3rd COURSE: IMPLEMENTATION OF BIOLOGICAL CONTROL OF MOSQUITOES USING BACTERIAL BIOINSECTICIDES

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SATELLITE SYMPOSIUM: MOSQUITO VECTOR BORNE TROPICAL DISEASES AND BIOLOGICAL CONTROL

CONFERENCE ABSTRACT:

USING *B. thuringiensis* subsp. *israelensis* (Bti) IN BLACKFLIES CONTROL PROGRAMS IN SOUTH AND SOUTHWESTERN BRAZIL

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Historical Background

The common name blackfly (= borrachudo or pium in Brazil) refers to the small haematophagous flies (Diptera Culicomorpha) from the family Simuliidae. The group comprises about 1,700 species arranged in 28 genera all around the world. Usually black in colour, they are 1.5 - 4 mm in length. The eggs, larvae and pupae are only found in moving water, ranging according to species, from wave movement on lake shores to small trickles in vegetation, from choked forest streams to the lip of the highest waterfalls in the largest rivers.

No more than 10% of the blackfly species show preferences for the blood of humans and domestic animals. From that, around 40 species are incriminated as nuisance or vectors of medical and veterinary important diseases. The blackflies are vectors of onchocerciasis or river blindness in Africa and in Central and north of South America. In Africa the most important species are *Simulium neavei* and members of the *Simulium damnosum* complex. In addition, blackflies are a serious nuisance in many parts of the world because of their painful bites and the sometimes enormous numbers involved in attacks. Blackfly bites may cause localized swelling and inflammation and intense irritation of the skin lasting days or weeks.

First historical records of nuisance blackflies (called buffalo-gnats by the pioneers), seems to be from the St. Lawrence River, region of Quebec and Montreal in the early of 1600. After that, by 1800 the Humboldt-Bonpland expedition was the first journey in the history of the western world taken solely for research, and they record an intensive blackfly attack on the region of the Orinoco River. Also, from the beginning of recorded history, river blindness has been a problem in Africa. In the 1970s, drugs were used to kill the adult worms in humans, but these drugs had horrific side effects, frequently causing blindness itself. The disease, caused by the worm *Onchocerca volvulus* renders well-watered areas uninhabitable, so villagers abandoned good farmland to live on drier land, which was quickly overused and declined in productivity. In the early of 1970 two French scientists came up with solution--to attack the blackfly when it was most vulnerable: in its larval stage, when it clung to sticks and rocks in the rivers. If blackflies could be controlled for at least 14 years--the time an adult worm lives in the human body--then theoretically the parasite reservoir in humans would die out. In 1972, they convinced Robert McNamara, then President of the World Bank, that this would work. Technically supported by the WHO, the program to control blackfly larvae in Africa began in 1974 as the Onchocerciasis Control Programme (OCP). More recently a drug called Ivermectin was tested, and found safe, effective, and suitable for mass distribution. The OCP began distributing the drug to West African villagers on a wide scale, once it was approved by French authorities in 1987. By 1992, more than 30 million people were protected from the disease. Due to larval control and the Ivermectin, people born in the OCP countries after 1974 face low risk of contracting river blindness although they are still suffering from blackfly attacks. The areas included in the control site were Guinea and Sudan Savanna in seven countries of West Africa (Mali, Upper Volta, Ghana, Toga, Benin, Niger and the Ivory Coast). The site as a whole constituted some 654,000km^2 and included the whole of the Volta River Basin. The area to the north and northeast were natural limits to the vector population and the south was a forest zone.

The same drug, Ivermectin, has been now distributed in Mexico, Guatemala, Venezuela, Colombia and Brazil aiming the elimination of the disease by 2007.

