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# Diversity and Distribution of Stream Fishes of Pulau Langkawi, Malaysia

(Kepelbagaian dan Taburan Ikan Sungai di Pulau Langkawi, Malaysia)

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ABSTRACT

*Fishes from five streams in Gunung Machinchang and six streams in Gunung Raya areas of Pulau Langkawi were surveyed with the aim to investigate their diversity and distribution. Fish samples were collected from 23rd to 29th November 2007. Samplings took place along the 50 m reach of each of the site using an electrofisher and scoop nets. A total of 619 individuals of fish comprising 27 species and 14 families were recorded. Sixty-six percent from the taxa listed were of the cyprinids and* Puntius binotatus *was the most abundant species.* Carassius auratus auratus *was recorded for the first time in Pulau Langkawi. Streams of the Gunung Machinchang area were dominated by secondary freshwater fish species, but in the Gunung Raya area the streams were dominated by primary freshwater fish species. The highest diversity of fish was recorded for Sg. Kubang Badak with Simpson Index $D_s$ = 0.838 and the lowest was for Sg. Perangin with $D_s$ = 0.450. The highest evenness index of fish species was detected for Sg. Temurun with $E_s$ = 0.684 and the lowest was for Sg. Perangin with $E_s$ = 0.299. Species overlapping between streams of the two areas was 9.6%.*

*Keywords: Habitat; Pulau Langkawi; species composition*

ABSTRAK

*Ikan dari lima sungai di kawasan Gunung Machinchang dan enam sungai di kawasan Gunung Raya di Pulau Langkawi telah ditinjau untuk meneliti kepelbagaian dan taburannya. Sampel ikan telah dikumpulkan antara 23 hingga 29 November 2007. Pensampelan dibuat sepanjang 50 m di setiap lokasi menggunakan perenjat elektrik dan jaring sauk. Sebanyak 619 individu ikan yang terdiri daripada 27 spesies dan 14 famili telah direkodkan. Sejumlah 60% daripada taksa tersebut adalah siprinid dan* Puntius binotatus *merupakan spesies yang paling tinggi kelimpahannya.* Carassius auratus auratus *telah direkodkan buat kali pertama di Pulau Langkawi. Sungai-sungai di kawasan Gunung Machinchang didominasi oleh spesies daripada kumpulan ikan air tawar sekunder, tetapi di kawasan Gunung Raya sungai-sungainya didominasi oleh spesies daripada kumpulan ikan air tawar utama. Kepelbagaian spesies ikan paling tinggi telah direkodkan di Sg. Kubang Badak dengan Indeks Simpson $D_s$ = 0.838 dan paling rendah di Sg. Perangin dengan Indeks Simpson $D_s$ = 0.450. Keseragaman spesies paling tinggi dikesan di Sg. Temurun dengan $E_s$ = 0.684 dan paling rendah di Sg. Perangin dengan $E_s$ = 0.299. Pertindihan spesies bagi sungai-sungai di antara dua kawasan tersebut adalah 9.6%.*

*Kata kunci: Habitat; komposisi spesies; Pulau Langkawi*

## INTRODUCTION

Streams in Peninsular Malaysia are highly diverse ecosystems and support extensive fish diversity. Many new fish species have been discovered during the last several decades. According to Lim and Tan (2002), there are at least 278 native species have been recognised and 24 exotic species that were introduced in Peninsular Malaysia. Since 1990, 50 new native species have been added to the list and more than half are new to science. According to Zakaria-Ismail (1994), species composition of freshwater fish in Peninsular Malaysia is heavily influenced by Siamese and Indonesian elements. Peninsular Malaysia is bounded by Thailand in the north and Indonesian archipelago in the south. About 17,000 years ago where the sea levels were about 120 m below the present level, these lands were once drained by a large river system named the Sunda River. As the major path of Sunda River was drowned, what's left are its headwaters which drain the eastern and the south-western part of Peninsular Malaysia, the middle and southern part of Thailand, the southern tip of Sumatera and the northern part of Java. Therefore, the effect of this ancient river connectivity is very important in terms of the present distribution of fish. However, rivers in northeastern Peninsular Malaysia and northern Sumatera took a northwesterly path to debouch into the Indian Ocean (Rainboth 1996), thus suggesting the isolation of its fish fauna from those of the Sunda Basin.

