Decapod Crustacean Shelf-Fauna of the Campeche Bank: Fishery Aspects and Ecology[1]

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RESUMEN

En Julio de 1978 se llevó a cabo una investigación preliminar de los recursos vivos en la plataforma continental justamente frente a la Laguna de Términos, Campeche, con énfasis en la fauna de crustáceos decápodos. La investigaciónse realizó a bordo de "La Nueva Ley de Pesca," a fín de determinar la distribución en el área, y la biomasa de la población de camarones actualmente en explotación, así como evaluar el volumen potencial de la captura normalmente realizada durante las operaciones de arrastre para camarones.

Se realizaron arrastres de 30 minutos, durante el día y la noche, con dos redes, a lo largo de transectos de la costa hacia afuera, a predeterminadas profundidades de 5, 10, 20 y 40 brazas. Entre las seis especies diferentes de camarones peneidos capturados, el camarón rosado *Penaeus duorarum duorarum* representó casi el 42% de la captura; el camarón de roca *Sicyonia dorsalis,* el 32%; el camarón carmelita *P. aztecus,* el 11%; el camarón blanco *P. setiferus,* el 12%; y el porcentaje restante estaba representado por las especies *Trachypenaeus similis* y *Solenocera vioscai.* La mayor captura de camarones fué de 12 kilos por media hora de arrastre. La captura promedio de 18 arrastres con éxito fué de 3k/30 minutos. La tasa de captura máxima fué obtenido en arrastres do noche en la isobática de 20 brazas, y se obtuvo como promedio 6.7 kilos por media hora de arrastre.

Durante las pruebas de captura se obtuvo una variedad de peces e invertebrados. Se identificó un total de 17 especies de congrejos braqirros, entre los cuales sólo la jaiba *Callinectes similis* fué notablemente abundante.

Se describe el patrón de distribución de las especies predominantes, en relación con la temperatura, subestrato y profundidad.

INTRODUCTION

Recently the interest in studying the conditions which prevail in the southwestern Gulf of Mexico, particularly on Campeche Bank, has been greatly accelerated and there is much evidence that this interest will continue due to the promising resources of the area. For the fishing industry, Campeche Bank constitutes an extremely productive area where important shrimping grounds are found. The commercial exploitation of these grounds was initiated by the U.S. in 1945; 4 years later México started to operate on the Bank, and in 1968 Cuba also began participating in the shrimp fishery (Wise, 1976).

The area known as Campeche Bank extends along the states of Tabasco, Campeche and Yucatán coasts, approximately 400 nautical miles (780 km) to

[1] Contribution 206 from the Centro de Ciencias del Mar y Limnología, UNAM

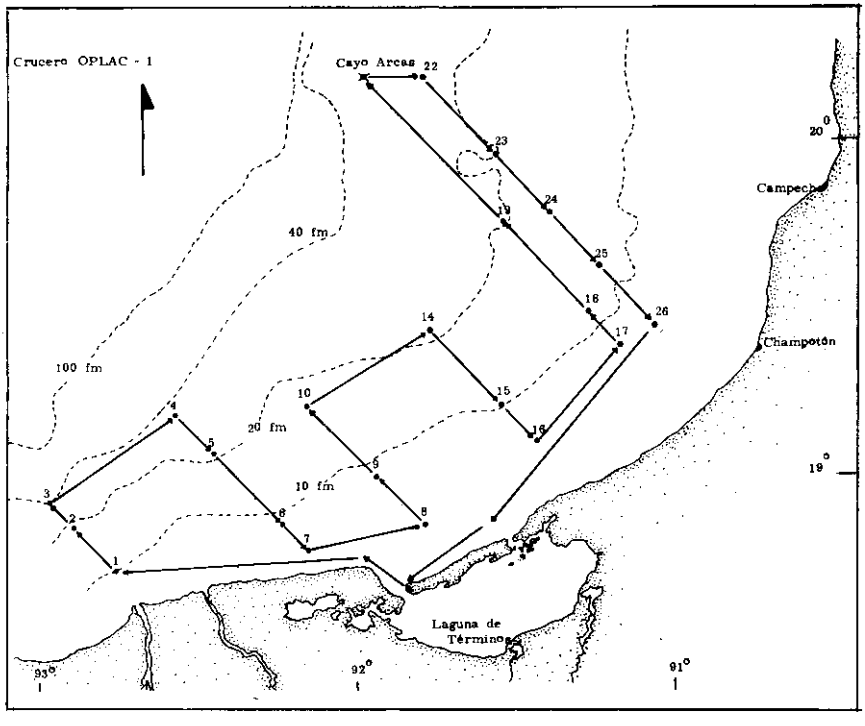


Figure 1. Location of stations of cruise OPLAC-1.

