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FRESHWATER FISHES FROM THE HEADWATERS OF THE BELALONG-TEMBURONG RIVER SYSTEM, BRUNEI DARUSSALAM, BORNEO

Satish C. Choy and **P. K. Chin**

ABSTRACT. - Forty four species belonging to 10 families and 30 genera were collected from the headwater streams within the primary dipterocarp forest of the Belalong-Temburong river system, upstream from the confluence (Kuala Belalong) and within the Batu Apoi Forest Reserve, Temburong District, Brunei Darussalam. All but three species are new records for Brunei Darussalam. Twenty three (52%) of these are endemic to Borneo, with 15 belonging to the family Balitoridae. As with other streams in Southeast Asia, the fish fauna in the Kuala Belalong area is dominated by Cyprinoidea (three families, totalling 29 species) with the Balitoridae and Cyprinidae comprising 15 and 13 species, respectively. In the absence of data from the rest of Brunei, the ichthyofauna of the study area is North Bornean (*sensu* Inger & Chin, 1962) with western elements and resembles most closely to that of the western part of Sabah. Over 20 of the fish species recorded form the basis a subsistence fishery for the Iban longhouse population.

INTRODUCTION

There is little information on the freshwater fish fauna of Brunei Darussalam. Regan (1910), in his review of the genus *Betta* described *Betta macrostoma*, now known as the 'Brunei Beauty' or the 'large-mouth fighting fish'. Brittan (1954) described a cyprinid, *Rasbora tubbi* and Burridge (1992) described a loach, *Pangio agma* (as *Acanthophthalmus agmus*). Eden (1984) reported on twenty two local aquarium fishes, mainly from the coastal areas of Belait and Temburong districts.

This paper is based on a study of fishes collected from the Belalong-Temburong river system, upstream from the confluence (Kuala Belalong) and within the Batu Apoi Forest Reserve, Temburong District, Brunei Darussalam, Borneo (Fig. 1). Its objective was to catalogue the species of fish present in the area, so as to provide baseline data for research and educational use by the newly built Kuala Belalong Field Studies Centre. The study was

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carried out as part of the Universiti Brunei Darussalam (UBD)/Royal Geographical Society (RGS) Rainforest Project 1991-2, within the Batu Apoi Forest Reserve.

AREA

The Temburong and Belalong Rivers and associated tributaries together form much of the drainage system in Temburong District, Brunei Darussalam (Figure 1). They extend from lowland dipterocarp forest rising to an altitude of about 915 m near Bukit (= Mt.) Belalong and to about 1700 m near Bukit Pagon. The climate is hot and humid with daily ambient shade temperatures varying between 23° and 35°C during the day. The annual rainfall is

