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GILL NET SAMPLING STANDARDISATION IN LARGE RIVERS OF FRENCH GUIANA (SOUTH AMERICA).

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ABSTRACT

In this paper is analyzed the sampling efficiency of repeated batteries of mixed gillnets mesh size from 15 to 70 mm. The study was conducted in three French Guiana rivers : the Sinnamary, Comté and Malmanoury rivers. Efficiency of sampling methods is one of the problems faced by freshwater ichthyologists. If the choice of one approach must consider its efficiency and cost/profit rates for a determinate level of accuracy, the abiotic characteristics of the environment sampled has also an important role in this process. Large rivers, like those sampled in French Guiana, present specific abiotic characteristics that prevent the large use of non-selective sampling methods like electrofishing or rotenone poisoning. Differently, other sampling gear such as gillnets is used frequently. This kind of gear presents known bias problems related to fish size or species. However, bias can be diminished through the use of mixed gillnets mesh size, which efficiency was previously determined. Results of Principal Component Analysis (PCA) suggest that gillnet mesh size 15 to 35 mm are the most efficient in sampling fish fauna in the rivers sampled. Regarding the number of repeated batteries, the analysis of Catch Per Unit of Effort (CPUE), species richness, sample structure (rank correlation) and the examination of their variance suggest that the use of three batteries gives a good estimation for the fraction of the fish community sampled.

STANDARDISATION DE L'ÉCHANTILLONNAGE AU FILET MAILLANT DANS LES GRANDS COURS D'EAU DE LA GUYANE FRANÇAISE (AMÉRIQUE DU SUD).

RÉSUMÉ

Cette étude porte sur l'analyse du compromis entre l'effort d'échantillonnage et la minoration des variabilités expérimentales en utilisant de façon répétitive des batteries de filets maillants de 15 à 70 mm. L'étude a été développée dans trois cours d'eau de la Guyane française : le Sinnamary, la Comté et la Malmanoury. L'efficacité des méthodes d'échantillonnage est un des problèmes majeurs dans le quotidien des ichtyologistes. Le choix d'une méthode doit considérer son efficacité et la relation coût/bénéfice pour arriver à un certain niveau de précision des résultats. Toutefois, dans ce processus les caractéristiques du milieu à échantillonner ont un rôle important. Les cours d'eau, comme ceux trouvés en Guyane française, présentent certaines particularités qui empêchent l'utilisation des méthodes non sélectives comme la pêche électrique ou l'utilisation d'ichtyotoxique. En revanche, d'autres types de matériel de pêche, comme les filets maillants sont couramment utilisés. Ce matériel présente des problèmes de biais par

rapport aux espèces et à la taille des poissons. Toutefois, ce biais peut être réduit en utilisant des filets de différentes mailles, dont l'efficacité a été démontrée préalablement. Le résultat de cette étude suggère que les filets de maille 15 à 35 mm de vide de maille sont les plus efficaces pour échantillonner les peuplements de poissons des rivières ici considérées. Les résultats de l'analyse sur le nombre de batteries répétées basés sur la variance de la capture par unité d'effort, de la richesse spécifique et de la structure de l'échantillon (corrélation de rang) suggèrent que l'utilisation de trois batteries représente un compromis acceptable entre l'effort d'échantillonnage et la précision de l'estimation des caractéristiques du peuplement de poissons.

INTRODUCTION

One problem faced by many fish ecologists is to get unbiased estimates of fish assemblage in a studied habitat. A number of methods were developed (BACKIEL and WELCOMME, 1980 ; BAYLEY, 1985), but each of them is limited in its use by constraints related to habitat characteristics.

In opening the « Large River Symposium » held in Honey Harbour (Ontario) in 1986, D.P. DODGE defined large rivers as those large enough to intimidate research workers (HYNES, 1989). Although it is obviously difficult to set an arbitrary boundary between small and large rivers, authors generally agree that above 1 m deep and about 20 m wide, a river can be considered as large (KELLERHALS and CHURCH, 1989 ; CHURCH, 1992). In these habitats the more efficient catching methods for fish are generally inapplicable. Direct observation by snorkelling cannot be done because of the low water transparency. Trawling is impeded by frequent presence of rocks or woody debris at the bottom. Electric fishing has been used in certain occasions (NELVA et al., 1979 ; PERSAT and COPP, 1990) but the method is limited. In forest rivers, like those encountered in French Guiana, water conductivity is as low as 30 µS and electric fishing is only possible through heavy equipment. Depth of many aquatic environments and fish behaviour make also this technique inadequate for large rivers (LAMARQUE, 1990). The use of ichthyotoxics, which is considered a very efficient method for catching the whole community of fish, is limited to small and shallow areas and cannot be used repeatedly. PONTON and COPP (1997) using the rotenone in Guiana rivers appointed that in deeper places the retrieval efficiency of sunk fishes decreases, greater water velocities require greater quantities of toxicants which can increase the risk of mortality of fishes downstream the place sampled. Seine nets have been used in few occasions for biomass estimates purposes, but the method is restricted to relatively clean biotopes and disturbs the habitat (BAYLEY, 1982 ; LAGLER et al., 1971).