an average depth of 50 fm (90 m). México's primary shrimp production in the Gulf of Mexico is from the Campeche Bank. Presently, this fishery supports a Mexican fleet of 655 vessels whose calculated annual production amounts to 22 tons/trawler. Until 1969 the fishery was practically sustained by the pink shrimp (90%); more recently there has been a steady increase in the percentage of brown and white shrimp in the captures. Shrimp trawling operations in this part of the Gulf of Mexico, are conducted almost all year; however, activities slow down during the season of strong northerly winds that extends from September to April.

In addition to its fishery importance, Campeche Bank has acquired further significance in view of the recent findings of large oil deposits along the continental shelf. The rapid development of the oil industry in this area, and the massive oil-spill accident which occurred on the continental shelf in June 1979, have aroused serious doubts about the future of the shrimp industry. The Mexican government has realized this, and has promoted studies to gather information to aid in planning a rational development so that the richness of the natural system may be preserved.

The University of México, through the Center of Marine Science and Limnology, as a way of contributing to this initiative by the government, is currently engaged in the study of the living resources of the Laguna de

Términos, and the adjacent continental shelf. Part of this program was a survey made in June 1978 to determine the areal distribution and biomass of the shrimp stocks under exploitation, and to assess the potential volume of the by-catch taken in the shrimp trawling operation. The results obtained in this survey, from cruise OPLAC-1 (Oceanography of the Continental Shelf of Campeche), are presented here.

Background

The living resources of Campeche Bank have been the subject of a series of important studies of different aspects of the biology and fisheries of crustaceans. Without intending to describe in detail all these contributions, I will make reference to those more relevant to this paper.

To Hildebrand (1955) and Ramírez (1963) we owe much of our present knowledge of the composition of the shrimp by-catch from the Campeche Bank. Allen and Jones (1974) provided a general view on the fisheries of the three main species of shrimp captured in the area. Fuentes and Portugal (1974), on the other hand, evaluated the catch capacity of the shrimp fleet based in the State of Campeche as a function of the vessel's design. More recently, Shultz and Chávez (1976) conducted a thorough analysis of the population dynamics of the white shrimp in the same area. A summary of the history of the shrimp fishery in the Campeche Sound can be found in the paper written by these two authors.

METHODS

Cruise OPLAC-1 was carried out on board the commercial vessel LA NUEVA LEY DE PESCA, a double-rigged shrimp trawler equipped with two standard shrimp trawls 19 m long, 9 m across the mouth, and with a 3.2-cm mesh netting; both nets were towed simultaneously day and night at approximately 2 to 3 knots for periods of 30 minutes. The calculated swept area for each trawl was approximately 4 ha. Specimens collected were preserved in 10% formalin and returned to the laboratory for identification, measuring, sex determination and weighing. Catch per unit effort (CPUE) values refer to weight of shrimp caught per 30 minute tow.

Six inshore-offshore transects were marked out on the continental shelf off Laguna de Términos, extending from the mouth of the river Grijalva on the west, to the area off Champotón to the east (Fig. 1). A total of 21 trawl stations was made at depths ranging from 5 to 40 fm. Bottom temperature and sediment samples were taken at each station.

RESULTS

Catch Analysis

During cruise OPLAC-1 the following eight species of penaeid shrimp were caught: *Penaeus aztecus, P. duorarum, P. setiferus, Trachypenaeus similis, Solenocera vioscai, Sicyonia dorsalis, S. brevirostris,* and *P. notialis.*

In terms of weight percentages (Fig.2), the pink shrimp *P. duorarum* made up 42% of the total catch, the rock shrimp *S. dorsalis* 32%, the white shrimp *P.*

