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Fish Abundance Related to Organic Matter in the Plata River Basin, South America

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Abstract

The ichthyofauna of the Plata River Basin (Argentina, Uruguay, Paraguay, Brazil, Bolivia) consists mainly of illiophagous (mud-eating) and detritivorous species. The primary productivity of phytoplankton is generally low. Regressions of ichthyomass and catch per unit effort against total organic nitrogen, total organic carbon, and other variables indicate that much of the spatial variability in fish abundance is explained by the content of the organic matter in the water column. These relationships are demonstrated for the Middle Paraná River and for the Salto Grande Reservoir on the Uruguay River. More limited evidence suggests that water column organic matter influences fish distribution elsewhere in the basin as well, and may account for the higher average fish abundance at the mouths of tributary rivers and streams of the Paraná and Uruguay rivers.

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The relatively low importance of phytoplankton production in large floodplain rivers is well known (Bonetto et al. 1969; Bayley 1979; Welcomme 1979; FAO 1980; Vanotte et al. 1980; Wissmar et al. 1981). In such systems, seasonal inundation generally controls the important cycle of macrophyte production and decay (Bonetto 1975; FAO 1980; Bayley 1981), and a large amount of allochthonous organic matter enters the permanent rivers as detritus each year (Welcomme 1979; Chapman 1981). The annual flood cycle also controls production and other biological features of the fish community (Bayley 1981). Fish communities in floodplain rivers often contain a high proportion of detritivorous species (Bakare 1970; Welcomme 1979); it would be expected that, in turn, fish production in such environments would be related directly or indirectly to organic richness of the substratum (FAO 1980).

Fish production can be increased when organic fertilizers are added to controlled systems (Schroeder 1978; Noriega Curtis 1979). The nutritional value of organic matter is increased by microheterotrophs, both by the organisms themselves and by their metabolic byproducts (Wissmar et al. 1981). Microheterotrophs need a balance of nutrients, which may be lacking in "black waters" of high humic acid content, waters that typically have low fish production (Sioli 1975; Welcomme 1979; Bayley 1981; Bonetto et al. 1981; Rai and Hill 1981).

Detritus inputs to rivers are likely to accumulate mainly in the more lentic channels and backwaters and, as Welcomme (1976) summarizes, average fish abundance is much greater in such areas. Differences in average fish abundance have been related to the degree of organic fertilization in aquatic environments (Hrbácek 1969; Fox 1976; Gilmore 1978; Quirós et al. 1984).

In the Plata River Basin, which covers large parts of Argentina, Uruguay, Paraguay, Brazil, and Bolivia, major concentrations of fish biomass are known in lagoons of the middle Paraná River floodplain (Bonetto et al. 1969; Bonetto_1 et al. 1970; Bonetto_2 et al. 1970; Cordiviola de Yuan and Pignalberi 1981). Similar concentrations occur at confluences of tributaries with the Paraná and Uruguay rivers, and of these two rivers to form the Plata River, as well as in the coastal zone near Buenos Aires. A large proportion of these fish communities is detritivorous; *Prochilodus platensis* is the most notable species.

In this paper, we explore the extent to which fish distributions are associated with total organic matter in the water column in the Plata system.

The Plata River Basin

The Plata River (Fig. 1) is formed by the confluence of the Paraná and Uruguay rivers, whose drainage basins are 2.61×10^6 km^2 and 0.37×10^6 km^2, and whose average discharges at the

