

REPORT ON BIOLOGICAL STUDIES
CONDUCTED IN THE AREA AROUND THE
PROPOSED MONASAVU HYDROELECTRIC DAM

ENVIRONMENTAL STUDIES REPORT NO. 1

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THE PROPOSED MONASAVU
HYDROELECTRIC DAM

INSTITUTE OF NATURAL RESOURCES
UNIVERSITY OF THE SOUTH PACIFIC

REPORT ON BIOLOGICAL STUDIES CONDUCTED
IN THE AREA AROUND THE PROPOSED NOWASAVU HYDROELECTRIC DAM

BY

THE INSTITUTE OF NATURAL RESOURCES.

THE UNIVERSITY OF THE SOUTH PACIFIC

FOR

SIR ALEXANDER GIBBS AND PARTNERS.
AUSTRALIA, AND THE FIJI ELECTRICAL AUTHORITY

June, 1977

PERSONNEL INVOLVED IN COLLECTION OF
DATA AND PREPARATION OF THIS REPORT

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T A B L E O F C O N T E N T S

Section	Page
PREFACE	
1 INTRODUCTION	1
2 PROPOSED MONASAVU LAKE SITE	3
3 REGION BELOW THE DAM SITE AS FAR AS THE JUNCTION WITH THE WAINIMALA RIVER	7
4 WAILOA RIVER-BELOW THE WAILOA POWER STATION SITE AS FAR AS THE JUNCTION WITH WAILOA AT LALELEVU	8
5 REPRESENTATIVE BIOTA FROM TRANSECT AREAS	11
6 INSECTS OF THE AREA	25
7 NEMATODES OF THE AREA	26
8 BIRDS AND OTHER LAND VERTEBRATES OF THE AREA	28
9 FISH	30
10 RECOMMENDATIONS	33
11 ACKNOWLEDGEMENTS	34
 Bibliography	
 Appendix	

PREFACE

Between April 13th and May 22nd, 1977 four two-day trips were made to the area about Monasavu falls. A fifth trip was terminated, prevailing weather conditions at the area preventing access by helicopter.

During these trips, data and impressions of the biota of the area were gathered. This report is a preliminary assessment of those data and impressions.

The report has two functions.

To provide evidence as to the biological status of the area.

To provide proposals for a more prolonged and detailed assessment of the likely overall impact of the proposed hydrological changes.

The present state of knowledge of much of the fauna of the area necessitated submitting samples to overseas institutions for taxonomic determinations. At the time of writing such determinations were mostly unavailable, and many species have here been referred to by genus or family.

1. INTRODUCTION

A series of brief biological observations were made in response to a request for some baseline data from Sir Alexander Gibbs and Partners. Our terms of reference for these observations were as follows:-

" The study will consist of :

- i) observations of the groups of organisms specified;
- ii) identification of groups of organisms collected to the lowest feasible taxon;
- iii) recommendations for further studies leading to a biological component of an environmental impact study considered satisfactory by the Institute of Natural Resources study group ;
- iv) statements pertinent to the effect, on the locations studied, of the hydro project under consideration where possible

The observations to be made relate to the construction of a dam up to a level of 2,400 ft. across the Nanuku River immediately upstream of the Monasavu Falls and a power station approximately two miles, upstream from the village of Laselevu.

They will consist of:

- a) the identification, as far as possible of existing aquatic plant species and existing aquatic animals at selected locations in the following areas:-

1. Above the dam site and below as far as the junction with Wainisavulevu.
2. Below the Wailoa power station site as far as the junction with the Wainimala at Laselevu.

- b) Identification as far as possible, of existing land animals at selected locations in the Monasavu catchment area and particularly in the area in which inundation is proposed.

- c) Identification as far as possible, of terrestrial plant communities at selected locations in the area in which inundation is proposed.

N.B. It is likely that not all specimens can be identified in detail at USP and that some specimens will be sent abroad for detailed identification; the results of these may not be available by June 30th 1977. However, broad categorisation will be possible by that date in these cases."1

Because of the limited time available and the teaching commitments of the staff involved only a total equivalent of 27 man days were spent on the whole study. It must therefore be emphasised that these studies have very little predictive value. Further, more thorough studies must be carried out before definitive statements can be made on the possible biological effects of the hydro-electric project on the area.

1. Taken from agreement between INR, GIBBS & PTNRS & FEA

PROPOSED MONASAVU LAKE SITE

The proposed lake is estimated to cover some 180 hectares² and will be about 6 kilometres long and 1.5 kilometres at its maximum width. It will be some 100 metres deep when full with a 15 metre drawdown.

2.1. Terrestrial Biota

Some 5-6 man days were spent on observations in the land area that will be inundated (site 1, see map).

2.1.1. Forest Type

The area to be inundated is covered by rainforest of variable structure and composition. Although most of it is classified as commercial forest³ the general appearance is one of very open, light forest. Dominant emergents are kauvula (Endospermum macrophyllum), Canarium sp. Parinari sp. and dakua (Agathis vitiensis) (See Fig.1.) These occur largely on the more gentle slopes. The steeper slopes (40° or more) are covered with lower, more dense forest, the trees forming either one or two storeys.
(See Fig. 2.)

Some observations made and worth noting are:

- i) the apparent paucity of regrowth of the emergent tree species;
- ii) the abundance and vigour of introduced species along the stream banks (See Fig.3.)
- iii) the absence of the common reed (Miscanthus) from the area.

2. ENEX - REPORT ON HYDROELECTRICITY IN FIJI

3. BERRY & HOWARD - FIJI FOREST INVENTORY

2.1.2

ENDANGERED PLANT SPECIES

It is not possible to make any statement regarding the occurrence or non-occurrence of endangered plant species in the area. An extremely thorough combing of the area over several months (to cover flowering and fruiting times) is necessary.

A list of plants noted or collected from the area is provided in Appendix 1. These represent only a small proportion of species that occur in the area. 20 of them are endemic.

2.1.3.

RIVERBANK VEGETATION

In as much as it may give some indication of the shoreline vegetation of the proposed lake, the riverbank vegetation was noted. This comprises three main types:-

- (a) pebbly shore vegetation
- (b) muddy shore vegetation
- (c) rock face vegetation

(a) Exposed pebbly shores are scantily covered with hardy species including the characteristic endemic native shrub, Acalypha rivularis, and a collection of weeds such as Cyperus brevifolius, Cuphea carthagensis, Cyperus polystachyos, and Stachytarpheta urticifolia.

(b) Where the shore is muddy, Brachiaria rufica (para grass) abounds (See Fig.5.) With it are other species, such as Erianthus maximus, Ageratum spp., Ludwigia octovalvis, Cestrum nocturnum, and Datura stramonium.

(c) While the above groups are largely herbs and shrubs with a high proportion of exotics, the sheer rock face is still largely composed of native shrubs, herbs, lianes and some low trees (See Fig. 2.).

2.1.4.

C O M M E N T S

2.2.1. This forest is part of a transition zone between the wet and the dry vegetation areas. Its role as a suture zone, not only for plants, but also for animals, is unknown. Further studies are necessary in order to assess the role of this community in maintaining neighbouring communities. This is particularly important if further areas are to be inundated in the central plateau, so that post-project management proposals will ensure the occurrence of as little damage as possible to the overall plateau biotic communities.

Our transect indicates that the forest is a rich one in terms of species diversity.

Clearings in the forest are first invaded by a mixture of native and introduced herbaceous species, not including grasses. These leave over 50% bare soil surface between them and will probably mean much erosion into the lake for many years after forest clearing, unless grasses such as Paspalum distichum invade early.

2.2 AQUATIC BIOTA

This was sampled by means of line transects across fast and quiet sections of the stream. Organisms occurring on these transects were observed at 2 metre intervals.

In addition, general observations and collections were made in the stream. Relevant physical parameters such as water temperature, turbidity and oxygen content were recorded. Results of transects at this station and other selected stations are presented in section 5 of this report. Locations of sampling stations are indicated on the map provided.

2.3 COMMENTS.

2.3.1 Nanuku stream water was highly turbid. The reasons for the turbidity and the possible implications in terms of the proposed dam need to be explored.

2.3.2. The absence of any fish, including eels, or large prawns is notable. The reasons for this cannot be merely assumed to be due to high elevation of the area. Further studies are necessary not only to find reasons for the absence of the named organisms, but also to explore the feasibility of introducing fish to the area.

2.3.3. As data from the transects indicates, some species found in Nanuku creek ~~is~~ exist only rapids. Studies should be made to assess the effect of the loss of these species on the total aquatic and terrestrial system.

2.3.4. Lake conditions will favour growth of a different association of plant and animal life. Initial high content of organic material from rotting submerged vegetation, extreme deoxygenation, possibly significant temperature gradation, and lack of water circulation are very important environmental changes. Our studies are so limited that we cannot predict the fate of many existing organisms under lake conditions.

2.3.5 Aquatic plants that may pose a problem to the proposed hydro-electric scheme may include the profusely branching Cladophora sp. found in quiet sections. However, experience from other such lakes in tropical countries ~~is~~ not in comparison.

TABLE 1.

RESULTS OF QUADRANT SURVEYS TABULATED

Form	Description	Height	Species list	Relative Abundance *(Occurrence as % of total trees)
Trees	Emergents	About 20n.	<u>Endospermum macrophylla</u> <u>Callophyllum vitiense</u> <u>Burkella thurstonii</u> <u>Canarium harveyi</u> <u>Palauquin hornei</u> <u>Parinari insularum</u>	2.4 1.2 2.4 1.2 1.2 2.4
	Main Canopy	Up to About 15 n.	<u>Macaranga graeffeana</u> <u>Plorandra grayi</u> <u>Bironniera celtidifolia</u> <u>Dendrocnide harveyi</u> <u>Parasponia andersonii</u> <u>*Myristica castaneifolia</u> <u>*Mauittoa sp.</u> <u>*Dysoxylum hornei</u> <u>*Canarium harveyi</u> <u>*Pittosporum brackenridgei</u>	26.5 14.5 8.4 7.2 6.0 4.8 2.4 2.4 1.2 1.2
	Understorey	from about 5n.	<u>*Vavaya unicolorum</u> <u>Ficus spp.</u> <u>*Gonostylus punctatus</u> <u>Cordyline terminalis</u> <u>Aglaia sp.</u> <u>Cyathea affinis</u> <u>*Palauquin hornei</u> <u>* Parinari insularum</u> <u>* Macaranga graeffeana</u>	1.2 1.2 1.2 1.2 1.2 2.4 2.4 2.4 1.2

* Immature form

Form	Description	Height	Species List	Relative Abundance (Occurrence as % of total shrubs)
Shrubs	On steep slope (40°-45°)	From 1-5m	<u>Heliconia indica</u>	27.2
			<u>Clidemia hirta</u>	22.7
			<u>Piper puberulum</u> var. <u>puberulum</u>	9.1
			<u>Cyrtandra sp.</u>	9.1
			<u>Ficus sp.</u>	4.5
			<u>Psychotria archboldiana</u>	4.5
			* <u>Plerandra sp.</u>	4.5
			* <u>Cestrum sp.</u>	4.5
			<u>Elatostema australe</u>	13.6
Ridge Top	1-5m.	<u>Clidemia hirta</u>	55.5	
		<u>Alpinia sp.</u>	11.1	
		<u>Pteridium esculentum</u>	8.3	
		* <u>Geniostoma uninervum</u>	2.8	
		* <u>Psychotria sp.</u>	2.8	
		* <u>Gironiera celtidifolia</u>	2.8	
		* <u>Macaranga graeffeana</u>	2.8	
		<u>Rubus molluccanus</u>	2.8	
		* <u>Araliaceae</u>	2.8	
		* <u>Angiopteris evecta</u>	2.8	
		* <u>Canarium sp.</u>	2.8	
* <u>Cyathea affinis</u>	2.8			

Herbs &
Climbers

(Within the
forest Herbs
covered about
50% of the
forest floor)

Elatostema eximum

E. filicoides

*Epipremnum pinnatum

Pepperomia parhamii

*Freycinetia sp.

