

SHRIMP SURVEY IN COASTAL AND OFFSHORE WATERS OF NORTHEASTERN AND NORTHERN BRAZIL

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Two tentative trawling surveys were made by an American firm based at São Luís (Maranhão — Brazil) in coastal waters of Maranhão, at the maximum depth of 50 fathoms (Lemos, 1956), with no success.

After that another shrimp and fish survey along and off the coast of northeastern and northern Brazil was made by the Japanese research vessel "Tôkô-Marû" in 1956 — 1957 (Nakamura *et al.*, 1957, 1958, 1963).

In the fall of 1957 the U. S. exploratory fishing vessel "Oregon" made one cruise from Trinidad to the mouth of the Amazon River (Bullis, Jr. & Thompson, 1959), and another one in 1963, from the British Guiana to northeastern Brazil (Bullis, Jr., 1963).

The authors had the opportunity of making survey aboard two commercial otter-trawlers based at Fortaleza (Ceará — Brazil), with the purpose of obtaining preliminary information on the shrimp resources of coastal and offshore waters of Ceará, Piauí, Maranhão and Pará States, and Amapá Territory.

This paper deals with the shrimp fishery as well as the record of species of fish, tunicates, echinoderms, mollusks, crustacea, coelenterates and sponges, in the area mentioned above, followed by some ecological notes. Also the data on length and weight of a species of pink shrimp, *Penaeus aztecus* Ives, are analysed.

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SURVEY STATIONS

The two otter-trawlers on which the authors made the observations — "Doña Maria" and "Gabriel E. Urias" — were built in Mexico, both attaining 65 feet length, being powered with a Caterpillar diesel engine of 220 H. P., developing 9 miles per hour, and having ice-chambers capacity of 20 tons.

The crew is made out only by four men: the master, the cook and two fishermen.

Three cotton nets can be used simultaneously: one is a small try-net of 8 feet length; the other two have 42 feet length, all three having a mean stretched mesh size of 31 mm at the cod-end; they are all operated by three trawling winches.

The try-net is always cast off first. According to the proportion of shrimp caught in twenty minutes trawling, the setting of the larger nets took place.

Trawling operations were started on June 26, and lasted until July 6, 1965.

The several survey stations made by both boats are shown in figure 1, tables I and II. Several try-net operations of the otter-trawler "Gabriel E. Urias" were not recorded.

SAMPLING PROCEDURE

Soon after the hauling up of the nets, one or more specimens of every species, according to its abundance, were picked up and immersed in formalin, for further identification at the laboratory. As to the pink shrimp, *Penaeus aztecus* Ives, when the haul yielded less than 100 specimens, the whole catch was used as a sample. In cases of more than that number, 100 specimens were picked up at random and all measured aboard.

The data collected from each specimen were the following: a) total length in millimeters, from the tip of the rostrum to the end of the telson, with the shrimp lightly extended on a ruler; b) carapace length in millimeters: b.1) from the tip of the rostrum to the posterior mid-dorsal edge of the carapace, and b.2) from the base of the eye notch to the posterior mid-dorsal edge of the carapace; c) sex; d) total weight to the nearest tenth of a gram; e) tail weight to the nearest tenth of a gram.

ANALYSIS OF THE DATA

Fish and other zoological groups — In the identification of the fishes and other species of animals, the following literature was used: Jordan & Evermann (1896, 1898a, 1898b, 1900); Rathbun (1901); Ribeiro (1915, 1918); Verrill (1922); Meek & Hildebrand (1923, 1925, 1928); Castro (1949, 1955); Carvalho (1950); Bernasconi (1955); Zim & Ingle (1955); Rossignol (1957); Holthuis (1958, 1959a, 1959b); Guinot-Dumortier (1960); Caso (1961); Abbott & Zim (1962); Rodrigues (1962); Warmke & Abbott (1962); Boschi (1963) and Neiva & Mistakidis (1964).

The list of those species, together with the survey stations numbers where they were caught, are shown in table III.

Proportional measurements of the pink shrimp, Penaeus aztecus Ives — Data on total

$$\begin{aligned} \text{males: } \log W &= -5.617 + 3.143 \log L \quad (r = 1.00) \\ \text{females: } \log W &= -4.759 + 2.762 \log L \quad (r = 1.00) \end{aligned}$$

where W is the tail weight in grams and L is the total length in millimeters (figure 5).

Regression coefficients of tail weight on total weight were calculated by using 61 males and 39 females. Significant difference was found between sexes, and the equations are:

$$\begin{aligned} \text{males: } Y &= 0.96 + 0.59X \quad (r = 0.99) \\ \text{females: } Y &= 0.71 + 0.59X \quad (r = 0.99) \end{aligned}$$

length were grouped in 5 millimeters interval. Table IV shows total and carapace length (two kinds of measurements of carapace), both in millimeters, distributed by sexes; table V shows total length in millimeters, total and tail weight in grams, distributed by sexes; table VI shows total and tail weight in grams, distributed by sexes; in this case, total weight data were grouped in 2.5 grams interval.

The analysis of each biometrical data separately by sexes are shown in table VII.

Regression coefficients of carapace length (first case: from the tip of the rostrum to the posterior mid-dorsal edge of the carapace) on total length were calculated by using 270 males and 296 females. In this case, significant difference was found between sexes, and the equations are:

$$\begin{aligned} \text{males: } Y &= -0.77 + 0.37X \quad (r = 0.99) \\ \text{females: } Y &= -3.31 + 0.41X \quad (r = 1.00) \end{aligned}$$

where X is the total length and Y is the carapace length, both in millimeters (figure 2).

Regression coefficients of carapace length (second case: from the base of the eye notch to the posterior mid-dorsal edge of the carapace) on total length were calculated by using 52 males and 44 females. No significant difference was found between sexes, and the equation is:

$$Y = -12.00 + 0.32X \quad (r = 1.00)$$

where X is the total length and Y is the carapace length, both in millimeters (figure 3).

Regression coefficients of total weight on total length were calculated by least squares of a logarithmic transformation, by using 268 males and 295 females. No significant difference was found between sexes, and the equation is:

$$\log W = -5.356 + 3.124 \log L \quad (r = 1.00)$$

where W is the total weight in grams and L is the total length in millimeters (figure 4).

Regression coefficients of tail weight on total length were calculated by least squares of a logarithmic transformation, by using 61 males and 39 females. Significant difference was found between sexes, and the equations are:

where X is the total weight and Y is the tail weight, both in grams (figure 6).

Sex-ratio — Total number of males sampled was 270 specimens, and females, 296 specimens, representing 47.70% and 52.30% of the total, respectively. Qui-square test ($\chi^2 = 1.18$; $P > 0.05$) showed that there is no significant difference in sex-ratio.