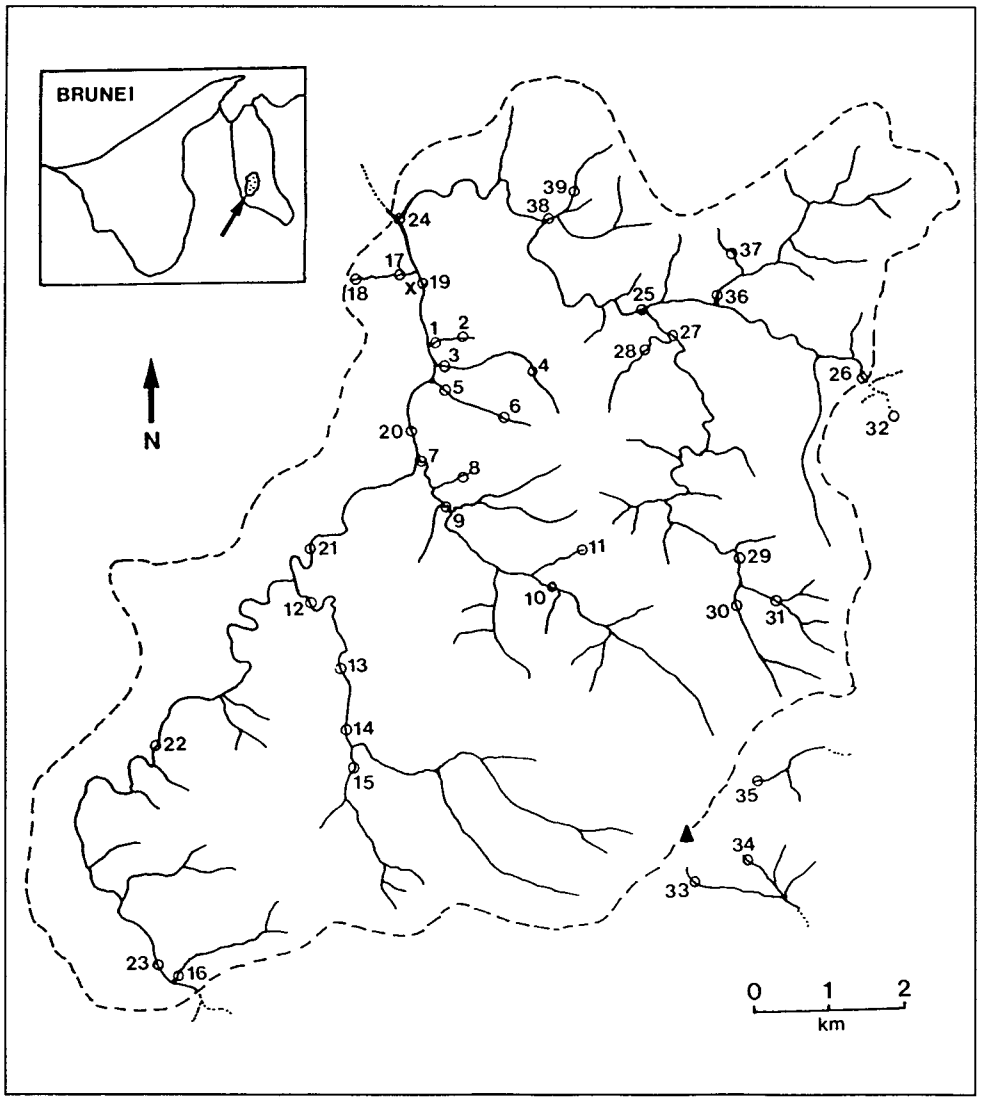

Fig. 1. Locality map of the Temburong-Belalong River system showing the UBD-RGS Rainforest Project boundary and the sampling stations, as listed in Table 1. Station 40 (not shown) is about 10 km southeast of Bukit Belalong (▲).

Table 1. Sampling station numbers, localities, altitude and the number of fish species collected from each locality. Altitude was determined from 1 : 50 000 topographic maps. S, sungai (river); a.w., above waterfall areas; b.w., below waterfall areas; KBFSC, Kuala Belalong Field Studies Centre.

Station	Locality	Altitude (m)	Number of fish species
1.	S. Anak Esu, b.w.	60	5
2.	S. Anak Esu, a.w.	152	0
3.	S. Esu, b.w.	60	6
4.	S. Esu, a.w.	183	2
5.	S. Engkabang, b.w.	60	7
6.	S. Engkabang, a.w.	152	2
7.	Lower S. Sitam, b.w.	6	8
8.	Tributary of S. Sitam, a.w.	183	0
9.	Middle S. Sitam, b.w.	92	9
10.	Upper S. Sitam, below Pondok Busiri, b.w.	131	9
11.	Bathing stream, below Pondok Busiri. a.w.	335	0
12.	Lower S. Engkiang, b.w.	76	8
13.	Middle S. Engkiang, b.w.	107	8
14.	Upper S. Engkiang, b.w.	128	9
15.	Upper right trib. S. Engkiang, a.w.	134	3
16.	S. Split, b.w.	152	7
17.	S. Sumur Wanita, near KBFSC, b.w.	60	6
18.	S. Sumur Wanita, near KBFSC, a.w.	122	3
19.	S. Belalong, near KBFSC, b.w.	55	25
20.	S. Belalong, btw. S. Engkabang & S. Sitam, b.w.	67	21
21.	S. Belalong, near S. Engkiang, b.w.	70	13
22.	S. Belalong, btw. S. Engkiang & S. Split, b.w.	100	10
23.	S. Belalong, near S. Split, b.w.	137	6
24.	Confluence of S. Belalong & S. Temburong, b.w.	49	13
25.	S. Temburong, near S. Babi, b.w.	61	24
26.	S. Temburong, near S. T-Machang, b.w.	79	12
27.	Lower S. Babi, b.w.	92	15
28.	Trib. Lower S. Babi, a.w.	152	0
29.	Upper S. Babi, b.w.	214	10
30.	Upper S. Babi, above runs, b.w.	275	11
31.	Trib. Upper S. Babi, a.w.	335	3
32.	Lower S. T-Machang, b.w.	100	19
33.	Trib. S. T-Machang, below Bt. Belalong, a.w.	610	1
34.	Trib. Upper S. T-Machang, a.w.	579	1
35.	Trib. Upper S. T-Machang, a.w.	457	3
36.	S. Inging, b.w.	70	11
37.	Trib. S. Inging, a.w.	140	0
38.	S. Apan, b.w.	61	12
39.	S. Apan, a.w.	137	4
40.	Stream below Bukit Pagon	1400	4

between 2500 and 4000 mm, with seasonal and event rainfall being extremely variable. During torrential rain about 100 mm can fall within five hours; 181.5 mm has been recorded for a single rain event (Cranbrook, 1992). River level can rise or fall by as much as 3.5 m over an 8-hour period, this being more pronounced in the steeper, deeply cut upland streams. The stream banks are very steep, up to 70 degrees in slope. The streams have rocky, shale gravel or sandy beds, sometimes covered by organic debris composed of leaves and twigs. There are no aquatic macrophytes in the streams although the boulders and banks harbour rheophytes. The streams are extensively shaded by overhanging trees. There are no flood plains in the area although the lower reaches may have deposited clay substratum. The stream water is slightly acidic and nutrient poor (Choy, 1992). Details of other environmental features of the study area can be found in Cranbrook (1992).

