ASSESSMENT OF THE POPULATIONS OF FISH AND SHRIMP LARVAE IN THE MANGROVE SWAMPS OF CHAME AND AGUADULCE, THE REPUBLIC OF PANAMA

FINAL REPORT

Prepared for:

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

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February, 1985

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1. Introduction.-

Tropical estuaries and mangroves swamps are well known as nurseries sites for larvae and juveniles of marine and freshwater species. This relationship is of great importance to fisheries in most tropical countries with mangrove bordered coasts.

Currently, the ecological roll of mangrove swamps is of great importance for the local fishing industry, which depend on the recruitment of juveniles and to shrimp mariculture operations that use wild postlarvae and juveniles as seed for stocking the ponds.

The increasing use of mangrove areas for socioeconomic activities including agriculture, urban development and industry has concerned several local and international agencies related to natural resources management, getting them involved in diverse aspects of the development and conservation of these areas. Perhaps among the main problems preventing the agreement among the differents interested parties is the lack of information necesary as base for decision making and defining a harmonizing policy between mariculturists, fishermen and conservationsists.

The purpose of this study was to assess the populations of fish and shrimp larvae of commercial importance in the mangroves of Chame, Province of Panama, and Aguadulce, Province of Cocle, and to determine the effect of human activity on mangroves as nurserys areas for larvae and juveniles of aquatic species.

2. Methodology and Area of Study.-

2.1 Sampling area: Samples were obtained in the tidal channels of Chame (Figure 1), a mangrove forest that recently (since 1979) has been altered by the construction of shrimp ponds. All areas where plankton was collected in Chame were surrounded by mangroves and did not present noticeable evidence of desforestation. The salinity during sampling ranged between 23.9 and 27.1‰. Samples were also obtained from the mangrove bordered estuary of Palo Blanco, Aguadulce, and area of historical anthropogenic pressures (Figure 2). This area has been used for several decades for the production of salt by seawater evaporation ponds and more recently (since 1974), for the construction of near 2,500 hectares of shrimp ponds. Additionally there is a small port in this mangrove from which most of the production of sugar cane and molasses from the region of Cocle is shipped. In this area human influence is quite obvious due to the previosly expained activities. The salinity during the Aguadulce sampling was recorded between 22 an 28‰.

2.2 Plankton Samplings: Plankton tows were done using a standard 500 micron net of 0.5 meter diameter provided with a flowmeter. The tows lasted at least 10 minutes. In every tow the net was placed at mid depth. The samples were preserved in 5% formalin, diluted with sample water. In this manner 8 samples were collected in Chame (November 19 and 22) and 9 samples in Aguadulce (December 19 and 20). Additionally, stationary sampling of 2 tide cycles was carried out in Chame. In this case, the net was placed at intermediate depth in the center of the tidal channel, and the plankton samples were taken every 30 to 60 minutes during ebbing and flowing tides. These tidal cycle samplings were performed during daytime in December 2, and at nighttime on November 27-28 for a total of 15 samples. Water depth was measured with a portable depth finder and salinity with a refractometer.

2.3 Sample Counting: Each plankton sample was totally presorted for counting and identification of larvae.
Shrimp were identified to species when possible and fish larvae were identified to family.
Results were expressed as the number of organisms collected per volume of water filtered by the plankton net in 100 m^3 calculated from the number of revolutions recorded by the flowmeter.

3. Larvae Sampling Results.-

3.1 Plankton tows in Chame and Aguadulce: The results of these tows are presented in Table 1. Volumes of filtered water ranged from 50 to 140 m^3. The population density of shrimp and fish ranged between 3 and 104 shrimp/100 m^3 and between 2 and 385 fish larvae/100 m^3. The shrimp larvae (Table 2) collected were Penaeus stylirostris, one of the species of white shrimp fished in the Gulf of Panama. This species is also used as seed for the shrimp mariculture operations, although Penaeus vannamei is prefered because of its faster growth. Observed concentrations of P. stylirostris were 2.3 to 32 larvae/100 m^3 with a mean of approximately 8 larvae/100 m^3. Two other species of shrimp collected in Chame were Carideans shrimp of the genus Palaemon spp. and Macrobrachium spp.. Samples of Palaemon varied between 6 and 30 larvae/100 m^3 ($\overline{X}$ = 10 larvaes/100 m^3) while Macrobrachium ranged from less than 1/100 m^3 to 71.3/100 m^3 ($\overline{X}$ = 27 larvae/100 m^3).

Fish larvae of commercial interest included Anchovies (Engraulidae), Mojarras (Gerridae), Cavallas (Carangidae) and Croakers (Scianidae). Among these, the Engraulids and Scianids were the most abundant (19.8/100 m^3 and 11.3/100 m^3) The most abundant fish larvae collected were two groups of no commercial value fishes: Atherinidae (55.9/100 m^3) and Gobiidae (53.3/100 m^3).

Results of plankton tows in the Aguadulce mangroves are shown in Tables 3 and 4. In Table 3 it can be seen that the flowmeter only registered 95 revolutions on the first collection for a period of 21 minutes. This seems an obvious sampling error so this data was discarded. As in the Chame samples the volume of water filtered in the tows ranged between 50 and 140 m^3.

Shrimp larval density in the Aguadulce mangroves was 43.8 larvae/100 m^3. In contrast to the Chame results, where the dominance was by far of the Caridean Shrimps, most (60%) of the shrimp larvae in Aguadulce were Penaeids. On the average, collections of *P. stylirostris* were 26.6 larvae/100 m^3, which was 3 times the density observed in Chame. The larval density of *Palaemon* (10.2 larvae/100 m^3) At Aguadulce was similar to samples from the Chame mangroves but the density of *Macrobrachium* was particulary low (6.2 larvae/100 m^3).