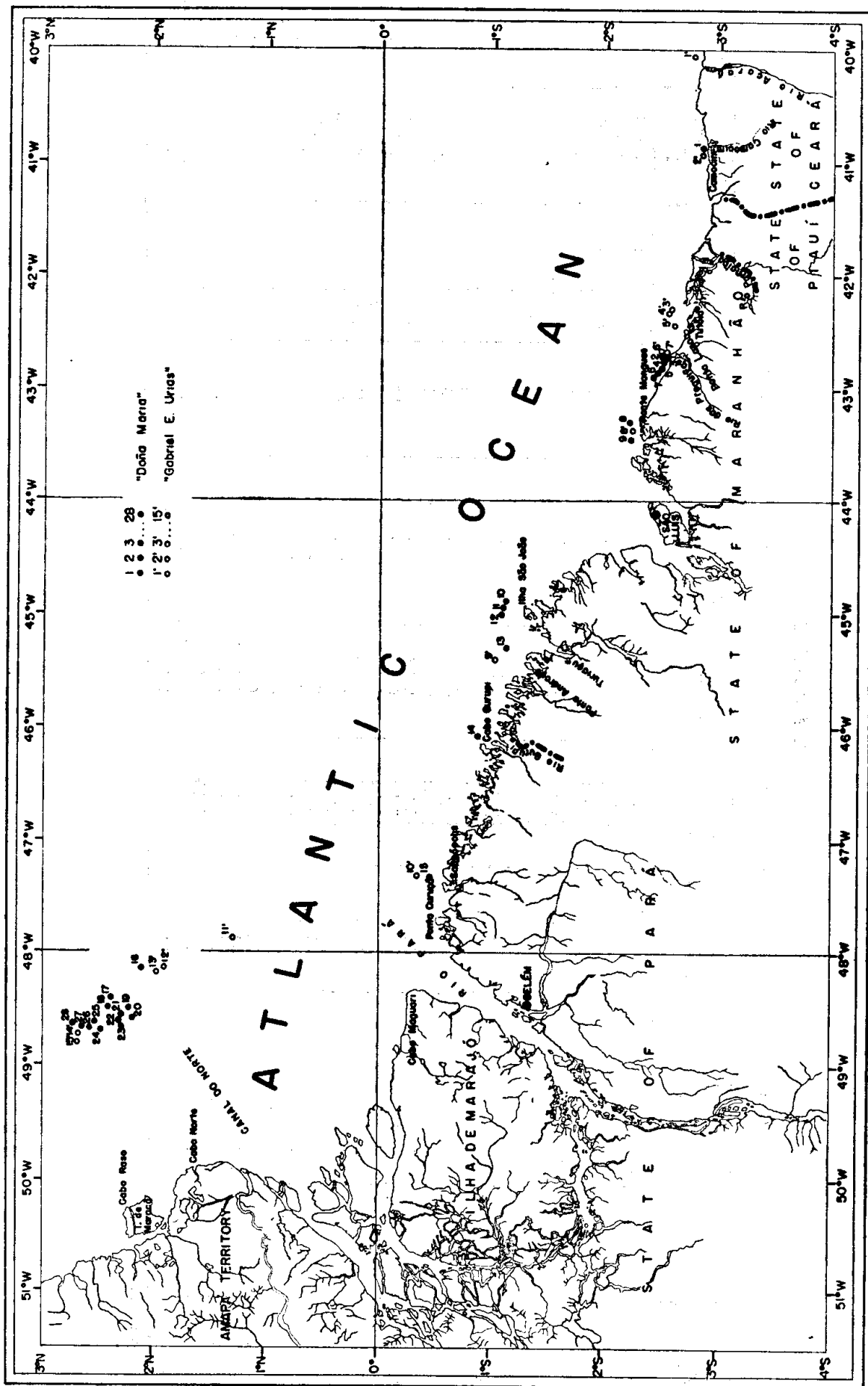


Figure 1 — Map showing the survey stations numbers of the otter-trawlers "Doña Maria" and "Gabriel E. Urias", in coastal and offshore waters of northeastern and northern Brazil.

T A B L E I
Characteristics of the survey stations and catch amount of the otter-trawler "Doña Maria".

Date (1965)	Station no.	Survey area	Time (h)		Trawling time (h)	Distance from coast (nautical miles)	Depth (fathoms)	Nature of the bottom	Catch amount (total weight in kg)	
			Net casting	Net hauling					Fish	Shrimp
June, 26	1	Camocim	17.30	17.50	0.20	3	9	sandy shell	0.400	—
June, 27	2	Rio Preguiças	9.13	9.33	0.20	2	6	sandy shell	0.500	—
June, 27	3	Rio Preguiças	9.55	10.15	0.20	1	4	sandy shell	0.500	0.050
June, 27	4	Rio Preguiças	10.20	10.40	0.20	1	4	sandy shell	—	0.040
June, 27	5	Rio Preguiças	10.45	11.05	0.20	1	4	sandy shell	0.800	—
June, 27	6	Rio Preguiças	11.45	12.05	0.20	1	4	sandy shell	1.000	0.100
June, 27	7	Rio Preguiças	13.10	13.30	0.20	1	4	sandy shell	0.500	0.040
June, 27	8	Ponta Mangues	17.50	18.10	0.20	6	6	sand	—	—
June, 27	9	Ponta Mangues	18.15	18.35	0.20	6	6	sand	—	0.100
June, 29	10	Ilha São João	8.30	8.50	0.20	7	10	sand	0.200	0.439
June, 29	11	Ilha São João	10.50	11.10	0.20	7	10	sand	0.100	0.823
June, 29	12	Ilha São João	11.45	12.05	0.20*	7	10	sand	5.000	—
June, 29	13	Ponta Andrade	15.20	17.00	2.00*	10	10	sand	100.000	4.000
June, 30	14	Cabo Gurupi	12.00	12.20	0.20	6	10	mud	0.100	0.050
July, 1	15	Salinópolis	8.00	8.20	0.20	5	10	mud	0.200	0.040
July, 3	16	Canal do Norte	11.10	11.30	0.20	95	30	sandy shell	0.300	—
July, 3	17	Cabo Maguari	19.50	20.25	0.35	100	40	mud	0.100	0.151
July, 3	18	Cabo Maguari	20.30	21.00	0.30	100	40	mud	0.100	0.100
July, 4	19	Cabo Maguari	6.30	7.00	0.30	100	30	mud	0.100	0.290
July, 4	20	Cabo Maguari	7.10	7.30	0.20	100	20	mud	0.150	0.426
July, 4	21	Cabo Maguari	8.00	8.20	0.20	100	23	mud	0.300	—
July, 4	22	Cabo Maguari	8.00	10.00	2.00*	100	23	mud	100.000	1.150
July, 4	23	Cabo Maguari	8.30	8.50	0.20	100	23	mud	0.100	0.020
July, 4	24	Cabo Raso	18.10	22.20	4.10*	89	30	mud	50.000	70.000
July, 4/5	25	Cabo Raso	22.30	2.30	4.00*	89	40	mud	100.000	90.000
July, 5	26	Cabo Raso	2.30	6.30	4.00*	89	40	mud	150.000	80.000
July, 5	27	Cabo Raso	20.00	24.00	4.00*	89	40	mud	30.000	90.000
July, 6	28	Cabo Raso	1.00	6.00	5.00*	89	40	mud	50.000	60.000

* Large-nets; the rest, try-net.

T A B L E I I
 Characteristics of the survey stations and catch amount of the otter-trawler "Gabriel E. Urias".

