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Chapter 5

Aquatic Biota: Fishes, Decapod Crustaceans and Mollusks of the Upper Essequibo Basin (Konashen COCA), Southern Guyana

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SUMMARY

During the period from October 15 -26, 2006, a rapid assessment of the aquatic ecosystems of the Acarai Mountains and Sipu, Kamoa and Essequibo rivers upstream from the Amaci Falls, Konashen Indigenous District of Southern Guyana was conducted. We studied fishes, crustaceans and mollusks at 18 sampling stations within five focal areas: 1) Focal Area 1 – Sipu River; 2) Focal Area 2 – Acarai Mountains; 3) Focal Area 3 – Kamoa River; 4) Focal Area 4 – Wanakoko Lake/Essequibo River; and 5) Focal Area 5 – Essequibo River at Akuthopono and Masakenari Village. A total of 113 species of fish were identified, representing six orders and 27 families. The order Characiformes (tetras, piranhas, etc.) with 61 species (51.7%) was the most diverse, followed by Siluriformes (catfishes) with 32 species (27.1%), Perciformes (cichlids, drums) and Gymnotiformes (electric or knife fishes) with nine species each (15.3% respectively), and Cyprinodontiformes (killifishes) and Synbranchiformes (eels), both with one species (0.8%, respectively). Family Characidae contributed the most species, with 31 species collected (27.4%), followed by Loricariidae with 13 species (11.5%); Cichlidae with 8 species (7.1%); Crenuchidae, Curimatidae, Anostomidae and Heptapteridae with 5 species each (4.4%, respectively), and Auchenipteridae, Callichthyidae and Erythrinidae, with 4 species each (3.5% respectively). The 17 remaining families represented a combined total of 29 species (25.7%). Focal Area 5 exhibited the highest species richness, with 53 species of the 113 identified (46.9%), followed by Focal Areas 1 and 3, with 48 and 45 species, respectively (42.58% and 39.8%), while Focal Areas 4 and 2 had 33 and 32 species, respectively (29.2% and 28.3%). According to the distribution of fish species, and based on the similarity index and physicochemical variables, Focal Areas 1 and 3 exhibited the highest similarity (0.67), and can be viewed as possessing similar ichthyological communities. The remaining Focal Areas exhibited lower values, between 0.4 and 0.26, and are therefore considered to be of moderate similarity. Nearly half of the fish species we recorded are considered important subsistence fish resources, 20% are of sport fishing interest and approximately 75% have ornamental value. Four species of fishes are considered likely to be new to science (*Hoplias* sp., *Ancistrus* sp., , *Rivulus* sp., and *Bujurquina* sp.). Ten species of aquatic macroinvertebrates were identified, belonging to three classes (Crustacea, Gastropoda, and Bivalvia), of which Crustacea was the most diverse, with three families. Of these, Pseudothelphusidae showed the highest richness, with four species, followed by Palaemonidae and Trichodactylidae with two species each. The classes Gastropoda (snails) and Bivalvia (mussels) were represented by one species each. The greatest species richness was found in Focal Areas 2 and 3, with five and six species of aquatic macroinvertebrates respectively, whilst three species were collected in each of the remaining focal areas, except for Focal Area 5 where four species were recorded.

INTRODUCTION

With 700 known fish species, Guyana is arguably the best studied country in the Guayana Shield from an ichthyological perspective, followed by French Guiana. However, within Guyana there is still a scarcity of information as many regions remain unstudied (Lasso et al. 2003). Initial studies were carried out by North American ichthyologist Carl Eigenmann at the turn of the century, and covered a large part of the Guyanese territory. He studied eight localities in the Lower Essequibo and published the results in a comprehensive summary in 1912. Much later, Watkins et al. (1997) and Hardman et al. (2002) collected again at the Lower Essequibo and compiled an updated study, compiling a list of nearly 400 species for the basin of the Lower Essequibo (Lasso 2002). Nevertheless, all these efforts were concentrated on the Lower Essequibo, while the Upper Essequibo remained virtually unstudied. In 2001, Conservation International conducted the second Rapid Assessment Program (RAP) expedition in the Eastern Kanuku Mountains, in the Lower Kwitaro River and the Upper Rewa River at Corona Falls. During this survey 113 species were documented (Mol 2002).

The present RAP expedition is the first comprehensive fish and crustacean investigation of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers upstream from the Amaci Falls. These data are new as the aquatic biota of the Essequibo's headwaters have never been studied, and the waters never before characterized. The hydrochemistry (Chapter 4) and data on the aquatic fauna from this study, coupled with a mini-survey on fishing resources of Masakenari carried out by Alexander et al. (2005) constitute a significant contribution to the knowledge of the biodiversity of Guyana.

In addition, in 2002, the Fishes and Freshwater Ecology of the Guayana Shield Conservation Priorities Consensus recognized the Acarai Mountains as a region completely unexplored biologically, and emphasized the need for surveys in the area, deeming it a conservation priority (Lasso et al. 2003).

METHODS AND STUDY SITES

During the period from October 15-26, 2006 we surveyed 18 sampling stations within five focal areas (see Table 5.1):

Focal Area 1: Sipu River: six sampling stations (GR-SR-01 to GR-SR-05 and GR-SR-08).

Focal Area 2: Acarai Mountains: three sampling stations (GR-AM-06 to GR-AM-07a, b).

Focal Area 3: Kamoa River: four sampling stations (GR-KR-09 to GR-KR-12).

Focal Area 4: Wanakoko Lake/Essequibo River: one sampling station (GR-WL-13).

Focal Area 5: Essequibo River at Akuthopono and Masakenari Village: four sampling stations (GR-AR-14 a, b; GR-PF-15; GR-MAR-16).

Table 5.1. Localities studied during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

CODE	Locality	Coordinates	Focal Area
GR-SR-01	Sipu River	1º25.558 N-58º56.958 W	AF 1
GR-SR-02	Sipu River	1º25.558 N-58º56.958 W	
GR-SR-03	Sipu River	1º42.293 N-58º95154 W	
GR-SR-04	Sipu River - small creek	1º42.340 N-58º95202 W	
GR-SR-05	Sipu River - isolated pool	1º25`05.9`` N-58º57`12.4`` W	
GR-AM-06	Acarai creek	1º42180 N-58º95221 W	AF 2
GR-AM-07a	Acarai creek marginal pool	1º42180 N-58º95221 W	
GR-AM-07b	Acarai creek	1º42180 N-58º95221 W	
GR-SR-08	Sipu River - small creek	1º38990 N-58º94486 W	AF 1
GR-KR-09	Kamoa River	1º51`51.1``N-58º49`41.9``W	AF 3
GR-KR-10	Kamoa River - small creek	1º31`46.5``N-58º49`14.7``W	
GR-KR-11	Kamoa River - small creek	1º31`48.6``N-58º48`34.5``W	
GR-KR-12	Kamoa River - small creek	1º31`42.3``N-58º49`14`W	
GR-WL-13	Wanakoko Lake - Essequibo River	1º40`41.2``N-58º37`50``W	AF 4
GR-AR-14a	Essequibo River - palm swamp Akothopono	1º65148 N-58º62367 W	AF 5
GR-AR-14b	Essequibo River - Akuthopono rocks	1º39`02.4``N-58º37`40.5``W	
GR-PF-15	Essequibo River - Akuthopono forest	1º39`02.4``N-58º37`40.5``W	
GR-MAR-16	Essequibo River - Akuthopono rapids	1º34`08.8``N-58º38`48.9``W	