The observed mean of fish larvae in the Aguadulce mangroves was close to 35 larvae/100 m^3. This was somewhat low compared to the Chame results, where the mean was 146 larvae/100 m^3. The larvae of Cavallas (Carangidae), Anchovies (Engraulidae) and Croakers (Scianidae) are the most abundant in the Aguadulce mangroves (7-10 larvae/100 m^3). These species have local commercial importance. The rest of the fish larvae collected in Aguadulce such as Gobies (Gobiidae) and Puffers (Tetraodontidae), are of little or no commercial interest, and were found in low densities (less than 4 larvae/100 m^3).

The diversity of fish and shrimp (species richness) between sampled locations in Chame and Aguadulce is very similar (Table 5). The main differences observed were that larvae of Puffers (Tetraodontidae), Tarpons (Megalopidae) and Flounders (Pleuronectidae) were collected in Aguadulce only, while larvae of Mojarras (Gerridae) were exclusively found in Chame.

3.2 Tidal Cycle Sampling: During stationary sampling the 0.5 meter standard net with 500 micron mesh was used. Plankton collections of november 2 were diurnal, while november 27-28 collections were nocturnal. General data on tidal cycle sampling are presented in Tables 6 and 7. The volume of water filtered, estimated from flowmeter records, ranged from less than 1 m^3 to slightly more than 4 m^3 during the sampling of november 2. These low measurements of filtered water indicated a very slow pattern of water flow during the ebbing and flooding tides. During the samplings performed on november 27 and 28, however water flow was more intense varying between 1 to 135 m^3 of water filtered through the plankton net.

Tables 8 and 9 show results of stationary plankton net samplings in Chame. Nocturnal sampling resulted in higher densities of shrimp larvae in comparison to diurnal sampling. However, fish larval densities recorded during the days were slightly higher than those observed at night.

While shrimp diversity among diurnal and nocturnal samples was similar, fish diversity measured during night collections was higher (6 additional families) than diurnal samplings. The density of the larval population seemed to be inversely related to the water level. Higher densities of shrimp and fish larvae were observed during ebb tide, when larvae were concentrated in the water of the tidal creeks. During high tide the larval populations were more dispersed in open areas and among mangrove roots.

Shrimp larvae collected during tidal cycles included the 3 species of White shrimp (Penaeus occidentalis, P. stylirostris and P. vannamei). The White shrimp is the most important commercial species in Panama. Penaeus stylirostris was that found most often in larval collections. Probable larvae of the Brown shrimp Penaeus californiensis were also collected. The small size of specimens made their definite identification difficult however. Brown Shrimp are found in low densities in local catches, and are usually considered by fishermen as Red shrimp (Penaeus brevirostris).

4. Mangroves and its importance to local fisheries and mariculture.

4.1 Shrimps related to mangroves: Eight species of local Peneid shrimp are found in mangrove swamps during early stages of their life cycles (Table 10). Among these, White shrimp are the most abundant and economically important for local fisheries. Three species are recognized as White shrimp (Penaeus occidentalis, P. stylirostris and P. vannamei). Penaeus occidentalis account for more than the 80% of the commercial landings of White shrimp in Panama. Juveniles and postlarvae are dominant in mangrove swamps and estuaries in the eastern part of the Gulf of Panama. Spawning of P. occidentalis occurs throughout the year, however, there is a marked peak in December. High densities of postlarvae and juveniles in mangrove swamps are reported during the dry season (January to April) and a strong recruitment to the fishing ground is observed from April to July (D'Croz et.al., 1979). Juveniles of Penaeus stylirostris have been reported to be abundant in the mangrove swamps between August and September, and recruitment to the fishing ground is believed to occur between December and February. P. vannamei is the least abundant of the white shrimp, representing 1-17% of white shrimp catches. This species reported to be in mangrove swamps from September to December. During this study this species was not collected. Interesting in view of its use in mariculture

The relative densities of P. stylirostris and P. vannamei increase eastward along the Pacific coast of Panama in contrast to P. occidentalis.

In addition to white shrimp, juveniles and postlarvae of the Brown shrimp Penaeus californiensis and the Red shrimp P. brevirostris are present in small densities in the mangrove swamps of the Gulf of Panama. Other species of Peneid shrimp like the Seabobs (Xiphopenaeus riveti and Protrachypene precipua) are not found within the mangrove swamps, however, their populations are very dense at the mouth of the mangrove bordered estuaries. Apparently, these species are not as euryhaline as White shrimp, but are dependant to some degree on the organic export from mangrove.

The shrimp fishery in Panama is almost exclusively limited to the Pacific Coast. Approximatelly 80% of the annual total catch comes from the Gulf of Panama, with the remainder from the Gulf of Chiriqui. In 1983, 7,564 metric tons of shrimp were fished and exported, representing an income of $57,000,000. Table 11 shows the landing records of shrimp during the last 5 years. Increasing yields were due to larger catches of seabobs, a small Peneid shrimp. Fishermen directed their efforts towards this species when catches of White shrimp started to decline because of overfishing. The local Department of Fisheries (Dirección General de Recursos Marinos), has indicated that the only way to increase the shrimp production in Panama is through mariculture, since traditional fisheries are at their maximum sustainable yield or are overexploited, as with the White Shrimp (González M., 1984). According to available statistics, however the current level of mariculture production of shrimp is less than 600 metric tons per year.

The main fisheries in Panama represents an annual income of $70,000,000 , and the related labor force is about 10,000 workers.

