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Chapter 8

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Jan H. Mol and Kenneth Wan Tong You

SUMMARY

Eighteen sites near three camps along the Upper and Middle Palumeu River, Suriname, were sampled between 9 and 25 March, 2012. We recorded 94 species of fishes, and, in combination with a collection of fishes from Lower Palumeu River by Covain et al. in 2008, 128 species are now known to occur in Palumeu River. This diversity is high compared to the rest of the world, but is typical for a medium-sized river of the Guiana Shield. Alpha diversity was high in the Upper Palumeu River (71 species), while two sites in the Middle Palumeu River had low α diversity probably because they could not be assessed adequately due to high water level and strong current that reduced sampling effectiveness, especially in the rapids. We collected eleven species of fishes potentially new to science, including a *Bryconops* species with red fins, a small *Parotocinclus* catfish (*Parotocinclus* aff. *collinsae*), and a head-and-tail-light tetra (*Hemigrammus* aff. *ocellifer*). Of these eleven species, gen.nov. sp.n. aff. *Parotocinclus* was collected before in the Upper Marowijne River, but both this species and its genus are still undescribed. Two species are new records for Suriname: *Hyphessobrycon heterorhabdus* and *Laimosemion geayi*; a third and fourth species, *Ituglanis nebulosus* and *Pimelodella megalops*, may also represent new species for Suriname if their identity is confirmed. One species, *Aequidens paloemeuensis*, is endemic to Palumeu River, while an additional 6 species are endemic to the Marowijne River System, which includes Palumeu River: *Cyphocharax biocellatus*, *Semaprochilodus varii*, *Jupiaba maroniensis*, *Moenkhausia moisae*, gen.nov. sp.n. *Parotocinclus* and *Pimelodella procera*. An additional five species of Palumeu River collected by Covain et al. in 2008 are also endemic to the Marowijne River System: *Hemiodus hurault*i, *Corydoras* aff. *breei*, *Hemiancistrus medians*, *Pimelabditus moli* and *Platydoras* sp. We collected 71 species in Upper Palumeu River and tributaries (Site 1), 16 species in the Makrutu and Tapaje creeks (Site 3), and 49 species at the Kasikasima site (Site 4). The differences in the number of species among the three sites probably reflect differences in opportunity to sample effectively with seine net in shallow water at the three sites, diversity of habitat types that could be sampled at each site and total sampling time at each site. Species composition varied strongly among sites: sites 3 and 4 included large-sized fishes from the main channel of the Middle Palumeu River, while site 1 had many small-sized species of creek habitat. Overall, large top-level predators were still common in Palumeu River, indicating intact ecosystems. The primary threat to the fishes of Palumeu River is the so-called Tapajai Project, which proposes to build one or more dams in the Tapanahony River in order to divert its water via Jai Creek to Brokopondo Reservoir and thus increase power generation by the hydroelectric station at Afobaka. The dam(s) would directly affect migratory fishes, fishes of running water and creek habitats and fishes downstream of the dam(s). Several migratory fish species, which people throughout Suriname depend upon for food, may require the pristine headwaters of Southeastern Suriname for spawning, although very little is known. Furthermore, the dam(s) would effectively mix the fish faunas of the Marowijne River System and the Suriname River System, which each support distinct communities with endemic species, possibly leading to species declines or extinctions.

INTRODUCTION

Fishes are a critical source of protein to the Trio and Wayana people in villages along the Tapanahony and Palumeu rivers. They are a common and highly-valued component of many meals. Large and medium-sized fish species that are routinely eaten have local names. However, most fish species are small and often ignored by local people. However, many of these small species are highly valued in the aquarium hobby and could play an important role in the development of the area if fisheries for these species are strictly regulated. Fish species are an important component of the aquatic ecosystem. Large top-predators like anyumara (*Hoplias aimara*) (see page 19) and detritivores like kwimata (*Prochilodus* and *Semaprochilodus*) are often keystone species in aquatic ecosystems (Schindler 2007); as popular food fishes they are also most vulnerable to overfishing. Smaller fishes forage on aquatic invertebrates and serve as prey for larger fishes, caiman, and

birds. Fish excretion can be an important source of recycled nutrients readily available to nutrient-starved primary producers in tropical streams (Vanni 2002, McIntyre et al. 2007). Recycling of limiting nutrients from prey or detritus pools represents one of the dominant sources of nutrients to aquatic primary producers in many ecosystems. Thus changes in species composition and fish diversity have the potential to alter the availability of limiting nutrients to primary producers, and hence ecosystem production, in systems where fish excretion is an important nutrient source (Taylor et al. 2006, McIntyre et al. 2007, Schindler 2007). Fish diversity reflects the health of the river systems.

