

Freshwater Fishes of Gunung Jerai, Kedah Darul Aman: A Preliminary Study

Amir Shah Ruddin Md Shah^{*}, Zarul Hazrin Hashim and Shahrul Anuar Mohd Sah

School of Biological Sciences, Universiti Sains Malaysia, 11800 USM,
Pulau Pinang, Malaysia

Abstrak: Sejumlah 37 spesies ikan yang terdiri daripada 14 famili telah direkodkan dalam persampelan 8 sungai di Hutan Simpan Gunung Jerai bermula Januari hingga Mac 2005. Spesies yang tersenarai ini termasuklah *Rasbora trilineata* dan *Systemus partipentazona* yang dikenalpasti melalui pemerhatian di bahagian hilir Sungai Teroi. Hanya satu spesimen spesies *Leiocassis micropogon*, *Clarias macrocephalus* dan *Hampala macrolepidota* telah berjaya disampel di stesen terpilih. Spesies *Devario regina* dan *Systemus binotatus* merupakan dua spesies yang banyak serta boleh ditemui di kesemua stesen penyampelan. Walau bagaimanapun senarai spesies ini masih lagi tidak lengkap disebabkan banyak lagi kawasan yang belum disampel. Kehadiran spesies eksotik (*Carassius auratus*) di Sungai Badak menunjukkan gangguan manusia telah mempengaruhi diversiti ikan tempatan. Oleh yang demikian, satu pemantauan jangka panjang untuk melihat perubahan biodiversiti ikan dan kualiti air di Hutan Simpan Gunung Jerai perlu dirancang dan dilaksanakan akibat aktiviti pembangunan masa depan.

Kata kunci: Ikan, Sungai, Gunung Jerai, Distribusi, Diversiti, Kelestarian

Abstract: A total of 37 fish species from 14 families were observed during surveys conducted from January to March 2005 at 8 selected streams near the Gunung Jerai Forest Reserve. The list includes two species (*Rasbora trilineata* and *Systemus partipentazona*) that were visually identified at the lower part of the Sungai Teroi stream. Single specimens of *Leiocassis micropogon*, *Clarias macrocephalus* and *Hampala macrolepidota* were also obtained at certain sampling stations. *Devario regina* and *Systemus binotatus* were the most abundant species at all sampling stations. However, the list is still incomplete as the study was carried out over a short time period and there are large areas that have not yet been surveyed. The presence of exotic species (*Carassius auratus*) at Sungai Badak indicates anthropogenic influences. Therefore, a long-term monitoring program for Gunung Jerai Forest Reserve streams should be planned and carried out to assess the impacts of future development on fish biodiversity and water quality.

Keywords: Fish, Stream, Gunung Jerai, Distribution, Diversity, Conservation

INTRODUCTION

Research on the freshwater fish fauna of Malaysia began in the mid-19th century (Zakaria-Ismail 1991). However, studies of whole river systems, or even specific stretches of a river, are still lacking. Zakaria-Ismail (1987) stated that the available literature is incomplete because most studies have only been short-term

^{*}Corresponding author: amirjaws@gmail.com

and have lacked follow-up to monitor changes in fish distribution related to changes in habitats.

A study by Kottelat and Whitten (1996) noted that the upper reaches of rivers are the least studied riverine habitats, and likely contain undiscovered endemic species. The exact number of freshwater ichthyofauna in Peninsular Malaysia is still unknown, as a large area still has yet to be studied. Based on the Zakaria-Ismail (1996) study, the total number of fish species could be more than 300, whereas Lim and Tan (2002) only listed about 278 species native to Peninsular Malaysia and 24 introduced species. These counts included the rivers and streams that flow through forested reserves. Othman *et al.* (2002) also noted that there is limited information about fish diversity in forest reserves in Peninsular Malaysia. Most species have not been studied, although they are utilised by local or indigenous people as food. One of the major forest reserve areas is the Gunung Jerai Forest Reserve, located in the State of Kedah. Gunung Jerai is composed mainly of sandstone and quartzite, with a granite core that rises to 1220 m above sea level and is visible for kilometres around (Gregory-Smith 1994). The main features of the northern part of Gunung Jerai are paddy fields, whereas the west side is covered by rubber and oil palm estates. Mangrove forests lie on the southern side, and the reserve faces the Straits of Malacca to the east.