Rubus moluccanus

Steep Slope

Up to
about
1m.

Ridge Top

Elatostema vitiensis

E. eximum

Piper insectifugum

*Epipremnum pinnatum

Pepperomia parhamii

Davallia solida

*Freycinetia sp.

*Cordyline terminalis

Passiflora maliformis



Fig 1. Open, light forest, Namuku River, gentle slopes.



Fig.2.
Namuku River, Steep Slope.



Fig.3. Stream bank vegetation, Namuku River.

3. REGION BELOW THE DAM SITE AS FAR AS THE JUNCTION WITH THE
WAINIM'LA RIVER

3.1 AQUATIC BIOTA.

This region of some 10 or more kilometres was briefly surveyed and sampled over a period of 2 visits. Three stations (2,3, & 4 on map) were selected for survey of aquatic fauna. The results of these surveys are contained in the sections 5,6,7,8 & 9.

3.2. COMMENTS.

It is suspected that the construction of the dam will have two major effects on the area below the falls.

a) A prolonged period of high sediment content in the stream water below the falls during the period of dam construction. This may seriously affect fishing of the Waibasaga villagers. Wainisavulevu and Wainivondi creeks provide the villagers with their weekly supply of fish-their major source of protein. The villagers informed us that they are unable to fish whenever water turbidity increases beyond the normal. The alternative fishing area, Wainimala, is according to the villagers, not as rich in fish.

b) During the rainy seasons, when some water is expected to flow over the dam into Wainivondi creek, the resulting increased water flow may have significant effects on the aquatic life below the dam. For any assessment of this change in flow, measurements of water flow, and observations on living organisms in the area must be taken over a period of 1-2 years.

3.2.2. In addition, the possibility of the dam "opening up" is very real in the minds of the people of Wainibasanga. This will necessarily restrict their use of the low-lying areas below the dam. They have recently begun introducing cattle to the area, and have extended grazing higher up the valley of Wainisavulevu, as well as nearer to village. They must be assured of the low probability of the threat before they can continue any longer-term agricultural use of the area.

3.2.3. The Wainimala river is navigable up to Waibasaga village. What effect the diversion of Nanuku waters will have on the navigability of the section between Waibasanga and Lutu is uncertain.

3.2.4. Wainbasanga villagers use the water from Wainisavulevu and Wainivondit creeks for washing, cooking, drinking, and bathing.

Wainimala River is similarly used.

4. WALLOA RIVER-BELOW THE WALLOA POWER STATION SITE AS FAR AS THE JUNCTION WITH THE WAINIMALA AT LASELEVU

4.1. ASPECTS OF THE AREA

Measurements during May, 1977, along this 5 to 6 kilometre length of the river showed the water to be saturated with oxygen, of high clarity and to have a pH of about 8 (refer to transect data, Section 5). Along this length, the river is dominantly of shallow rapids with fewer slow-moving sections. Infrequently deep pools occur where surface water movement is much less apparent.

The stream bed shows evidence of periodic flooding, with wide expanses of silt coated rocks on either or both sides of the main stream. Isolated pools of water, generally less than 2 metres square, occur in such regions.

Large, extensive islands of rock and sand, colonized by grasses and secondary bush growth, sometimes bisect the main stream. These occur immediately upstream of the village of Laselevu.

4.2. AQUATIC BIOTA

The results of surveys are presented in Sections 5-9 of this report. The presence of Eichhornia crassipes, the Water Hyacinth, and Hydrilla verticillata, the water weed, in the region is noteworthy.

Eichhornia appears to be healthily growing in a large pond at Laselevu. Fragments of the plant were observed in the semi-persistent pools, isolated from the main stream of the river. The presence of these plants may indicate the future development of more extensive populations. In view of the possible consequence of such populations, the occurrence of this species in this area cannot be overlooked in any subsequent investigation.

4. See for example, PARHAM, 1947 and McGARRY et al, 1972.

Hydrilla was noted in large quantities at the water's edge of the Wainimala River, less than 100 metres from the junction with the Wailoa. As for Eichhornia, Hydrilla in large numbers can pose serious problems.

Mention needs to be made of the possible role of the semi-persistent pools of warm, still water as sites of invertebrate breeding. Developmental stages of a variety of invertebrates were abundant in these pools.

4.3. COMMENTS.

4.3.1. The proximity of Laslevu to this length of river has resulted in most areas being utilized by man. The frequent shallow rapids afford stream crossings necessary for foot traffic. Shallow areas also provide regions in which the flow of water can be modified by villagers to create areas for accumulation of prawn. Deeper pools are used for fishing with hand-held spears.

The herbaceous growth of the islands is utilized for cattle grazing. of/ For the villagers, the loss/crossing points, cattle grazing areas, and prawn catchment areas, may be of great consequence.

4.3.2. It is apparent that changes in the volume of flow of the Wailoa and in the quality of the water entering the Wailoa (as would result from the diversion of the Hanulu water via the power house) will have marked consequences for this region. (For example, see Section 9)

An increase in volume of water may decrease the frequency of shallow rapids, deepen the pools and eliminate the semi-permanent isolated pools and the islands.

Such modifications may provide pathways of deeper and less rapid water, by which both Eichhornia and Hydrilla will move upstream.

Since modifications or loss of the semi-permanent pools is likely, some considerations should be given to the role of these pools in sustaining invertebrate populations of the region.

The likely increase in turbidity and change in chemical composition of the Wailoa water resulting from diversion of the water of the proposed lake, will have consequences that can only be guessed at after a survey as brief as this. Detailed investigation of the nature and biological consequences of such changes will need to be conducted.

5. REPRESENTATIVE BIOTA FROM TRANSECT AREAS.

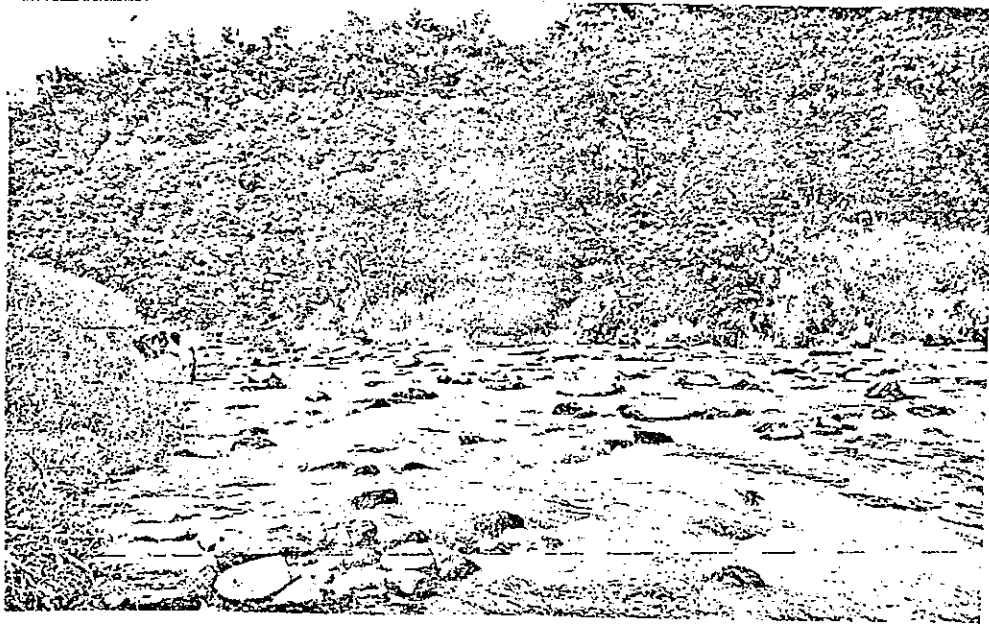
This, and following sections provide the details of the results of transects at station 1-6, and results of general collections of selected faunal groups from the region. Observations and comments arising are also provided.

Station 1 Nanuku Creek

Above Monasavu Falls



Slow Flow Transect 1



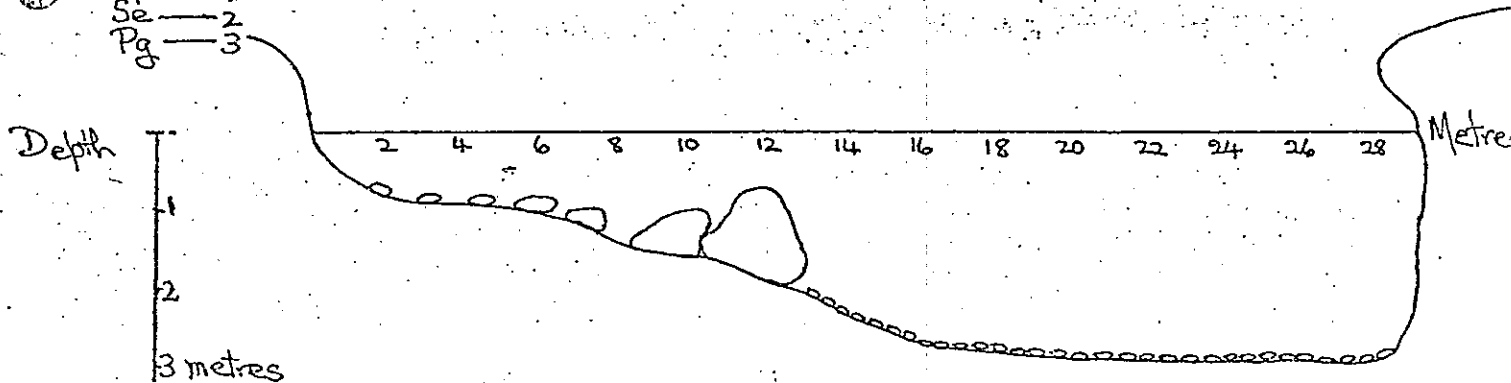
Fast Flow Transect 2

Station I. Above Monasavu Falls

Transect 1. — Slow flowing \approx 22 m/sec

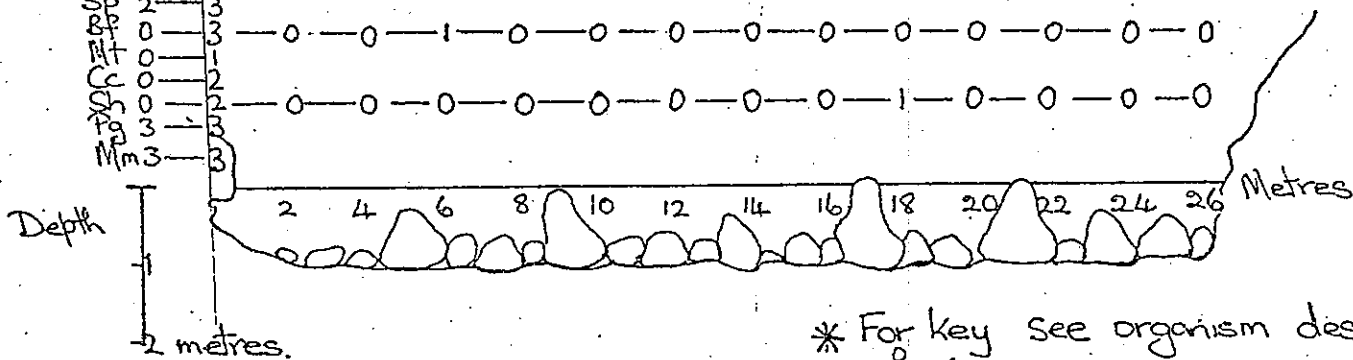
*	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	1	1	0
0	0	0	0	0	2	0	0	0	0
0	0	0	1	0	0	0	0	0	0
0	0	0	2	1	2	2	2	0	0
0	0	0	2	1	0	2	2	2	0
0	0	1	0	0	0	0	0	0	0
0	0	2	1	0	0	0	0	0	0
0	0	2	0	2	1	0	2	2	0
0	0	1	3	3	3	2	3	2	3
0	0	3	0	1	0	0	2	1	1
0	0	3	3	1	2	2	2	2	2
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3

Turbidity made bottom survey in this area impossible.



