Relative Abundance, Diet and Feeding Behaviour of Fishes in *Lawis* Stream, Buruun, Iligan City

Ephrime B. Metillo[1] and Aries Joey C. Acma[2]

Abstract

Species composition, relative abundance and feeding behaviour of fishes were determined at different elevations of Lawis *stream (124° 0.67' E; 8 ° 11.26'N) in Buruun, Iligan City. Visual census at three stations with riffle and pool areas showed six species of fish:* Therapon cancellatus *(Theraponidae),* Kuhlia *sp. (Kuhlidae),* Boroda expatria *(Eleotridae),* Ryacichthys aspro *(Rhyacichthyidae),* Sicyopteros extranous *and* S. cyanopterus *(Gobiidae). The cylindrical shaped* S. extranous *was the most abundant in pool areas while the dorsoventrally flattened* R. aspro *dominated the riffle areas. Relative abundance of fish decreased with elevation. Gut content analysis indicated a broad diet in fish species examined, but in general diet includes a mixture of insect larvae, amorphous bodies,* Macrobrachium *sp. larvae and bryophytes.* Boroda expatria *showed an exclusive molluscan (*Bursa echinata*) diet. Daytime observation showed that both juveniles of* S. cyanopterus *and* S. extranous *exhibited similar sucking behaviour on hard rock surfaces, but the latter species also showed the straining behaviour. The feeding strike movement in these juveniles was absent in adult* S. extranous *which showed the straining behaviour.*

Key Words: tropical stream fish, feeding ecology, feeding behaviour

Introduction

Forty percent (40%) of the earth's vertebrate species is composed of fish occupying several ecological niches (Reid and Wood, 1976; Goldman and Horne, 1983; Moss, 1988). Definite habitat preference characterizes most of the fishes and many have fixed home ranges for feeding, breeding, and avoidance of predation (Hynes, 1970; Nelson, 1976). In freshwater environments, the distribution of fish species in lakes and streams may follow vertical, and horizontal zonation patterns. These patterns are influenced by several factors that only a well designed ecological study could pinpoint factors that offer most explanatory power (Odum, 1971).

Very few ecological studies have been done in many streams in the Philippines despite the fact that these habitats have relatively rich biodiversity (Guzman et al., 1997). Fish species surveys, in particular, are inadequate that some species may just swim their way to extinction before being fully examined as to their biological and economic importance. These

[1] Department of Biological Sciences, College of Science and Mathematics, MSU-Iligan Institute of Technology, Iligan City
[2] College of Medicine, Mindanao State University, Marawi City

different species of stream fish portray a diversity of niches that, in ensemble, contribute to a productive and normally functioning stream habitat. Reports on fish species in Mindanao streams are purely on taxonomic surveys; rarely any ecological approach has been published (Vallejo, 1985; Conlu, 1986). In the present study, apart from describing physical and chemical features of the study area, we investigated the species composition, relative abundance, and feeding behaviour of fish species in *Lawis*, a stream found in Iligan City, Northern Mindanao.

Materials and Methods

Study Area. The study was conducted in *Lawis* stream (124° 0.67' E longitude; 8 ° 11.26'N latitude) of Buruun, Iligan City which is approximately eight kilometers southwest of Iligan City proper. It is a permanent natural watercourse that developed from a groundwater source and opens into the nearby sea channel along Iligan Bay. From the spring, the water flows along a 70-meter stream channel that forks at 30 m before joining again and flowing into a pool at the downstream portion which is augmented by two tributaries (Fig. 1).

