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In the upper Maroni River (French Guiana), Wayana Amerindians fish by poisoning the rivers with toxins, mainly rotenone, extracted from lianas. We studied the impacts of this fishing practice on benthic invertebrate communities associated with Podostemaceae meadows in October 2000. Ephemeroptera or Diptera Simuliidae were dominant. The other Diptera, mainly Chironomidae, represented the third group of invertebrates, followed by Lepidoptera and Trichoptera. Annelida, mainly Oligochaeta, and Acarina were of little abundance, and Odonata and Coleoptera scarce. Densities were generally lower after fishing but no statistically significant effect was found. The toxic used by the Amerindians had no significant effect on invertebrate communities and the indirect impact for fishes is probably negligible.

neotropical, rotenone, stream, toxicity

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Les indiens Wayanas du Haut Maroni (Guyane française) pêchent en empoisonnant les rivières avec des toxines (principalement de la roténone) extraites de lianes. Nous avons étudié l'effet de ces pratiques sur les peuplements invertébrés des herbiers à Podostemaceae en octobre 2000. Les Ephéméroptères ou les Diptères Simuliidae dominaient les peuplements. Les autres Diptères, principalement les Chironomidae, représentaient le troisième groupe d'invertébrés, suivis par les Lépidoptères et les Trichoptères. Les Annélides, principalement des Oligochètes, et les Acariens étaient généralement peu nombreux! ; les Odonates et les Coléoptères étaient rares. Les densités étaient généralement plus faibles après les pêches, sans que les différences soient statistiquement significatives. Les toxiques utilisés par les Amérindiens ne semblent donc pas avoir d'effet significatif sur les peuplements invertébrés. L'impact indirect sur les poissons reste aussi probablement négligeable.

cours d'eau, néotropical, roténone, toxicité

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In the Upper Maroni River (French Guiana), Wayana Amerindians fish by poisoning the rivers with toxins extracted from lianas such as *Derris elliptica* (Grenand & Moretti, 1982, Pagezy & Jégu, 2002). The active component of the poison, rotenone, is a well known fish toxicant (Schnick, 1974).

Growing on rocky substrates in fast flowing waters, Podostemaceae meadows form a complex biotope in clear or black water streams draining the Precambrien shields in the Guianas, Venezuela and Brazil. A rich invertebrate fauna is associated with these meadows, composed mainly of insects larvae (Tavares *et al.*, 1998, Odinetz-collart *et al.*, 2001). Patrimonial fishes like the large phytophagous Serrasalminae (Teleostei : Characidae) feed on these invertebrate communities when juveniles (Py-Daniel & Jégu, 1996, Pagezy & Jégu, 2002).

The impact of this traditional fishing practice on benthic invertebrate communities was studied in October 2000, as part of an IRD (Institut de Recherche pour le Développement) and MNHN (National Museum of Natural History of Paris)'s project. The aim of this project was to describe the invertebrate communities in the Upper Maroni River and evaluate the impact of fish poisoning with rotenone on benthic invertebrate communities (Jégu *et al.*, 2003).

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Our study area was the Upper Maroni River Basin (Figure 1). Invertebrate communities were described before fishing in five sites near Antecume Pata (one on the Marouini River - M - and four on the Litany River – L1-L4) and in two areas in Saut Pierkourou, on the Upper Tampok (T1, T2). One large commercial fishing was observed on the Upper Tampok, where no fishing had been practiced for five years. Four familial fishing operations were studied near Antecume Pata, where fishing occurs each year, as soon as the water level is low.

Figure 1.

Mourera fluviatilis is the dominant Podostemaceae in the Upper Maroni River (Pagezy & Jégu, 2002). *Mourera fluviatilis* fragments (3 to 20 g each, 3 fragments in the Marouini and Litany Rivers sites, 5 fragments in the Tampok River sites, due to different operators) were taken in plants in a homogeneous meadow, in a rapid shallow area (10 - 30 cm depth), just before and 24 h after the fishing operations. The organic matter and invertebrates associated with the plant fragments were filtered (250 µm mesh-size) and preserved with formaldehyde in the field. Organisms were determined and counted under a binocular microscope in the laboratory. Densities were reported in relation to fresh weight of plants (individuals.g^{-1}) and compared with t-tests (p!≤!0.05).