The Palumeu River is a large tributary of the Tapanahony River, which itself is the largest tributary of the Marowijne (Maroni) River. There is a modest amount of published information concerning the fishes of the Marowijne River System (which includes Palumeu River). Most fish surveys in the Marowijne watershed are in the Marowijne / Lawa River proper or in the Litani, Tapanahony and Oelemari tributaries (e.g., Planquette et al. 1996, Ouboter et al. 1999). Other fish collections in the Upper Marowijne River have not been published but were included in reviews (e.g. Le Bail et al. 2012, Mol et al. 2012, Mol 2012), while the important 1966-collections of King Leopold III of Belgium from the Palumeu River (housed in Brussels) have yet to be studied. Le Bail et al. (2012) mention 242 strictly freshwater fish species and 37 marine cycle species (total 279 species) for the Marowijne (Maroni) River System, while Mol et al. (2012) have 314 fish species listed for the Marowijne River System. To our knowledge, there have been two scientific fish collections in the Palumeu River: the collection by Covain et al. in 2008 in the Lower Palumeu River (unpublished; Table 8.1) and the collection of King Leopold III of Belgium in 1966 in the Lower and Middle Palumeu River (collection yet to be studied; Table 8.2). This expedition was the first to collect fishes in the Upper Palumeu River, and will serve as a baseline for subsequent aquatic biodiversity studies.

STUDY SITES AND METHODS

Eighteen sites near three camps were sampled between 9 and 25 March 2012. Fishes were collected with a 3×2-meter fine-mesh seine, dip nets, 30-meter trammel nets, and hook and line. We also talked extensively with our Trio and Wayana guides about their knowledge of local fishes, and to discern what they were catching during the expedition while they were fishing for food. Every habitat was sampled with as many methods as practical in order to rapidly assess the diversity of the region and maximize the number of species observations. Rocks and woody debris were scraped. Submerged logs were cut open. Leaf litter was searched. Seines were pulled through patches of vegetation, leaf litter or submerged roots, as well as over sandy substrates. Canoes were used to travel extensively upstream and downstream from the camps. We also walked through the forest to survey

Table 8.1. Fish species collected in the period 27–31 October 2008 at Weyu Rapid and a small tributary forest creek upstream of Weyu Rapid, Lower Palumeu River, Suriname, by R. Covain, J. Montoya-Burgos, J.H. Mol and K. Wan Tong You. The forest creek was sampled with rotenone. Species marked with an asterisk were not collected during the present study.

Taxon	Weyu Rapid	Unnamed tributary of Lower Palumeu River upstream of Weyu Rapid
Characiformes		
Parodontidae		
Parodon guyanensis	x	
Curimatidae		
Cyphocharax spilurus		x
Cyphocharax sp.	x	
Prochilodontidae		
*Prochilodus rubrotaeniatus**	x	
Semaprochilodus varii	x	
Anostomidae		
Anostomus brevior		x
Hypomasticus despaxi		x
Leporinus fasciatus	x	
*Leporinus maculatus**	x	
*Leporinus nijsseni**		x
Chilodontidae		
Caenotropus maculosus	x	
Crenuchidae		
Melanocharacidium sp.	x	
Hemiodontidae		
*Hemiodus hurault**	x	
Alestidae		
Chalceus macrolepidotus	x	
Characidae		
Bryconops affinis		x
Bryconops caudomaculatus		x
Bryconops sp.	x	
Jupiaba abramoides		x
Moenkhausia aff. *intermedia**	x	
Moenkhausia oligolepis		x
Moenkhausia sp.	x	x
*Brycon pesu**	x	
Triportheus brachipomus	x	
*Acnodon oligacanthus**	x	
Myloplus rhomboidalis	x	
Myloplus rubripinnis	x	
Myloplus sp.	x	
Pristobrycon eigenmanni	x	
Pristobrycon striolatus	x	

table continued on next page

Table 8.1. *continued*

Taxon	Weyu Rapid	Unnamed tributary of Lower Palumeu River upstream of Weyu Rapid
Serrasalmus rhombeus	x	
Tometes lebaili	x	
Cynopotamus essequibensis	x	
Roeboexodon guyanensis	x	
Bryconamericus guyanensis	x	
Tetragonopterus chalceus	x	
Acestrorhynchidae		
Acestrorhynchus falcatus		x
Erythrinidae		
Erythrinus erythrinus		x
*Hoplerythrinus unitaeniatus**		x
Hoplias aimara	x	x
Hoplias malabaricus		x
Lebiasinidae		
Pyrrhulina filamentosa		x
Siluriformes		
Cetopsidae		
Helogenes marmoratus		x
Trichomycteridae		
Ituglanis amazonicus		x
Callichthyidae		
Callichthys callichthys		x
Corydoras aff. *breei**	x	x
*Corydoras guianensis**		x
*Corydoras nanus**		x
Loricariidae		
Cteniloricaria platystoma	x	
Harttia guianensis	x	
*Metaloricaria paucidens**	x	
Rineloricaria sp. nov.*		x
*Ancistrus temminckii**	x	x
Guyanancistrus brevispinis	x	
*Hemiancistrus medians**	x	
*Hypostomus tapanahoniensis**	x	
*Lithoxus planquettei**	x	
*Pseudancistrus barbatus**	x	