Finally gill netting remains one of the few available methods for catching fish in most large rivers. Naturally, fish ecologists know how uncertain this method is, mainly because of selectivity problems (HAMLEY, 1975) although, it revealed efficiency in detecting changes in fish community structure of floodplain lakes when compared to high efficient methods like electrofishing (TEJERINA-GARRO et al., 1998). The probability of capture of an individual fish using gillnets depends not only on the adequacy of its size to net mesh size (HAMLEY and REGIER, 1973 ; HENDERSON and WONG, 1991 ; HELSER and CONDREY, 1991), but also on its shape and behaviour (HAMLEY, 1975 ; JENSEN, 1986). Individual capture is also submitted to chance. This situation leads to the statement that getting an unbiased sample of a diverse fish assemblage in large rivers seems unrealistic. However, realistic is the possibility to compare samples trying to reduce the bias. Mesh size selectivity can be reduced using large range of gillnets of different mesh sizes and using a large number of nets of each mesh size can reduce chance parameters. Obviously, there is a limit in the number of nets that a research team can handle. This

study proposes a method to determine the best compromise between the number of mesh sizes and the number of nets of each size, which must be used in order to get a stabilized sample in large rivers.

MATERIAL AND METHODS

The principle of the method used in this study was to set a large number of gillnets in the same area within a limited period of time. Gillnets were organized in batteries ; each battery was composed by nine nets of mesh sizes 15, 20, 25, 30, 35, 40, 50, 60 and 70 mm between adjacent knots. The choice of this combination of mesh sizes was determined by earlier sampling. A 10 mm gillnet has a very low efficiency, rapidly filled by debris or algae. Due to the scarcity of very large species in French Guiana freshwaters, the capture of gillnets of 70 mm mesh size is only accidental, making the use of nets of larger mesh size inadequate. Each net was 25 m long and 2 m high. In order to get general results samplings took place in different periods of the year and in different rivers.

Five samples were taken :

- In the Sinnamary River upstream from the Petit-Saut reservoir (Figure 1). Sampling took place two times, in November 1995 with 5 batteries and in November 1996 with 7 batteries. Sampling was done in three different sites distant about 25 km one from other. Correlation of normalized species abundance between the 3 sites are highly significant (Table I). In the three areas the river width varied between 26 and 63 m and riverbanks were covered by dense and continuous primary vegetation.

- In the Sinnamary River, downstream from Petit-Saut dam, sampling took place in April 1997 in a section of 800 m at about 30 km from the dam (Figure 1). Five batteries were used. River width in sampling area ranged from 59 to 112 m. The river flows through the coastal plain and is bordered by primary forest.

- In the Malmanoury River, a small coastal watercourse crossing the coastal plain, one sample was taken in April 1997 (Figure 1). Six batteries of gillnets were set in a section of about 800 m located in the middle course. In the sampled area the channel width varied from 25 to 35 m. This river runs throughout forest, savanna and some disturbed areas also.

- In the Comté River one sample was taken in March 1998. The sample took place in the most upstream half of the river (Figure 1). Six batteries were used. The river width ranges between 23 and 45 m and the banks are covered with vegetation.

Table I
  Correlation values among the three stations sampled in the upstream Sinnamary in 1995 and 1996. A = Saut Takari Tanté, B = Saut Dalle, C = Saut Deux Roros. * n = 36, p < 0.01 ; ** n = 44, p < 0.01.

Tableau I
  Valeurs de la corrélation entre les trois stations échantillonnées dans le Sinnamary amont en 1995 et 1996. A = Saut Takari Tanté, B = Saut Dalle, C = Saut Deux Roros. * n = 36, p < 0.01 ; ** n = 44, p < 0.01.

		1995 Station			1996 Station		
		A	B	C	A	B	C
	A	1			1		
Station	B	0.695*	1		0.646**	1	
	C	0.690*	0.726*	1	0.703**	0.680**	1
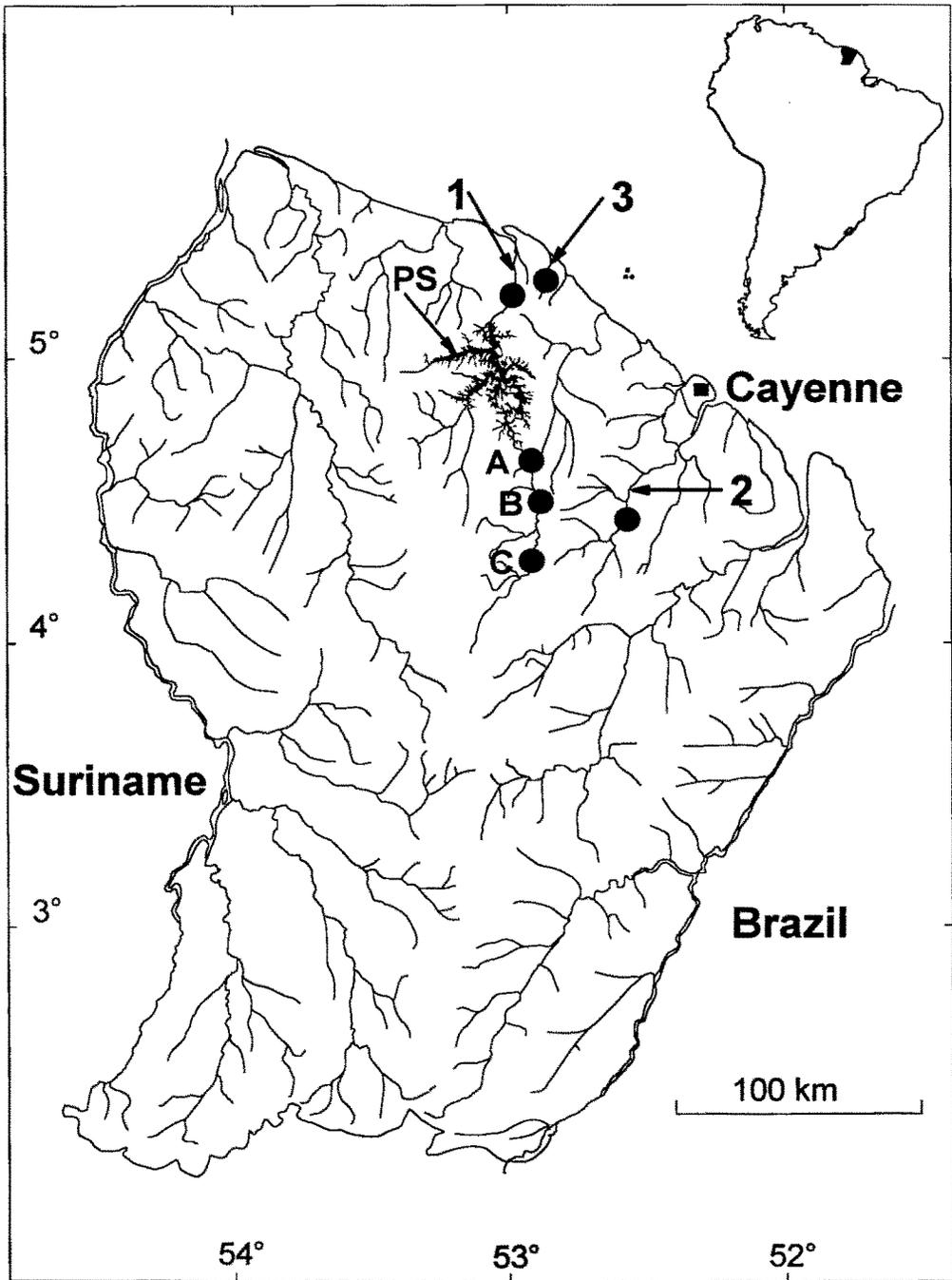
Figure 1
   Localization of the Sinnamary River (1), Comté River (2), and Malmanoury River (3) in French Guiana. Dots represents sampling sites. In Sinnamary upstream three sites were sampled (A = Saut Takari Tanté, B = Saut Dalle, C = Saut Deux Roros) and one area downstream the hydroelectric dam of Petit-Saut (PS).