Transect 2 — Fast flowing \approx 1 m/sec

*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	1	1	0	2	1	0	0	0	1	0	0	1	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
0	0	3	3	3	3	3	3	3	3	3	3	3	3	1	1
0	0	1	1	0	1	0	0	0	1	2	1	0	1	1	1
0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3



* For key see organism description
 1 few
 2 moderate
 3 abundant

Station 2
Below Monasavu Falls



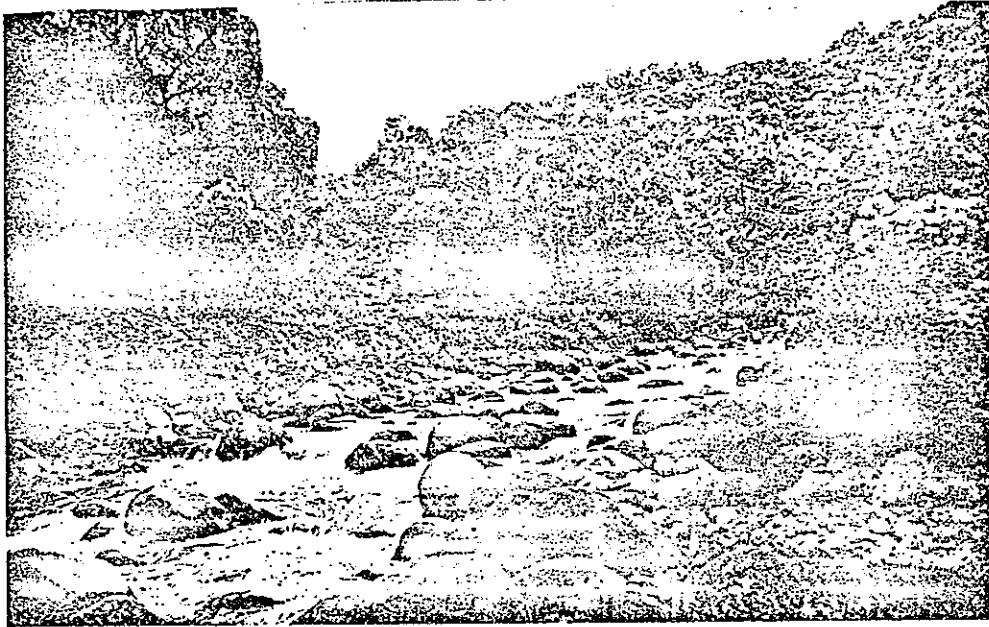
General View



Transect Area

Station 3

Junction of Wainivondi and Wainisavulevu Creek



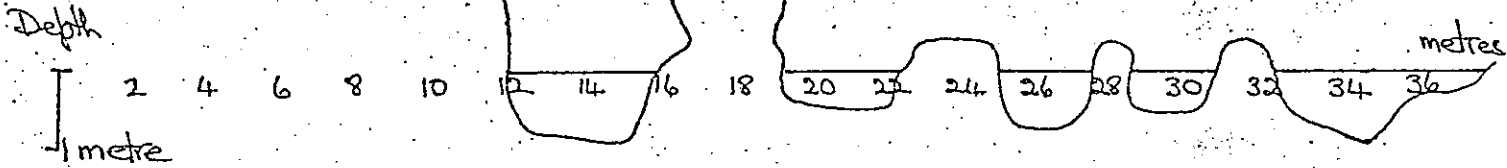
Site of Transect

Station 2 Below Monasavu Falls $\approx 1\text{m/sec}$

*
 S
 U
 R
 V
 E
 Y
 I
 N
 T
 E
 R
 S
 P
 E
 C
 I
 M
 E
 N
 T
 S

0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	2	3	1				
0	0	0	0	0	0	1	0							
0	0	0	0	1	2	0								
0	0	1	1	0	2	3	0	3	1	0				
0	0	1	0	0	2	0	0	0	2	0				
0	1	0	1	0	1	2								
0	1	0	0	0	0	3	2	3	0	2				
0	1	1	1	1	1	1	1	1	1	1				
0	0	0	0	0	0	1								
0	0	0	0	0	0	0								

River too swift
to carry survey
further

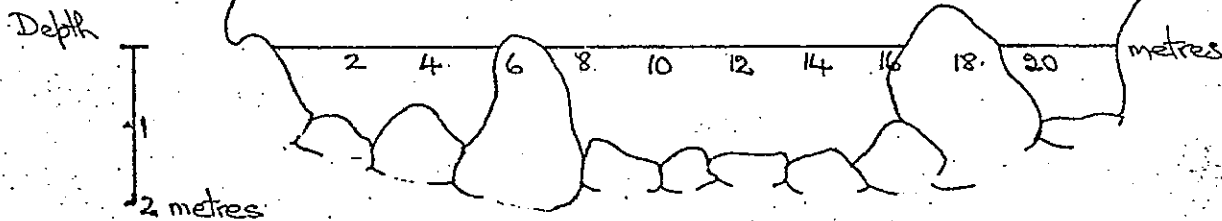


Station 3 Wainivodi $\approx 0.5\text{m/sec}$

*
 S
 U
 R
 V
 E
 Y
 I
 N
 T
 E
 R
 S
 P
 E
 C
 I
 M
 E
 N
 T
 S

0	1	0	0	0	0
0	1	0	0	0	1
0	1	3	3	3	3
0	3	3	3	3	3
0	3				
3	0				

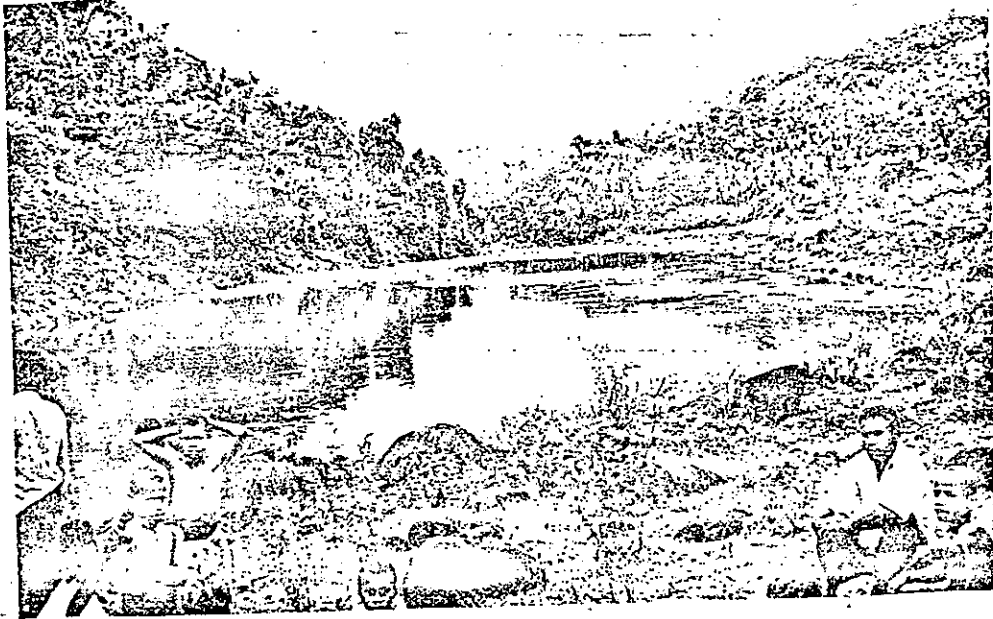
River too swift
to carry survey
further.



* for key see organism description
 1 few
 2 moderate
 3 abundant.

Station 4

Waimbasanga Village



Slow Flow Transect 1



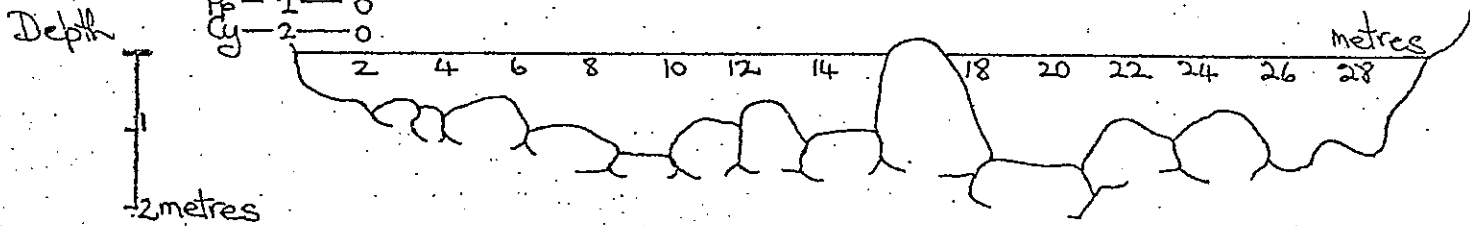
Fast Flow Transect 2

Station 4 Waibasaga Village
 Transect 1 Fast flowing 56 m/sec

*

Cl	0	3	1	0	0	0	0	0	0
Ne	0	0	0	1	0	0	0	0	0
SS/g	0	0	0	1	0	0	0	0	1
M	0	0	1	1	0	0	0	0	0
M _h	0	1	1	0	0	0	0	0	0
M _n	0	2	2	2	3	3	3	3	3
SZ	0	3	3	3	3	3	3	3	3
SE	1	0							
EE	1	0							
EP	1	0							
ED	2	0							

Current too swift to carry survey further

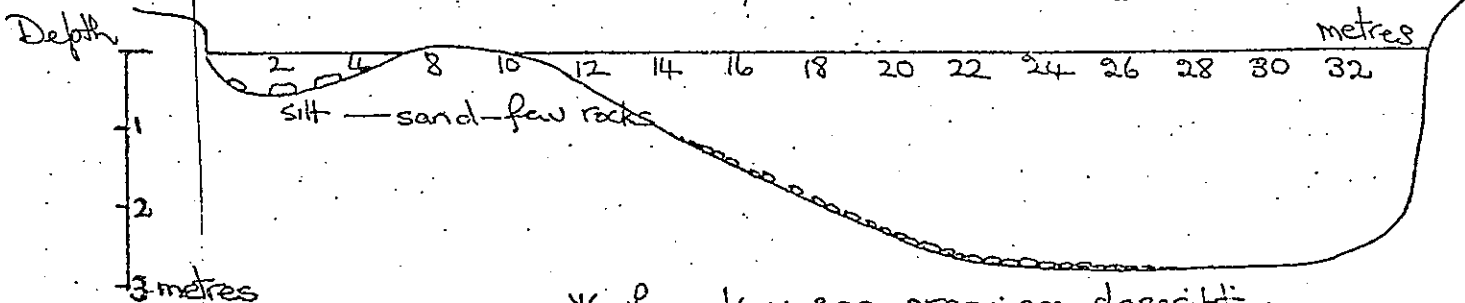


Transect 2 Slow flowing 18 m/sec

*

SE	0	0	0	0	0	2	1	1	1
EE	0	2	3	0	3	3	2	2	1
EP	0	1	1	0	0	0	0	0	0
ED	0	2	1	0	0	0	0	0	0
SZ	0	2	1	0	0	0	0	0	0
M	0	1	0	0	0	0	0	0	0
M _h	0	1	0	0	0	0	0	0	0
M _n	0	2	2	0	0	0	0	0	0
SS/g	0	2	1	0	0	0	0	0	0
Ne	0	2	1	0	0	0	0	0	0
Cl	0	2	1	0	0	0	0	0	0