Gunung Jerai Forest Reserve has more than a dozen small streams with favourable potential for recreational use by locals. Among these streams, Sungai Tupah, Sungai Batu Pahat, Sungai Teroi and Sungai Badak are most well-known in the community. Most of the streams in Gunung Jerai form on the isolated hills, where the streams flow outwards in all directions from a central elevated tract. The streamflow patterns show the topographical features of the forest, such as isolated conical hills (Fig. 1). Information regarding the fish species present in the streams of the Gunung Jerai Forest Reserve is still scarce. Shah *et al.* (2005) reported briefly on the fish distributions in selected streams around Gunung Jerai. Adequate descriptions of freshwater fish communities require accurate taxonomy and quantitative measures of abundance (Kottelat *et al.* 1993). Kottelat and Whitten (1996) noted that for effective environmental monitoring, knowledge of the distribution of species and their relative abundance is required.

The present study utilises a short survey to determine the diversity and abundance of fish species in selected small streams in the Gunung Jerai Forest Reserve in Kedah, Peninsular Malaysia.

MATERIALS AND METHODS

Study Site

Eight small streams within the Gunung Jerai Forest Reserve (Fig. 1) were surveyed from January to March 2005. The sampling stations were selected on the basis of their accessibility. Generally, these streams can be divided into four main zones based on the direction of water flow. The northern zone consists of Sungai Teroi and Sungai Badak; the eastern zone is comprised of Sungai Tok Pawang and Sungai Bukit Merah; the southern zone is represented by Sungai

Tupah and Sungai Batu Pahat; and the western zone includes Sungai Singkir and Sungai Titi Lubuk Panjang. Two sampling points were used at Sungai Teroi, Sungai Tupah, Sungai Batu Pahat and Sungai Singkir, whereas the other streams were represented by only one sampling point. Most of the sampling stations have a characteristic low order, forested headwater stream habitat typical of Peninsular Malaysia. The stream sites' substrates were composed of bedrock and coarse sand.