Date (1965)	Station no. *	Survey area	Time (h)		Trawling time (h)	Distance from coast (nautical miles)	Depth (fathoms)	Nature of the bottom	Catch amount (total weight in kg)	
			Net casting	Net hauling					Fish	Shrimp
June, 26	1'	Acaraú	14.40	15.00	0.20	5	3	sand	0.100	—
June, 26	2'	Carnocim	15.45	16.10	0.25	3	2	sandy shell	0.060	—
June, 27	3'	Tutóia	6.00	6.20	0.20	13	16	sand	1.000	—
June, 27	4'	Tutóia	6.25	6.45	0.20	13	16	sand	1.000	—
June, 27	5'	Ponta Lazou	8.00	8.20	0.20	10	9	sand	3.000	0.200
June, 27	6'	Rio Preguiças	9.45	10.00	0.15	3	5	mud	1.000	0.030
June, 27	7'	Rio Preguiças	11.10	11.30	0.20	2	4	sand & mud	2.000	—
June, 28	8'	Ponta Mangues	6.00	6.20	0.20	8	8	sand	3.000	—
June, 29	9'	Ponta Andrade	12.00	15.00	3.00 **	15	6	sand & mud	1.000	0.100
June, 30	10'	Salnópolis	12.45	13.00	0.15	15	7	sand & mud	0.300	0.200
July, 2	11'	Ponta Curuçá	20.45	21.15	0.30 **	90	25	rocks	0.100	0.150
July, 4	12'	Cabo Maguari	17.00	19.00	2.00 **	100	30	mud	30.000	50.000
July, 4	13'	Cabo Maguari	20.00	24.00	4.00 **	100	30	mud	80.000	70.000
July, 5	14'	Cabo Raso	18.00	22.00	4.00 **	89	40	mud	40.000	50.000
July, 6	15'	Cabo Raso	1.00	6.00	5.00 **	89	40	mud	35.000	60.000

* Several try-net operations were not recorded.

** Large nets; the rest, try-net.

DISCUSSION

Fish and other zoological groups — Catch data of "Doña Maria" are complete, but not those of "Gabriel E. Urias". Based on the data of the first otter-trawler, 65 species of fish were taken during the whole survey (table III). The most abundant demersal species in the main shrimp fishing grounds are: shark, *Scoliodon tetrarhynchus* Richardson; guitar-fish, *Rhinobatus percellens* (Walbaum); rays, *Gymnura micrura* (Bloch & Schneider), *Dasyatis gymnura* (Müller) and *Urotrygon microphthalmum* Delsman; catfishes, *Felichthys bagre* (Linnaeus) and *Galeichthys* sp.; moray-eels, *Ariosoma nitens* (Jordan & Bollman), *Ophichthus magniocularis* (Kaup), *Gymnothorax ocellatus* Agassiz and *Gymnothorax jordani* (Evermann & Marsh); goat-fish, *Prionotus caprella* (Ribeiro); lane snapper, *Lutianus synagris* (Linnaeus); grunt, *Conodon nobilis* (Linnaeus); soles, *Scyrium latifrons* (Jordan & Gilbert), *Achirus fasciatus* (Lacépède), *Achirus* sp. and *Symphurus elongatus* (Günther).

Among the echinoderms, starfishes, *Luidia senegalensis* (Lamarck) and *Astropecten marginatus* Gray, and brittle star, *Ophioderma* sp., were abundantly found at several stations.

Among mollusks, the scallop, *Amusium papyraceus* Gabb, was abundantly found in the main shrimp fishing grounds. This species, as well as *Bursa spadicea* Montfort, *Distorsio clathrata* Lamarck, *Oliva caribaeensis* Dall & Simpson and *Lima pellucida* Adams, are new occurrences for Brazilian waters.

Among crustacea (except Penaeidae) were abundantly found *Scyllarides delfosi* Holthuis; crabs, *Calappa nitida* Holthuis, *Calappa sulcata* Rathbun and *Callinectes danae* Smith; and mantis shrimp, *Squilla lijdingi* Holthuis, in the main shrimp fishing grounds. The first three species, as well as *Hepatus gronovii* Holthuis and *Hepatus scaber* Holthuis, are new occurrences for Brazilian waters.

Occurrence of other species of animals (tunicates, coelenterates and sponges) were sporadic, except for sponges, of which several species, not yet identified (probably some of Laubenfels' (1956) sponge species were collected), were found at station no. 16.

Penaeidae catches — Young and medium sized pink shrimp, *Penaeus aztecus* Ives, were caught in coastal waters of Maranhão and Pará States (stations no. 3, 6, 7, 9, 13, 15 and 5', 6', 10'), but not in large quantities. According to observations of Coelho (1963), this species is very abundant in estuaries and along the beaches of Maranhão State, in the catches made with stop seines and trap nets. Large ones were only caught in offshore waters of Pará State and Amapá Territory (stations no. 17/28 and 11'/15'), at 20 to 40

TABLE III

List of species of fish, tunicates, echinoderms, mollusks, crustacea, coelenterates and sponges caught during shrimp survey made in coastal and offshore waters of northeastern and northern Brazil in June-July, 1965, together with the survey stations numbers where they were caught and the boat's name.