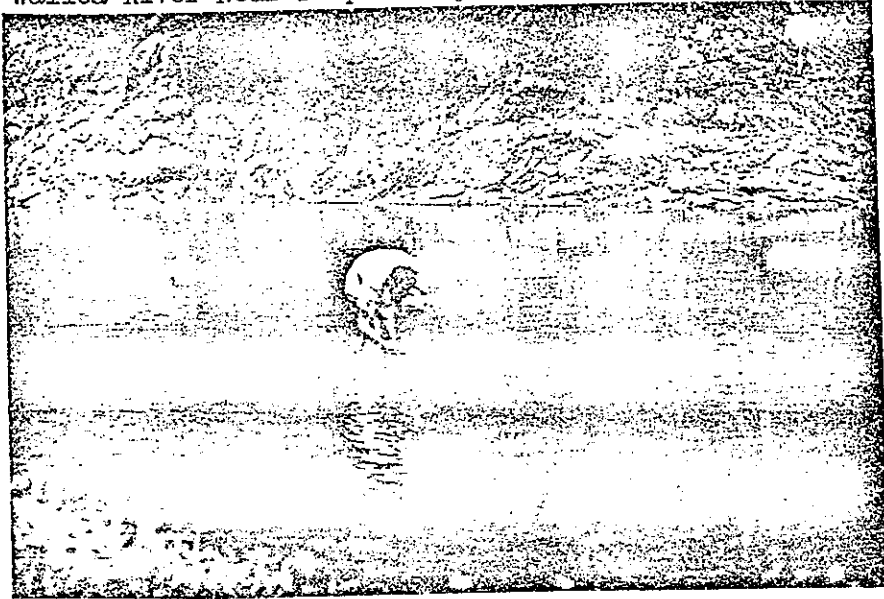
SCUBA required for thorough survey



* for key see organism description
 1 few
 2 moderate

Station 5

Wailoa River Near Proposed Hydroelectric Station



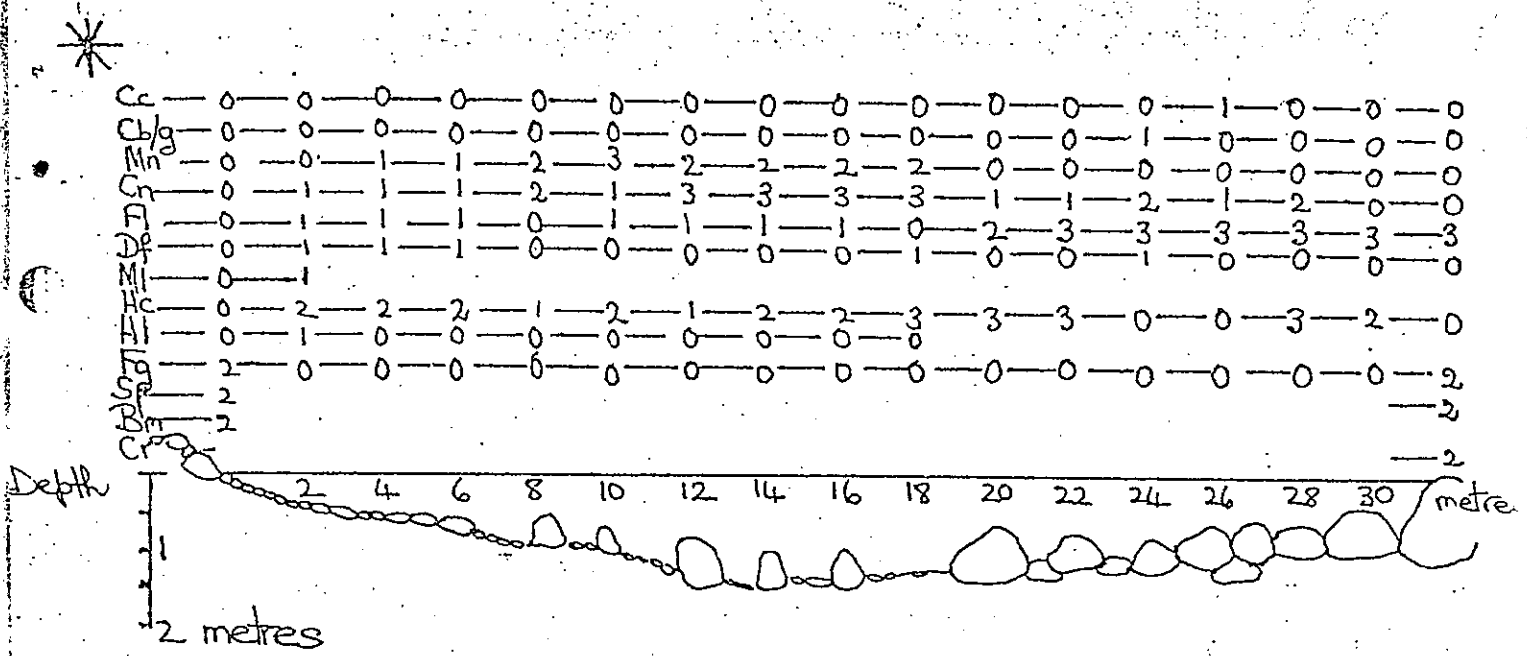
Slow Flow Transect 1



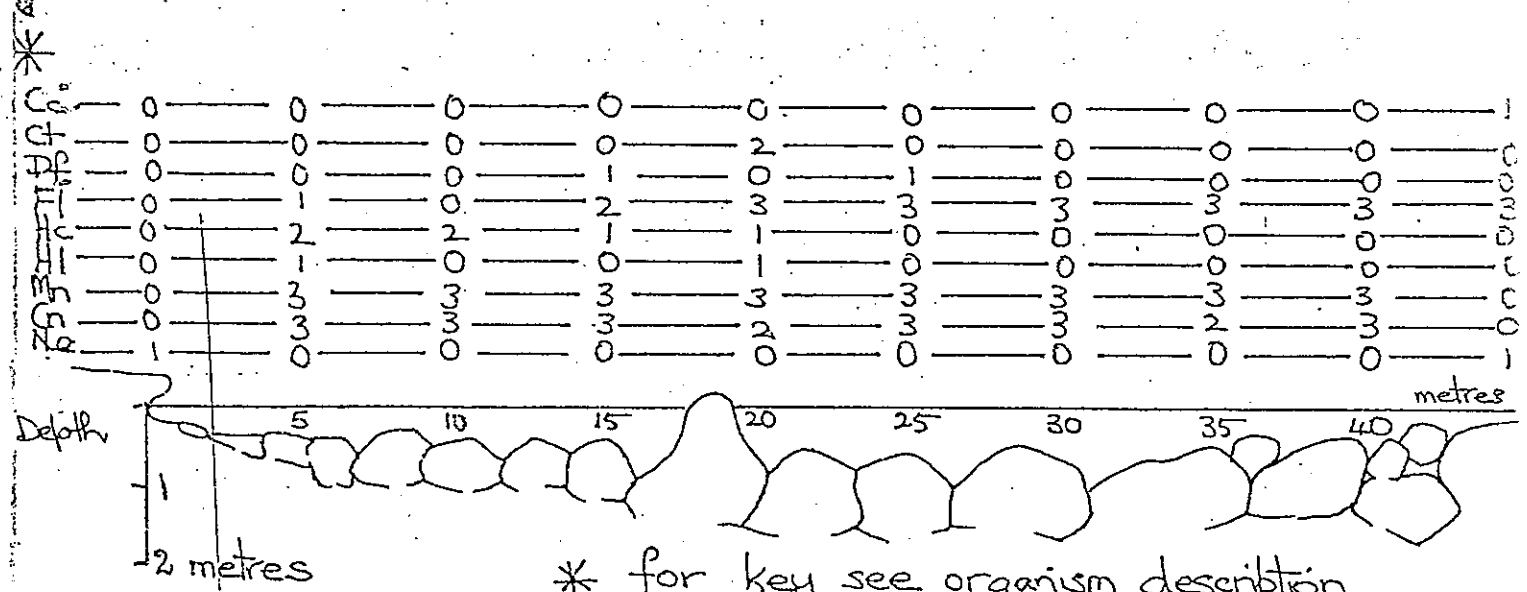
Fast Flow Transect 2

Station 6. Laselevu Village

Transect I Slow flowing



Transect 2 Fast Flowing



* for key see organism description.
 1 few
 2 moderate
 3 abundant.

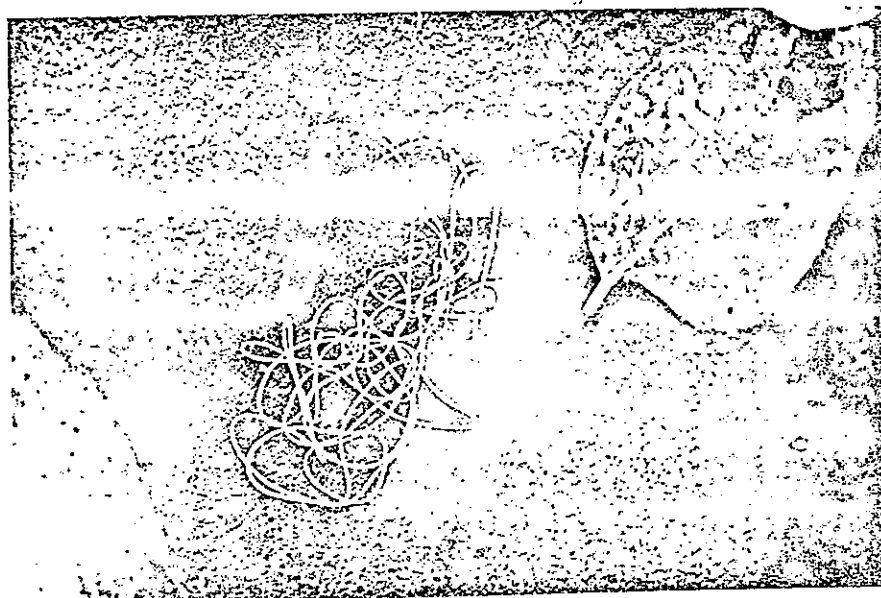
ORGANISM DESCRIPTION

Key to Transects

The following list of species recorded in the transects are the result of field trips of limited duration and therefore not to be taken as an exhaustive list of species occurring in the area.

Nematomorph.

Gordius fulvur was recorded at stations 1,5 and 6, in quiet waters at the side of the mainstream. The host of the larval stage has not been determined. One worm measured 2.5 metres.



Nematomorph worm in situ

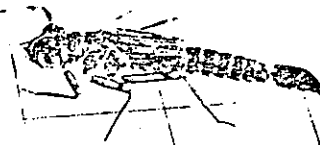
- Le A leech, measuring 3cm, was recorded at stations 1,2 and 3. The organism, Barbronia sp. (Erpobdellidae) has not previously been recorded from Fiji.
- PI Planaria were abundant amongst rotting vegetation and on the under sides of stones, in slow flowing sections at all stations.
- Pw Unidentified polychaete worms were recorded in muddy substrates at stations 1 and 4.

Insects

Mn Mayfly nymphs. A variety of different sizes of mayfly nymphs were abundant on all fast flowing sections at each station. Identification of these larval stages has not yet been made.

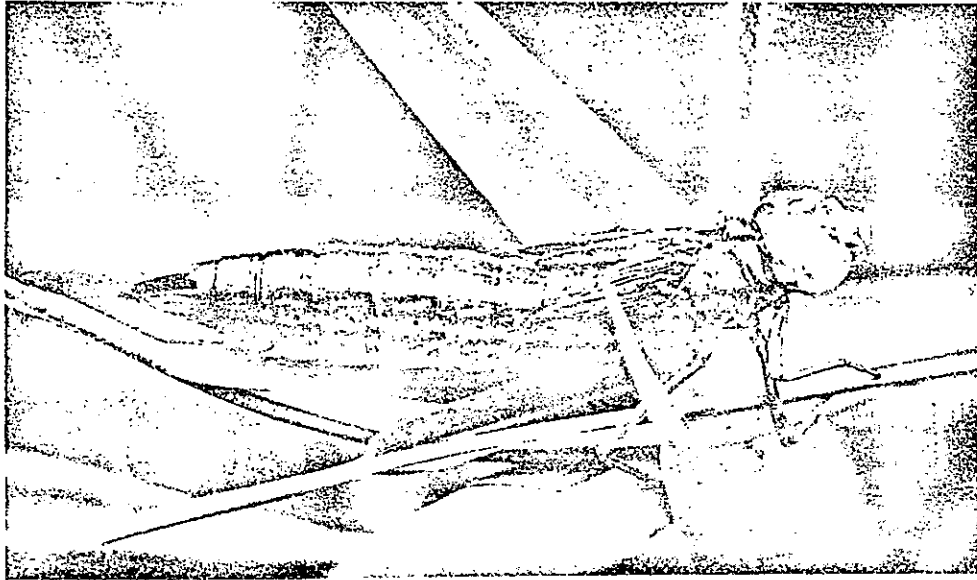
Black and white striped nymphs, located only in a side stream running into Manuku Creek above the Monasavu falls, have a superficial, similarity to the striped shrimp which is confined to the Manuku Creek.

