Report of the Field Mission to Consider Schistosomiasis Biological Control for the Lower Senegal River Basin

Participants:

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2 Drivers

Goals:

1. To discuss the situation concerning impact and control of human schistosomiasis with regional and local medical officers.
2. To examine a range of transmission foci.
3. To determine if data on absolute densities of medically important snails could be readily obtained.
4. To reveal potential adverse environmental impacts of biological control.
5. To detect unrecognized schistosomiasis-related environmental changes caused by the Diama Dam.
6. To survey local residents for the possible presence of introduced crayfish and other potential crustacean predators of medically important snails.
7. to gather some information on local demographics, occupations, access to global communications and the status of village-level women's organizations (M Gachassin).

Background:

In 1986 the Diama Dam was completed. This low barrier is 27 km upstream from the mouth of the Senegal River. Its primary purpose was to eliminate the estuarine conditions of the lower ~100 km of the Senegal River during the extended dry season. In effect it created a long freshwater lake or low current flow river for ~75 km from the dam to Richard Toll. Before the dam, Lac de Guiers, a large overflow lake, was filled in the wet season by the Marigot Taouey, a river from the Senegal R to the lake. It is now maintained at a relatively constant level by a canal from the Senegal R. A severe adverse impact of the dam was the establishment of intense transmission of intestinal schistosomiasis caused by the blood fluke, *Schistosoma mansoni*. This has caused extensive morbidity and thousands of deaths per year. The recognition of this public health disaster at Richard Toll elicited a massive chemotherapy campaign using Praziquantal. This has substantially reduced morbidity and mortality. Still, at

present, the disease is considered the most important health problem at locations from Diama to at least Podor. A large sugar cane plantation, CSS (Compagnie Sucriere, Senegaloise) has added a large network of canals and drains mostly to the south and east of Richard Toll. Here too schistosomiasis is its major public health problem. It employs 3000 full time and 3000 part time workers. More recently, urinary schistosomiasis, caused by *S. haematobium*, has also increased, adding substantially to the medical burden of schistosomiasis. Broadly the ultimate cause for these public health problems was the vast expansion of slow flow freshwater habitat along the river and in the associated waterways creating ideal habitat for aquatic plants. This in turn provided appropriate habitat for snail intermediate hosts, *Biomphalaria pfeifferi* for intestinal schistosomiasis and B*ulinus* spp. for urinary schistosomiasis. *Lymnaea natalensis*, the intermediate host for the liver fluke also has greatly increased along with disease in humans and animals. It is generally considered that immigrant workers, perhaps from Casamance, following employment opportunities associated with the dam and large scale agriculture may have introduced *S. mansoni* to the Lower Senegal River Basin (Urinary schistosomiasis was already endemic but at low prevalences.) Although chemotherapy has limited morbidity and mortality, the lack of options to reduce transmission has created a severe public health problem. Overall, the Lower Senegal River Basin, and particularly the vicinity of Richard Toll, is considered to include some of the most intense, transmission foci for human schistosomiasis in the world.

Schedule (13-21 March, 2007):

Day 1 – Dakar to Saint Louis
Day 2 – Lampsar River
Day 3 – Richard Toll
Day 4 – Richard Toll, Taouey river and canal, Lac de Guiers
Day 5 - CSS (Compagnie Sucriere, Senegaloise) canals and drains
Day 6 – CSS Aquaculture Facility and Podor
Day 7 – Dagana and Djoudj
Day 8 – Diama Dam, return to Dakar

Activities:

The duration of the trip was 8 days (13-21 March, 2007). At each urban center the Chief Medical Officer was interviewed (Saint Louis, Richard Toll, Dagana, Podor, as well as the Head of CSS medical facility). Our group spent one day along the Lampsar River (a large delta tributary of the Senegal River, two days near Richard Toll, one day at Dagana and one day at Podor. At each location we visited several water contact sites, seeking a variety of circumstances. At most water sites we briefly sampled aquatic vegetation for snails and other fauna.

Since *P. clarkii* is a candidate exotic biological control agent and *Macrobrachium* prawns are possible snail predators and competitors with crayfish, we sought information on their possible presence (the crayfish might have been present due to an unrecorded introduction). At each site residents, fishers, and sometimes local officials, were shown pictures of the Louisiana crayfish and a *Macrobrachium* prawn. Residents were asked if these large crustaceans were present and if they were (or had been) fished, consumed or marketed. Ms Gachassin interviewed village and women's association leaders concerning population characteristics, occupations and access to communication technology (ro be reported elsewhere).

