Feeding habits of fish fauna in Batang Kerang floodplain, Balai Ringin, Sarawak

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Bachelor of Science with Honours
(Aquatic Resource Science and Management Programme)
2011
Feeding habits of fish fauna in Batang Kerang floodplain, Balai Ringin, Sarawak

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A report submitted in partial fulfillment of the

Final Year Project 2 (STF 3015)

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2011
I am very grateful to God for giving me the strength to complete my final year project. Here, I would like to express my gratitude and appreciation to those who bring successful completion to my project. Heartiest thanks to my supervisor, Mr Khairul Adha A. Rahim for the help, advices and encouragement throughout the whole project.

Thanks to field assistants Mr Jeman Mardzuki, Nakhoda Jeman and also to the local people of Balai Ringin that had helped us in catching fish samples during fieldtrip. I would also like to thank to laboratory assistants, Mr Zulkefli Ahmad, Mr Nazri Latip and Mr Richard Toh for the guidance in laboratory works and fieldworks. Not forget also expressing my gratitude to coursemates, master students and friends.

I would like to appreciate and acknowledge my family especially my father, Emit Seling and my mother, Lydia Unjong Eban for giving me support, encouragement and confidence to proceed and finish my final year project.

Lastly, thank to all Aquatic Resource Science and Management Programme lecturers who had support, educates me while I am in Unimas.

Thank you all

Lorna Emit.
DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institutions of higher learning.

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Table of Contents

Acknowledgements ........................................................................................................ I
Declaration ...................................................................................................................... II
Table of Contents ......................................................................................................... III
List of Abbreviations ................................................................................................... IV
List of Tables .................................................................................................................. V
List of Figures ............................................................................................................... VI
Abstract ....................................................................................................................... 1

1.0 INTRODUCTION ................................................................................................. 2
  1.1 Background ........................................................................................................ 2
  1.2 Problem Statement .......................................................................................... 4
  1.3 Objectives .......................................................................................................... 4

2.0 LITERATURE REVIEW .................................................................................... 5
  2.1 Status of fish fauna in Malaysia .................................................................... 5
  2.2 Importance of study fish diet ........................................................................ 6
  2.3 Feeding behavior of fish ................................................................................ 7
  2.4 Dietary of fishes in wild habitat .................................................................... 8
  2.5 Gut anatomy and gut length of fish .............................................................. 11

3.0 MATERIALS AND METHODS ....................................................................... 13
  3.1 Study Site ......................................................................................................... 13
  3.2 Sampling methods .......................................................................................... 15
  3.3 Gut content analysis ...................................................................................... 15
  3.4 Data analysis .................................................................................................... 16

4.0 RESULTS AND DISCUSSIONS ..................................................................... 18
  4.1 Fish fauna composition .................................................................................. 18
  4.2 Fish species for gut content analysis ............................................................. 23
  4.3 Relative Gut Index (GRI) .............................................................................. 26
  4.4 Food habits .................................................................................................... 30
  4.5 Food composition ......................................................................................... 34
  4.6 Frequency of occurrence ............................................................................. 37

5.0 CONCLUSION RECOMMENDATIONS ....................................................... 40

REFERENCES ........................................................................................................ 41
List of Abbreviations

cm  centimeter
°C  degree Celcius
E   East
g   gram
GRI Gut Relative Index
GL  Gut Length
n   number of sample
N   North
N/A Non availability
SL  Standard Length
SD  Standard Deviation
SE  Standard Error
TL  Total Length
## List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Descriptions</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The feeding habits of common freshwater fish fauna</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Fish samples collected from black and brown water habitats at Batang Kerang floodplain of Balai Ringin, Serian, Sarawak</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Fish samples used for gut content analysis</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>Total length, standard length and weight of the fish samples for gut content analysis</td>
<td>24</td>
</tr>
<tr>
<td>5a</td>
<td>Relative Gut Index (RGI)</td>
<td>27</td>
</tr>
<tr>
<td>5b</td>
<td>Fish category based on GRI</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>Food items consumed by fish species</td>
<td>31</td>
</tr>
<tr>
<td>7</td>
<td>Percentage (%) of food composition in the fish guts</td>
<td>34</td>
</tr>
<tr>
<td>8</td>
<td>Percentage (%) of frequency of occurrence</td>
<td>38</td>
</tr>
</tbody>
</table>
List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Descriptions</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maps of Batang Kerang floodplain, Balai Ringin, Serian, Sarawak</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>The percentage (%) of fish families collected in Batang Kerang</td>
<td>21</td>
</tr>
</tbody>
</table>
Feeding Habits of Fish Fauna in Batang Kerang floodplain, Balai Ringin, Sarawak