Df Danselfly nymphs. These were recorded at all stations, generally in protected positions under stones in the river bed. Adults were observed completely submerged and laying eggs on logs in the stream.



Danselfly nymph

Dragonfly nymphs. These were recorded at all stations. The elongated nymph photographed, and the more common shortened form were both observed either as empty cases on Brachiaria rutica or live nymphs in still ponds on the sides of the rivers.



Dragonfly nymph

Bf Blackflies. ..

Simulium sp. larvae and pupae were found attached to submerged stems and stones. in fast flowing sections of stations 1 and 2.



Simulium sp larvae

Caddis fly. Larvae and pupae were found at all stations.

Net building: Arabacasia larvae were abundant in all fast flowing sections.



Arabacasia sp larvae net

Other Caddis fly larvae included:

1. One that builds a loose mesh net, recorded at stations 4, 5, and 6, in shallow, slow flowing sections of the river.

2. One that makes a purse of old leaves to protect its bright yellow body.



Caddis larva

- Hl 3. One that secretes a smooth horn
and
- Hc 4. One that constructs a horn shaped case of cemented stones.

Water Beetles.

A water beetle, probably Hydrophilus sp was observed at stations 1 and 4, in still or semistagnant sections of the river.

- An The back water swimmer, Anisops sp. was observed in side pools at stations 1, 2, and 3.

The water strider probably Lymnogenas sp. was observed in shaded, slow flowing sections of river at stations 1, 2, 3, and 5.

Ct Water Crickets

Specimens probably belonging to the Nemobilineae were abundant, living just above the water-line on the sides of boulders in fast flowing sections at stations 2, 3 and 5.

MI Moths

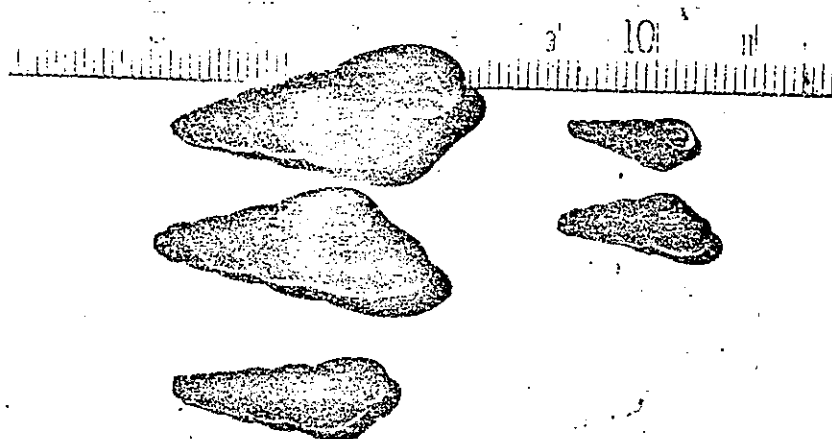
The moth, (Nymphulide ?) larva was recorded on the sides of rocks at all stations where moderate flow prevailed.

Molluscs

The Mollusc recorded included:-

Melanoides tuberculata- found at all stations in regions of slow to moderate flow. A wide range of colour variation was observed.

(See photograph overleaf)



Pn Phyastra nasuta - recorded in abundance at station 1 and less frequently at all other stations. This gastropod prefers slow flowing sections of the river.

Fluriopupa pupoides was recorded at all stations.

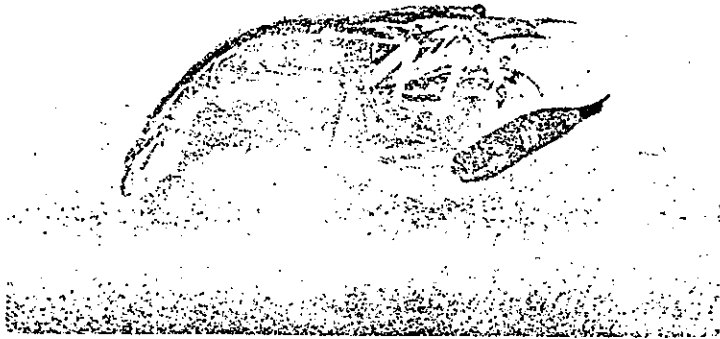
Fe Ferrissia (Pettancylus) sp was recorded at stations 1,3, and 4.

? Neritina sp was recorded only at stations 3,4,5 and 6. It was particularly abundant in sections of the Wailoa river.

Crustaceans

Crustaceans recorded included:-

Sh A species (Palaemonidae) found only above the Nenasavu falls. The average F.L. (fork length) of the specimens was 1.7 cms. (fe males carrying eggs.). The eggs of this species are large (approximately 1 mm in diameter). This slender crustacean is found in large populations both on rocks in slow flowing sections of the river, and under the overhanging stems of Mikania and Brachiaria. The majority of the individuals show a distinctive black and white spotting or banding, although red, light-brown, and semitransparent patterns were also observed. (See photograph overleaf).



The striping of the crustacean does not show clearly in this photograph.

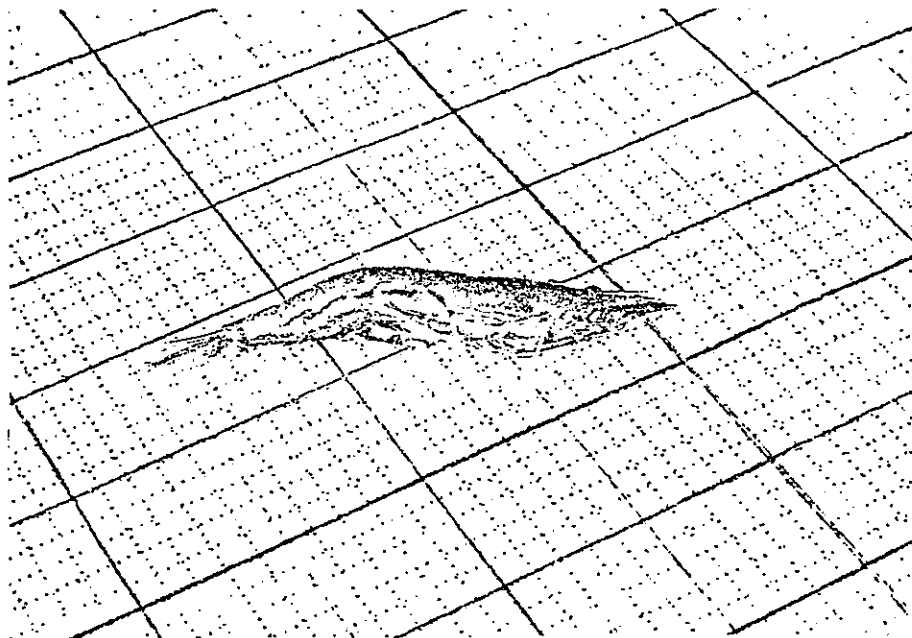
Live specimens of the nymph and the crustacean show a remarkably similar pattern.

St Two other species of Palaeonidae occurred at all stations below the Monasavu falls.

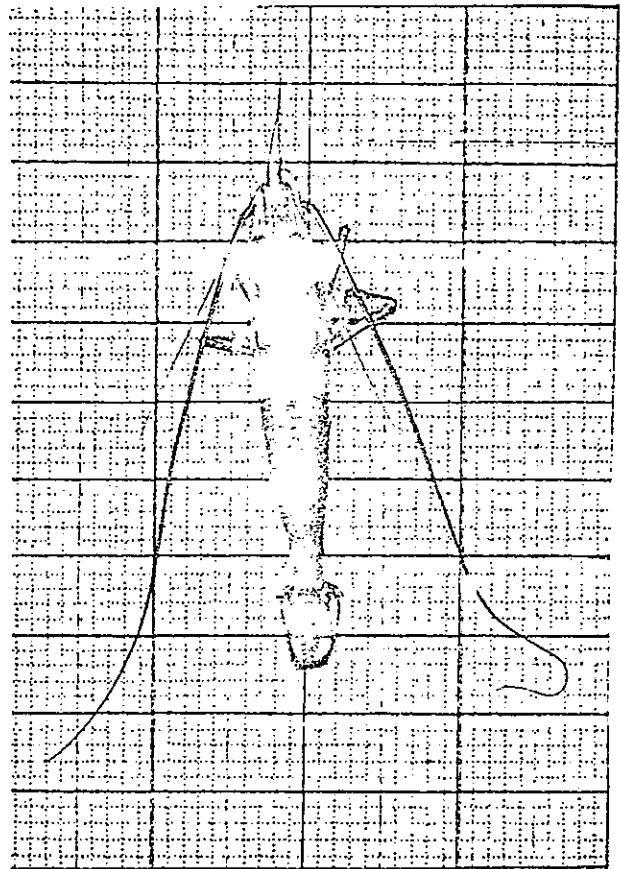
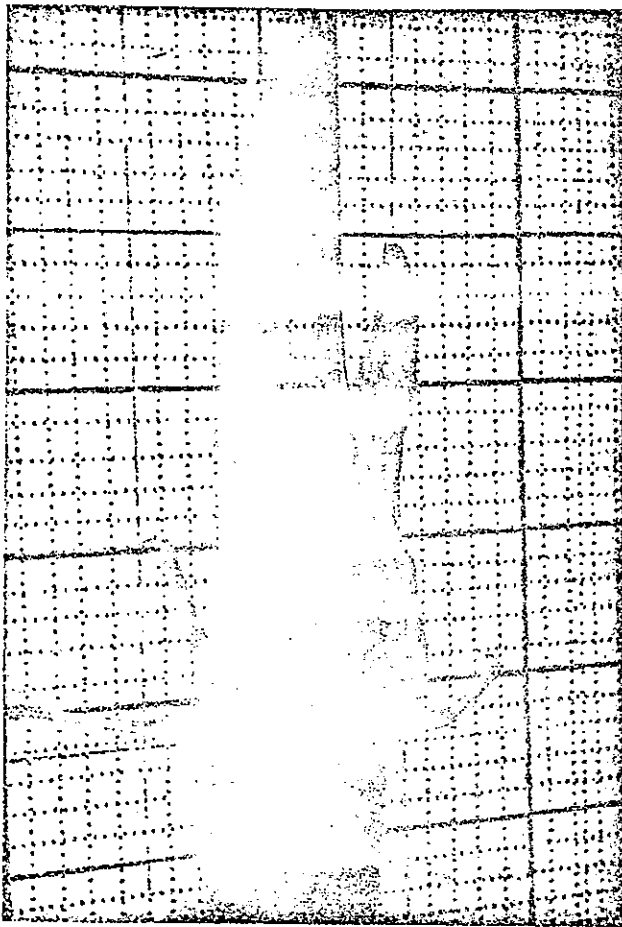
1. Average FL 2.7. cm. (females carrying eggs). It is dark brown in colour with a light mid-dorsal line. The dorsum is smooth and somewhat concave. This species is not slender. Usually found under grass cover overhanging the water's edge. Photograph below.



2. Average F.L. 2.6 cm. (females carrying eggs). It is light brown in colour, almost translucent. It has distinct dark brown to red bands on the thorax and abdomen. A distinct band is found running on the abdominal segments along the border of the dorsum of the pleopods. This species has a distinct hump on the dorsal surface. Occasionally the band markings are absent. The species is found under vegetation on the water's edge.