MATERIALS AND METHODS

Between February, 1991 and March, 1992 fish were collected from the middle to upper reaches of two adjoining rivers, Sungai (Sg.) Belalong and Sg. Temburong and from most of their tributaries (Figure 1). A list of the sampling stations, their altitudes and the number of species caught at each station are given in Table 1. Since the objective of this study was to catch as many species as possible present and, to overcome the problem of gear selectivity, several sampling techniques (gill netting, cast netting, seining, dip-netting, hand-lining and trapping) were utilized to collect from the different available micro-habitats (e.g. pools, runs, riffles, under boulders and litter). At most localities, sampling was carried out during the day. However, some night samplings were also carried out at stations 10, 11, 16-19, 23, 24, 33 and 38.

The fish were fixed in 10% formalin and later preserved in 70% ethanol. Most specimens collected during this study are currently deposited in the UBD/RGS Rainforest Project 1991-92 Reference Collection at the Department of Biology, Universiti Brunei Darussalam while some are in the Reference Collection (Cat. Nos. F/1-F/146) of the Fisheries Department of Sabah at Likas, Kota Kinabalu. All specimens will eventually be deposited in the Natural History Section of the Brunei Museum, Bandar Seri Begawan, Brunei Darussalam.

SYSTEMATIC ACCOUNT

The checklist below gives the station numbers and the total number (N) of specimens of each species caught during the survey. The range of size (given as standard length, SL) of fish is also indicated. The families of fishes are arranged in alphabetical order.

FAMILY ANGUILLIDAE

Anguilla marmorata Quoy & Gaimard, 1824

Material examined. - Stations 19, 20, 25, 27, 30, 32 & 38; N=8; SL=42-65 cm.

Remarks. - This eel is commonly caught with handline in the larger streams. They are found under boulders and plant debris and are nocturnal. None were caught or seen above waterfalls.

FAMILY BAGRIDAE

Mystus baramensis (Regan, 1906)

Material examined. - Stations 5, 19, & 25; N=6; SL=10-16 cm.

Remarks. - This does not seem to be a very common species in the area. It is nocturnally active and benthic. The species is expected to be more common downstream, perhaps with other congeneric species.

Mystus sp.

Material examined. - Station 26; N=1; SL=15 cm.

Remarks. - This species was recorded from a photograph taken by Awg. Samhan Nyawa. Its dorsal surface is brownish, unlike *M. baramensis* which is greyish. It also seems to be a much larger species than *M. baramensis*.

Leiocassis micropogon (Bleeker, 1852)

Material examined. - Stations 19 & 24; N=18; SL=13-18 cm.

Remarks. - This is a common, nocturnally active species often caught in large numbers in turbid waters following heavy rainfall. Its microhabitat seems to be similar to that of *Mystus* spp., amongst larger boulders.

FAMILY BALITORIDAE

The gastromyzontins, previously designated as the family Gastromyzontidae (Inger & Chin, 1961; 1962), have been incorporated into the family Homalopteridae (Roberts, 1982; 1989). Kottelat (1989) reported that the family-group name Homalopterini Bleeker, 1858 is a junior synonym of Balitoridae Swainson, 1838.

Gastromyzon borneensis Günther, 1874

Material examined. - Stations 15, 19-21, 25, 26, 29 & 30; N=33; SL=1.5-8.5 cm.

Remarks. - Like all the other members of the genus *Gastromyzon* (endemic to Borneo), this is a rheophilic species. They are common in runs and riffles with clear water and stony beds. Collected from up to 600m but all below any major waterfall. In smaller specimens, the secondary rostrum is not very prominent. The number of pigmented vertical bands on the body vary from 12 to 14 (including 3 on the caudal fin). It was previously known only from the north-eastern part of Borneo (Roberts, 1982, 1989).

Gastromyzon fasciatus Inger & Chin, 1961

Material examined. - Stations 19 & 35; N=3; SL=4.0-5.5 cm.

Remarks. - Collected from Sg. Belalong near the Field Studies Centre and from Sg. Temburong Machang above waterfalls, at an altitude of about 600m. This species has previously been reported from Sabah, Sarawak and western Kalimantan (Roberts, 1989).

Gastromyzon monticola (Vaillant, 1902)

Material examined. - Stations 7, 10, 14, 19, 20, 25, 27 & 32; N=22; SL= 2.1-4.8 cm.