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ABSTRACT

Diet analysis of fish is important for the studies of competition, predator-prey relationship, trophic level, food webs and potential fish aquaculture. Analysis on feeding habit of fish fauna in Batang Kerang was still less studied. The objectives of the study are to identify the feeding habits and to analyze the food items consumed by fish fauna in Batang Kerang. Fish samples were collected from Batang Kerang floodplain, Balai Ringin in August 6 to 7, 2010 and in March 12, 2011. The total length, standard length and weight were measured to the nearest centimeter (cm) and gram (g), and fish species were identified. Fifty eight specimens were dissected to collect their gut content for the study of feeding habits. The feeding habits were determined based on Gut Relative Index (GRI), percentage (%) of food composition and percentage (%) of frequency of occurrence. The results showed that the major food item consumed by fish fauna in brown water is detritus (44.6%) followed by plant materials (31.8%) and insects (11.5%).

In black water, major food item is detritus (41.5%) followed by plant materials (34.1%) and algae (12.2%). Further study on detail feeding habit of fish should be done.

Key words: fish fauna, diet analysis, feeding habits, food item, gut content

ABSTRAK

Analisis diet ikan adalah penting untuk mengetahui persaingan makanan, hubungan mangs a pemangsa, rantai pemakanan dan juga penting untuk ikan yang berpotensi untuk akuakultur. Analisis tentang tabiat pemakanan ikan di Batang Kerang masih kurang dikaji. Objektif kajian ini adalah untuk mengenal pasti tabiat pemakanan dan menganalisis item makanan yang dimakan oleh fauna ikan di Batang Kerang. Sampel ikan telah ditangkap dari Batang Kerang, Balai Ringin pada 6 hingga 7 Ogos, 2010 dan pada 12 Mac, 2011. Panjang dan berat diukur menghampiri skala sentimeter (cm) dan gram (g), dan species ikan dikenal pasti. Lima puluh lapan specimen telah dibedah untuk mengambil kandungan isi perut bagi kajian tabiat pemakanan. Tabiat pemakanan dapat diketahui melalui Indeks Relatif Perut, peratus (%) komposisi makanan dan peratus (%) kejadian frekuensi. Keputusan memunjukkan makanan utama bagi fauna ikan di air hitam adalah detritus (44.6%) diikuti dengan tumbuhan (31.8%) dan serangga (11.5%). Di air coklat, makanan utama ikan adalah detritus (41.5%) diikuti dengan tumbuhan (34.1%) dan alga (12.2%). Kajian yang lebih terperinci tentang tabiat pemakanan ikan harus dijalankan.

Kata kunci: fauna ikan, analisis diet, tabiat pemakanan, item makanan, kandungan isi perut
1.0 INTRODUCTION

1.1 Background

The quality and quantity of food consumed by fish are the most important factors affecting their growth, survival and mortality. Studies of the feeding habits of fish fauna are useful to examine conservation fishery biology and fisheries management in an aquatic environment (Alp et al., 2008). In addition, it is also essential for aquaculture development. Over the years, the aquaculture sector has gained a rapid demand due to the increasing of human population and the important of fish as a low cost source of animal protein (Offem et al., 2009). Thus, for the effectiveness of fish farm management, there is a need for effective nutritional management strategies which can be achieved by further understanding and study on the food requirement and feeding habits of fish that potentially to be cultured (Offem et al., 2009). The stomach content of the an organisms is a valuable source in order to obtain the detail information about the food web in a certain area as well as to determine the population parameters of species that could not be determined by other methods (Nimet and Hacer, 2009).

