoology, University of Calabar, Nigeria, †Department of Zoology, University of Jos, Nigeria, ‡Benue State University, Makurdi, Nigeria and §The Natural History Museum, London, U.K.

Abstract. On the basis of sex chromosome variation, three cytotypes of Simulium squamosum (Enderlein) (Diptera: Simuliidae) are described from Cameroon and Nigeria. Simulium squamosum A is the typical form as originally described by Vajime & Dunbar (1975) with chromosome I as the sex chromosome. It occurs throughout most of Cameroon and south-east Nigeria. A second cytotype, S. squamosum B, is described from the river Sanaga (Cameroon). It also has chromosome I as the sex chromosome, but the nature of the sex differential region is different. Simulium squamosum C has no sex-linked chromosomal rearrangements. It is widespread in Nigeria and occurs near Mount Cameroon, where it seems to hybridize with S. squamosum A.

Key words. Simulium damnosum complex, S. squamosum, cytotaxonomy, hybridization, onchocerciasis, sex-chromosomes, sibling species, taxonomy, Cameroon, Nigeria.

The vectors of human onchocerciasis in Nigeria and Cameroon are members of the Simulium (Edwardsellum) damnosum complex (Diptera: Simuliidae). Nine sibling species, sometimes called 'cytospecies', were described by Vajime & Dunbar (1975, 1977) from West Africa on the basis of larval salivary gland polytene chromosome differences. Of these, S. damnosum Theobald sensu stricto and S. sirbanum V. & D. were recorded from both countries, with S. squamosum Enderlein and S. mengense V. & D. additional for Cameroon.

Traore-Lamizana & Lemasson (1987) surveyed the larval distribution of the S. damnosum complex in northern Cameroon and published distribution maps for five cytospecies. Simulium damnosum s.s. and S. sirbanum were common in the savanna zones; S. squamosum was associated with the forested zones and spread north into the savanna rivers during the rainy season. Simulium yahense V. & D. was reported locally in the west, whereas S. mengense had a scattered distribution throughout the area.

Correspondence: Dr R. J. Post, Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.
E-mail: R.Post@nhm.ac.uk

© 2001 Blackwell Science Ltd
Fig. 1. Map showing the distribution of Simulium squamosum in Cameroon and Nigeria classified according to sex chromosome system as S. squamosum 'A', 'B' and 'C'.

several chromosomal floating inversions vary across the range of the species and one fixed (i.e. homozygous) inversion defines the south-eastern subspecies S. squamosum kitetense (Elsen & Post, 1989). Geographic variation in the sex chromosomes of S. squamosum has been reported by numerous workers (Vajime & Dunbar, 1975; WHO, 1988; Elsen & Post, 1989; Boakye, 1993). Sex chromosomes are generally considered to be sensitive indicators of taxonomic divergence in the Simulidae (White, 1978; Rothfels, 1979) and have been used to distinguish some of the sibling species and geographical races within the S. damnosum complex; for example, S. yahense (Vajime & Dunbar, 1975), the Beffa form of S. soubrense (Meredith et al., 1983; Post, 1986) and the Djodji form of S. sanctipauli (Surtees et al., 1988). The objective of this study was to consider the taxonomic significance of sex chromosome variation among S. squamosum populations, which was discovered while surveying geographical distributions of the members of the S. damnosum complex in Cameroon and Nigeria.

Collection sites of S. squamosum were listed and mapped by Traore-Lamizana & Lemasson (1987) for northern Cameroon, and for the whole of Nigeria by Mafuyai et al. (1996a) and Somiari (1998). These sites, along with additional localities in southern Cameroon, are mapped on Fig. 1. Final and penultimate stage larvae of the S. damnosum complex were collected from their riverine breeding sites and fixed in Carnoy's solution (3 : 1 : 1 ethanol : acetic acid : chloroform, or 3 : 1 ethanol : acetic acid, or 1 : 1 ethanol : acetic acid). These samples were then stored at 4°C before chromosome preparation. Polytene chromosomes were prepared from the larval silk glands by dissection and staining in feulgen or orcein according to standard procedures (Dunbar, 1972; Quillévéré, 1979). The resultant chromosome preparations were then compared with the standard chromosome maps published by Vajime & Dunbar (1975), Quillévéré (1975), Elsen & Post (1989) and Boakye (1993).

