A PRELIMINARY ANALYSIS OF FUNCTIONAL FEEDING GROUPS OF STREAM MACROINVERTEBRATES IN THE WESTERN EXTENSION AREA OF THE WEST AFRICAN ONCHOCERCIASIS CONTROL PROGRAM

February 1987

by

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I. INTRODUCTION

The Onchocerciasis Control Program (OCP) was initiated in 1974 in a seven country area of West Africa with the goal of eliminating "onchocerciasis as a disease of public health and socioeconomic importance throughout the OCP area and to ensure that there is no recrudescence of the disease thereafter" (World Health Organization, 1985). The strategy chosen to control the disease was the application of insecticide to fast-flowing stretches of water where the larvae of the vector, Simulium damnosum, develop. It was estimated that the parasite, Onchocerca volvulus, could be eliminated by controlling the vector through repeated applications of the larvicide for a period longer than the parasite's lifespan. The needed treatment period was determined to be 20 years.

The life cycle of S. damnosum is approximately 10 days, so the target stream reaches are treated with larvicides on a weekly basis. "The Participating Countries, as well as the Donors, had reason to fear that 20 years' repeated applications of insecticides in the watercourses would cause serious disturbances in the freshwater ecosystems. The Sponsoring Agencies therefore set up before the Programme was launched an independent advisory body, the Ecological Panel (subsequently the Ecological Group) whose specific function was to ensure that vector control carried out by OCP did not endanger the environment" (World Health Organization 1985).

To evaluate the impact of larviciding on the aquatic fauna and flora, the OCP has a program of research and environmental monitoring which is supervised by the Ecological Group. A major thrust of the research has been to assess the impact of larvicides on the non-target aquatic fauna. The monitoring program supported by OCP is conducted by national hydrobiological teams who regularly sample treated streams according to a protocol established by the OCP Ecological Group. Although the monitoring program was established before some rivers were treated, there is no pre-treatment data for many of the monitoring sites. Thus, the assessment of the effect of larviciding on the fauna is more difficult.

After the decision was made to extend treatment into four countries on the western boundary of the original OCP area (Senegal, Guinea-Bissau, Guinea (Conakry), Sierre Leone), a monitoring system was put into place to provide a pre-treatment data base. The biogeography of some portions of the western extension area is a continuation of that found in the original OCP area. Thus, samples from these areas may provide a vicarious pre-treatment baseline for areas already treated. There are also some unique biotypes in the western extension area which should be examined before treatment, as the fauna may change when treatment begins.
The purpose of this consultancy was to assess the macro-invertebrate fauna in selected areas of the western extension area, especially through the analysis of functional feeding groups.
II. SCOPE OF WORK

As defined in the consultant employment agreement between the consultant and Medical Service Consultants, Inc. (MSCI), the scope of work was to be the following:

Your role will be to carry out field studies to make an inventory of the biota in selected areas of the OCP area utilizing standard protocols developed by OCP and their Ecological Group. These will include testing reactions of selected non-target organisms to larvicides that may be used in the control of the Simulium vectors.

1. This work is to be accomplished before the attack phase spraying begins in March/April 1987.

2. Four locations, of a possible seven, in Mali and Guinea are to be selected for follow-up studies.

3. Protocols to be followed are those prepared for and approved by the OCP Ecological Group. The protocols mentioned above will be discussed with Prof. Cummins in Accra, and later with OCP hydrobiologists.

4. If time permits, collect specimens for functional analysis of invertebrate communities and short-term growth experiments in the field.

5. Submit an acceptable report.

The consultant and Prof. Cummins discussed in Accra the sampling protocols (of point 3., above), as well as the overall objectives of the consultancy. Laurent Yameogo, Chief Hydrobiologist for OCP, also participated in some of the discussions. These discussions resulted in the following observations relative to the proposed scope of work:

1. OCP has other researchers testing the susceptibility of non-target fauna to larvicides and was more interested in having the consultant concentrate on work pertaining to functional feeding groups, especially in view of the limited duration of the consultancy.

2. Four locations in Guinea and Mali had already been selected as sites for permanent monitoring and for follow-up studies, following the recommendations of the OCP Ecological Group.
3. The quality of the field work would be enhanced if the National Hydrobiological Team of Guinea and/or the ORSTOM (Institut de Recherche Scientifique pour la Développement en Coopération) Hydrobiological Team, who are familiar with the sites and the aquatic fauna, were available to accompany the consultant into the field.

4. ORSTOM hydrobiologists and the Guinea National Team would be unavailable for field work until after the annual OCP Hydrobiologists Meeting in early January. After the meeting, there would be some possibility of going into the field with them.

In view of these discussions and the resulting observations, the objectives and scope of work of the consultancy were slightly modified to be as follows.