Fishes and aquatic invertebrates (crustaceans and mollusks) were collected during both night and day using several methods: two gill nets were put out daily between the hours of 5:30 and 8:30 and between 17:00 and 19:00. In the small creeks we employed a 2 m seine net (height = 1.1 m, mesh size = 1 mm). In addition, we used 10 minnow traps daily to collect small fish and crustaceans. The fish team also conducted manual collecting using a dip net and, in the Essequibo rapids, medium-sized fishes were captured using a cast net. On one occasion (Acarai creek), we employed a traditional Wai-Wai technique and used a natural ichthyocide extracted from lianas of hiari (*Derris elliptica*), a plant native to Guyana. We sampled a variety of different habitat types including the main channels of rivers (open waters, littoral or river banks, pocket waters with rocks and rapids, e.g. Sipu, Kamoa and Essequibo rivers), side pools (standing waters of the Essequibo River at Wanakoko Lake), small lowland creeks (clear and black waters); mountain creeks (clear waters, e.g. foothills of Acarai Mountains), and palm swamps and seasonally dry ponds (e.g. flooded forests of lower Essequibo River near Akuthopono). We surveyed all encountered microhabitats e.g., riffles, pools, leaf litter and woody debris. In addition, we recorded underwater observations. Biophysical characteristics (general description), hydrochemical traits and georeference points were recorded for all localities sampled.

Laboratory work

Fishes were preserved in 10% formalin and later transferred to 70% ethanol. Samples were deposited in the Center for the Study of Biological Diversity of the University of Guyana, Georgetown, and a small reference collection was taken for identification to the Museo de Historia Natural La Salle, Caracas (Venezuela).

In order to establish the level of similarity of fish communities between localities, the Simpson Index of similarity was used (*RN2 = 100 (s) / N2*), where *s* is the number of species shared between both subregions or localities, and *N2* is the number of species in the subregion or locality with the lowest richness. Principal component and cluster analysis were also done, using the statistical package PAST (Hammer et al. 2001) to graphically group the localities.

RESULTS AND DISCUSSION

Fishes

Composition and species richness

During the RAP expedition to the Konashen COCA Southern Guyana, a total of 2651 specimens belonging to 113 species in six orders and 27 families were collected (Appendix 2). The order Characiformes (tetras, piranhas, etc.), with 61 species (51.7%), was the most diverse, followed by Siluriformes (catfishes), with 32 species (27.1%), Perciformes (cichlids, drums) and Gymnotiformes (electric or knife fishes), with nine species each (15.3% respectively), and finally Cyprinodontiformes (killifishes) and Synbranchiformes (eels), both with one species (0.8% respectively) (Figure 5.1). Family Characidae contributed the most species with 31 species collected (27.4%), followed by Loricariidae with

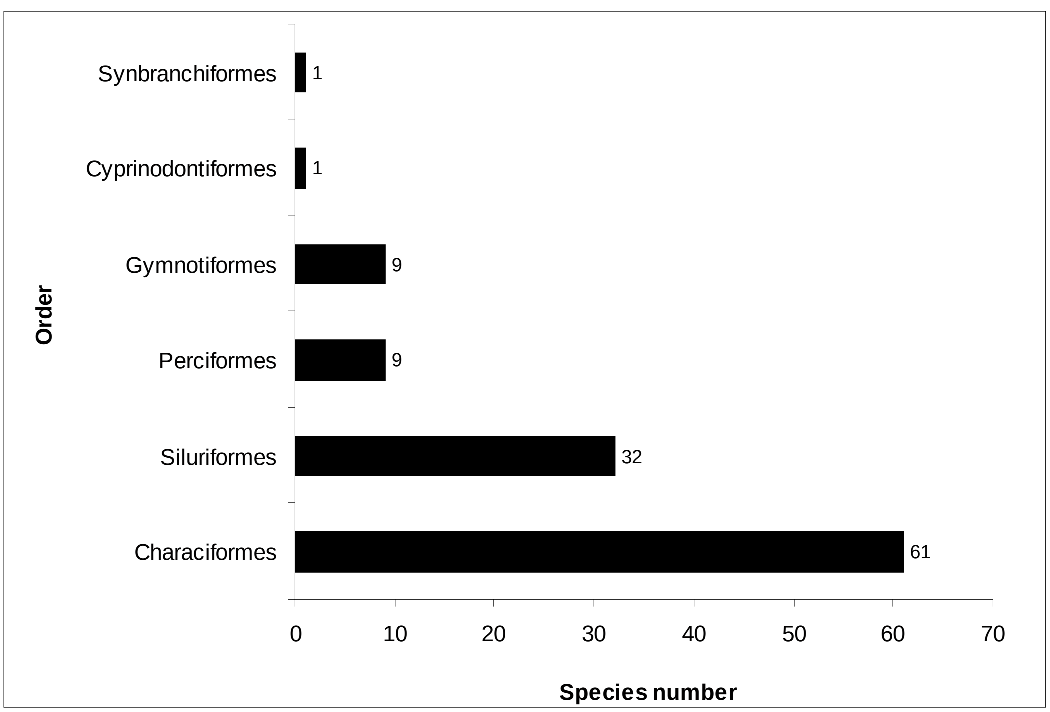

Figure 5.1. Richness of fish orders reported during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

13 species (11.5%); Cichlidae with 8 species (7.1%); Crenuchidae, Curimatidae, Anostomidae and Heptapteridae with 5 species each (4.4% respectively), and Auchenipteridae, Callichthyidae and Erythrinidae with 4 species each (3.5%, respectively). The 17 remaining families represent a combined total of 29 species (25.7% in total) (Figure 5.2).

Results for Focal Areas

In order to make comparisons of species richness, the study area was divided into five focal areas: Focal Area 1: Sipu River (SR), Focal Area 2: Acarai Mountains (AM), Focal Area 3: Kamoa River (KR), Focal Area 4: Wanakoko Lake (WL)/Essequibo River (AR, PF and MAR), and Focal Area 5: Essequibo River at Akuthopono and Masakenari Village. Focal Area 5 was found to exhibit the highest species richness, with 53 of the 113 species identified (46.9%), followed by Focal Areas 1 and 3, with 48 and 45 species respectively (42.58% and 39.8%), while Focal Areas 4 and 2 exhibited 33 and 32 species respectively (29.2% and 28.3%) (Table 5.2, Appendix 2).

Taking into account the distribution of taxa, and based on Simpson's Index of similarity, Focal Areas 1 and 3 were shown to possess the highest similarity (0.67) and can be considered to have equal, or at least most similar, ichthyological composition. The other Focal Areas exhibit lower values for this index, between 0.4 and 0.26, which can be considered as average similarity that diminishes as the value on the X-axis increases (Figure 5.3).