Figure 1
   Localisation du fleuve Sinnamary (1), de la rivière Comté (2) et du fleuve Malmanoury (3) en Guyane française. Les points indiquent les sites d'échantillonnage. Sur le fleuve Sinnamary trois sites ont été échantillonnés en amont (A = Saut Takari Tanté, B = Saut Dalle, C = Saut Deux Roros) et un en aval du barrage de Petit-Saut (PS).

The nets were set parallel to shore line, in places with low current. They were deployed at 5 pm and retrieved at 7 am. Tentative of fishing during day showed that additional capture, in terms of number of specimens as well as species, is negligible.

Captured fishes were identified in field using keys for adults elaborated by ROJAS-BELTRAN (1984), SANTOS et al. (1984), PLANQUETTE et al. (1996), and BOUJARD et al. (1997).

In order to know the contribution of each gillnet mesh size to total variance a Principal Component Analysis (PCA) was conducted on the matrix species frequency by mesh size for each sample using statistical package ADE-4 (THIOULOUSE et al., 1997). Each column of mesh size gillnets was transformed (standardized) and the PCA analysis was conducted using the covariance matrix. This kind of analysis and the transformation allows to compare heterogeneous variables in nature and scale (SIMIER, 1998).

In order to determinate the optimal number of gillnets batteries, we generated randomly, without reposition, batteries composed by five nets of mesh size 15, 20, 25, 30 and 35 mm. Fifty random draws were made for each number of batteries used in each river sampled. The parameters examined were :

- Species richness - we adjusted the mean values of richness against number of batteries to a logistic curve : $y = ya(1-e^n)$ in order to estimate the theoretical species richness (Sra) for every river sampled.

- Catch Per Unit of Effort - number of specimen captured/gillnet/hour.

- Sample structure using rank correlation between sample from each battery and total sample.

For each of these parameters the mean and the coefficient of variation defined in % were plotted against the number of batteries.

RESULTS

The contribution of each mesh size to total inertia in the PCA analysis shows similar decrease of inertia from mesh size 15 to 25 mm for the Sinnamary upstream in 1997, Sinnamary downstream and Comté River. From mesh size 35 up, inertia presents low values (< 4) until net 70 mm in the three rivers mentioned (Figure 2). In the Sinnamary upstream in 1995, inertia decreases from net 15 mm to 20 mm and reaches high value at net 25 mm showing low values (< 2) for meshes larger than 35 mm. In the Malmanoury River inertia increases from gillnets 15 to 30 mm and reaches low values (< 2) from mesh 40 mm on (Figure 2).

In addition, mesh size 40 to 70 brings few additional species : 3 at Sinnamary downstream station, 2 in the Malmanoury River, 1 in the Comté River and none in the 2 samples from the upstream part of the Sinnamary River.