Taxon	Weyu Rapid	Unnamed tributary of Lower Palumeu River upstream of Weyu Rapid
Pseudopimelodidae		
*Batrochoglanis raninus**	x	
*Pseudopimelodus bufonius**	x	
Heptapteridae		
*Imparfinis pijpersi**	x	
*Pimelodella cristata**		x
*Rhamdia quelen**		x
Pimelodidae		
*Pimelabditus moli**	x	
*Pimelodus ornatus**	x	
*Pseudoplatystoma fasciatum**	x	
Doradidae		
*Doras micropoeus**	x	
Platydoras sp.*	x	
Auchenipteridae		
*Auchenipterus dentatus**	x	
Ageneiosus inermis	x	
Gymnotiformes		
Gymnotidae		
*Electrophorus electricus**		x
Gymnotus carapo		x
Sternopygidae		
Sternopygus macrurus	x	
Hypopomidae		
Hypopomus artedi		x
Perciformes		
Sciaenidae		
*Pachypops fourcroi**	x	
Cichlidae		
*Cleithracara maronii**		x
*Crenicichla multispinosa**	x	
Crenicichla gr. *saxatilis*		x
Guianacara owroewefi	x	
*Krobia itanyi**	x	x
Total number of species = 79	**53**	**31**

Table 8.2. Fish collection localities and dates of King Leopold III of Belgium and J.P. Gosse in Palumeu River, Suriname, 25 October - 8 November 1966. These collections have yet to be studied.

Fieldnumber (Station)	Locality	Date
151	Tapanahoni River at Palumeu Village	25 October 1966
151a	Palumeu River at Kasikasima	27 October 1966
152	Palumeu River at Kasikasima	28 October 1966
153	Palumeu River at Papadron Rapid	1 November 1966
154	Waloemeroe Creek, right tributary of Palumeu River	2–3 November 1966
155	rapids of Palumeu River upstream of Waloemeroe Creek	3 November 1966
156	small right tributary of Palumeu River between Trombaka Noord Rapid and Trombaka Zuid Rapid	8 November 1966
157	Palumeu River at Trombaka Noord Rapid	8 November 1966

creeks, mountain brooks and a waterfall. Many individuals were released, but representative specimens were preserved in 4% formalin and later transferred to 70% ethanol for long-term storage at the National Museum of Natural History, Smithsonian Institution, in Washington, DC, USA.

Figure 8.1. A 50-m high waterfall in a right tributary of Upper Palumeu River was the collection site of a diverse fish fauna including many interesting characoids and loricariid and trichomycterid catfishes that are either new to science or collected for the first time in Suriname.

For convenience sake we distinguish a lower section of Palumeu River (including Weyu Rapid), a middle section (including the large Tronbaka and Papadron rapid complexes and sites 3 and 4) and an upper headwater section (upstream of Tapaje Creek, site 1; strongly meandering and mostly without rapids). Fishes were collected in the Upper and Middle Palumeu River near three camp sites: first the headwaters of Palumeu River and tributary forest creeks at basecamp (site 1), secondly the large Makrutu and Tapaje tributaries, upstream of the Papadron Rapid (site 3), and finally the Middle Palumeu River in the reach between the Papadron and Tronbaka rapid complexes and some mountain brooks crossing the trail up the Kasikasima Mountain (site 4).

At site 1 the Upper Palumeu River is a narrow (10–15 m wide), shallow, and strongly meandering stream with characteristics of a medium-sized forest creek without rapids. The headwaters of Palumeu River have large amounts of woody debris (fallen trees) which make navigating the river difficult and time consuming. Downstream of basecamp, the inner bends of the river have remarkable herbaceous shore vegetation that is inundated during high water levels; upstream of basecamp, the river runs mostly under a closed forest canopy and is very shallow (mainly <2 m water depth). Considerable areas of riparian forest are flooded during high-water levels (e.g. our basecamp and trail to the helicopter pad). No people were seen, but apparently our camp site is also used by Trios from Brazil when they travel to Palumeu Village and Weyu Rapid. Fishes were collected in the main channel of the river with seine, trammel nets and hook-and-line, and in tributaries with seine nets. One right tributary of the Upper Palumeu River was characterized by a 50-m high waterfall (Figure 8.1) and with seine net we collected fishes both up- and downstream of this waterfall.