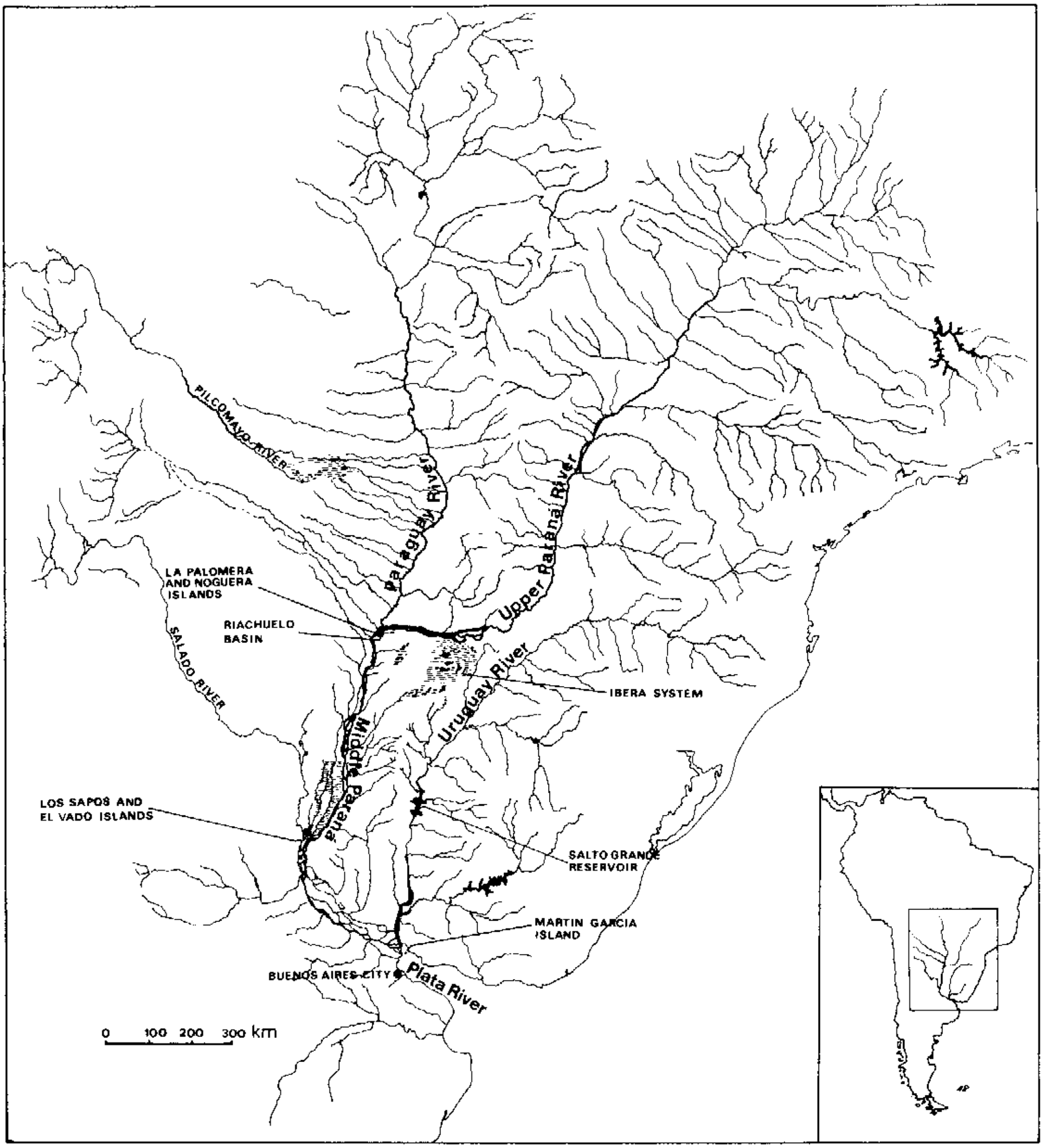

FIGURE 1.—*The Plata Basin.*

confluence are 16,000 m^3/s and 4,800 m^3/s, respectively.

The Paraná is the second most important South American river after the Amazon. Its upper basin, located in Brazil, shows a stepped and uneven profile; abundant falls and rapids are interspersed with considerable extents of low gradients and floodplain up to the confluence with the Paraguay River. Its width varies from 100 to 4,000 m. Except for some tributaries starting in the Andes region, the Paraguay River presents extensive floodplains with swampy marginal areas. After the confluence with the Paraguay, the upper Paraná changes its hydrological and limnological characteristics to form the middle Paraná with its massive floodplain.

As it flows southwards, its valley widens up to create an extensive delta before flowing into the Plata.

The sources of the Uruguay River are in southeastern Brazil and the upper river, with its rocky bed, resembles the upper Paraná. The Salto Grande Dam has been built in its middle section. South of Salto Grande, the Uruguay River widens and deepens considerably, before flowing into the Plata without showing floodplain development.

The Riachuelo River is a small tributary to the Paraná River south of its confluence with the Paraguay River (Fig. 1), and the Iberá system is a wide complex of lentic water bodies and wetlands in Corrientes Province (Bonetto et al. 1981).

Los Sapos and El Vado islands (Bonetto et al. 1969; Cordiviola de Yuan and Pignalberi 1981) are located on the outflow of the Salado River into the floodplain of the Paraná River, near Santa Fe City (Fig. 2). Chepes Island is south of Los Sapos and El Vado islands under the influence of the main channel. La Palomera and Noguera islands are in the river plain south of the confluence of the Paraná and Paraguay rivers.