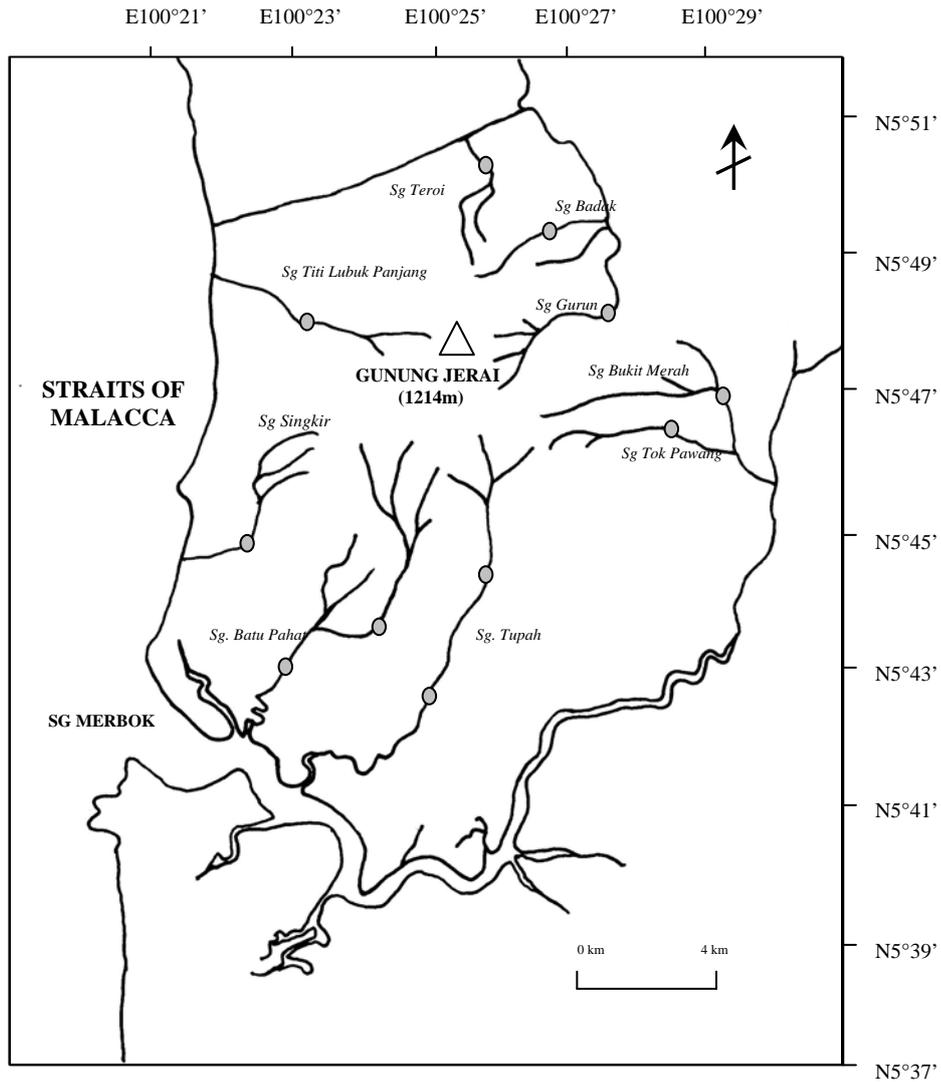


Figure 1: Location of sampling stations used to assess ichthyofauna biodiversity and distribution near the Gunung Jerai Forest Reserve (January–March 2005).

Fish communities were sampled twice during the study period. A modified backpack electro-fisher was used to determine species occurrence, relative species abundance, species composition and population structures. At each sampling point, electro-shocking was carried out for 30–45 minutes, covering a distance of 30 to 100 metres, including pools and riffles.

The specimens were counted and identified to the species level using the methods of Mohsin and Ambak (1983), Kottelat *et al.* (1993) and Rainboth (1996). After identification and data recording, all specimens were preserved in 5% formalin and taken back to the laboratory for further analysis. Voucher specimens from previous collections were deposited at Universiti Sains Malaysia, Pulau Pinang.

Replicates of selected water parameters such as dissolved oxygen (DO) and temperature were obtained *in situ* at each sampling site using a YSI meter Model 57; conductivity ($\mu\text{mS/cm}$) and total dissolved solids (TDS, mg/l) were obtained using a Hach meter Model C0150; and pH was measured using a Model Orion 230A pH meter.

The Shannon-Weiner diversity index and the evenness index were used to analyse the fish communities; any species represented by a single specimen or noted by visual observation only was excluded. Jaccard's Coefficient of Similarity (JCS) was used to cluster the fish groups by sampling station. The Unweighted Pair Group Method (UGPMA) (van Tongeren 1995) and Multivariate Statistics Package (MVSP) Version 3.11 (Krebs 1989) were used to calculate and construct the dendrogram based on the JCS values.

RESULTS

The mean values for selected physico-chemical water parameters are shown in Table 1. The Sungai Teroi stream had the highest DO, pH and temperature values, at 7.3 ± 1.2 mg/l, 6.3 ± 1.0 and $28.3 \pm 4.6^\circ\text{C}$, respectively. Meanwhile, the highest levels of conductivity and TDS were observed at the Sungai Tok Pawang stream, with values of 43.5 ± 2.2 $\mu\text{mS/cm}$ and 20.5 ± 0.7 mg/l, respectively. On the other hand, Sungai Batu Pahat had the lowest values of conductivity (22.0 ± 0.4 $\mu\text{mS/cm}$), TDS (10.3 ± 0.5 mg/l) and temperature ($25.6 \pm 0.5^\circ\text{C}$). The lowest pH (5.3 ± 0.5) was recorded at Sungai Titi Lubuk Panjang and the lowest DO (4.7 ± 1.5 mg/l) value was observed at Sungai Tupah.