Public Health and Fisheries Contacts:

Chief Medical Administrator, Saint Louis – Dr Diop
Chief Medical Administrator Ricard Toll – Dr Dieye
Head of District Hospital, Dagana – Dr Ndiaye
Medical Chief, CSS – Dr el H. Aboubacar Gassama
Head, Fisheries Center, Mbane – Mr Malick Gueye
Snail Collector, ISRA, Richard Toll – Mr Moussa Wade

Findings:

We examined 26 water contact sites at 12 locations. At Mbodiene and Ross-Bethio water contact sites were on the Lampsar R and at an irrigation scheme pump inlet. In the vicinity of Richard Toll water contact occurred along the bank of the Senegal R and at various canals along the periphery of the CSS plantation. Contact sites south of Richard Toll were visited along the Canal Taouey and Marigot Taouey (the natural river) and on the shore of Lac de Guiers. At both Dagana and Podor water contact sites were investigated along the shore of the Senegal R and along canals near these urban areas. On the CSS plantation workers and their families have frequent water contact at sites along the primary and secondary canals, some workers also have contact at tertiary canals. Drains have vegetation and snails but there is little human contact at those water bodies. At all locations water contact is at defined sites (other than for some irrigation workers). Adjacent shorelines are heavily vegetated by *Typha* reeds and other plants that make access to the water difficult.

We detected some snails at most sites. *Bulinus truncatus* and *Lymnaea natalensis* were the most widespread species in our samples and often the most abundant at sites. *Biomphalaria pfeifferi* was only recovered from one water contact site (at Ross-Bethio). It was also present in abundance at the CSS aquaculture facility. Other snails, *Thiara granifera* and *Bellamia sp* were also present at some sites. For several of the visited locations data, compiled by Dr Diaw, are available for snail presence and relative densities from before and after

construction of the Diama Dam. Thick aquatic vegetation made estimates of absolute density unfeasible. No large crustaceans were recovered. At two sites a small grass shrimp was common.

All medical officers and physicians contacted declared that schistosomiasis was their primary medical concern. This point was often passionately made. Some indicated that it was a greater source of mortality than even malaria (also endemic in this region). Other related medical concerns were liver disease directly or secondarily associated with intestinal schistosomiasis and fascioliasis (liver flukes, *L. natalensis* being the first intermediate host). All medical officers were enthusiastic, often emphatically so, for a transmission intervention. When the potential for biological control using crustacean predators was presented as a possibility all endorsed its further investigation. Several of these medical officers stressed that telling people to avoid water contact was educationally futile. People must have access to water.

The CSS has constructed an aquaculture facility that is operational but not in production. It includes 8 ~3X1 m cement tanks, 6 small ~40X18 m ponds and 2 large ~50X23 m ponds, pumps and an equipment shed. Grass carp and Tilapia are being reared and trialed by UCAD aquaculture staff. *Bulinus truncatus, L. natalensis* and *B. pfeifferi* were common in the tanks.

Fishers along the Senegal R and at Lac de Guiers readily recognized the photo of a male *Macrobrachium*. Given its distinctive morphology (very elongated claws), we considered this a definitive identification. An internet search revealed that this was likely the native *M. vollenhovenii*, a large catadromous prawn native to the Senegal river and other drainages in West Africa. At least one other species, *M. macrobrachion* is also present in Senegal but it is limited to the estuarine portion of the rivers. Experienced fishers reported seasonal changes in its abundance and all were in agreement that it was decidedly more common before the construction of Diama Dam, supporting local fisheries. Only a few of the fishers but many of the residents recognized our picture of *P. clarkii* (in a lateral view partially obscuring the claws). Respondents that recognized the image provided varied, often contradictory, descriptions of the habitat, abundance and behavior. Because female *Macrobrachium* superficially resemble our *P. clarkii* in lateral profile, we are unable to ascertain whether respondents were referring to *P. clarkii*, female *M. vollenhovenii*, or another large decapod crustacean such as an atyid shrimp. Attempts to set traps for crustaceans or offers of bounties for crustaceans were unsuccessful. River crabs were not observed nor were burrows seen in the banks.