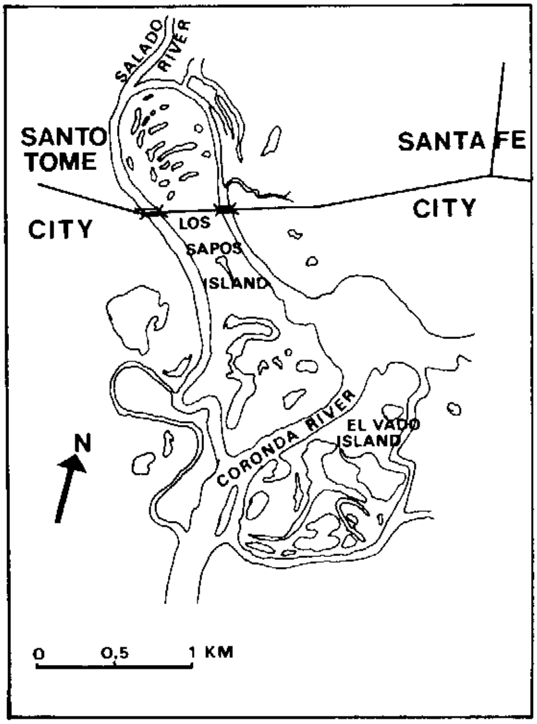

FIGURE 2.—*Los Sapos and El Vado islands, middle Paraná River (adapted from Bonetto et al. 1969).*

Methods

The area considered covers the lower part of the Plata Basin (Fig. 1) including the Paraná River (lower, middle, upper), lower Paraguay River, Uruguay River, and the Plata River itself. More than 60% of the commercial fishing catch in this area consists of *Prochilodus platensis* (Characidae); this species and some elements of the Loricaridae and Curimatidae have been grouped in the detritivore category for analysis.

Published abundances and biomass estimations, plus personal communications, have been taken into account as the only sources of information, due to the low level of exploitation in the system and the unreliability of commercial fishing statistics.

Fish Sampling

Salto Grande Reservoir (Fig. 3) was sampled during two periods; 1980–1981 at six stations and 1981–1982 at five stations, each of them representative of the reservoir's different subenvironments. The gear used was a fleet of nine gill nets, each net 50 m long, 185 m^2 in surface, and hung by a 0.5 ratio. Stretched-mesh sizes were 42, 50, 60, 70, 78, 105, 120, 140, and 170 mm. The fleet was set at the surface, perpendicular to the shore with the smallest mesh toward shore. Stations were sampled on two consecutive nights, bimonthly in 1980–1981 (Quirós et al. 1984) and trimonthly in 1981–1982. The captured fishes were identified, weighed, and measured in the field and only fish caught at night (1900–0700 hours) were considered. The catch per unit effort (CPUE) is expressed as kg/fleet-night as an indicator of fish abundance.

Fish sampling in the Plata River, in the coastal zone near Buenos Aires (Fig. 4), was performed with a commercial fishing vessel and a surround net. The catches were not weighed and only their total volume was qualitatively estimated.

Concerning the Paraná River (upper and middle), data have been derived from Bonetto et al. (1969), Bonetto$_1$ et al. (1970), Bonetto$_2$ et al. (1970), Bonetto et al. (1971), Cordiviola de Yuan (1977), and Cordiviola de Yuan and Pignalberi (1981). Data from Bonetto et al. (1978) have been used for the subbasin of the Riachuelo River, and from Bonetto et al. (1981) for the Iberá

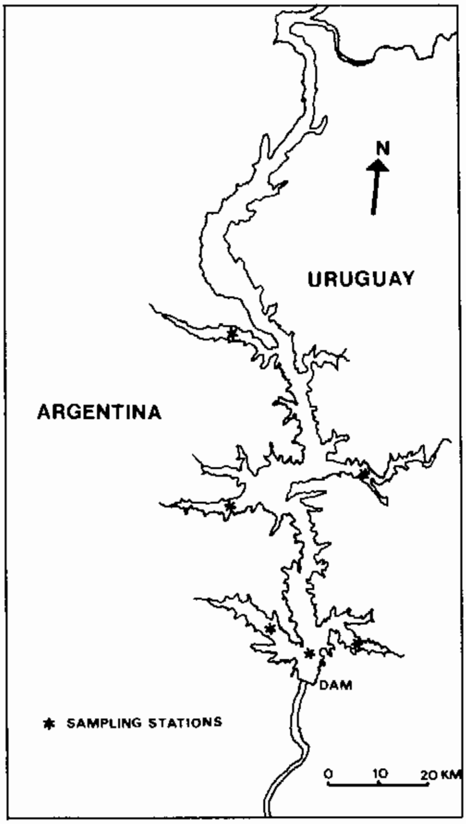

FIGURE 3.—*Salto Grande Reservoir.*

FIGURE 4.—*The Plata River.*

system (Fig. 1). For determining fish abundance in island lagoons of the floodplain, they used a depletion method with a beach seine. Bonetto et al. (1969) presume that such depletions may be considered exhaustive, and we consider them as fish biomass (FB) in our analysis.