Table 1: The mean values of selected physico-chemical water parameters at each sampling station during the study.

Stations	DO (mg/l)	pH	Conductivity ($\mu\text{mS/cm}$)	TDS (mg/l)	Temperature ($^{\circ}\text{C}$)
Sungai Teroi	7.3 \pm 1.2	6.3 \pm 1.0	33.4 \pm 4.7	15.7 \pm 2.2	28.3 \pm 4.6
Sungai Badak	6.2 \pm 1.1	5.5 \pm 0.4	38.2 \pm 15.4	17.7 \pm 7.2	27.7 \pm 0.2
Sungai Bukit Merah	7.2 \pm 0.6	6.1 \pm 0.1	32.8 \pm 4.2	15.3 \pm 2.1	27.9 \pm 1.2
Sungai Tok Pawang	6.5 \pm 1.3	7.2 \pm 1.6	43.5 \pm 2.2	20.5 \pm 0.7	27.2 \pm 1.1
Sungai Tupah	4.7 \pm 1.5	5.4 \pm 0.4	25.9 \pm 1.9	12.4 \pm 1.1	26.9 \pm 3.4
Sungai Batu Pahat	6.1 \pm 0.3	5.7 \pm 0.1	22.0 \pm 0.4	10.3 \pm 0.5	25.6 \pm 0.5
Sungai Singkir	6.2 \pm 1.4	5.5 \pm 0.6	28.7 \pm 1.7	13.3 \pm 1.0	27.4 \pm 0.5
Sungai Titi Lubuk Panjang	6.0 \pm 2.1	5.3 \pm 0.5	27.8 \pm 2.3	12.8 \pm 1.0	27.4 \pm 0.1

A total of 2458 specimens representing 35 species from 14 families were collected in the first survey. Two species, *R. trilineata* and *S. partipentazona*, were identified by visual observation alone (specimens not collected) at Sungai Teroi. Thus, a total of 37 fish species were recorded (Table 2). The total number of species, families and their abundance at each sampling station is summarised in Figure 2. Sungai Teroi had the highest number of species present (17), followed by Sungai Badak (16 species) and Sungai Batu Pahat (14 species). The highest number of fish were collected at the Sungai Tupah station (561 individuals) followed by Sungai Batu Pahat (414 individuals) and Sungai Titi Lubuk Panjang (347 individuals). Sungai Badak had the highest number of families sampled (10), whereas only 6 families were observed at Sungai Batu Pahat. *Cyprinidae* was the dominant family, which accounted for 35.1% (13 species) of the species sampled; the next most abundant family was *Mastacembelidae* (10.8% of species).

Table 2: The fish taxa present at each sampling station during the survey.

Family and species	1	2	3	4	5	6	7	8
Amblycipitidae								
<i>Amblyceps foratum</i>	+	-	-	-	+	-	+	-
Aplocheilidae								
<i>Aplocheilus panchax</i>	-	-	+	+	-	-	-	-
Bagridae								
<i>Hemibagrus nemurus</i>	-	+	-	-	-	-	+	-
<i>Leiocassis micropogon</i>	-	-	-	+	-	-	-	-
<i>Mystus micracanthus</i>	-	+	-	-	-	-	-	+
Balitoridae								
<i>Acanthocobitis zonalternans</i>	+	+	+	+	-	-	-	+
Channidae								
<i>Channa striata</i>	-	-	-	+	+	-	+	+
<i>Channa gachua</i>	-	-	+	-	+	-	-	-
Clariidae								
<i>Clarias leiacanthus</i>	+	+	+	-	-	+	-	+
<i>Clarias batrachus</i>	-	-	-	+	-	-	-	-
<i>Clarias macrocephalus</i>	-	-	-	-	-	-	+	-
Cyprinidae								
<i>Carassius auratus</i>	-	+	-	-	-	-	-	-
<i>Cyclocheilichthys apogon</i>	+	-	-	-	-	-	-	-
<i>Danio albolineatus</i>	-	+	+	+	-	+	-	-
<i>Devario regina</i>	+	+	+	+	+	+	+	+
<i>Hampala macrolepidota</i>	+	-	-	-	-	-	-	-
<i>Neolissochilus hendersoni</i>	-	-	-	-	+	+	+	-
<i>Osteochilus hasseltii</i>	+	+	-	-	-	-	-	-
<i>Poropuntius deauratus</i>	-	-	-	-	-	+	+	-
<i>Rasbora paviei</i>	+	+	+	+	-	-	+	+