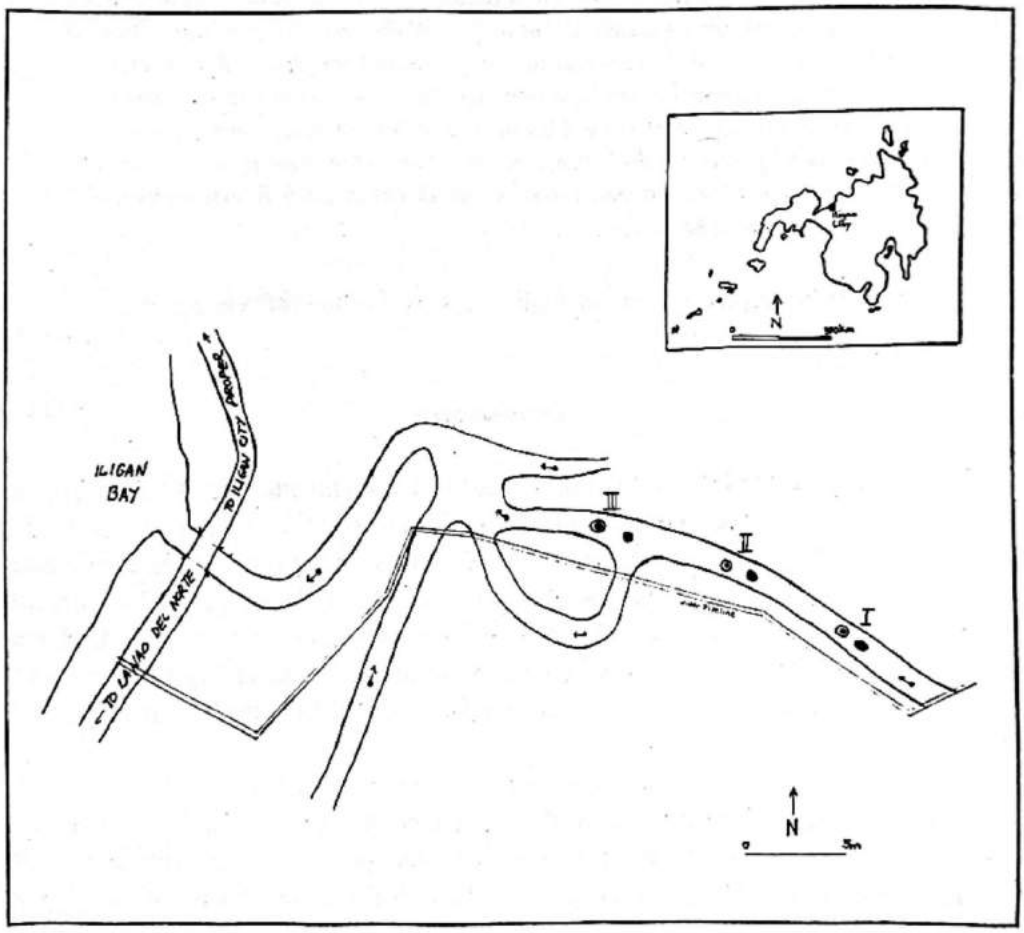

Figure 1. Map of a portion of Barangay Buruun, Iligan City showing *Lawis* stream (coordinates: approximately 124° 65' East; 80° 11.2' North), and the three (I,II, III) sampling sites (• - pool area; ◉- riffle area). •→ - stream flow direction

Three stations, each with pool and riffle, located at different elevations were established. Riffles were distinguished by breaking anti-waves at the water surface, while pools by smooth surface flow with minimal of such anti-waves. Riffle areas are shallower than pool areas. Pool station I is located 700 ft above sea level towards the spring source, with a mean depth of 0.88 m and an area of 81.8 m^2. It has vegetation on one of its sides and percent canopy coverage of <50%. The second pool station is situated 68 m from the first station, and with an elevation of 300 ft above sea level. It has an area of 66 m^2 with a mean depth of 1.0 m Both sides are not well vegetated with a percent canopy coverage of less than 5%. Pool station III is located downstream 56 m from station II. It is elevated 100 ft above sea level, has an area of 87 m^2, mean depth of 1 m, and has >50% canopy coverage. The first riffle station is situated 34 m downstream from pool station I, elevated 400 ft above sea level, has an area of 47.6 m^2 and a mean depth of 0.5 m. It is vegetated on both sides and has <50% canopy coverage. Riffle stations II and III are located 24 m and 38 m downstream from riffle station I, respectively. The former has an area of 18 m^2 with mean depth of 0.34 and elevated at 300 ft. The latter is elevated at 200 ft and held an area of 120 m^2 with mean depth of 0.25 m. The substratum at each station was primarily gravel and cobble but boulders and exposed shale bedrock were prominent in pool stations II and III.