The consultant would:

1. Not test the susceptibility of any non-target organisms to larvicides that may be used by OCP.

2. Conduct field work in collaboration with the Guinea National Team and ORSTOM scientists, if the latter were available. The field work would consist of routine monitoring and field growth experiments at one or both of the permanent monitoring sites in Guinea and if possible, sampling for analysis of functional feeding groups at other sites.

3. Examine data collected in routine monitoring activities and past annual reports prepared by national hydrobiological teams to familiarize himself with the monitoring program.

4. Review research on the ecology of aquatic macro-invertebrates conducted in the OCP area, especially in view of retrieving information related to functional feeding groups.

5. Examine collections and identification keys at the ORSTOM Hydrobiological Laboratory in Bamako to become familiar with the aquatic fauna of Guinea.

6. The consultant would participate as an observer at the OCP Hydrobiologists Meeting to be held in Bamako, January 6-9, 1987.
The following approximate timetable was adopted:

Dec. 15-20 - Ouagadougou - Discussions with L. Yameogo
- Review of monitoring data
- Review of past research

Dec. 22 - Jan. 5 - Bamako - Review of past research
- Consultation with ORSTOM scientists
- Preparation for field work

Jan. 6-9 - Bamako - Hydrobiologists meeting

Jan. 12-31 - Guinea - Field work (exact timetable to be arranged with ORSTOM hydrobiologists and Guinea National Team)
- Examination of results
- Preparation of report

Feb. 2-7 - Bamako and Ouagadougou - Preparation of report
- Consultation with OCP and USAID officials
III. FUNCTIONAL FEEDING GROUPS

The use of functional feeding groups (Merritt and Cummins 1978, 1984; Cummins and Wilzbach 1985) "allows samples of running water invertebrates to be categorized according to mechanisms they utilize in acquiring food. The functional approach is directed primarily at the invertebrate morphology (e.g., mandibles, forelegs, etc.), and behavior that drives it, utilized in food acquisition" (Cummins and Wilzbach 1986). The five major functional feeding groups and the food resource category that each harvests most efficiently are summarized in Table 1.

Functional feeding group characteristics are known for many North American aquatic insect larvae (Merritt and Cummins 1978, 1984). However, the functional feeding group relationships of larvae from other parts of the world are not as well understood. The consultant did not find any published work analyzing per se the functional feeding group status of aquatic insect larvae in the OCP zone. However, the classification of some taxa is possible based on available information (Table 2).
### TABLE 1. STREAM-RIVER INVERTEBRATE FUNCTIONAL GROUPS AND THEIR FOOD RESOURCE CATEGORIES
(modified from Merritt and Cummins 1984)

<table>
<thead>
<tr>
<th>Functional Groups</th>
<th>Dominant Food Resources</th>
<th>Feeding Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shredders</td>
<td>Decomposing (conditioned) terrestrial vascular plant litter or wood: coarse particulate organic matter (CPOM, &gt; 1mm)</td>
<td>Chewers of litter; chewers or miners of live aquatic plants; gougers that excavate and gallery wood</td>
</tr>
<tr>
<td>Collectors</td>
<td>Decomposing fine particulate organic matter (FPOM, &lt; 1mm &gt; 0.5 mm)</td>
<td></td>
</tr>
<tr>
<td>Filtering Collectors</td>
<td></td>
<td>Suspension feeders that filter with structures equipped with setae or with various silk mesh structures produced by silk glands</td>
</tr>
<tr>
<td>Gathering Collectors</td>
<td></td>
<td>Depositors: feeders that ingest loose particles on surfaces or as mixed organic and inorganic sediments</td>
</tr>
<tr>
<td>Scrapers</td>
<td>Periphyton--attached algae and associated material</td>
<td>Graze solid mineral and organic surfaces by sheering off attached algae with edges of mandibles, maxillary brushes, tarsi of front legs, etc.</td>
</tr>
</tbody>
</table>
TABLE 1 cont.

<table>
<thead>
<tr>
<th>Functional Groups</th>
<th>Dominant Food Resources</th>
<th>Feeding Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piercers</td>
<td>Living tissue of aquatic vascular plants or macro-algae (large filamentous forms)</td>
<td>Pierce tissues and cells and suck out fluids.</td>
</tr>
<tr>
<td>Predators</td>
<td>Living animal prey</td>
<td>Attack and capture prey, engulfing whole individuals or their parts, or pierce body wall and suck fluids</td>
</tr>
</tbody>
</table>

From Cummins and Wilzbach 1986
TABLE 2. SUMMARY OF PREFERRED HABITATS AND FUNCTIONAL FEEDING GROUP STATUS WITHIN THE OCP AREA FOR SOME AQUATIC GENERA FROM FOUR INSECT ORDERS: EPHEMEROPTERA, LEPIDOPTERA, PLECOPTERA AND TRICHOPTERA

