ACTA
AMAZONICA

Fisheries and fishing effort at the Indigenous reserves Ashaninka/Kaxinawá, river Breu, Brazil/Peru.

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ABSTRACT

This article aimed to describe the subsistence fisheries of traditional populations of three ethnic groups, one Ashaninka and two Kaxinawá, lying on the banks of the River Breu. Initially, monitors were trained to fill logbooks with data from fisheries of the villages during an annual cycle (august/1995 – august/1996). Based on these data, it was realized an inventory of the most common fish species caught as well as one about the fishing environment. The following results were obtained: i) Indians prefer to use pools, locally known as "poços", for fishing; ii) the most common caught species are the "mandis" (35%, Pimelodidae), armored catfishes (Loricariidae), specially Hypostomus sp. (25%), the "curimatá" (9%, Prochilodus sp.) and the "saburus" (8%, Curimatidae), among others; iii) the fishing gears that lead to a high rate of fishing are the native "tingui", nets and bow and arrows; iv) fisheries are more intensive during summer; v) the fishing effort and their associated factors statistically significant in predicting the catches in the Indian Reserve were f_1 = number of fishermen, f_2 = (number of fishermen*total time devoted to fishing), f_3 = *[*(number of fishermen)*(total time devoted to fishing)-(the time displacement)*]* and the factor villages and fishing gears; vi) although almost all the fisheries are done by walking to the fishing places, catches increase when paddle boats are used; and vii) the most active fishermen belong to Kaxinawá tribe.

KEY WORDS

Amazon; indigenous fisheries; Ashaninka; Kaxinawá; River Breu; Juruá basin.

As pescarias e esforço de pesca na Reserva Indígena Ashaninka/Kaxinawá, rio Breu, Brasil/Peru.

RESUMO

Este artigo tem o objetivo de descrever a pesca de subsistência das populações tradicionais de uma aldeia Ashaninka e duas Kaxinawá vivendo à beira do rio Breu. Inicialmente, foram treinados monitores para preencher fichas de coleta de dados das pescarias nas aldeias durante um ciclo anual (agosto/1995 – agosto/1996). A partir desses dados realizaram-se os inventários das espécies de peixes capturadas e dos ambientes pesqueiros. A análise dos dados foi efetuada por meio de estatística descritiva e exploratória. Os resultados obtidos foram os seguintes: i) *os ambientes mais procurados pelos índios foram os poços;* ii) *as espécies mais capturadas os mandis (35%, Pimelodidae), os bodes ou cascudos (Loricariidae), com destaque para o bode praiano (25%,* Hypostomus *sp.), o curimatã (9%,* Prochilodus *sp.) e os saburus (8%, Curimatidae), entre outros;* iii) *constatou-se que os arreios ou apetrechos de pesca que mais capturam peixes são o tingui (veneno), a tarrafa e o arco/flecha, respectivamente;* iv) *durante o verão a atividade de pesca é mais intensa;* v) *as medidas de esforço de pesca e os fatores associados que foram estatisticamente significativos nas predições das capturas na Reserva Indígena foram:* f_1 *= o (número de pescadores),* f_2 *= o (número de pescadores*tempo total das pescarias) e* f_3 *= o [(número de pescadores*tempo total das pescarias)-(o tempo de deslocamento)] e os fatores aldeias e arreios;* vi) *apesar da maioria das pescarias serem realizadas a pé até os pesqueiros, as capturas são maiores quando a locomoção se dá através de canoa a remo; e* vii) *os pescadores mais ativos nas pescarias na Reserva Indígena foram os Kaxinawá.*

PALAVRAS-CHAVE

Amazônia, Pescarias Indígenas, Ashaninka, Kaxinawá, Rio Breu, Bacia do Juruá.

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INTRODUCTION

Anthropoid interventions in the great rivers of the world are millenary with varying degrees of environmental impacts. The degradation of the biotic integrity (Karr, 1981) of these aquatic ecosystems set in several continents, like the Mississippi River in North America, the River Tietê in South America, the River Nile in Africa and the River Danube in Central Europe, among others (Petrere &Agostinho, 1993; Bayley, 1995; Barry *et al.* 1995). On the other hand, many tropical rivers maintain their biotic integrity like the ones in the headstreams of the upper River Juruá above the municipality of Marechal Taumaturgo, Acre State, North of Brazil. The ecosystems in this region maintain the structure and its natural functions, keeping the rate of anthropoid interventions low.

The upper River Juruá groups conservation units with several territories of traditional human populations, like rubber latex extractors villages and the ethnic groups Ashaninka, Kaxinawá, Manchineri, Kulina, Katukina, Nukuni, Jaminawa, Arara, Poyanawá, Yawanawá, among others, that have no contact with the occidental civilization. The Ashaninka is an ethnic group of the linguistic family Arawak who descends from the pre-Andean Arawak, from the subgroup Kampa. The languages of the Arawak family extend from the Guyana region of the rivers Orinoco, Solimões, and Marãnon until the western part of Mato Grosso State in Brazil (Mendes, 1991). On the other hand, the Kaxinawá group was enslaved by rubber-tappers at the end of the XIX century. Nowadays, this traditional population lives in a social pattern that resembles those from their past colonizers, though they retained their language and customs of their masters. This ethnic group is the largest Indian population of Acre State, with about 4000 people living in nine Indian areas, some of them in Peru, in the upper River Purus and River Caranja. The Kaxinawá belongs to the linguistic family Pano (Aquino & Iglesias, 1992).

This region in the Amazonian basin still possesses low demographic density, low mining (mainly gold), low farming activity, and low use of hydro energetic resources. The exception is the plan to build the highway BR-364, which will link the cities Rio Branco and Cruzeiro do Sul, in Brazil, that possibly will expand to the Pacific Ocean, after joining the Transamerica highway in Peru. This enterprise is a matter of concern, because of the way it has been developed; it will probably have the possibility of repeating the same expansionist model of the agriculture frontiers done in Rondônia State in the last decades (Aquino, 1997).