The Makrutu and Tapaje creeks (site 3) are rather large (70–100 m stream width) and deep (>2 m) tributaries of the Palumeu River which are better described as small rivers (at the confluence with Palumeu River they are both of

approximately the same size as the Palumeu River itself); they were fished mainly with trammel nets and hook-and-line. The lower Makrutu Creek had extensive herbaceous shore vegetation of *Montrichardia* sp. (Sur. mokomoko) while Tapaje Creek had high dryland forest (terra firme) along its banks. A rapid complex and river island were situated immediately downstream of the confluence of Makrutu Creek and Palumeu River. No people were seen in the area. At this point along the river course the Palumeu River no longer has any true meanders and extensive flood plains, but instead the channel tends to follow troughs that coincide with joints and faults in the rock (thus irregular and angular bends).

Site 4 (Kasikasima) was situated in the middle reach of the Palumeu River, between the large Papadron and Tronbaka rapid complexes. There is a small village on the right bank of the Palumeu River, i.e. opposite our camp site, and a transit tourist camp (for the ascent of Kasikasima Mountain) approximately 2 km downstream of our camp. We fished in the main channel of the river with trammel nets and hook-and-line, but heavy rains created high water-level and strong current which limited sampling effectiveness in the rapids (see below). With seine nets we fished in a small lowland tributary near our camp and in three mountain brooks crossing the trail to Kasikasima.

RESULTS AND DISCUSSION

We recorded 94 species of fishes in the Upper and Middle Palumeu River (Appendix 8.1). This is typical for the interior of Suriname and nearby parts of the Guiana Shield; for example, the Coppename RAP survey recorded 112 species (Mol et al. 2006), the Sipaliwini/Kutari RAP survey recorded 99 species (Willink et al. 2011), the Oelemari River yielded 102 species (Ouboter et al. 1999), and a similar rapid assessment of the upper Essequibo River yielded 110 species (P.W. Willink et al. *unpublished data*). Although fish collection in the Upper Palumeu River and tributaries (site 1) was relatively effective, the Middle Palumeu River (sites 3 and 4) was certainly not adequately sampled due to high water levels in the river. Rapids and large tributaries (Makrutu and Tapaje creeks) have not been adequately sampled during the present study. A fish collection from the Lower Palumeu River in and near Weyu Rapid by Covain et al. (October 2008) (Table 8.1) yielded 34 fish species that were not collected during the present RAP survey: *Prochilodus rubrotaeniatus, Leporinus maculatus, Leporinus nijsseni, Hemiodus hurault, Moenkhausia* aff. *intermedia, Brycon pesu, Acnodon oligacanthus, Hoplerythrinus unitaeniatus, Corydoras* aff. *breei, Corydoras guianensis, Corydoras nanus, Metaloricaria paucidens, Rineloricaria* sp.n., *Ancistrus temminckii, Hemiancistrus medians, Hypostomus tapanahoniensis, Lithoxus planquettei, Pseudancistrus barbatus, Batrochoglanis raninus, Pseudopimelodus bufonius, Imparfinis pijpersi, Pimelodella cristata, Rhamdia quelen, Pimelabditus moli, Pimelodus ornatus, Pseudoplatystoma fasciatum, Doras micropoeus, Platydoras* sp., *Auchenipterus dentatus, Electrophorus electricus, Pachypops fourcroi, Cleithracara maronii, Crenicichla multispinosa*, and *Krobia itanyi*. Many, but not all, of these fish species live in rapids and most are expected to occur in the Middle Palumeu River. Combining the collections of October 2008 and the present RAP collection we arrive at a species list for Palumeu River of 128 fish species. This diversity is high compared to the rest of the world, but is typical for the Guiana Shield. Although the number of species collected in Palumeu River is thus comparable to the number of species collected in other rivers of the Guiana Shield, the species that were actually collected are only partly the same as those collected in, for example, Coppename River or Sipaliwini River. It is probably safe to state that all large rivers of the Guiana Shield have some fish species that are endemic to that specific river (see Le Bail et al. [2012] for French Guiana and Mol et al. [2012] for Suriname). The Palumeu River is part of the Marowijne River System and seven species we collected during the present study are endemic for that river system, but only one of these species, *Aequidens paloemeuensis*, is endemic to the Palumeu River proper (see below).

We collected eleven species of fishes potentially new to science, including a *Bryconops* species with red fins (photograph in Mol 2012 and page 22), a small *Parotocinclus* catfish with a *Microglanis*-like pigmentation pattern (*P.* aff. *collinsae*, Figure 8.2a), a head-and-tail-light tetra (*Hemigrammus* aff. *ocellifer*) (see page 23) with a black midlateral line running from the caudal spot to a vertical line through the beginning of the dorsal fin (photograph in Mol 2012). The other potentially new species are *Characidium* sp. (see page 22), *Ituglanis* sp., *Eigenmannia* sp. 2, *Rivulus* sp., *Jupiaba* sp., *Pimelodella* sp. (see page 22), gen.nov. sp.n. aff. *Parotocinclus,* and *Hyphessobrycon* sp. (heterorhabdus group) (see page 23). The *Eigenmannia* species (photograph in Mol 2012) was initially recognized on a previous RAP survey in the Coppename River (Willink and Sidlauskas 2006), and appears to be more widely distributed throughout Suriname's interior than originally thought (see Willink et al. 2011). The species gen.nov. sp.n. aff. *Parotocinclus* was collected before in the Upper Marowijne River (e.g. Le Bail et al. 2000), but both the species and its genus are still not described formally. A small ancistrine catfish with a striking dark dorsolateral pigmentation pattern on its head (collected at site 1 in a pool below a waterfall; Figure 8.1) was identified as postlarval *Guyanancistrus brevispinis* by S. Fisch-Muller (Museum National d'Histoire Naturelle, Genève, Switzerland) and thus not a new species. The number of eleven new species is typical for Neotropical rivers that have not been well surveyed by fish biologists.