There were collected 4,121 specimens distributed in 74 species in the five stations sampled. 38 species were sampled at the Comté River and 15 species at the Malmanoury River. At the Sinnamary upstream 95, Sinnamary upstream 96 and Sinnamary downstream the total of species collected were 43, 44 and 32, respectively (Table II). Adjusted curves of sample species richness versus number of batteries show a clear decline in the slope of three rivers sampled (Comté, Sinnamary upstream 96 and Sinnamary downstream). In those rivers the percentage of the theoretical species richness

(Sra) reached by four batteries is high : 78.8 % of 43.9 ; 82.1 % of 43.7 and 79.3 % of 27.1, respectively (Figure 3). For the two other samples (Malmanoury and Sinnamary upstream 95), the adjusted curves appears like straight lines and the number of species given by four batteries is low : 56.7 % of 15.7 and 59.1 % of 48.7, respectively (Figure 3). The coefficient of variation displays homogenous values from 3 batteries on. At this level, variance varies from 6.6 % in the Sinnamary upstream 96 to 13.1 % in the Malmanoury River, where the number of species is low.
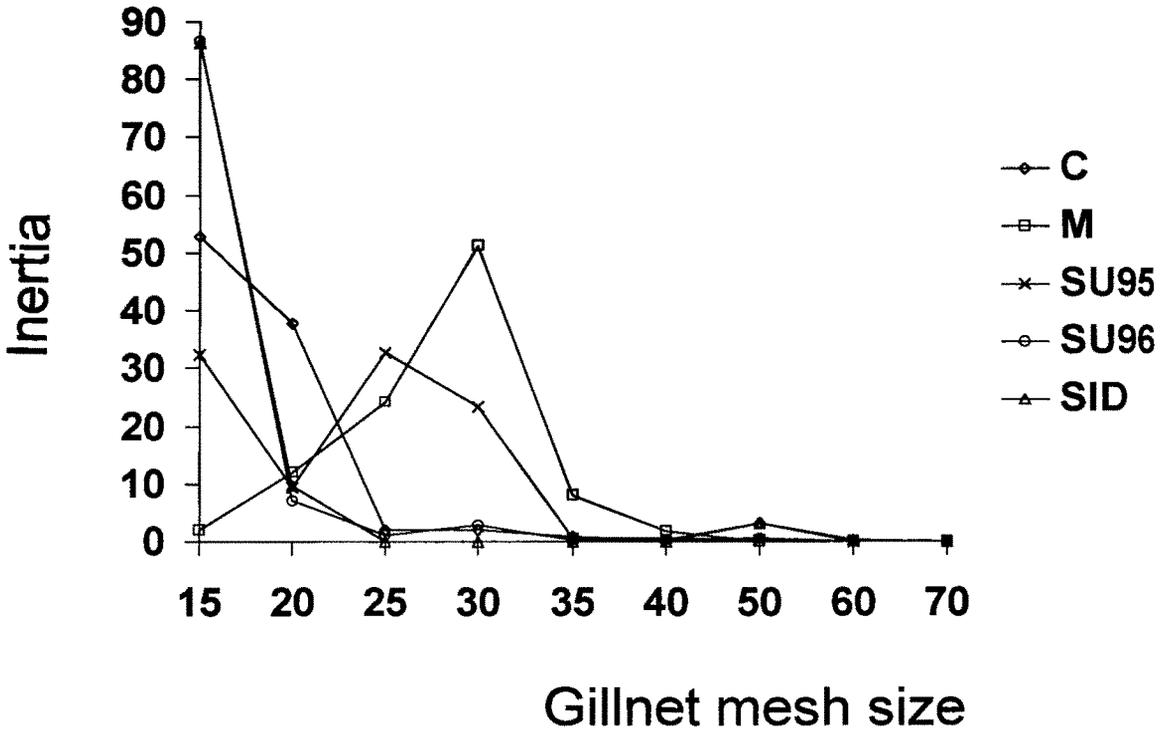

Figure 2
    Contributions of each gillnet mesh size to total inertia. C = Comté River ; M = Malmanoury River ; SU95 = Sinnamary upstream 95 ; SU96 = Sinnamary upstream 96 ; SID = Sinnamary downstream.

Figure 2
    Contribution de chaque maille à l'inertie totale. C = Comté ; M = Malmanoury ; SU95 = Sinnamary en amont 1995 ; SU96 = Sinnamary en amont 1996 ; SID = Sinnamary en aval.

    Plot of the mean rank correlation between the total sample and the samples from increasing batteries of gillnets, chosen randomly, are asymptotic curves but no clear breaking in slope is evidenced. The coefficient of variation declines continuously from 1 to 6 batteries but reaches low values from 3 batteries where the coefficient of variation varies between 2.6 % (Malmanoury River) and 3.7 % (Sinnamary upstream 95). However, stabilized values are observed at two/three batteries (Malmanoury and Sinnamary upstream 96) and at three/four batteries (Sinnamary upstream 95), but downs afterwards (Figure 4).

Table II
   Frequency of species sampled at the Sinnamary, Comté and Malmanoury River, French Guiana.

Tableau II
   Fréquence des espèces échantillonnées sur le Sinnamary, la Comté et la Malmanoury, Guyane française.