Petrere (1992) stated that the economical and social development models adopted in the past decades by the governments to the Amazonian basin were misleading since they did not respected the ecological peculiarities of the region, the soil fragility, the purity of their waters, the health and the well being of the traditional populations. The modern development model assumes a sustainable use of the resource, not only it's merely exploitation. Thus, we shall not repeat in the Amazonian region the motto "destroy first, try to fix after", as it was adopted in Europe, United Stated, Japan and in the southern part of Brazil. Petrere (1992) also stated that we have the moral obligation, as people and as a Nation, of developing the Amazonian region in an equilibrated way. The aim of this work is to describe, compare, and analyze the subsistence fisheries of the traditional populations of the Ashaninka and the Kaxinawá Indian tribes in the Indian reserve that belongs to the River Breu.

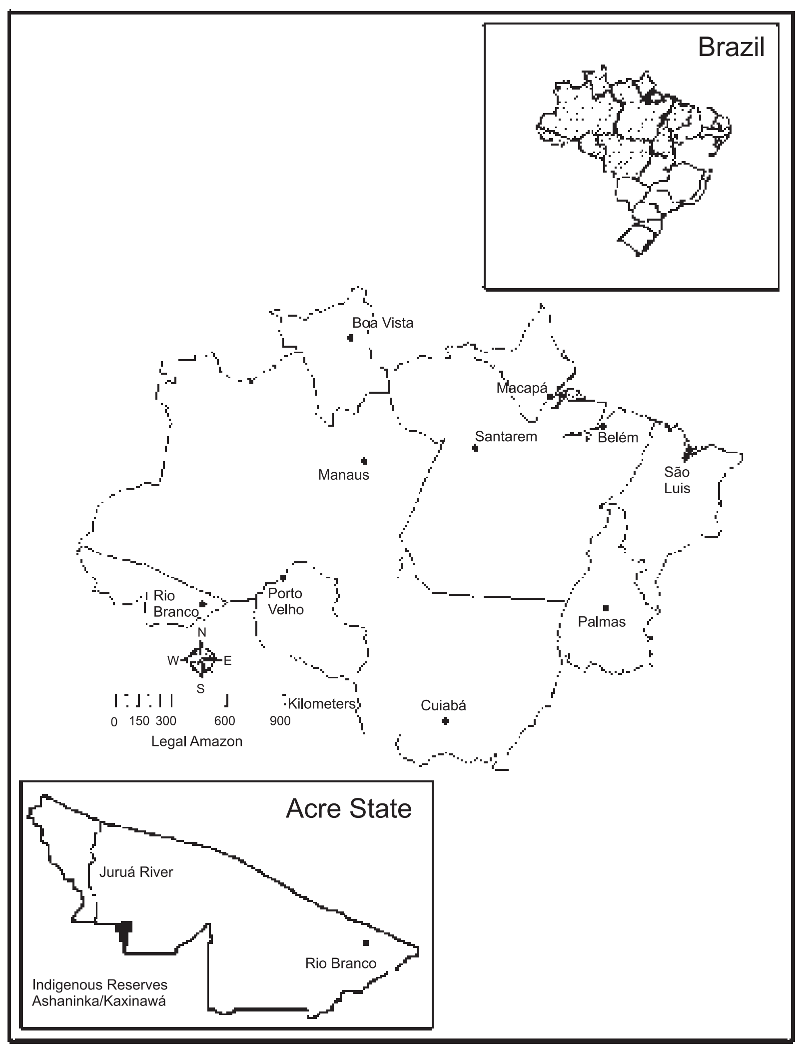

Figure 1 - Study area and its geographical location in Amazon basin. Source: RADAMBRASIL, (1977).

MATERIAL AND METHODS

The study area is in the Indian Reserve Ashaninka-Kaxinawá, in the River Breu basin, in the frontier of Brazil with Peru (Figure 1). The regional physiography is a dissected and undulated landscape, showing low plateaus covered by open tropical forest and spots of dense tropical forest. The River Breu is a third-order affluent of the alluvial basins of the rivers Javari and upper Juruá. The Indian Reserve lies in the middle and upper Breu River, with an area of 23,840 hectares in the municipality of Marechal Taumaturgo, Acre State, Brazil. The estimated Indian population is 350 inhabitants (Aquino & Iglesias, 1992). The regional climate consists of rainy (November to May) and dry (June to November) periods, with annual precipitation around 2,224 mm (RADAMBRASIL, 1977).

Sampling of Fisheries Data

Three teachers who taught in the schools of the Ashaninka and the Kaxinawá villages were responsible for gathering continuous data about the fisheries in the Indian Reserve. They were trained through pilot fisheries, which had the purpose of assembling a routine protocol for data sampling as well as to make the local community used to the development of this study. Sampling of fisheries data in the villages was monitored by a field assistant (November 1995 to July 1996) and by the first author (August 1995 to April 1996). The village houses and the collective fisheries were the sampling units in this study. Fisheries data sampling in the Indian Reserve grouped a hydrological cycle however, due to technical difficulties, data sampling were carried out for 6 months in the Ashaninka village, for 12 months in the Kaxinawá village at Mourão and for 8 months at the Kaxinawá village at Japinim.

Inventory of Fish Species

The inventory of fish species caught in the basin of the River Breu was done in summer (August 1995) and winter (April 1996) periods, along with the fishing carried out by the inhabitants of the villages. Field inventories provided a lower number of species in relation to those effectively caught in the villages. The author identified the collected species, and voucher specimens were deposited in the Zoological Museum of the University of São Paulo (MZUSP). Taxonomic identification of specimens caught in the villages, but absent in the inventory, were done with the aid of a Fish Catalogue for the studied area provided by Silvano *et al.* (2000) and Silvano *et al.* (2001).

Data Analyses

Information gathered with the fishermen about fisheries and fisheries resources was tabulated with basic statistics (mean, standard deviation), with the purpose of describing some demographic characteristics through estimation and participation of the fishermen during each fishery. For example, fishing duration, number of fishermen per boat, fishing habitats, seasons of high abundance of fish species caught and the most common gears used by them. Initially, fisheries in the villages were analyzed through the index of pondered dominance ID% = $[(P_i*W_i)/(\sum P_i*W_i)]*100$, where P_i is the number of individuals and W_i is the weight of the fish species by fishing spot, among villages and by fishing gears (Beaumord, 1991).