4.2 Prawns related to mangrove swamps: Four species of Palaemonid shrimps are found temporarily in mangrove swamps of the Pacific coast of Panama. These are: Macrobrachium americanum, M. tenelium, M. panamense and M. digueti.

These species are freshwater organisms. Adults live in freshwater streams while larvae and juveniles are commonly found in the upper part of mangrove bordered estuaries where salinities are low. Macrobrachium americanum and M. tenellum are the most frequently found in mangrove swamps. M. americanum is the largest sized prawn of the Central American region, and a typical adult might weigh one pound. This species reaches sexual maturity in freshwater habitats, living hidden among the river's stores. They spawn during the rainy season. Eggs and larvae are passively transported downstream by river flow. After an unknown period of time in the brackish environment (probably a few weeks), juveniles start an upstream migration to their freshwater habitats. The life history for M. tenellum is very similar to that described for M. americanum and is smaller than M. americanum. In addition, the genera Palaemon represents a small brackish water prawn, whose larvae have been fairly common during the larval collection in the mangrove swamps of Chame and Aguadulce.

Currently, these prawns are not fished commercially, but make up part of the diet of fishermen and their families. Some attempts have been made to culture the larger species of prawns however, there has been no indication of success thus far.

4.3 Mangrove as a nursery for local commercially important fishes:

Results from larval collections in the mangrove swamps of Chame and Aguadulce give a good idea of the fishes which utilize mangroves swamps as nurseries areas.

These results and those from Martínez et.al. (1983) and D'Croz and Kwiecinski (1980), indicate that among the mangrove related fishes the most important species for local fishermen are Croakers, Snappers, Mullets and Snooks.

These data revealed that there were near 30 species of fish collected as juveniles in mangrove swamps of the Gulf of Panama. Among these were the following commercial species: the Snooks Centropomus armatus, C. nigrescens, C. robalito and C. unionensis; the Snappers Lutjanus aratus and L. argentiventris; the Croakers Cynoscion squamipinnis, Larimus argenteus, Micropogon altipinnis and Paralunchurus dumerilii; and the Crevalle Jack Caranx marginatus; and the Mullet Mugil curema.

Table 12 lists the mangrove related species of finfish which are part of the artisanal landings in the Bahia de Parita. The relative importance of these species is high, ranging from 20% to almost 89% of the total catch. Figure 3 shows the artisanal fishery landing points in the Bahia de Parita.

4.4 Mangrove swamps and Shrimp Mariculture: Shrimp mariculture started in Panama in 1974 when Agromarina S.A., a subsidiary of the Ralston Purina Company, established a hatchery and 34 hectares of ponds in Aguadulce. Since then approximately 4,000 to 5,000 hectares of ponds have been built, During the early 80's 12 local companies were involved in shrimp mariculture.

Shrimp ponds are usually built on salt flats, locally called 'albinas", which are flooded by the spring tides (twice a month). However, in a few cases, the demand for more land to expand the shrimp farms, has resulted in development of the mangroves forests surrounding the albinas. The flats are usually connected to the sea through mangrove bordered estuaries and tidal creeks. Vegetation is almost absent in many of these flats, however, in some cases it could be a dwarf mangrove coverage. The figures reported for the total area of these flats in the Pacific Coast of Panama range from 10,000 hectares (Gonzalez M., 1984) to almost 20,000 hectares (Pretto, 1983), and probably the most suitable areas for pond construction are those located from Chame to Aguadulce.

Two species of White shrimp are use for mariculture in Panama: Penaeus vannamei and P. stylirostris. P. vannamei has the highest growth rate and can withstand higher stocking densities, however, is the least abbundant among the 3 species of White shrimp. Penaeus occidentalis is considered unsuitable for farming because of its low growth rate and high mortality in the ponds. Ponds are stocked with postlarvae and juvenile reared in hatcheries or collected from mangrove swamps. The stocking densities range between 40,000 to 80,000 postlarvae/hectare in semi-intensive method farms which use wild seed, and from 100,000 - 200,000 postlarvae/hectare in intensive highly technical operations that use hatcheries for seeds production.

Two are the major mariculture companies in Panama. Agromarina S.A., with nearly 1,000 hectares of ponds and a hatchery with a production capability of 12,000,000 postlarvae/ month, and Camaronera de Nata S.A. (CANASA), a fairly new operation with 2,000 hectares of ponds and a hatchery (post-larval production unknown). Both companies are operating in Aguadulce using the intensive system. The remaining shrimp farmers are small to medium size operations which collected wild postlarvae for stocking their ponds, using a semi-intensive method similar to ecuadorian operation. For these shrimp farmers, the availability of wild postlarvae from the mangrove swamps is the most critical aspect of their operations. If we assume that these farmers operate around 1,000 hectares of ponds, the quantity of wild seed required would vary between from 40,000,000 to 80,000,000 postlarvae per crop. According Pretto (1983), shrimp crops could range from 1 to 2.8/year depending on the availability of seed. It is possible therefore that the average annual requirement of wild seed could be in excess of 100,000,000 postlarvae/ year. just for them

But Agro Marino (Ruiz outfit in Panama) produces up to 300 million p.l.'s/yr. according to Lou Van Houten

In December 1984, the University of Panama sponsored a work-shop to analize the panamanian fishing industry (current conditions and perspectives). During the meeting Ingeniero Luis Hooper, a shrimp culture expert of the Dirección Nacional de Acuicultura, reported that medium and small size shrimp farmers are operating half of their capability because of the limited availability of wild postlarvae for stocking their ponds. *Penaeus stylirostris* postlarvae are found mostly from June to August, at the start of the rainy season, whereas P. vannamei postlarvae are commonly collected from October to November when rainfall is at the highest peak. During the dry season most ponds are not in production since the only postlarvae available in mangrove swamps are those from Penaeus occidentalis. Because of this many semi-intensive operations have only one crop per year and their yields generally do no exceed 900-1000 pounds/hectare (headless shrimp) in contrast, intensive culture operations (like Agromarina S.A.), up to 2.8 crops/year are achieved and with yields around 2,000 pounds/hectares/crop. In the future the problem of limited quantities of postlarvae is expected to be solved with the instalation of a government hatchery, run by the Dirección Nacional de Acuicultura. This hatchery will have a projected production capability of 20,000,000 postlarvae per month and should provide enough seed to stock 2,000 - 3,000 hectares of shrimp ponds.