Determination of Physical Parameters. Determination of temperature for each station was done using a mercury thermometer. Air temperature was obtained by exposing the mercury bulb in the atmosphere until the reading became stable. Water temperature was obtained by dipping the thermometer in the bottom, middle and surface regions for the pool stations and surface layer for the riffle stations. The surface velocity was measured by timing a neutrally buoyant object along one meter of reach. Water depth, stream width, and elevation were determined using a meter stick, a calibrated rope and Global Positioning Sensor (GPS), respectively. Substratum texture was noted.

Determination of Chemical Parameters. Chemical parameters were determined in three replicates for each station per sampling. A Corning DO meter was used for dissolved oxygen determination. Water pH was determined using a Corning pH meter. Preliminary sampling revealed that salinity did not vary from station to station (< 0.01 ppt) thus eliminated from the procedure.

Sampling Methods. A total of nine samplings were made (three per station) from November 1996 to January 1997. Sampling was done from 0800 H until 1100 H, and in each sampling, physico-chemical parameters were determined. Fish were censused visually using snorkel and mask. The substratum of each pool region was divided into four horizontal imaginary areas from which fish were counted. Unnecessary movements were avoided so as not to scare away fishes. The fish in the riffle region were directly counted by an observer moving upstream while counting.

Fish were collected through electric stupefaction (Brandth 1972) using a 6 V motorcycle battery enclosed in a wooden box that can be conveniently strapped onto one's back. Connected to the terminals by electric cords were two cylindrical metal rods each about one meter long and about 0.5 cm in diameter. Provided with a wooden handle, these electric metal rods were pushed forward underwater in operation. Fish that happened to be in between the two electrodes were stunned, and were then collected with a scoop net. It was noted that shocked fish, if left abandoned, recovered completely after a while. Stunned fishes were immediately fixed in 10% formalin, placed in labeled polyethylene plastic bags, and were brought to the research laboratory of the Department of Biological Sciences of MSU-Iligan

Institute of Technology. The stomach of each fish was removed and kept for food item analysis. Select representatives of every species were then transfered to 70% ethanol for permanent storage and treated as voucher specimens for taxonomic study. The preliminary identification was done using the book of Conlu (1986). Final systematic classification was done by Professor Pedro T. Escudero of MSU-Marawi City.

Diet Composition Analysis. Stomach contents were extracted through lavaging. Both ends of the stomach and intestine were opened and water was introduced to one end such that the contents were driven out at the other end into a Petri dish. The different diet components were analyzed under the stereomicroscope, and identified using the best possible available taxonomy. The percentage occurrence (Escudero et al. 1980) of each diet component in each of the species of the collected samples was calculated using the formula:

$$\%\text{Occurrence} = \frac{\text{number of fish to where the food item occured}}{\text{total number of fish}} \times 100$$

Relative Gut Length and Gill Raker Features. Individual standard length of fish was determined to the nearest 1 cm by measuring the length from the snout to the tip of the caudal fin. Gills were dissected out and number and gross morphology of gill rakers were noted for each species examined. Gut length was determined to the nearest 1 cm. From these data relative gut length was computed using the formula:

$$\text{Relative Gut Length} = \frac{\text{length of gut}}{\text{total length of the body}}$$

Feeding Behavior. For two daytime sampling periods, feeding movements of each species were ascertained under direct observation using mask and snorkel. Each observation was standardised to 30 minutes during which duration of each distinct movement was recorded and expressed as % relative duration. Some general information on feeding habits were referred from Lagler (1977), Goldman and Horne (1994), and Nikolsky (1971).