Several studies on the food and feeding habits of freshwater fishes in Malaysia are available (Khan et al., 1993; Yap, 1998; Peralta, 2003; Mat Isa et al., 2010; Simon and Mazlan, 2010). However, there are still lacking of studies focusing on the fish dietary in Sarawak. This study is conducted to study the feeding habits of fish fauna in Batang Kerang floodplain, Sarawak. Batang Kerang floodplain situated in Balai Ringin, Serian which has two water habitats, brown water and black water habitat that had created a unique habitat for the fish fauna. The food and feeding habits of different fishes depends upon variable factors. The differences of fish habitat may influence the food consumed by
the fish fauna inhabit in Batang Kerang. The brown water habitat supports more diverse plants than black water habitat. The vegetation along riverbank such as stand of littoral, floating and submerged plants are presented which provides food sources and nursery ground for the fish fauna (Khairul et al., 2009). Floodplain is defined as an area of low-lying ground adjacent to a river that is subject to flooding. Floodplain plays an important role as nurseries, food sources and shelter for the young and adult of various fish species (Morrow and Fischenich, 2000). Thus, the study on the feeding habits of fish fauna in Batang Kerang needs to be specifically study to analyze the food consumption from their natural environment.

Various techniques are available for undertaking the gut analysis of fish. The selection of an appropriate technique could be determined by the investigation type, existing hypothesis or nature of the food to be analyzed (Windell and Bowen, 1978). Balik et al. (2006) stated that the common calculation methods for gut content are the 'percentage composition by number' and 'frequency of occurrence'. To identify overlap in food consumed between two species, Schoener's formula was applied (Guruge, 2002). Gut Relative Index (GRI) also being applied in dietary study to show the calculation of the ratio of total gut length to the standard length of fish (De Silva, 1985). Such methods for analyzing gut contents are conducted to identify and assess their dietary (Hyslop, 1980). The information on the dietary of commercial and important fish fauna may contribute to effective and accurate food security, nutritional and thus, enhances economic development (Reantosa and Subasinghe, 2008).
1.2 Problem Statement

There was still lacking of information on the food and feeding habit of fish fauna examined in Batang Kerang. Hafiza (2006) had studied the dietary analysis of fish species in Sungai Sarawak Kanan and Batang Kerang. However, the study only compared the fish dietary between Sungai Sarawak Kanan and Batang Kerang. Therefore, the aims of this study are to specifically investigating and analyzing the food and feeding habits of fish in black and brown water habitats in Batang Kerang. This study is also to examine the ecological feature toward the feeding habit of fish fauna on fish’s feeding behavior in Batang Kerang floodplain. Information on the feeding habit of fish fauna in the area are useful for future studies particularly on the pattern of food consumption by the fish in natural habitat.

1.3 Objectives

The objectives of the study are:

1) to identify the feeding habit of fish fauna in black and brown water habitat.

2) to identify the food category of fish species in Batang Kerang.

3) to analyze the food composition and frequency of occurrence of food items in the fish gut.
2.0 LITERATURE REVIEW

2.1 Status of fish fauna in Malaysia

In Malaysia, approximately 1957 species of freshwater and marine fish fauna belonging to 704 genera and 186 fish families were recorded (Chong et al., 2010). Cyprinids are dominant fish family contributing of 30% of all fish species in Peninsular Malaysia and Borneo (Salam and Gopinath, 2006).

There are many studies on the distribution and ecology of freshwater fishes in Sabah (Inger and Chin, 1962; Smith and Laird, 1998; Kathryn, 2002; Hajisamae et al., 2003; Amirrudin and Syed, 2006). Inger and Chin (1962) focused much more complete account of the ecology of fish in streams and rivers of Sabah. According to Kottelat and Whitten (1996), approximately 440 of freshwater fish species were found in Borneo. More than 6700 individuals of 38 fish species were recorded from all rivers and streams of Sabah (Smith, 1998). A survey of freshwater fish fauna by Khairul et al. (2001) in the Upper Rivers of Crocker Range National Park, Sabah also had been done. The fish family presents are Gastromyzontidae (59.5%), Cyprinidae (37.7%), Cobitidae (2%) and Sirosidae (0.8%).

There were few surveys on fish distribution studied in Sarawak by Parenti and Lim (2005); Watson and Balon (2006); Khairul et al. (2009). At least 164 species were listed and recorded from Belaga, Balui River, Kapit, Baleh River and Rajang Basin. There were approximately 184 species from eight fish families recorded from headwaters of Dappur and Tutoh Rivers until Baram River (Nyanti and Jongkar, 2007). In Batang Kerang, Balai Ringin, Serian, fish fauna in brown water habitat was dominated by Cyprinidae while in black water dominated by Helostomatidae (Khairul et al., 2009). Most of the study mainly
focused on the ecology distribution of species composition in specific habitat. However, the examination and analysis of diet and feeding habit are still scarce.