Remarks. - Numerous specimens were collected from several streams and with one exception, in areas up to the first waterfall. At Sg. Engkiang (Station 15), it was also collected from a tributary pool above the first waterfall. Small individuals have a blackish blue-spotted appearance, particularly if seen in the sunlight. The fins have red edges and there are four dark vertical bands on the caudal fin. This species has previously been reported from Sabah and Sarawak (Roberts, 1989).

Gastromyzon lepidogaster Roberts, 1982

Material examined. - Stations 3, 4, 9, 10, 15, 18-20, 25, 29, 30, 32, 35 & 38; N=18; SL=2.6-7.5 cm.

Remarks. - This is one of the common gastromyzontins in the area. Large specimens are often bright to dark green in colour, with faint stripes and covered with black nuptial spots. Bright orange specimens have been reported from Telupid, Sabah (Chin, 1990). The species is often seen above waterfall areas of streams. It is a widespread species in Borneo, previously known from Sabah, Sarawak and Kalimantan (Roberts, 1989).

Gastromyzon punctulatus Inger & Chin, 1961

Material examined. - Stations 6, 19, 25 & 27; N=7; SL=3.8-4.7 cm.

Remarks. - This uncommon species, collected from below and above waterfall areas has been recorded from all states in Borneo, except Kalimantan. However, it is likely to occur there as well.

Gastromyzon ridens Roberts, 1982

Material examined. - Stations 19 & 25; N=3; SL=4.5-5.5 cm.

Remarks. - Specimens were collected from runs of the main channels of Sg. Belalong and Sg. Temburong. This species differs from all other *Gastromyzon* species in having the sublacrimal groove extending well along the side of the head. Previously collected only from western Borneo (Roberts, 1989) and so this record extends eastward the species' known range.

Glaniopsis hanitschi Boulenger, 1899

Material examined. - Stations 31, 33, 34 & 40; N=7; SL=1.6-6.0 cm.

Remarks. - All specimens were caught in sections of streams above waterfalls. It is a montane species and the only one to be caught in the vicinity of Bukit Belalong, at an altitude of 600 m. It has also been collected from a stream just below Bukit Pagon, the highest peak in Brunei Darussalam. It was previously known only from the Mt. Kinabalu area.

Glaniopsis gossei Roberts, 1982

Material examined. - Station 40, N=1; SL=2.8 cm.

Remarks. - This is another montane species; a single juvenile specimen was collected from a stream below Bukit Pagon. Previously only known from near Bario, Sarawak at an altitude of about 1100 m.

Neogastromyzon nieuwenhuisii Popta, 1905

Material examined. - Stations 3-6, 9, 10, 12-15, 17-27, 35, 38 & 39; N=54; SL=0.8-4.5 cm.

Remarks. - Perhaps the most common and widespread gastromyzontin in the area, it is found in the fast flowing sections of streams. It has a more slender body than *Gastromyzon* species. This species was previously known only from the Kapuas River, Kalimantan (Roberts, 1989).

Neogastromyzon sp.

Material examined. - Station 40; N=2; SL=1.2-1.5 cm.

Remarks. - Two juveniles were collected from a montane stream near Bukit Pagon.

Protomyzon whiteheadi (Vaillant, 1893)

Material examined. - Stations 16, 18-20, 24-26, 29-32 & 39; N=16; SL=1.8-4.7 cm.

Remarks. - This is a common species, found below and above waterfall zones. Previously known from Sabah.

Protomyzon griswoldi (Hora & Jayaram, 1951)

Material examined. - Stations 32; N=1; SL=4.2 cm.

Remarks. - Only a single specimen was collected during the survey. Previously known from Sabah.

Protomyzon sp.

Material examined. - Station 39; N=2; SL=2.5-2.9 cm.

Remarks. - This species has yet to be identified. It is a rheophilic species, collected from above a waterfall zone of Sg. Apan.

Sundoreonectes sabanus (Chin, 1990)

Material examined. - Station 40; N=2; SL=4.6-4.8 cm.

Remarks. - Collected from a stream below Bukit Pagon, this high-altitude species has previously been recorded only from Mt. Kinabalu, Sabah.

Nemacheilus sp.

Material examined. - Station 31, N=4; SL=1.2-1.5 cm.

Remarks. - These juveniles, collected from above waterfalls of a tributary of the upper Sg. Babi, could not be identified with certainty to a species. Only one other congeneric species, *Nemacheilus selangoricus* has been reported from Brunei Darussalam (Eden, 1984).

FAMILY CLARIIDAE

Clarias leiacanthus (Bleeker, 1851)

Material examined. - Stations 19, 25 & 32; N=3; SL=13-16 cm.

Remarks. - This tentatively identified species does not seem to be very common in the area. Unlike *C. teijsmanni*, it is much darker in colour and does not have whitish spots on the side of its body. Like other catfish, *Clarias* spp. are benthic and nocturnally active.