Results

Physical and Chemical Parameters. Dissolved oxygen values were within the 5 mg/L - 6 mg/L range. These values indicate non-pollution (Moss 1988). Both riffle and pool areas of Station I showed the highest dissolved oxygen concentration at mean values of 6.4 mg/L and 5.8 mg/L respectively. There was no significant variation in the pH values (7 - 8) obtained from the stations. However, Station II of the pool region exhibited the highest velocity at mean value of 0.62 m/s. In contrast, Station I of the riffle region exhibited the

fastest surface current with mean value at 1.3 m/s. The three stations of both pool and riffle showed similar water temperature of 24 °C. The highest elevation exhibited the coldest air temperature at mean value of 26 °C for pool and 28 °C for riffle. Warmest air temperature was exhibited by Station II of pool and riffle at mean values of 28.2 °C and 29°C, respectively.

Relative Abundance. A total of six (6) species were encountered during a three sampling period to each of the three stations in Lawis stream (see Table 1). Four belonged each to a distinct Family and two to a single Family. All *Sicypterus cyanopterus* individuals observed were juveniles thus were disregarded in the count. Juvenile of the species were disregarded due to their temporary nature that enhances changes in the assemblage composition (Gelwick, 1990). Seventy three percent (73%) of fishes were counted in the pool regions and only twenty-seven percent (27%) were from the riffle region.

Table 1. A list of fish species caught in Lawis stream, Buruun, Iligan City

SPECIES	FAMILY	COMMON ENGLISH NAME
Therapon cancellatus	Theraponidae	cross-barred grunt
Kuhlia sp.	Kuhliidae	aholeholes
Boroda expatria	Eleotridae	sleeper
Ryacichthys aspro	Ryacichthyidae	loach
Sicyopterus extranous	Gobiidae	goby
Sicyopterus cyanopterus	Gobiidae	goby

Table 2 shows the relative abundance of each species from the different elevation of the pool and riffle regions of the stream. The most abundant species was *S. extranous* with a total relative abundance of 63.2%. In contrast, *Kuhlia* sp. was the least abundant at 1.8%. This species was observed only during the first sampling and third sampling periods of pool station I. Its catadromic nature is believed to be the cause of its absence in some of the sampling periods. The order of relative abundance of each species was consistent for all the stations. *S. extranous* was found to dominate in the pool region followed by *R. aspro*. This trend was reversed in the riffle regions where the latter became relatively more abundant than the former. The relative abundance of total fishes was found to differ significantly for the different stations ($p < 0.05$, one-way ANOVA). Relative abundance of all fish from the three stations had weak negative correlation coefficients (Pearson-Product Moment Correlation) for dissolved oxygen (-0.04), pH (0.12), temperature (-0.08). However, it had a strong negative correlation of -0.95 with elevation.

Table 2. Relative abundance of fish species visually censused at three stations of Lawis stream, Buruun, Iligan City.

	TOTAL NUMBER (N)	N/M²	RELATIVE ABUNDANCE %
POOL			
Therapon cancellatus	73	0.31	4.96
Boroda expatria	100	0.43	6.87
Ryacichthys aspro	120	0.51	8.15
Kuhlia sp.	38	0.16	2.56
Sicyopterus extranous	1138	4.85	77.52
RIFFLE			
Therapon cancellatus	28	0.15	4.67
Boroda expatria	20	0.11	3.42
Ryacichthys aspro	383	2.06	64.1
Kuhlia sp.	1	0.005	0.06
Sicyopterus extranous	165	0.89	27.7
Grand Total			
Therapon cancellatus	101	0.24	4.89
Boroda expatria	120	0.28	5.7
Ryacichthys aspro	503	1.20	24.4
Kuhlia sp.	39	0.09	1.8
Sicyopterus extranous	1303	3.1	63.2

