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# BIOSYSTEMATICS AND DISTRIBUTION OF SIMULIID VECTORS OF HUMAN ONCHOCERCIASIS IN SOUTH AMERICA

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*A brief review is given of the taxonomic status, biology and medical importance, and distribution of the vectors of human onchocerciasis in Latin America. Key reference works are cited and distribution maps of each vector species in relation to the known onchocerciasis foci are given.*

Key words: simuliid vectors – biosystematics – distribution – onchocerciasis – South America

Comparatively little is known about the bionomics of vectors of human onchocerciasis in South America because of the relatively low public health importance of the disease, recent discovery of some of the foci, and difficulty of access to affected areas. No concerted control campaigns have yet been conducted against the vectors with only preliminary trials of DDT as a larvicide in the northern foci of Venezuela having been attempted (Lewis & Ibañez de Aldecoa, 1962). Consequently the literature concerning the vectors is small, scattered, and has not yet been comprehensively reviewed. Extracts of this current review were initially used as a working paper for the recently published report on the epidemiology of onchocerciasis by the World Health Organization (World Health Organization, 1987).

The following species are proven vectors of onchocerciasis in South America: *Simulium exiguum* s. l., *S. guianense, S. metallicum* s. l., *S. oyapockense* s. l. and *S. quadrivittatum. Simulium limbatum* (here used to include the related *S. yarzabali;* see Shelley et al., 1988) is a suspected vector.

## *Simulium exiguum* Roubaud

*Simulium exiguum* is widespread in South America from Colombia and Venezuela in the north to Argentina and Bolivia in the south (Fig. 1) and occurs in all the onchocerciasis foci. It is a species complex in Ecuador consisting of three cytotypes designated as the Cayapa and Aguarico forms from the onchocerciasis focus and the Bucay form from southern Ecuador (Procunier et al., 1986). The differing biologies of populations of this species from Brazil and Venezuela suggest the existence of further cytospecies in these countries.

*Simulium exiguum* s. l. is the primary vector of onchocerciasis in the Santiago focus in Ecuador (Shelley & Arzube, 1985), the only vector in Colombia (Tidwell et al., 1980) and a presumed sporadic vector in the northern Venezuelan focus (Lewis & Ibañez de Aldecoa, 1962). Its vector competence, estimated by comparing the percentage of ingested microfilariae that develop to the L3 stage in experimentally infected flies, varies for each focus (Shelley et al., 1987). In Ecuador the high vector competence, equivalent to that of *S. damnosum* s. l. in West Africa, is reflected in the high natural infection rates of *S. exiguum* s. l. and the rapid appearance of parasite transmission in new onchocerciasis foci resulting from the migration from the main focus of infected Indians. The lower vector competence of *S. exiguum* s. l. in other foci explains the hypoendemicity of onchocerciaais in Colombia and its suspected poor secondary vector status in northern Venezuela. *Simulium exiguum* s. l., like all other Latin American vector species, ingests larger numbers of microfilariae when feeding than African vectors; this concentration effect can cause the death of flies when large numbers of parasites (over 20) are ingested, particularly in species that lack a cibarial armature (*exiguum* s. l., *guianense, metallicum* s. l.).

*Simulium exiguum* s. l. also varies in its biting activity probably in relation to cytospecies, parity and season. It generally shows population peaks (up to 2000 flies/man/day) in

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the dry season in areas where flies are highly anthropophilic; in localities with principally zoophilic populations anthropophily is more evident in the wet season. *Simulium exiguum* s. l. bites man, generally on the legs where skin microfilarial densities are highest, both inside and outside habitations. Large domestic animals are also bitten and in some localities total zoophily occurs. Biting occurs throughout the day generally with mid morning and afternoon peaks of activity.

Larvae and pupae of *S. exiguum* s. l. are typically found in the middle reaches of large rivers and their tributaries (5m wide upwards) attached to submerged vegetation in deeper parts of the rivers, and in shallow water running over shingle beds.

