Fishes of the Mitaraka Mountains (French Guiana)

Sébastien BROSSE, Frédéric MELKI & Régis VIGOUREOUX
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ABSTRACT
The “Our planet reviewed” expedition allowed to investigate the fish fauna from the Mitaraka Mountain Range (French Guiana). We sampled fishes at 14 sites using complementary sampling methods including rotenone, underwater observation, seine, cast nets, traps and hooks. We present the first detailed fish inventories from this region. Thirty eight species belonging to 16 families were observed, and at least one unknown species belonging to the genus *Jupiaba* Zanata, 1997 was collected. At two torrential sites we recorded an unusual fish assemblage made of a single Trichomycteridae species, *Ituglanis nebulosus* de Pinna & Keith, 2003. A few rare species were also recorded such as *Pimelodella procera* Mees, 1983 hereby extending its known distribution 100 km Southward. *Anablepsoides gaucherii* (Keith, Nandrin & Le Bail, 2006) was collected for the first time since its description in 2006. This species was collected in a stream located 15 km eastern from its type location, revealing its distribution might span over the entire Mitaraka range. Overall, the species turnover between sites was high even between sites with similar environmental conditions, suggesting that dispersal limitation is playing a significant role in fish assemblage composition. This indicates that complementary inventories in nearby areas may still provide new species and original information on the fish fauna inhabiting small streams of Southern French Guiana.

KEY WORDS
Community, Guiana shield, species list, species distribution, species assemblages, mountain streams, environmental characteristics.
INTRODUCTION

Our knowledge of the freshwater fish fauna of French Guiana has benefitted from intensive fish inventories for more than 50 years. The seminal works (e.g. Puyo 1949; Planquette et al. 1996; Boujard et al. 1997; Keith et al. 2000; Le Bail et al. 2000), were recently updated (e.g. Le Bail et al. 2012; Melki 2016; Covain et al. 2012; Fisch-Muller et al. 2018) and the fish fauna of French Guiana is among the best known in the Guiana Shield. Such taxonomic knowledge, together with intensive field sampling occasions, led to the development of ecological approaches on the structure of fish communities (Cilleros et al. 2016, 2017) and their responses to anthropogenic stressors (Brosse et al. 2011; Allard et al. 2016). However, gaps in our knowledge remain since access to the southern half of the territory remain particularly difficult due to the absence of roads or tracks. This is an area of c. 30 000 km² of hilly and mountainous terrain covered by almost undisturbed tropical rainforest. Access to this zone is only possible by boat, and the fish fauna from most of the small streams of southern French Guiana, particularly those located far from navigable waterways, remains largely unknown. To remedy this deficiency, several research projects were initiated during the last decade to inventory the fish fauna of streams throughout French Guiana, leading to set an upstream-downstream fish typology for small streams (Cilleros et al. 2017). This typology identifies five successive types of stream fish assemblages from the source to the confluence with a larger river (i.e. more than ten meters wide and one metre deep). In this typology, the upstream zone account for the mountainous streams hosting only a few specialised fish species. Studies focussing on this particular zone revealed a strong fish micro-endemism (Covain et al. 2012; Brosse et al. 2013), but were limited to a few mountains due to access limitations. In this context, acquiring data from the Mitaraka Mountains, located in the southernmost region of French Guiana has a particular interest since: 1) this remote area of steep sloped granitic hills (also called inselbergs) has never been sampled for entire fish communities; and 2) studies on fish assemblages from Guiana Shield mountains remain particularly scarce, and the works of Mol et al. (2007) and Fisch-Muller et al. (2018) on Lely Nassau and Brownsberg Mountains (Suriname) and Brosse et al. (2013) on Itoupé mountain (French Guiana) remain, to our knowledge the only fish inventories on such kind of environment. Here we report on the fish assemblages from 14 environmentally contrasted sites in the Mitaraka Mountains and analyse faunistic differences between sites in relation to the environmental characteristics of the streams.

MATERIAL AND METHODS

The Mitaraka Mountains is a series of low altitude hills (not exceeding 600 meters a.s.l.), which constitute a part of the Tumuc-Humac mountain range (Hurault 1973). They constitute the Southeastern boundary between French Guiana and Brazil, and therefore the watershed divide between the Amazon Drainage in Brazil and the Maroni Drainage in French Guiana. These mountains are covered by dense rainforest, with the exception of their summit, where the granitic substratum is apparent, resulting in rocky islands emerging from the rainforest, also called inselbergs (Fig. 1). The southern slope of the Mitaraka Mountains is drained by several small streams flowing to the Alama River, a tributary of the Maroni. Due to the remoteness of the area, access to the base-camp (located close to site S11, Fig. 1) was only possible by helicopter, and

RÉSUMÉ

Les poissons des monts Mitaraka (Guyane).