The covariance analysis was used to understand how the catches in the Indigenous Reserve were generated from the efforts of fishing gears used by the fishermen of the villages. Data were log transformed to achieve linearity between the response variable (catches) and the explanatory variables (fishing efforts). The covariance model used was as follow:

(eq.1)

$$Y_{ijklmn} = m+a_i+p_j+q_k+d_l+k_m+\sum_{n=1}^{5} b_n(f_{ijklmn} - \bar{f})+e_{ijklmn},$$

where:

Y_{ijklmn} is the response variable, as described by the catches (kg);

m is the overall mean;

a_i is the factor village, with 3 levels: 1- Ashaninka, 2 – Kaxinawá at Mourão and 3 – Kaxinawá at Japinim;

p_j is the factor fishing gears with 3 levels: 1- bow and arrow, 2 – nets and 3- native venomous "tingui";

q_k is the factor seasonality, with 2 levels: 1 – summer and 2 – winter;

d_l is the factor kind of locomotion to the fishing spot, with 2 levels: 1- walk and 2- boat;

k_m is the factor fishery environment, with 4 levels: 1 – pools, 2- run, 3 – lakes and 4 – "igarapés"

b_n is the linear coefficient;

f_{ijklmn} is the covariate of fishing effort *n* = 1, 2, 3, 4, and 5 different units, where f_1 = number of fishermen, f_2 = number of fishermen*total time devoted to fishing, f_3 = [(number of fishermen)*(total time devoted to fishing - the time displacement)]; f_4 = number of fishing gears; and f_5 = number of fishermen*total time devoted to fishing*number of fishing gears or kilo of "tingui"; $\bar{f}$ is the covariates means of different fishing efforts; and e_{ijklmn} is the random error, supposed $N(0, s^2)$.

As we did not have enough degrees of freedom for testing a full model including all factors interactive and covariates, we needed to break up the analyses in two different ones. The first included the factor villages and fishing gears and covariates. The second included the factor fishing gears, seasonality and locomotion and covariates.

After this, the step-wise analyses were carried out in order to obtain which factors and explanatory variables, concerned the five units of fishing effort were significant to explain the response variable. The second step was to analyze the parallelism between the lines of the response variable, factors, and explanatory covariates, leading to a saturated model.

Plotting studentizated residuals and the estimated values did sensitivity analysis of the model. A histogram of the normality of the residuals was also plotted, with the asymmetry (g_1), kurtosis (g_2) tests. Tukey test was used for a comparison between the significant factors in the covariance analysis model with the Indigenous Reserve (Sokal & Rholf, 1995).

RESULTS

The Indigenous populations Ashaninka and Kaxinawá

It can be seen that the Kaxinawá population showed some marked demographic differences compared with the Ashaninka (Table 1). The Ashaninka tribe possesses a younger population with familiar nucleus of about four people and an average of two siblings per family. The anthropoid intervention in the basin by the inhabitant can be considered as minor priority, with emphasis on fishing, hunting, "coivara" agriculture (planting after vegetation burning) and extrativism. In the past years, beans culture has increased for commercialization in the municipality of Cruzeiro do Sul (AC). Nowadays, rubber latex exploration has a low production in the upper area of the reserve in the Kaxinawá village at Japinim. Subsistence fishing and hunting are common among Indian populations. It can be noted an expansion of Kaxinawá community in the Reserve, mainly, after displacements associated with the beginning of the bean agriculture.

Inventory of Fish Species

In the inventories performed at the Indigenous Reserve, 41 fish species were collected. Other 27 species that were not collected during the sampling period were described by Silvano *et al.* (2000) and Silvano *et al.* (2001). Thus, catches in the Indigenous Reserve Ashaninka/Kaxinawá groups 59 species plus one species of crab *Sylviocarcinus devillei*. The fish species belong to the Order Characiformes, with six families, Siluriformes, with three families, Gymnotiformes and Perciformes, with two families each and Rajiformes with Potamotrygonidae family (Table 2).

Table 1 - Demographic characteristics of the Ashaninka and the Kaxinawá villages.

Variables	Ashaninka	Kaxinawá at Mourão	Kaxinawá at Japinim
Number of interviews	11	13	17
Mean age	26 years	34 years	39 years
Estimated number of inhabitants	44	69	110
Estimated number of children	22	43	76
Average family size	4	5	6
Average number of children	2	3	4

Fishing at the Indigenous Reserve

Three hundred and fifty nine fishing activities were sampled in the Indigenous Reserve, where 96, 176 and 87 trips occurred between the Ashaninka, the Kaxinawá at Mourão, and the Kaxinawá at Japinim villages, respectively. Total catches in the Indigenous Reserve was 2.895 kg with 44.583 specimens of several species. The most common fish species were the mandis (35% *Pimelodus sp.*), the bode praiano (25% *Hypostomus sp.*), the curimatã (9% *Prochilodus sp.*) and, the saburus (8% Curimatidae), among others. Most of the fishing (72%) was carried out in pools. Fishing spots with the highest catch were the "Algodão" pool (46%) in the Kaxinawá village at Mourão, "Mulateiro" (16%) and "Alho" (4%) pools, used by fishermen from both the Kaxinawá villages. The "Cuchirir" pool (6%) was the fishing spot most commonly used by the Ashaninka fishermen. The gears most often used during fishing, accordingly to the season of the year (summer/winter) were:

i) "Tingui" fishing (or fish venom) done with "tingui" plant (locally known as "puikaman" and "siká") in areas inside the forest, with the wild "tingui", which is collected in the forest and can be of different types such as "assacu" milk, "cipó de axá", and leaves of "psymin" and "ninpri". This type of fishing is normally carried out in a collective way in pools during the summer and in the "igarapés" during the winter;

ii) Net fishing, which is carried out during the summer and winter, in a collective way or by a single individual;

iii) Individual fishing during the summer with the aid of bow and arrows;

iv) Use of line and fishhook, which is practiced by single individuals near the houses during the summer and winter, and;

v) Diving fishing with *"bicheiro"*, which consists of a fishhook tied to a large piece of wood. Fishermen dive with this gear, attempting to catch large armored catfishes.

The fishing gears were used in the three villages, apart from the Ashaninka village, where the fishhook was used (Table 3). The mean number of fishermen shows that the "tingui" is the most used collective fishing method, and few fishermen use the fishing with a fishhook. The mean number of fishermen was higher in the Kaxinawá village at Japinim, since this village had the largest population and, relatively fewer fishermen do fishing at the Ashaninka village. Moreover, fishermen at this village spend more time in their fishing sites. Kaxinawá fishermen spend relatively little time to go to their fishing sites. The mean of fishing gears used is higher among the Kaxinawá, specially the "tingui" volume. The highest catches and the average kg/fisherman are related to the net use in the three villages. The "tingui" showed a high value in caught captured and average kg/ fisherman in the Kaxinawá village at Mourão. Tingui was

Table 2 - Fish species list of the River Breu (villages: A1 - Ashaninka; A2 - Kaxinawá do Mourão; and A3 - Kaxinawá do Japinim).