5. Larval assessment conclusions.

From the results and information compilated for this report the importance of the mangrove swamps in the fishery mariculture production of the area is evident. The proper management of mangrove swamps areas will guarantee the required recruitment of juveniles of shrimps and finfhishes to traditional fishing ground and will also provide some seed for maricultural operations. However the wild postlarvae resource will not support the expected increase of the shrimp production for mariculture and it will be necessary to operate hatcheries for such purposes.

The direct or indirect dependance on mangrove swamps for most of the shrimp and finfish production in Panama obligates all parties involved in the use of these areas (fishing industry, shrimp farmers and government) to realize the importance of the mangrove swamps as a natural resource and to search for the policies and actions toward their preservation.

6. References.

But what about the effect of human activity on mangroves as nurseries for larvae & juveniles (p. 2)? What can we conclude from this study - anything? Any data from before & after shrimp ponds or cutting - or from areas protected from human activity?

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Figure 1: Collecting Stations in Chame

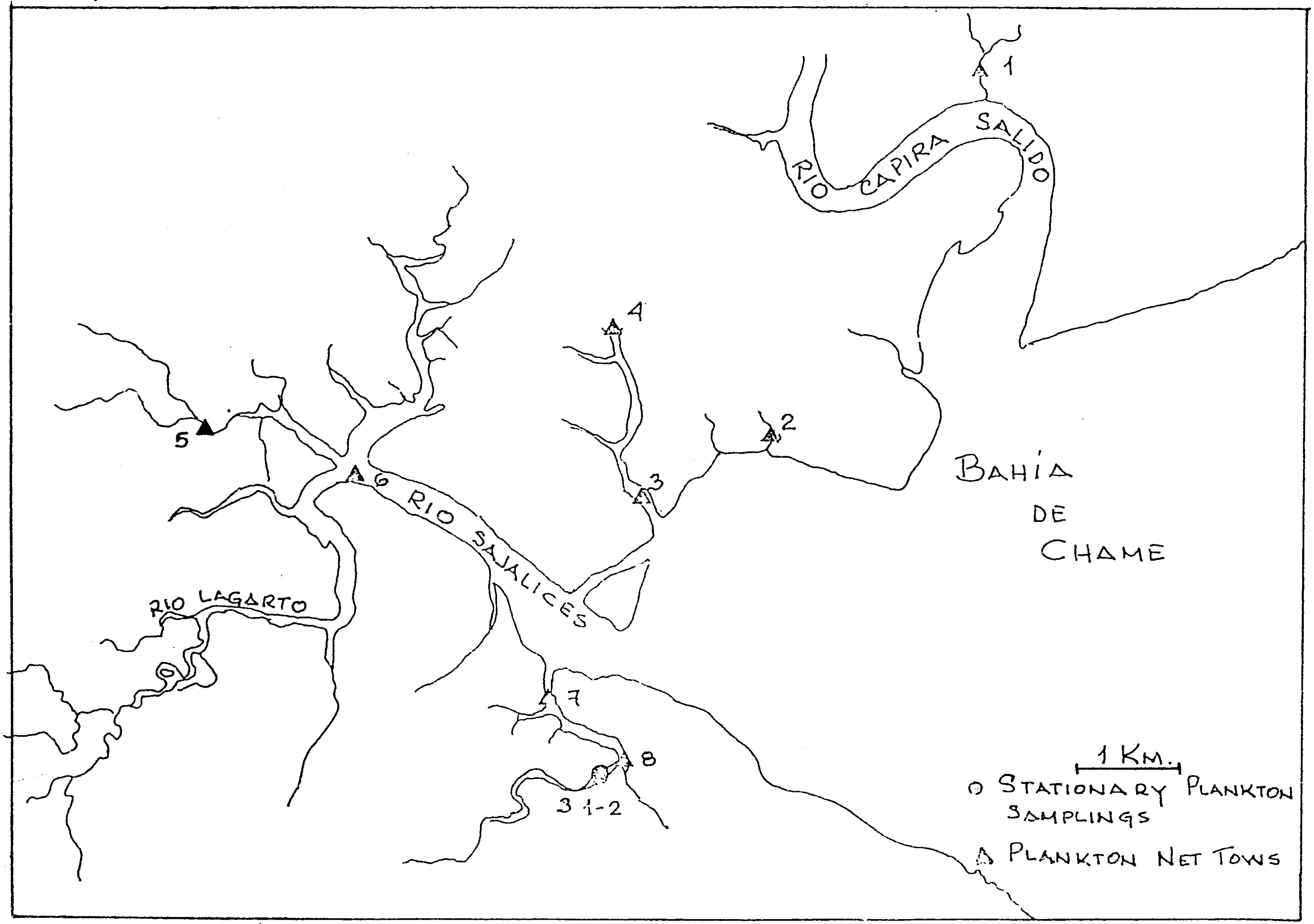

FIGURE 2 COLLECTING STATIONS IN AGUADULCE

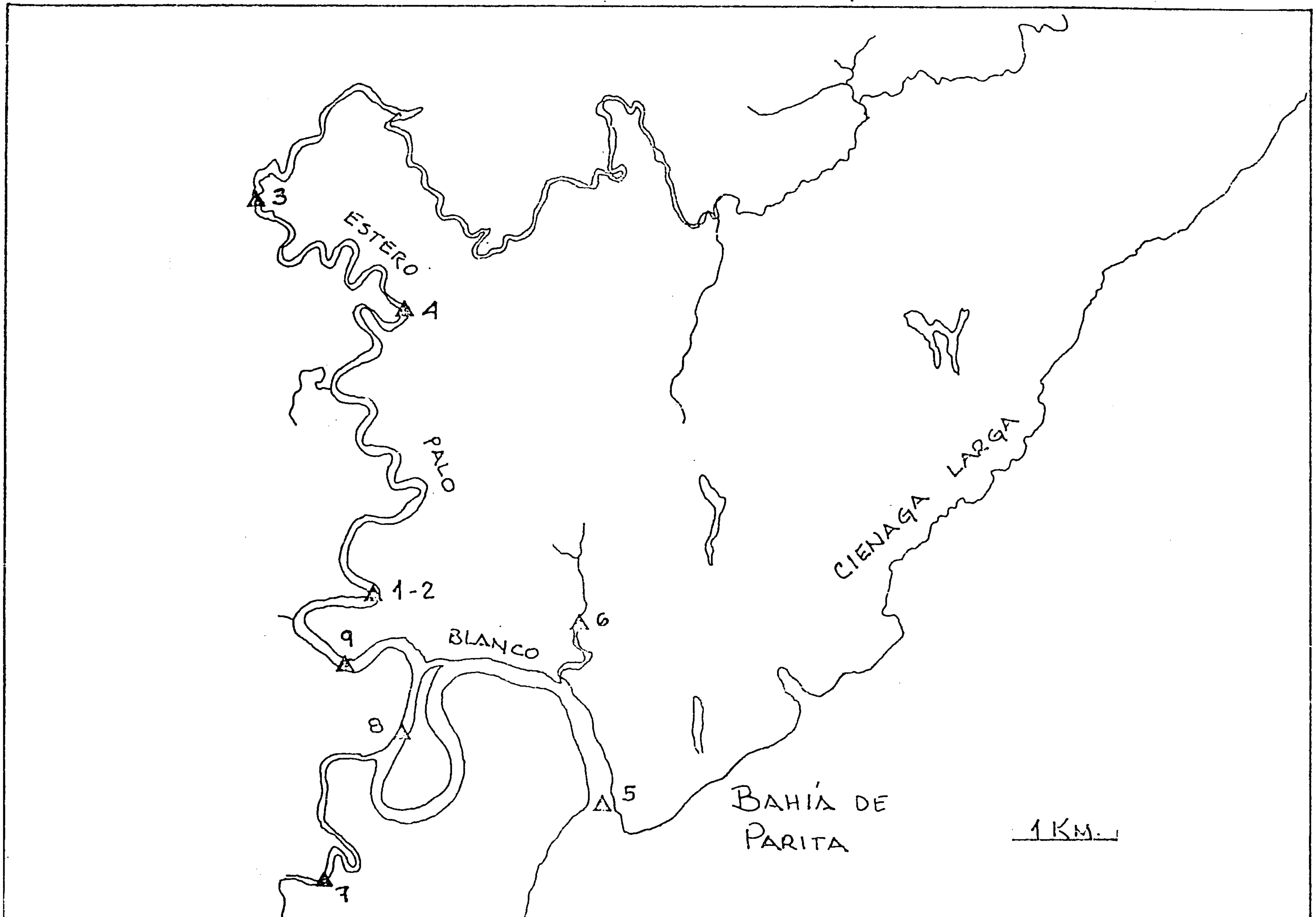

FIGURE 3: ARTISANAL LANDING POINTS IN THE BAY OF PARITA

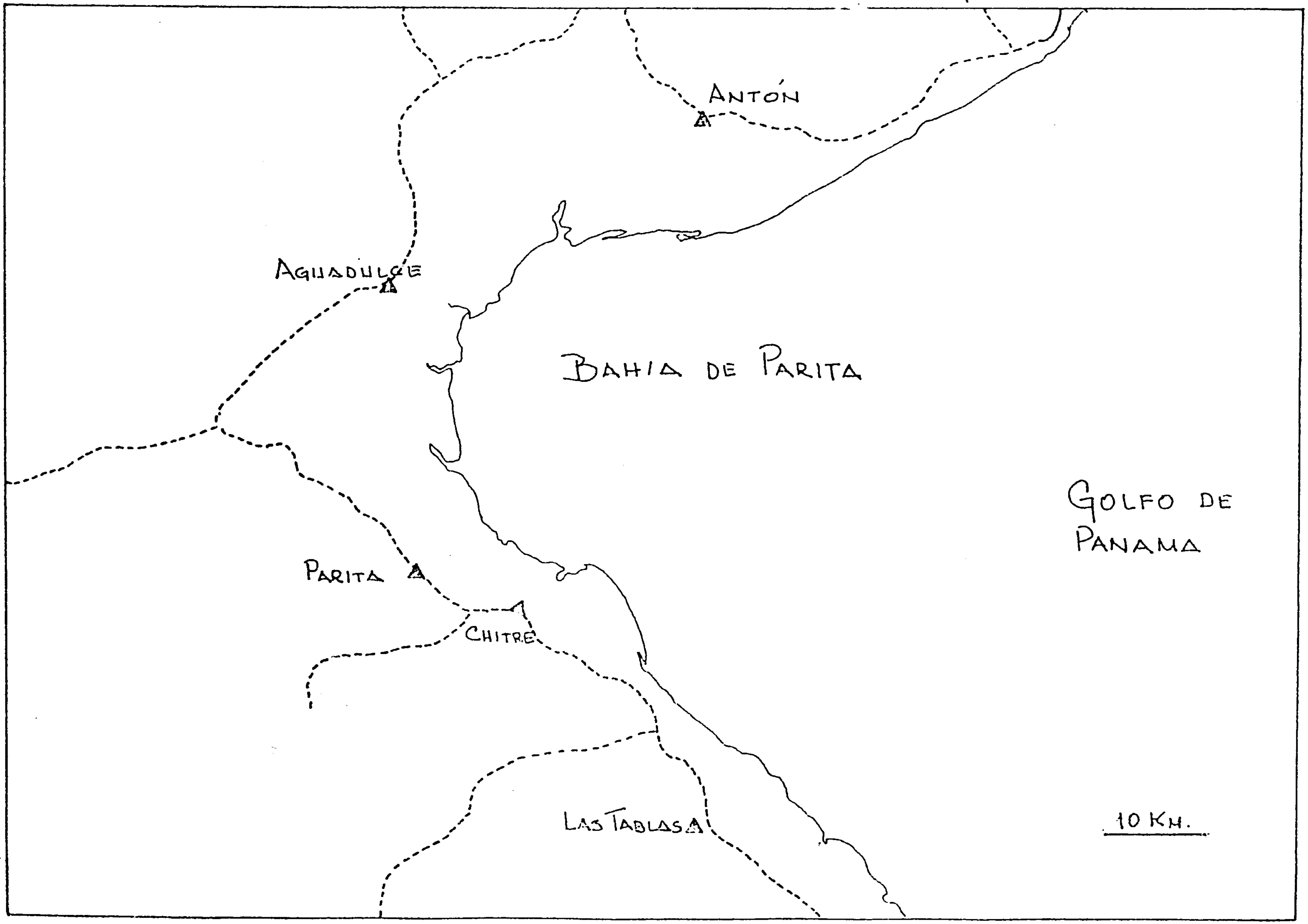

TABLE 1: GENERAL DATA OF THE PLANKTON NET TOWS IN CHAME MANGROVE SWAMPS

pling tion	Date	Time	Salinity ‰	Towing Time	FLOWMETER initial reading	Final reading	revolutions	r.p.s.	Filtered Volume m^3	Shrimps & Prawns collected	Fishes collected	Shrimps & Prawns/ $100m^3$	Fishes/ $100\ m^3$
1	11-19-84	11:13	25.5	11 min.	62492	65133	2641	4.00	66.70	0	0	0	0
2	11-19-84	12:15	26.0	14 min. 30 seg.	62400	66820	4420	5.080	112.20	13	0	11.6	0
3	11-19-84	12:42	25.0	15 min.	66830	70168	3338	3.709	84.16	15	10	17.8	11.9