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Habitat</th>
<th>Functional Feeding Group (FFG)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ephemeroptera</strong></td>
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<tr>
<td>Baetidae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baetis</td>
<td>Dead leaves</td>
<td>Scraper</td>
<td>Dejoux et al. 1983</td>
</tr>
<tr>
<td>Centroptiloides</td>
<td>Rocks</td>
<td>Predator?</td>
<td>Dejoux et al. 1983</td>
</tr>
<tr>
<td>Centroptilum</td>
<td>Rocks, sand, dead leaves, rapid currents, stagnant water</td>
<td>Scraper</td>
<td>Dejoux et al. 1981,83</td>
</tr>
<tr>
<td>Cloeon</td>
<td>Rocks</td>
<td></td>
<td>Dejoux et al. 1981,83</td>
</tr>
<tr>
<td>Pseudocloeon</td>
<td>Rocks, rapid currents</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Caenidae</strong></td>
<td></td>
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<td></td>
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<td>Caenodes</td>
<td>Slow currents</td>
<td></td>
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<td>Caenomedea</td>
<td>Sandy bottoms</td>
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<td><strong>Ephemeridae</strong></td>
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<td>Afronera (=Ephemera)</td>
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<td></td>
<td>Dejoux et al. 1983</td>
</tr>
<tr>
<td>Batonic</td>
<td>Depositional zones Collector</td>
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<td><strong>Heptageniidae</strong></td>
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<td>Afronurus</td>
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<td></td>
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<td>Notonurus</td>
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<td></td>
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<td><strong>Leptophlebiidae</strong></td>
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<td>Adenophlebioides</td>
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<td></td>
<td>Dejoux et al. 1981,85</td>
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<tr>
<td>Choroterpes</td>
<td>Calm areas</td>
<td></td>
<td>Dejoux et al. 1981,83</td>
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<td>Thraulus</td>
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<td></td>
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<td><strong>Oligoneuridae</strong></td>
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<td>Elassoneuria</td>
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<td>Family</td>
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<td><strong>Trichoptera</strong></td>
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<td>Ecnomus</td>
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<td><strong>Hydropsychidae</strong></td>
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<td>Chimarra</td>
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<td>Dejoux et al. 1981,83</td>
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<td></td>
<td>under rocks, collector, in vegetation, predator</td>
<td>Marlier 1962, Gibon pers. comm.</td>
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<tr>
<td>Polycentropidae</td>
<td>Calm area, Filtering</td>
<td>Dejoux et al. 1983</td>
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<tr>
<td>Dipseudopsis</td>
<td>sandy bottoms collector</td>
<td>Gibon pers. comm.</td>
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</table>
IV. SUMMARY OF FIELD WORK

Two methods of field assessment were used to determine functional feeding group status of aquatic macroinvertebrates at selected sites in the western extension zone of the OCP area. The first was "in-situ" growth experiments and the second, collection of substrates (and the attached insects) from various microhabitats. The basis for the first method is that insects given different types of food will perform best when given the food that they are best equipped to utilize. The basis for the second is that insects will most likely be found in a microhabitat where there is a food resource which they are capable of utilizing.

A. Field Growth Experiments

Two "in-situ" growth experiments were conducted in the Niandan River at the permanent monitoring site near Sassambaya using 3-chambered growth boxes. The first experiment examined the growth of Tricorythus (Ephemeroptera: Tricorythidae) and the second examined the growth of Pyralus (Lepidoptera: Pyralidae). The choice of these two genera was based on several criteria. Their functional feeding group status is unclear and their ecology is appropriate for such an experiment. They can be easily identified in the field. They are large enough to be manipulated and to be weighed accurately in small groups. They are fairly abundant. They are both found on rocks covered with Tristicha; this microhabitat is very important in the stream reach where the experiments took place as well as in most rivers in the OCP area.

The boxes for the experiments were constructed using hermetic plastic boxes, measuring 20 cm x 9 cm x 8 cm. Three 3.5 cm x 5 cm windows were cut out of the long sides of each box and a 15.5 cm x 4 cm opening was cut in the top. These openings were covered with 200 um mesh screening held in place with "Metalline" glue. The insides of the boxes were divided into three chambers of approximately equal size using partitions of 200 um mesh screening attached with "Metalline" glue.

Cummins and Wilzbach (1986) recommend that coarse particulate organic matter (CPOM), mainly consisting of decaying leaf litter taken from the streams; fine particulate organic matter (FPOM), fine sediments; and attached algae be examined as potential food categories. However, the consultant's field work and discussions with ORSTOM hydrobiologists convinced him that leaf litter may not be an important food resource for aquatic macroinvertebrates in reaches similar to that chosen for the experiment. Thus rocks covered with Tristicha spp., a moss-like
Plant, were substituted for CPOM. The importance of Tristicha in the rivers in the OCP area has been noted by many authors (e.g., Dejoux et al. 1981, Elouard 1983).