There were several collections of stream fishes taken from various islands in the Malaysian waters. For example, Ng et al. (1999) found 48 species in which 10 species (*Megalops cyprinoides, Apogon hyalosoma, Butis gymnopomus, Eleotris melanosoma, Giuris margaritacea, Lophogobius bleekeri, Exyrias puntang, Pseudogobius javanicus, Stiphodon atropuprpureus* and *Parioglossus raoi*) were new records for Pulau Tioman. A number of stream fish collections were conducted in Pulau Langkawi

by Tweedie (1936), Alfred (1969) and most recently by Amirrudin and Lim (2006). There was no particular report regarding the stream fishes of Pulau Langkawi between the year 1969 and 2006 except as part from a limnological survey by Ng and Ping (1989).

Forty one fish species are presently known from the stream waters of the island (Amirrudin & Lim 2006) whereby 24 species are primary freshwater fishes. Thirty species were recorded for the first time in Pulau Langkawi, of which two species (*Oreochormis mossambicus* and *Trichogaster pectoralis*) were introduced. *Anguilla marmorata, Acanthocobitis zonalternans* and *Dermogenys sumatrana* were the three species recorded for the first time in Peninsular Malaysia.

Studies on diversity and distribution of freshwater fish are not just about taxa, but also require certain measurements to be recorded to indicate the environmental status of the habitat. It is important to note that the island fish species of Pulau Langkawi also comprise a significant portion of secondary freshwater fish (Amirrudin et al. 2006). It could be a typical characteristic of an island fish community composition, but the type of species that occurred may differ for different locations in the islands although they are within the same geographical region. Changes in habitat condition that are mainly associated with human activities are the main factors that could potentially alter the fish abundance and distribution (Zakaria-Ismail 1994). These changes may also contribute to the substantial reduction of fish diversity in the respective areas. This study highlights the diversity and distribution of the stream fishes of Pulau Langkawi with respect to geographical area.

## Materials and Methods

### Data Collection

Fish samples were collected from 23rd to 29th November 2007. There were 11 streams surveyed namely Sungai Datai, Temurun, Cina, Lenggara and Perangin in Gunung Machinchang and Sungai Lawer, Tok Puteri, Kubang Badak, Limbong, Kisap and Batu Asah in Gunung Raya, respectively, and were tagged as S01 to S11 (Figure 1). These streams were small, short, high longitudinal gradient and with no floodplain. It was observed that heavy rainfall would cause flashflood, but it usually lasting in a day or lesser. Thus suggesting that seasonal variation in water level was unlikely significant to the local fish diversity and distribution, temporally (Bain et al. 1988; Casatti 2005; Lowe-McConnell 1987). The physical features of these streams are given in Table 1.

A 50 m stream reach was selected at each site to represent its fish fauna and physical habitat characteristics. Fishes were sampled using an electrofisher (Smith-Root Model 15-D) for the period of 30 minutes along the selected site and the stunned fishes were collected using scoop nets.

Upon collection, the sampling sites were classified into 'upper, middle or lower' stretches due to the stream morphological profile. In the upper stretch, the riparian zone was vegetated with the primary dipterocarp forest with steep bank slope clear and fast flowing water with sandy, gravel and rocky bottoms. In the middle stretch, the riparian zone was vegetated with secondary forest,