MOTS CLÉS
Communautés, plateau des Guyanes, liste d’espèces, distribution d’espèces, assemblages d’espèces, ruisseaux de montagne, caractéristiques environnementales.
all the equipment was hand carried from the base-camp to the sampling sites, a reason why we were unable to sample more sites or cover a longer distance to find distant sampling sites. The fish samples were collected in March 2015. We sampled 14 sites (Fig. 1) belonging to the Alama main stream (site S11) and its tributaries (the remaining 13 sites). All the sites were GPS referenced and altitude was measured using a Garmin GPSMAP62. We measured the site physical characteristics by measuring the stream width, water depth and current velocity along three transects. Current velocity was estimated by measuring the time necessary for a floating object to cover a distance of one meter. The roughness of the stream granulometry was visually estimated as the percentage of large-sized pebbles and boulders (above 10 cm diameter). We also measured pH and water temperature with a WTW pH 3110 fitted with a WTW pH-Electrode SenTix 41. Turbidity was measured with an Eutech Instruments Tubidimeter TN-100, and water conductivity was measured with a WTW conductivity sensor.

Fishes were collected using various sampling techniques in relation to the stream/site environmental characteristics, to maximize the probability to collect the entire fauna. At all stream sites with the exception of the Alama main stream (site S11) fishes were sampled using rotenone. At each site, a river section was isolated using two fine mesh (4 mm) stop nets. The length of each section was proportional to stream width and was on average 16.35 ± 5.85 m (mean ± SD). Fishes were collected after releasing a small quantity of rotenone (PREDA-TOX®: a 6.6% emulsifiable solution of rotenone extracted from Derris elliptica (Wallich) Benth. by Saphyr, Antibes, France).

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few meters upstream of the first net. Fishes were then collected with fine meshed dip nets (2-mm mesh). At the end of each sampling session we searched for fishes lying on the bottom or hidden in the leaves and debris. This sampling method has been described in detail by Mérigoux & Ponton (1999), and or hidden in the leaves and debris. This sampling method has been described in detail by Mérigoux & Ponton (1999), and

**Table 2.** Species occurrence in each site and family membership of each species. The sites (S) are grouped in four types according to their physical characteristics and their fish fauna (see text for detail).

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<td>Loricariidae</td>
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<td>Loricariidae</td>
<td>Ancistrus temminckii</td>
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<td>Guyanancistrus megastictus</td>
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specimens collected benefited from the Access and benefit sharing agreement of the “Our Planet Reviewed” program (APA 973-1) (Tourrot et al. 2018).

We collected 328 fish specimens that were identified in the field with Planquette et al. (1996), Keith et al. (2000) and Le Bail et al. (2000). Taxonomy was then updated according to Le Bail et al. (2012) and Melki (2016). For specimens of particular taxonomic interest, tissue samples were taken and stored in 96% ethanol for molecular analyses and the specimen was then fixed in 5% formaldehyde solution for taxonomic confirmation.

Fish data were compiled for each sampling site, and fish abundance was converted to occurrences in order to combine quantitative (rotenone) and qualitative (snorkelling, nets, traps) data and get species lists from the 14 sites. To ordinate sites according to their fish fauna, we ran a Principal Component Analysis (PCA) on fish species lists. Presence-absence data was here preferred to abundance data because sampling methods differ between sites. The sites S6 and S7 were excluded from the PCA because their fauna was made of a single species that was not encountered in any of the 12 other sites.
The altitudinal range of the 14 sites varies from 275 to 410 m a.s.l. The sites are characterized by a low conductivity that never exceeded 17.3 μS.cm⁻¹ and a turbidity lower than 8.5 NTU. Temperature and pH were also homogenous among sites and ranged from 23.1 to 23.8°C and between 4.52 and 5.73, respectively. Sites nevertheless differed in their size and slope (Table 1). Two sites were torrential streams with current velocities higher than 0.30 m.s⁻¹ and coarse bottom substratum made of large boulders (site S6) or pebbles (site S7). All the other sites were characterised by a low current velocity (<0.25 m.s⁻¹) and with the exception of site S12, a bottom substratum dominated by fine particles (sand, silt). Site S12 is a side arm of the Alama River, flowing on a granitic substratum, explaining its coarse substratum size despite its limited slope and current velocity. Finally, two groups of low current velocity sites can be distinguished according to their width and depths. Sites S4, S5, S12, S13 and S14 were small (width = 1.30 ± 0.40 m) and shallow (depth = 9.00 ± 1.22 cm); whereas sites S1, S2, S3, S8, S9 and S10 were larger (2.96 ± 1.84 m) and deeper (27.51 ± 15.10 cm). Finally, S11 is the Alama mainstream and it is therefore markedly larger and deeper than the other sites (Table 1).