(continued on next page)

Table 2: (continued)

Family and species	1	2	3	4	5	6	7	8
<i>Rasbora trilineata</i>	+*	-	-	-	-	-	-	-
<i>Systemus binotatus</i>	+	+	+	+	+	+	+	+
<i>Systemus lateristriga</i>	-	-	+	+	-	-	-	-
<i>Systemus partipentazona</i>	+*	-	-	-	-	-	-	-
Gobiidae								
<i>Glossogobius giuris</i>	+	+	-	-	-	-	+	+
Hemiramphidae								
<i>Dermogenys corlattei</i>	-	-	-	-	-	-	+	-
Mastacembelidae								
<i>Macrogathus maculatus</i>	+	+	-	-	+	+	-	-
<i>Mastacembelus cf. armatus</i>	-	-	-	-	+	+	-	-
<i>Mastacembelus erythrotaenia</i>	+	-	-	-	+	+	-	-
<i>Mastacembelus favus</i>	-	+	-	-	-	-	-	-
Osphronemidae								
<i>Betta pugnax</i>	+	+	-	-	+	+	+	+
<i>Betta bellica</i>	+	-	-	-	-	-	+	-
<i>Trichopsis vittata</i>	-	-	-	-	+	+	-	-
Poeciliidae								
<i>Poecilia reticulata</i>	-	+	+	+	-	-	-	-
Siluridae								
<i>Ompok bimaculatus</i>	+	-	+	-	-	-	-	+
<i>Silurichthys hasselti</i>	+	+	-	-	+	+	+	+
Synbranchidae								
<i>Monopterus albus</i>	-	+	-	-	+	+	-	-

Notes: + = present; - = absent; 1 = Sungai Teroi; 2 = Sungai Badak; 3 = Sungai Bukit Merah; 4 = Sungai Tok Pawang; 5 = Sungai Tupah; 6 = Sungai Batu Pahat; 7 = Sungai Singkir; 8 = Sungai. Titi Lubuk Panjang; * = identified by observation.

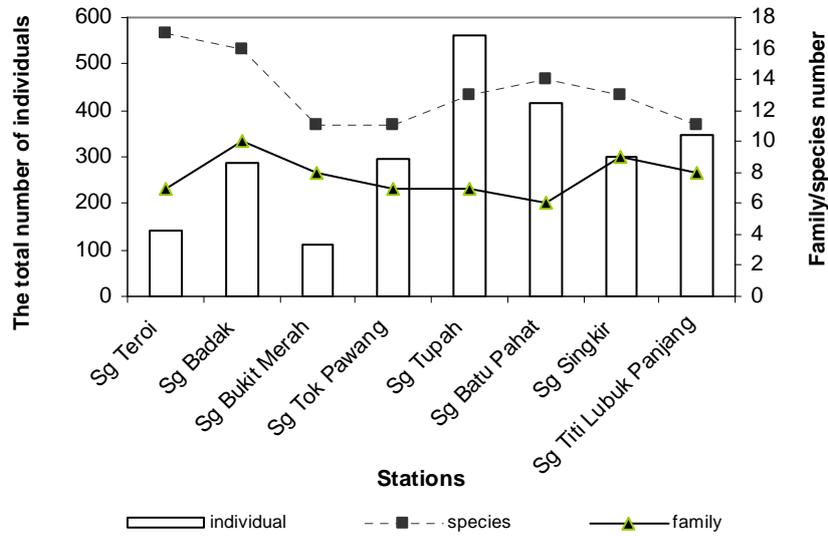


Figure 2: The total number of individuals, species and families collected at each sampling station during the study (Sg = Sungai).