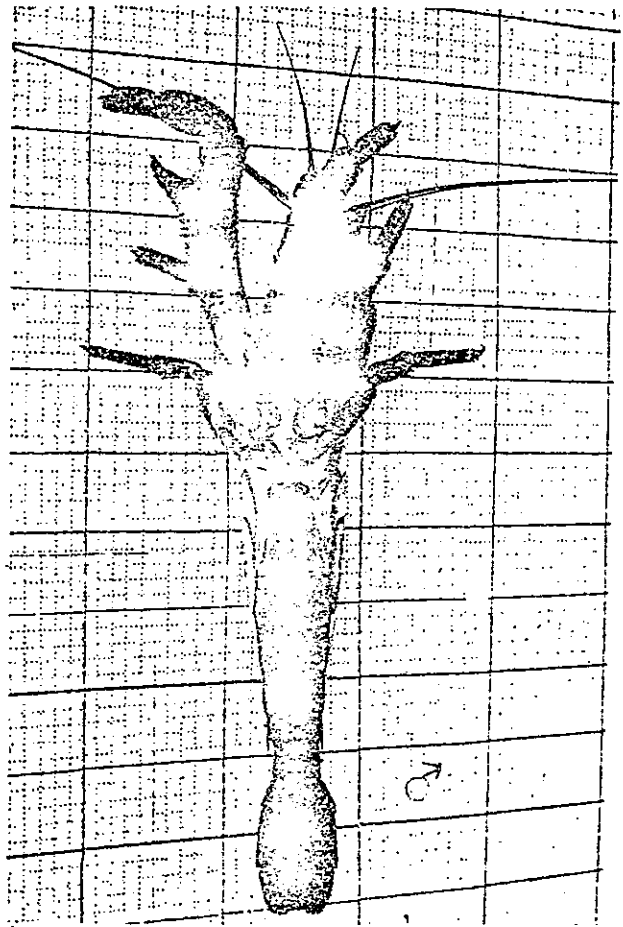
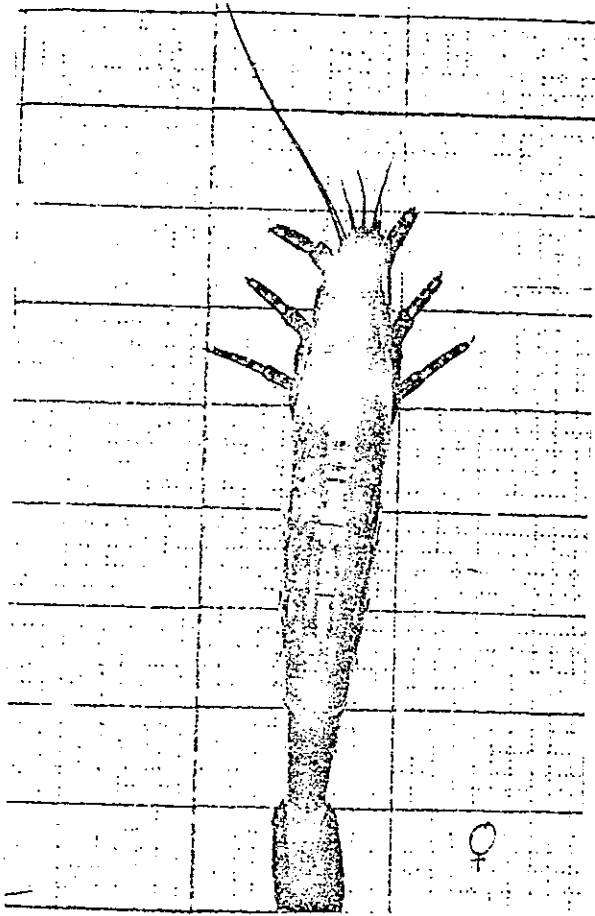


An Astacus sp? was found under river-side cover and under rocks. Average Fl 7.5 cm (adult -male ?) It has a serrated rostrum and large fan shaped extention on the dorsum of the antenna base (basipodite). The large claws are disproportionately heavy, approximately the same length as the individual. The female (carrying eggs) has average fork length of 5 cm. The claws of the female are not as robust as that of the male. This crustacean is found under vegetation on the river's edge or under rocks. It was not observed above the Monasavu Falls. See the two photographs below.



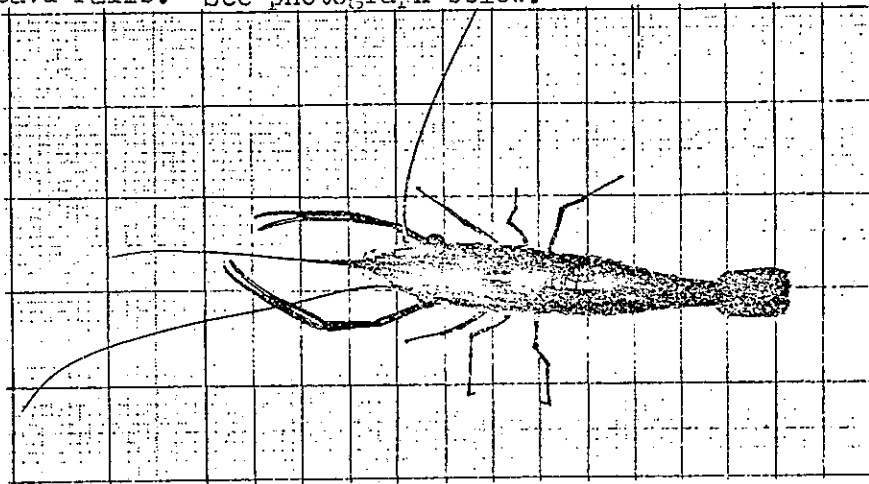
Atya bisulcata

Average F.L. 6.5 cm. (adult males) and F.L. 6.cm. (female carrying eggs). This species is found in crevices on water falls or on rock surfaces over which water cascades. There is no great development of the front limbs (except in old males) but all the limbs are well adapted for clinging to rocks. Colouration variable. This species was not found above the Monasavu Falls.
See the two photographs below.



Macrobrachium lar

This species is found more commonly under cover in pools. Its large chelate front legs, more pronounced in males, are sometimes longer than the entire body length. It can grow up to 20 cms. but the specimens in the survey were approximately 8 cm. long. This crustacean was not found above the Monasavu Falls. See photograph below.



Organisms referred to in the transects and occurring amongst border plants included:-

Bufo marinus ♀ recorded at all stations. Tadpoles were found in pools isolated from the mainstream.

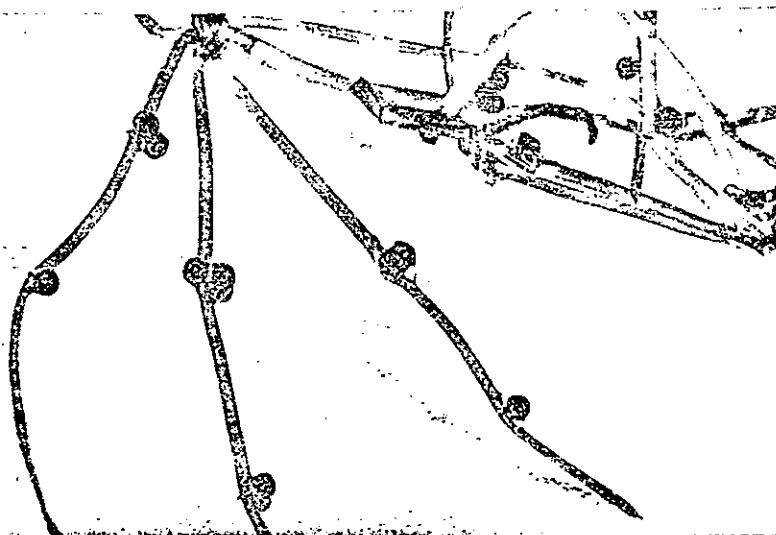
- Sp Spiders - a variety of spiders were observed.
- Cr Crickets - a variety of crickets were observed.
- Mi Millipede - one species was abundant.

Aquatic Plants recorded were:-

Hydrilla verticillata was recorded at station 6

Eichorniacrassipes was recorded at station 6

Nitella sp. - found in slow flowing sections of the river at all stations except 5 and 6.



Nitella sp. with conspicuous orange oogonia

Gb/g

Nostoc sp- globular blue-green alga found in greatest abundance on exposed sides of submerged rocks at station 1. Also recorded from stations 4.

Cb/g

Lyncebya sp. - cushiony blue-green alga recorded at stations 1, 4, 5, and 6.

Fg

Cladophora sp. - branches green filamentous alga, recorded at stations 1, 2, 3, 4.

FI

Filamentous green algae including Ulothrix sp. and Spirogyra sp, recorded at stations 1, 3, 4, 5, and 6. The clear Wailoa river was especially rich in green filamentous algae.

Other algae collected included Charaesiphon incrustans, (epiphytic on Cladophora sp) Tolybothrix sp. and Anabaena

River border plants referred to in the transects included:-

- Li Lichens
- Lu Ludwigia octovalvis (False primrose weed)
- Pg Brachiaria mutica (Para grass)
- Se Sedges
- Mo Mosses
- Mn Mikania micrantha (Milc-a Minute)
- Cu Psidium guajava (Guava)
- Mp Mimosa pudica (Sensitive plant)
- Bp Bidens pilosa (Cobbler's foot)
- Cn Crotalaria mucronata (Rattle pod)
- Sa Sida acuta (Broom weed)
- Ps Solanum torvum (Prickly solanum)
- Cu Cuphea carthagenesis (Tar wood)
- Bi Bidens sp.
- Pp Paspalum sp
- Cy Cyperus sp

6.

INSECTS OF THE AREA

Details of insect larval and nymphal stages, as they occur within the rivers, were provided in Section 5.

Brief visits were made to the areas surrounding the camp site above Monasavu Falls (5-6 May) and the village of Wainbasanga (7-8 May).

Because of the short time available, only a small collection of insects could be made. In most cases, insects and other arthropods associated with host plants were collected together with a herbarium specimen of the plant. Some insects and other arthropods were collected from the streams. In total, representatives of about 200 taxa were collected.

As a result of a very poor state of knowledge concerning the fauna of Fiji forests, it will not be possible to provide identifications of the material collected before the end of 1977. Many specimens will be sent to overseas institutions, e.g. British Museum, Bishop Museum, Honolulu, etc, for determination.

Amongst the interesting occurrences were those of several forest weevils and parasitic wasps near the camp sites, scale insects on some forest plants, blackflies (Simuliidae) near the streams and their larvae in the streams. (N.B. Blackflies are noted as vectors of river-blindness, onchocerciasis, in Africa and South America.)

As the material collected is identified lists of the insects will become available.

7.

NEMATODES OF THE AREA

Over the period May 5th to May 8th, sampling for plant parasitic nematodes was conducted above the Monasavu dam site and at the village of Wainbasanga.

Soil samples, taken from the root zones of crop and non-crop plants, were brought to Koronivia Research Station where nematodes were extracted by a modified Baermann funnel technique. Live nematodes were identified to genus and samples were permanently preserved for later species determinations.

Samples were taken from 35 locations comprising both agricultural and non-agricultural sites. From the area surrounding Monasavu Dam site 15 samples were from bush species and one was from banana (Musa sp). From around Wainbasanga Village, 6 samples were from bush species and 13 from crops including banana (Musa sp), bele (Abelmoschus sp), breadfruit (Artocarpus sp), Mallics (Capricorn sp), Citrus sp, coconut (Cocos nucifera), Mallo (Calceasia esculenta), Syraka (Saccharum edule), Vaididi (Alccasia sp), veivoi (Pandanus sp), and yagona (Piper methysticum).

The numbers of samples from which different nematodes were recorded from each area are as follows:

Nematode genus (common name)	Monasavu	Wainbasanga
1. <u>Criconeoides</u> (ring)	4	8
2. <u>Eutylenchus</u> (no common name)	1	0
3. <u>Helicotylenchus</u> (spiral)	12	14
4. <u>Hericycliophora</u> (sheath)	1	0
5. <u>Meloidogyne</u> (root-knot)	8	10
6. <u>Paratylenchus</u> (pin)	4	0
7. <u>Pratylenchus</u> (lesion)	2	2
8. <u>Radopholus</u> (burrowing)	3	3
9. <u>Rotylenchulus</u> (reniform)	1	6
10. <u>Trichodorus</u> (stubby-root)	2	1
11. <u>Tylenchulus</u> (citrus) (?)*	5	1
12. <u>Xiphinera</u> (dagger)	10	0
13. Unidentified <u>Tylenchoidea</u>	1	0
Total Samples Taken	16	19

only/ *Tylenchulus questionable because/immature specimens found.