Considering fish fauna, we collected 38 species in 16 families. Four families were represented by more than two species, namely Characidae (six species), Heptapteridae (six species), Loricariidae (four species) and Crenuchidae (three species). Among the 38 species, two are only known from the Mitaraka Mountains (*Anablepusoides gaucheri* Keith, Nandrin & Le Bail, 2006 and *Guyanancistrus megastictus* Fisch-Muller, Mol & Covain, 2018), two (*Characidium* sp. and *Copella* aff. *arnoldi*) are still unnamed but known species (Le Bail et al. 2012) and another one (*Jupiaba* sp.) is a new record for French Guiana. We were not able to identify this last species and it might be new to science. The fish assemblages are characterised by a low species richness ranging from one to 23 species according to the sites, and a marked species turnover between sites. Indeed, only two out of the 38 species occurred in more than half of the sites (*Gymnotus carapo* Linnaeus, 1758 and *Hemibrycon surinamensis* Gery, 1962), and 12 species occurred in a single site. Moreover, two sites (S6 and S7) were characterised by the presence of a single species (*Ituglanis nebulosus* de Pinna & Keith, 2003), that only occurs in those sites.

Ordinating 12 out of the 14 sites by PCA revealed three main types of sites according to their fish fauna (Fig. 2; Table 1). Sites S4, S5, S12, S13 and S14 (type 1), are small and shallow streams characterised by the presence of Gymnotidae (*G. carapo*), Erythrinidae (*Erythrinus erythrinus* Bloch & Schneider, 1801, *Hoplias malabaricus* Bloch, 1794) and Heptapteridae (*Pimelodella procera* Mees, 1983). Sites S9, S10, S11 and to a lower extent S3 and S8 (type 2) account for the Alama main stream and large (or deep, for site S3) tributaries of the Alama river (Table 1). Type 2 fish fauna was characterised by Characidae (*H. surinamensis*, *Moenkhausia moaisae* Gery, Planquette & Le Bail, 1995), Crenuchidae (*Characidium zebra* Eigenmann, 1909) and Sternopygidae (*Sternopygus macrurus* (Bloch & Schneider, 1801)) (Fig. 2). Site S1 was characterised...
by the presence of *A. gaucheri*, and Site S2 by *Jupiaba* sp. together with *A. gaucheri* and a few other accompanying species (type 3). Those two sites are located far from the confluence with the Alama river (Fig. 1). Finally, sites S6 and S7 (not included in the PCA) were torrential streams characterised by the presence of a single species, *Ituglanis nebulosus* de Pinna & Keith, 2003. Those two sites constitute another type of sites (type 4, Table 2).

The following list of the species observed in the Mitaraka Mountains area follows the arrangement in Le Bail et al. (2012) and provides ecological observations on the species. In accordance with Our Planet Reviewed taxonomic agreement, fish specimens are stored at MNHN. The following list of species is summarized in the Table 2 indicating fish occurrence per site.

Order CHARACIFORMES Goodrich, 1909
Family PARODONTIDAE Eigenmann, 1910
Genus *Parodon* Valenciennes, 1850

*Parodon guyanensis* Gery, 1959
(Fig. 3)

**FIRST RECORD FOR THE MITARAKA.** — This study.

**OCCURENCES.** — S8, S11.

**SPECIMEN IN COLLECTION.** — None.

**DISTRIBUTION IN FRENCH GUIANA.** — Widespread.

**ECOLOGY.** — Observed during underwater inventories in rapid and rocky areas.

**SPECIES CODE.** — PGUY.

Family ANOSTOMIDAE Günther, 1864
Genus *Leporinus* Agassiz, 1829

*Leporinus gossei* Géry, Planquette & Le Bail, 1991

**FIRST RECORD FOR THE MITARAKA.** — This study.

**OCCURENCES.** — S11.

**SPECIMEN IN COLLECTION.** — None.

**DISTRIBUTION IN FRENCH GUIANA.** — Widespread.

**ECOLOGY.** — Only observed during underwater inventories in the Alama main stream. Inhabits large and deep streams, in pools and in slow flowing areas.