Nº	Order	Family	Sub-family	Genera/Species	Portuguese Name	Ashaninka Name	Kaxinawá Name	A1	A2	A3
1	Characiformes	Anostomidae		*Schizodon* fasciattus*	piau aracú	koana	puke batu	X	X	X
2				*Leporinus* sp1*	piau		mushu batu	X	X	X
3				*Leporinus* sp2**	piau lavrado		batu	X	X	X
4				*Abramites hypselonotus**	piau de pedra		isku tsa tsa		X	X
5				*Leporinus* sp3**	piau manteiga		batu			X
6				*Leporinus* sp4**	piau areia		batu		X	
7		Characidae	Characinae	*Roeboides* affinis*	madalena	thakiri	shetawa	X	X	X
8			Cynodontinae	*Rhaphiodon* aff. *vulpinus**	cachorrão	sawirimeki	kamã	X	X	X
9				*Hydrolycus scomberoides**	manoel besta, cachorro	assana	shau	X	X	X
10				*Boulengerella lucis**	agulha		pinu tsa tsa		X	X
11			Tetragonopterinae	*Astyanax bimaculatus**	piaba chata	matsistake	yapa	X	X	X
12				*Tetragonopterus argenteus***	matapiri		tapaturu		X	X
13			Triportheinae	*Triportheus* sp.*	sardinha	kaparano	yapatetuya	X	X	X
14			Serrasalminae	*Serrasalmus* sp*	piranha	roma	make	X	X	X
15			Salmininae	*Salminus hilarii**	tubarana		shãwãwã		X	
16		Gasteropelecidae		*Thorocacharax stellatus**	machadinha		shepatetu		X	X
17		Curimatidae		*Curimatella immaculata*** / *Steindachnerina* sp1*	saburu	thôtho	be	X	X	X
18				*Steindachnerina* sp2*	piaba	mereto	yapa	X	X	X
19				*Steindachnerina* sp3*	piaba comprida	matsistake		X		
20				*Potamorhina altamazonica**	mocinha	shimaniroki	tuká	X	X	X
21				*Psectrogaster amazonica***	casca grossa		beruwã	X	X	
22		Erythrinidae		*Hoplias* aff. *malabaricus**	traíra	txekori	meshku	X	X	X
23		Prochilodontidae		*Prochilodus nigricans**	curimatã	shima	kaprimã	X	X	X
24	Siluriformes	Callichthydae		*Hoplosternum litoralle***	tambuatá		bashu		X	

* Inventory in Ashaninka/Kaxinawá Reserve at River Breu; ** Silvano, *et al.* 2001.

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continuação da tabela 2

Nº	Order	Family	Sub-family	Genera/Species	Portuguese Name	Ashaninka Name	Kaxinawá Name	A1	A2	A3
25		Loricariidae	Hypostominae	*Glyptoperychthys punctatus**	bode amarelo	samoto	taxi ipu	X	X	X
26				*Glyptoperychthys gibbiceps***	bode grande		ipu	X	X	X
27				*Liposarcus pardalis***	bode seringueira		iã ipu	X	X	
28				*Hypostomus* sp1*	bode praiano	thentsi	mashã ipu	X	X	X
29				*Hypostomus* sp2**	bode machado	kirassaperi	masãkere	X	X	X
30				*Hypostomus* sp3**	bode preto	txentxemoko	ishki	X	X	X
31				*Hypostomus* sp4**	bode arraia		kanitê		X	X
32				*Hypostomus* sp5**	bode pintado		buku ipu		X	X
33			Loricariinae	*Loricaria* sp1*/ *Spatuloricaria evansii***/ *Limatulichthys punctatus***	bode cachimbo	thopiro	kushpã	X	X	X
34				*Loricaria* sp2.**	b. cachimbo areia	thopiro	maxi	X	X	X
35				*Sturisoma robustum***/ *Loricariichthys maculatus**	bode bico fino	koshiwa	tautia	X	X	
36				*Lamontichthys filamentosus**	bode cachoeira	manari		X		
37			Ancistrinae	*Ancistrus sp.**/ *Panaque* sp1*	bode mão na cabeça	shimpi		X	X	
38				*Panaque* sp2.*	bode barba		heshku		X	X
39				*Panaque* sp3.**	bode espinho		ipu		X	X
40		Pimelodidae	Pimelodinae	*Pimelodus* sp1*/ *Cheirocerus* sp1.**/ *Pimelodina* sp1.**/ *Pimelodella* sp1.**	mandi	kório	tunu	X	X	X
41				*Pimelodus* sp2.**	mandi igarapé	okonashi	ybu	X	X	X
42				*Pimelodus* sp3.**	mandi duro		tunu		X	X
43				*Pimelodus* blochii**	mandi listrado		ixish		X	
44				*Pimelodella gracilis***	mandi mole		ybu		X	X
45				*Cheirocerus eques**	mandi liso	tossorentsi	yuma	X	X	X
46				*Callophysus macropterus***	pintadinha	mota	tutu	X	X	X
47				*Pinirampus pirinampu**	piranambu, grudado			X		
48			Sorubiminae	*Duopalatinus peruanus* *Brachyplatystoma vaillantii***	piramutaba, mota		chistubai		X	X

* Inventory in Ashaninka/Kaxinawá Reserve at River Breu; ** Silvano, *et al.* 2001.