ORDER Family *Genus and species*	Comté	Malmanoury	Sinnamary upstream 1995	Sinnamary upstream 1996	Sinnamary downstream	Total
BELONIFORMES						
Belonidae						
Pseudotylosorus microps	1	–	–	–	–	1
CHARACIFORMES						
Anastomidae						
Leporinus friderici	5	1	83	114	5	208
Leporinus despaxi	–	–	–	4	–	4
Leporinus fasciatus	–	–	1	5	–	6
Leporinus gossei	–	6	1	4	–	11
Leporinus granti	–	–	4	5	–	9
Leporinus pellegrini	–	–	2	3	–	5
Characidae						
Acestrorhynchus falcatus	13	14	8	60	–	95
Acestrorhynchus microlepis	13	–	25	136	4	178
Characidae						
Astyanax bimaculatus	–	3	2	1	–	6
Astyanax polylepis	1	–	2	13	2	18
Bivibranchia bimaculata	–	–	1	20	–	21
Bryconops melanurus	–	–	31	61	–	92
Bryconops caudomaculatus	82	–	99	288	5	474
Bryconops affinis	–	–	6	38	–	44
Charax gibbosus	8	–	–	–	3	11
Hemigrammus unilineatus	–	–	1	5	–	6
Moenkhausia collettii	–	–	–	–	2	2
Moenkhausia comma	–	1	2	12	1	16
Moenkhausia georgiae	–	–	23	20	–	43
Moenkhausia oligolepis	–	–	7	83	1	91
Moenkhausia surinamensis	3	–	3	25	–	31
Piabucus dentatus	3	–	–	–	3	6
Poptella orbicularis	8	–	29	94	3	134
Triportheus rotundatus	–	–	191	54	13	258
Characidiidae						
Characidium sp. 1	–	–	1	–	–	1
Curimatidae						
Chilodus zunevei	2	–	1	27	–	30
Curimata cyprinoides	21	1	–	33	117	172
Cyphocarax spilurus	1	–	50	351	1	403
Cyphocharax helleri	–	–	–	33	–	33
Cyphocharax sp. 1	–	–	9	76	5	90
Erythrinidae						
Hoplias aimara	1	–	10	28	1	40
Hoplias malabaricus	–	–	2	20	–	22
Hemiodidae						
Hemiodopsis quadrimaculatus	–	2	4	11	–	17
Hemiodus unimaculatus	55	–	15	–	–	70
Lebiasinidae						
Pyrrhulina filamentosa	–	–	1	–	–	1
Serrasalmidae						
Myleus rhomboidalis	1	–	1	3	–	5
Myleus ternetzi	11	–	48	130	2	191
Serrasalmus humeralis	5	–	–	–	–	5

Table II (Continued)

| ORDER Family *Genus and species*	Comté	Malmanoury	Sinnamary upstream 1995	Sinnamary upstream 1996	Sinnamary downstream	Total
CLUPEIFORMES						
Clupeidae						
Pellona flavipinnis	1	-	-	-	-	1
Engraulidae						
Anchovia surinamensis	9	-	-	-	35	44
Anchoviella sp.	-	-	-	-	2	2
Lycengraulis batesii	10	-	-	-	-	10
ELOPIFORMES						
Megalopidae						
Megalops atlanticus	-	2	-	-	1	3
GYMNOTIFORMES						
Hypopomidae						
Parupygus savannensis	-	-	-	1	-	1
Sternopygidae						
Eigenmannia virescens	-	-	-	2	2	4
Sternopygus macrurus	1	-	-	-	8	9
PERCIFORMES						
Centropomidae						
Centropomus parallelus	1	1	-	-	3	5
Cichlidae						
Aequidens guianensis	-	-	14	5	2	21
Crenicichla saxatilis	-	-	1	2	-	3
Geophagus surinamensis	-	-	-	4	2	6
Heros severus	2	-	74	78	-	154
Satanoperca sp. aff. leucosticta	2	-	-	-	-	2
Scianidae						
Plagioscion squamosissimus	3	-	-	-	-	3
Stellifer microps	8	-	-	-	-	8
SILURIFORMES						
Ageneosidae						
Ageneiosus brevifilis	11	-	10	59	-	80
Ageneiosus sp.	4	-	-	-	-	4
Auchenipteridae						
Auchenipterus nuchalis	40	-	94	290	238	662
Parauchenipterus galeatus	18	83	-	-	2	103
Parauchenipterus nodosus	4	72	-	-	1	77
Tatia intermedia	-	2	-	-	2	4
Callichthyidae						
Corydoras spilurus	1	-	2	2	-	5
Doradidae						
Doras carinatus	1	-	3	5	-	9
Loricariidae						
Ancistrus hoplogenis	1	-	4	2	-	7
Ctenoloricaria maculata	-	-	2	-	-	2
Harttia surinamensis	-	4	-	-	-	4
Hypostomus plecostomus	2	6	1	-	1	10
Lithoxus planquettei	-	-	1	-	-	1
Loricaria cataphracta	-	-	-	-	8	8
Loricaria gr. cataphracta	4	-	-	-	-	4
Pimelodidae						
Pimelodella cristata	-	-	-	5	3	8
Pimelodus ornatus	-	-	1	2	1	4
Pseudoplatystoma fasciatum	1	-	-	-	-	1
Rhamdia quelen	-	2	-	-	-	2
Number of species	38	15	43	44	32	74
Number of specimens	358	200	870	2214	479	4121
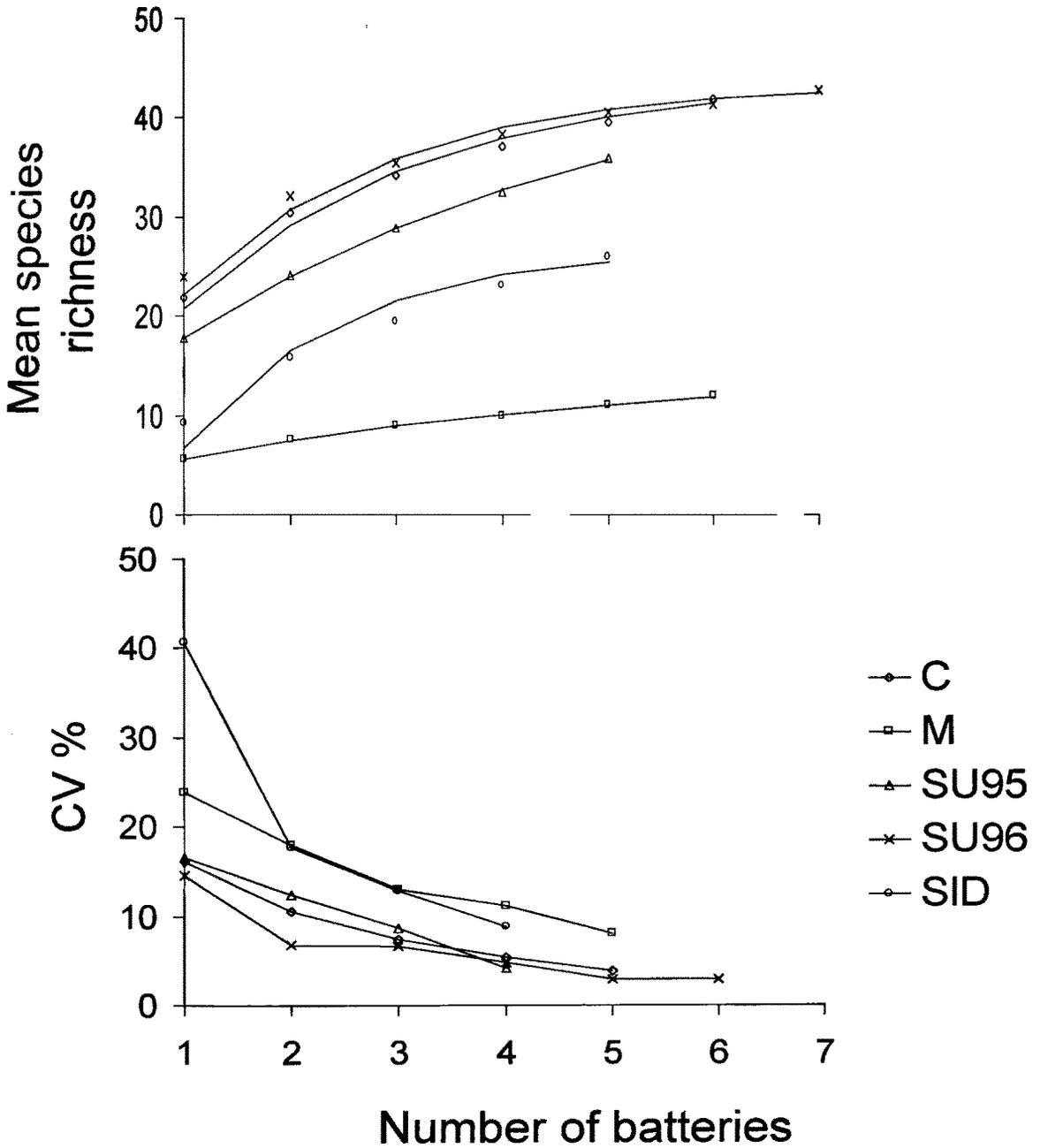
Figure 3