Three boxes were used for the Tricorythus experiment, but only two were used for the Pyralus experiment due to technical constraints described below. The boxes were first prepared by placement of each of the three substrates in the chambers of each box. For the Tricorythus experiment the substrates were placed in a Latin-square design. For the Pyralus trial the substrates were placed randomly in each box in an incomplete randomized block design. Since no rocks with attached algae or Tristicha were of suitable size for placement in the chambers of the boxes, larger rocks were broken into pieces of suitable size. The FPOM was collected by pulling a drift net with 200 um mesh through a pool which was disturbed to suspend the particles. The harvested particles were then passed through a 800 um mesh sieve and 200 um mesh filter cloth. Thus, particles retained for the experiment were between 200 um and 800 um. This size range is somewhat more restricted than the definition of FPOM, which is from 50 um to 1000 um. However this choice of size range was dictated by available equipment.

After the boxes were stocked with the food materials, insects were collected for placement in the boxes. Two collection methods were initially tested. The first consisted of placing a Surber sampler over Tristicha-covered rocks, a usual habitat for both groups, and carefully disturbing the Tristicha with the intent of causing the animals to drift into the net. However this method was abandoned in favor of the second. The animals were collected by taking Tristicha-covered rocks from the stream, then carefully removing the animals with forceps and placing them into dishes for holding. The Tricorythus were counted by lots of five into a series of four dishes until each of the four held 25 insects. At this point, one of the four dishes was selected as an initial control and the insects in each of the other three were placed into one of the compartments of a growth box. The box was then placed into the stream in an area with medium current. This process was repeated for each of the three boxes. The insects of the control groups for each box were placed on aluminum foil in a dish and air dried. Not all of the Tricorythus collected were used in the experiment. In order to minimize individual variation, smaller individuals were eliminated.

The number of Pyralus gathered during the collection of the Tricorythus was not adequate for the planned experiment. After the placement of the Tricorythus boxes, more rocks were examined in search of additional Pyralus. However only 32 of nearly uniform size were found. These were divided into eight groups of
four. Two of the groups were used as controls and the other six were placed into the six chambers of two boxes. A third box which had been prepared was not used due to the inadequate number of animals.

The boxes were left in place for almost seven days. The mesh screens were cleaned at least once daily without opening the boxes. Stream water temperatures were measured several times daily and were used in the calculation of accumulated degree-days (i.e., the cumulative sum of the median daily temperature). The experiment covered a period of 175 degree days. The median daily temperature was 26 degrees Celsius.

The experiment was terminated by removing the boxes from the stream and subsequently removing the animals from the chambers. The number of animals present in each chamber was noted to allow determination of survival (Table 3). All of the insects from each chamber were placed on aluminum foil in a dish and air dried. Those dishes as well as those containing the initial control groups were then transported to the ORSTOM Hydrobiological Laboratory at Bamako where they were weighed on a Sartarous 2842 microbalance. Although this type of balance is capable of accuracy to 0.1 mg when adequately installed, the balance used for this research was determined to be accurate only to 1 mg. Thus, in order to have sufficient weight for accurate measurement, each group was weighed as a whole. Average weights were then determined for the initial control groups and for animals in each treatment (Table 3).
### TABLE 3. INITIAL WEIGHTS, AND FINAL WEIGHTS AND SURVIVAL FOR THE THREE TREATMENT GROUPS FOR TRICORYTHUS AND PYRALUS

<table>
<thead>
<tr>
<th>Group</th>
<th>Tricorythus</th>
<th>Pyralus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Survival(%)</td>
<td>Weight (mg)</td>
</tr>
<tr>
<td>Initial</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Tristicha</td>
<td>85</td>
<td>1</td>
</tr>
<tr>
<td>Algae</td>
<td>53</td>
<td>1</td>
</tr>
<tr>
<td>FPOM</td>
<td>37</td>
<td>1</td>
</tr>
</tbody>
</table>
Survival of insects from both taxa in the chambers with Tristicha was superior to that in chambers with the other two foods. Also, for both insect taxa, survival in the chambers with algae was superior to that in chambers with FPOM. Mean insect weight decreased in all groups, but any differences in amounts or rates of weight loss among treatments were not detectable.

The results of this experiment were not entirely satisfactory. The high survival rates of insects in the chambers with Tristicha demonstrates that this method can be used in conditions such as those in the Niandan. However, the weight losses in all groups indicate that the method needs refining. Two possible modifications would be: (1) replacement of the 200 um mesh screening with screening of a larger mesh size, to assure good water circulation; and/or (2) varying the food per insect per time ratio to assure that the insects would not be food limited.

Nevertheless one can conclude from this experiment that the Tristicha environment was superior to that of the other food sources and that algae-covered rocks were superior to FPOM. These results are in agreement with results from field collections. Tricorythus are abundant on Tristicha-covered rocks but were not found on algae-covered rocks or in areas where there is deposition of FPOM. Tricorythus probably eat Tristicha (J. M. Elouard pers. comm.), but Tristicha-covered rocks may have more interest to them as a microhabitat where other food resources collect. This latter hypothesis is substantiated by their abundance in leaf litter and on wood samples, which also serve as substrates for collection rather than as direct dietary items.