2.2 Importance of study fish diet

Diet analysis of fish is the study on food items present in the gut of an individual fish. The gut content is the important part in which measurement of the gut length is essential. Information on the quality and quantity of food consumed by fish is important for the ecological study particularly for investigating fish category, feeding competition, understanding predator-prey interaction and the stability of food webs (Nyunja et al., 2002). Data on diet composition are also important for the estimation of trophic levels that can show the relative position of an animal in the food webs (Rogdakis et al., 2010). The study on fish diet allows the improvement of new approaches to analysis food webs. Thus, dietary study is essential for the fisheries resources management as well as quantifying the effects of fishing within aquatic ecosystem.

In addition, it is imperative to study the food and feeding habits of freshwater fish continuously to sustain and improve their importance in aquaculture (Ndimele et al., 2010). Throughout the year, aquaculture contribution of foods fish supply will increase due to the development of aquaculture (Consultative Group on International Agriculture Research (2007); Bostock et al., 2010). It is necessary to study on fish diet to enhance the food security and nutritional value in aquaculture (Reantosa and Subasinghe, 2008). In addition, the farmer can manage the feed of the fishes adequately and consequently hence, provide aquaculturist with information about the appropriate diet and nutrient for the fish to be cultured (Reantosa and Subasinghe, 2008).
Study on fish diet also provides information on the fish feed formulation. Severed studies have been conducted in order to determine the nutrient requirement of fish cultured (Kaushik and Aguirre, 1993; Ramseyer and Garling, 1993). The main criteria focused in the management of fish diet are on the essential nutrients and adequate proportion of energy produces by the food consumed in order to optimize the requirement of diet in the fish cultured (Kaushik and Aguirre, 1993; Consultative Group on International Agriculture Research (2007); Sogbesan and Ugwumba, 2008).

2.3 Feeding behavior of fish

Food is an important factor regulating growth, abundance, feeding and migratory movements of fish (Nyunja et al., 2002). Presently, fishes have become adapted to a wide range of food variety they consumed. The importance of the information on food and feeding habits of fish in understanding its fishery biology and ecology had been well established. Feeding is a part daily routine for living organisms. The nature of food composition of fish depends on the habitats it frequents. Variation in the seasonal and diurnal abundance of the preferred food items of different fish species may influence the food they consumed (Podrazhanskaya, 1993).

The amount and types of food ingested by fish fauna per day and feeding activities performed depends on many factors. For active predators, which have high metabolic rates require more food energy than sluggish fishes (Guruge, 2002). Daily and seasonal temperature fluctuations may affect food consumption in most fishes. Some species feed mainly by sight are active during day although peaks of feeding usually occur in morning and evening. Other fishes that depend on chemical sense can feed efficiently in the absence of light (Hanjavanit and Sangpradub, 2009). The result of many studies on feeding of
various fishes however show that small fishes tend to consume more food per day in relation to their body weight than larger fishes.

Most fishes are highly adaptable in their feeding habits. Freshwater fishes can be divided into four feeding types and categories which are herbivorous, omnivorous, carnivorous and plankton feeders. Herbivorous fish feed mainly on aquatic plants, unicellular algae, and filamentous algae along with some sand or mud. Fish that consumed plant materials about 75% or more of total gut content considered as herbivorous (German and Horn, 2006). For omnivorous fishes, they consume both plants and animals such as aquatic plants, unicellular and filamentous algae, rotifers, insects, insect larvae, crustaceans which consumed. Chang (2010) stated that carnivorous fishes feed on high percentage of animal such as insects, beetles, crustaceans, water bugs, dragonfly larvae and small fishes. For plankton feeders, they consume on phytoplankton and zooplankton by filtering the water through their gill rakers. Feeding habits’ of carnivorous fish had been studied by Yap (1998) on *Hampala macrolepidota* and by Islam *et al.* (2004), Bhuiyan *et al.* (2006) on *Channa punctatus*.

2.4 Dietary of fishes in wild habitat

- Fish consumed variety of food such as plants fragments, animals, algae, detritus and many others. Table 1 shows the feeding habits of common freshwater fish fauna. Fish species need to use their habitat in energy-efficient ways in order to recognize the nutritious food sources (Kelley and Magurran, 2003). Fishes that unable to overcome challenges in the wild may result in mortality (Kelley and Magurran, 2003). In natural habitat, catfishes of genus *Nocturus* feed on aquatic invertebrates (Carman *et al.*, 2006) and *Helicophagus waandersii* is a bottom feeder which is omnivorous species, consumed on bivalves and
nematode (Jiwyam and Tippayadara, 2009). The food consumed may due to their selective feeding behavior. Round goby has a diverse feeding capability and mainly feed on the insect larvae (Ricciardi and Rasmussen, 1998).