Species	"Doña Maria" Station no.	"Gabriel E. Urias" Station no.
FISH:		
<i>Scoliodon terrae-novae</i> Richardson	22, 25/28	9', 11'/15'
<i>Rhinobatus percellens</i> (Walbaum)	22, 26/28	11'/15'
<i>Gymnura micrura</i> (Bloch & Schneider)	6, 13/15, 24/28	9', 10', 12'/15'
<i>Dasyatis gymnura</i> (Müller)	6, 13/15, 24/28	9', 10', 12'/15'
<i>Urotrygon microphthalmum</i> Delsman	6, 13/15, 24/28	9', 10', 12'/15'
<i>Narcine brasiliensis</i> (Olfers)	20	13'
<i>Felichthys bagre</i> (Linnaeus)	5/7, 11, 13, 15	10', 11'
<i>Galeichthys</i> sp.	5/7, 10, 13, 15, 24/28	10'/15'
<i>Platystacus ?cotylephorus</i> Bloch (freshwater catfish)	15	—
<i>Ariosoma ?nitens</i> (Jordan & Bollman)	24/28	11'/15'
<i>Ophichthus magniocularis</i> (Kaup)	24/28	11'/15'
<i>Gymnothorax ocellatus</i> Agassiz	24/28	11'/15'
<i>Gymnothorax jordani</i> (Evermann & Marsh)	24/28	11'/15'
<i>Opisthonema oglinum</i> (Le Sueur)	12, 24	2'
<i>Odontognathus mucronata</i> Lacépède	13	9'
<i>Anchoa spinifera</i> (Cuvier & Valenciennes)	13	9'
<i>Synodus foetens</i> (Linnaeus)	22, 24, 26, 28	12'/15'
<i>Paroexocoetus ?brachypterus hillianus</i> (Gosse)	1	2'
<i>Polyneemus virginicus</i> Linnaeus	26, 28	14', 15'
<i>Sphyræna ensis</i> Jordan & Gilbert	22	12'
<i>Prionotus ?caprella</i> Ribeiro	11, 23/28	12'/15'
<i>Rachycentron canadus</i> (Linnaeus)	22	12'
<i>Chloroscombrus chrysurus</i> (Linnaeus)	2, 11, 12, 22	6' 12'
<i>Selar crumenophthalmus</i> (Bloch)	22	13', 14'
<i>Vomer settipinnis</i> (Mitchill)	22, 26, 28	12'/15'
<i>Peprilus paru</i> (Linnaeus)	19, 20, 22	9'
<i>Scomberomorus maculatus</i> (Mitchill)	13, 22	9'
<i>Acanthurus</i> sp.	16	—
<i>Pseudomulloidés carmineus</i> Ribeiro	22	—
<i>Macrodon ancylodon</i> (Bloch)	13, 22, 26, 28	10'
<i>Paralonchurus brasiliensis</i> (Steindachner)	10	—
<i>Stellifer ?illecebrosus</i> Gilbert	10	—
<i>Stellifer ?lanceolatus</i> (Holbrook)	10	—
<i>Nebris microps</i> Cuvier	13	—
<i>Micropogon furnieri</i> (Desmarest)	3, 13, 22	6'
<i>Menticirrhus martinicensis</i> (Cuvier)	11, 13	9'
<i>Larimus breviceps</i> Cuvier	22, 26	12'
<i>Sparisoma</i> sp.	16	—
<i>Chaetodipterus faber</i> Broussonet	16, 28	—
<i>Chaetodon ocellatus</i> (Bloch)	16, 26	14'/15'
<i>Pomacanthus paru</i> (Bloch)	18, 20	12'
<i>Priacanthus arenatus</i> Cuvier	27, 28	14'/15'
<i>Diplectrum ?pacificus</i> Meek & Hildebrand	13	—
<i>Prionodes</i> sp.	13	—
<i>Lutianus synagris</i> (Linnaeus)	22, 25/28	11'/15'
<i>Genyatremus luteus</i> Bloch	26, 28	15'
<i>Conodon nobilis</i> (Linnaeus)	5, 6, 17/28	6', 11'/15'
<i>Orthopristis ruber</i> (Cuvier & Valenciennes)	1, 2, 24, 26, 28	6'
<i>Cephalacanthus volitans</i> (Linnaeus)	1	2'
<i>Amphichthys cryptocentrus</i> (Cuvier & Valenciennes)	20, 25, 28	12', 15'
<i>Porichthys porosissimus</i> (Cuvier & Valenciennes)	25, 26	14', 15'
<i>Pseudobythites</i> sp.	20	—
<i>Scyaciium ?latifrons</i> (Jordan & Gilbert)	24/28	11'/15'
<i>Achirus fasciatus</i> (Lacépède)	2, 11, 14, 15, 18, 19, 21, 22, 24/28	1', 2', 10'/15'
<i>Achirus</i> sp.	14, 15, 18, 24/28	10'/15'
<i>Symphurus ?elongatus</i> (Günther)	19, 22, 24/28	10'/15'
<i>Balistes vetula</i> Linnaeus	22, 23, 28	12', 15'
<i>Lactophrys tricornis</i> (Linnaeus)	16, 28	14', 15'
<i>Colomesus psittacus</i> (Bloch)	13	9'
<i>Lagocephalus laevigatus</i> Linnaeus)	13	14', 15'
<i>Chilomycterus ?antennatus</i> (Cuvier)	21	—
<i>Trichiurus lepturus</i> Linnaeus	6, 13, 22, 26	9', 14'
<i>Antennarius scaber</i> Cuvier	6	—
<i>Ogcocephalus longirostris</i> (Cuvier & Valenciennes)	13, 28	9', 15'
<i>Scorpaena</i> sp.	17, 18	13', 15'

Species	"Doña Maria" Station no.	"Gabriel E. Urias" Station no.
TUNICATES:		
<i>Ascidia nigra</i> (Savigny)	16	—
? <i>Molgula</i> sp.	16	—
ECHINODERMS:		
<i>Astrophytum muricatum</i> (Lamarck)	—	12'
<i>Euclidaris tribuloides</i> (Lamarck)	28	—
<i>Luidia senegalensis</i> (Lamarck)	17, 18, 22, 23, 28	2', 6', 9', 10'
<i>Astropecten marginatus</i> Gray	17, 18, 21/24, 26, 28	1', 2', 6', 9', 15'
<i>Echinaster echinophorus</i> (Lamarck)	16	1'
<i>Encope emarginata</i> (Leske)	4/6, 16	6'
<i>Mellita quinquesperforata latiambulacra</i> Clark	4/6, 15	6', 7'
<i>Holothuria grisea</i> Selenka	—	6'
<i>Ophioderma</i> sp.	19, 20, 21/28	1', 11'/15'
MOLLUSKS:		
<i>Polystira albida</i> Perry	20	13'
<i>Bursa spadicea</i> Montfort	20/23	12'/15'
<i>Distorsio clathrata</i> Lamarck	20/23	12'/15'
<i>Terebra taurinus</i> Solander	—	12'
<i>Architectonica nobilis</i> Røeding	20	12'
<i>Phalium granulatum</i> Born	20	—
<i>Oliva caribaeensis</i> Dall & Simpson	—	11'
<i>Marginella</i> sp.	20	—
<i>Natica cayennensis</i> Récluz	20	—
<i>Xancus laevigatus</i> Anton	13, 16, 26	9', 14', 15'
<i>Tonna galea</i> Linnaeus	16	12'
<i>Fasciolaria</i> sp.	20	—
<i>Conus</i> sp.	16	—
<i>Fusinus</i> sp.	—	12'
<i>Lima pellucida</i> Adams	—	14'
<i>Amustum papyraceus</i> Gabb	20, 26/28	13'/15'
<i>Modiolus ?americanus</i> Leach	20	—
<i>Atrina ?seminuda</i> Lamarck	19, 21	—
<i>Octopus</i> sp.	25, 26	—
<i>Loligo</i> sp.	11, 22, 28	7', 9'
CRUSTACEA:		
<i>Scyllarides delfosi</i> Holthuis	25/28	12'/15'
<i>Palaemon (Nematopalaemon) schmitti</i> Holthuis	14, 15	10'
<i>Penaeus aztecus</i> Ives	3, 6, 7, 9, 13, 15, 17/28	5', 6', 10', 11'/15'
<i>Penaeus schmitti</i> Burkenroad	4, 11, 13	9'
<i>Xiphopenaeus kroyeri</i> (Heller)	14, 15	10', 11'
<i>Sicyonia typica</i> Boeck	26	—
<i>Sicyonia dorsalis</i> Kingsley	—	10'
<i>Trachypenaeus constrictus</i> (Stimpson)	—	10'
<i>Solenocera ?geijskesi</i> Holthuis	—	13'
<i>Calappa ocelata</i> Holthuis	11, 18, 25	13'/15'
<i>Calappa nitida</i> Holthuis	24/28	12'/15'
<i>Calappa sulcata</i> Rathbun	24/28	12'/15'
<i>Hepatus gronovii</i> Holthuis	16	—
<i>Hepatus scaber</i> Holthuis	16	—
<i>Persephona punctata</i> (Linnaeus)	14, 15	10'
<i>Persephona lichtensteinii</i> Leach	14, 15	10'
<i>Collodes inermis</i> Edwards	—	3'
<i>Libinia bellicosa</i> Oliveira	—	10'
<i>Libinia ferreirae</i> Capello	—	9'
<i>Stenorhynchus seticornis</i> (Herbst)	11	9'
<i>Mithrax depressus</i> Edwards	—	12'
<i>Mithrax caribaeus</i> Rathbun	—	11'
<i>Inachoides ?intermedius</i> Rathbun	17	—
<i>Paradasiggyus tuberculatus</i> Castro	—	11'
<i>Portunus rufiremus</i> Holthuis	—	15'
<i>Portunus spinicarpus</i> (Stimpson)	28	15'
<i>Portunus spinimanus</i> Latreille	26	—
<i>Portunus</i> sp.	27	—
<i>Callinectes danae</i> Smith	13, 18/28	7'/15'
<i>Callinectes bocourti</i> Edwards	17	—
<i>Leiolambrus nitidus</i> Rathbun	—	12'
<i>Clibanarius vittatus</i> (Bosc)	20	13'