Coefficient of variation (CV) and adjusted curves of species richness. Marks represent average of species richness. River codes are the same as those of Figure 2.

Figure 3

Coefficient de variation (CV) et courbes de richesse spécifique ajustées. Les symboles représentent la moyenne de la richesse spécifique. Les codes des cours d'eau sont les mêmes que ceux de la Figure 2.
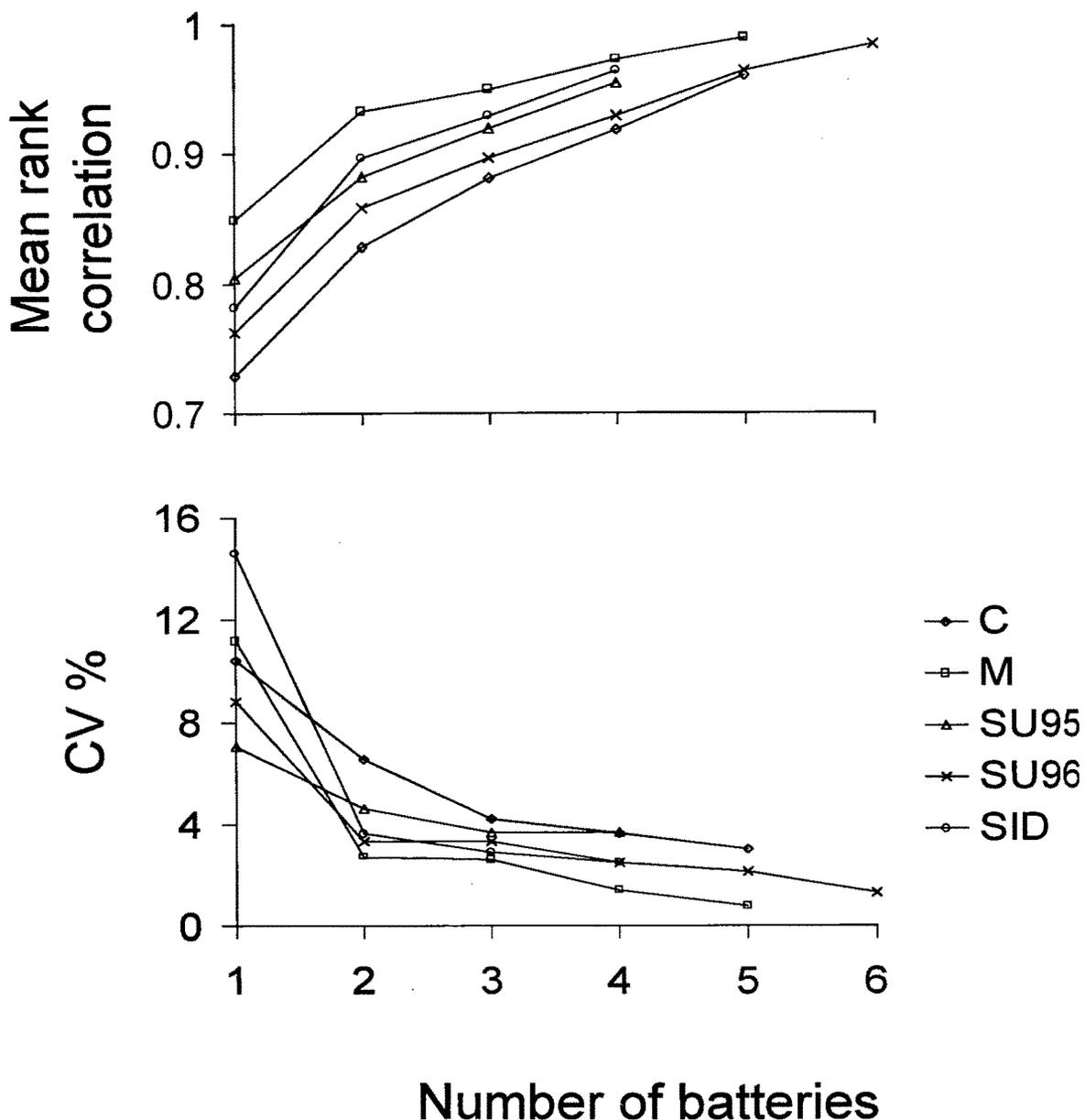
Figure 4
   Coefficient of variation of Spearman correlation (CV) between total sample
   structure and those of batteries formed by mixed gillnets mesh size randomly
   chosen. River codes are the same as those of Figure 2.