Ephemeroptera (Leptohyphidae, Baetidae and Leptophlebiidae) were dominant in the Litani River (up to 70 % of the total invertebrates number in L4) and in one of the Tampok rapids (T2, 69 % - Table 1). However, Diptera Simuliidae were dominant in the Marouini River and in Tampok-1 site (90 and 62 % respectively), but were less abundant in the other rapids (0 - 17 %). The other Diptera, mainly Chironomidae, represented the third group of invertebrates (1 - 34 %). Lepidoptera and Trichoptera larvae were regular in the samples, although less numerous (roughly 1 - 11 %). Annelida, mainly Oligochaeta, and Acarina were of little abundance (less than 5 %). Odonata and Coleoptera were always scarce (less than 0.5 %).

Table 1.

Except for Litany-4, densities of invertebrates were lower after the fishing campaigns with rotenone (densities reduced by half in the Tampok 1) but not statistically (Figure 2). The community analysis showed a weak effect of the rotenone in the Tampok River. Some taxa, such as Philopotamidae, Trichoptera A, Hydropsychidae were not found after fishing.

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Ephemeroptera were abundant in our samples, although Diptera are generally dominant in Amazonian river invertebrate communities (Tavares *et al*. 1996, Odinetz-Collart *et al*. 2001). The large larvae of Lepidoptera and Trichoptera, although of little abundance, represented a major part of the biomass. In rapids of the Sinnamary River (French Guiana), aquatic invertebrates, mainly Diptera and Ephemeroptera, represented 71 % of the diet of the fishes (Horeau *et al*. 1998).

Effects of rotenone on fish communities have been well studied (Schnick, 1974), but references for invertebrates are scarce, and usually focus on standing waters. Invertebrates are generally less sensitive than fishes, except planctonic crustacea (*in* Schnick, 1974). In the laboratory, rotenone is more toxic to Daphnia (Cladocera) than to fishes (Rach *et al*., 1988). In temperate areas, rotenone is known to have important effects on stream invertebrate communities: e.g., total loss of invertebrates along several kilometers (Dexter, 1965), loss of Ephemeroptera and Trichoptera (Binns, 1967), reductions of 34 to 100 % of individuals, depending on the invertebrate Order (Little, 1966, Helfrich, 1978). However, This effect was often assessed as weak (Morrison, 1977). It is generally accepted that the observed reductions are not critical to population survival because of possible re-colonization (*in* Schnick, 1974). In tropical areas (Papua-New-Guinea), rotenone was used to kill fishes in two streams and significally reduced three invertebrates populations (a Baetidae, a Hydropsychidae, a Dixidae) but did not affect abundance and richness of the communities (Dudgeon 1990).

In our study, the toxics used by the Amerindians had no significant effect on invertebrate communities. The difference between the streams may be related to different fishing practices by the Indians!: they use probably more toxic in a remote river than near their village. A rapid recolonization through drift may compensate the effect of the toxic when only one reach is treated, like during traditional fishing operations. A higher level of identification could reveal sensitive species whereas a whole group is not sensitive. However, the right taxonomic level for this seems to be the species level (see Dudgeon 1990) and this level of identification is not yet possible for the Maroni fauna. In fact, this publication is the first one on invertebrates of the Upper Maroni River.

Although rotenone is toxic to invertebrates and fishes do feed on aquatic invertebrates, the indirect impact on fish communities, through effects on invertebrate communities, is probably negligible compared to direct mortality. However, our limited sampling does not allow strong inference. A more intense sampling effort, on both spatial and temporal scales, would lead to better statistical power to assess rotenone effects on invertbrates. .

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Table 1. Relative abundances (%) of invertebrates collected at the seven study sites (M = Marouini, L = Litany, T = Tampok).

Figure 1. Study area, with river indicated.

Figure 2. Overall densities of invertebrates (individuals.g of leaves^{-1}) on *Mourera fluviatilis* leaves before and after the fishing campaigns (mean ± standard deviation - L = Litany, 3 fragments of leaves ; T = Tampok, 5 fragments of leaves).