*Simulium guianense* Wise

References in the literature to *S. guianense* and *S. pintoi* as vectors of onchocerciasis concern a single species which is here regarded as being close to *S. guianense*. This confusion has been caused because of the similarity and probable synonymy of the two species (Rassi et al., 1977; Shelley et al., 1979; Tada, 1983; Takaoka et al., 1984). *S. guianense* has a wide distribution from southern Venezuela to southern Brazil and also occurs in the Guianas (Fig. 1).

*Simulium guianense* is a natural vector of *O. volvulus* in the Brazil/Venezuela onchocerciasis focus. Its high vector competence (Shelley et al., 1987) and predominance (with *S. limbatum*) in the mountainous (mainly hyperendemic) localities of the focus suggest its role of primary vector in the lowland localities because of its low anthropophily.

As with *S. exiguum* s. l., biting activity is variable. Man-biting rates fluctuate seasonally in the highland areas of the focus with larger anthropophilic populations (200 flies/man/day) occurring in the dry season than in the wet (1 fly/man/day). Biting occurs throughout the day with variable cycles depending on the locality and season with the legs generally being the favoured site. *S. guianense* has not been recorded entering houses.

Immature stages are typically found on emergent vegetation in large fast-flowing rivers, but in the Brazil/Venezuela onchocerciasis focus the breeding grounds on the anthropophilic form have not been found.

*Simulium metallicum* Bellardi

*Simulium metallicum* is common in Central America, some Caribbean Islands, the Andes as far south as Ecuador, and in the northern coastal belt of Venezuela (Fig. 1). In Central America *S. metallicum* is a complex of five sibling species (J. Conn, pers. comm.).

*Simulium metallicum* s. l. is the only proven vector of onchocerciasis in the northern Venezuelan foci of Altamira and Caripe (Duke, 1970; Lewis & Ibañez de Aldecoa, 1962; Ramírez Pérez, 1985). At low microfilarial intakes (3 mfs/fly) it is an efficient vector of *O. volvulus* but its efficiency decreases when higher intakes (20 mfs/fly) increase fly mortality (Duke, 1970). This is reflected in the relatively high natural infection rates with *O. volvulus* in these foci where the disease is hypoendemic.

Recent reviews (Ramírez Pérez, 1985; Tada, 1983) deal with the bionomics and medical importance of *S. metallicum* s. l. in these foci where it is a primary vector and compare them with the different biologies of the same morphospecies in Guatemala where it is a secondary vector; these differences in vector capacity and biology may be attributed to differences in cytospecies. In the northern Venezuelan foci *S. metallicum* is highly anthropophilic, preferring to bite man below the waist, although it will also bite large domestic animals. High biting rates of up to 200 flies/man/hour are recorded with variable biting cycles depending on locality and season. Man-biting populations appear to be highest in the dry season.

Larvae and pupae are found on submerged vegetation in small streams.

*Simulium oyapockense* Floch &Abonnenc

*Simulium oyapockense* is one of the most common anthropophilic species of lowland forests and savannas of the Amazon and Orinoco basins of Bolivia, Brazil, Colombia and Venezuela and is present in the Guianas (Fig. 2). It is regarded as a polymorphic species until chromosomal evidence is available to clarify character variation in adults and pupae. The