Pyralus, on the other hand, seems more likely to be primarily a grazer on the Tristicha. These larvae are strongly associated with Tristicha-covered rocks (Dejoux et al. 1981). Other members of the family are also generally found on aquatic vegetation (Dejoux et al. 1983).

B. Field Collections

The consultant visited and made field collections at six sites on three rivers: the Bakoye in Mali; the Niandan in Guinea; and the Milo in Guinea. The most intensive sampling was done at the permanent monitoring site on the Niandan River near Sassambaya, which was also the site of the field growth experiments. The consultant also participated in routine monitoring activities for the Milo and Niandan. At the time of the visit to the Bakoye, water levels were too low to sample for monitoring.
The field collections made by the consultant consisted of a number of qualitative and quantitative samples taken in different microhabitats. The 20 quantitative samples were sorted to family level, or to generic level when possible, and counted. The data from these samples as well as from the qualitative samples are summarized in Table 4.
TABLE 4. ABUNDANCE OF AQUATIC INSECT LARVAE IN THE
PREDOMINANT SUBSTRATE TYPES FOR THE SIX SITES EXAMINED (see 'ext)
Blank = not found, P = Present, C = Common, A = Abundant

<table>
<thead>
<tr>
<th>Family</th>
<th>Wood</th>
<th>Leaf Litter</th>
<th>Rocks with Tristicha</th>
<th>Rocks with algae</th>
<th>FPOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coleoptera</td>
<td></td>
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<tr>
<td>Elmidae</td>
<td></td>
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<tr>
<td>Larvae</td>
<td>A</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>C</td>
<td>P</td>
<td></td>
<td>P</td>
<td>P</td>
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<tr>
<td>Diptera</td>
<td></td>
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<tr>
<td>Chironomidae</td>
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</tr>
<tr>
<td>Chironomini</td>
<td>C</td>
<td>C</td>
<td></td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Orthocladiinae</td>
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<td>P</td>
<td></td>
<td>P</td>
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<tr>
<td>Tanytarsini</td>
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<td>P</td>
<td></td>
<td>P</td>
<td>P</td>
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<tr>
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<td>C</td>
<td>C</td>
<td></td>
<td>C</td>
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<tr>
<td>Ephemeroptera</td>
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<tr>
<td>Baetidae</td>
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<tr>
<td>Afrobaetodes</td>
<td>P</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>P</td>
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<tr>
<td>Centroptilum</td>
<td>P</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>P</td>
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<tr>
<td>Caenidae</td>
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<td>P</td>
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<td>P</td>
<td>P</td>
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</tr>
<tr>
<td>Leptophlebiidae</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Tricorythidae</td>
<td></td>
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<tr>
<td>Dicercomyzon</td>
<td>P</td>
<td>A</td>
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<tr>
<td>Machadorythus</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<tr>
<td>Tricorythus</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<tr>
<td>Heteroptera</td>
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<tr>
<td>Naucoridae</td>
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<tr>
<td>Lepidoptera</td>
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<tr>
<td>Pyralidae</td>
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<tr>
<td>Pyralus</td>
<td></td>
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<td>P</td>
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<tr>
<td>Odonata</td>
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<td>Gomphidae</td>
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<tr>
<td>Paragomphus</td>
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<td>C</td>
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<td>Libellulidae</td>
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<td>C</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>Leaf</td>
<td>Rocks with Tristicha</td>
<td>Rocks with algae</td>
<td>PFPOM</td>
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<tr>
<td>Plecoptera</td>
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<tr>
<td>Perlidae</td>
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<tr>
<td>Neoperla</td>
<td>A</td>
<td>A</td>
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<tr>
<td>Tricoptera</td>
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<tr>
<td>Hydropsychidae</td>
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<tr>
<td>Hydropsychinae</td>
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<tr>
<td>Cheumatopsyche</td>
<td>C</td>
<td>P</td>
<td>C</td>
<td>P</td>
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<td>Micronematinae</td>
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<td>Macrostemum</td>
<td>C</td>
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<td>Protomacronema</td>
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<tr>
<td>Leptoceridae</td>
<td>P</td>
<td>P</td>
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<td></td>
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<tr>
<td>Philopotamidae</td>
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<td></td>
</tr>
<tr>
<td>Chimarra</td>
<td>P</td>
<td>C</td>
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<td>P</td>
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</tbody>
</table>
Wood seems to serve generally as a substrate, rather than as a food source, in the streams examined. The only insects burrowing into and ingesting the wood appeared to be Elmid beetle larvae. Some chironomids may also be ingesting the wood. Other groups which are common or abundant on the wood generally function as filtering collectors (Simuliidae, Cheumatopsyche, Macrostemum), gathering collectors (Elmidae <adults>, Tricorythus), or predators (Neoperla). Cheumatopsyche and Macrostemum may also serve as predators (Statzner 1982, J. Schorscher pers. comm.).