**SPECIES CODE.** — LGOS.

*Characidium zebra* Eigenmann, 1909
(Fig. 6)

**FIRST RECORD FOR THE MITARAKA.** — This study.

**OCCURENCES.** — S3, S8, S9, S11.

**SPECIMEN IN COLLECTION.** — None.

**DISTRIBUTION IN FRENCH GUIANA.** — Widespread.

**ECOLOGY.** — Observed on sandy bottoms and moderate to high current velocities in both Alama mainstream and tributaries. Lies immobile head directed upstream, waiting for drifting food. Captured using rotenone and observed in underwater inventories.

**SPECIES CODE.** — CZEB.

**RemarK**
An undetermined morphospecies (*Characidium* sp., [Fig. 5]) is known from the Maroni drainage basin. It is referred as *Characidium* sp. 2 in Le Bail et al. (2012), but the particular colour pattern of the individuals collected in the Mitaraka might indicate another undetermined species, only known from Mitaraka, which was referred as *Characidium* sp. 3 by Melki (2016).

**FIRST RECORD FOR THE MITARAKA.** — Keith et al. 2006.

**OCCURENCES.** — S8, S9.

**SPECIMENS IN COLLECTION.** — 1 MNHN (MNHN-IC-2018-0424); 1 Hydreco.

**ECOLOGY.** — Observed in median sized streams with sandy bottoms and moderate current velocities. Captured using rotenone and observed in underwater inventories.

**SPECIES CODE.** — CSP.

Genus CRENUCHIDAE Günther, 1864

Family CRENUCHIDAE Günther, 1864
Genus *Characidium* Reinhardt, 1867

REMARK
An undetermined morphospecies (*Characidium* sp., [Fig. 5]) is known from the Maroni drainage basin. It is referred as *Characidium* sp. 2 in Le Bail et al. (2012), but the particular colour pattern of the individuals collected in the Mitaraka might indicate another undetermined species, only known from Mitaraka, which was referred as *Characidium* sp. 3 by Melki (2016).

**FIRST RECORD FOR THE MITARAKA.** — Keith et al. 2006.

**OCCURENCES.** — S8, S9.


**DISTRIBUTION IN FRENCH GUIANA.** — Widespread except in Oyapock drainage.

**ECOLOGY.** — Ubiquitous species. Captured using rotenone and by angling in both Alama mainstream and tributaries, in pools and in slow flowing areas. Also observed during underwater inventories.

**SPECIES CODE.** — LGRA.


FIG. 5. — *Characidium* sp. Photograph: F. Melki.
OCCURRENCES. — S12.


DISTRIBUTION IN FRENCH GUIANA. — Maroni, Mana and Sinnamary drainages. Only known from a few sites.

ECOLOGY. — This rare species was only observed in a side arm channel of a rapid area of the Alama River. It was found in a bedrock and boulders habitat with turbulent water. Captured using rotenone.

SPECIES CODE. — MDIS.

Family Characidae Latreille, 1825
Genus Astyanax Baird & Girard, 1854
Astyanax validus
Géry, Planquette & Le Bail, 1991
(Fig. 7)

FIRST RECORD FOR THE MITARAKA. — This study.

OCCURRENCES. — S5, S10, S11, S14.


DISTRIBUTION IN FRENCH GUIANA. — Widespread.

ECOLOGY. — Observed in groups in both Alama mainstream and tributaries, in sandy areas with moderate current velocities. Captured using rotenone, seine nets and by angling. Also observed in underwater inventories.

SPECIES CODE. — AVAL.

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Genus Bryconamericus Eigenmann, 1907

Bryconamericus guyanensis
Zarske, Le Bail & Géry, 2010

FIRST RECORD FOR THE MITARAKA. — Keith et al. 2006.

OCCURRENCES. — S8, S9, S11.


DISTRIBUTION IN FRENCH GUIANA. — Widespread.

ECOLOGY. — Observed in shallow sandy areas with moderate to high current velocities of the Alama mainstream and tributaries. Captured using rotenone.

SPECIES CODE. — BGUY.

Genus Hemibrycon Günther, 1864

Hemibrycon surinamensis Géry, 1962
(Fig. 8)

FIRST RECORD FOR THE MITARAKA. — This study.

OCCURRENCES. — S3, S8, S9, S10, S11, S12, S14.