Cyprinids consumed insects and fungi which were categorized into carnivorous however some cyprinids tend to evolutes to herbivores which feed on green algae, microbes and diatoms. Bluegill *Lepomis machrochirus* feed on zooplankton, macroinvertebrates, small fish and insect (Olson *et al.*, 2003). *Tilapia guineensis* mainly feeds on silt, plant materials, invertebrates, zooplankton and animal eggs (Louca *et al.*, 2010) in Gambia River floodplain. However, zebraﬁshes feed mainly on mosquito larvae and insect, in stream, they feed primarily on insect (Raymond *et al.*, 2007). In the study done by Bastos *et al.* (2010), the feeding habit of the nektonic fish species (Characiformes) was correlated with riparian vegetation. If there are absent of the riparian vegetation, the nektonic fish species will eat on other available food in the habitat.
Table 1: The feeding habits of common freshwater fish fauna

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Food items</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notopteridae</td>
<td><em>Notopterus notopterus</em></td>
<td>Fishes, arthropods, rotifers</td>
<td>Chakrabarti et al. (1995)</td>
</tr>
<tr>
<td>Channidae</td>
<td><em>Channa striatus</em></td>
<td>Channidae feed on dipteran larvae, zooplankton, fish fry, worms, insects, crustaceans, insects, mollusks, fishes, plants</td>
<td>Chakrabarti et al. (1995) Bhuiyan et al. (2009)</td>
</tr>
<tr>
<td></td>
<td><em>Channa punctatus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cichlidae</td>
<td><em>Oreochromis nilotica</em></td>
<td>Worms, insects, crustaceans, fish fry, detritus algae, rotifers</td>
<td>Chakrabarti et al. (1995)</td>
</tr>
<tr>
<td>Anabantidae</td>
<td><em>Trichogaster pectoralis</em></td>
<td>Planktons</td>
<td>Yap (1998)</td>
</tr>
<tr>
<td>Anguillidae</td>
<td><em>Anguilla rostrata</em></td>
<td>Decapods</td>
<td>Sheldon and Mette (1993)</td>
</tr>
<tr>
<td>Cyprinidae</td>
<td><em>Barbodes schwanenfeldii</em></td>
<td>All the three species mainly feed mainly on detritus</td>
<td>Yap (1998)</td>
</tr>
<tr>
<td></td>
<td><em>Cyclocheilichthys apogon</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Labiobarbus festiva</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mugilidae</td>
<td><em>Liza subviridis</em></td>
<td>Diatoms, detritus, filamentous algae, inorganic sediment</td>
<td>Chan and Chua (2006)</td>
</tr>
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2.5 Gut anatomy and gut length of fish

Gut can be described as a muscular tube lined by a mucous membrane of columnar epithelial cell (Switman et al., 2008). Fish gut is commonly divided into four parts (head gut, fore gut, mid gut and hind gut). The most anterior part is the head gut, occupied in terms of the two components, the oral (buccal) and gill (branchial and pharyngeal) cavities. The foregut begins at the posterior edge of the gills includes the oesophagus, stomach and pylorus. The mid gut includes the intestine posterior part to the pylorus which is always the longest portion of the gut and may be coiled into complex loops (Smith, 1998). In some fish, the beginning of the hindgut is marked by an increase in diameter of the gut and the posterior end of the hindgut is the anus. The capability of fish to consume ingested food depends on the presence of appropriate enzymes at suitable locations along the lumen of intestinal tract and in the wall (Tengjaroenkul et al., 2000).