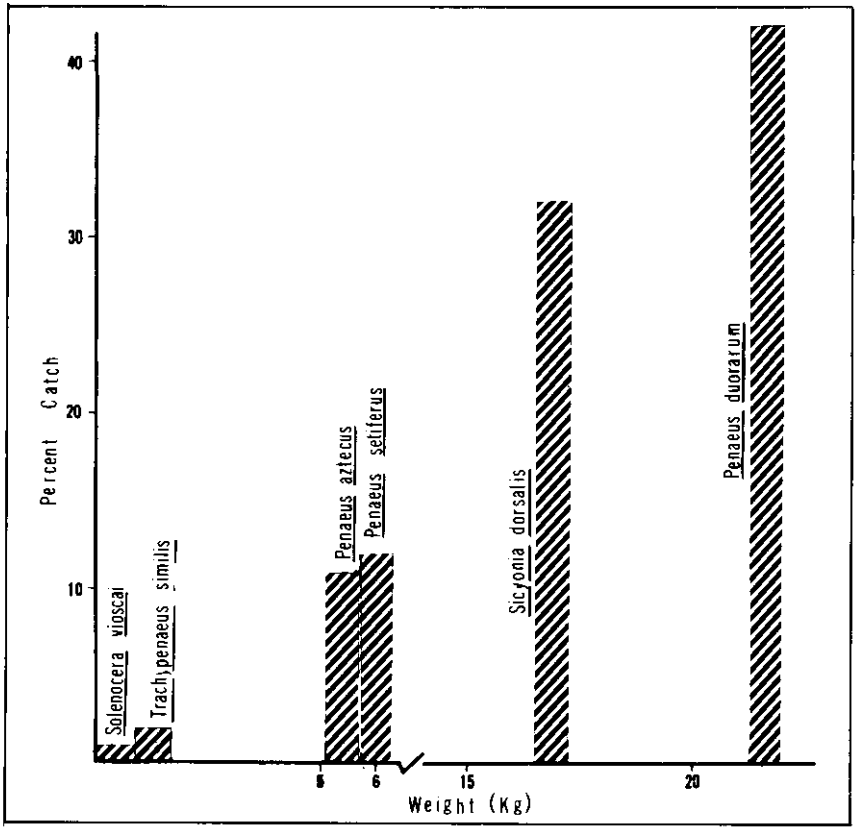


Figure 2. Species compostion of penaeid shrimp by weight percentages.

setiferus 12%, the brown shrimp *P. aztecus* 11%, and the remaining percentage was represented by the species *T. similis* and *S. vioscai.* Among the species of the genus *Penaeus,* the percentages by weight were very similar to the percentages by number; only in the case of the rock shrimp *S. dorsalis* a significant change was registered. This species proved to be quite abundant, accounting for nearly 50% of the total catch. The largest shrimp catch taken was approximately 12 kg (Table 1). The average catch in 18 successful tows was 3 kg per 30 min tow. The maximum catch was obtained in the trawl stations made at night along the 20 fm isobath, averaging 6.7 kg/30 min. In only three offshore stations made at this depth were the hauls of commercial-size (about 11 kg/h). The occurrence of penaeid shrimp and other decapod crustaceans during tows made in daytime was incidental.

Pink Shrimp: appeared widely distributed along the offshore sector of the area of study, although they seemed more concentrated toward the Yucatán Península. Their depth distribution was practically confined between the 10- and 20-fm isobaths, and occurred on sandy-silt substrates. Nearly 392 pink

Table 1. Shrimp catch per unit effort (Biomass)

Station No.	Catch (kg)	Station No.	Catch (kg)
1N	0.35	14N	11.657
2N	3.412	15	0.241
3N	3.120	18	8.45
4	0.60	19	2.435
5	0.626	22N	0.780
6	0.210	23N	11.383
7	1.487	24N	0.593
8	0.157	25	0.38
9N	5.120	Total Shrimp Catch	=52 kg
10N	10.615	Average Catch/30'	= 3 kg

shrimp weighing a total of 22 kg were caught from 13 stations. Maximum CPUE's were obtained off Laguna de Términos and in the proximity of Arcas Reef (Fig. 3).