This distribution coincides with the behavior of physicochemical variables (Table 5.3). In the principal component analysis, the two primary ordination axes explained 89.67% of variation in the data, furthermore the variables pH and temperature were highly positively correlated (0.829), as were pH and conductivity (0.706). Figure 5.4 shows that Focal areas 4 and 5 (AF-4 and AF-5) are closely related with respect to water temperature since they possess similar average values; with respect to pH, Focal Area 4 exhibited the highest value, followed by Focal Areas 1 and 5. This is represented clearly in the graph, and is indicated by proximity of each focal area to the vector for pH. Conductivity exhibited highest values in Focal Areas 1 and 4. Focal Areas 1 and 3 exhibited highest values for dissolved oxygen. Focal Area 2 was found to be furthest from all measured vectors due to the low values recorded in the physicochemical variables of interest. Focal Areas 1 and 3 exhibited high correlation in the bi-plot since their physicochemical variables behave in a similar manner, in the same way the pairs consisting of Focal Areas 4-5 and 1-4 exhibited a medium correlation, whereas Focal Area 2 was found to be far away from these groups.

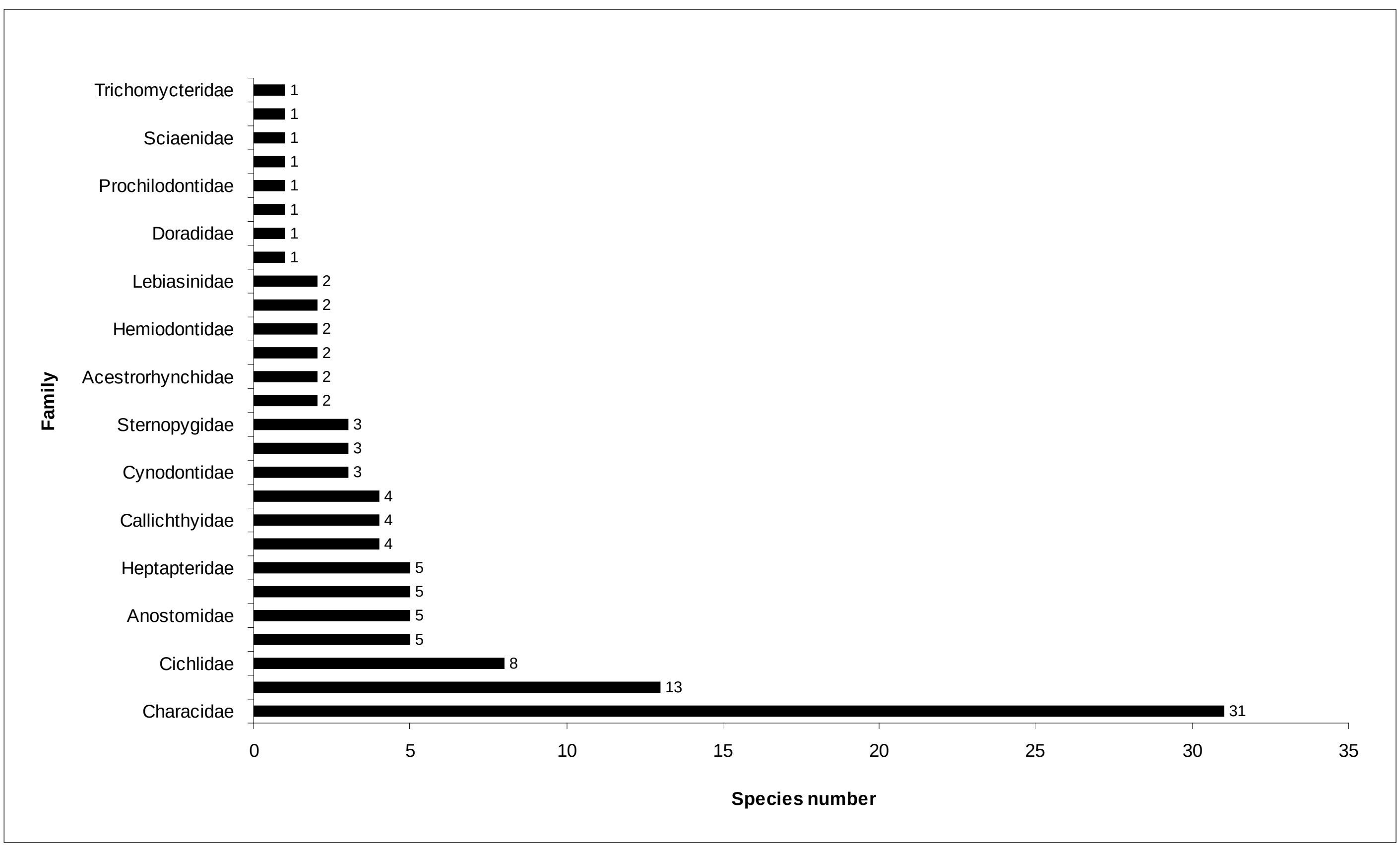

Figure 5.2. Richness of fish families reported during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

Table 5.2. Fish species richness reported from focal areas evaluated during the 2006 RAP survey of the Acarai Mountains (AM), Sipu (SR), Kamoa (KR) and Essequibo rivers (ESSEQ), and Wanakoko Lake (WL), Konashen Indigenous District of Southern Guyana.

Order	Family	SR	AM	KR	WL	ESSEQ
Characiformes	Acestrorhynchidae	2	-	2	1	-
	Anostomidae	2	3	-	1	3
	Characidae	18	9	15	13	13
	Crenuchidae	2	3	2	-	4
	Curimatidae	3	-	2	2	2
	Cynodontidae	-	-	-	3	-
	Erythrinidae	3	1	1	1	4
	Hemiodontidae	1	-	1	1	2
	Lebiasinidae	2	-	2	2	2
	Parodontidae	-	1	-	-	1
	Prochilodontidae	-	-	1	-	-
Siluriformes	Auchenipteridae	1	-	3	1	1
	Callichthyidae	1	2	-	-	2
	Cetopsidae	2	1	-	-	-
	Doradidae	-	-	-	1	-
	Heptapteridae	1	1	3	-	2
	Loricariidae	4	7	1	-	9
	Pimelodidae	-	-	2	-	-
	Trichomycteridae	-	-	1	-	1
Cyprinodontiformes	Cyprinodontidae	-	1	-	-	-
Gymnotiformes	Gymnotidae	1	-	2	-	2
	Hypopomidae	-	-	2	-	2
	Rhamphichthyidae	-	-	1	-	-
	Sternopygidae	-	1	-	1	1
Synbranchiformes	Synbranchidae	1	-	1	-	-
Perciformes	Cichlidae	4	2	3	5	2
	Sciaenidae	-	-	-	1	-
Total		**48**	**32**	**45**	**33**	**53**

Focal Areas 1 and 2

Focal Areas 1 and 2 were completely pristine and well protected within the Konashen Indigenous District of Southern Guyana. The fish sampled in these focal areas were highly abundant, and of particular interest as subsistence resources. The high abundance, coupled with the large size of the fish that were collected and/or observed, indicate that the Sipu River and Acarai creek maintain intact populations of fish that have not been subject to exploitation. There are also significant populations of aimaras (*Hoplias macrophthalmus*) in both rivers. We sampled the main channel of the Sipu River (open waters and littoral or bank areas), small black water creeks, one dried pond of the Sipu River and a mountain clearwater creek (Acarai creek at the foothill of the Acarai Mountains). In the Sipu River, which included sampling in a flowing creek and an isolated pond, we observed high species richness. The Acarai creek is very important as its hydrochemical and other environmental characteristics clearly differentiate it from the other creeks and rivers studied. This is reflected in the composition of the aquatic biota, especially the fish. Many of the species collected are typical of the riffle microhabitat (e.g. Crenuchidae, Parodontidae, Loricariidae and Hepapteridae). Of particular interest in the Acarai creek were the armored catfish (Family Loricariidae), tentatively assigned (pending further identification) to the genera *Ancistrus*. and could be endemic to the river basin and new to science. This could also be the case for the cichlid, *Bujurquina* sp., and the killifish, *Rivulus* sp., recorded in this study area.