Cordiviola de Yuan and Pignalberi (1981) present results of fishing in island lagoons in the floodplain of the middle Paraná, where latitudes range from 31°40′S (Los Sapos, El Vado, Sirgadero and Los Chepes islands) to 27°28′S (Noguera and Palomera islands). The number of fishing hauls were not the same for all lagoons, so we use "catch per fishing haul" (CPUEh) as an approximation to fish abundance. We omit lagoon number 5 where too many fishing hauls were performed. The information on capture composition was obtained from the authors (Cordiviola de Yuan, personal communication).

Environmental Sampling

In Salto Grande Reservoir, limnological sampling occurred on the same dates of fish sampling. At all stations, temperature, dissolved oxygen, conductivity, and pH profiles were measured with a Horiba U-7 deep sensor calibrated in situ. Water samples were taken at three depths with a plastic Van Dorn bottle; in the field laboratory (Quirós and Cuch 1982), dissolved oxygen in these samples was determined by the alkali–azide modification of Winkler's method (APHA et al. 1978), and conductivity, alkalinity, and total inorganic carbon were measured by titration and with an Orion 407 ion analyzer (Golterman et al. 1978). Separate samples were taken at 0.2-m depth to determine total concentrations of nutrients. Other samples were filtered through Whatman GF/C filters and afterwards through Millipore membrane filters (0.45-μm pores) to determine soluble compounds. The water samples for nutrient analysis were preserved with sulfuric acid at 4°C, and the determinations were performed within 10 days after the samples were taken. Total phosphorus was analyzed by the ascorbic acid method (APHA et al. 1978). Total organic nitrogen and total and soluble chemical oxygen demand were measured according to Golterman et al. (1978). At one of the stations, these determinations were made at three depths (Quirós and Cuch, in press). Chlorophyll determinations were done according to Stauffer et al. (1979) after filtration through a Whatman GF/C filter (Quirós and Luchini 1982).

In the Plata River, samples were taken at 0.5-m depth at each fishing ground in the coastal zone and along a transect from Buenos Aires to Martín García Island (Quirós and Senone, unpublished; Fig. 4). The analytical methods were those described above.

The chemical oxygen demand was taken as an indicator of organic matter levels (Maciolek 1962).

Limnological data for the middle Paraná River (Bonetto et al. 1969; Cordiviola de Yuan and Pignalberi 1981) come from surface samples taken during the period of fish sampling. Analysis generally followed APHA et al. (1976). Chlorophyll determinations were performed on acetone extracts filtered through 45-μm-pore Millipore membrane filters, and total organic matter was measured by permanganate oxidation. These data are available from INALI (National Limnology Institute, Santo Tomé, Santa Fe, Argentina). Data for the Iberá system belong to Bonetto et al. (1981) and Bonetto (personal communication); those pertaining to the Uruguay River tributaries come from Comisión Técnica Mixta de Salto Grande (1982).

Data Analysis

Each data base was analyzed separately because of the different methods used to determine fish abundance and levels of organic matter in the water column.

Correlation–regression analyses were performed. Dependent variables are average catch per unit effort in each sampling period (CPUE) for Salto Grande Reservoir (1980–1982), and fish biomass (FB, 1969) and catch per fishing haul (CPUEh, 1981) for the middle Paraná. Independent variables for Salto Grande Reservoir are chemical oxygen demand in the water column (COD) in milligrams of oxygen consumed per litre; total organic nitrogen (TON), total phosphorus (TP), electrical conductivity at 20°C (K_{20}), total chlorophyll concentration (CHL), and, as indicators of heterotrophic activity, carbon dioxide and dissolved oxygen concentrations at the surface (CO_{2s}, DO_s) and at the bottom (CO_{2b}, DO_b). For the middle Paraná, 1969 and 1981, they are permanganate oxidizability (OX) in mg of oxygen consumed per litre, electrical conductivity (K), bicarbonate concentration HCO_3, and turbidity (TURB). Measurement units are: TP and CHL, mg/m^3; TON, g/m^3; DO, mg/L; CO_2, milliequivalents/L; HCO_3, mg/L; TURB, Jackson turbidity units.

Regression and residual analysis follow Draper and Smith (1966); significances are based on t- and F-tests for simple and multiple correlation coefficients, respectively.