The dominant species was *D. regina*, which represented 45.3% of the total number of fish caught, followed by *S. binotatus* (28.7%) and *Neolissochilus hendersoni* (7.0%). The two most abundant species were also observed at all sampling stations (Table 2). Single specimens of *L. micropogon*, *C. macrocephalus* and *H. macrolepidota* were collected at Sungai Tok Pawang, Sungai Titi Lubuk Panjang and Sungai Teroi, respectively.

Sungai Badak exhibited the highest Shannon-Wiener Diversity Index with a value of 0.8158, followed by Sungai Batu Pahat (0.7130) and Sungai Singkir (0.7018) (Table 3). Sungai Badak also had the highest evenness index (0.6775), followed by Sungai Bukit Merah (0.6720) and Sungai Singkir (0.6300). The lowest Shannon-Wiener Diversity Index and evenness index values occurred at Sungai Tupah, with values of 0.4762 and 0.4275, respectively.

Table 3: The Shannon-Wiener Diversity Index and evenness index values by sampling station.

Sampling stations	Shannon-Wiener Diversity Index	Evenness index
Sungai Teroi	0.6651	0.5655
Sungai Badak	0.8158	0.6775
Sungai Bukit Merah	0.6998	0.6720
Sungai Tok Pawang	0.5350	0.5137
Sungai Tupah	0.4762	0.4275
Sungai Batu Pahat	0.7130	0.6221
Sungai Singkir	0.7018	0.6300
Sungai Titi Lubuk Panjang	0.5132	0.4928

DISCUSSION

Generally, the water quality of the streams around Gunung Jerai can be classified as good (Yusoff *et al.* 2006). According to Paugy (2002), low order streams have high concentrations of dissolved oxygen and low levels of suspended solids; these characteristics are favourable for fish and other aquatic organisms. Paugy (2002) also noted that low order streams are important nursery grounds for fish, as many juvenile fish were observed in her study. The same result was also obtained by Zarul *et al.* (2004) at two headwater streams of the Temengor Reservoir.

However, these results suggest that Sungai Teroi, Sungai Tupah and Sungai Tok Pawang may have had some setbacks with respect to water quality. The high temperatures recorded in the Sungai Teroi stream may be related to the open canopy at the site; the rubber trees adjacent to this stream had been recently cut down for replanting during the study. It is also assumed that this river will face sedimentation problems in future, as there was no buffer zone between the clearing zone and the stream (personal observation). The siltation of the stream became more obvious during the rainy season; this effect was also observed in the Lubuk Kawah Recreational area, located at the lower part of the Sungai Teroi. The low DO reading at the Sungai Tupah site may be related to microbial aerobic respiration, as this stream received more allochthonous runoff due to heavy disturbance by human recreation compared to other sampling stations. Meanwhile, agricultural activities at the upper reaches of Sungai Tok Pawang resulted in high levels of conductivity and TDS. More long-term studies should be carried out to further characterise the impact of recreational activities on the fish population. Nevertheless, Yusoff *et al.* (2006) determined that the water quality of streams near the Gunung Jerai Forest Reserves can be classified as Class I and II based on the Harkins Index.

The cyprinids are the dominant fish family in the streams of Gunung Jerai. Many studies have shown that the cyprinids are the most common species found in Malaysian freshwater bodies (Zakaria-Ismail 1987, 1991, 1996). The fish census of the Gunung Jerai Forest Reserve is not yet complete; most work to date has involved short-term collection over a period of only a few days, and the surveys were performed at times that could miss rare or seasonally abundant species. According to Martin-Smith and Tan (1998), species accumulation curves for almost all taxa in tropical areas show extremely long tails, with new species being recorded for long periods after the initial collection had started.

Roberts (1989) noted that headwater streams often harbour endemic species that are specialised for life in the fast-flowing and highly oxygenated water. A possible species specialised to the Gunung Jerai Forest Reserve is *Acanthocobitis zonalternans*, which was sampled at the Sungai Teroi, Sungai Badak, Sungai Bukit Merah, Sungai Tok Pawang and Sungai Titi Lubuk Panjang stations. According to Amirrudin (pers. comm.), this species has also been recorded in the Baling and Langkawi streams. Kottelat (1990) reported that this species was collected from smaller streams along the west-east coast of Peninsular Thailand, which all drain to the Andaman Sea and Gulf of Thailand.