Species	"Doña Maria" Station no.	"Gabriel E. Urias" Station no.
<i>Dardanus ?venosus</i> Edwards	16, 26	—
<i>Isocheles wurdemanni</i> Stimpson	—	12'
<i>Albunea paretii</i> Guérin	6	7'
<i>Squilla tijdingi</i> Holthuis	17/28	12'/15'
<i>Balanus</i> sp.	26	—
COELENTERATES:		
<i>Telesto</i> sp.	14, 15	—
<i>Renilla</i> sp.	20, 26	14', 15'
<i>Scyphomedusae</i>	14, 15	6', 7', 9', 10'
SPONGES:		
Species not identified	16, 26, 28	14', 15'

TABLE IV

Total length (mm) and carapace length (mm) distribution by sexes, of the pink shrimp, *Penaeus aztecus* Ives, sampled during June-July 1965, along and off the coast of northeastern and northern Brazil.

Midpoint of total length interval (mm)	Males				Females			
	Number sampled	Average carapace length (mm) (1)	Number sampled	Average carapace length (mm) (2)	Number sampled	Average carapace length (mm) (1)	Number sampled	Average carapace length (mm) (2)
73	...	...	...	...	3	28.0	...	...
78	...	...	...	...	2	28.5	...	...
83	2	31.5	...	...	2	31.0	...	...
88	3	32.7	...	...	2	32.5	...	...
93	1	36.0	...	...	4	35.0	...	...
98	2	37.5	...	...	4	38.0	...	...
103	3	39.0	...	...	1	39.0	...	...
108	18	40.5	...	...	3	39.7	...	...
113	27	42.3	2	25.0	2	42.0	...	...
118	36	43.6	2	26.0	10	44.3	...	...
123	29	46.3	7	27.4	15	47.4	...	...
128	38	47.8	7	28.6	21	49.2	1	28.0
133	35	49.9	17	30.1	11	51.5	3	32.0
138	35	51.8	5	32.0	18	53.3	3	32.7
143	19	53.7	6	33.2	20	54.8	3	35.3
148	11	55.7	1	35.0	16	57.5	6	36.5
153	10	57.5	1	37.0	24	58.8	3	38.0
158	1	60.0	1	39.0	29	61.8	6	38.5
163	...	...	1	41.0	22	62.9	6	39.7
168	...	...	1	42.0	25	65.8	4	41.0
173	...	...	1	43.0	23	67.5	4	43.3
178	...	...	...	...	16	70.3	2	44.0
183	...	...	...	...	10	71.6	2	46.0
188	...	...	...	...	4	73.7	1	48.0
193	...	...	...	...	9	76.4	...	...
Total	270	47.4	52	39.8	296	57.6	44	38.8

(1) From the tip of the rostrum to the posterior mid-dorsal edge of the carapace.

(2) From the base of the eye notch to the posterior mid-dorsal edge of the carapace.

fathoms depth, on muddy bottom. Only 17 offshore surveys were made. Lemos (1956) has the opinion that survey at 150-200 fathoms depth should be made because adult shrimp use to inhabit in deep waters. We had no opportunity to survey at those depths, but we caught large shrimp at 40 fathoms depth, north latitude, off Pará State and Amapá Territory. Holthuis (1959a) also says that adult specimens of pink shrimp are, as a rule, found farther offshore (12-30 fathoms depth). At

offshore waters of Maranhão State, however, the bottom at over 22 fathoms depth is composed of corals, and is not proper for trawling because fishing nets are damaged, according to "Tôkô Maru's" report (Nakamura *et al.*, 1957, 1958, 1963). Only at station no. 28, off Amapá Territory, one of "Doña Maria's" large nets was damaged by stones, and one of "Gabriel E. Urias", was damaged twice (stations no. 12' and 15'), both times by tree trunks.

TABLE V

Total length (mm), total weight (g) and tail weight (g) distribution by sexes, of the pink shrimp, *Penaeus aztecus* Ives, sampled during June-July 1965, along and off the coast of northeastern and northern Brazil.

Midpoint of total length interval (mm)	Males				Females			
	Number sampled	Average total weight (g)	Number sampled	Average tail weight (g)	Number sampled	Average total weight (g)	Number sampled	Average tail weight (g)
73	...	...	...	...	3	3.0	...	...
78	...	...	...	...	2	3.5	...	...
83	1	4.0	...	...	2	4.0	...	...
88	3	4.7	...	...	2	5.0	...	...
93	1	6.0	...	...	4	6.8	...	...
98	2	7.5	...	...	4	7.1	...	...
103	3	9.2	...	...	1	8.5	...	...
108	18	10.3	1	6.0	2	9.8	...	...
113	27	11.4	1	7.0	1	10.5	...	...
118	36	12.9	...	...	11	12.2	...	...
123	29	14.3	4	8.8	15	15.3	...	...
128	38	15.9	12	10.2	21	17.6	...	...
133	34	17.9	11	11.6	11	19.8	...	...
138	35	20.0	12	12.9	18	21.7	...	...
143	19	21.9	6	14.0	20	23.2	3	14.7
148	11	25.0	9	15.9	16	26.7	4	17.6
153	8	27.8	5	17.3	24	28.7	4	18.1
158	3	29.5	...	...	30	33.0	7	20.0
163	...	...	...	...	22	36.3	1	22.0
168	...	...	...	...	25	39.4	5	24.3
173	...	...	...	...	23	44.0	4	26.5
178	...	...	...	...	16	49.6	4	29.1
183	...	...	...	...	10	52.9	3	31.6
188	...	...	...	...	3	56.7	1	33.0
193	...	...	...	...	9	62.6	3	38.3
Total	268	16.2	61	12.8	295	30.2	39	24.6

TABLE VI

Total weight (g) and tail weight (g) distribution by sexes, of the pink shrimp, *Penaeus aztecus* Ives, sampled during June-July 1965, along and off the coast of northeastern and northern Brazil.