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continuação da tabela 2

Nº	Order	Family	Sub-family	Genera/Species	Portuguese Name	Ashaninka Name	Kaxinawá Name	A1	A2	A3
49				*Brachyplatystoma flavicans***	dourada		shatxu			X
50				*Pseudoplatystoma fasciatum***	surubim	tharawo	bai	X	X	
51				*Hemisorubim platyrhynchus**	braço de moça	kirana	bari i	X	X	X
52				*Platysilurus barbatus***	barba de arame		bixtu bai		X	
53				*Sorubim lima**	bico de pato	sawatari	kushu	X	X	X
54	Gymnotiformes	Apteronotidae		*Apteronotus bonapartii**	soia		ishapu	X	X	
55		Sternopygidae		*Eigenmannia macrops**	sarapó	thewiro	xima	X	X	X
56				*Sternopygus macrurus**	sarapó mutum		hasixima		X	
57	Perciformes	Sciaenidae		*Plagioscion* sp.**	pescada		maxishau	X	X	X
58		Cichlidae		*Aequidens* sp.*	cará	mâyto	mãi	X	X	X
59	Rajiformes	Potamotrygonidae		*Potamotrygon* sp.*	arraia	tsiweta	i	X	X	X
60	Crustaceous			*Sylviocarcinus devillei***	caranguejo	oerontsi	shatxu	X	X	X

* Inventory in Ashaninka/Kaxinawá Reserve at River Breu; ** Silvano, *et al.* 2001.

dominant in the Kaxinawá village at Japinim. However, in volume, the caught captured using this method was higher in the Kaxinawá village at Mourão, with 12 kg per fishing.

Catch variation in the Indigenous Reserve

Results from the analysis of covariance (ANCOVA) for the Indigenous Reserve are displayed in Tables 4, 5 and Figures 2 and 3. In Table 4, ANCOVA for the factor villages, fishing gears, and fishing effort showed variation in catch ($R^2 = 0.595$). Fishing effort congruent with catch was the (f_2) number of fishermen*total time devoted to fishing and (f_3) number of fishermen*(total time devoted to fishing - displacement time to fishing sites). Adjusted means for catches showed that higher catches occurred at the Kaxinawá village at Mourão, followed by the Kaxinawá at Japinim and the Ashaninka villages. Adjusted means were higher for "tingui" and nets than for catches using bow and arrows.

Results from ANCOVA for the factors fishing gears, seasonality, and locomotion to fishing sites and fishing efforts for the Indigenous Reserve are in Table 5. Fish catches were significant for all factors analyzed with a $R^2 = 0.383$. This suggests that, accordingly to the season of the year, the type of locomotion and the used gear had a distinction in fish catches. Fishing effort that showed significance for explaining of catches were (f_1) number of fishermen and (f_2) number of fishermen*total time devoted to fishing. It can be noted that in this covariance model, catches were differentiated between all factors, even between fishing gears. Accordingly, to the adjusted means (seasonal – summer, 3,269kg and winter, 1,635 kg), during the summer, catches became more expressive and locomotion by boats is associated with higher catches, although walking does most of the locomotion.

Residuals in the covariance model are shown in Figures 2 and 3. Some outliers (3 and 4 respective; ³ 2 residuals) were dropped from the analysis and the residuals are normal. Studentized residuals are shown as random points (Figures 2a and 3a) and histograms of the residuals suggest that they are normal (Figures 2b and 3b).

DISCUSSION

Fisheries at the Indigenous Reserve Ashaninka/Kaxinawá are strictly devoted to the subsistence of the families, a common pattern in the upper River Juruá and its tributaries (Peres, 1993; Begossi *et al.* 1999)

A distinction can be noted in the activity of the villages' fishermen during fishing. The Kaxinawá village at Mourão stands out in relation to the Ashaninka and the Kaxinawá at Japinim villages, for its high catch rate, and it is suggested that this fact is related to the every day life of this village.

Catches at the Ashaninka and the Kaxinawá at Japinim villages are lower because these populations devoted more time to collecting and hunting, while the Kaxinawá village at Mourão left behind the rubber latex exploitation to pursue beans agriculture. This pattern was also verified by another population at the upper River Juruá, where only 8% of the inhabitants devoted their time to rubber latex exploitation, while 92% are involved with harvesting beans (84%), corn (71%) tobacco (51%), among other plantations (Begossi *et al.* 1999). Thus, the agriculture starts to have a higher importance, since it starts to be directed towards commercialization.

This fact leads to a stronger dependence on fishing stocks by local people for their daily food intake. Time devoted to hunting tends to decrease, since the probability of finding a prey is smaller than that of catching a fish. Moreover, fishing has a more profitable reward with less time effort than hunting. Accordingly, to Beckerman (1983), fishing has a higher income of protein per hour than hunting, for almost all of the studied cases in Amazon. This trend of shifting from hunting to agriculture by local people may increase the deforestation of the area and lead to an increase effort at fishing sites.

Shifting in the strategies of the use of fishing gears is in accordance with the interactions of the factors village*gears and gears*seasonal*locomotion. Nets and the "tingui" possess the same patterns in the catches for the Kaxinawá villages, no matter the order of magnitude of the catches, with distinction to the catching patterns showed by the gears in the Ashaninka village. On the other hand, the gears (bow/arrow, nets and "tinguis") were differentiated in catching in relation to the season and locomotion to the fishing sites. These differences are related to the fact that the interaction between gears*locomotion is significant. Fishing with nets tends to be higher when locomotion is by walking, while fishing with "tinguis" tends to have higher catching rates when locomotion is done by boat.

Fishing carried out in the villages at the Indigenous Reserve still exerts a low pressure upon the fishing stocks. The majority of the displacements in the villages are by walking during the summer, although the adjusted means for the catches are higher for displacements by boats. This fact, along with the fishing effort that were

Table 3 - Fishing aspects of the Indian Reserve villages (inside parenthesis: standard deviation).