Notably, exotic species such as goldfish (*C. auratus*) were present in the Sungai Badak stream. It is believed that this species was released by a local aquarist near the sampling station, as it is located in an urban area. This phenomenon has also been observed at Pulau Pinang, where more exotic species such as Tilapia (*Oreochromis* spp.), armour catfish (*Liposarcus pardalis*) and sword tail (*Xiphophorus helleri*) have been caught in the drainage systems (personal observation).

Cluster analysis showed that the similarity of fish species cohorts at each sampling station can be divided into two subgroups, as shown in Figure 3. The first subgroup consists of Sungai Tupah, Sungai Batu Pahat and Sungai Singkir that flow to the southwest sides of Gunung Jerai (Fig. 2 and 3). The second subgroup consists of Sungai Titi Lubuk Panjang, Sungai Teroi, Sungai Badak, Sungai Bukit Merah and Sungai Tok Pawang, where the first three sampling stations flow to the northwest and the latter two flow to the southeast of Gunung Jerai. Based on the cluster analysis, Sungai Singkir has the lowest similarity index (<0.50) of all the sampling stations, whereas Sungai Batu Pahat and Sungai Tupah have the highest similarity indices (Fig. 3). Further studies should be carried out to confirm this finding.

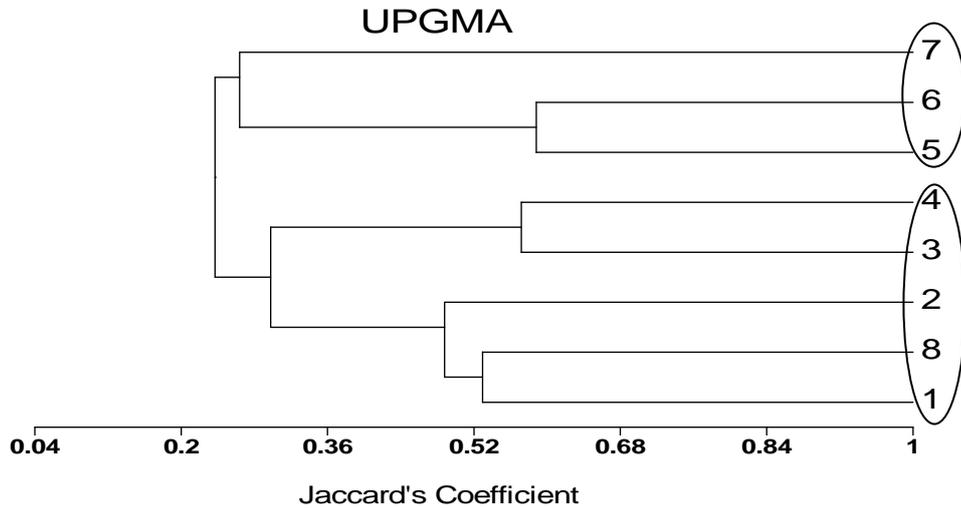


Figure 3: Dendrogram based on Jaccard's Coefficient similarities of fish species assemblages present at each sampling station (1 = Sg Teroi; 2 = Sg Badak; 3 = Sg Bukit Merah; 4 = Sg Tok Pawang; 5= Sg Tupah; 6 = Sg Batu Pahat; 7 = Sg Singkir; 8 = Sg Titi Lubuk Panjang).

CONCLUSION

Fish diversity in the streams of the Gunung Jerai Forest Reserve in Kedah Darul Aman can be considered high, and most of the species found in the area are headwater fish species. Almost all streams visited are well-known recreational areas for the local community, and the development of this area should be well-planned and managed to ensure the continued existence of native species. The occurrence of an exotic species at one site is not alarming, but some attention should be given to prevent further introduction of non-native species that could lead to the alteration of the indigenous community structure and biodiversity.

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