Midpoint of total weight interval (g)	Males		Females	
	Number sampled	Average tail weight (g)	Number sampled	Average tail weight (g)
8.5	1	6.0	...	...
11.0	1	7.0	...	...
13.5	5	8.9	...	...
16.0	14	10.4	...	...
18.5	15	12.1	...	...
21.0	10	13.7	2	14.3
23.5	4	14.9	...	...
26.0	7	16.4	2	15.8
28.5	3	17.7	5	17.8
31.0	1	19.0	5	18.5
33.5	...	...	2	19.5
36.0	...	...	2	23.0
38.5	...	...	5	23.7
41.0	...	...	...	...
43.5	...	...	3	26.0
46.0	...	...	2	26.7
48.5	...	...	2	28.3
51.0	...	...	4	31.1
53.5	...	...	2	32.0
56.0	...	...	...	...
58.5	...	...	...	...
61.0	...	...	...	...
63.5	...	...	2	39.3
66.0	...	...	1	40.0
Total	61	12.2	39	23.4

TABLE VII

Data concerning the proportional measurements of length (mm) and weight (g) of the pink shrimp, *Penaeus aztecus* Ives, sampled during June-July 1965, along and off the coast of northeastern an northern Brazil.

Proportional measurements	Number of specimens		Maximum value		Minimum value		Arithmetic mean		Standard deviation		Coefficient of variation	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Total length (1)	270	296	158.00	193.00	83.00	73.00	126.74	161.51	13.76	25.29	10.86	15.66
Total length (2)	52	44	173.00	188.00	113.00	128.00	134.44	157.20	12.90	15.01	9.60	9.55
Total length (3)	268	295	158.00	193.00	83.00	73.00	126.92	149.47	13.64	24.69	10.75	16.52
Total length (4)	61	39	153.00	193.00	108.00	143.00	136.44	165.69	9.93	14.81	7.28	8.94
Carapace length (5)	270	296	60.00	76.40	31.50	28.00	47.47	57.90	12.26	9.83	25.83	16.98
Carapace length (6)	52	44	43.00	48.00	25.00	28.00	30.80	38.53	3.91	4.26	12.69	11.06
Total weight (7)	268	295	29.50	62.60	4.00	3.00	16.24	46.28	4.88	13.86	30.05	29.95
Total weight (8)	61	39	31.00	66.00	8.50	21.00	19.52	39.65	4.68	11.68	23.98	29.46
Tail weight (9)	61	39	19.00	40.00	6.00	14.30	12.59	24.11	2.79	6.93	22.16	23.74
Tail weight (10)	61	39	17.30	38.30	6.00	14.70	12.57	23.99	1.65	6.64	12.57	27.68

- (1) Used for obtaining the regression coefficients of carapace length (5) on total length.
 (2) Used for obtaining the regression coefficients of carapace length (6) on total length.
 (3) Used for obtaining the regression coefficients of total weight (7) on total length.
 (4) Used for obtaining the regression coefficients of tail weight (10) on total length.
 (5) From the tip of the rostrum to the posterior mid-dorsal edge of the carapace.
 (6) From the base of the eye notch to the posterior mid-dorsal edge of the carapace.
 (7) Used for obtaining the regression coefficients of total weight on total length (3).
 (8) and (9) Used for obtaining the regression coefficients of tail weight on total weight.
 (10) Used for obtaining the regression coefficients of tail weight on total length (4).

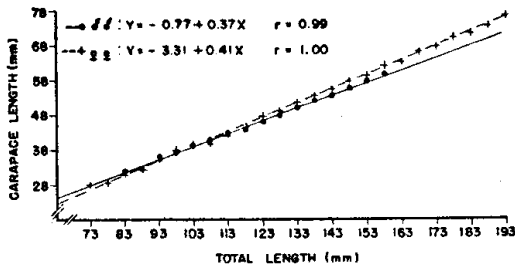


Figure 2 — Regressions of carapace length (mm) (from the tip of the rostrum to the posterior mid-dorsal edge of the carapace) on total length (mm) of the pink shrimp, *Penaeus aztecus* Ives.

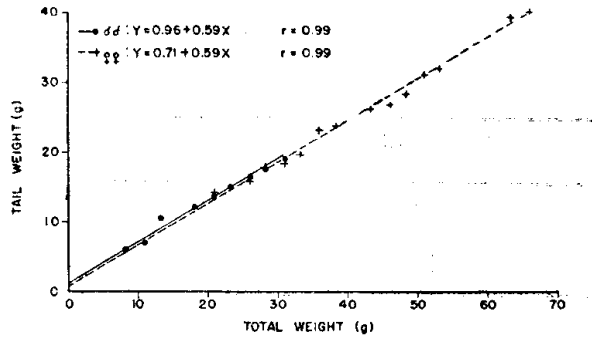


Figure 6 — Regressions of tail weight (g) on total weight (g) of the pink shrimp, *Penaeus aztecus* Ives.

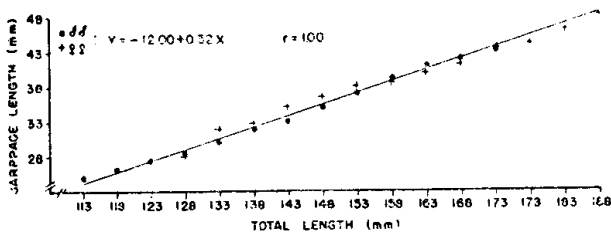


Figure 3 — Regression of carapace length (mm) (from the base of the eye notch to the posterior mid-dorsal edge of the carapace) on total length (mm) of the pink shrimp, *Penaeus aztecus* Ives.

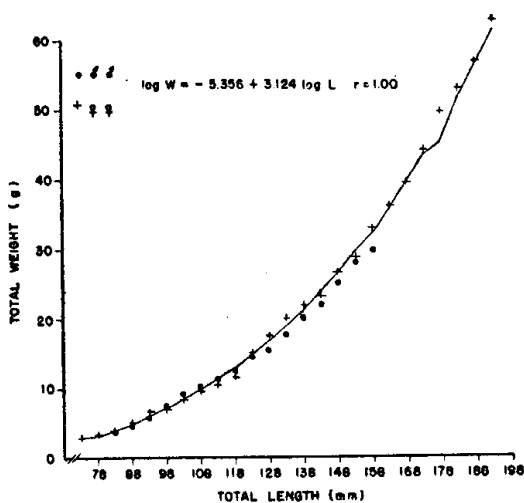


Figure 4 — Regression of total weight (g) on total length (mm) of the pink shrimp, *Penaeus aztecus* Ives.

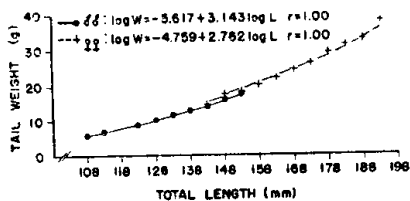


Figure 5 — Regressions of tail weight (g) on total length (mm) of the pink shrimp, *Penaeus aztecus* Ives.

The "Tôkô Maru" report emphasizes that shrimp fishing must be considered in the future for the coastal zone of Maranhão State. In waters south of Pará River mouth, the research vessel "Tôkô Maru" made only five trawling survey stations on a small flat zone of 10-16 fathoms depth, and they concluded that the vastly mud accumulated zone north of the Pará River mouth must be more promising as fishing ground rather than south's.

According to Anonymous (1953), offshore waters from the Amazon River to Recife (Pernambuco) yield heavy catches of large shrimp from June through September, but he does not quote the scientific name of the species.