Results

Salto Grande Reservoir

Salto Grande Dam was completed in July 1979 and the reservoir was at full capacity in September 1979. Results from the first year of sampling (February 1980–February 1981) indicated that fish were distributed within the reservoir according to the organic matter content of the water column: CPUE was significantly correlated with COD and TON (Table 1); CPUE was also significantly correlated with indicators of heterotrophic activity: positively with CO_2 and negatively with DO. Catch was not well correlated with K_{20} or TP, measures of inorganic and organic nutrients, or with total chlorophyll concentrations (Quirós and Cuch 1982; Quirós and Luchini 1982; Quirós and Cuch, in press).

These relationships generally were borne out during the second sampling period (June 1981–February 1982), but nutrient concentrations (K_{20}, TP) were more important (Table 1). Linear regressions of CPUE versus TON and K_{20} explained 96% of CPUE variation during 1981–1982 ($\log_e CPUE = 1.33 + 2.0 \times 10^{-3} TON + 0.014 K_{20}$; $R^2 = 0.96$; $P < 0.05$).

During the first sampling period, the proportion of detritivores in the catch (f_D) correlated fairly well with total CPUE ($r^2 = 0.56$; $P < 0.09$) and very well with COD ($r^2 = 0.89$; $P < 0.01$) (Quirós et al. 1984). This could indicate that a higher proportion of detritivorous elements were present in subenvironments having a higher content of organic matter during the first months after the reservoir was at full capacity. This was not repeated during the following sampling periods.

Middle Paraná River

In 1969, fish biomasses (FB) in Los Sapos and El Vado lagoons of the middle Paraná River were most closely correlated with organic matter in the water column (OX) (Table 1). The largest deviation from this regression occurred in the lagoon having the lowest proportion ($f_D = 0.03$) of detritivores. Turbidity, HCO_3 and K were unrelated to biomass. There was not enough information about CHL to allow a regression, but the lagoon with the highest FB had the highest CHL; this suggests that the relevance of CHL should

TABLE 1.—*Regressions of catch per unit effort (CPUE), catch per fishing haul (CPUEh), and fish biomass (FB) against physicochemical variables for Salto Grande Reservoir on the Uruguay River and the middle Paraná River at Los Sapos Island. Range of the dependent variable and the number of measurements that enter each regression are in parentheses.*

Regression[a]	r^2	P	Regression[a]	r^2	P
Salto Grande 1980			***Salto Grande 1981***		
$CPUE = -126.4 + 245.71TON$	0.94	0.01	$CPUE = -90.9 + 193.57TON$	0.73	0.10
$\log_e CPUE = 1.51 + 3.57TON$	0.94	0.01	$\log_e CPUE = 1.76 + 2.86TON$	0.83	0.03
(TON: 0.63–1.04; $N = 6$)			(TON: 0.57–1.02; $N = 5$)		
$CPUE = -36.9 + 3.92COD$	0.86	0.01	$CPUE = -36.3 + 5.12COD$	0.94	0.01
$\log_e CPUE = 2.70 + 0.05COD$	0.83	0.01	$\log_e CPUE = 2.65 + 0.07COD$	0.91	0.01
(COD: 17–41; $N = 6$)			(COD: 12–32; $N = 5$)		
$CPUE = 34.0 + 0.34K_{20}$	0.03	0.75	$CPUE = -91.9 + 2.05K_{20}$	0.75	0.10
(K_{20}: 51–87; $N = 6$)			(K_{20}: 57–101; $N = 5$)		
$CPUE = 26.5 + 2.77CHL$	0.10	0.55	$CPUE = 50.3 + 1.12CHL$	0.02	0.81
(CHL: 3.7–13.6; $N = 6$)			(CHL: 1.6–16.4; $N = 5$)		
$CPUE = -81.4 + 2.63TP$	0.25	0.32	$CPUE = -51.6 + 1.51TP$	0.92	0.01
(TP: 42–62; $N = 6$)			(TP: 48–117; $N = 5$)		
$CPUE = -30.5 + 874.40CO_{2(b)}$	0.78	0.02	$CPUE = 571.8 - 67.40DO_b$	0.82	0.04
			(DO_b: 8.11–6.64; $N = 5$)		
$\log_e CPUE = 2.74 + 11.68CO_{2(b)}$	0.82	0.02	$\log_e CPUE = 2.94 + 14.49CO_{2(b)}$	0.72	0.08
($CO_{2(b)}$: 0.06–0.17; $N = 6$)			($CO_{2(b)}$: 0.04–0.12; $N = 5$)		
Middle Paraná 1969[b]			***Middle Paraná 1981***[c]		
$FB = 152.1 + 22.85OX$	0.68	0.10	$CPUEh = 0.5 + 0.33OX$	0.22	0.07
(OX: 99–28.3; $N = 5$)			(OX: 7.7–29.6; $N = 15$)		
$FB = 429.0 + 0.80HCO_3$	0.01	0.89	$CPUEh = 8.3 - 0.07HCO_3$	0.09	0.30
(HCO_3: 135–210; $N = 5$)			(HCO_3: 8.9–82.7; $N = 15$)		
$FB = 671.1 - 0.80TURB$	0.38	0.28	$CPUEh = 2.9 + 0.01TURB$	0.47	0.01
($TURB$: 15–385; $N = 5$)			($TURB$: 22–888; $N = 15$)		
$FB = 441.7 + 0.08K$	0.01	0.89	$CPUEh = 5.2 - 0.002K$	0.00	0.85
(K: 1,241–1,774; $N = 5$)			(K: 56.5–308; $N = 15$)		