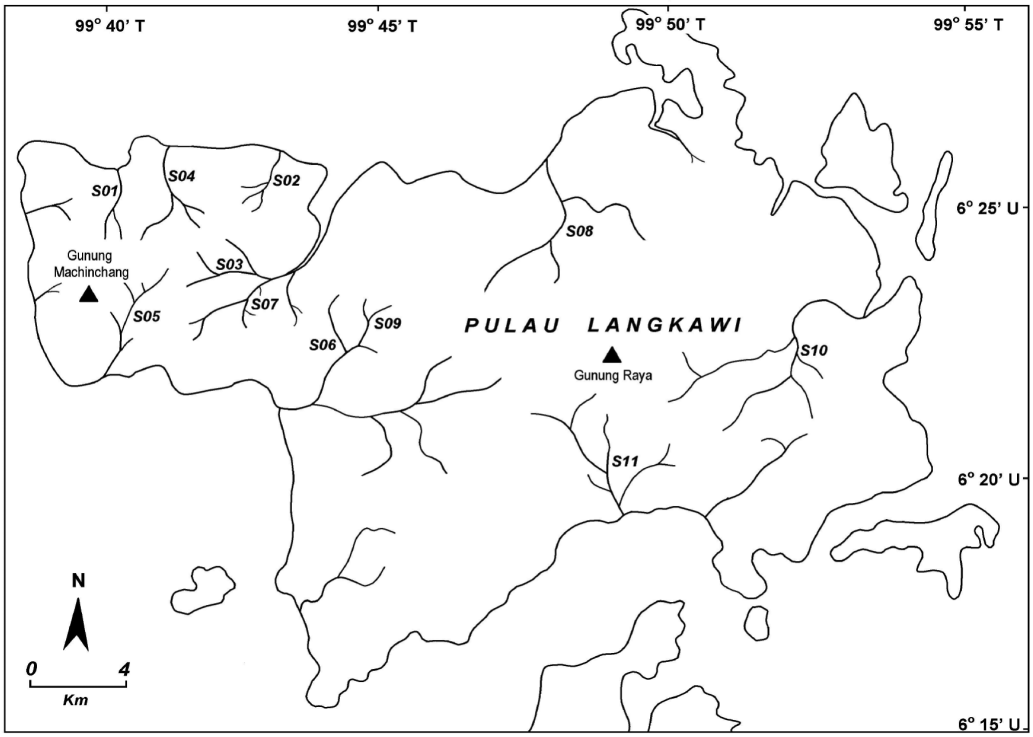


FIGURE 1. Map of Pulau Langkawi showing the streams where fishes were collected

moderate bank slope, and turbid water with silt, sand, gravel bottom. In the lower stretch, it is near to the estuaries so the shore was vegetated with mangrove and under the influence of saline water.

The fish specimens were weighed, measured and identified to species using key suggested by Kottelat et al. (1993) and Rainboth (1996). Specimens were preserved in 10% formalin and later stored in 70% alcohol. Voucher specimens were kept in the museum of zoology, Universiti Kebangsaan Malaysia, Bangi.

## DATA ANALYSIS

In this study, the species diversity of fish was indicated by the Simpson Index (Magurran 1988) represented as $Ds = 1 - [\Sigma n_i (n_i - 1)] / [N(N-1)]$ where $n_i$ is the number of individuals in the $i$-th species and $N$ is the total number of individuals. The $Ds$ value is set between 0 and 1; a better tool to explain results obtained from a single snapshot sampling, where 'temporal' element was not involved. The evenness of distribution was presented by the Evenness Index (Magurran 1988) whereby $E_s = D_s / D_{max}$ where $D_{max}$ is the value $D_s$ would take if the abundances in the samples are all equal.

The Jaccard's Coefficient was used to determine species similarity between the streams. It is calculated as S = 2C / (A+B), where A and B each indicates the number of species found in sample A and B, and C is the number of overlapping species found in sample A and B. Catch index was used to express the number of individuals per species caught, thus dominant species can be determined. The value of this index is calculated as $Ci = n_i / N$, where $n_i$ is the number of individuals in the $i$-th species and $N$ is the total number of individuals caught.

## RESULTS AND DISCUSSION

A total of 619 individual stream fishes were collected from the eleven streams in Pulau Langkawi. They belong to 27 species and 14 families (Table 2). Species diversity of fish among the streams surveyed varied and its value ranged between 0.450 and 0.838. While the evenness index ranged from 0.299 to 0.711. The highest species richness was recorded in Sg. Kubang Badak with 11 species (14.1%) and the lowest was in Sg. Temurun with three species (3.9%) (Table 3). For an island, the streams were considered rich in fish fauna (Alfred 1966; Lee & Zakaria-Ismail 1996; I-Shiung & Tan 2005). Certain streams were found to be dominated by a particular species of fish. For example, *Devario regina* was dominant in the fish community of Sg. Perangin, *Eleotris melanosoma* in Sg. Lenggara, *Puntius*