Figure 4
   Coefficient de variation de la corrélation de Spearman (CV) entre la structure de
   l'échantillon total et celle des batteries reconstituées aléatoirement. Les codes
   des cours d'eau sont les mêmes que ceux de la Figure 2.

   The CPUE displays large variation from sample to sample but the mean is
surprisingly well estimated by a unique battery. However, the variance of this estimate from
one battery is very high. The variance downs, as the numbers of batteries increases and at
3 batteries on values are close. The coefficient of variation at this number of batteries
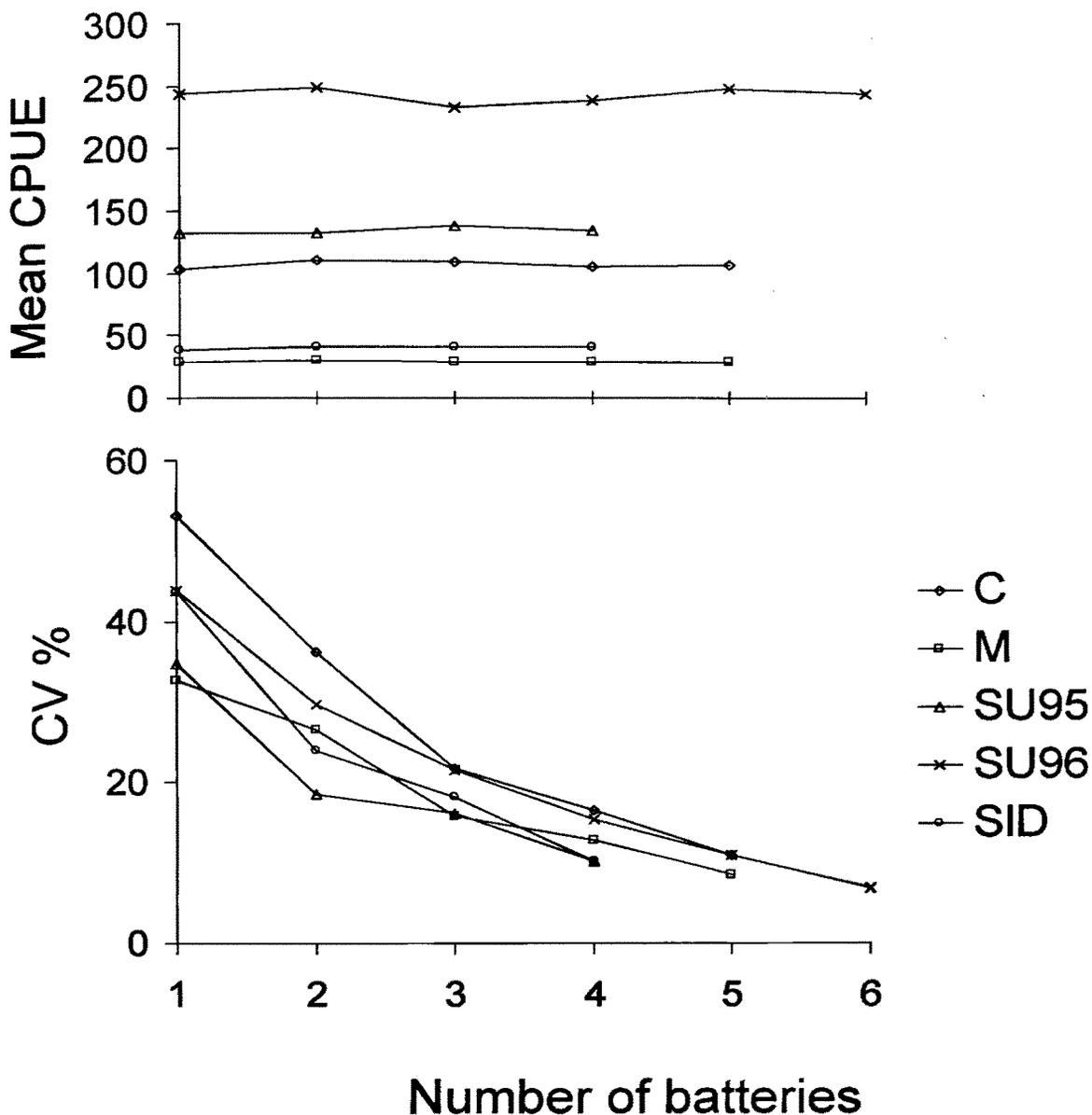varies between 15.8 % in the Malmanoury and 21.7 % at the Comté River (Figure 5).