In the leaf litter, there seems to be a complete absence of the shredder functional feeding group. None of the groups which normally function as shredders are present. Nor are there any indications of the presence of any shredders; there was no evidence of any skeletonization of leaves in any of the leafpacks examined. The leaves in the packs generally had a tough cuticle, and only a few leaves had been softened by microbial activity. Those insects common or abundant in leaf litter were Chironomini (gathering collectors and predators), Tricorythus (gathering collectors and/or predators), Neoperla (predators), and Chimarra (collectors and/or predators). Thus, leaves function as a substrate rather than as a food source.

Rocks covered with Tristicha have a varied and abundant fauna, as has been reported elsewhere (e.g., Dejoux et al. 1981, Elouard 1983). The macroinvertebrate community in this microhabitat consists of numerous taxa functioning as filtering collectors, gathering collectors, and predators. There also may be some insects that are facultative grazers or some that feed directly on the Tristicha.

No insects were found to be common or abundant on rocks covered with algae. This substrate type was not common at the sites examined. Of the taxonomic groups which are generally associated with this type of habitat, functioning as grazers, only Heptageniidae were present; even they were only present in minimal numbers, and may function as predators (Dejoux et al. 1983). Insects of this family also are rare on algae-covered rocks in other areas of the OCP (L. Yameogo, pers. comm.).

The areas with FPOM which were examined were slow current areas within the rapids complex. In these areas there is a fine layer of silt which has settled onto rocks or sand. The large, deep pools between the rapids were not examined. Taxa which were found to be common or abundant in the FPOM examined were gathering collectors (Chironomini, Caenidae, Machadorythus) or predators (Naucoridae, Ptragomphus).
V. CONCLUSIONS AND RECOMMENDATIONS

The results presented here suggest the existence of notable differences between the functional feeding group structure in streams in the OCP area and those in temperate areas which have been previously examined. In the streams examined by the consultant, scrapers are poorly represented and shredders are absent except for wood-gouging beetle larvae. The paucity of representatives of these two groups seems to be generalized throughout the OCP area (F. Gibon pers. comm., L. Yameogo pers. comm.). The reasons for this absence are not readily apparent. Several of the taxa with important representatives in those two groups absent from the OCP area include Limnephilidae (Trichoptera), which has members from both groups; Phrynganeidae (Trichoptera), shredders; Glossosomatidae (Trichoptera), scrapers; as well as the setapalpian stoneflies (Plecoptera), shredders.

It seems, however, that if the resource were available, other groups would utilize it. The algae-covered rock micro­habitat is limited, but leaf packs are abundant. As previously mentioned, the leaf packs examined were not "well-conditioned" through microbial activity and most leaves had a waxy cuticle. Thus they were not an available resource for aquatic macroinvertebrates. Furthermore, the rapid fluctuating water levels may prevent adequate microbial conditioning as leaves trapped in leaf packs would be stranded by declining water levels or deposited in deep pools where microbial activity is inhibited by anaerobic conditions.

Another explanation, at least for shredders, would be the life strategy necessary for utilization of the resource. Since the food quality of the leaf litter resource is poor, many shredders have rather long life cycles and slow growth. However, the limited temporal availability of the resource would prohibit this strategy.

The presence of piercers was not determined, but the collectors, both filtering and gathering, and the predators are well represented at the sites examined. The most important habitat type is the Tristicha-covered rock which provides attachment points for the nets of filtering collectors. The Tristicha itself also functions as a filter for FPOM used by gathering collectors, and as a habitat for predators.

The preliminary results presented in this report indicate that the trophic structure of the macroinvertebrate communities in the streams examined, as determined using functional feeding group analysis, may be very different from those in the northern
temperate zones which have been studied in depth. The region in eastern Guinea where most of this work was accomplished is sparsely populated and villages are not close to the streams. Nor is there substantial, if in fact any, agricultural activity in proximity to the streams, except for larger rivers. Thus from a scientific perspective it is important to document in as much depth as possible the pretreatment condition of these streams. This is especially true in view of OCP's need to use more drastic larvicides (Chlorphoxim, Carbosulfan, Permethrin) due to resistance problems with the less toxic temephos.

In addition to purely scientific value, a more in-depth analysis of the functional feeding group structure in the rivers in the western extension zone could also assist in the interpretation of post-treatment data from this zone as well as other OCP areas for which pre-treatment data are not available.