Villages	Fishing gears	Number of fisheries	Average number of fishermen	Average traveling hours till the fishing spot	Total fishing time	Average time spent in the fishing spot	Average number of fishing gears or kg of "tingui"	Total catch (kg)	Average total catch (kg)	kg fisherman
Ashaninka	"Tingui"	5	5	0:59(0:37)	3:34(1:34)	2:35(0:59)	3.8kg	16.0	2.666(3.145)	0.090
	Net fishing	75	2	0:53(0:27)	5:14(2:15)	4:21(2:08)	1	220.685	2.942(3.225)	0.566
	Individual fishing	16	3	0:58(0:46)	5:12(2:17)	4:13(1:59)	3	9.398	0.391(0.539)	0.087
Kaxinawá at Mourão	"Tingui"	31	7	0:30(0:27)	3:07(1:25)	2:37(1:08)	11.6kg	773.911	24.964(29.758)	0.542
	Net fishing	119	4	0:29(0:29)	3:14(1:42)	2:42(1:22)	2	1.162.875	9.772(9.658)	0.588
	Individual fishing	26	4	0:29(0:29)	3:12(1:58)	2:43(1:35)	4	82.325	3.166(2.601)	0.213
	Line and fish-hook	7	4	0:23(0:32)	2:50(1:36)	2:26(1:25)	1	2.775	0.462(0.463)	0.031
Kaxinawáat Japinim	"Tingui"	28	9	0:34(0:34)	3:02(1:24)	2:27(1:13)	9.5kg	173.265	6.188(6.343)	0.088
	Net fishing	31	5	0:28(0:38)	3:37(2:43)	3:08(2:18)	1	74.395	2.324(2.346)	0.159
	Individual fishing	14	5	0:28(0:38)	3:41(3:07)	3:13(2:33)	3	8.275	0.636(0.560)	0.050
	Line and fish-hook	14	3	0:10(0:10)	2:11(1:44)	2:00(-1:37)	2	13.100	0.935(0.856)	0.142

Table 4 - ANCOVA where the response variable are the catches (kg) and the factors villages and fishing gears and covariates f_2 (number of fishermen* total fishing time), f_3 [(number of fishermen*total fishing time)-(time displacement)].

Response variable (catch, kg) N = 352 R = 0.771 R2 = 0.595					
Source of variation	SQ	GL	MQ	F	P
Villages	149.711	2	74.856	82.389	0.000
Fishing gears	95.185	2	47.592	52.382	0.000
Villages* Fishing gears	18.013	4	4.503	4.956	0.001
f2	11.241	1	11.241	12.372	0.000
f3	3.490	1	3.490	3.841	0.050
Error	309.820	341	0.909		

Table 5 - ANCOVA where the response variable are the catches (kg) and the factors fishing gears, seasonality and locomotion and the covariates f_1 (number of fishermen) and f_2 (number of fishermen* total fishing time).

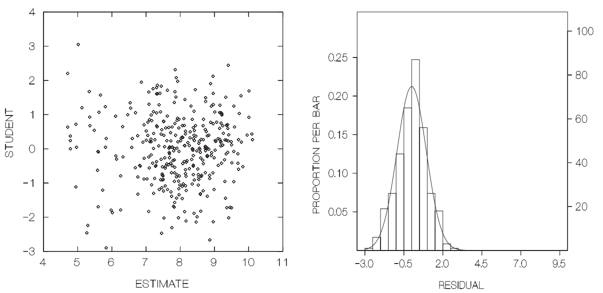
Response variable (catch, kg) N = 351 R = 0.619 R2 = 0.383					
Source of variation	SQ	GL	MQ	F	P
Fishing gears	94.0550	2	47.0275	34.9824	0.000
Seasonality	28.5739	1	28.5739	21.2553	0.000
Locomotion	9.0816	1	9.0816	6.7555	0.009
Fishing zears* Locomotion	10.6180	2	5.3090	3.9492	0.020
f1	13.2620	1	13.2620	9.8652	0.001
f2	11.3074	1	11.3074	8.4112	0.020
Error	461.1012	343	1.3443		

significant in predicting catching rates, showed that the obtained catches depend on the number of fishermen, time devoted to fishing and time spent at the fishing sites. Fishermen maximize their catching capacity only enough to supply food to their families (Beckerman, 1983; Begossi & Richerson, 1992; Begossi, 1992). Boats are only used when some festive parties happen, when local people get together for harvesting and for fishing of some particular species that when migrating, may increase catching rates.

These results confirm that fishermen optimize their time and strategies during fishing, by choosing environmental conditions that favors the development of fishing at the river basin. Accordingly to Hilborn & Walters (1992), catches are directly proportional to the efforts of the fishermen during fishing, varying in accordance with time and distance from fishing sites. Bayley (1988) showed that in 59 multi-specific tropical artisan fisheries, fishing efforts are pivotal for fishing income, especially the number of fishermen and time devoted to fishing. Petrere (1978) described the fisheries and fishing effort for the Rei and Janauacá lakes, in Amazonas State, through the CPUE, with emphasis on the effort unit defined by the number of fishermen*days spent fishing.

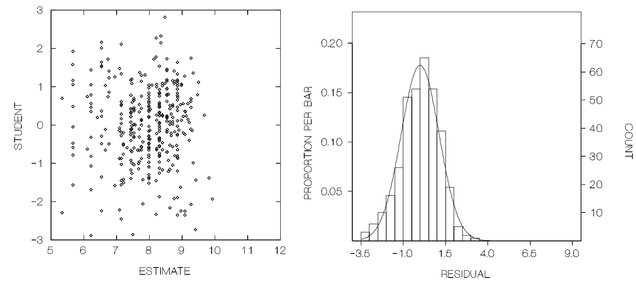
Junk *et al.* (1989) stated that the fish biomass productions are related to the lake environment and its adjacent areas that are flooded by the "pulse effects" generated by the hydrological cycles of the Amazon region. The pulse effects concept is the most plausible to explain the fishery productivity in the area of the upper River Juruá. The rain in the winter season is constant and abundant with high variation in water level (7 meters, Barthem, 1995), which leads to the fall of the marginal forest caused by the high forces of the hydraulic power of the river waters. Parts of the headstreams of the rivers still have a meandric pattern, but the development of the pools followed by runs fitted in geological fault systems and the low rupture of the main channel are more frequent in the upper River Juruá. Most of the pools at River Breu, locally know as "balseiros" due to the large amount of trapped fallen trees, were the most visited fishing sites (72%). The pools sustain a higher fish biomass in comparison with the headstreams of the rivers, where the decrease in alluvial plains leads to a decrease in lake formation. In some rivers, synergistic processes of lake formation (abandoned meandrous or low lakes) are smaller in comparison with large alluvial plain areas, with lower declivity in the area (Tricart, 1977).