Among the penaeid shrimp caught, *P. duorarum* ranked third in relation to its size (Fig. 9). The carapace length ranged from 27 to 69 mm, with a mean

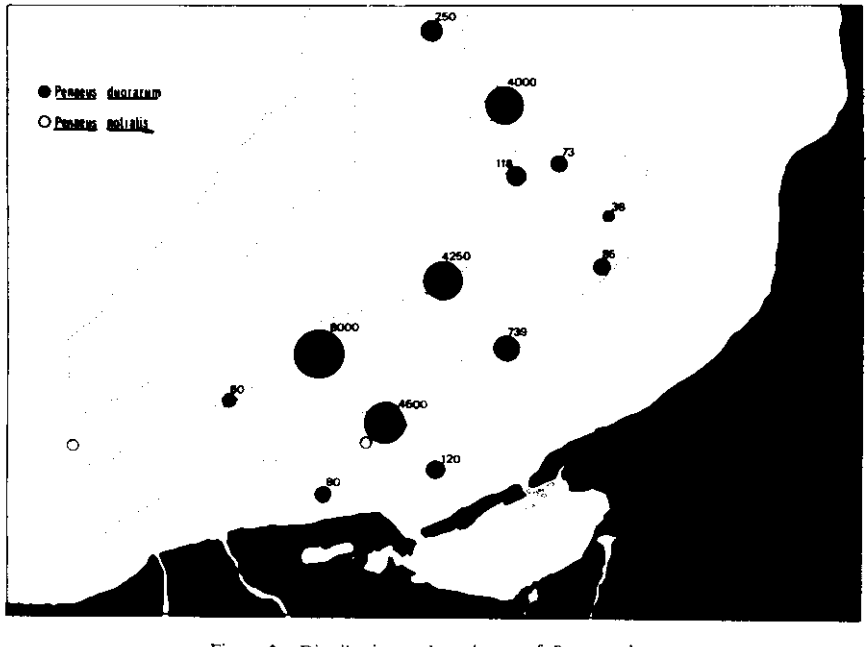


Figure 3. Distribution and catch rate of *Penaeus duorarum*.

Figure 4. Distribution and catch rate of *Penaeus aztecus*.

value of 44 mm. The calculated sex-ratio for this species (1.4:1) favored the males. The carapace length frequency diagram of *P. duorarum* (Fig. 10) displays a slight discrepancy between males and females; the males present two strong modal values (30 and 50 mm), and appear best represented by subadult shrimp. The females, in contrast, seemed equally represented by subadult and adult stages.

Brown Shrimp: during this survey were found concentrated on the western sector of the area of study, which lies under the direct influence of the Grijalva and San Pedro rivers, as well as the run-off of rivers emptying into Laguna de Terminos (Palizada, Chumpán and Candelaria) (Fig. 4). The presence of brown shrimp in this particular area is undoubtedly related to the high percentage of organic matter (7 - 17%) contained in the sediments analysed by Machado et al. (1979). Brown shrimp were caught from 4 to 40 fm, on substrates composed predominantly of clay and silt.

Approximately 200 individuals were recovered, weighing a total of 5.5 kg. Maximum CPUE's were recorded at two offshore stations located near the mouth of the Grijalva river. The nocturnal habits of this species accounted for the poor catches obtained in the second transect of the cruise; trawl stations 4, 5, 6 and 7 were all made in daylight (Table 1).

P. aztecus was the second largest penaeid shrimp captured (Fig. 9). Its

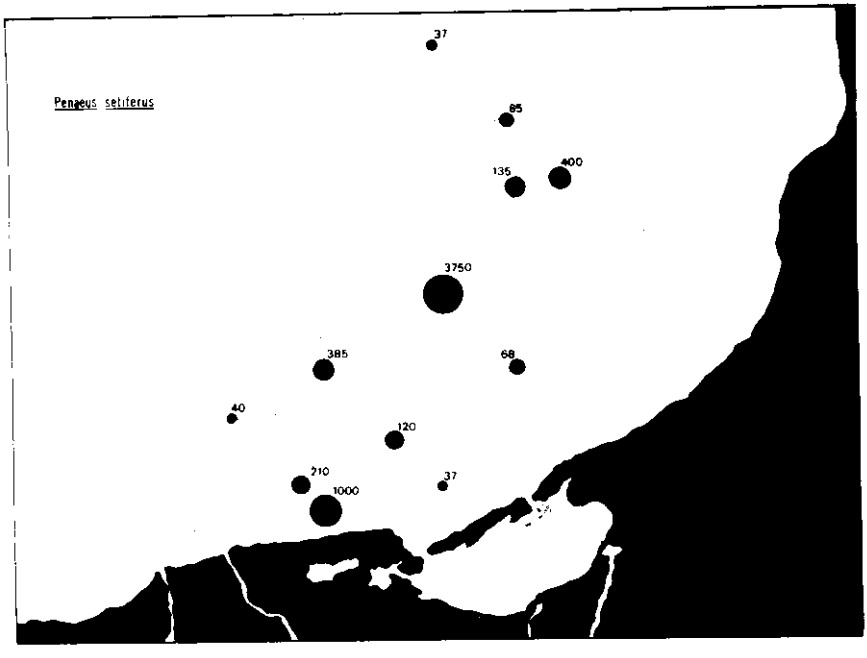


Figure 5. Distribution and catch rate of *Penaeus setiferus*.

carapace length ranged from 35 to 56 mm, with a mean value of 47 mm. The females were slightly predominant over the males (1.2:1), and also reached larger sizes (Fig. 11). The carapace length-frequency diagram shows a difference of roughly 10 mm in modal values between the two sexes.