In general, the observations are similar to those obtained from other parts of Fiji. Differences in nematode occurrences between Monasavu and Wainbasanga mostly reflect differences between agricultural and non-agricultural areas. For example, Paratylenchus, Tylenchulus (?), and Xiphinera are more commonly found in the bush, while Criconeoides and Rotylenchulus are more common in agricultural situations.

Three species from Monasavu (Eutylenchus, one of the Helicotylenchus species, and the "unidentified Tylenchoidea") are previously unknown in Fiji. Possibly species of other genera will also prove to be new species or new Fiji records. Out of 18 genera of plant parasitic nematodes known to occur in Fiji, 12 (or 13) more recorded in this survey.

8.

BIRDS AND OTHER LAND VERTEBRATES OF THE AREABIRDS.

8.1.1. The forest, both above and below the falls appears to have a proportionately higher density of Golden Whistlers and Fiji Warblers, than noticeable in forests elsewhere in Fiji. Layards, White Eyes and Spotted Fantails are abundant here as everywhere in Forests in Viti Levu.

Birds noted in the area are presented in Table 2. The list can by no means be considered a complete account of even the more common birds of the area. It represents the results of only about 6½ hrs. of actual observations by one person, on the afternoon of 23rd April and morning of 24 April. During much of this time precipitation and fog severely limited visibility.

COMMENTS

8.1.2.

(a) These observations are entirely inadequate for even the most cursory faunal survey. A good survey must be particularly concerned with species which are believed rare, but it is just these species which are most likely to be missed during such a limited period of observation.

(b) A more thorough survey for birds should be carried out. This should include both observation and mistnetting at several different localities scattered throughout the area to be inundated, as well as in adjacent areas for comparison. The variety and distribution of sampling localities would increase chances of encountering pockets of concentration of birds which are rare overall. At each locality, mistnetting should be carried out for at least a week with nets of several standard mesh sizes ranging from 1¼ in. to 4 in. Preferably, birds should be banded and released and a week of netting repeated at a later date at each site to obtain rough estimates of population densities by the mark-recapture method.

8.2. OTHERS:

29.

8.2.1. No detailed observations or surveys of any other vertebrate animal group was undertaken. Wild pigs, rats and lizards were noted as being present in the area. The native tree-frog has also been reported.

8.2.2.

COMMENTS

The lack of information on some groups of terrestrial animals - particularly the mammals, reptiles and amphibians - is an important omission. Further studies must include thorough surveys of these groups.

9. FISH

9.1. PHYSICAL AND CHEMICAL CONDITIONS

On the basis of presently available physical and chemical data (Tables 3 & 4) the rivers in the project area could be classified as moderately productive. There is no evidence of any conditions which might severely limit fish and other aquatic organisms. Water temperatures appear to be rather stable at a cool 18-20° C; oxygen concentrations were at saturation levels at all stations. Waters of the Wainimala and its tributaries tended to be slightly acidic with pH levels of 6 to 7 while Wailoa waters were alkaline with a pH of 8 to 8.5. Alkalinities of 24 to 30 ppm (as calcium carbonate) would indicate that river waters are well buffered.

Conductivities increased substantially from 63 umhos/cm at the Monasavu dam site to 140 umhos/cm at the junction of the Wainimala and Wailoa Rivers.

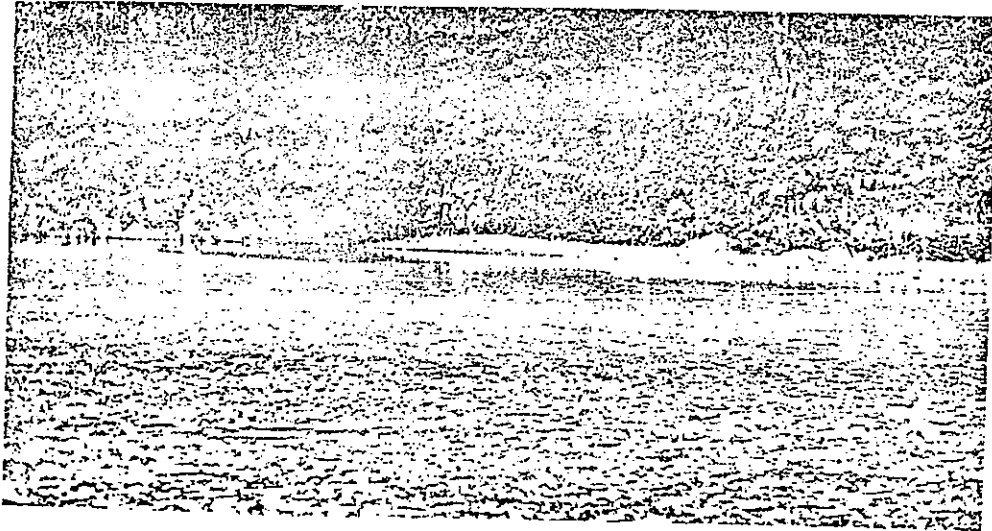
9.2 FISH STOCKS.

9.2.1. On the basis of the collections and observations made the diversity of riverine fish species in the project area is not great - only six species were collected on field surveys (Table 5). Villagers at several stations reported additional species which were not represented in the collection, and it is therefore doubtful whether the total number of fish species found in the area would exceed twelve. Of the six recorded species, four could be considered as having a commercial importance - the eel, Anguilla fijiensis, Kuhlia sp. - Eleotris sp. and Tilapia mossambica.

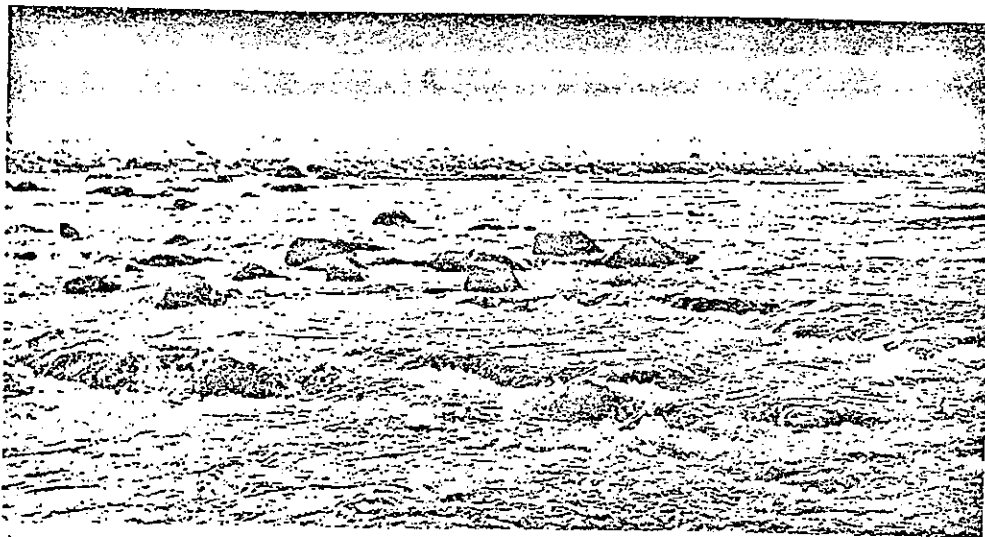
9.2.2. Information on stock abundance or catch data are not available. However, reports from several villagers indicate that one meal a week includes fish. This was usually locally caught, but occasionally canned or even frozen fish would be substituted. While the total amount of fish consumed does not seem very large, a government nutritionist has expressed the opinion that, in view of the limited and often inadequate alternative protein sources which are available, fish represent a very important dietary component of these people.

(See section 9.3. below).

Station 6 Lasalevu Village



Slow Flow Transect 1



Fast Flow Transect 2

9.2.3. Fishing methods appear to be restricted to hook and line or spearing. From discussions with villagers, the turbid conditions usually associated with high water levels makes fishing difficult or impossible. Villagers would not attempt fishing at these times.

9.3. FISH IN THE DIET OF VILLAGERS

Some information arising out of surveys conducted by the Foundation for the South Pacific Nutrition Programme along the Waindina River is of considerable relevance to the Monasavu proposals.

Survey of eight villagers has shown that along the downstream portions of that river, fish, including eel, and prawn was abundant and readily utilized in the diet. However upstream villagers found it difficult to obtain fish because of river conditions. Because of the limited amounts of protein available, infant malnutrition is extensive in the interior villages:

Alternative protein sources for the upstream villagers are being considered at the present time, and include hen eggs and fish cultivation.

The parallel between the once-a-week protein of the villagers in the upper reaches of the Waindina, and the once-a-week protein of the villagers in the Monasavu area, necessitate careful consideration of the prospect of changes in the fish stock status of rivers (such as the Wainimala and Wailoa) that may be brought about by the proposed Monasavu scheme.

9.4. COMMENTS

Any attempt at impact assessment in relation to fish stock based on presently available data must be considered somewhat speculative. However, some of the proposed developments are certain to affect the river fishery of the area.

9.4.1. The river flow below the dam site will be reduced during dry periods - possibly to zero - with adverse effects on fish populations.

9.4.2. The decomposition of large amounts of organic material and detritus in the proposed deep impoundment will certainly result in anoxic conditions and in the production of hydrogen sulphide in the bottom water strata. This condition could last for five to ten years⁵. A deepwater outlet would reduce this condition of cool, deoxygenated water, high in toxic hydrogen sulphide, accumulating in the proposed lake.

Never-the-less, if this water is diverted into the Wailoa river by the power station, it could have severe consequences for fish stocks and other aquatic organisms downstream from the generating station, especially during periods of low flow on the Wailoa.

9.4.3. The diversion of the turbid water of the Nanuku River into the Wailoa may affect productivity, regardless of whether the anoxic - hydrogen sulphide strata are avoided by diversion of upper strata water from the proposed lake. On the other hand, the steady spillage of water into the Wailoa could have a stabilizing effect and reduce seasonal variations in flow. Such stabilization could benefit fish stocks and improve river transportation.

9.4.4. The Tilapia mossambica found in the lower reaches of the river system could thrive, if introduced, in the upper water layers of the proposed lake, even during the initial nutrient flush before stability is achieved. However, in view of recent controversies associated with introductions of species into artificial lakes⁶ any proposals ought to be preceded by thorough investigations.

5. BALON AND COCHE (1974)

6. ACKERMAN, WHITE & WORTHINGTON (1973)

10. Recommendations towards the conducting of the biological component of an environmental impact study considered appropriate by the INR group responsible for this report.

10.1. That any effective environmental impact study be continued over a period of at least twelve months to ensure consideration of all seasonal variations.

10.2. That assessment be made of the likely water quality of the proposed Monasavu lake consequent to the impounding of the Nanuku river, with particular emphasis upon the water likely to be diverted via the power generator intake, and the water likely to flow over the dam during the periods of excessive rainfall.

10.3. That the likely biological consequences of the diversion of impounded Nanuku water, chemically and physically defined according to recommendation 1 above, into the Wailoa river be determined.

10.4. That the effectiveness of Monasavu falls as a biological barrier of significance to the biota of the water systems both upstream and downstream of the falls be assessed.

10.5. That the likely biological consequences of the inevitable and periodic over-dam flow of impounded Nanuku water into the Wainisavulevu and Wainivondi river systems be determined.

10.6. In the light of the total absence of fish in the Nanuku river above Monasavu falls, that any intended stocking of the proposed Monasavu Lake be preceded by thorough feasibility considerations.

10.7. In view of the likely changes in fish and prawn stocks in both the Wainivondi and Wainisavulevu river systems and the Wailoa river system, either during the scheme's construction period, or both during and after the construction period, that detailed assessment be made of the year round status of locally caught fish, prawns and other aquatic invertebrates in the diet of local villagers.