DISTRIBUTION IN FRENCH GUIANA. — Known from Maroni, Mana, Comté, and Approuague rivers.

ECOLOGY. — Widespread in the Mitaraka mountains. Observed in groups in Alama mainstream and tributaries, often in high current velocity areas. Captured using rotenone and observed in underwater inventories.
**Fig. 7.** — *Astyanax validus* Géry, Planquette & Le Bail, 1991. Photograph: F. Meiki.

**Fig. 8.** — *Hemibrycon surinamensis* Géry, 1962. Photograph: F. Meiki.

**Species code.** — HESU.

**Genus Jupiaba Zanata, 1997**

**Remark**

An undetermined morphospecies (*Jupiaba* sp.; [Fig. 9]) is only known by three specimens collected in a single site of the Mitaraka Mountains.

**First record for the Mitaraka.** — This study.

**Occurrences.** — S2.

**Specimens in collection.** — 2 MNHN (MNHN-IC-2018-0449, MNHN-IC-2018-0450); 1 Hydreco.

**Ecology.** — Observed in a single median sized stream, in a sandy area with moderate current velocity. Captured using rotenone.

**Species code.** — JSP.
Genus *Moenkhausia* Eigenmann, 1903

*Moenkhausia moisae* Géry, Planquette & Le Bail, 1995 (Fig. 10)

First record for the Mitaraka. — This study.

**Occurences.** — S8, S9, S11.


**Distribution in French Guiana.** — Maroni and Mana drainage basins.

**Ecology.** — Observed in groups in both Alama mainstream and tributaries, in sandy areas with moderate current velocities. Captured using rotenone, seine nets and by angling. Also observed in underwater inventories.

**Species code.** — MMOI.

Family *Erythriniidae* Valenciennes, 1847

Genus *Erythrinus* Scopoli, 1777

*Erythrinus erythrinus* (Bloch & Schneider, 1801) (Fig. 11)

First record for the Mitaraka. — Keith et al. 2006.

**Occurences.** — S2, S5, S9, S10, S11, S14.


**Distribution in French Guiana.** — Widespread.

**Ecology.** — Found in pools or hidden under branches in slow flowing and standing water areas in both Alama mainstream and tributaries. Observed individuals were red bellied and had an elongated dorsal fin. Captured using rotenone and in baited traps. Also observed in underwater inventories.

**Species code.** — EERY.

Genus *Hoplias* Gill, 1903

*Hoplias malabaricus* (Bloch, 1794) (Fig. 12)

First record for the Mitaraka. — This study.

**Occurences.** — S4, S11, S12, S14.

**Specimens in collection.** — 2 MNHN (MNHN-IC-2018-0461, MNHN-IC-2018-0462); 1 Hydreco.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Found in pools or hidden under branches in slow flowing and standing water areas in both Alama mainstream and tributaries. Captured using rotenone and in baited traps. Also observed in underwater inventories.

**Species code.** — HMAL.

Family *Lebiasinidae* Gill, 1889

Genus *Copella* Myers, 1956

*Copella arnoldi* (Regan, 1912)

First record for the Mitaraka. — Keith et al. 2006.

**Occurences.** — S3, S9, S10, S12, S14.

**Specimens in collection.** — 2 MNHN (MNHN-IC-2018-0463, MNHN-IC-2018-0464); 1 Hydreco.

FIG. 11. — Erythrinus erythrinus (Bloch & Schneider, 1801). Photograph: S. Brosse.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Observed in shallow areas, near the surface and close to the banks. Captured using rotenone and observed in underwater inventories.

**Species code.** — CCAR.

Copella aff. arnoldi (Regan, 1912)

**First record for the Mitaraka.** — This study.

**Occurences.** — S12.

**Species in collection.** — None.

**Distribution in French Guiana.** — Only known from a few localities in the Maroni and the Comté drainages in French Guiana. This unnamed species is referred as *Copella aff. arnoldi* in Le Bail et al. (2012).

**Ecology.** — This rare species was only observed in a side arm channel of a rapid area of the Alama River. It was found in small rocky pools with low current velocity. Captured using rotenone.

**Species code.** — CARN.

Order Siluriformes Rafinesque, 1820

Family Cetopsideae Bleeker, 1858

Genus Cetopsideum Vari, Ferraris & de Pinna, 2005

Cetopsideum orientale (Vari, Ferraris & Keith, 2003)

**First record for the Mitaraka.** — This study.

**Occurences.** — S9, S12.

**Specimens in collection.** — 1 MNHN (MNHN-IC-2018-0465); 1 Hydreco.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Observed in both Alama mainstream and tributaries. Nocturnal species that hides during the day. Captured using rotenone.