4	11-19-84	13:10	24.0	14 min. 40 seg.	70187	73578	3391	3.85	85.50	89	45	104.0	52.6
5	11-22-84	11:18	24.7	15 min. 21 seg.	73710	78346	4636	5.03	117.68	4	2	3.3	1.7
6	11-22-84	11:55	23.9	15 min. 30 seg.	78348	83591	5243	5.638	133.09	47	104	35.2	78.1
7	11-22-84	13:15	24.60	15 min.	84692	86721	2029	2.25	50.12	48	175	95.7	349.1
8	11-22-84	15:22	27.10	15 min.	86721	89752	3031	3.36	76.17	36	293	47.3	384.7

TABLE 2: FISH, SHRIMP AND PRAWN LARVAE COLLECTED IN PLANKTON NET TOWS IN CHAME MANGROVE SWAMPS (LARVAE/100 m^3)

Sampling Station	1	2	3	4	5	6	7	8	$\bar{X}$
Shrimps & Prawns		11.6	17.8	104.0	3.3	35.2	96.0	47.0	45.0
Penaeus stylirostris		10.7	2.4	2.3	2.5	2.2	32	03	7.9
Palaemon sp.			8.3	30.4		6.0	160	9	10.0
Macrobrachium sp.		0.9	7.1	71.3	0.8	27.0	48.0	35.0	27.2
Fishes			11.9	52.3	1.6	77.9	34.9	384	146.2
Atherinidae			1.2	2.3	0.8	69.1	106	156	53.9
Carangidae			1.2	10.5					1.9
Engraulidae				5.8	0.8	2.2		104	18.8
Gerridae			3.6	8.2		3.7			2.6
Gobiidae							243	.77	53.3
Scianidae				18.7		2.2		47.0	11.3
Syngnathidae						0.7			0.1
Unidentified larvae			5.9	7.0					2.1