Focal Area 3

Like the two preceding focal areas, Focal Area 3 (Kamoa River) is in pristine condition. The Kamoa River's fish composition and species richness are similar to that of the Sipu River, although somewhat different from the Acarai creek in species composition. In this region, the smaller fish dominated the clear and black water tributaries of the Kamoa River. We obtained a very representative sample of the creek's ichthyofauna. The richness of this system was lower but the vast majority of species were very tiny, associated with cryptic habitats and leaf litter. In the principal channel of the Kamoa River we also observed fish species of large size and in considerable abundance. There are important populations of aimaras (*Hoplias macrophthalmus*), which also indicate the presence of the tiger fish (*Pseudoplatystoma fasciatum*).

Table 5.3. Physico-chemical variables reported from focal areas evaluated during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

Focal areas	Water temperature (°C)	pH	Dissolved oxygen (mg/l)	Conductivity (ms/cm)
AF1	25.30	5.85	6.11	0.02
AF2	23.90	5.02	4.74	0.01
AF3	25.13	5.44	6.32	0.01
AF4	28.10	6.10	5.70	0.02
AF5	28.23	5.83	4.74	0.01

Focal Area 4

Focal Area 4 (Wanakoko Lake) is not really a lake, but a large curvature of the main channel of the Essequibo River which is regularly fished by members of the Wai-Wai community. It is more similar to a side pool that is shallower than the river itself, and with calm waters. We recorded fish species typical of fast-moving, highly oxygenated river water (e.g. Acestrorhynchidae, Characidae, Erythrinidae), as well as species characteristic of slower, calmer river waters (e.g. Cichlidae, Curimatidae, Electrophoridae) in Wanakoko Lake. This region, according to preliminary results of a community-based fish mini-survey conducted by CI-Guyana (Alexander et al. 2005), is considered to be one of the four most important fishing areas in the Konashen Indigenous District.

Focal Area 5

In the Focal Area 5 (Essequibo River at Akuthopono and Masakenari Village) we studied four habitat types, which included the main channel of the Essequibo River (pocket water with numerous large rocks), one palm swamp, and one dried pond in the flooded forest of Akuthopono and the rapids of the Essequibo River between Akuthopono and Masakenari. We estimate that there were around 100 species in this area. The species numbers were low due to the cursory nature of our sampling of the habitats of the main channel (littoral area, banks and pocket waters). In the palm swamp we recorded some interesting species associated with standing water habitats, including some electric fish (Gymnotidae, Hypopomidae). In the dried pond of the flooded forest we observed a high abundance of *Hoplerythrinus unitaeniatus* (Erythrinidae), a species with aerial respiration, which allows it to tolerate the anoxic conditions of the pond. The rapids of the Essequibo River were better sampled than the pocket waters, especially the zones with rocks and aquatic plants of the family Podostemaceae (*Apinagia* sp. and *Mourera fluviatilis*), where the associated microichthyofauna is unique. In this habitat type, we collected many species of fish found only in this type of habitat (e.g. *Leporinus* spp., *Hemiodus* spp., *Rineloricaria platyura*, *Characidium* spp., *Melanocharacidium blennioides*, *Imparfinis* sp., etc.).

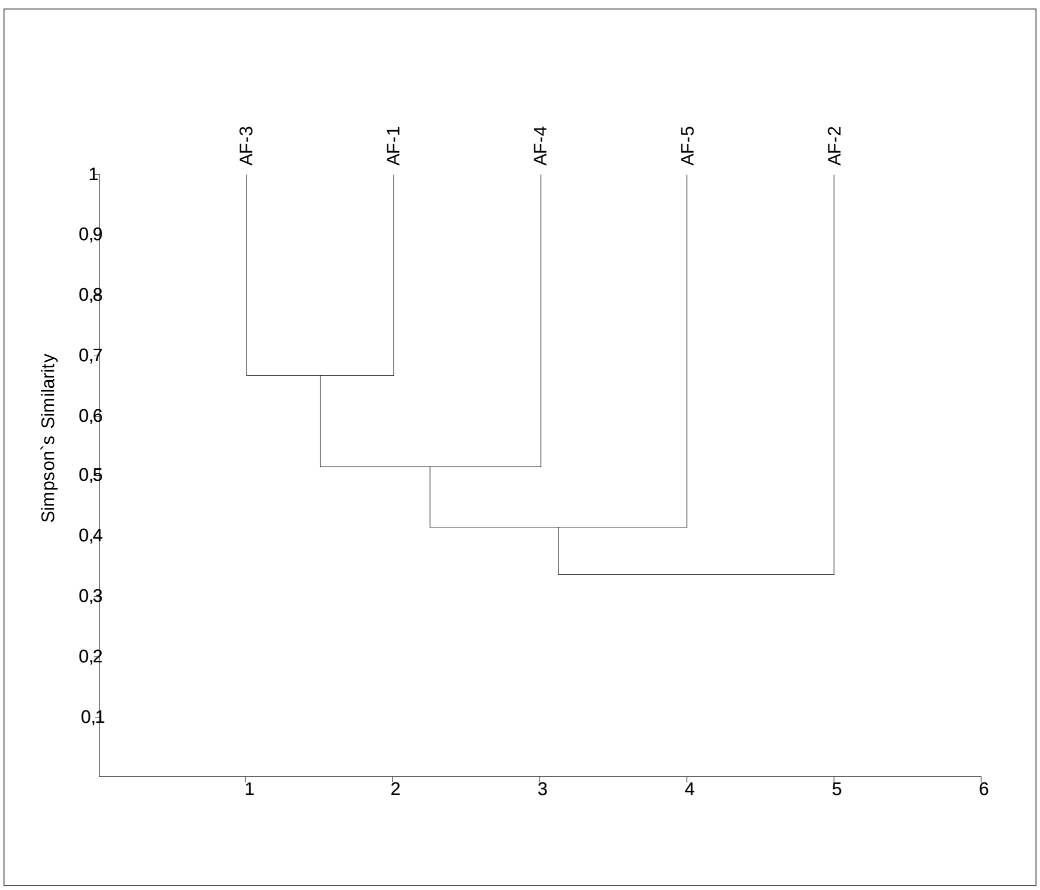

Figure 5.3. Cluster analysis based on the Simpson Index of similarity for the focal areas evaluated during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