[a] CHL = total chlorophyll, mg/m^3;
COD = chemical oxygen demand, mg O_2/L;
$CO_{2(b)}$ = dissolved CO_2 at bottom, mmol/L;
DO_b = dissolved oxygen at bottom, mg/L;
HCO_3 = bicarbonate, mg/L;
K_{20} = conductivity at 20°C, µS/cm;
K = conductivity, µS/cm;
TON = total organic nitrogen, g/m^3;
OX = permanganate oxidizability, mg O_2/L;
TP = total phosphorus, mg/m^3;
$TURB$ = turbidity, Jackson units.

[b] Bonetto et al. (1969).

[c] Cordiviola de Yuan and Pignalberi (1981).

be explored. Zooplankton abundance was not related to FB.

In 1981, CPUEh in the Los Sapos lagoons of the middle Paraná was correlated with OX but not with HCO_3 or K (Table 1). The observed correlation between CPUEh and TURB (r^2 = 0.47; $P < 0.01$) could indicate a phenomenon related to catchability due to the type of gear used, or to a relation we can not determine with the existing information.

The lagoons at Los Sapos and El Vado islands are influenced by the Salado River with high levels of organic matter (OX = 15 mg O_2/L) of both natural and cultural origin (Maglianesi and Depetris 1970; Stangenberg and Lenardon 1970), and have the most important ichthyomass that has been registered in the floodplains of the middle Paraná River (Bonetto et al. 1969; Bonetto$_2$ et al. 1970; Cordiviola de Yuan and Pignalberi 1981). In the lagoons under greater influence of the main channel (middle Paraná River: OX = 3.90 mg O_2/L), the fish abundance is reduced, parallel to the lowering of OX and nutrient concentrations (Stangenberg and Maglianesi 1968a, 1968b; Bonetto and Maglianesi 1969; Bonetto$_1$ et al. 1970; Cordiviola de Yuan 1977; Bonetto and Lancelle 1981). For instance, lagoons at Los Sapos and El Vado islands showed higher CPUEh (73% and 75% respectively) than lagoons at Los Chepes and Sirgadero islands in the main channel, and the differences were even greater when Los Sapos and El Vado catches were compared with those from up river lagoons at La Palomera and Noguera islands (Cordiviola de Yuan and Pignalberi 1981). This allows us to affirm that the relation between fish abundance and organic matter of the water column applies over a wider spatial scale than that given by Los Sapos and El Vado islands.

At Los Sapos, El Vado, and Los Chepes islands (1981), CPUEh correlated linearly with f_D (N = 27; $r = 0.49$; $P < 0.01$), Los Sapos lagoon showing the highest f_D registered (56% of catches with $f_D > 0.90$) together with the greatest CPUEh and the highest levels of OX and HCO_3. Residual analysis of regressions *CPUEh* versus *OX* and *CPUEh* versus f_D, for Los Sapos Island, showed that *OX* underestimated *CPUEh* at high f_D values (Fig. 5); this may indicate a positive CPUEh dependence on the latter variable. When residuals of the regression *CPUEh* versus f_D were analyzed, the latter overestimated CPUEh at low OX values; at intermediate OX values, residuals were randomly distributed, and at high OX values, CPUE was underestimated (Fig. 5).