Two species, *Hyphessobrycon heterorhabdus* (see page 23) and *Laimosemion geayi*, were new records for the country of Suriname (Mol et al. 2012; photographs in Mol 2012). *Laimosemion geayi* was previously only known from French Guiana and Brazil to the east of Suriname, while *H. heterorhabdus* was previously only known to occur in the Lower

and Middle Amazon River to the south of Suriname (Géry 1977); however, *H. heterorhabdus* is also known from southwestern French Guiana (P.Y. Le Bail, pers. communication). Two additional species, *Ituglanis* cf. *nebulosus* (Fig. 8.2b) and *Pimelodella* cf. *megalops*, may also represent new records for Suriname if their identity can be confirmed; *Ituglanis nebulosus* is only known from its type locality in the Approuague River and Sinnamary River in French Guiana (De Pinna & Keith 2003, Le Bail et al. 2012) and we were not able to examine specimens of *I. nebulosus*; *Pimelodella megalops* is known from both Guyana (Eigenmann 1912) and French Guiana (Le Bail et al. 2012). We encountered seven fish species known only from the (Upper) Marowijne River System (i.e. endemic to the Marowijne River System): *Aequidens paloemeuensis*, *Cyphocharax biocellatus*, *Jupiaba maroniensis*, *Moenkhausia moisae*, gen.nov. sp.n. aff. *Parotocinclus* (see Le Bail et al. 2000, p. 262), *Pimelodella procera* and *Semaprochilodus varii*. Five other endemics of the Marowijne River System were collected by Covain et al. (2008) in the Palumeu River (Table 8.1): *Hemiodus hurault*i, *Corydoras* aff. *breei*, *Hemiancistrus medians*, *Pimelabditus moli* and *Platydoras* sp. The cichlid *A. paloemeuensis* seems restricted to its type locality and is the only species of these that is endemic to the Palumeu River proper.

We collected 71 species in Upper Palumeu River and tributaries (site 1), 16 species in the Makrutu and Tapaje creeks (site 3), and 49 species at the Kasikasima site (site 4) (Appendix 8.1). The differences in the number of species collected among the three sites probably reflect differences in opportunity to sample effectively with seine net in shallow water at the three sites, diversity of habitat types that could be sampled at each site and total sampling time at each site. The shallow (creek-like) Upper Palumeu River and its tributaries at site 1 were sampled easily with seine net and trammel nets in the main channel. The deep (river-like) Makrutu and Tapaje creeks (site 3) could only be sampled with trammel nets and hook-and-line, while site 4 included a few small creeks that could be sampled by seine besides the main channel of Middle Palumeu River that was sampled with trammel nets. Rapids that were present at both sites 3 and 4 could not be sampled effectively because of high water levels and strong currents.

The three sites also yielded different fish species. For example, site 1 yielded many small-sized fishes in the families Crenuchidae, Characidae, Trichomycteridae and Loricariidae that were not present at the other two sites, but the large predator *Hoplias aimara* was also common in the main channel of the meandering Upper Palumeu River. Especially interesting was the diverse fish fauna up- and immediately downstream a 50-m high waterfall in a right tributary of Upper Palumeu River (Fig. 8.1) which included several potentially new species or species collected for the first time in Suriname, e.g. gen.nov. sp.n aff. *Parotocinclus*, *Parotocinclus* aff. *collinsae*, *Bryconops* sp 'red fins', *Characidium* sp., *Hyphessobrycon heterorhabdus* and *Ituglanis* cf. *nebulosus*. Other species collected at this site are rare or have a restricted distribution: *Tetragonopterus rarus*, *Creagrutus melanzonus*, *Hemibrycon surinamensis*, *Bunocephalus aloikae* , *Lithoxus surinamensis*, and *Pimelodella procera*).