Although not all of the western extension area will come under treatment when larviciding operations begin in March/April 1987, it is imperative that such research, if undertaken, begin as soon as possible to provide adequate pre-treatment data before the entire zone is treated. This work should cover the entire annual cycle and should be coordinated with ORSTOM and OCP hydrobiologists to maximize the efficiency of the work.
VI. LITERATURE CITED AND/OR CONSULTED


The consultant discussed the results and conclusions of this work individually with B. Philippon (Chief of Vector Control Unit, OCP), J. Grunewald (Coordinator of Research, OCP) and L. Yameogo (Chief Hydrobiologist, OCP). Each expressed interest in the work which was done and the desire to see a follow-up study. They were all anxious to present the results at the meeting of the Ecological Group in late March 1987 and each was hopeful that the Ecological Group would recommend follow-up work in this area. However, as OCP funds are currently very limited, there is little chance that OCP will fund the work. Thus they are hoping that the follow-up work can be funded by a donor, as was this study. They see this line of research as not only of basic scientific interest, but also of possible value to the OCP aquatic monitoring program as a method of improving the interpretation of the monitoring data. Although part of the western extension area is scheduled to be treated as of March/April 1987, not all of the area will be treated. Thus there is a possibility that more work in this area may be undertaken before treatment begins.

The OCP officials lamented that materials sent by Prof. Cummins did not arrive. The consultant was obliged to construct the boxes for the field growth experiments with locally available materials and he was not able to fix and preserve samples for scanning electron microscopy.

They also suggested that a future study should have a longer duration and have more time allotted for field work. The consultancy was arranged quickly at the urgent request of OCP which desired completion of this study prior to the initially planned spraying in March/April 1987. The efficiency of future consultancies will be enhanced by greater coordination of timing and schedules between all parties concerned.

ORSTOM entomologists offered their collaboration and use of their laboratory to the consultant if further work is undertaken.
APPENDIX II. LIST OF PERSONS CONTACTED

I. World Health Organization (WHO)

A. Headquarters, Geneva
   1. Douglas Marr, WHO/OCP Liaison Officer

II. Onchocerciasis Control Program (OCP) Staff

A. Direction
   1. Ebrahim Samba, Director
   2. D. Cavalho, Coordinator and Acting Director

B. Vector Control Unit (VCU)
   1. Bernard Philippon, Chief
   2. David Baldry, Administrator
   3. Jorg Grunewald, Research Coordinator
   4. Laurent Yameogo, Chief Hydrobiologist
   5. Pierre Guillet, Chief, Western Operational Zone
   6. Bruce Wahle, Consultant, Larvicide Testing

III. OCP Ecological Group

A. Members
   1. Kenneth W. Cummins, Chairman
   2. Christian Leveque

B. Consultant
   1. Colin Fairhurst, Statistician

IV. Guinea National OCP Team

A. Direction
   1. Yaya Kassé, National Director

B. National Hydrobiological Team
   1. Keletigui Nabe, Entomologist
   2. Kerfalla Camara, Technician

V. ORSTOM (Institut de Recherche Scientifique Pour le Developpement en Coopération), Hydrobiological Laboratory, Bamako

A. Ichthyology
   1. Didier Paugy, Ichthyologist and Director of Laboratory
   2. Vincent Benesch, Ichthyologist

B. Entomology
   1. Jean Marc Elouard, Entomologist
   2. Francois Gibon, Entomologist
   3. Jean Jacques Troubat, Technician
APPENDIX II cont.

4. Patricia Hideux-Elouard, Consultant, Larvicide Testing
5. Judith Schorscher, Doctoral student
6. Jean Wuillou, Doctoral student
7. Fanfodé Condé, Guinean trainee

VI. USAID

A. Accra
   1. Jerre Manarolla, Acting Director

B. Ouagadougou
   1. Richard Green, Health and Population Officer

C. Bamako
   1. Eugene Chiavaroli, Director
   2. Wilbur Thomas, Assistant Director
APPENDIX III. DAILY ACTIVITY SUMMARY

Fri. Dec. 5 - Obtained air ticket to Nairobi. Briefed OAR (Office of the A.I.D. Representative)/Kigali on TDY. Traveled via air to Nairobi. Obtained Kenya visa at airport.

Sat. Dec. 6 - Searched (unsuccessfully) for prepaid air ticket to Accra. Purchased air ticket.

Sun. Dec. 7 - Spent the day at the airport attempting (unsuccessfully) to board Ethiopian Airways flight to Accra via Lagos, thereafter making subsequent flight arrangements.


Tue. Dec. 9 - Layover in Nairobi

Tue. Dec. 16 - Discussed workplan and logistical needs with L. Yameogo and D. Baldry. Continued examination of data sheets from national teams. Briefed USAID/Ouagadougou (F. Green, Health and Population Officer) on purpose of TDY. Also discussed the JPC meeting in Accra and the devolution process of OCP.
APPENDIX III cont.


Thu. Dec. 18- Prepared field equipment for transport to Bamako. Continued review of research on non-target invertebrates.


Sat. Dec. 20- Traveled via route to Bobo-Dioulasso.