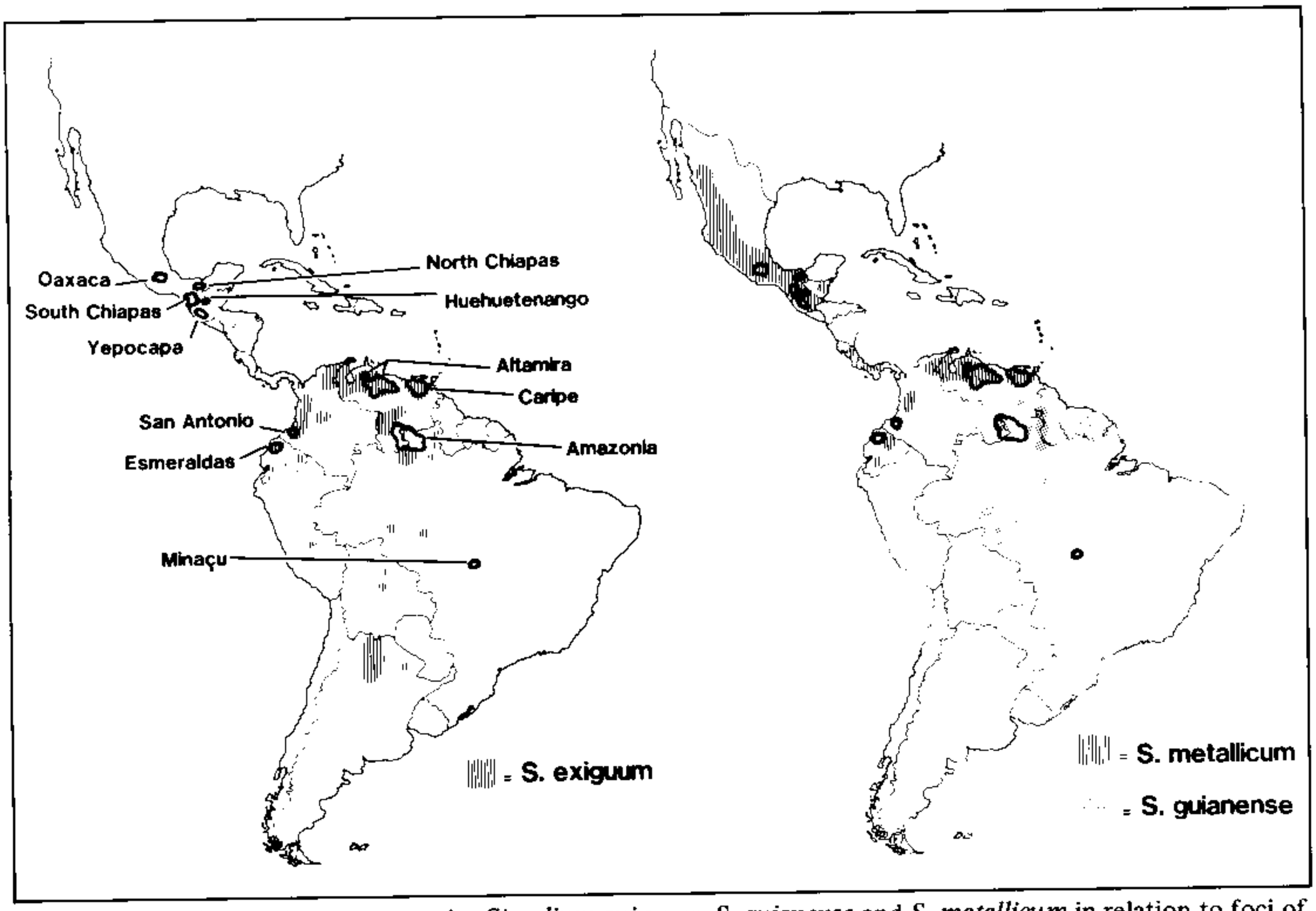


Fig. 1: distribution of the vector species *Simulium exiguum*, *S. guianense* and *S. metallicum* in relation to foci of human onchocerciasis.

various synonyms of *S. oyapockense* s. l. necessary to understand the recent literature on its medical importance have been reviewed (Shelley et al., 1985; 1988; Table). *Simulium roraimense* is indistinguishable in the female from *S. oyapockense* s. l. and because of their sympatry in the Brazil/Venezuela onchocerciasis focus reference to *S. oyapockense* s. l. includes the former species.