Lindner (1957) states that about 60 per cent of the catch in the area of Marajó Bay to São Luís, and the area around Parnaíba, appears to be sea-bobs, and the remainder is about equally divided between the young of *Penaeus schmitti* Burkenroad and of *Penaeus aztecus* Ives. Shrimps are caught throughout the year, in northern grounds, says Lindner (1957); however, Coelho (1963) states that in coastal waters of Maranhão State the best period of shrimp fishing is from April to August, after rainfall season.

In the neighbourhood of the area where we caught *Penaeus aztecus* Ives (latitudes between 1° and 3° N and longitudes between 48° and 49° W), the exploratory fishing vessel "Oregon" made sporadic catches of that species in the fall of 1957 (Bullis, Jr. & Thompson, 1959). They were caught from 10 to 50 fathoms depth, but beyond 40 fathoms the quantity caught was considerable less, being more frequent in the 25 to 30 fathoms range along with *Penaeus brasiliensis* Latreille. However, in our samples of shrimp catches at 20-40 fathoms depth, in the region already mentioned, we did not find any *Penaeus brasiliensis* Latreille, but only *Penaeus aztecus* Ives. As our boats, the "Oregon" also found them predominantly on muddy bottoms, best catches of this boat amounting to 30 to 45 pounds per hour (heads-on).

TABLE VIII

Measurements of the white shrimp, *Penaeus schmitti* Burkenroad, from coastal waters of northeastern Brazil.

Total length (mm)	Carapace length (mm) (including rostrum)	Total weight (g)	Sex
129	47	16.5	male
135	49	20.0	male
138	49	22.0	male
161	54	24.5	female

During our survey, we sighted 28 boats in operation in the area, confirming the statement of Richardson (1962) that foreign backed shrimp boats were fishing off the mouth of the Amazon River.

In a diagram presented by Richardson (1962, 1963, 1964), there are no data on catch per unit-of-effort in the shrimp grounds off northern Brazil. One of the 28 boats, "Gulf King III", from Barbados, caught an average of 1,000 pounds (heads-off) per night fishing (12 hours), equivalent to about 83 pounds (heads-off) per hour, much more than the "Oregon's". As to our boats, "Doña Maria", for instance, caught only about 280 pounds (heads-off) from sundown of July 4 to dawn of July 5, 1965 (12 hours), equivalent to about 23 pounds (heads-off) per hour.

As to the white shrimp, *Penaeus schmitti* Burkenroad, only six large specimens were caught at 3 to 7 fathoms depth, in coastal waters of Maranhão State (stations no. 4, 11, 13 and 9'), alone or mixed with medium sized pink shrimp, *Penaeus aztecus* Ives. Four specimens were measured and sexed, as shown in table VIII.

Large sized specimens of white shrimp are commonly caught in estuaries and beaches of Maranhão coast (Coelho, 1963), but due to the few survey stations we made, it is not possible to say whether white shrimp is, or not, abundant in offshore waters.

Few quantities of sea-bob, *Xiphopenaeus kroyeri* (Heller) were caught at stations no. 14, 15, 10' (inshore waters of Maranhão and Pará States), and 11' (offshore waters of Pará State).

One specimen of *Sicyonia typica* Boeck was found at station no. 26, and three specimens of *Solenocera ?geijskesi* Holthuis at station no. 13', both mixed with *Penaeus aztecus* Ives; one specimen of *Sicyonia dorsalis* Kingsley and one specimen of *Trachypenaeus constrictus* (Stimpson) at station no. 10', both mixed with *Penaeus aztecus* Ives, *Penaeus schmitti* Burkenroad and *Xiphopenaeus kroyeri* (Heller).

Sicyonia dorsalis Kingsley, *Trachypenaeus constrictus* (Stimpson) and *Solenocera geijskesi* Holthuis, were recorded by Holthuis (1959) for Suriname (Dutch Guiana) waters.

The first two species were recorded for southern Brazil waters by Mistakidis & Neiva (1964). Now the thought of Boschi (1964) that those Penaeidae inhabiting Suriname waters should be found in tropical Brazil, is confirmed.

Proportional measurements of the pink shrimp, Penaeus aztecus Ives — All correlation coefficients found are positive and significant ($P < 0.01$). As to the regression coefficients of carapace length on total length, the best ones found are the second case, i. e., from the base of the eye notch to the posterior mid-dorsal edge of the carapace, because there is no significant difference between sexes, while the first case, i. e., from the tip of the rostrum to the posterior mid-dorsal edge of the carapace, presents that difference.

Those proportional measurements are closely correlated; so, it is possible to deal only with the measurement of the carapace length (second case), converting it easily to total length, total and tail weight, by making use of those regression coefficients.

CONCLUSIONS

From the analysis made in previous paragraphs, it is possible to draw the following conclusions:

a — 65 species of fish were taken during the whole survey and 18 out of them were most abundant in the main shrimp fishing grounds: shark, *Scoliodon terraenovae* Richardson; guitar-fish, *Rhinobatus percellens* (Walbaum); rays, *Gymnura micrura* (Bloch & Schneider), *Dasyatis gymnura* (Müller) and *Urotrygon microphthalmum* Delsman; cat-fishes, *Felichthys bagre* (Linnaeus) and *Galeichthys* sp.; moray-eels, *Ariosoma ?nitens* (Jordan & Bollman), *Ophichthus magniocularis* (Kaup), *Gymnothorax ocellatus* Agassiz and *Gymnothorax jordani* (Evermann & Marsh); goatfish, *Prionotus ?caprella* (Ribeiro); lane snapper, *Lutianus synagris* (Linnaeus); grunt, *Conodon nobilis* (Linnaeus); soles, *Scyacium ?latifrons* (Jordan & Gilbert), *Achirus fasciatus* (Lacépède), *Achirus* sp. and *Symphurus ?elongatus* (Günther).

b — 3 species of echinoderms were most abundant in the main shrimp fishing grounds: starfishes, *Luidia senegalensis* (Lamarck) and *Astropecten marginatus* Gray, and brittle star, *Ophioderma* sp.

c — First record for Brazilian waters are the following species of mollusks: *Bursa spadicea* Montfort, *Distorsio clathrata* Lamarck, *Amusium papyraceus* Gabb (this was most abundant in the main shrimp fishing grounds), *Oliva caribaeensis* Dall & Simpson and *Lima pellucida* Adams.

d — 37 species of crustacea (except Penaeidae) were taken during the whole survey and only 5 out of them were most abundant in the main shrimp fishing grounds: *Scyllarides delfosi* Holthuis; crabs, *Calappa nitida* Holthuis, *Calappa sulcata* Rathbun and *Callinectes danae* Smith; and mantis shrimp, *Squilla lijdingi* Holthuis. The first three species, as well as *Hepatus gronovii* Holthuis and *Hepatus scaber* Holthuis, are new occurrences for Brazilian waters.

e — Among the Penaeidae shrimps, 7 species were taken in the following order of reverse importance as to the quantities caught: *Penaeus aztecus* Ives, *Xiphopenaeus kroyeri* (Heller), *Penaeus schmitti* Burkenroad, *Solenocera ?geijskesi* Holthuis, *Sicyonia typica* Boeck, *Sicyonia dorsalis* Kingsley and *Trachypenaeus constrictus* (Stimpson). *Sicyonia dorsalis* Kingsley and *Trachypenaeus constrictus* (Stimpson) are new occurrences for northern Brazil, and *Solenocera ?geijskesi* Holthuis is new occurrence for Brazilian waters.