Clarias teijsmanni Bleeker, 1857

Material examined. - Station 19; N=1; SL=17 cm.

Remarks. - Some authors such as Roberts (1989) have spelt the species name as *C. teysmanni*. However, since the original spelling is *C. teijsmanni* and it does not seem to be a typographical error, the International Code for Zoological Nomenclature (ICZN) (1985) dictates that *C. teijsmani* be used. Roberts (1989) has stressed the difficulty in separating this species from *C. leiacanthus* (Bleeker, 1851) as the diagnostic characters used for identification seem to be highly variable. The *C. teijsmanni* complex is in need of a taxonomic revision.

FAMILY COBITIDAE

Pangio mariarum (Inger & Chin, 1962)

Material examined. - Stations 19-21, 27, 32 & 36; N=8; SL=4.5-6.5 cm.

Remarks. - Kottelat (1987) demonstrated the generic name *Pangio* Blyth, 1860 rather than *Acanthophthalmus* (which is an objective synonym of *Cobitis)* is appropriate. This eel-like fish is found mainly amongst plant debris in slow flowing areas of streams. This species has previously been collected only from eastern Sabah and it is endemic to Borneo.

FAMILY CYPRINIDAE

Chela sp.

Remarks. - A specimen (SL about 5 cm) was caught from the upper Sg. Belalong (near Stn. 23) and photographed by a reconnaissance team in 1990. Unfortunately, the specimen was not retained. A similar species *C. oxygastroides* Bleeker, 1852 has been reported from the Benutan Reservoir, Tutong (Booth, *et al.*, 1994).

Hampala bimaculata (Popta, 1905)

Material examined. - Stations 7, 9, 10, 12-14, 16, 19-27, 29, 30, 32, 36 & 38; N=65; SL=2-21 cm.

Remarks. - This is an important food fish. Small and intermediate sized fish are very common in fast and slow flowing areas of most streams, particularly in clear waters. Very small specimens (< 3 cm) have only one vertical black stripe running from the tip of the dorsal fin to behind the pelvic fin. Intermediate-sized specimens have a very distinct saddle-like black marking just below the dorsal fin and another circular one on the caudal peduncle. The body is blackish dorsally and silvery ventrally. A reddish orange tinge may be present just above the lateral line. The outer edges of the caudal fin has black stripes; the rest of this and the dorsal fin is reddish orange. The edges of the pectoral and pelvic fins are iridescent silvery cream. This species is very common in the upper reaches of Sg. Babi. Only one other congeneric species, *H. macrolepidota* has previously been reported from Brunei Darussalam (Eden, 1984).

Lobocheilus bo (Popta, 1904)

Material examined. - Stations 7, 9, 10, 12-14, 16, 19-22, 25-27, 32 & 38; N=58; SL=4-18 cm.

Remarks. - This is another important food fish. The species is common in the deeper channels of streams, swimming close to the bottom. Live and freshly caught specimens have a fluorescent cream streak along the outer edges of the pectoral and ventral fins.

Nematabramis steindachneri (Popta, 1905)

Material examined. - Stations 1, 3, 5, 7, 9, 10, 12-14, 16, 17, 19-27, 29, 30, 32, 36 & 38; N=153; SL=1-12 cm.

Remarks. - This is an ubiquitous species and numerically, perhaps the most abundant fish in the Kuala Belalong area. It is found predominantly in pools and slow-flowing reaches of streams. It is a surface dwelling fish, occurring together with the rasboras.

Osteochilus spilurus (Bleeker, 1851)

Material examined. - Stations 19, 24 & 36; N=7; SL=4-14 cm.

Remarks. - This species is found co-existing with *Puntius collingwoodi* and *Hampala bimaculata*, in the deeper, slow-flowing channels of the larger streams. This record forms a westward extension of this species range of distribution in Borneo. Its former known distribution is Sabah.

Paracrossochilus acerus Inger & Chin, 1962

Material examined. - Stations 5, 10, 12-14, 19-22, 25-27, 29, 30, 32, 36 & 38; N=102; SL=2.3-7.9 cm.

Remarks. - A common rheophilic species, occurring in clear water runs with rocky or gravel substrata. We have recorded densities of up to 50 m^{-2} in some areas. Juveniles were caught from among the leaf debris in the streams. This species is endemic to Borneo.

Paracrossochilus vittatus (Boulenger, 1894)

Material examined. - Station 36; N=4; SL=2.1-4.5 cm.

Remarks. - This species seems rare and was found in only one upstream locality. The small specimens were found in the leaf debris in the stream. This species is endemic to Borneo.

Puntius binotatus (Valenciennes, 1842)

Material examined. - Stations 19 & 24; N=5; SL=8.2-12.1 cm.