*Simulium oyapockense* s. l. is the only significant vector of onchocerciasis in the lowland forested areas of the Brazil/Venezuela focus where it is the predominant anthropophilic species. As an experimental vector it has recently been shown to have a low vector competence (Shelley et al., 1987) and low natural infection rates with L3 larvae of *O. volvulus* (Shelley et al., 1979). This factor also explains the continued hypoendemicity of onchocerciasis on the periphery of the focus in Brazil and the lack of dispersal of the disease to adjacent areas despite high biting rates (6,800/man/day) (Shelley et al., 1987).

TABLE

Summary of the vectors of onchocerciasis in South America

| Focus | *Simulium* species |
|---|---|
| Colombia | 1. *S. exiguum* s. l. |
| Ecuador | 1. *S. exiguum* s. l. |
| | 2. *S. quadrivittatum* |
| Venezuela | |
| Caripe & Altamira | 1. *S. metallicum* s. l. |
| | ? *S. exiguum* s. l. |
| Brazil/Venezuela | |
| highland areas | 1. *S. guianense (pintoi)* |
| | ? *S. limbatum (incrustatum, yarzabali)* |
| lowland areas | 1. *S. oyapockense* s. l. *(amazonicum, cuasisanguineum, minusculum, sanguineum)* |

( ) – other identifications given to the species in the literature.
1: primary vector; 2: secondary vector; ?: suspected vector.

*Simulium oyapockense* s. l. is highly anthropophilic but will bite large domestic animals if present. Biting occurs on all exposed parts of the body with a slight preference for areas above the waist, and man is rarely bitten indoors. Biting occurs throughout the day with morning and afternoon activity peaks. Population peaks occur in the wet season when rivers flood their banks and provide submerged vegetation for breeding in small to large rivers.

*Simulium quadrivittatum* Loew

This Central American species has only been recorded in South America from the coastal lowlands of Ecuador, west of the Andes (Fig. 2).

*Simulium quadrivittatum* is a natural vector of *O. volvulus* in Ecuador where it plays a secondary role to *S. exiguum* s. l. at the end of the wet season as a vector of onchocerciasis because of its low biting rates. Experimentally infected *S. quadrivittatum* were shown to be poorer potential vectors than *S. exiguum* s. l.; though ingesting more microfilariae than *S. exiguum* s. l. fewer parasites developed to the L3 stage, due to the lethal effect of the cibarial armature – a phenomenon already reported for *S. ochraceum* s. l. (Shelley & Arzube, 1985).

Biting occurs throughout the day with mid-morning and afternoon activity peaks. Biting occurs mainly on the legs and man can be attacked inside houses.

This species breeds in small shaded forest streams on submerged plants and debris.

Suspected vectors

Although *S. exiguum* s. l. may act as a sporadic vector of onchocerciasis in lowland areas of the Brazil/Venezuela onchocerciasis focus, the only species that is suspected of significantly contributing to transmission is *S. limbatum* (including *S. yarzabali*) in the highland areas of the focus. This species is commonly found throughout Venezuela, the Guyanas, and northern Brazil (Fig. 2). It is a suspected vector because of its high anthropophily in the focus and its successful experimental infection with *O. volvulus* outside the focus (Shelley et al., 1987).