f — At 20-40 fathoms depth, on muddy bottom, large concentrations of the pink shrimp, *Penaeus aztecus* Ives, were found, particularly at 1° — 3° N latitude and 48° — 49° W longitude (northern Brazil), about 100 nautical miles off the coast of Pará State and 89 nautical miles off the coast of Amapá Territory, where 28 boats were fishing that species on July, 1965. One of the boats, "Gulf King III", caught an average of 83 pounds (heads-off) per hour, while one of our's, "Doña Maria", caught only about 23 pounds (heads-off) per hour.

g — It seems to us that offshore waters of northeastern Brazil are not rich in shrimp resources, at least in the area surveyed.

h — Sex-ratio of *Penaeus aztecus* Ives was found to be not significantly different.

i — Five regression coefficients of *Penaeus aztecus* Ives were calculated: carapace length (first case: from the tip of the rostrum to the posterior mid-dorsal edge of the carapace) on total length; carapace length (second case: from the base of the eye notch to the posterior mid-dorsal edge of the carapace) on total length; total weight on total length; tail weight on total length; and tail weight

on total weight. All correlation coefficients found are positive and significant ($P < 0.01$). Those proportional measurements are closely correlated; so, it is possible to deal only with the measurement of the carapace length (second case), converting it easily to total length, total and tail weight, by making use of those regression coefficients.

S U M Á R I O

A literatura especializada registra algumas prospecções pesqueiras efetuadas na região nordeste e norte do Brasil. Com o fito de obter informações preliminares sobre os recursos camaroneiros dessas duas regiões, um dos autores viajou a bordo do barco "Doña Maria" e o outro, a bordo do barco "Gabriel E. Urias", ambos arrastões-de-porta de fabricação mexicana.

Este trabalho trata da pesca do camarão, assim como do registro de espécies de peixes, tunicados, equinodermas, moluscos, crustáceos, celenterados e esponjas capturadas nas regiões acima mencionadas, seguido de algumas notas ecológicas. Trata também da análise de dados biométricos do camarão rosa, *Penaeus aztecus* Ives.

A análise dos dados permitiu a obtenção das seguintes conclusões:

a — 65 espécies de peixes foram capturadas durante toda a prospecção efetuada. 18 são as espécies mais abundantes nos bancos camaroneiros: cação, *Scoliodon terrae-novae* Richardson; cação-viola, *Rhinobatus percellens* (Walbaum); arraias, *Gymnura micrura* (Bloch & Schneider), *Dasyatis gymnura* (Müller) e *Urotrygon microphthalmum* Delsman; bagres, *Felichthys bagre* (Linnaeus) e *Galeichthys* sp.; moréias, *Ariosoma ?nitens* (Jordan & Bollman), *Ophichthus magniocularis* (Kaup), *Gymnothorax ocellatus* Agassiz e *Gymnothorax jordani* (Evermann & Marsh); cabrinha, *Prionotus ?caprella* (Ribeiro); ariacó, *Lutianus synagris* (Linnaeus); roncadador, *Conodon nobilis* (Linnaeus); linguadós, *Scyaciium ?latifrons* (Jordan & Gilbert), *Achirus fasciatus* (Lacépède), *Achirus* sp. e *Symphurus ?elongatus* (Günther).

b — 3 espécies de equinodermas são mais abundantes nos principais bancos camaroneiros: estrêlas-do-mar, *Luidia senegalensis* (Lamarck) e *Astropecten marginatus* Gray, e serpentes-do-mar, *Ophioderma* sp.

c — Pela primeira vez são registradas em águas brasileiras as seguintes espécies de moluscos: *Bursa spadicea* Montfort, *Distorsio clathrata* Lamarck, *Amusium papyraceus* Gabb (a espécie mais abundante nos principais bancos camaroneiros), *Oliva caribaeensis* Dall & Simpson e *Lima pellucida* Adams.

d — 37 espécies de crustáceos (excluindo-se os Penaeidae) foram capturadas durante

tôda a prospecção efetuada, e somente 5 delas são as mais abundantes nos principais bancos camaroneiros: sapata, *Scyllarides delfosi* Holthuis; caranguejos, *Calappa nitida* Holthuis, *Calappa sulcata* Rathbun e *Callinectes danae* Smith; e tamburutacas, *Squilla liidingi* Holthuis. As três primeiras espécies são ocorrências novas para as águas brasileiras, assim como *Hepatus gronovii* Holthuis e *Hepatus scaber* Holthuis.

e — Entre os Penaeidae, 7 espécies foram capturadas na seguinte ordem de importância decrescente no que se refere à quantidade anotada: *Penaeus aztecus* Ives, *Xiphopenaeus kroyeri* (Heller), *Penaeus schmitti* Burkenroad, *Solenocera ?geijskesi* Holthuis, *Sicyonia typica* Boeck, *Sicyonia dorsalis* Kingsley e *Trachypenaeus constrictus* (Stimpson). *Sicyonia dorsalis* Kingsley e *Trachypenaeus constrictus* (Stimpson) são ocorrências novas para o norte do Brasil, e *Solenocera ?geijskesi* Holthuis é ocorrência nova para as águas brasileiras.

f — A 20-40 braças de profundidade, em fundo lodoso, foram encontradas grandes concentrações de camarão rosa, *Penaeus aztecus* Ives, particularmente entre 1° e 3° latitude N e entre 48° e 49° longitude W (norte do Brasil), a cerca de 100 milhas náuticas da costa do Estado do Pará e 89 milhas náuticas da costa do Território do Amapá, onde operavam 28 barcos em julho de 1965. Um dos barcos, "Gulf King III", capturou uma média de 83 libras de caudas de camarões por hora, enquanto um dos nossos, "Doña Maria", capturou somente cerca de 23 libras de caudas de camarões por hora.

g — Parece-nos que as águas afastadas do litoral do nordeste brasileiro não são ricas em recursos camaroneiros, pelo menos nos locais pesquisados.

h — A proporção entre os sexos não se mostrou significativamente diferente para o camarão rosa, *Penaeus aztecus* Ives.

i — Foram calculadas cinco regressões do camarão rosa, *Penaeus aztecus* Ives: comprimento da carapaça (primeiro caso: da ponta do rostro à margem médio-dorsal posterior da carapaça) em relação ao comprimento total; comprimento da carapaça (segundo caso: da base do entalhe formado pelos olhos até a margem médio-dorsal posterior da carapaça) em relação ao comprimento total; peso total em relação ao comprimento total; peso da cauda em relação ao comprimento total; peso da cauda em relação ao peso total. Os coeficientes de correlação encontrados são positivos e significantes ($P < 0,01$). Esses pesos e comprimentos acham-se intimamente correlacionados; assim, é possível se lidar somente com a medição do comprimento da carapaça (segundo caso), convertendo-a facilmente para o comprimento total, peso total

e peso da cauda, fazendo uso desses coeficientes de regressão.

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