TABLE 3: GENERAL DATA OF THE PLANKTON NET TOWS IN AGUADULCE MANGROVE SWAMPS (ESTERO PALO BLANCO)

pling tion	Date	Time	Salinity ‰	Towing Time	FLOWMETER Initial reading	Final reading	Revolutions	r.p.m.	Filtered Volume m^3	Shrimps & Prawns collected	Fishes collected	Shrimps & Prawns/ 100 m^3	Fishes 100 m^3
	12-19-84	11:38	27	21 min.	0	95	95	4.523	0.1137	10	0	9090	0
	12-19-84	12:07	27	17 min.	100	5528	5428	319.294	137.79	67	24	49	17
	12-19-84	13:07	22	10 min.	5528	8773	3245	324.50	82.37	24	19	29	23
	12-19-84	13:45	23	10 min.	8773	11725	2952	295.2	74.94	24	15	32	20
	12-19-84	14:30	28	10 min.	11725	11725	13772	204.7	51.44	62	47	120	91
	12-20-84	10:58	26	10 min.	13772	16710	2938	293.8	74.58	7	13	9	17
	12-20-84	11:30	24	10 min.	16710	19835	3125	312.5	79.38	82	23	103	29
	12-20-84	12:04	26	10 min.	20350	22768	2418	241.8	61.07	7	17	11	28
	12-20-81	13:23	26.5	10 min.	22768	26333	3565	356.5	90.80	4	36	4	40

TABLE 4: FISH, SHRIMP AND PRAWN LARVAE COLLECTED IN PLANKTON NET TOWS IN AGUADULCE MANGROVE SWAMPS (LARVAE/100 m^3)

Sampling Station	1	2	3	4	5	6	7	8	9	$\bar{x}$
Shrimps & Prawns	909.0	49.0	29.0	32.0	121.0	10.0	94.0	11.3	4.0	43.8
Palaemon sp.		25.0	10.0	11.0			36.0			10.2
Macrobrachium sp.		8.0	13.0		10.0	7.0		8.3	3.0	6.2
Penaeus stylirostris	364.0	16.0	6.0	21.0	105.0	3.0	57.0	3.0	1.0	26.5
Penaeus sp.	545.0				6.0		1.0			0.9
Fishes		17.7	23.0	20.0	90.0	34.0	28.0	27.0	38.0	34.6
Atherinidae				1.0						0.1
Carangidae		4.0	8.0	3.0	21.0	17.0	1.0	5.0		7.4
Gobiidae			5.0							0.6
Megalopidae		4.0		5.0						1.1
Pleuronectidae		1.0								0.1
Engraulidae		5.0	5.0	11.0	17.0	4.0	19.0	5.0	25.0	11.4
Sciaenidae		3.0	5.0		25.0	5.0	6.0	11.0	3.0	7.2
Syngnathidae					12.0	5.0		6.0		2.9
Tetraodontidae					15.0	3.0	2.0		10.0	3.7
Unidentified larvae		0.7								0.1

TABLE 5

COMPARATIVE DIVERSITY OF FISHES
SHRIMPS AND PRAWNS LARVAE FROM
PLANKTON NET TOWS SAMPLES COLLECTED IN CHAME
AND AGUADULCE MANGROVE SWAMPS

SPECIES	COMMON NAMES	CHAME	AGUADULCE
Shrimps & Prawns			
Macrobrachium sp.	Prawns	+	+
Penaeus stylirostris	White shrimp	+	+
Palaemon sp.	Prawns	+	+
Fishes			
Atherinidae	Silverside	+	+
Carangidae	Cavallas	+	+
Engraulidae	Anchovies	+	+
Gerridae	Mojarras	+	
Gobiidae	Gobies	+	+
Megalopidae	Tarpons		+
Pleuronectidae	Flounders		+
Syngnathidae	Pipefishes	+	+
Sciaenidae	Croakers	+	+
Tetradontidae	Puffers		+

TABLE 6 : GENERAL DATA ON THE STATIONARY PLANKTON NET SAMPLING OF LARVAE DURING A TIDAL CYCLE (NOVEMBER 2, 1984)

Sampling Station	DATE	TIME	Salinity ‰	Collect Time	FLOWMETER Initial reading	FLOWMETER final reading	FLOWMETER revolutions	FLOWMETER R P M	Filters Volume m^3	Shrimps & Prawns collected	Fishes collected	Shrimps & Prawns /100 m^3	Fishes/ 100 m^3
Puerto Liborio	2-Nov.	10:50 11:30	29.69	40 min.	23630	24452	822	20.55	4.34	28	70	645	1613
Puerto Liborio	2-Nov.	11:40 12:50	29.21	70 min.	24507	25197	690	9.86	3.64	-	3	-	82
Puerto Liborio	2-Nov.	13:00 13:55	29.07	55 min.	25213	25332	119	2.16	0.63	2	1	317	159
Puerto Liborio	2-Nov.	14:00 14:55	29.31	55 min.	25330	25325	5			3	2		
Puerto Liborio	2-Nov.	15:00 15:50	27.82	50 min.	25326	25371	45	0.9	0.24	2	31	833	12912
Puerto Liborio	2-Nov.	16:00 17:50	18.78	110 min.	25371	25445	74	0.67	0.39	1	69	256	17692
Puerto Liborio	2-Nov.	18:55 19:50	29.76	55 min.	25867	26005	138	2.51	0.73	36	9	4931	1233
Puerto Liborio	2-Nov.	19:55 21:05	29.86	70 min.	26026	26092	66	0.94	0.35	-	32		9143

TABLE 7 : GENERAL DATA ON THE STATIONARY PLAKTON NET SAMPLING OF LARVAE DURING A TIDAL CYCLE (NOVEMBER, 27, 1984)