The main channel of the Middle Palumeu River at sites 3 and 4 yielded some large-sized species such as *Pseudoplatystoma tigrinum*, *Tometes lebaili* , *Semaprochilodus varii*, *Serrasalmus rhombeus* and *Brycon falcatus* (Fig. 8.3) that were absent from the headwaters. The tiger catfish *P. tigrinum* and the kwimata *S. varii* may be migratory species, while the pacu *Tometes lebaili* is endemic to the Marowijne River System. The mountain brooks crossing the trail to Kasikasima (site 4) yielded some small or medium-sized species characteristic of ephemeral streams: *Microcharacidium eleotrioides*, *Astyanax bimaculatus*, *Erythrinus erythrinus*, *Copella arnoldi*, *Pyrrhulina filamentosa*, *Callichthys callichthys*, *Helogenes marmoratus* , and three rivulines *Laimosemion geayi* , *Rivulus* aff. *holmiae* and *Rivulus* sp. (the latter potentially new to science).

Overall, large top-level predators like anyumara (*H. aimara*) were common in the Upper Palumeu River (site 1), an area that is difficult to access. Large piscivores were also present at sites 3 and 4, but at these sites their abundance was difficult to assess due to high water levels. In pristine environments, these types of fishes are abundant, but they are the first to disappear when there is excessive fishing pressure (Mol et al. 2006).

The primary threat to the fishes of the Palumeu River is the so-called Tapajai Project, which proposes to build one or more dams in the Middle Tapanahony River in order to divert its water via Jai Creek to Brokopondo Reservoir and thus increase power generation by the hydroelectric station at Afobaka. A recent study of the long-term impacts of the hydroelectric dam at Afobaka on the fish fauna of the Middle Suriname River (Mol et al. 2007) showed that out of

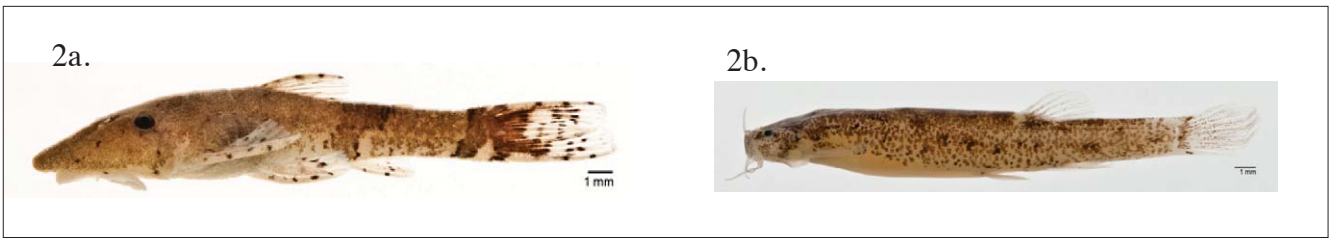

Figure 8.2. Two interesting fish species collected in a tributary of Upper Palumeu River. **A.** A potentially new *Parotocinclus* species (*P.* aff. *collinsae*) with a *Microglanis*-like pigmentation pattern. **B.** *Ituglanis* cf. *nebulosus* collected for the first time in Suriname. (photographs by Sandra Raredon, National Museum of Natural History, Smithsonian Institution)

172 species known from the Middle Suriname River before construction of the dam in 1964 only 41 fish species survived in Brokopondo Reservoir and that migratory species such as *Prochilodus rubrotaeniatus* no longer occurred downstream of the dam. Both *Prochilodus rubrotaeniatus* and the related *Semaprochilodus varii* occur in the Marowijne River System, which includes the Palumeu River. *Prochilodus* are keystone species in Neotropical rivers (Taylor et al. 2006), while *Semaprochilodus varii* is endemic to the Marowijne River system. Diversion of Tapanahony water to Brokopondo Reservoir would also (1) severely diminish the flow in the Marowijne River with consequent significant changes in aquatic habitats such as the area of flooded riparian forest and likely the fish fauna downstream of the reservoir and (2) effectively connect the Marowijne and Suriname river systems, each with their own endemic species (Mol et al. 2012). Mixing of these faunas may well lead to an ecological disaster, i.e. the introduction of Marowijne endemics into the Suriname River and *vice versa*, because changes in species interactions could lead to massive species declines or extinctions. We are unaware of any imminent plans for logging or (gold) mining in the area, but both would have negative impacts on the fish fauna by increasing erosion and sedimentation (which would affect bottom fishes and visually oriented fishes) and by decreasing the amounts of food that falls into the water, especially when the river floods. Gold mining in tributaries of the Upper and Middle Marowijne River and in the Marowijne River proper already has substantially increased turbidity from suspended sediments in the main channel: on 5 February 2012 we measured a Secchi disc transparency of only 5–10 cm in the Marowijne River near Nassau Mountains (km 105) (in 1990, Secchi transparency was >150 cm in the then still undisturbed Marowijne River). The increased turbidity (decreased transparency) in the main channel may affect long distance fish migrations in the Marowijne River and thus potentially also the migratory fishes of Palumeu River.