TABLE 1. Sampling sites at Pulau Langkawi with its locality and habitat description

| Site | Stream | Description of Site |
|---|---|---|
| S01 | Sungai Datai (06° 25.0' N ; 99° 42.0' E) | 2nd. order. Low gradient bank slope. No macrophyte vegetation. Substratum: rocks and sand. Depth: <0.5 m. Water: clear and influenced by salt water. Flow velocity: steady |
| S02 | Sungai Temurun (06° 25.5' N; 99° 42.5' E) | 2nd. order. Low gradient bank slope. No macrophyte vegetation. Substratum: rocks gravel and sand. Depth: <0.5 m. Water: clear. Flow velocity: fast |
| S03 | Sungai Cina (06° 23.5' N; 99° 42.2' E) | 2nd. order. Low gradient bank slope. No macrophyte vegetation. Substratum: gravel. Depth: <0.5 m. Water: clear. Flow velocity: steady. |
| S04 | Sungai Lenggara (06° 25.5' N; 99° 41.0' E) | 1st. order. Nearby to estuary. No macrophyte vegetation. Substratum: gravel and sand. Depth: <0.5 m. Water: clear. Flow velocity: steady. |
| S05 | Sungai Perangin (06° 23.0' N; 99° 40.5' E) | 2nd. order. Low gradient bank slope. No macrophyte vegetation. Substratum: gravel and sand. Depth: <0.7 m. Water: clear. Flow velocity: steady. |
| S06 | Sungai Lawer (06° 22.0' N; 99° 44.5' E) | 1st. order. Low gradient bank slope. A relatively high gradient stream with steep sloping bank. With macrophyte vegetation. Bank populated by grasses. Substratum: pebbles gravel and sand. Depth: < 0.5 m. Water: clear Flow velocity: fast. |
| S07 | Sungai Kubang Badak (06° 23.5' N; 99° 43.0' E) | 2nd. order. Low gradient bank slope. No macrophyte vegetation. Substratum: sand and pebbles. Depth: <0.5 m. Water: clear. Flow velocity: fast. |
| S08 | Sungai Tok Puteri (06° 24.0' N; 99° 47.5' E) | 2nd. order. Nearby to estuary. Low gradient bank slope. No macrophyte vegetation. Substratum: gravel and sand. Depth: <0.5 m. Water: clear and influenced by salt water. Flow velocity: slow and almost dried up. |
| S09 | Sungai Limbong (06° 22.5' N; 99° 44.5' E) | 2nd. order. Low gradient bank slope. No macrophyte vegetation. Substratum: sand and pebbles. Depth: <0.5 m. Water: clear. Flow velocity: fast. |
| S10 | Sungai Kisap (06° 22.0' N; 99° 51.5' E) | 2nd. order. Moderate sloping bank. With macrophyte vegetation; moss. Subtratum: gravel. Depth: < 0.7 m. Water: clear. Flow velocity: fast. |
| S11 | Sungai Batu Asah (06° 20.5' N; 99° 48.5' E) | 2nd. order. Steep slope bank covered with grasses. No macrophyte vegetation. Substratum: rocks and sand. Depth: <0.5 m. Water: clear. Flow velocity: fast. |

TABLE 2. The occurrence of fish species from the eleven streams surveyed in Pulau Langkawi