Figure 5
 Coefficient of variation of CPUE (CV) values by battery of gillnet of the **five** sampling sites. River codes are the same as those of Figure 2.

Figure 5
 Coefficient de variation du CPUE (CV) par batterie de filets maillants. Les codes des cours d'eau sont les mêmes que ceux de la Figure 2.

DISCUSSION

In this study the contribution of each gillnet mesh size to total variance (inertia) decreases until still regularly, but the decrease is not similar for all rivers. Despite differences in number of batteries used in each river (Sinnamary upstream 96, 7 **batteries** ; Sinnamary upstream 95 and Sinnamary downstream, 5 ; Comté and Malmanoury River, 6) gillnets mesh sizes 15, 20, 25, 30 and 35 mm showed significant contribution to total inertia, whereas gillnets of mesh sizes 40, 50, 60 and 70 mm had low contribution. This

suggests that nets of mesh sizes 15 to 35 mm are more adequate to sample fish communities in the rivers studied than nets of mesh sizes 40 to 70 mm. However, the inertia variation observed among nets in the rivers sampled can also be explained partly by the characteristics of the habitat (*e.g.* running velocity, kind of substrate, type of riverbank) rather than net catch (BOUJARD *et al.*, 1990). Although, other factors seems to be important. Indeed, tropical fish faunas, like those found in French Guiana, are naturally formed by a high proportion of small species (< 10 cm) (WELCOMME, 1979). This may explain the expressive contribution of net mesh size 15 mm in most of stations. However, the differences observed among gillnets 15 to 35 mm are also related to the abundance of some species. That is the case of *Acestrorhynchus microlepis*, *Bryconops caudomaculatus* and *Cyphocharax spilurus* in the Sinnamary upstream 96 (mesh size 15 mm) ; *Bryconops caudomaculatus* and *Hemiodopsis quadrimaculatus* in the Sinnamary upstream 95 (mesh size 15 mm). *Parauchenipterus galeatus* is the main responsible for the peak observed at gillnet 30 mm in the Malmanoury River.

By the way, the low capture of large mesh size gillnets (40 to 70 mm) would be due to fish behaviour, especially that of large predators like *Hoplias aimara* and *Ageneiosus brevifilis*. These fishes are almost always tangled in gillnets of small mesh, where they are attracted by movements of caught fish.

Because we are interested in fish communities we did not consider here the biomass. Accidental capture of very large specimens introduce a great variability mainly generated by chance and so bringing an information of difficult ecological interpretation.

In spite of the problems related to the capture of fish by gillnets, our results are in accord with the suggestion of HELSER and CONDREY (1991) of mixing different mesh size in order to reduce bias due to selectivity of gillnets. In our study the combinations of gillnets mesh 15 to 35 mm seems to be satisfactory for sampling the fish communities of the large rivers sampled.

In this paper the number of repeated set of nets was estimated based on two type of statistics (mean and variance of estimations randomly chosen in a system of increasing number of batteries of gillnets) from three parameters : CPUE, species richness and sample structure (rank correlation).

The estimation of the fish density (CPUE) does not vary much with increasing number of batteries in all the rivers sampled, but chance seems to be an important factor that accounts for the high variance observed among the samples. However, this variance may be also due to other factors such as seasonal variability (*e.g.,* Sinnamary upstream 1995 and 1996) or river size (*e.g.,* the Malmanoury, a coastal river compared to the other rivers sampled). CPUE results display that at 3 batteries of gillnets relative low values is reached by variance, which afterwards displays little variation. This allow us to assume that from 3 batteries of gillnets on we get a good estimator of the density of the fish communities sampled.

Species richness and sample structure do not stabilize even beyond 5 batteries, but their evolution in function of the number of batteries is almost always asymptotic. The coefficient of variation of the mean rank correlation displays plateaus from 2 to 3 or from 3 to 4 batteries in different samples and in all of them after 3 batteries variance do not vary very much. This suggests that from 3 batteries on we have a good estimation of the sampling structure. Species richness variance decreases fast from 1 to 5 batteries. However, from 3 batteries on, variance values vary slightly in all sampling. The adjusted points in relation to theoretical species richness appointed to an average of 71.2 % species sampled at 3 batteries of gillnets. This represents an expressive number of the species of the fish community sampled, even if we consider that species richness is a factor that

changes accordingly to the size of the sample (MAGURRAN, 1988) and it may be not well evaluated for the effort of sampling employed in this study.

Despite the parameters used present confidence limits rather than punctual results, these seems sensitive enough to determinate the best number of batteries. Thus, 3 batteries seem to be a good compromise between sampling effort and accuracy of results that give us a reliable image from the fraction of the fish community sampled. This number of batteries takes account of the material possibilities of a research team and the habitat density in a determined section of the river where the use of gillnets is feasible. However, because the data set used for this study does not cover the whole range of conditions in French Guiana rivers, one could use an additional battery providing a sufficient fishing crew.

If the use of mixed mesh size of gillnets and repeated batteries are useful to sampling fish communities of large rivers, the practices of standardize this kind of gear is not usual. Thus, since different rivers present different specific composition of the fish fauna, it seems important to include the standardization of gillnets in sampling protocols.

ACKNOWLEDGEMENTS

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