Remarks. - This species is not as common in this area as downstream. It has previously been recorded (as *Barbodes binotatus*) from Brunei Darussalam by Eden (1984).

Barbodes collingwoodi (Günther, 1868)

Material examined. - Stations 19-22, 27, 29, 30, 32 & 36; N=71; SL=0.6-15.0 cm.

Remarks. - This species, which is endemic to Borneo, is common in larger streams with clear water and rocky or gravel substrata. It was previously recorded from Brunei Darussalam by Eden (1984).

Rasbora argyrotaenia (Bleeker, 1850)

Material examined. - Stations 1, 3, 5, 7, 9, 10, 12-14, 16, 17, 19-27, 29, 30, 32, 36 & 38; N=148; SL=0.5-11.0 cm.

Remarks. - This species is one of the two most common species of *Rasbora*, the other being *R. sumatrana* (Bleeker, 1852). They are abundant in most pools and slow-flowing areas of clear water streams. The species is a near-surface dweller, occurring with *Nematabramis steindachneri*. It is a widespread species in the Sunda region.

Rasbora sumatrana (Bleeker, 1852)

Material examined. - Stations 1, 3, 5, 7, 9, 12-14, 16, 19-26, 29, 30, 32 & 36; N=32; SL=0.8-10.6 cm.

Remarks. - Numerous specimens of this widely distributed and supposedly highly variable species were collected. It is present in most of the sampled streams, co-existing with *R. argyrotaenia*. This species has previously been recorded from Brunei Darussalam (Eden, 1984).

Rasbora sp.

Material examined. - Stations 19-21, 25 & 38; N=8; SL=2.5-6.5 cm.

Remarks. - This species seems closely related to *R. argyrotaenia*. It differs from other *Rasbora* species in having a much more silvery colouration without the mid-lateral black streak on the body. The black anal streak extends from the base of the anal fin to the caudal peduncle.

Tor douronensis (Valenciennes, 1842)

Material examined. - Stations 1, 3, 5, 7, 9, 10, 12, 13, 16, 19-27, 29, 30, 32, 36 & 38; N=51; SL=2-21 cm.

Remarks. - This is an important food fish, found in the demersal zone of the deeper channels and pools.

FAMILY GOBIIDAE

***Parawaous* sp.**

Material examined. - Stations 1, 7, 9, 19, 20, 24, 25, 27, 32 & 38; N=15; SL=3.4-6.0 cm.

Remarks. - This species is common near the shallow stream edges with clear flowing water and rocky or gravel substrata.

***Pseudogobiopsis campbellianus?* (Jordan & Seale, 1908)**

Material examined. - Stations 1, 9 & 38; N=3; SL=4.2-5.3 cm.

Remarks. - The identity of this uncommon species has yet to be confirmed. It is a slender species with darker body colouration and very faint pigmented markings.

FAMILY MASTACEMBELIDAE

***Macrognathus maculatus* (Cuvier, 1831)**

Material examined. - Stations 19-27, 32, 36 & 38; N=18; SL=8.0-16.2 cm.

Remarks. - The specimens have been tentatively assigned to this species (see Roberts, 1989 for comments on its identity). Small specimens were collected from the leaf debris in the streams while the larger ones were caught from under boulders.

***Mastacembelus unicolor* Cuvier, 1831**

Material examined. - Stations 24, 36; N=4; SL= 5-21 cm.

Remarks. - Roberts (1989) re-classified the Bornean species of "*M. armatus* Lacepède, 1800" as *M. unicolor* Cuvier, 1831.

FAMILY SILURIDAE

***Krytopterus* sp.**

Remarks. - A specimen was caught from the upper Sg. Belalong and photographed in 1990. The specimen was not retained.

Ompok sp.

Material examined. - Station 32; N=1; SL= 3.5 cm.

Remarks. - A single juvenile was collected from the leaf debris in the stream.

Silurichthys hasselti Bleeker, 1858

Material examined. - Stations 17, 19 & 25; N=7; SL=7.5-13.2 cm.

Remarks. - A common species; nocturnally active.

Silurus sp.

Material examined. - Station 32; N=1; SL=2.0 cm.

Remarks. - A small juvenile specimen. The specimen has a small, soft dorsal fin and the caudal fin is pointed. It was found amongst the leaf debris in the stream.

FAMILY SISORIDAE

Glyptothorax major (Boulenger, 1894)

Material examined. - Stations 17, 19, 24, 25 & 27; N=9; SL=8-15 cm.

Remarks. - This is a common species in the lower reaches of the larger streams.

FISHERY

About 20 species of the freshwater fishes found in the Batu Apoi area (Table 2) provide a subsistence fishery predominantly for the inhabitants of an Iban longhouse (population about 170) at Batang Duri, about nine km downstream from the 'kuala', the confluence of Sg. Temburong and Sg. Belalong. The fishing methods utilized include cast, seine and gill nets, rod and line, traps and poisoning. The last method, however, was not observed within the Reserve area; its usage was observed to be limited to downstream areas. Samples identified were roots of *Derris elliptica* (tuba, Fabaceae) and *Dioscorea hispida* (gadong, Dioscoreaceae) as well as barks of *Pometia pinnata* (kasai, Sapindaceae) and *Diospyros* sp. (pauh, Ebenaceae).