White Shrimp: P. setiferus displayed a similar areal distribution to that already described for *P. duorarum* (Fig.5). These two species were found 90% of time coexisting in the same habitat, although when captured the white shrimp always occurred in low numbers except for the trawls made in daylight. The calculated ratio between the above two species was about 4:1. White shrimp were taken at depths ranging from 7 to 24 fm on sandy silt bottoms.

From 12 tows, just 87 white shrimp were caught, weighing 6.2 kg. The maximum CPUE was obtained off Laguna de Términos. Even though this penaeid is generally considered to be diurnal in habit (Joyce, 1965; Perez-Farfante, 1969), the largest catch was taken at night near the 20-fm line.

The white shrimp occupied the first category in size among the penaeids captured (Fig. 9). Its carapace length ranged from 42 to 72 mm with a mean value of 61 mm. The sex-ratio for this species approached a 1:1 ratio. The carapace length-frequency diagram shows a difference of about 5 mm in the

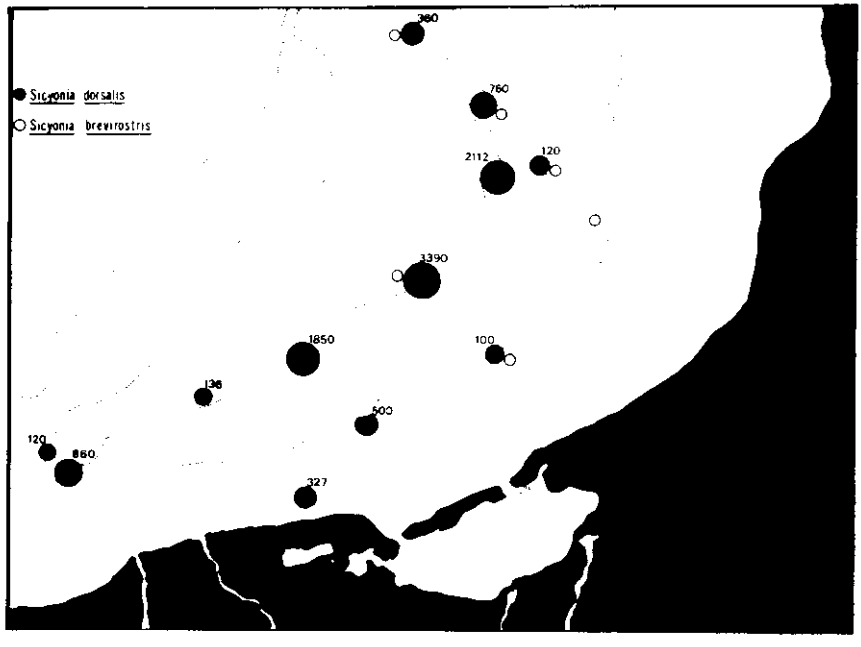


Figure 6. Distribution and catch rate of *Sicyonia dorsalis*.

modal values between males and females (Fig. 12); females had larger sizes than males.

Rock Shrimp: Sicyonia dorsalis was the most common penaeid caught throughout this survey. It appeared widely distributed over the continental shelf, from the mouth of the Grijalva river to Arcas Reef (Fig. 6). Its bathymetric range extended from 7 to 40 fm, though it tended to be more frequent near the 20-fm isobath. It occurred on substrates made up of clay and silt, but seemed to prefer the sandy bottoms of the eastern sector of the area studied. Twelve successful tows yielded approximately 495 rock shrimp, weighing about 17 kg. The maximum CPUE was obtained from hauls made at night off Laguna de Términos.

The individuals of *S. dorsalis* were the smaller penaeids caught (Fig.9). Their carapace length ranged from 5.1 to 25.7 mm, with a mean value of 20 mm. The males and females of this species appeared in almost equal proportion. The carapace length-frequency diagram shows a remarkable similarity in the size composition of the two sexes; 90% of the population measured was concentrated between 15 and 25 mm of carapace length (Fig. 13).