**Species code.** — CORI.

Genus Helogenes Günther, 1863

*Helogenes marmoratus* Günther, 1963

**First record for the Mitaraka.** — This study.

**Occurences.** — S10.

**Specimens in collection.** — 1 MNHN (MNHN-IC-2018-0466); 1 Hydreco.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Observed in a single small stream site. Nocturnal species that hides during the day. Captured using rotenone.

**Species code.** — HMAR.

Family Trichomycteridae Bleeker, 1858

Genus Ituglanis Costa & Bockmann, 1993

*Ituglanis nebulosus* de Pinna & Keith, 2003 (Fig. 13)

**First record for the Mitaraka.** — Keith et al. 2006.

**Occurences.** — S6, S7.


**Distribution in French Guiana.** — Widespread.

**Ecology.** — Found in two torrential streams, with rocky substratum. Observed active during the day in pools and hidden under the rocks in fast flowing areas. Captured using rotenone and observed in underwater inventories.

**Species code.** — INEB.

Family Callichthydae Bonaparte, 1835

Genus Callichthys Scopoli, 1777

*Callichthys callithyrs* (Linnaeus, 1758) (Fig. 14)

**First record for the Mitaraka.** — This study.

**Occurences.** — S4.

**Specimens in collection.** — None.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Observed in a single small stream, in a low current velocity area. Captured using rotenone.

**Species code.** — CCAL.

Family Loricariidae Rafinesque, 1815

Genus Cteniloricaria Isbrücker & Nijsen, 1979

*Cteniloricaria platystoma* (Günther, 1868) (Fig. 15)

**First record for the Mitaraka.** — This study.

**Occurences.** — S11.

**Specimens in collection.** — None.

**Distribution in French Guiana.** — Maroni, Mana and Sinnamary basins

**Ecology.** — Found on sandy bottoms, only in Alama mainstream. Only observed in underwater inventories.

**Species code.** — CPLA.


FIG. 15. — Cteniloricaria platystoma (Günther, 1868). Photograph: F. Melki.
Genus Harttia Steindachner, 1877

_Harttia guianensis_ Rapp Py-Daniel & Olivieira, 2001 (Fig. 16)

**First record for the Mitaraka.** — This study.

**Occurrences.** — S11.

**Specimen in collection.** — None.

**Distribution in French Guiana.** — Widespread between Maroni and Approuague rivers.

**Ecology.** — Species living on rocks, only in Alama mainstream. Only observed in underwater inventories.

**Species code.** — HGUI.

Genus Ancistrus Kner, 1854

_Ancistrus temminckii_ (Valenciennes, 1840) (Fig. 17)

**First record for the Mitaraka.** — This study.

**Occurrences.** — S11.

**Specimen in collection.** — None.

**Distribution in French Guiana.** — Only known from the Maroni river drainage.

**Ecology.** — Only found in Alama mainstream, on flooded woods in medium flow areas. Only observed in underwater inventories.

**Species code.** — ATEM.

Genus Guyanancistrus Isbrücker, 2001

_Guyanancistrus megastictus_ Fisch-Muller, Mol & Covain, 2018 (Fig. 18)

**First record for the Mitaraka.** — Fisch-Muller _et al._ 2018.

**Occurrences.** — S1, S3, S11, S12.


**Distribution in French Guiana.** — Restricted to the Mitaraka Mountains.

**Ecology.** — Found in both Alama mainstream and tributaries. Species living mainly on rocks but also found on flooded woods. Captured using rotenone and observed in underwater inventories.

**Species code.** — GMEG.

Genus Batrochoglanis Gill, 1858

_Batrochoglanis raninus_ (Valenciennes, 1840)

**First record for the Mitaraka.** — This study.

**Occurrences.** — S2.

**Specimens in collection.** — 2 MNHN (MNHN-IC-2018-0481, MNHN-IC-2018-0482); 1 Hydreco.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Found in a single small stream site. Captured using rotenone.

**Species code.** — BRAN.

Genus Heptapterus Bleeker, 1858

_Heptapterus bleekeri_ Boesman, 1953

**First record for the Mitaraka.** — This study.
Fig. 16. — Hartia guianensis Rapp Py-Daniel & Oliveira, 2001. Photograph: F. Melki.

Fig. 17. — Ancistrus temminckii (Valenciennes, 1840). Photograph: F. Melki.