Mon. Dec. 22- Met with P. Guillet (Director, WOZ [Western Operational Zone]/VCU), briefed him on the purpose of consultancy and needs for logistical support. He accompanied me to the ORSTOM Hydrobiological Laboratory and introduced me to staff members. Met with J. M. Elouard, who briefly explained his work with Ephemeroptera and showed me the laboratory facilities. Briefed USAID/Bamako (E. Chiavaroli, Director) on purpose of consultancy.

Tue. Dec. 23- Discussed with F. Gibon his work with Trichoptera and ORSTOM hydrobiological research in the western extension zone of OCP. Applied for visas for Mali and Guinea.

Wed. Dec. 24- Reviewed documents reporting research on non-target invertebrate fauna in the OCP area. Discussed with ORSTOM staff my research review, and the invertebrate fauna of the western extension area.

Thu. Dec. 25- ----


Sun. Dec. 28- ----

Mon. Dec. 29- Continued activities of Dec. 27.

Tue. Dec. 30- Continued activities of Dec. 29.


Thu. Jan. 1- ----

APPENDIX III cont.

Sat. Jan. 3 - Continued activities of Jan. 2. Discussed with J. Wuillou (Doctoral student with ORSTOM) his research plans. Examined preserved specimens of Ephemeroptera. Discussed with L. Yameogo advancement of work and plans for field work.

Sun. Jan. 6 - ----

Mon. Jan. 5 - Continued activities listed for Jan. 2. Applied for Ivory Coast visa.

Tue. Jan. 6 - Attended annual OCP hydrobiologists meeting. Discussed with B. Wahle OCP larvicide tests on non-target invertebrate fauna.

Wed. Jan. 7 - Attended hydrobiologists meeting. Discussed with C. Fairhurst (Univ. of Salford, U.K.) his analyses of OCP hydrobiological data.

Thu. Jan. 8 - Attended hydrobiologists meeting. Discussed briefly plans for field work with J. M. Elouard. Discussed plans for and goals of field work with B. Philippon, C. Leveque (Member, OCP Ecological Group) and J. Grunewald (Research Coordinator, OCP).


Sat. Jan. 10 - Preparation of detailed plan for field work.

Sun. Jan. 11 - ----

Mon. Jan. 12 - Traveled via route and conducted field work on the Bakoye River.


Wed. Jan. 14 - Revised some details on plan for field work. Discussed plan for field work with ORSTOM staff. Prepared documents needed for field work.

Thu. Jan. 15 - Prepared for field work. Constructed equipment needed for field growth experiments.

Fri. Jan. 16 - Continued preparations for field work.

Sat. Jan. 17 - Continued preparations for field work.

Sun. Jan. 18 - ----


Tue. Jan. 20 - Traveled via route: Yanfolila-Kankan - permanent monitoring site on the Niandan River near Sassambaya. Sampled the Niandan, including routine monitoring.
APPENDIX III cont.

Wed. Jan. 21- Concluded sampling of the Niandan. Traveled via route and by dugout canoe to a site on the Niandan near Bessekoro, where we briefly sampled. Traveled to the permanent monitoring site on the Milo River near Boussoule. Sampled the Milo, including routine monitoring.

Thu. Jan. 22- Concluded sampling of the Milo, visited another site on the Milo about 500 meters upstream. Returned to permanent monitoring site on the Niandan.

Fri. Jan. 23- Prospected different sub-habitats at the monitoring site of the Niandan. Prepared materials for field growth experiments.

Sat. Jan. 24- Collected substrates and insects, and initiated field growth experiments.

Sun. Jan. 25- Examined samples of wood and leaf litter for analysis of invertebrates found in these microhabitats.


Tue. Jan. 27- Analyzed sampling results and prepared report.

Wed. Jan. 28- Sampled microhabitats at the permanent monitoring site and at another site about 1 km downstream.

Thu. Jan. 29- Analyzed sampling results and prepared final report.

Fri. Jan. 30- Sampled microhabitats at the site 1 km downstream. Assisted Guinea National Team with sampling for monitoring.

Sat. Jan. 31- Terminated field growth experiment and prepared samples for transportation to Bamako. Traveled via route to Bamako.

Sun. Feb. 1 - ----

Mon. Feb. 2 - Briefed USAID/Bamako (E. Chiavaroli, Director) and OCP (B. Philippon, Chief, VCU) on results of field work. Prepared report.

Tue. Feb. 3 - Analyzed results of field work and prepared final report.

Wed. Feb. 4 - Discussed results with ORSTOM staff and with J. Grunewald (Research Coordinator, OCP). Traveled via air to Ouagadougou. Discussed report with L. Yameogo (Chief Hydrobiologist, OCP).

Sat. Feb. 7 - Traveled via air to Addis Ababa with a layover in Abidjan.
Mon. Feb. 9 - Layover in Addis Ababa.
Tue. Feb. 10 - Traveled via air from Addis Ababa to Kigali.