The large geographical distribution and high population densities of *Simulium (Chirostilbia) pertinax* are the major problem in the Southern and Southeastern States of Brazil as well as Paraguay and Argentina. No vector relevance has been pointed out for this species, but attack rates use to be a common concern for the local public health systems, besides an obstruction for tourist development. As for any other anthropophagic mosquito species, sampling and density population estimative can be made by collecting the flies around you with an entomological net. By this way blackfly adults obtained during 10 to 15 min may be transformed in the index blackfly/ hour/ man (b/h/m) for a given site and period of the year. We use to do that in a stand position waiving the net around both legs, the only part of the body unprotected by clothes, and we have experienced attack rates as high as 1,500 b/h/m. Few reports indicate economic losses resulting from livestock attack. But in some cases even death can be caused by a combination of anaphylactic shock from bites, blood loss and respiratory problems due to the inhalation of blackflies.

<u>Evolution of larval control</u>

One of the first records of larval blackfly control in the Americas was back in 1944 in Guatemala by the use of DDT. Followed by the use of BHC, these options were adopted by some countries like Japan, and in Brazil from 1957 to 1970. But besides many obvious environmental impacts resistance becomes a problem once detected for some Japanese blackfly populations in 1963 and 1966. In the costal areas of São Paulo and Rio de Janeiro, some old residents still remember that big amount of fish and freshwater shrimps drifting on the treated streams.

In the State of Rio Grande do Sul larval blackfly control start by1970 carried out by the State Office for Tourism, and subsequently by the State Health Secretary from 1976 on, involving that time only 14 municipalities. Five years late, due to the raise of attack rates all over the area subject to treatments, it was started a study in order to detect operational failures. By 1982, it was presented a new system to calculate stream flow rates and the study pointed out for the need of *Bacillus thuringiensis israelensis* (Bti) based products, due to resistance to the chemical larvicide.

In the State of São Paulo the official choice was also for the organophosphate temephos as larvicide, used since 1971 over an area of about 900 km^2. And despite we have proved the resistance for some populations of *S.*

pertinax from the costal areas, the use of temephos lasted until the early of 1990. Some years later we were carried out *In situ* bioassays for populations from the states of Paraná (Tibaji and Rolândia), Rio de Janeiro (Muriqui) and São Paulo (Barra do Una, Ilhabela and Morungaba). The populations were characterized as susceptible (S) or resistant (R) by submitting larvae in the last instars to the operational concentration of 0.1 ppm a.i./10 min of Temephos (Abate 500E) as diagnostic. The possible mechanisms for the organophosphorus resistance development are discussed and the use of *Bti* recommended. In a subsequent approach, chromosomal studies were carried on six larval populations of *S.pertinax* collected in the States of Paraná, Rio Grande do Sul, Rio de Janeiro and São Paulo. Polytene chromosome map comparisons within and among populations showed no differences in banding pattern, except for some limited polymorphism (secondary NOR and four band polymorphisms). We found no chromosomal variations associated with the resistance or susceptibility of the larvae to temephos, and a chromosomal homosequentiality suggesting that *S. pertinax* may be a monomorphic species.

Two Bti based products have been intensively used now in south and southwestern Brazil for blackfly control; both are emulsifiable concentrates with 1,200 International Toxic Units (ITU)/mg. A common field concentration use to be 1.2 ppm/10min in São Paulo, but for the State of Rio Grande do Sul, it was adopted a range from 12 to 50 ppm/1min, according to flow rates from 0.17 to 20 m^3/min.

Back in 1994 we evaluated a product from Cuba, which presented a low and inadequate potency for practical blackfly control treatments. It was necessary a concentration of 288 ppm/10min in order to result in 90% control of *S. pertinax* larvae. In 1999 the technical staff from Rio Grande do Sul evaluated an experimental Brazilian product (Inpalbac) with apparent good results, but due to high natural larval mortality (24 to 80%) at sites upstream to the application point, it makes necessary additional trials under controlled conditions. The blacckfly control program in Rio Grande do Sul nowadays comprises around 200 municipalities, covering more than 43,000 Km^2 and relieving more than 3,5 million people.

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