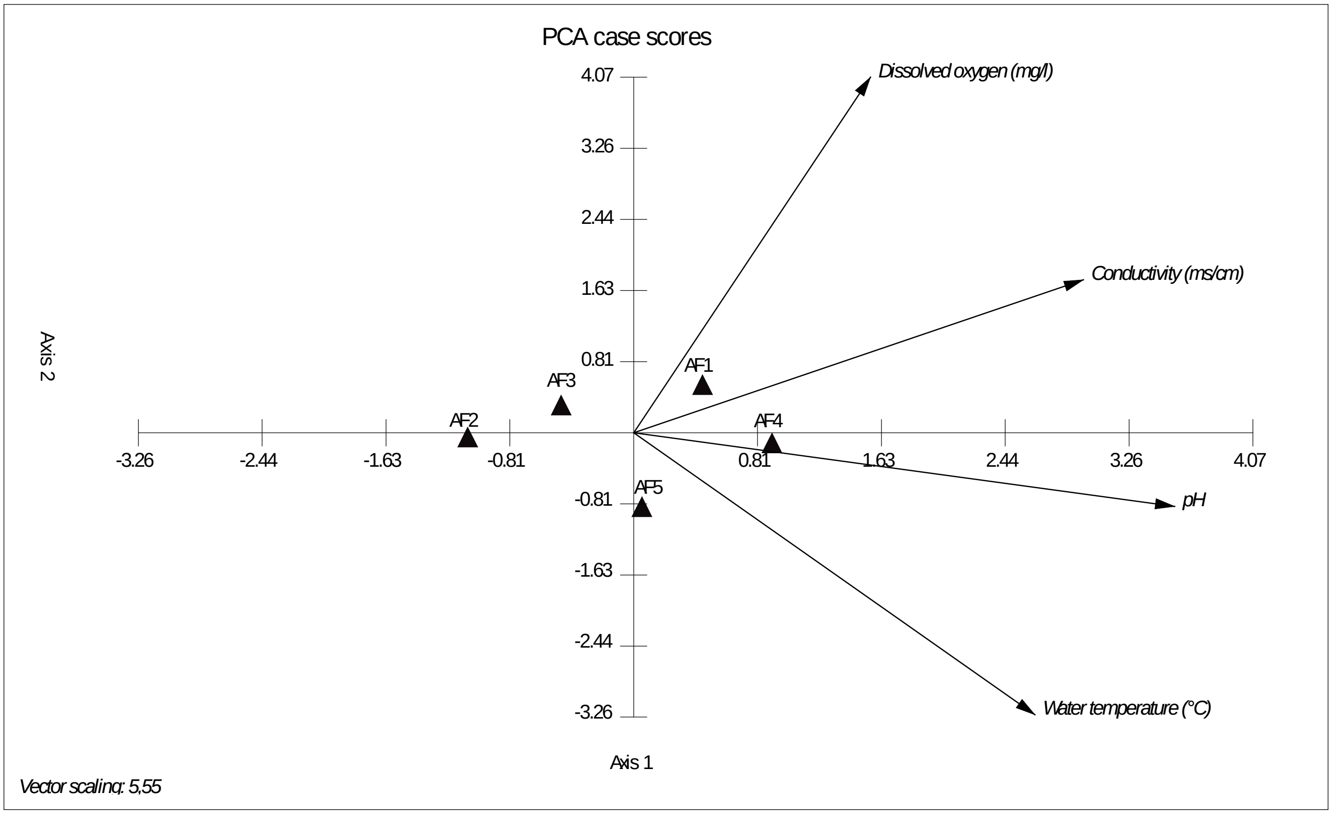

Figure 5.4. Biplot based on Principal Component Analysis (PCA) showing the relationship between the focal areas according to selected physico-chemical variables evaluated during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

Results for each sampling station

18 sampling stations were evaluated during the RAP expedition to the Konashen COCA. Sampling results suggest that Wanakoko Lake (WL: Focal Area 4) possesses the highest species richness with 29.2% of the species collected, followed by Focal Area 2 (AM-07b), Focal Area 4 (PF-14b) and Focal Area 3 (KR-09), all with richness higher than 20%. The lower richness reported for Focal Area 2 or Acarai Mountains (AM-06 and AM-07a), with two species each, represents 1.77% of the total number of species identified (Appendix 2, Figure 5.5). The cluster analysis based on the Simpson Index of similarity for each of the sampling stations did not identify associations consistent with the distribution previously described for the focal areas (Figure 5.6). Thus, species richness alone is not a reliable variable for determining the type of relationship between the evaluated sampling stations.

Species Accumulation Curve

The species accumulation curve (Figure 5.7) provides evidence of the efficiency of sampling during the RAP expedition to the COCA. On the first day, 26 species were collected (representing 23% of the total captured), with a subsequent phased increase until day five, when no additional species were recorded. On day six the curve increased again with the addition of 13 species before stabilizing during day seven when no new species were added. During day eight the curve exhibited sustained growth until day ten with 10 more species added to the total collected during sampling.

The behavior of the curve demonstrates that sampling permitted the collection of a number of important species. However, the curve did not level out sufficiently to indicate that sampling effort was sufficient to record the majority of species present. The shape of the curve suggests that a number of species were not recorded in the sample, and that additional sampling of longer duration is necessary to record those species that were potentially excluded from the samples analyzed here.

Interesting Species

The fish team did not encounter any species currently recognized to be threatened (e.g. IUCN Red List, CITES, regionally or locally threatened). It is too early to determine accurately the endemism of the fish, mollusks and crustaceans that were collected since many of the species occur in the Lower Essequibo and are widely distributed throughout the Guianas. However, the samples are still being identified, and it is likely that some of the species collected will turn out to be endemic to the river basin of the Essequibo, especially members of the family Crenuchidae, and some of the Characidae, Hepapteridae, Cetopsidae, Rivulidae, and Cichlidae. Special attention should be given to the loricarid assigned tentatively to the genera *Ancistrus*; the killifish (*Rivulus* sp.), and the cichlid (*Bujurquina* sp.). It is important to note that these last four species, which are restricted to the Acarai Mountains, along with a species of aimara that lives only in the rapids of the Essequibo River (*Hoplias* cf. *malabaricus*), are thought to be new to science.