| Scientific Name | Site | | | | | | | | | | | Catch Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S01 | S02 | S03 | S04 | S05 | S06 | S07 | S08 | S09 | S10 | S11 | |
| Familly: Cyprinidae | | | | | | | | | | | | |
| *Puntius lateristriga* | | | | | | | | 2 | | | | 0.02 |
| *Devario regina* | 11 | 13 | 1 | 6 | 39 | | | | | | | 0.7 |
| *Danio albolineatus* | 12 | 19 | | 5 | 1 | | 1 | | | | | 0.38 |
| *Neolissochilus hendersoni* | 1 | | | | | | | | | | | 0.01 |
| *Cyclocheilichthys apogon* | | | | | | | 27 | | | | | 0.27 |
| *Rasbora paviana* | | | | | | 22 | 9 | 4 | 23 | 12 | 3 | 0.73 |
| *Puntius binotatus* | | | 5 | | 10 | 26 | 27 | 39 | 27 | 23 | 40 | 1.97 |
| *Carassius auratus auratus* | | | 1 | | | | | | | | 0.01 | |
| Family: Anguillidae | | | | | | | | | | | | |
| *Anguilla marmorata* | 1 | | | | | | | | | | | 0.01 |
| *Anguilla bicolor* | | 1 | | 7 | 1 | 1 | 4 | | | | | 0.14 |
| Family: Osphronemidae | | | | | | | | | | | | |
| *Betta pugnax* | 3 | | 2 | 1 | 1 | | | | 2 | | | 0.09 |
| *Trichogaster trichopterus* | | | | | | 2 | | | 1 | | | 0.03 |
| Family: Aplocheilidae | | | | | | | | | | | | |
| *Aplocheilus panchax* | | | | | | | 8 | | | 8 | | 0.16 |
| Family: Balitoridae | | | | | | | | | | | | |
| *Schistura robertsi* | 1 | | | | | | | | | | | 0.01 |
| Family: Gobiidae | | | | | | | | | | | | |
| *Pseudogobiopsis oligactis* | 1 | | | | | | | | | | 4 | 0.05 |
| *P. melanosticta* | | | | | | | 2 | | | | | 0.02 |
| *Glossogobius giuris* | | | | 6 | 2 | | | | 1 | 7 | | 0.16 |
| Family: Anabantidae | | | | | | | | | | | | |
| *Anabas testudineus* | | | | | | 1 | 2 | 1 | 2 | | | 0.06 |
| Family: Bagridae | | | | | | | | | | | | |
| *Mystus nigriceps* | | | | | | 3 | | | 2 | | | 0.05 |
| *Batasio havmolleri* | | | 1 | | | | | | | | | 0.01 |
| Family: Eleotridae | | | | | | | | | | | | |
| *Eleotris melanosoma* | | | | 27 | | | | | | | | 0.27 |
| Family: Synbranchidae | | | | | | | | | | | | |
| *Monopterus albus* | | | | 6 | | | 5 | 2 | | | | 0.13 |
| Family: Andrianichthyidae | | | | | | | | | | | | |
| *Orizias javanicus* | | | | 13 | | | | | | | | 0.13 |
| Family: Channidae | | | | | | | | | | | | |
| *Channa gachua* | | | | | | 1 | 8 | 4 | 5 | 7 | 10 | 0.35 |
| *Channa striata* | | | 5 | | | 1 | 11 | 8 | | 3 | | 0.28 |
| Family: Siluridae | | | | | | | | | | | | |
| *Silurichthys schneideri* | | | 2 | | | | | 1 | | | | 0.03 |
| Family: Clariidae | | | | | | | | | | | | |
| *Clarias leiacanthus* | | | | | | 9 | | 1 | | 2 | | 0.12 |
| Total no. of species | 7 | 3 | 6 | 9 | 6 | 9 | 11 | 9 | 8 | 7 | 4 | |

TABLE 3. Diversity Index of freshwater fish in Pulau Langkawi

| Sites | Streams | Number of Species | | Simpson's Index | Evenness Measures |
|---|---|---|---|---|---|
| S01 | Sg. Datai | 7 | (8.97 %) | 0.715 | 0.462 |
| S02 | Sg. Temurun | 3 | (3.85 %) | 0.528 | 0.684 |
| S03 | Sg. Cina | 6 | (7.69 %) | 0.817 | 0.711 |
| S04 | Sg. Lenggara | 9 | (11.54 %) | 0.802 | 0.532 |
| S05 | Sg. Perangin | 6 | (7.69 %) | 0.450 | 0.299 |
| S06 | Sg. Lawer | 9 | (11.54 %) | 0.722 | 0.385 |
| S07 | Sg. Kubang Badak | 11 | (14.10 %) | 0.838 | 0.535 |
| S08 | Sg. Tok Puteri | 9 | (11.54 %) | 0.586 | 0.262 |
| S09 | Sg. Limbong | 8 | (10.26 %) | 0.684 | 0.383 |
| S10 | Sg. Kisap | 7 | (8.97 %) | 0.792 | 0.648 |
| S11 | Sg. Batu Asah | 4 | (5.13 %) | 0.477 | 0.471 |

*binotatus* in Sg. Lawer, Kisap, Batu Asah, Limbong and Tok Puteri, *Cyclocheilichthys apogon* in Sungai Kubang Badak.