10.8. That an assessment be made of the likelihood and consequences of upstream spread of Eichhornia crassipes and Hydrilla verticillata in the Wainimala and Wailoa rivers as a consequence of Manuku water diversion.

10.9. That the twelve or more month period be additionally utilized to completely assess the terrestrial and aquatic flora and fauna of areas affected by the proposed scheme, in order to recognise and identify rare or endangered species and communities, as determined by presently accepted criteria.

11. ACKNOWLEDGEMENT

Mr. Ian Simpson for his helpfulness in transporting people and equipment.

TABLE 2

BIRDS NOTED WITHIN ONE KM OF MONASAVU FALLS

Australian Grey Duck	<u>Anas superciliosa</u>
Identification not absolutely certain. Possibly Whistling Duck.	
Peregrine Falcon	<u>Falco peregrinus</u>
Reported by local Fijian workers.	
Peale's Pigeon	<u>Ducula latrans</u>
Collared Lory	<u>Phigys solitarius</u>
Yellow-breasted Musk Parrot	<u>Prosopeia personata</u>
White-rumped Swiftlet	<u>Collocalia spodiopygia</u>
Polynesian Starling	<u>Aplonis tabuensis</u>
Polynesian Triller	<u>Lalage maculosa</u>
Fiji Warbler	<u>Vitia ruficapilla</u>
Spotted Fantail	<u>Rhipidura spilodera</u>
Slaty Flycatcher	<u>Myzomela lessona</u>
Vanikoro Broadbill	<u>Myiagra vanikorensis</u>
Blue-crested Broadbill	<u>Myiagra azureocapilla</u>
Golden Whistler	<u>Pachycephala pectoralis</u>
Orange-breasted Honeyeater	<u>Myzomela jugularis</u>
Wattled Honeyeater	<u>Foulehaio carunculata</u>
Giant Forest Honeyeater	<u>Gymnomyza viridis</u>
Layard's White-eye	<u>Zosterops explorator</u>
White collared Kingfisher	<u>Halcyon chloris</u>

TABLE 3

Physical and chemical data - field measurements.

parameter	Station									
	1	2	3				5			
			a	b	c	d	4	a	b	c
Water temperature (C)	21		21	21	18	NR	NR	21.5	21.5	19.5
Surface flow (m/Sec)	0.2-1.0		1.0	0.02	0.6	NR	0.3-1.0	NR	NR	NR
Secchi (m)	1.0		NR	2.5	NR	NR	4+	NR	NR	NR
Oxygen (ppm)	NR		9.2	7.2	8.8	NR	NR	8.6	10.4	9.6
Oxygen % saturation	NR		114	89	100	NR	NR	106	128	114
pH	NR		6-7	6-7	6-7	NR	NR	82	85	68
Conductivity (umhos/cm)	63	No data	97	107	NR	86	NR	118	NR	140
Total Alkalinity (ppm CaCO3)	24		28	24	NR	30	NR	29	NR	28

Station 3a - Wainivondi Creek above junction with Wainisavulevu River,
 b - Wainisavulevu River - quiet pool
 c - Wainisavulevu River - rapids
 d - Wainimala River above junction with Wainisavulevu River.

5a - Wailoa River - above junction with Wainimala River
 b - Wailoa River - above junction with Wainimala River
 c - Wainimala River - above junction with Wailoa River.

NR - not recorded

TABLE 4

Comprehensive chemical analysis - Laboratory determinations in ppm
(Data supplied by the Government Analyst, Ministry of Agriculture, Fisheries,
and Forestry, Suva).

parameter	Station				
	1	3a	3b	4	*
Suspended matter	67	24	66	42	51
Total dissolved solids	66	66	89	69	83
NH ₃	0.10	0.08	0.08	0.08	0.10
NO ₃	0.02	0.02	0.02	0.02	0.02
NO ₂	Nil	Nil	Nil	Nil	Nil
Na	2.40	2.60	4.00	3.00	4.00
K	1.37	0.85	0.85	1.20	0.85
Ca	4.95	5.80	6.65	6.45	7.95
Mg	2.43	1.93	2.20	2.48	3.50
PO ₅	0.13	0.05	0.06	0.09	0.05

Station 3a Wainivondi and Wainisavulevu River junction

3b ~~Wainisavulevu~~ and Wainimala River junction

* Rewa River under Rewa Bridge

TABLE 5

Fish species recorded on field surveys

Species	Station				
	1	2 ^a	3 ^b	4 ^c	5
<u>Anguilla fijiensis</u> (eel) "Duna"	-	-	+		+
<u>Poecilia mexicana</u> (molly) "Tiatia"	-	-	+		+
<u>Sicydium</u> sp (sucker fish)	-	+	+		+
<u>Eleotris</u> sp. (gudgeon)	-	-	+		+
<u>Kuhlia</u> spp. "Ika Droka"	-	-	+		-
<u>Tilapia mossambica</u> "Maliya"	-	-	+		+

- a) Villagers reported that Anguilla and Poecilia are also found here.
- b) Villagers reported that 3 "types" of eel are found here.
- c) No fish sampled at station 4, but villagers reported that several species of fish were found in the river, including 2 "types" of eel, Tilapia, Poecilia, Kuhlia, Eleotris, "Isa kelo" and "Voloa".

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APPENDIX I

List of plants noted or collected from the area of proposed inundation.

Species	Family
* <i>Acalypha rivularis</i>	Euphorbiaceae
<i>Acalypha insularia</i>	Euphorbiaceae
<i>Acalypha</i> sp.	Euphorbiaceae
<i>Adiantum diaphanum</i>	Pteridaceae
+ <i>Ageratum conyzoides</i>	Compositae
+ <i>Ageratum houstonianum</i>	Compositae
* <i>Agathis vitiensis</i>	Pinaceae
<i>Aglaia</i> sp.	Meliaceae
<i>Agrostophyllum</i> sp.	Orchidaceae
<i>Alstonia</i> spp.	Apocynaceae
<i>Aneilema vitiensis</i>	Commelinaceae
<i>Angiopteris evecta</i>	Marattiaceae
<i>Antrophyum subfalcatum</i>	Vittariaceae
<i>Appendicula bracteosa</i>	Orchidaceae
<i>A. reflexa</i>	Orchidaceae
<i>Athyrium esculentum</i>	Aspidiaceae
<i>Arthropteris articulata</i>	Davalliaceae
<i>Asplenium laserpitifolium</i>	Aspleniaceae
<i>Bischofia javanica</i>	Euphorbiaceae
<i>Blechnum aggregatum</i>	Blechnaceae
<i>B. patersonii</i>	Blechnaceae
<i>B. lanceolatum</i>	Blechnaceae
<i>Roehmeria virgata</i>	Urticaceae
<i>Bolbotesis</i> sp.	Aspididceae
* Endemic species	
+ Introduced species	

* <i>Burkella thurstonii</i>	Sapotaceae
<i>Callophyllum vitiensis</i>	Clusiaceae
<i>Canarium harveyi</i>	Burseraceae
+ <i>Cestrum nocturnum</i>	Solanaceae
<i>Cheirostylis longiflora</i>	Orchidaceae
<i>Christella arida</i>	
+ <i>Clidemia hirta</i>	Melastomataceae
+ <i>Colocasia esculenta</i>	Araceae
<i>Commelina diffusa</i>	Commelinaceae
<i>Cordyline terminalis</i>	Agavaceae
+ <i>Crassocephalum crepidioides</i>	Compositae
+ <i>Cuphea carthagenesis</i>	Lythraceae
<i>Cyathea affinis</i>	Cyatheaceae
* <i>Cyathea lunulata</i>	Cyatheaceae
<i>Cyathea sp.</i>	Cyatheaceae
<i>Cyrtandra spp.</i>	Gesneriaceae
<i>Dacrydium nidulum</i>	Podocarpaceae
<i>Datura stramonium</i>	Solanaceae
<i>Davallia fijeensis</i>	Davalliaceae
<i>Davallia solida</i>	Davalliaceae
<i>Decussocarpus vitiensis</i>	Podocarpaceae
<i>Dendrocnide harveyi</i>	Urticaceae
<i>Dianella ensifolia</i>	Liliaceae
<i>Dicksonia brackenridgei</i>	Pteridaceae
<i>Diellenia biflora</i>	Dielleniaceae
<i>Diplazium dilatatum</i>	Aspidiaceae
<i>D. javanica</i>	Aspidiaceae
<i>D. tripinnatifidum</i>	Aspidiaceae
*Endemic species	
+Introduced species	

* <i>Dolicholobium oblongifolium</i>	Rubiaceae
* <i>Dysoxylum hornei</i>	Meliaceae
<i>Elatostema eximum</i>	Urticaceae
<i>E. filicoides</i>	Urticaceae
<i>E. vitiensis</i>	Urticaceae
<i>Elaeocarpus storkii</i>	Tiliaceae
* <i>Endospermum macrophylla</i>	Euphorbiaceae
<i>Entada phaseoloides</i>	Mimosaceae
<i>Epipremnum pinnatum</i>	Araceae
<i>Erianthus maximus</i>	Gramineae
<i>Erythrina</i> sp.	Papilionaceae
<i>Fagraea berteriana</i>	Potaliaceae
<i>Ficus obliqua</i>	Moraceae
* <i>F. vitiensis</i>	Moraceae
<i>Ficus</i> spp.	Moraceae
<i>Freycinetia</i> spp.	Pandanaceae
* <i>Geniostoma uninervium</i>	Loganiaceae
<i>Gironniera celtidifolia</i>	Ulmaceae
* <i>Glochidion scemanii</i>	Euphorbiaceae
* <i>Gonostylus punctatus</i>	Gonostylaceae
<i>Hedychium coronarium</i>	Zingiberaceae
<i>Heliconia indica</i> var. <i>indica</i>	Strelitziaceae
<i>Hoya</i> spp.	Asclepiadaceae
* <i>Hydnophytum wilkinsoni</i>	Rubiaceae

* Endemic species

+Introduced species

+Ludwigia octovalvis	Onagraceae
Lycopodium phyllanthum	Lycopodiaceae
Macaranga graeffeana	Euphorbiaceae
Macrothelypteris polypodioides	
Maniltoa sp.	Caesalpiniaceae
Marattia smithii	Marattiaceae
Medinilla heterophylla	Melastomataceae
Mesophelebion hopeanum	
+Mikania micrantha	Compositae
+Musa sp.	Musaceae
*Myristica castaneifolia	Myristicaceae
Nephrolepis tuberosa	Davalliaceae
*Palaquim hornei	Sapotaceae
Parasponia andersonii	Ulmaceae
Parinari insularum	Rosaceae
Passiflora maleformis	Passifloraceae
*Pepperomia parhamii	Piperaceae
Piper aduncum	Piperaceae
P. puberulum	Piperaceae
*Pittosporum brackenridgei	Pittosporaceae
*Plerandra grayi	Araliaceae
Pronephrium rubrinervi	Rubiaceae
Psychotria spp.	Psychotriaceae
Pteridium esculentum	Pteridaceae
Pueraria lobata	Papilionaceae
Rubus moluccanus	Rosaceae
*Endemic species	
+Introduced species	
*Palaquim hornei	
Parasponia andersonii	
Parinari insularum	

Selaginella spp.	Selaginellaceae
Selaginella distans	Selaginellaceae
Shefflera sp.	Araliaceae
*S. seemanii	Araliaceae
Syzygium spp.	Myrtaceae
+Solanum repandum	Solanaceae
Sphaerostephanos invisus	
+Stachytarpheta urticaefolia	Verbenaceae
Tectaria decurrens	Aspidiaceae
*T. godeffroyi	Aspidiaceae
*Timonius affinis	Rubiaceae
Trichomanes apicifolium	Hymenophyllaceae
T. dentatum	Hymenophyllaceae
*Vavaea amicorum	Meliaceae
*Weinmannia affinis	Cunoniaceae
*Endemic species	
+Introduced species	