Sampling Station	DATE	TIME	Salinity ‰	Collect Time	FLOWMETER Initial reading	final reading	revolutions.	R P M	Filtered Volume m^3	Shrimps + Prawns collected	Fishes collected	Shrimps + Prawns/ 100 m^3	Fishes/ 100 m^3
Puerto Liborio	27-Nov.	19:15 20:15	30.79	60 min.	27305	40207	12402	2067	65.44	17	147.	26	225
Puerto Liborio	27-Nov.	20:30 21:00	28.84	30 min.	40234	65824	25590	853	135.02	6	434	4	321
Puerto Liborio	27-Nov.	22:03 22:30	27.52	27 min.	65849	66111	262	9.70	1.38	25	53	1811	3841
Puerto Liborio	27-Nov.	23:04 23:45	26.92	41 min.	66122	66337	215.	5.24	1.13	189	67	16726	5929
Puerto Liborio	28-Nov.	03:35 04:23	28.44	48 min.	66350	66608	258	5.37	1.36	21	177	1544	13015
Puerto Liborio	28-Nov.	05:35 06:18	27.69	43 min.	66611	81110	14499		76.50	8	96	11	125

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TABLE 8 : STATIONARY PLANKTON NET SAMPLING OF LARVAE DURING A TIDAL CYCLE (NOVEMBER 2, 1984) LARVAE/100 m^3

mple	1	2	3	5	6	7	8	9	Mean
ter level (centimeters)	396	330	264	157	149	190	272	306	Value
rimp & Prawns	645.0		317.0	833.0	256.0		4931.0		872.7
naus stylirostris (White shrimp)	461.0		317.0	833.0	256.0		2466.0		541.6
naeus occidentalis (White shrimp)							273.0		34.1
laemon sp. (Prawn)	115.0						959.0		134.2
crobrahium sp. (Prawn)	69.0						1233.0		162.8
shes	345.0	82.0	159.0	13333.0	17688.0	3772.0	1233.0	9143.0	5719.4
herinidae (Silversides)		82.0	159.0	2500.0		274.0			376.9
graulidae (Anchovies)	322.0					613.0	274.0	4000.00	651.1
biidae (Gobies)				2083.0	769.0	1037.0			486.1
gilidae (Mullets)				7917.0	16150.0	2075.0	685.0	5143.0	3996.3
euronectidae (Flounders)						47.0			5.9
ianidae (Croakers)				833.0	769.0				200.3
identified larvae	23.0								2.9

Negative collection during the 4th sampling.

TABLE 9

STATIONARY PLANKTON NET SAMPLING OF LARVAE

DURING A TIDAL CYCLE (NOVEMBER, 27, 1984)

LARVAE/100 m^3

SAMPLE	1	2	3	4	5	6	Mean Value
Water Level (centimeters)	472	457	297	160	122	325	
Shrimps & Prawns	25.0	1.5	1810.0	16637.0	1543.0	11.0	3337.9
Penaeus stylirostris (White shrimp)	12.0	1.0	1087.0	10885.0	1176.0	3.0	2194.0
Penaes vannamei (White shrimp)			362.0	2124.0			414.3
Penaeus occidentalis (White shrimp)			217.0	1858.0	73.0		358.0
Penaeus californiensis (Brown shrimp)	6.0	0.5					1.1
Palaemon sp. (Prawn)	1.0		72.0	1770.0	294.0	8.0	357.5
Macrobrachium sp. (Prawn)	6.0		72.0				13.0
Fishes	210.0	245.2	3694.0	5928	12939.0	132	3859.9
Atherinidae (Silversides)	46.0	2.0	217.0	177.0	1323.0	82.0	307.8
Batrachoididae (Toadfishes)	105.0	0.2					17.5
Bothidae (flounders)		145.0					24.2
Carangidae (Cavallas)	3.0						0.5
Engraulidae (Anchovies)		69.0	1956.0	3363.0	4485.0	25.0	1649.7
Gerridae (Mojarras)				88.0			14.7
Gobiidae (Gobies)	61.0	13.0	1159.0	1593.0	2278.0	17.0	853.5
Leptocephala					147.0		24.5
Lutjanidae (Snappers)				619.0			103.2
Mugilidae (Mullets)					3603.0		600.5
Pleuronectidae (Flounders)					1103.0	5.0	184.7
Scianidae (Croakers)		1.0	145.0	88.0		3.0	39.5
Unidentified larvae	6.0	15.0	217				39.7

TABLE 10: SPECIES OF PENEIDS SHRIMPS RELATED TO THE FISHERIES IN THE PACIFIC COAST OF PANAMA

SPECIE	COMMON NAME	FISHING DEPTH RANGE (FATHOM)	% OF THE TOTAL CATCH	MANGROVE RELATED
Penaeus occidentalis	White Shrimp	3 - 15	34.0 - 40.5	+
P. stylirostris	White Shrimp	3 - 15	1.9 - 2.25	+
P. vannamei	White Shrimp	3 - 15	1.9 - 2.25	+
P. brevirostris	Red Shrimp	30 - 45	25.0	+
Xiphopenaeus rivetti	Seabod	Shallow waters**	27.5	-
Protrachypene precipua	Seabob	Shallow waters**	27.5	-
Trachypenaeus byrdi	Tiger Shrimp	Shallow waters**	2.7	+
Trachypenaeus faoe	Tiger Shrimp	Shallow waters**	2.7	+
Salenocera agassizi	Fidel	45 - 60	0.18 - 1.86	-

* Based on D'Croz and Kwiecinski (1980)

** Generally fished near the mouth of the mangrove bordered estuaries.

TABLE 11: SHRIMP PRODUCTION IN PANAMA (METRIC TONS)*

YEAR	INDUSTRIAL FISHERY	ARTISANAL	MARICULTURE	TOTAL
1979	4,990	___	___	4,990
1980	5,559	___	___	5,559
1981	7,052	___	___	7,052
1982	6,932	248	565	7,745
1983	6,749	267	548	7,564

* According Gonzalez M. (1984).

___ No information available