A brief visit by pirogue to the Djoudj National Park revealed some of the impacts of Diama Dam on wildlife. Fish-eating birds were in great abundance and have increased considerably since the dam was constructed. Shore birds that feed on

invertebrates were quite scarce having greatly declined once tidal exposure of their prey was terminated by the dam. Catadromous fishes such as mullet are now very scarce above Diama.

Diama Dam is regulated by a quadrinational authority (Senegal, Mauritania, Mali and Guinea). The impounded water is maintained at a higher level in the dry season than in the wet season. The ship lock is opened for traffic (very infrequent) or once a month for 30 minutes if it was not used for traffic. This means that some seasonal or otherwise movement of some catadromous species may still occur, but is likely reduced greatly.

Conclusions:

1. Human schistosomiasis remains a severe public health problem in the Lower Senegal River Basin. Chemotherapy remains the only effective measure in use and its use is always reactive to disease presence. No transmission reduction measures are in effect nor planned, at least for the short term. All medical officers in afflicted jurisdictions supported the potential use of biological control using crustacean predators of snail intermediate hosts. The essential and frequent need to contact water makes reduced transmission imperative. With a mass treatment chemotherapy campaign these measure could reduce schistosomiasis to a minor and localized public health problem.

2. Virtually all water contact sites in this region are interconnected. Any successfully introduced snail predator will almost certainly spread throughout the freshwaters of the Lower Senegal River and its tributaries, canals and the Lac de Guiers. This means that a careful examination of the potential environmental impact will be needed prior to implementation of such a control program.

3. The CSS/UCAD aquaculture facility at Richard Toll presents an ideal opportunity to conduct experiments on prawn and crayfish predation on the medically important snails of the Senegal River Basin. The facility will enable replication of experimental treatments, an investigation of the impact of these crustaceans on each other and could serve for the initial cultivation of crayfish and the grow-out of prawns (should an effective hatchery for *M. vollenhovenii* be developed).

4. The indigenous likely snail predator, *M. vollenhovenii,* may have experienced a decline in abundance due to the construction of Diama Dam. This may also have contributed to the subsequent expansion of snail populations and the resultant marked increase in schistosome transmission. This may provide a partial explanation for the unexplained

increase in schistosomiasis at locations, such as Podor, upstream from the impounded water of the dam.

5. The great loss of wading birds habitat at Djoudj (above Diama Dam) may also have contributed to the increase in snail abundance after completion of the dam because some of these birds were potential snail predators and may have foraged in freshwater habitats along shorelines.

6. In these preliminary investigations no major adverse impacts of an exotic crustacean predator were recognized. Its likely impact will include reduction in abundance of non-medically important snails and on aquatic vegetation. Since exotic vegetation such as *Typha* is also an adverse environmental impact of the Diama Dam some further benefits of the crayfish may accrue. These crustaceans may also provide food for some native birds (i.e. ibises) and fishes (i.e. certain species of catfishes). Catfishes are diverse and abundant in the Lower Senegal River.

7. Discussions with residents suggested that crayfish would be readily accepted culinary items. The prawns are already marketed when available. Should either become abundant export market economies are possible.

Recommendations:

1. Determine if *M. vollenhovenii* eats snails that host medically important trematodes.

2. Review the present and historical distribution and abundance of *M. vollenhovenii* and other native decapod crustaceans in the Senegal river Basin. This may also identify the “other crustacean” recognized by residents in our survey.

3. Encourage installation of a ladder for prawn and fish passage at the Diama Dam.

4. Encourage development of *M. vollenhovenii* aquaculture.

5. Identify predation effects of crayfish on medically important snails and other potential non-target prey in the Senegal R. system (including *M. vollenhovenii*).

6. If *M. vollenhovenii,* proves insufficient for snail control, review the fauna and aquatic flora of the Senegal river to aid recognition of negative and positive potential impacts of an exotic crustacean.

7. Develop a food web model for the Senegal R. with links to Medically important snails to help estimate direct and indirect effects of crayfish introduction.

8. Develop a cost-benefit analysis of the potential release of crayfish with stakeholders, including environmental groups, from the 4 potentially impacted countries.

Reporter:

Armand Kuris