CONSERVATION RECOMMENDATIONS

Local communities along the Tapanahony River (including Palumeu Village) should be extensively informed about the potential impacts of the Tapajai Project on their immediate environment (including the fish fauna) so they can make rational, well-informed choices about their future with or without the Tapajai Project. The leaders of the villages should be given the opportunity to visit Brokopondo Reservoir and talk with elderly maroons who used to live in villages along the Middle Suriname River before construction of the Afobaka Dam in 1964 (and who now often live in transmigration villages, e.g. Brownsweg). Conserving the headwaters and middle reaches of the Palumeu River will be important for maintaining food for people for many years to come. Protecting forests and rivers of the upper Palumeu and other nearby headwaters in Southeastern Suriname will not only maintain the high water quality that sustains fish for people to eat downstream, but may also sustain the spawning grounds for migratory species that people depend upon. However, more research is needed to understand migratory fish behavior in Suriname.

The fishes of Palumeu River can be of interest to the aquarium hobby (*Hyphessobrycon roseus*, *Hyphessobrycon heterorhabdus*, *Hypomasticus despaxi*, *Anostomus brevior*, *Corydoras* spp., *Farlowella reticulata*, *Bunocephalus aloikae*, *Laimosemion geayi*, and many others) and sport fishers (*Hoplias aimara*, *Pseudoplatystoma tigrinum*, *Tometes lebaili*, *Brycon falcatus*) and thus generate income for local people if catches are regulated. Sustainable catch and export of aquarium fishes of the Palumeu River should be promoted.

3a.

3b.

Figure 8.3. Two large fish species of the Middle Palumeu River. **A.** Pacu *Tometes lebaili* (Serrasalminae). **B.** Tiger catfish *Pseudoplatystoma tigrinum* (Pimelodidae).

Additional actions that should be taken:

1. Assess which fish species from the Palumeu River are used for food.
2. Determine amount caught and eaten.
3. Study life-history of these species to determine how fast they reproduce and grow.
4. Determine the amount of fish that can be sustainably harvested, both for food fishes and aquarium fishes.
5. Set catch limits and/or seasons if necessary to avoid overfishing.

In addition, it is recommended to create picture guides of fishes, especially colorful species and fun-to-catch species, in order to increase appreciation and knowledge of fishes. These guides can be used to promote ecotourism. In collaboration with METS ecotourism organization, we suggest setting up and maintaining a few aquariums in Palumeu Village with fishes of the river for the benefit of both local school children and ecotourists. Both guides and aquariums will increase understanding of the fish fauna of Palumeu River and thus promote conservation of the aquatic habitat and the fish fauna.

The collection of eleven potentially new fish species in the Upper and Middle Palumeu River under unfavorable (high-water) conditions during the present study and the absence of many fish species from the rapids in the present collection (as is clear from a comparison of the present collection with that of Covain et al. in October 2008) both indicate a richer fish fauna in Palumeu River than the fish fauna that is currently known (i.e. 128 species from the RAP collection and the collection of Covain et al 2008). In order to arrive at a more complete list of the fish fauna of Palumeu River we recommend:

Additional scientific surveys are necessary to document the fish biodiversity. There are species present that we did not collect (see for example Table 8.1), and there could be new species to science yet to be discovered. Additional surveys should be conducted at different times of the year, but especially when river levels are lower; and collection efforts should be aimed mainly at the major rapid complexes and the main river channel and tributaries in middle reaches of the Palumeu River.

The 1966-collections of King Leopold III of Belgium and J.P Gosse in Palumeu River (Table 8.2) should be studied. These collections, which include collections in the large Trombaka and Papadron rapid complexes during the dry (low-water) season (27 October – 8 November 1966), are housed in Brussels and have not been studied as far as we know (Richard Vari, Smithsonian Institution, American Museum of Natural History, *personal communication*).

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Appendix 8.1. List of fish species recorded in the Upper and Middle Palumeu River, Suriname.

Taxon	Upper Palumeu River (basecamp, site 1) n = 9	Makrututu and Tapaje Creeks (Site 3) n = 3	Middle Palumeu River and mountain streams (Site 4) n = 6
Characiformes			
Parodontidae			
Parodon guyanensis	3	2	0
Curimatidae			
Cyphocharax biocellatus	8	0	5
Cyphocharax helleri	3	0	10
Cyphocharax spilurus	0	0	1
Prochilodontidae			
Semaprochilodus varii	0	0	1
Anostomidae			
Anostomus brevior	16	0	2
Hypomasticus despaxi	1	0	14
Leporinus fasciatus	0	0	1
Leporinus friderici	4	4	0
Leporinus gossei	0	0	1
Chilodontidae			
Caenotropus maculosus	1	0	0
Crenuchidae			
Characidium zebra	24	0	0
Characidium sp. A	13	0	0
Melanocharacidium blennioides	10	0	0
Melanocharacidium dispilomma	13	0	0
Microcharacidium eletrioides	0	0	6
Hemiodontidae			
Bivibranchia bimaculata	0	0	3
Alestidae			
Chalceus macrolepidotus	7	0	0
Characidae			
Astyanax bimaculatus	0	0	1
Bryconops affinis	4	0	0
Bryconops caudomaculatus	37	4	0
Bryconops melanurus	2	0	28
Bryconops sp. (red fins)	35	0	0
Hemigrammus aff. *ocellifer*	18	0	3
Hyphessobrycon heterorhabdus	15	0	0
Hyphessobrycon sp. (heterorhabdus grp.)	0	0	2
Hyphessobrycon roseus	82	0	12
Jupiaba abramoides	7	0	0
Jupiaba keithi	6	0	2
Jupiaba maroniensis	1	3	1
Jupiaba sp. A	3	0	0
Moenkhausia georgiae	1	0	0
Moenkhausia grandisquamis	0	0	1
Moenkhausia inrai	0	0	7