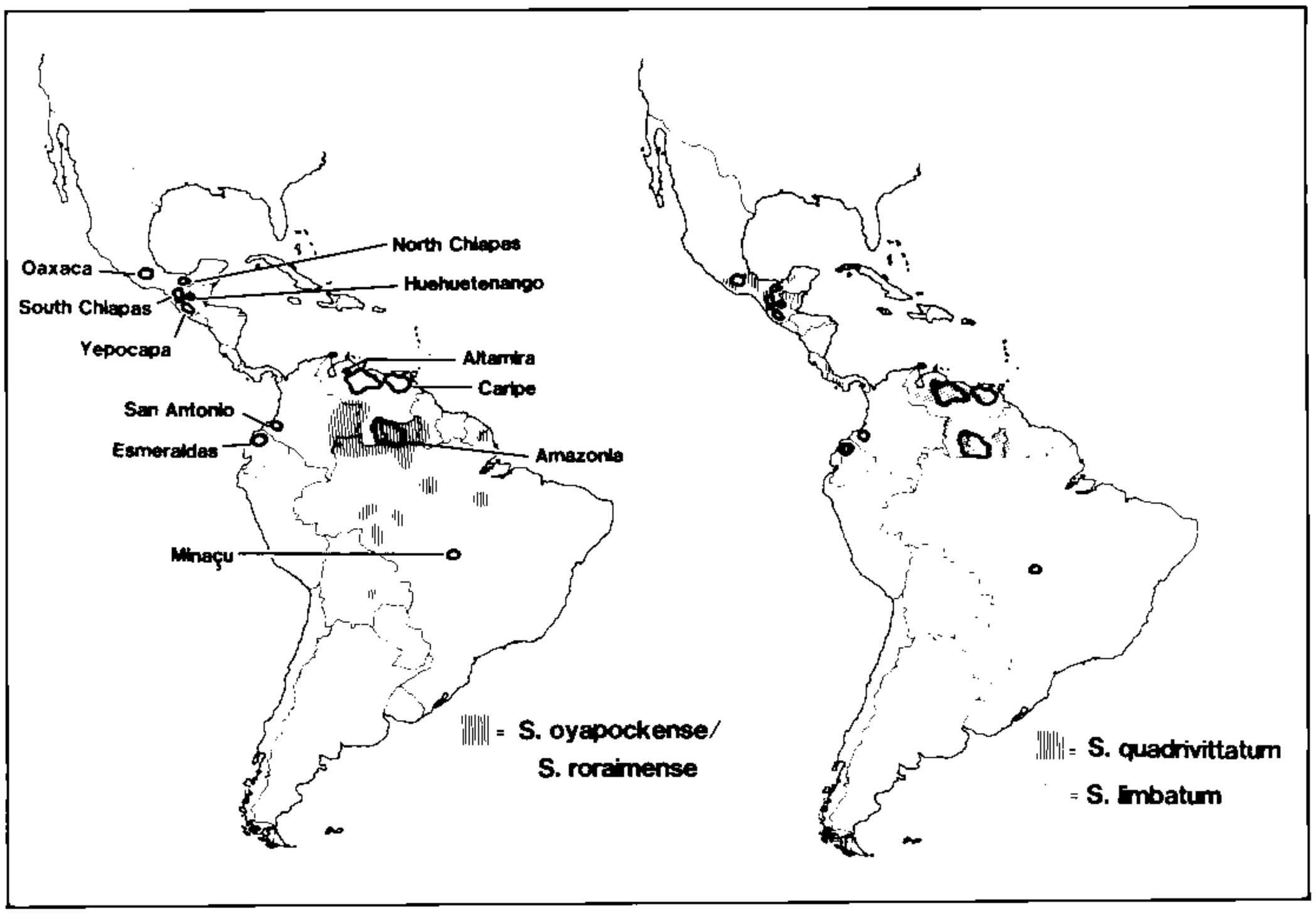


Fig. 2: distribution of the vector species *Simulium oyapockense/S. roraimense, S. quadrivittatum* and *S. limbatum* in relation to foci of human onchocerciasis.

RESUMO

**Biossistemática e distribuição de simulídeos vetores da oncocercose humana na América do Sul** – É dado um pequeno resumo sobre a posição taxonômica, biologia, importância médica e distribuição dos transmissores da oncocercose humana na América Latina. São citados como referência trabalhos com chaves taxonômicas e apresentados mapas sobre a distribuição de cada espécie vetora em relação aos focos de oncocercose já conhecidos.

Palavras-chave: simulídeos vetores – biossistemática – distribuição – oncocercose – América do Sul

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