Overall, the community of stream fishes of Pulau Langkawi was dominated by cyprinids, which comprised 29.63% of the total number of the species recorded. Other families were represented only by a few species. This is due to the fact that Cyprinidae constitutes a major proportion of stream fishes in Peninsular Malaysia (Mohsin & Ambak 1983). This is also a typical pattern of species composition for the Southeast Asian region, which is the center of cyprinid evolution with at least 1600 species recorded to date (Lowe-McConnell 1987; Moyle & Cerch 1988; Samat et al. 2005). Within the cyprinids, *Puntius binotatus* occurred in greater abundance than the other species in the family (31.83%) followed by *Rasbora paviana* (11.79%) and *Devario regina* (11.31%). The introduced species *Carassius auratus auratus* was recorded for the first time in Sg. Lenggara.

On the other hand, *Neolissochilus hendersoni, Anguilla marmorata, Schistura robertsi,* and *Batasio havmolleri* were not widely distributed in Pulau Langkawi. Only a single individual was caught for each of these species (0.16%), for example, *Schistura robertsi* (Family: Balitoridae) was only found in Sungai Datai. A sample of this species was also reportedly found by Amirrudin and Lim (2006) at Sg. Lenggara and Lubok Sembilang. The habitat of *S. robertsi* seems to be limited to cool, fast-flowing and rocky streams. According to Amiruddin and Samat (2005) the same species was also found in Wang Burma, Perlis with high abundance. The fish was previously reported to be known only from Peninsular Thailand, Phuket Island, Thailand (Kottelat 1990) and Pulau Langkawi (Lim & Tan 2002).

Lim and Tan (2002) claimed that *Neolissochilus hendersoni* is an island endemic species. It had been recorded in Pulau Pinang (Alfred 1963), Pulau Tioman (Ng et al. 1999) and Pulau Langkawi (Amiruddin & Lim 2006). According to Kottelat (1989) 15% of the species are shared with the Salween basin, 47% with Chao Phraya, 44% with the Mekong and 66% with the Indo-Malayan archipelago. Peninsular Malaysia harbours more than 200 species, four of which are endemic, *Neolissochilus hendersoni* being one of them (Zakaria-Ismail 1994).

In this study, the fishes caught were categorized into primary and secondary freshwater species. The primary freshwater species consisted of *Puntius lateristriga, Devario regina, Danio albolineatus, Neolissochilus hendersoni, Cyclocheilichthys apogon, Rasbora paviana, Puntius binotatus*, *Betta pugnax, Trichoptera trichopterus*, *Schistura robertsi*, *Anabas testudineus*, *Mystus nigriceps, Batasio havmolleri, Monopterus albus*, *Channa gachua, C. striata*, *Silurichthys schneideri,* and *Clarias leiacanthus*. These families are categorized as primary freshwater fish whose members have no or very little salt tolerance and are confined to freshwater only (Zakaria-Ismail 1994). However, there are still species like *Monopterus albus* that occur in both stream groups and are present in Sg. Lenggara, Kubang Badak and Tok Puteri.

Other five species (*Aplocheilus panchax, Orizias javanicus, Pseudogobiopsis oligactis, Pseudogobiopsis melanosticta,* and *Glossogobius giuris*) that preferred to live in the brackish water were grouped into the secondary freshwater species. These species are known as the secondary freshwater fish because their origins can be traced back to their marine relatives that live chiefly in freshwater but sometimes enter the sea and can survive there for a limited period of time.

Catfishes are among the most diverse groups of freshwater fishes in Peninsular Malaysia in terms of numbers and families (Lee & Zakaria-Ismail 1996). However, in Pulau Langkawi only members of the family of Siluridae and Clariidae were recorded. *Clarias leiacanthus* was a clariid that was found in small numbers in Sg. Lawer, Tok Puteri, and Kisap. This species was also found in Anambas and Natuna Islands (Tan & Lim 2004) and the nearest area was at Wang Burma in Perlis (Amiruddin & Samat 2005).

Similarity analyses through Jaccard's Coefficient showed that both the Sg. Lawer and Sg. Limbong have the highest similarity of species (0.545). More interestingly, it was found that there was least similarity of species composition between the streams located in Gunung Raya and those of the Gunung Machinchang area. Only 9.6% of fish species was found to be overlapped between these two areas (Figure 2).