The second species of rock shrimp captured was *S. brevirostris*. This

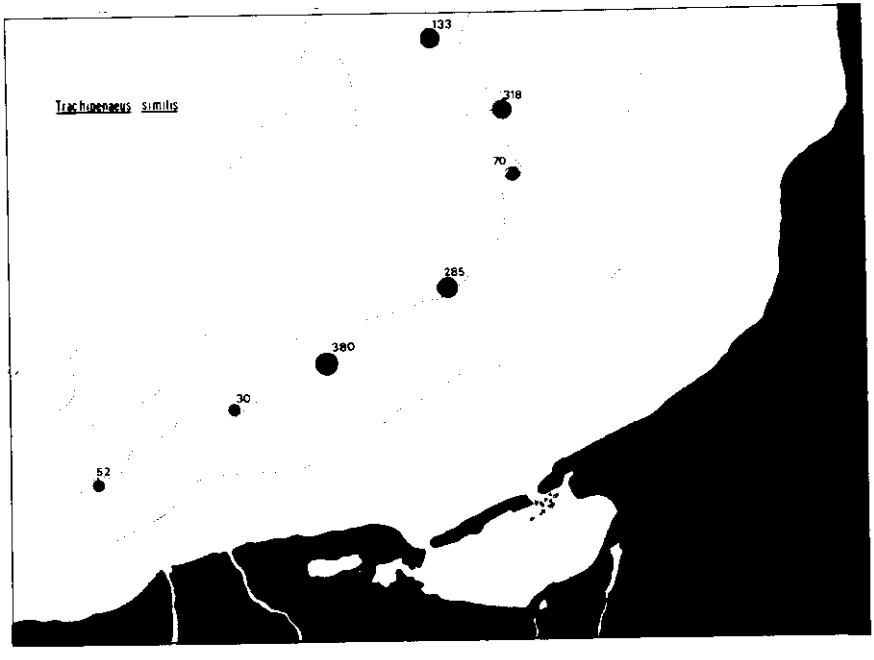


Figure 7. Distribution and catch rate of *Trachypenaeus similis*.

species was found coexisting with its congener *S. dorsalis* on the northeastern sector of the area of study, which is essentially characterized by the predominace of biogeneous sediments. Only a limited number of specimens of *S. brevirostris* (Fig. 6) were recovered at six stations, their size slightly bigger than *S. dorsalis* ($\bar{x}$ carapace length = 26 mm). The insufficient information obtained on *S. brevirostris* prevents meaningful interpretation of the potential of this stock on the Campeche Bank.

Trachypenaeus similis: locally known as "synthetic," appeared regularly distributed along the 20-fm isobath, from the area off the Grijalva river to the vicinity of Arcas Reef (Fig. 7). Although this species was not very abundant, it did appear commonly in the mixed shrimp catches obtained at night. From seven successful tows, 64 individuals were recovered, weighing 1.3 kg. The maximum CPUE was recorded off Laguna de Términos and near the shallows of Arcas Reef.

In terms of size, *T. similis* occupied a fourth category among the penaeids caught (Fig. 9). Its carapace length ranged from 22 to 47.5 mm, with a mean value of 32 mm. *T. similis* was the only penaeid shrimp whose catch was exclusively composed of females.