Diet, Gut and Gill Raker Features. The stomachs of 31 fish were dissected out for the diet analysis. Eighteen (18) individuals were *B. expatria*, six *T. cancellatus*, five *R. aspro*, one *Kuhlia* sp., and one *S. extranous*. The diet of *T. cancellatus* predominantly consisted of insect larvae of which 66.7 % were trichopterans. The rest of its diet comprised juveniles of the shrimp *Macrobrachium* sp. and unidentifiable amorphous bodies. Insect larvae of trichopterans and neuropterans as well as bryophytes and larvae of *Macrobrachium* sp. made up the diet of *R. aspro*. The diet of *Kuhlia* sp. consisted of odonates, some insect body parts and amorphous bodies. On the other hand, the gastropod mollusc *Bursa echinata*, was the sole diet found in the gut of *Boroda expatria*. The lone *S. extranous* had an empty gut.

Table 3. Classification and frequencies of occurrence of food items from the stomachs of fish collected from Lawis stream.

FOODITEM	%OCCURRENCE IN THE DIFFERENT FISH SPECIES				
	Kuhlia sp.	*T. cancellatus*	*B. expatria*	*R. aspro*	*S. extranous*
Odonates	100	66.7			
Dipteran larvae		33.3			
Trichopteran larvae		66.7		40	
Coleopteran larvae		50			
Lepidopteran larvae		16.7			
Ephemeropteran larvae		16.7			
Neuropteran larvae		16.7		60	
Insect body parts	100	16.7			
Bursa echinata			83.3		
Macrobrachium sp.		16.7		20	
Bryophytes					
Amorphous bodies	100	50			

Table 4 shows the mean relative gut length of each species as well as their type of gill rakers. *S. extranous* has the greatest relative gut length value of 3.6 and showed undeveloped gill rakers. *B. expatria*, on the other hand, showed a relative gut length = 0.7, and few and stubby gill rakers. The rest revealed numerous and finer gill rakers, and relative gut length ranging from 0.6-0.7.

Table 4. Summary of the mean gut length, number and type of gill rakers of the fish collected through electric stupefaction from three stations of Lawis stream.

SPECIES	MEAN STANDARD LENGTH (cm)	MEAN INTESTINE LENGTH (cm)	MEAN RELATIVE GUT LENGTH (cm)	NO. OF GILL RAKERS	TYPE OF GILL RAKERS
Therapon cancellatus	9.7	7.0	0.7	27	long & fine
Kuhlia sp.	11.4	6.8	0.6	30	long & fine
Boroda expatria	6.5	4.2	0.7	12	short & stubby
Ryacichthys aspro	7.1	3.4	0.5	14	short & fine
Sicyopterus extranous	5.4	19.5	3.6	undeveloped gill rakers	

Feeding Behaviour. *S. extranous* exhibited four distinct behaviours believed to be associated with its feeding activity:

1. **A body move** is defined as the change in the position of a fish by at least 1 cm relative to the stream substrate (see Vogt and Coon 1990)
2. **A strike** is any feeding attempt while swimming in a darting fashion.
3. **A suction** is accomplished by touching its mouth to the substrate while drawing water and prey into its mouth like a vacuum. The mouths then showed a chewing motion that somehow sorts particles in the mouth.
4. **A strain** which is an upward tilting of head while the mouth is opened to strain potential prey present in the water column. This is usually preceded by hiding in crevices between or underneath rocks while exposing the head.

Two types of complete feeding sequence were noted. The first type comprised a series of body moves and turns, a strain, and a suction. The second type composed of a series of body moves and turns, a strike and a suction. It was noted that both feeding sequences were not fixed. Each should terminate or revert back to preceding behaviour at any point. A body move did not always precede a strike or strain and a suction did not always follow a strike or a strain. The two species of *Sicyopterus* exhibited either type of feeding sequence.