DISCUSSION

A total of 44 species belonging to 10 families and 30 genera were collected from 40

Table 2. Local names of freshwater fishes in the Temburong-Belalong river system. Those which are fished for consumption are marked (*).

Genus/species	Malay name	Iban Name
*Nematabramis steindachneri**	Lallang	Engsuluai nipis
Rasbora spp.*	Seluang	Engsuluai segala
*Tor douronensis**	Luang	Tengas/Semah
*Lobocheilus bo**	Buroi	Kulong
*Glyptothorax major**	Kasili	Pait
*Mystus baramensis**	Baung	Baung
*Leiocassis micropogon**	Baung	Garsit
Chela sp.*	Lallang	Engsuluai
Clarias spp.*	Keli	Keli
Hampala spp.*	Barap	Juak
*Puntius binotatus**	Sela	Kepiat
Puntius spp.*	Patian	Tengada
*Osteochilus spilurus**	Lami	Bantai
*Silurichthys hasselti**	Duanbuloh	-
Wallago sp.*	Tapah	Lelipai
*Ompok bimaculata**	Tapah	Lawang
Krytopterus sp.*	Rutan/Lais	Elias
Anguilla spp.*	Kesidi	Bong
Paracrossochilus acerus	Buroi batu	Kemujuk
Gastromyzon spp.	Kelekat	Kelekap/Rogot
Mastacembelus sp.	Tilan	Kilan

sampling stations. This included unidentified species belonging to the genera *Chela*, *Mystus* and *Krytopterus* which were caught from the Sungai Belalong and photographed by a reconnaissance team in 1990. Unfortunately, none of these specimens were retained. A linear plot of cumulative sampling effort against the cumulative number of species collected indicate sampling efficiency of about 90%, suggesting that the watershed above the Belalong-Temburong confluence contains about 50 species of fish. Notable absentees from the checklist are species belonging to the genera *Betta*, *Channa*, *Cyclocheilichthys*, *Dermogenys* and *Homaloptera*, all of which are known to occur in forest streams elsewhere within as well as outside Brunei Darussalam. These have been collected from streams in the Bukit Patoi, Labi and the Benutan areas (S. C. Choy, unpubl. data). Twelve species, all belonging to the Balitoridae, were found in streams above the first major waterfall encountered (six species exclusively) while 38 species (32 exclusively) were found in streams below that.

As very few studies on the freshwater fishes of Brunei Darussalam have been carried out prior to this study, all but three species (*Puntius collingwoodi*, *P. binotatus* (as *Barbodes binotatus*) and *Rasbora sumatrana*) reported here are new records for the country. Twenty three (52%) of these are endemic to Borneo, with 13 belonging to the family Homalopteridae. The total number of species reported from Brunei Darussalam now stands at about 65. If those collected from the lower regions of the Sg. Temburong are included (S. C. Choy, unpubl. data) the number increases to about 85. If species which have not been collected yet are accounted for, then the total number of freshwater species in Brunei Darussalam is expected to be just over 100. Inger & Chin (1962) found that there was a constant proportion of about 40% between strictly riverine species and the total number of freshwater fish species in a drainage area (watershed). Assuming this to be the case for the Temburong-Belalong river

system, then the total number of species in the watershed is expected to be about 110. Since the fish species in the different watersheds of Brunei Darussalam (e.g. Sg. Belait and Sg. Tutong) are expected to be the similar, then the total number of species of freshwater fish in the country is not expected to be much greater than the number found in a large watershed such as the Sg.Temburong-Sg. Belalong watershed.

As with other streams in Southeast Asia (Rainboth, 1991), those in Kuala Belalong are dominated by Cyprinoidea (three families - Balitoridae, Cyprinidae and Cobitidae, 29 species and totalling 66%) with the Balitoridae and Cyprinidae comprising 15 and 13 species, respectively. The latter family is much more predominant in terms of the number of individuals caught, comprising 72% of the total catch. Only about 20% of the species collected in the study area were also found in the coastal tributaries of the Temburong River, where cyprinids (57%) and gobies (33%) predominate (Choy, 1992).