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Appendix 8.1. *continued*

Taxon	Upper Palumeu River (basecamp, site 1) n = 9	Makrututu and Tapaje Creeks (Site 3) n = 3	Middle Palumeu River and mountain streams (Site 4) n = 6
Moenkhausia moisae	9	0	4
Moenkhausia oligolepis	9	0	3
Brycon falcatus	0	1	0
Triportheus brachypomus	3	0	1
Myloplus rhomboidalis	0	1	2
Myloplus rubripinnis	2	4	2
Myloplus ternetzi	14	0	2
Mylopus sp (juvenile)	8	1	0
Pristobrycon eigemanni	62	8	2
Pristobrycon striolatus	0	4	3
Serrasalmus rhombeus	0	24	1
Tometus lebaili	0	0	1
Cynapotamus essequibensis	18	0	0
Phenacogaster wayana	79	0	3
Roeboexodon guyanensis	1	0	2
Poptella brevispina	12	0	0
Tetragonopterus chalceus	8	3	4
Tetragonopterus rarus	3	0	0
Bryconamericus guyanensis	0	1	0
Creagrutus melanzonus	52	0	0
Hemibrycon surinamensis	10	0	0
Acestrorhynchidae			
Acestrorhynchus falcatus	2	0	0
Acestrorhynchus microlepis	4	0	1
Erythrinidae			
Erythrinus erythrinus	0	0	1
Hoplias aimara	8	1	3
Hoplias malabaricus	1	0	0
Hoplias sp (juvenile)	3	0	0
Lebiasinidae			
Copella arnoldi	4	0	14
Nannostomus bifasciatus	23	0	4
Pyrrhulina filamentosa	0	0	2
Siluriformes			
Cetopsidae			
Helogenes marmoratus	0	0	1
Aspredinidae			
Bunocephalus aloikae	4	0	0
Trichomycteridae			
Ituglanis amazonicus	4	0	0
Ituglanus cf. *nebulosus*	15	0	0
Ituglanis sp. A	1	0	0
Ochmacanthus sp.	1	0	0

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Appendix 8.1. *continued*

Taxon	Upper Palumeu River (basecamp, site 1) n = 9	Makrututu and Tapaje Creeks (Site 3) n = 3	Middle Palumeu River and mountain streams (Site 4) n = 6
Callichthyidae			
Callichthys callichthys	1	0	1
Loricariidae			
Otocinclus mariae	3	0	0
Gen.nov. sp.n aff. *Parotocinclus*	34	1	0
Parotocinclus aff. *collinsae*	3	0	0
Cteniloricaria platystoma	1	0	0
Farlowella reticulata	3	0	0
Harttia guianensis	9	0	0
Ancistrus aff. *hoplogenys*	13	0	0
Guyanancistrus brevispinis	8	0	0
Lithoxus surinamensis	10	0	0
Pseudopimelodidae			
Microglanis poecilus	32	0	0
Heptapteridae			
Pimelodella cf. *megalops*	1	0	0
Pimelodella procera	12	0	0
Pimelodella sp. A	4	0	0
Pimelodidae			
Pseudoplatystoma tigrinum	0	2	0
Auchenipteridae			
Ageneiosus inermis	52	5	2
Gymnotidae			
Gymnotus carapo	1	0	1
Sternopygidae			
Sternopygus macrurus	1	0	0
Eigenmannia sp. 2	1	0	0
Hypopomidae			
Hypopomus artedi	2	0	1
Perciformes			
Cichlidae			
Aequidens paloemeuensis	4	0	1
Crenicichla albopunctata	14	0	0
Crenicichla sp (juvenile)	2	0	1
Guianacara owroewefi	60	0	27
Cyprinodontiformes			
Rivulidae			
Laimosemion geayi	0	0	7
Rivulus aff. *holmiae*	0	0	4
Rivulus sp. A	0	0	4
Total 94 species	71 species	16 species	49 species