The suction behaviour was found to dominate both in the adult *S. extranous* and juveniles of *S. cyanopterus*. It constituted 97.8% and 91.2% of the total feeding sequence of the former and the latter, respectively. However, the strike behaviour was absent in the feeding sequence of the adult goby while the strain movement was observed to dominate in the second sampling period. The juveniles tend to feed on finer substrates (e.g. gravel and sand) and were concentrated near the bank of the stream. The adults were observed to occupy larger substrates such as cobbles and boulders.

Feeding behaviours of the other four species were distinctly ascertained. There were no feeding attempts observed during the two sampling periods. *T. cancellatus* was found to exhibit an alternating behaviour of swimming against the water column and hiding in between rock assemblages. *B. expatria,* on the other hand, was observed to settle in the bottom near and behind objects for long periods without movement. If they moved, body displacement was often very slight. *R. aspro* exhibited only a series of body moves against the water column. It prefered to settle longer on rock surfaces. The exact mechanism of how it procures food was not clear. These four species are believed to be nocturnal feeders.

Discussion

This study reports for the first time the species composition and feeding ecology of stream fishes in Northern Mindanao, Philippines. Species reported here have been sampled in other regions of the Philippines (Conlu, 1986). Elevation significantly determined longitudinal distribution of fish in *Lawis* stream. This result is generally similar to those numerous studies of stream fish by Gorman and Karr (1978), and Schlosser (1982). The pattern of increasing species richness and abundance associated with decreasing elevation is due to

increasing habitat size and complexity downstream (Burton and Odum 1945; Evans and Noble, 1979). Barriers increase with increasing elevation (Matthews, 1987) thus fish penetration is decreased. There was higher abundance of fish in the lower elevation primarily due to its increased area with higher food and/or nutrient availability.

R. aspro was found to dominate in the riffle area due to its structural adaptations. It has flattened ventral surface in the cephalic region and developed fins that served as adhesive sucking organs which enables it to survive against the string current in the riffle area. The presence of a particular organism in particular type of habitat is directly related to its adaptive character (Nikolsky, 1971). The same reasoning is invoked with the dominance of the cylindrically-shaped *Sicyopterus* spp. in the pool region.

According to Nikolsky (1971), the length of the digestive tract is closely related to the type of food a fish subsists upon. Among fishes which have reduced stomachs, the intestine comprises less than 100% of the length of the body in carnivores and more than 100% in herbivores. A similar picture is seen on fishes that possess a stomach and a long intestine. Species with a relative gut length of less than one, meaning having intestines shorter in length relative to the total body length, have carnivorous types of feeding. For *S. extranous* whose relative gut length reached up to a maximum of 3.6, though the gut analysed was empty, indicates that it is herbivorous. Its herbivorous habits maybe realted on its grazing behaviour on submerged rock surfaces. Herbivorous fish have rapid turnover in food ingested due to the large proportion of bulky plant materials (Bowen et al., 1984). This could explain the empty gut observed for *Sicyopterus* spp. Temporal variations in maximum feeding would partly explain empty guts (Hynes, 1970). The small relative gut length and stubby and fewer gill rakers of *B. expatria* indicates its predatory behaviour (Lagler, 1977). This is supported by its exclusive diet on molluscs.

The assumption that the juveniles of both *Sicyopterus* species share a common feeding sequence supports another assumption that the absence of strike behaviour in the feeding sequence of the adult *S. extranous* indicates an ontogenetic change in feeding behaviour. According to Nikolsky (1971) the diet composition changes with the age of the fish. The ontogenetic changes in feeding are not only an adaptation toward increasing the supply of food, they are also determined by the need for the food of the organism to correspond its structure. Thus an adult *S. extranous* has to give up the strike behaviour in order to increase proportion of suction so as graze more on the rock surfaces to compensate increased energy requirement brought about by growth. Moreover, Ringler (1983) called attention to the dramatic and at time unwieldy variation exhibited by different fish of the same species. Vogt and Coon (1990) further stressed that fish size or sex may account for some of these variations. In this study, the straining movement of the young adult of *S. extranous* was one such behaviour. It is believed also that this variation represents response to changes in environmental condition (Vogt and Coon, 1990).

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