A number of generalizations about the gut of fishes have been attempted. Herbivorous fishes have longer gut length than carnivorous fishes. This concept may be true in limited groups of fish. The longest guts are categorized into herbivores (Wagner et al., 2009). However, not all herbivores have long guts. Kulabtong and Kunlapapuk (2010) stated that Cyclocheilichthys apogon is herbivorous which have short gut length. The gut lengths of certain herbivorous fish are shorter than those of some carnivores. The evolution on the physical and morphological of digestive tract lies in the fact that many fish consume a variety of food, sometimes ingested with considerable indigestible material such as mud and sand which may influences the gut length (Wagner et al., 2009). The size of the food particles ranged from microscopic plankton to whole fish may also influence the gut morphology and structure as study by Yap (1998).
Most studies on food habits have shown significant relationship with gut morphology (Gosch et al., 2009; Mat Isa et al., 2010; Ndimele et al., 2010). However, the gut also retains considerable reserve ability to respond to new foods, new environments and new opportunities. In addition, many factors could contribute to the difference in feeding behavior such as habitat, trophic level and food availability (Mat Isa et al., 2010). This adaptability has been demonstrated in a number of studies in which a single genus of fish has adapted to new niches and evolved into a new mode of feeding and digestion to utilize new adaptable food and unexploited food resources.
3.0 MATERIALS AND METHODS

3.1 Study site

Batang Kerang floodplain (N 01°14'00", E 110°41'00") is surrounded with varies vegetations in which the lower part of Batang Kerang is covered with floodplain of riverine mixed-dipterocarp, marshes and swamp forests (Figure 1). Batang Kerang floodplain has two different types of water habitat, brown and black water habitat. Brown water is muddy caused by high sediment contents and characterized with many floating plants and other submerged aquatic vegetation (Khairul et al., 2009). The brown water habitat supports more diverse and abundant of fish population compare to the black water habitat. Black water has low pH which is slightly acidic (pH 4.79 ± 0.51). Black water originates from peat swamp forests resulting on the acidic water. Flooded forests and floating vegetations of Batang Kerang floodplain may plays an important role for the habitat and provide food source for the fish fauna. In addition, Batang Kerang is important for fishing activities for local people of Balai Ringin.
Figure 1: Maps showing the sampling site at Batang Kerang floodplain, Balai Ringin, Serian, Sarawak (Khairul et al., 2009)
3.2 Sampling methods

The fish samples were collected using three-layered gill nets with different mesh sizes (4.0 cm and 25.5 cm) at six stations (three stations in black and brown water, respectively) along Batang Kerang. The nets were placed at the six selected area at suitable depth and were left overnight during wet season (August 6 to 7, 2010) and dry season (March 12, 2011). The total length, standard length, fork length and weight of the fish samples were measured using ruler to the nearest centimeter (cm) and gram (g). All the fish samples collected were identified to the species level following Inger and Chin (1962); Mohsin and Ambak (1983); Kottelat and Whitten (1996). Some of the specimens were selected for dietary analysis and were incised to remove the guts. Then, the guts were preserved in 5% formalin and each gut was put in labeled plastic bags. Other specimens that were not being incised were tagged and preserved in 5% formalin for further analysis in Universiti Malaysia Sarawak (Unimas) at Aquatic Teaching Laboratory.

3.3 Gut content analysis

Fish samples were incised and the guts were carefully removed and preserved in 5% formalin solution with labeled bottles prior for analysis gut contents. The total length of the guts was measured using a ruler in unit centimeter prior for the calculation of Gut Relative Index (GRI). The guts were dissected to remove the food items in the gut. Then, gut content of each specimen were removed and separated. Food items were placed on a Petri dish following method by Melo et al. (2004). The number of food items present in the gut were counted and identified. The food items were analyzed under Rax Vision Stereo microscope with magnification 10x and 40x and the smaller food items were analyzed using Leica ATC 2000 compound microscope with magnification 100x. Some of the
identified food items were photographed using *Olympus fe FE-5050* camera. The food items obtained were listed in a table form.

3.4 Data analysis

Gut contents analysis was assessed using three methods which are “Gut Relative Index (GRI)”, “Percentage of Food Composition” and “Percentage of Frequency of Occurrence”.

Relative Gut Index (De Silva, 1985) is the calculation of the ratio of total gut length to the standard length of fish multiplied by 100%.

\[ \text{Relative Gut Index (GRI)} = \frac{X}{Y} \times 100\% \]

\[ X = \text{Stomach length of a fish (cm)} \]

\[ Y = \text{Standard length of fish (cm)} \]

‘Percentage of Food Composition’ is the calculation of the number of food items of a given type in all specimens and divided by the total number of all food items in all specimens multiplied by 100%.

\[ \text{Percentage of Food Composition} = \frac{X}{Y} \times 100\% \]

\[ X = \text{number of food items of given type in all specimens} \]

\[ Y = \text{Total number of all food items that are found in all specimens} \]