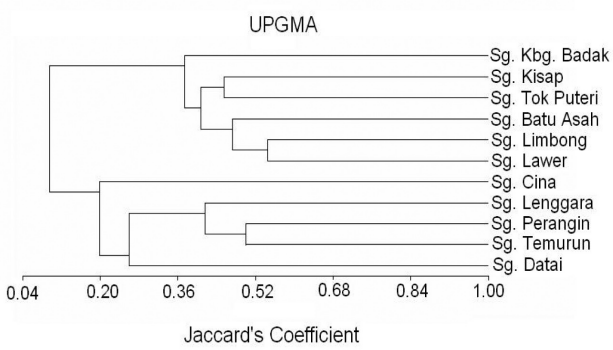


FIGURE 2. A dendrogram showing a cluster of the species occurrence among the streams studied

Differences in natural habitat conditions of these areas basically provide different types of macro- and micro- habitats for the fishes. Gunung Machinchang area was formed predominantly of sandstone and Gunung Raya area of granite (Shafeea et al. 2007). The sandstone causes alkalinity, but the granite causes acidity of the ground and stream water. According to Alabaster and Lloyd (1982) variations in the water chemistry could be the major factor that influenced the fish diversity and distribution. Besides, streams in the Gunung Machinchang area are short and much of their stretches are affected by tides and thus, the sea water. On the other hand, streams in the Gunung Raya area are relatively longer and much of their stretches are irrigating the lowland area of the Island that includes paddy fields, housing areas and plantations before reaching their confluences.

Different fish species was found passing downstream of a stream. In the upper stretch, the shallow water (< 0.3 m) with gravel and pebble bottoms and strong current represent favorable conditions for small fishes such as *Devario regina, Schistura robertsi* and *Danio albolineatus*. *Puntius lateristriga* and the juvenile of *Neolissochilus hendersoni* were also found in headstreams especially in the riffles. However, these species are progressively less frequent in the middle and lower stretches.

In the middle stretch, the water was deeper (to 0.1 m) with sandy bottoms and were most preferred by fishes such as *Anguilla bicolor, A. marmorata,* and *Monopterus albus*. *Cyclocheilichthys apogon, Carassius auratus auratus, Rasbora paviana* and *Puntius binotatus* and *Silurichthys schneideri* also inhabit the middle stretch of the stream in the areas with slow current. *Clarias leiacanthus, Betta pugnax, Mystus nigriceps, Batasio havmolleri, Trichogaster trichopterus, Anabas testudineus, Channa gachua* and *Channa striata* were the species recorded in the swampy and shallow middle stretch of the streams.

In the lower stretch the depth notably allows the presence of active swimmers such as *Aplocheilus panchax, Orizias javanicus* and *Eleotris melanosoma* and the gobiids, thriving in both brackish water and freshwater found near the confluence of the stream. These species are known as the secondary freshwater fish because their origin can be traced back to their marine relatives that live chiefly in freshwater but sometimes enter the sea and can survive there for a limited period of time.

Rasborinae is the species that is easily seen in sub-surface layer of the water. *Betta pugnax* also shared the same stratum but were more frequently found in the paddy field or swampy areas. *Puntius* and *Cyclocheilichtys* seem to occupy various strata but mainly stay at the middle strata with *Devario regina, Danio albolineatus, Orizias javanicus*. While *Channa gacua, C. striata*, *Anguilla bicolor, A. marmorata, Clarias leiacanthus* and *Eleotris melanosoma* were commonly found in the benthic zone. According to Inger & Chin (1990) and Ghaffar et al. (1997), these specific vertical distributions were mainly influenced by their mouth shape and feedings.

## CONCLUSION

The streams in Pulau Langkawi contain a moderate diversity of fish fauna and it is dominated by the cyprinids. Preliminary data suggest that there is a partial segregation in species composition between the area of Gunung Machinchang and Gunung Raya. It seems that this phenomenon is associated with the local hydrological regime. The most prominent factor is the intrusion of sea water into the tidal affected zone of a stream that harbor varieties of secondary freshwater fish species including the *Pseudogobiopsis oligactis, Glossogobius giuris* and *Eleotris melanosoma*. On the other hand, the sea water is a barrier that limits the spread of primary freshwater fish species such as the *Puntius lateristriga, Devario regina* and *Neolissochilus hendersoni* further downstream. Other factors are less likely influence the species diversity and distribution of stream fishes in Pulau Langkawi.

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