Fig. 18. — Guyanancistrus megastictus Fisch-Muller, Mol & Covain, 2018. Photograph: F. Melki.
**Pimelodella geryi** Hoedeman, 1961
(Fig. 19)

*First record for the Mitaraka.* — This study.

**Occurences.** — S10, S11.

**Specimen in collection.** — None.

**Distribution in French Guiana.** — Widespread.

**Ecology.** — Only observed in the Alama mainstream. Nocturnal species that hides during the day. Captured using rotenone and observed in underwater inventories.

**Species code.** — PGER.

**Pimelodella procera** Mees, 1983
(Fig. 20)

*First record for the Mitaraka.* — This study.

**Occurences.** — S4, S5, S11, S12, S14.


**Distribution in French Guiana.** — Only known from headwater streams of the Maroni drainage basin.

**Ecology.** — Observed in both Alama mainstream and tributaries, widespread in the Mitaraka area. Underwater observations revealed this species was active during the day contrary to the other species of *Pimelodella*. Captured using rotenone and observed in underwater inventories.

**Species code.** — PPRO.

**Rhamdia quelen** (Quoy & Gaimard, 1824)

*First record for the Mitaraka.* — This study.

**Occurences.** — S4, S10, S12.
Fishes of the Mitaraka Mountains

ECOLOGY. — Observed in both Alama mainstream and large tributaries. This nocturnal species hides in the undercut banks during the day. Captured using rotenone and observed in underwater inventories.

SPECIES CODE. — EVIR.

Genus *Sternopygus* Müller & Troschel, 1849

*Sternopygus macrurus* (Bloch & Schneider, 1801)

**FIRST RECORD FOR THE MITARAKA.** — This study.

**OCCURRENCES.** — S8, S9, S10, S11.

**SPECIMENS IN COLLECTION.** — 2 MNHN (MNHN-IC-2018-0513, MNHN-IC-2018-0514); 1 Hydreco.

**DISTRIIBUTION IN FRENCH GUIANA.** — Widespread.

ECOLOGY. — Observed in both Alama mainstream and tributaries. This nocturnal species hides in the undercut banks and in submersed tree roots during the day. Captured using rotenone.

SPECIES CODE. — SMAC.

Order CYPRINODONTIFORMES Berg, 1940

Family *RIVULIDAE* Myers, 1925

Genus *Anablepsoides* Huber, 1992

*Anablepsoides gaucheri*

(Keith, Nandrin & Le Bail, 2006)

(Fig. 21)

**FIRST RECORD FOR THE MITARAKA.** — Keith *et al.* 2006.

**OCCURRENCES.** — S1, S2.


**DISTRIBUTION IN FRENCH GUIANA.** — Only known from the Mitaraka Mountains. This species might be a junior synonym of *Kryptolebias sepia* Vermeulen & Hrbek, 2005, known from the Tapawahoni River (Maroni drainage) in Surinam (Vermeulen 2015).
ECOLOGY. — Observed in small to median sized streams, close to the bank in shallow areas. Captured using rotenone.

SPECIES CODE. — AGAU.

Genus *Laimosemion* Huber, 1999

*Laimosemion geayi* (Vaillant, 1889)  
(Fig. 22)

FIRST RECORD FOR THE MITARAKA. — This study.

OCCURRENCES. — S2, S4, S11, S14.


DISTRIBUTION IN FRENCH GUIANA. — Maroni, Mahury, Approuague, and Oyapock drainages.

ECOLOGY. — Observed in small and shallow streams with low current velocities and in the flooded forest areas of larger streams. Captured using rotenone.

SPECIES CODE. — LGEA.

Order *PERCIFORMES* Bleeker, 1859  
Family *CICHLIDAE* Bonaparte, 1835  
Genus *Aequidens* Eigenmann & Bray, 1894

*Aequidens tetramerus* (Heckel, 1840)  

FIRST RECORD FOR THE MITARAKA. — This study.

OCCURRENCES. — S11, S12.

SPECIMEN IN COLLECTION. — None.

DISTRIBUTION IN FRENCH GUIANA. — Widespread.

ECOLOGY. — Observed only in the Alama mainstream, in low current velocity areas. Captured using rotenone.

SPECIES CODE. — ATET.

Genus *Crenicichla* Heckel, 1840

*Crenicichla albopunctata* Pellegrin, 1904  
(Fig. 23)

FIRST RECORD FOR THE MITARAKA. — This study.

OCCURRENCES. — S8, S11.