Most populations of the S. damnosum complex sampled from Cameroon and Nigeria conformed with the standard cytotaxonomic descriptions by Vajime & Dunbar (1975, 1977). Simulium yahense showed typical sex linkage of inversion III-18 (homozygous in 97% of females and heterozygous in 65% of males). Chromosomal variation was observed in S. damnosum S.S. and S. sirbanum from Nigeria, S. mengense from Cameroon and S. squamosum from both countries.

No fixed inversions were found to differentiate any populations of S. squamosum from the standard karyotype (Vajime & Dunbar, 1975). Inversion III-18 is normally considered to be diagnostic between S. squamosum and S. yahense, but a few heterozygotes were found in both sexes of S. squamosum in parts of northern Cameroon, around Mount Cameroon (5%), the Jos plateau (3%) and SW Nigeria (36%).

Vajime & Dunbar (1975) described differences between the sexes of S. squamosum from Cameroon. Females (n = 81) were all homozygous for the chromosome I with complete
Simulium squamosum from Cameroon and Nigeria 221

Fig. 2. Centromeric long asynaptic sex-differential region of chromosome I (Ica) from a male of the typical form of Simulium squamosum. N = Nucleolus Organiser.

Fig. 3. Centromeric short asynaptic sex-differential region of chromosome I (Icb) from a male of the Sanaga population of Simulium squamosum. N = Nucleolus Organiser.

synapsis (ICs), whereas 43% of males (n = 69) showed a centromeric long asynaptic (non-pairing) region on chromosome I, indicating a sex-differential region designated Ica (Fig. 2). Cameroon S. squamosum outside the Sanaga river and Mount Cameroon area (6587 larvae examined by us) conformed to this description. However, in the majority of males from the Sanaga river the asynaptic centromeric region of chromosome I was shorter, designated ICb (Fig. 3): all of 593 females and 39% (286) of males had the short ICb asynaptic sex-differential region. Sites around Mount Cameroon harboured a mixture of situations. Simulium squamosum sampled from rivers draining south-east from the mountain (n = 91 larvae) showed no sex-linked chromosome variation and were consistently synaptic standard ICs. Sites around Mount Cameroon sampled from rivers draining south-east from the mountain (n = 91 larvae) showed no sex-linked chromosome variation and were consistently synaptic standard ICs in both sexes. Simulium squamosum from two sites north of the mountain (river Flango at Bikili dam and river Menge near Ikilivindi) carried the long asynaptic Ica region in both sexes: 18 larvae examined comprised three males and five females with long asynaptic ICa, plus four males and six females with synaptic ICs.

A total of 402 larvae of S. squamosum were identified from 21 sites in Nigeria. No sex-linked chromosome variation of any sort was observed at 18 sites, although three female larvae from the south-west had asynaptic ICa. From three sites (Kwa Falls, Karam river and Ibi river, in Cross River and Ino States). However, the 53 larvae examined were found to possess the ICs-ICa sex chromosome system widespread in Cameroon (Table 1).

Our observations reveal at least three allopatric sex chromosome systems in S. squamosum from Cameroon and Nigeria. It is proposed to recognize these different populations as informal geographical races A, B and C of S. squamosum. The distribution of the three forms is clearly separate (Fig. 1), except north of Mount Cameroon in south-west Cameroon where a number of anomalies were found. The results of Vajime & Dunbar (1975) and the older samples collected and analysed for this study (1979–83) indicated the presence of S. squamosum A, but more recent samples (1989–94) indicate a mixture of S. squamosum A and C in this area. Further sampling is required to clarify the cytotaxonomic composition of S. squamosum sensu lato populations around Mount Cameroon.