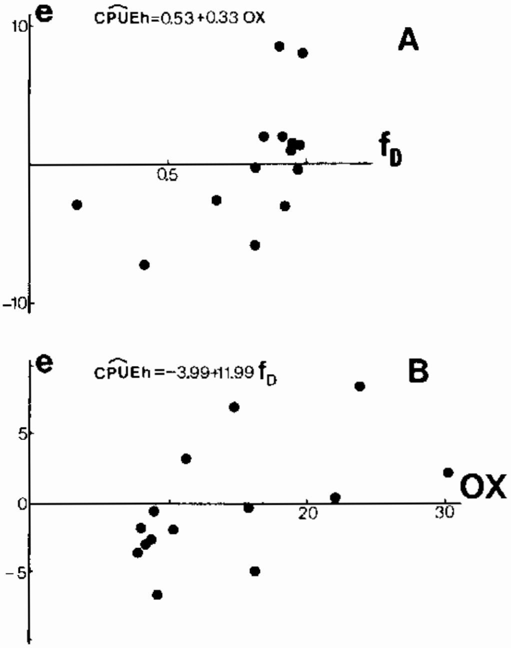

FIGURE 5.—*Los Sapos Island, middle Paraná River, 1981: residuals (e) of (**A**) the regression of catch per fishing haul (*CPUEh*) versus oxidizable matter (*OX*) plotted against the frequency of detritivorous fishes (*f_D*), and (**B**) of the regression of* CPUEh *versus* f_D *plotted against* OX.

Plata River

There are two important areas for commercial fishing in the Plata River (Candia and Milone, personal communication). The first is located west and northwest of Martín García Island, where the Paraná and Uruguay rivers meet to form the Plata. The second is located on the coastal zone along the waterfronts of the cities of Buenos Aires and La Plata. In the latter areas, streams containing high loads of organic matter of cultural origin flow into the Plata River, particularly in the vicinity of Berazategui not far from the city sewer discharge (Fig. 4). At a 1,500-m average distance from the shore, levels of organic matter increased from the mouth of Buenos Aires harbor (COD = 38 mgO_2/L; TP = 186 mg/m^3; TON = 0.91 g/m^3) to the sewer discharge area (COD = 80 mgO_2/L; TP = 237 mg/m^3; TON = 2.74 g/m^3). Fish catches, mainly *Prochilodus platensis* and *Mugil* sp., increased 10-fold along the same transect.

Another transect was made between Riachuelo stream mouth and Martín García Island (Fig. 4). Organic matter levels were high at the mouth of the stream (COD = 47 mg O_2/L; TP = 220 mg/m^3; TON = 2.00 g/m^3), decreasing towards the middle of the Plata River (COD = 33 mg O_2/L; TP = 96 mg/m^3; TON = 0.63 g/m^3), and increasing once more near Martín García Island (COD = 40 mg O_2/L; TP = 104 mg/m^3; TON = 1.19 g/m^3). The zones with highest values coincide with the commercial fishing grounds.

Other Subsystems

Bonetto et al. (1978) studied the structure of fish communities in three lagoons in the Riachuelo River basin (Fig. 1) near Corrientes city. Because of the qualitative sampling method used, the estimation of fish abundance is based on the author's judgement: Totora lagoons, "low density"; La Brava Lagoon, "moderate abundance"; Gonzalez Lagoon: "dense population . . . abundant *Prochilodus platensis* and "viejas de agua" (Loricariidae)." If we assign numbers to these assessments—1, 2, and 3, respectively—the regression of fish abundance versus *OX* gives r^2 = 0.997 ($P < 0.03$). The correlations with other environmental variables (Caro et al. 1979) were considerably lower.

In their study on the Iberá system ichthyofauna, Bonetto et al. (1981) described two ecological regions. Migratory species of the Paraná

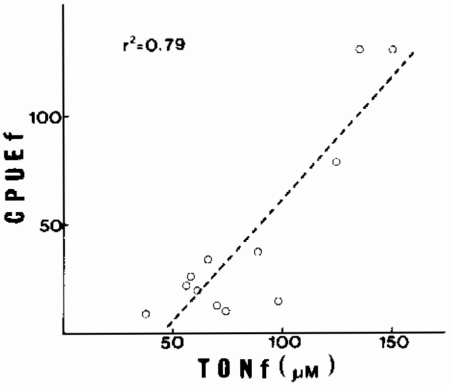

FIGURE 6.—*Salto Grande Reservoir. Relation between catch per unit effort (CPUEf) and total organic nitrogen (TONf) in February 1984.*

fauna, particularly *Prochilodus platensis*, are limited to the southwest region influenced by the Corrientes River; fish generally are less abundant to the northeast. The authors say this distribution is due to factors having direct effects on fish, such as dense vegetation that inhibits fish movements, increases in water acidity, and lack of dissolved oxygen in vegetated areas, among others. It is to be expected that the low concentrations of available nutrients (conductivity, 15–50 μS/cm) will keep heterotrophic production based on macrophyte decay low over the whole system, even with high levels of available organic matter (Bonetto, personal communication). It is then valid to assume that limits to abundance and distribution of fish could act at the level of the fish community. The possibly lower fish production in the northeast could be explained by the low nutrient concentrations.