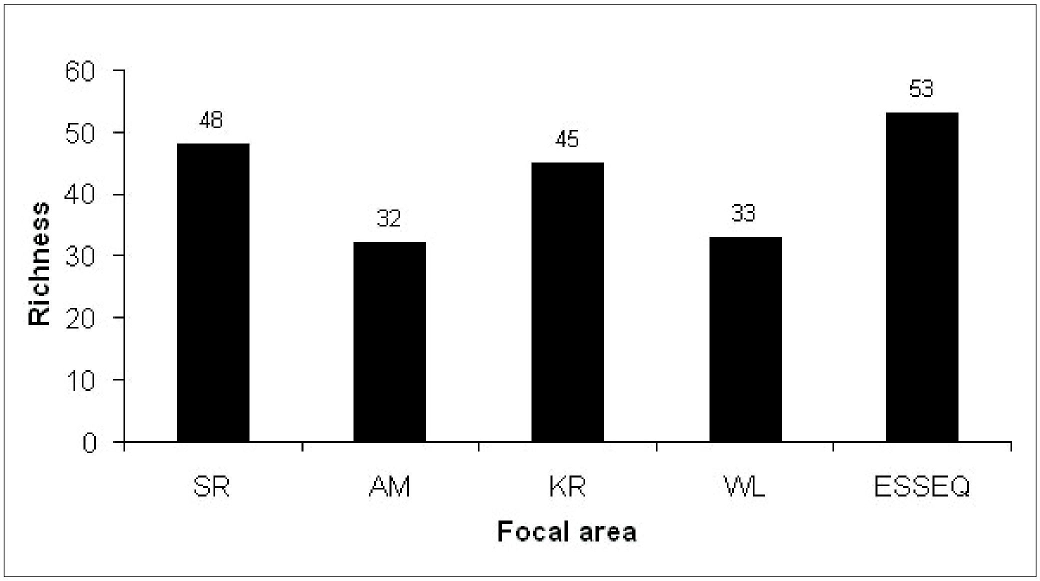

Figure 5.5. Fish species richness recorded in the focal areas evaluated during the 2006 RAP survey of the Acarai Mountains (AM), Sipu (SR), Kamoa (KR) and Essequibo (ESSEQ) rivers, and Wanakoko Lake (WL), Konashen Indigenous District of Southern Guyana.

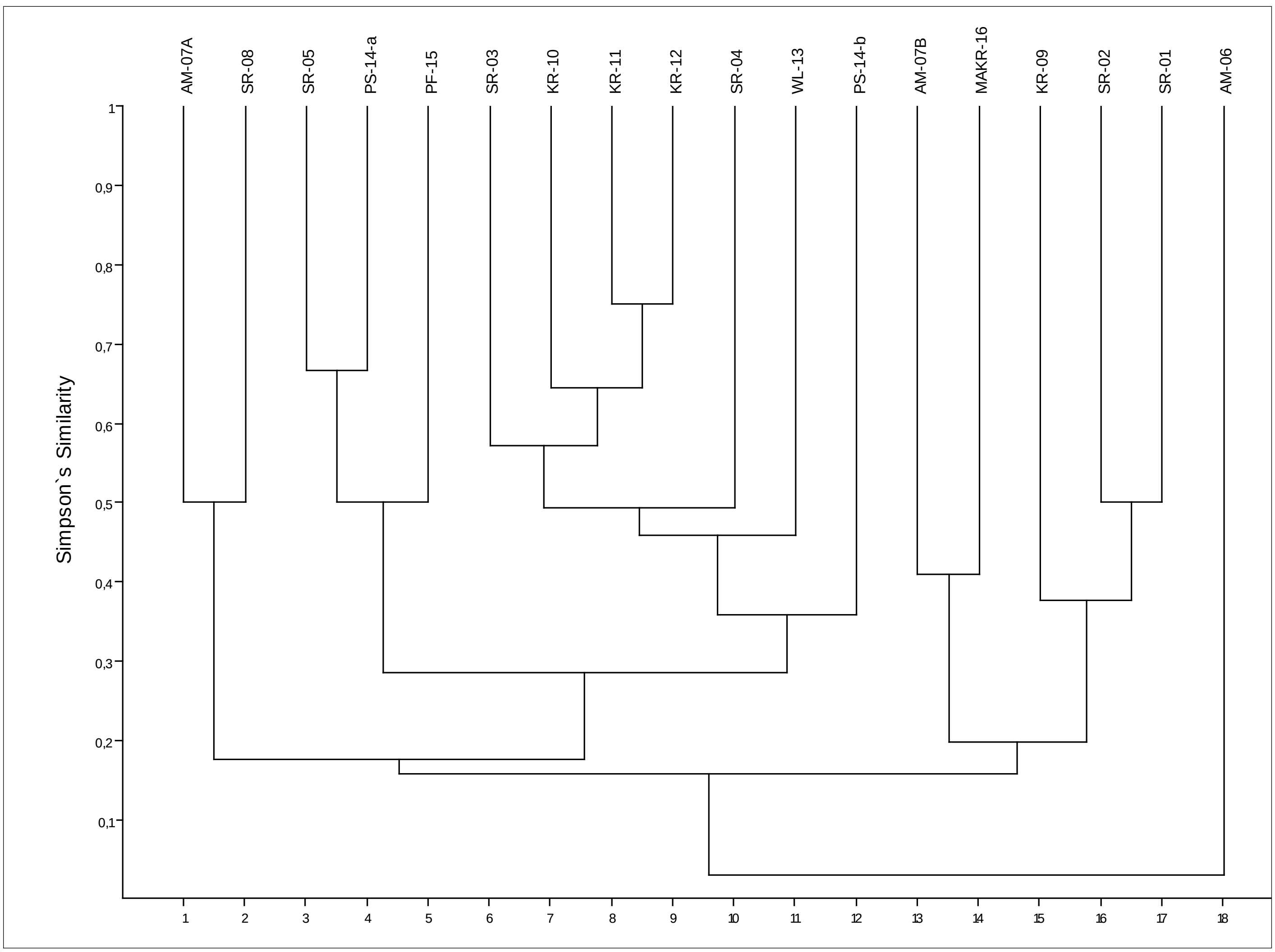

Figure 5.6. Cluster analysis using the Simpson Index of similarity for the localities sampled during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, and Wanakoko Lake, Konashen Indigenous District of Southern Guyana.

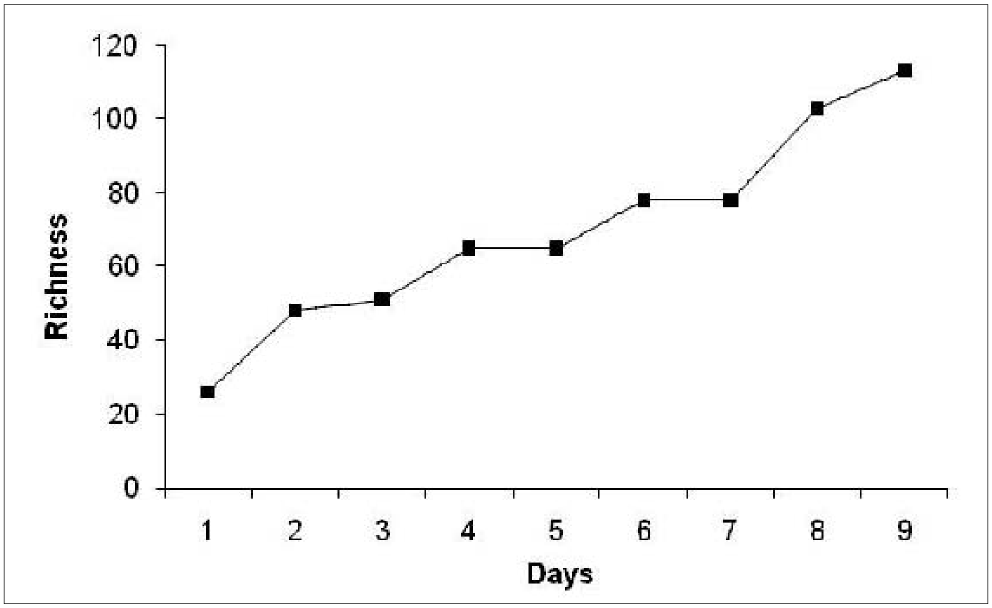

Figure 5.7. Accumulation curve for ichthyological species added to the overall species list per day of study during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana

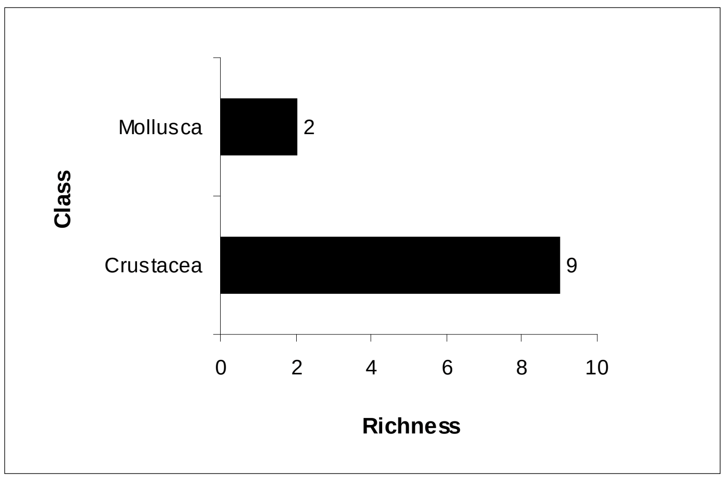

Figure 5.8. Speciess richness for classes collected during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

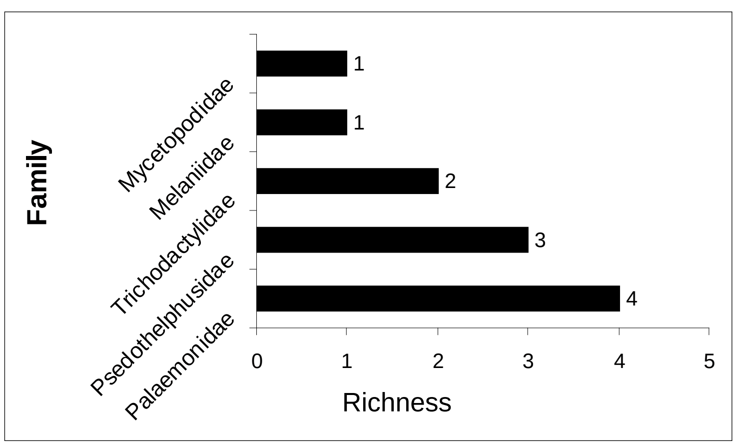

Figure 5.9. Species richness for families of aquatic macroinvertebrates collected during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

Table 5.4. Presence-absence matrix of crustacean and mollusk species collected during the 2006 RAP survey in the Acarai Mountains, Sipu, Samoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana. * Species observed but not collected.

Taxa	SR-01	SR-02	SR-03	SR-04	SR-05	AM-06	AM-07A	AM-07B	SR-08	KR-09	KR-10	KR-11	KR-12	WL-13	PS-14a	PS-14b	PF-15	MAKR-16	Total
CRUSTACEA																			0
Psedothelphusidae (3)																			0
Pseudothelphusidae sp. 1							1			1						1			3
Kingsleya cf. *latifrons*																1		1	2
Microthelphusa sp. 1												1							1
Trichodactylidae (2)																			0
Sylviocarcinus pictus										1	1	1	1						4
Valdivia serrata	1			1					1	1	1	1	1	1					8
Palaemonidae (4)																			0
Palaemonidae sp. 1												1							1
Euryrhynchus wrzeniowskii								1						1					2
Macrobrachium brasiliensis	1					1													2
Macrobrachium cf. *nattereri*	1	1	1	1		1		1	1	1	1	1	1	1			1		13
GASTROPODA																			0
Melaniidae (1)																			0
Doryssa sp. 1						1													1
BIVALVIA																			
Mycetopodidae (1)																			
Anodontites sp. 1																		1	
Total	3	1	1	2	0	2	1	2	2	4	3	5	3	3	0	2	1	2	37

Nearly half of the fish species we recorded are considered important subsistence fish resources, 20% are of sport fishing interest, and about 75% have high ornamental value.

Crustaceans and Mollusks (Gastropoda and Bivalvia)

Ten species grouped into three classes (Crustacea, Gastropoda, and Bivalvia) were recorded, of which Crustacea was the richest, with three families represented in the samples. Of these, Pseudothelphusidae exhibited the highest richness with four species, followed by Palaemonidae and Trichodactylidae with two species each. The mollusks were represented by only two species, a snail (*Doryssa* sp.), and a mussel (*Anodontites* sp.) (Figures 5.8 and 5.9).

The highest richness was concentrated in Focal Areas 2, 3 and 5, with five, six and four species respectively. Focal Areas 1 and 4 exhibited three species each (Table 5.4). The cluster analysis based on the Simpson Index of similarity identified Focal Area 5 as the locality most dissimilar, while Focal Areas 1 and 4 were the most related with a similarity of 0.67. Focal Areas 2 and 3 exhibited intermediate similarities, but closest to the group formed by Focal Areas 1 and 4, with a similarity index of about 0.5, which can be considered moderate (Figure 5.10).

The species accumulation curve exhibited sustained growth, starting with one species on day one, with no increase in the number of species on day two; from day three it increased on average by one species per day, until day nine, when the curve had still not stabilized completely, indicating that some species are yet to be recorded (Figure 5.11).

CONSERVATION RECOMMENDATIONS BY SITE

As previously indicated, all of the focal areas we sampled were in pristine, well preserved condition, probably as a result of being inside the Konashen COCA. The Acarai creek was the furthest and most inaccessible and therefore the best conserved. Although its diversity is not very high in comparison with other creeks in the Lower Essequibo, its conservation is very important given that it harbors unique species. It is important to notice that although the wealth of species in this creek seems low, its species numbers correspond to expected numbers in other streams located at similar elevations in the Guianas. Some of the Wai-Wai community members mentioned there was illegal mining in the region a few years back, but it currently appears to be a latent threat.

The Sipu and Kamoa rivers are very well conserved. The presence of numerous trunks, branches and trees crossed in the main channel are a clear indication of the low human disturbance and constitute an excellent refuge for fish. The zone most utilized by the Wai-Wai lies along the Essequibo River in the waters just above and below the Masakenari Village. Alexander et al. (2005) determined that four fishing waters below Masakenari, Amaci Falls, Kanaperu, Wanakoko and Mekereku, are of significant importance to the Wai-Wai community. In these areas, 26 species utilized by the community had previously been identified; we increased that number to 50 with the results of this RAP survey. All of these species are both of dietary and scientific (endemism, restricted distributions) interest, have elevated abundance, and show no evidence of overexploitation. The species faced with greatest subsistence fishing pressure are the aimara (*Hoplias macrophthalmus*) followed by the tiger fish (*Pseudoplatystoma fasciatum*). This fishing pressure could become problematic if fishing continues repeatedly at the same site. However, the Wai-Wai have well established fishing seasons and subsistence practices (hook and line) that are not as extractive as if they were to use gillnets or other, more deleterious fishing methods. The aimara is more obviously scarce closer to Masakenari Village, but populations are common both upstream and downstream from the village. We frequently observed the adults and the pre-adults in the main channel of the Essequibo, while the juveniles were more common in creeks. We collected little information about the tiger fish (*Pseudoplatystoma fasciatum*), as it is a rather cryptic species with nocturnal or crepuscular habits, but we assume their status to be similar to the aimara. During the dry season the Wai-Wai use a natural ichthyiocide, hiari, to capture fish in the creeks and pocket waters of the Essequibo River – however this does not appear to constitute a threat because it has been done for so long in a sustainable manner.