The number of species collected from other areas in Borneo as well as the number in common with that of the Sg. Temburong-Sg. Belalong system and Jaccard's coefficient of similarity (Southwood, 1978) are given in Table 3. Although most of the localities have not been sampled adequately and the data presented is preliminary, there is indication that the Temburong-Belalong fauna is more similar to that of the western part of Sabah, including the Kinabalu area ("west coast of Sabah", *sensu* Inger & Chin, 1962) than that of the Baram River in Sarawak. However, it seems more similar to that of the Baram than that of the eastern part of Sabah (localities 3-9 in Table 3). On the basis of the available habitat types

Table 3. Fish taxa reported from various localities in Borneo and the number of genera and species common to those in the Temburong-Belalong watershed. Area refers to approximate area of survey. C_j, Jaccard's coefficient of similarity.

Locality	Area (km^2)	Number families	Number genera	Number species	Number common genera	C_j	Number common species	C_j	*Ref
SABAH									
West Coast	10,000	14	12	34	7	0.21	22	0.39	1
Kinabalu Park	100	5	13	24	12	0.41	12	0.21	2
Kretam Kechil	40	12	17	27	7	0.18	3	0.04	3
Kinabatangan	1,000	17	31	38	3	0.05	3	0.04	1
Tabin Wildlife Res.	50	10	24	30	15	0.41	10	0.16	4
Tawau Park	100	4	8	13	8	0.29	7	0.14	5
Tawau Watershed	8,000	11	18	26	13	0.39	11	0.19	1
Danum Valley	438	10	27	37	17	0.44	12	0.17	6
Labuk-Segama	40,000	15	36	58	16	0.33	13	0.15	1
BRUNEI									
Temburong-Belalong	50	10	28	44					7
SARAWAK									
Baram River	1,600	16	36	57	20	0.46	13	0.15	8
Lambir Nat. Park	70	6	8	11	5	0.16	4	0.08	9
KALIMANTAN									
Kapuas River	28,000	42	122	289	25	0.20	22	0.07	10
Mahakam River	-	10	23	30	7	0.16	8	0.12	1

*1. Inger & Chin (1962), 2. Samat (1990a), 3. Inger (1955), 4. Taylor (1989), 5. Lee *et al.* (1990), 6. Samat (1990b), 7. present study, 8. Watson & Balon (1984), 9. Zakaria-Ismail (1984), 10 Roberts (1989).

and environmental conditions, we expect the fauna of the Sg. Belait and Sg. Tutong catchments to be more similar to that of the Baram River than that of the west coast of Sabah. These areas are expected to have some peat swamp/blackwater component. Generally, the Brunei freshwater fish fauna is of the "North Borneo" type (*sensu* Inger & Chin, 1962). This is clearly indicated by the relatively high number of shared gastromyzotin species when compared to that of the central and west Bornean regions. On the other hand, some species such as *Nematabramis steindachneri*, *Clarias leiacanthus*, *Neogastromyzon nieuwenhuisii*, *Gastromyzon ridens* and *Silurichthys hasselti* collected from the Temburong-Belalong area seem to be "west Borneo" species. They have been reported from the Baram and Kapuas Rivers in Sarawak (Watson & Balon, 1984; Roberts, 1989) but not from Sabah (Inger & Chin, 1962; Taylor, 1989; Samat, 1990a, b).

The ichthyofaunal diversity of the Kuala Belalong area is relatively high; 44 species collected in a watershed area of 50 km^2 (Table 3). High fish diversity in tropical streams has been attributed to high species packing, either due to increase in niche overlap or niche compression (Lowe-McConnell, 1987). Watson & Balon (1984) found that in the Baram River it was due to the latter. The community ecology of the Kuala Belalong fishes will be described in detail in a separate paper.

A study is currently underway to determine the feasibility of building a 50m high dam at the confluence of the Temburong and Belalong Rivers (Station 24) for water supply and generation of electricity. If this development proceeds, construction activities will significantly increase the sediment load downstream which could either destroy or force the aquatic fauna to move to unaffected tributaries. (Choy, 1987). The dam is expected to reduce seasonal variation in water flow and therefore have a stabilizing effect. If properly designed, it could still allow for the migration of diadromous species such as eels, catfish and prawns. Upstream the dam, areas up to the 100m altitudinal level are expected to be flooded and the resulting reservoir will initially have a high hydrogen sulphide content. The drastic change in the physiography of the watershed and water quality will have a negative impact on the aquatic fauna of Batu Apoi Forest Reserve. Most species of fish will either die or be forced to migrate upstream or into lateral tributaries and be replaced by lacustrine and aerial breathing ones such as *Anabas testudineus*, *Channa* spp., *Clarias* spp. and *Trichogaster* spp. This faunal change has occurred in the Benutan Reservoir (Tasek Jubli Perak) in Tutong District (Booth *et al.*, 1994). Species forced upstream may not survive the steeper gradients and faster waterflows. Those that do will impose greater demand on the available resources of these channels.

The capacity for the fauna in Batu Apoi Forest Reserve to adjust and recover from potential changes in flow and water quality resulting from dam construction will depend on the tolerance and adaptive features of the species in question as well as on the magnitude of environmental alteration. At present, we know very little about these.

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