Bonetto and Drago (1968) compared the amount of fish in the upper Paraná River to that of the axis formed by the Paraguay and middle Paraná rivers; fish abundance in the former was only 30% of that in the latter, the Loricariidae being poorly represented. Oxidizable matter was positively related to the fish abundance described (upper Paraná River, OX = 2.59 mg O_2/L; middle Paraná River, OX = 3.90 mg O_2/L; lower Paraguay River, OX = 9.24 mg O_2/L: Maglianesi 1973; Bonetto 1976; Bonetto and Lancelle 1981). On the other hand, Bayley (1973) observed big shoals of *Prochilodus platensis*, the fish with empty stomachs but in breeding condition, in the upper section of the Pilcomayo River, a tributary (with no floodplain) of the Paraguay River; he reasoned that fish migrate toward the lower swampy areas, in the middle section of the river, to feed.

In the riparian area of the Uruguay River, the best fishing grounds are found at the mouths of tributary streams and rivers, particularly the Mocoretá and Miriñay rivers. The Mocoretá River mouth is now the arm of the Salto Grande Reservoir having the most fish. At their mouths, both rivers have the highest levels of organic matter of all the Uruguay River tributaries south of the Miriñay River (Comisión Técnica Mixta de Salto Grande 1982). Such concentrations of fish at the mouths of tributaries also have been noted for three tributaries of the upper Paraná River, near Corpus (Castello, personal communication).

Discussion

Salto Grande Reservoir has a central zone of great water exchange and low inorganic turbidity. Our 1982 data show ratios of phytoplankton gross primary productivity to respiration in the water column less than one. Macrophytes are unimportant (Quirós et al., unpublished). On this basis, we characterize this reservoir as heterotrophic and suppose that a great proportion of the energy input is channeled through the detritus chain. Average fish abundance increases from the middle to the end of the arms together with increases in the levels of organic matter in the water column. The relationship between fish abundance and organic matter obtained in 1980–1982 cannot be considered "predictive" because five of the six stations had statistically nondistinguishable CPUEs. But extensive sampling at 12 stations in February 1984 showed that TON explained 79% of the CPUE variation with more uniform distributions of the dependent and independent variables (Fig. 6: Quirós and Delfino, unpublished). Such sampling included stations at the ends of the lateral reservoir arms. Also, during 1982, zooplankton abundances (number/L) were directly related to organic matter concentrations in the water column.

The middle Paraná seems to present similar results. Island lagoons under greater influence of the main river channel showed smaller ichthyomasses than those near the margins of the floodplain, where they are influenced by secondary channels and lateral tributaries with more organic matter. In particular, the lagoons at Los Sapos and El Vado islands, reported to have the highest biomasses registered in river–floodplain systems (Welcomme 1979), are under the direct influence of the Salado River, which discharges a high load of organic matter into them. Such a scheme seems to be repeated in the coastal zones of the Plata River.

The low average depth and the lack of permanent stratification in the environments considered may facilitate the resuspension of sediments by wind and wave action (Drago and Vasallo 1980) as well as mineralization of some organic matter within the water column. No matter where this organic matter is processed, we consider it a fundamental element in the total trophic structure of the system. The large proportion of detritivorous elements in the ichthyomass (particularly illiophagous ones) permits us to suppose that a substantial portion of the total organic matter is processed at the benthic detritus level (Bowen 1979, 1981). Presently, we lack the information to relate organic matter levels in the benthos to those in the water column. The results of Bonetto et al. (1981) in the Iberá system, as well as research in other places (Welcomme 1979), indicate that the relation between organic matter levels in the water column and fish abundance would not be valid in environments with low nutrient concentrations.

In Salto Grande Reservoir during the first 18 months after it filled, in the middle Paraná River, and in the Plata River there seems to be a direct relationship between the levels of organic matter in the water column and the proportion of detritivorous elements in the ichthyofauna. The relationship may be indirect—for example, both organic matter in the water and feeding opportunities for detritivorous fishes could be independent functions of such local factors as recent flooding of land or discharge of an organics-laden tributary—but it may be no less reliable for that. Our first results for Salto Grande Reservoir seem to repeat themselves in other subsystems of the Plata basin, particularly in the middle Paraná and the Plata rivers. The available data for the rest of the basin are consistent with these inferences although much less conclusive.

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