According to Morán (1990), flooded areas in upper Amazon River show a higher variability of habitats in comparison with flooded areas in the middle and lower Amazon River due to the dendritic pattern of the rivers such as Ucayali, Purus and Juruá, where the high number of lakes leads to a high number of microhabitats. Flooded areas and floating vegetation are important for the maintenance of the ichtyofauna diversity supporting these habitats, which allow the food proliferation that sustains the fisheries stocks in the Amazon basin. On the other hand, in rivers at the head of the basin, the flooding areas are smaller, so is the possibility of lake formation. Trapped fallen woods in the bends of the rivers help in pool formation and, thus, aid in the maintenance of a vertical structure in the river water. These "debris" have the capacity to aggregate several species of fish in the pools, with the fixation of the periphyton for the iliophagas species, shelter, resting, and reproduction habitats and, consequently, the presence of predatory species (Tundisi, 1990; Bryant & Sedell, 1995). These authors further suggest that the presence of fallen woods in the rivers increase the heterogeneity of the habitats by forming aloctonous material banks, shifting the water flow and creating microhabitats for aquatic organisms. Benke (1984 *fide* Bryant & Sedell, 1995) studied this type of habitat in the River Satilla (Georgia, USA) and suggested that only 4% of the areas, which aggregate fallen woods, support about 60% of the aquatic invertebrates biomass. The congruence among the habitats with a high structural diversity is directly proportional to the diversity in the taxonomic composition (Odum, 1988; Magurran, 1988).



(a) (b)

Figure 2 - Residuals of the ANCOVA where response (dependent) variable are the caches (kg), the factor villages and fishing gears, and covariates f_2 (number of fishermen* total fishing time), f_3 [number of fishermen*(total fishing time-time displacement)]. g_1 = -0.133, ns and g_2 = -0.075, ns. (a) Studentized residuals versus estimated values and (b) histogram of the residuals (Y – Y hat).



(a) (b)

Figure 3 - Residuals of the ANCOVA where response variable are the caches (kg), the factors fishing gears, seasonality and locomotion and covariates f_1 (number of fishermen) and f_2 (number of fishermen* total fishing time). g_1 = -0.269, ns and g_2 = -0.012, ns. (a) Studentized residuals versus estimated values and (b) histogram of the residuals (Y – Y hat).

All inhabitants of the area highlight the presence of large armored catfishes in the pools at the upper River Juruá. Fishing with "bicheiros" (see below) is a specialized strategy for catching such fish in the pools (Aquino & Iglesisas, 1992). This gear catches species such as the surubim *Pseudoplatystoma fasciatum*, the "jundiá" *Oxidoras niger*, the dourada *Brachyplatystoma flavicans*, the piramatuba *Brachyplatystoma vaillantii*, among others. It is suggested that the presence of such large fish in the pools at the upper River Juruá may be related to the presence of possible reproductive areas, or these species remain in the pools during the non-reproductive season, and then migrate for feeding and dispersing into the floodplains areas of the middle and lower Amazon basin. Fishermen from the Kaxinawá villages at River Jordão and from the Extrativist Reserve of upper River Juruá related that every year there is migration of several species of armored catfish and that the reproductive periods occur with the beginning of the rainy season in October (Begossi *et al.* 1999; Aquino & Iglesias, 1992).

Barthem & Goulding (1997) describe the ecology, migrations, and conservation of the largest armored catfish in the Amazon basin, with special emphasis on the life history of *Brachyplatystoma flavicans* and *B. vaillantii*. These two species possess large and non-overlapping home ranges, with feeding, reproductive, and migratory sites inside the Amazon basin. Migration starts in the estuaries and later moves to the main channel of River Amazon, with peaks occurring in September and October. The number of catches confirms this predominance of large armored catfish migration at the upper River Juruá, allied with their occurrence in pools during the summer and, it can be evidence that these species use these areas during their reproductive cycle.

An analogy can be made between the family Salmonidae species from North America and the large catfish of Pimelodidae family in South America, as both groups showed specimens with larger home ranges (Bryant & Sedell, 1995; Ruffino & Barthem, 1996). Salmonids use estuaries and marines areas for recruitment and migrate towards the southeast Alaska River. They also use habitats formed by the aggregation of fallen woods as reproductive areas. Sedell *et al.* (1984, *fide* Bryant & Sedell, 1995) related that the habitats with fallen woods in the rivers Hoh Fork and upper Queets, USA, are only 6% and 25% of all available habitats but respond for the production of 75% and 55% of all juveniles salmonids in these rivers respectively. The big stocks of the most important catfish species in the Amazon basin can use habitats with fallen woods in pools as reproductive sites. Barthem & Goulding (1997) cite that catches of these two species are nearly constant along the year in Letícia, Colombia, with some specimens with eggs being reported. It is known that reproductive migration reaches the heads of the Amazon basin, especially in white water rivers. Authors cite that the higher parts of the Colombia rivers are possible spawning sites for large catfish, especially in the frontier with the Brazilian Amazon.

In case that, the wood exploitation of the agriculture expansion turns to be a fact in this region after the project of highway BR-364 is completed, then the fish stocks may suffer impacts by the sedimentation of the pools, and may lose aloctone material retained in the meandric channels of the alluvial basin of the upper River Juruá (Aquino, 1997). If evidence exists relating the use of pools as reproductive sites by large catfish, the possible impacts due to the highway may change the principles of reproductive cycles of these species, since the synergistic dynamics associated with the pools and lake development in the upper Juruá region will be destroyed (Hilborn *et al.*, 1995).

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LITERATURE CITED

Aquino, T. T. V.; Iglesias, M. P. 1992. *Kaxinawá do Rio Jordão. História, Território, Economia e Desenvolvimento Sustentado.* Comissão Pró-Índio do Acre. Setor Gráfico. Rio Branco. Acre. p. 231.

Aquino, T. T. V. 1997. Índios nos corredores ecológicos da Amazônia - Unidades de conservação contínuas. *Folha do Meio Ambiente*. Folha de São Paulo. São Paulo. p.7-8.

Barry, L. J.; Richardson, W. B.; Naimo, T. J. 1995. Past, Present, and Future Concepts in Large River Ecology. *Bioscience* 45(3): 134-141.

Barthem, R. B.; Goulding M. 1997. *The catfish connection: ecology, migration and conservation of the Amazon predator.* Columbia University Press. New York. p.144.

Barthem, R. B. 1995. Development of commercial fisheries in the Amazon Basin and consequences for fish stocks and subsistence fishing. *In*: Clüsener-Godt, M.; Sachs, I. (eds), *Brazilian perspectives on sustainable development of the Amazon region.* UNESCO, Man and the Biosphere Series, 15, 9:175-204.

Bayley, B. P. 1995. Understanding large river-floodplain ecosystems. *Bioscience* 45(3): 153-158.