Simulium squamosum A is the typical form, with sex-linked long asynaptic ICa (Fig. 2), originally described by Vajime & Dunbar (1975). It is distributed throughout Cameroon, except in the Sanaga river, and around Mount Cameroon, where it appears to interbreed with S. squamosum C. Its distribution
Table 1. Cytotaxonomic summary of Simulium squamosum Vajime & Dunbar sensu lato from Nigeria and Cameroon

<table>
<thead>
<tr>
<th>Type</th>
<th>Data</th>
<th>Sex</th>
<th>ICa Synaptic</th>
<th>Long ICb</th>
<th>Short ICb</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>V &amp; D 1975</td>
<td>♂</td>
<td>92 (57%)</td>
<td>69 (43%)</td>
<td>0</td>
<td>Cameroon general</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♀</td>
<td>81 (100%)</td>
<td>0</td>
<td>0</td>
<td>Cameroon &amp; SW Nigeria</td>
</tr>
<tr>
<td>Ours</td>
<td></td>
<td>♂</td>
<td>1020 (29%)</td>
<td>2545 (71%)</td>
<td>9 (1%)</td>
<td>Cameroon Sanaga river</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♀</td>
<td>3036 (99%)</td>
<td>0</td>
<td>0</td>
<td>Nigeria and S.E. mt Cameroon</td>
</tr>
<tr>
<td>B</td>
<td>Ours</td>
<td>♂</td>
<td>286 (39%)</td>
<td>0</td>
<td>449 (61%)</td>
<td>N. mt Cameroon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♀</td>
<td>593 (100%)</td>
<td>0</td>
<td>0</td>
<td>Cameroon general</td>
</tr>
<tr>
<td>C</td>
<td>Ours</td>
<td>♂</td>
<td>102 (100%)</td>
<td>0</td>
<td>0</td>
<td>Cameroon general</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♀</td>
<td>124 (98%)</td>
<td>3 (2%)</td>
<td>0</td>
<td>Cameroon Sanaga river</td>
</tr>
<tr>
<td></td>
<td></td>
<td>?</td>
<td>290 (100%)</td>
<td>0</td>
<td>0</td>
<td>Cameroon Sanaga river</td>
</tr>
<tr>
<td>AxC</td>
<td>Ours</td>
<td>♂</td>
<td>4 (37%)</td>
<td>3 (45%)</td>
<td>0</td>
<td>Cameroon Sanaga river</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♀</td>
<td>6 (35%)</td>
<td>5 (45%)</td>
<td>0</td>
<td>Cameroon Sanaga river</td>
</tr>
</tbody>
</table>

Note: The numbers of specimens here do not always correspond to the numbers mentioned in the text because it was not possible to determine the sex of all larvae, especially for Nigeria (marked ? above).

Spreads across the border into south-east Nigeria, where it has been found at three localities.

Simulium squamosum B appears to be restricted to the Sanaga river where it has not been found sympatrically with any other member of the S. damnosum complex. It is characterized by the shorter asynaptic ICb region (Fig. 3) found in 61% of males. It is presumed to be responsible for the heavy man-biting in the area, requiring larviciding control operations to protect the population of the Song Loulou dam area. As a result, S. squamosum B has become resistant to temephos (Traore-Lamizana et al., 1985) and chlorphoxim (Traore-Lamizana and Klein, unpublished data).

Simulium squamosum C has no sex-linked chromosome variation and only very rarely shows IC asynapsis. It is the form distributed throughout most of Nigeria, occurring also around Mount Cameroon. Simulium squamosum C is a proven vector of onchocerciasis in Nigeria (Mafuyai et al., 1997). To the north of Mount Cameroon, populations occur that appear to be a mixture of S. squamosum A and C, with the long asynaptic ICa in some larvae of both sexes, suggesting introgression between forms A and C in this area.

References


Meredith, S.E.O., Cheke, R.A. & Garsa, R. (1985) Variation and

© 2001 Blackwell Science Ltd, Medical and Veterinary Entomology, 15, 219-223


Accepted 1 April 2001.