General Conservation Recommendations

- The lower section of the Essequibo River, from Masakenari to the Amaci Falls, is of great diversity and use to the Wai-Wai, and remains to be sampled. For this reason, it is fundamental to conduct a second sampling expedition in the low water season (November-December) on the Wai-Wai fishing grounds which include, but are not limited to Amaci Falls, Kanaperu, Mekereku and Wanakoko. This would result in a more comprehensive and accurate species list, particularly in regard to the smaller-sized species.

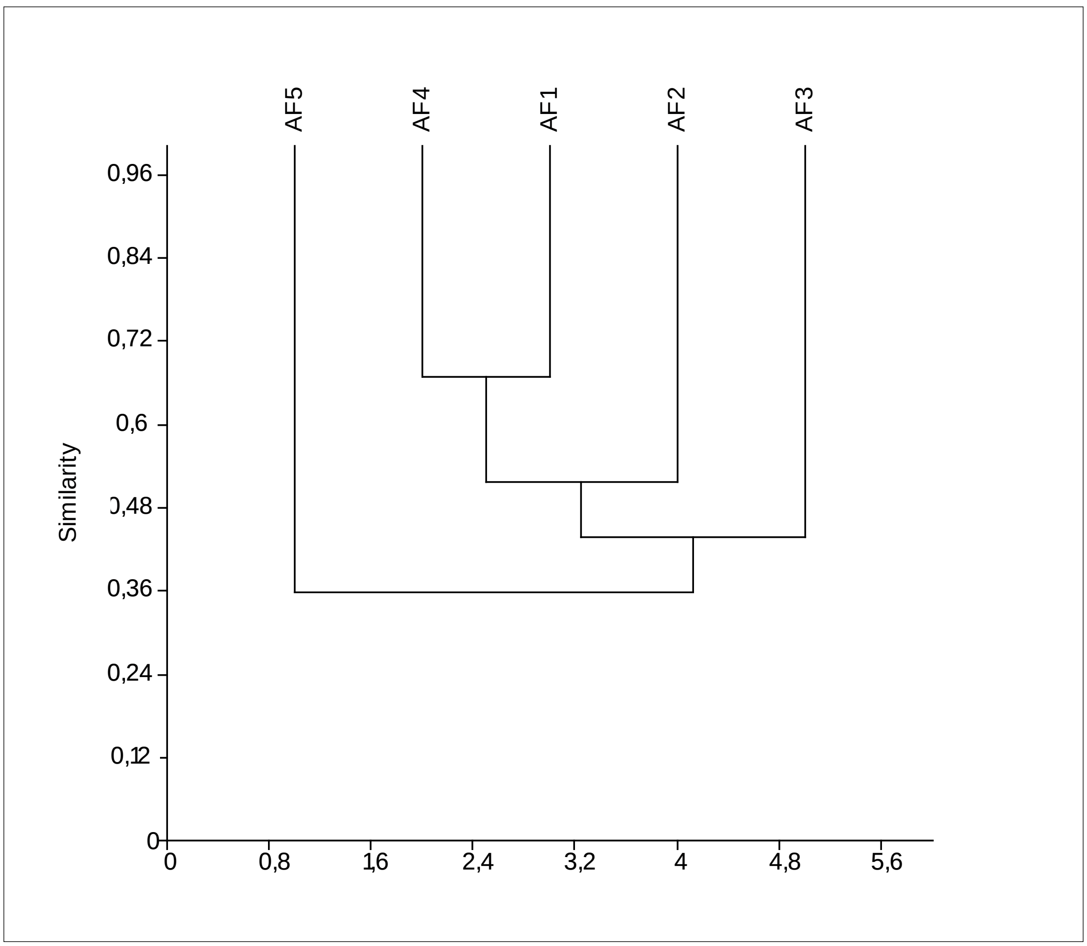

Figure 5.10. Cluster analysis using the Simpson Index of similarity for the aquatic macroinvertebrates collected during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

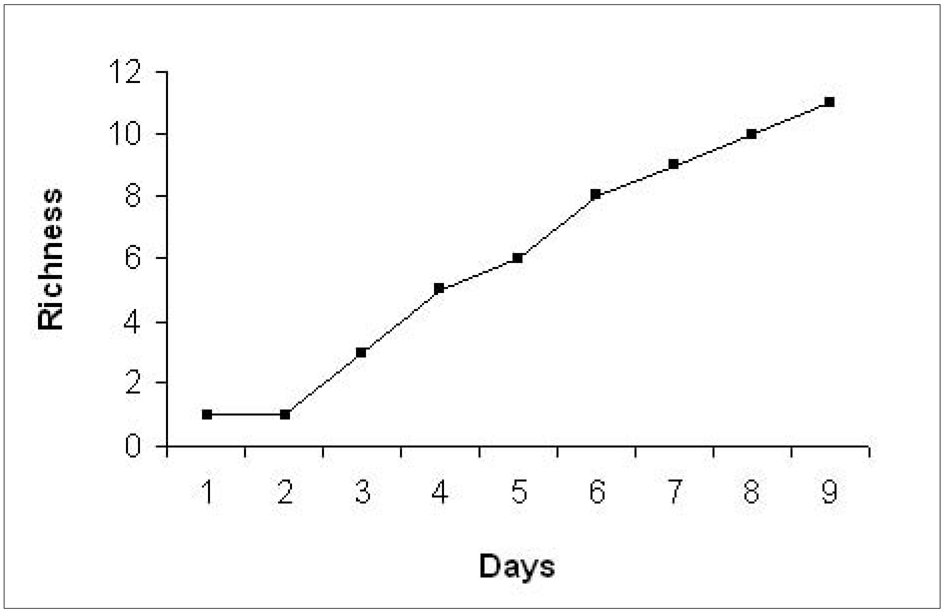

Figure 5.11. Accumulation curve of species of aquatic macroinvertebrates collected during the 2006 RAP survey of the Acarai Mountains, Sipu, Kamoa and Essequibo rivers, Konashen Indigenous District of Southern Guyana.

- Among the fish species we identified, there exists a considerable potential for aquarium and ornamental trade. However, to develop a plan that is sustainable and effective would require additional information on the present species' distribution and abundance. Taking this into account, it is recommended to complete an inventory of the fish species, and subsequently continue biological, ecological and market studies of these species.
- Begin biological, ecological and cultivation studies of the species that are important subsistence fishing resources. Particular focus should be given to aimara (*H. macrophthalmus*), tiger fish (*P. fasciatum*), kururú (*Curimata cyprinoides*) and the pakuchí or catabact pacú (*Myleus rhomboidalis*), among others.
- Design and implement a sustainable management plan, using the data from the studies outlined in the previous recommendations, which focuses on the Wai-Wai community's aquatic resources.
- Continue training parabiologists in the study, conservation and management of aquatic resources.

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