SPECIMEN IN COLLECTION. — None.

DISTRIBUTION IN FRENCH GUIANA. — Known from Maroni, Mana, Mahury, and Approuague drainages.

ECOLOGY. — Observed in both Alama mainstream and tributaries, in low current velocity areas. Captured using rotenone and observed in underwater inventories.

SPECIES CODE. — CALB.

DISCUSSION

The fish fauna from the Mitaraka Mountains included 38 species, which was lower than the fish species diversity recorded in similar size pristine rainforest streams. For instance, Brosse *et al.* (2011) counted 69 species from nine lowland and headwater tributaries of the Arataye river in the center part of French Guiana. Similarly, 58 species were collected in a set of 10 sampling sites from lowland, mountain and headwater tributaries of the Limonade river, in a highly comparable environmental context to this study (similar altitude, spatial extent and size of the main river).
Such a low richness might be explained by the upstream position of the sampling sites in the Maroni basin, limiting therefore fish dispersal between tributaries (Brown & Swan 2010; Schmera et al. 2018). Dispersal limitation is indeed known as one of the main processes determining the species composition in local fish faunas of Guianese streams (Cilleros et al. 2016). This dispersal limitation effect is also confirmed by the marked species turnover between sites, even within a similar environmental context. For instance, the small and shallow sites (depth ≤ 11 cm and width ≤ 2 m; S4, S5, S12, S13, S14) have a dissimilarity of 77.2% ± 8.4% (mean ± SD, Jaccard dissimilarity index).

We identified four types of fish assemblages in relation to the physical characteristics of the streams. The two torrential streams, S6 and S7 (type 4), both located on the same tributary, are characterised by an unusual fish fauna made of a single Trichomycteridae species (*I. nebulosus*). Although this species has already been reported from both floodplain and mountain headwater streams (De Pinna & Keith 2003; Mol et al. 2007; Brosse et al. 2013), it is unusual to record a stream assemblage made of a single species. This is quite surprising since the torrential hydrology of this stream (see Fig. 24 for a picture of the stream) appears as a favourable habitat for a few other species as predicted by the stream fish typology of Cilleros et al. (2017). Moreover, Mol et al. (2007) and Brosse et al. (2013) reported the presence of several Loricaridae (e.g. *Guyanancistrus* and *Harttiella*), and/or Rivulidae (e.g. *Anablepoides* or *Laimosemion*) from similar torrential streams in French Guiana and Suriname.
In contrast, small and shallow streams with lower current velocities (type 1) were colonised by more diverse assemblages and host 6.80 ± 3.96 species. These species are able to inhabit shallow waters (e.g. Lamosemion geayi; Keith et al. 2000) and to survive to temporary drying by air breathing while sheltering in relictual water pools (e.g. G. carapo, H. malabaricus Liem et al. 1984; Rantin et al. 1992). Larger and deeper streams (type 2 and 3) have a slightly more diversified fauna with 8.00 ± 4.69 species. Those sites are dominated by characids that are more sensitive to anoxia. Finally, the Alama main stream has a more diverse fauna with 20 recorded species, including most of the species found in the above discussed large and deep tributaries, revealing an accumulation of fish species according to the distance from the source, as already reported by Cilleros et al. (2017).

Among the fish assemblages, a few rare or unknown species were recorded, such as G. megastictus, a recently described Loricariidae species (Fisch-Muller et al. 2018) which distribution appears limited to the Mitaraka Mountains. We also recorded P. procera, an endemic species from the Maroni Basin. Its previously recorded southern limit of distribution was the Nouvelle France River (Brosse et al. 2018). The occurrence of P. procera in the Mitaraka streams therefore extends its known spatial distribution of more than 100 km to the south. We also collected A. gaucheri in two localities (S1 and S2), while the species was only known from a few Alama drainage tributaries located 10 to 15 km to the west of the study sites (Keith et al. 2006). This species, only known from the Mitaraka Mountains, might be endemic from the Alama Drainage. Although probably having a restricted distribution, it occurs in several tributaries of the Alama River. Finally, three adult individuals from a large (c. 60 mm SL) unknown species belonging to the genus Jupiaba were collected in site S2. The description of this species is currently pending.

To conclude, the fish fauna of the Mitaraka Mountains, although not very diverse, includes some micro-endemic species and unusual fish assemblages. Complementary samples in the southern part of French Guiana are thus needed to complement the taxonomic knowledge of the fish fauna of French Guiana and to document the structure of Guianese mountain streams fish assemblages.
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REFERENCES

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