Bayley, P. B. 1988. Accounting for effort when comparing tropical fisheries in lake, river-floodplains, and lagoons. *Limnol. Oceonagr.,* 33(4, part 2): 963-972.

Beaumord, A. C. 1991. As *Comunidades de Peixes do Rio Manso, Chapada dos Guimarães, MT: Uma Abordagem Ecológica Numérica.* MSc. Dissertation. UFRJ, Rio de Janeiro. p. 107.

Beckerman, S. 1983. Optimal foraging Group Size for a Human Population: The Case of Bari Fshing. *Amerc. Zool.,* 23: 283-290.

Begossi, A. 1992. The use of optimal foraging theory in the understanding of fishing strategies: A case from Sepetiba bay (Rio de Janeiro State, Brazil). *Human Ecology,* 20(4): 463-475.

Begossi, A.; Richerson, P. J. 1992. The animal diet of families from Búzios island (Brazil): An optimal foraging approach. *Journal of Human Ecology,* 3(2): 433-458.

Begossi, A.; Silvano, R. M.; Amaral, B. D.; Oyakawa, O. T. 1999. Uses of fish and game by inhabitants of an Extractive Reserve (Upper Juruá, Acre, Brazil). *Environment, Development and Sustainability,* 1: 1-21.

Benke A.C. 1984 Secondary Production. *In:* Resh V.H. & Rosenberg D.M. (eds.). *The Ecology of Aquatic Insects.* Praeger Publishing, New York, NY. pp 289-322.

Bryant, M.D.; Sedell, J. R. 1995. Riparian forests, wood in the water, and fish habitat complexity. *In*: Armantrout N.B. & Wolotira, Jr. R.J. (eds.). *Conditions of the World's aquatic Habitats.* Proceedings of the World Fisheries Congress Theme 1. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. p. 202-224.

Hilborn, R.; C. J. Walters, 1992. *Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty.* Chapman and Hall. New York. p. 570.

Hilborn, R., Walters, C. J.; Ludwig, D. 1995. Sustainable exploitation of renewable resources. *Annu. Rev. Ecol. Syst.,* 26: 45-67.

Junk, W. J.; Bayley, P. B.; Sparks, R. E. 1989. The Flood Pulse Concept in River-Floodplain Systems. *Can. Spec. Publ. Fish. Aquatic. Sci*. 106: 110-127.

Karr, D. J. 1981. Assessment of biotic integrity using fish communities. *Fisheries,* 6(6): 21- 27.

Magurran, A. E. 1988. *Ecological Diversity and its Mesurement.* Groom Helm, London. p. 192.

Mendes, M. K. 1991. *Etnografia Preliminar dos Ashaninka da Amazônia Brasileira.* MSc. Dissertation. UNICAMP. Campinas. 349 p.

Morán. E. F. 1990. *A ecologia humana das populações da Amazônia*. Ed. Vozes. Petropolis. p. 367.

Odum, E. P. 1988. *Ecologia.* Editora Guanabara S.A. Rio de Janeiro. 434 p.

Peres, C. A. 1993. *Biodiversity Conservation by Native Amazonians: a Pilot Study in the Kaxinawá Indigenous Reserve of Jordão River, Acre, Brazil.* A project report submitted to the World Wildlife Fund, Washington D.C. p. 47.

Petrere, M. J. 1978. Pesca e esforço de pesca no Estado de Amazonas. I- Esforço e captura por unidade de esforço. *Acta Amazonica,* 8(3): 439-454.

Petrere, M. J. 1992. As comunidades humanas ribeirinhas da Amazônia e suas transformações sociais.. *In*: Diegues, A. C. (ed.), *VI Encontro de Ciências Sociais e o Mar no Brasil.* Coletâneas de Trabalhos Apresentados.Programa de Pesquisa e Conservação de Äreas Úmidas no Brasil/IOUSP/ F. Ford, UICN. São Paulo. pp. 31-68.

Petrere, M. J.; Agostinho, A. 1993. La Pesca en el Tramo Brasileño de Rio Paraná. *In Taller sobre las pesquerias de la Cuenca del Prata.* Comision para la Pesca Continental de America Latina. Montevideo. pp. 52-72.

RadamBrasil, 1977. Folhas SB/SC, 18 Javari/Contamana; geologia, geomorfologia, pedologia, vegetação e uso potencial da terra. Departamento Nacional da Produção Mineral. *Levantamento dos Recursos Naturais.* Ministério das Minas e Energia. Rio de Janeiro. p. 420.

Ruffino, M. L.; Barthem, R. B. 1996. Perspectivas para el manejo de los bagres migradores de la Amazonia. Santa Fé de Bogotá. *Boletin Científico,* 4: 19-28.

Sedell, J.R.; Yuska, J.E.; Speaker, R.W. 1984. Habitats and salmonid distribution in pristine, sediment-rich river valley systems: S. Fork Hoh and Queets River, Olympic National Park. *In*: Meehan, W.R.; Merrell, T.R., Jr.; Hanley, T.A., eds. *Fish and wildlife relationships in old-growth forests*. Juneau, AK: American Institute of Fisheries Research Biologists: 33-46.

Silvano, R. A. M., Amaral, B.D.; Oyakawa, O.T. 2000, 'Spatial and temporal patterns of diversity and distribution of the Upper Juruá River fish community (Brazilian Amazon)', *Environmental Biology of Fishes* 57**:** 25-35.

Silvano, R. A. M.; Oyakawa, O. T.; Amaral, B. D.; Begossi, A. 2001. *Peixes do Alto Rio Juruá (Amazonas, Brasil).* FAPESP. Editora da Universidade de São Paulo. Imprensa Oficial do Estado. São Paulo. 304p.

Sokal, R. R.; Rohlf, F. J. 1995. *Biometry.* Third ed. Freeman San Francisco. p. 887.

Tricart, J. 1977. *Ecodinâmica.* Rio de Janeiro: IBGE. p. 91.

Tundisi, J. G. 1990. Conservation and Management of Continental Aquatic Ecosystems in Brazil. *In*: Hongliang, L.; Yutian, Z.; Haisheng, L. (eds.). *Lake Conservation and Management.* Proceedings of The 4th International Conference on The Conservation And Management of Lakes "Hangzhou'90". pp. 573-584.

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