By-Catch Analysis

The rational utilization of the fish, crustaceans, squid and other faunal

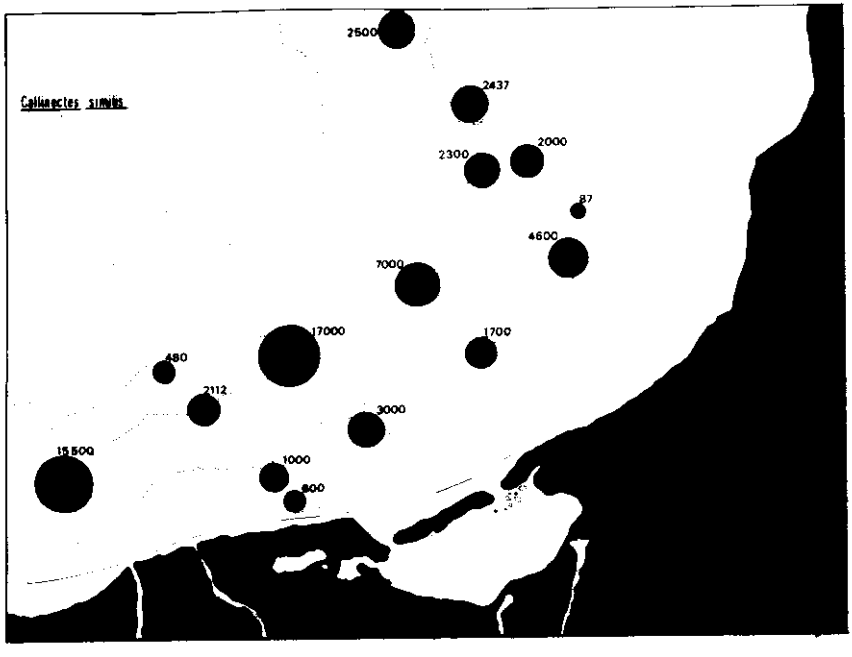


Figure 8. Distribution and catch rate of *Callinectes similis*.

elements caught simultaneously during the shrimp trawling operation has always been a subject of great concern for the fishery industry. It is common knowledge that under normal conditions this assorted group of organisms is thrown overboard once the more profitable penaeid shrimp are separated. According to Allsopp (1977), an estimated 0.9 million tons of shrimp by-catch are discarded at sea in the Gulf of México and the Caribbean.

To avoid such a waste of potential marine products, recently the Mexican Government, through its Fisheries Department, has stongly urged the shrimp trawlers operating both on the Gulf and the Pacific to preserve maximum quantities of fish and crabs, that with proper processing may be marketed for human consumption, or used as supplements in high-grade animal feeds. It is obvious, however, that before embarking on an enterprise of industrial magnitude, it is imperative to assess the potential volume of the by-catch and to analyse carefully the cost-benefit of the handling, processing, cold storage and market distribution of the resulting products. As a way of contributing to the first phase, the following information is here submitted.

The by-catch taken during cruise OPLAC-1 was largely composed of fish, decapod crustaceans, squid and echinoderms which according to their total biomass were roughly distributed as follows: 8:1:1. The fish by-catch amounted to 578 kg, comprising as many as 105 different species (Yáñez et al., 1979). Among the decapod crustaceans captured, a total of 17 species of

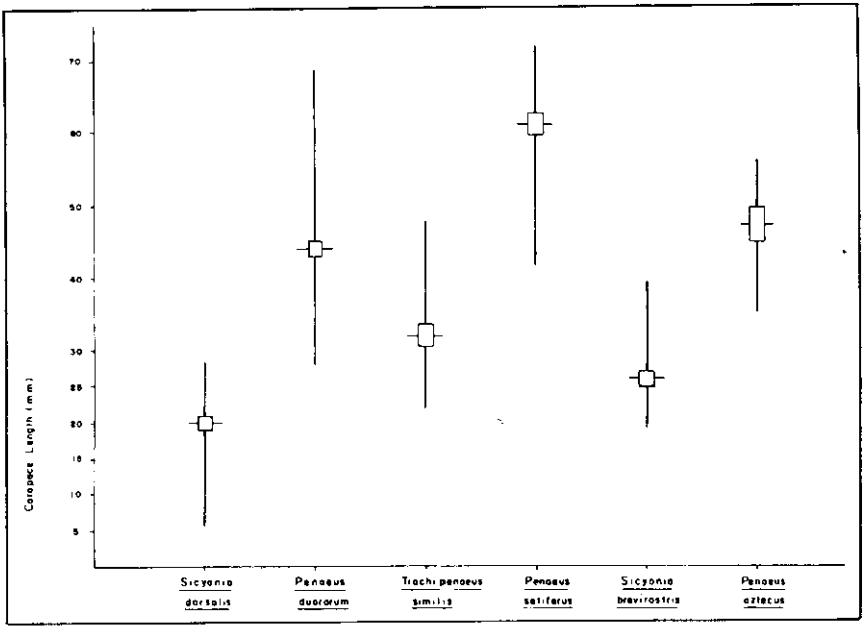


Figure 9. Mean, standard deviation, and range of penaeid shrimp.

brachyuran crabs was identified (Table 2). All these faunal elements constitute components of the benthic community commonly referred to as "the shrimp ground community," studied earlier by Hedgpeth (1954), Hildebrand (1954 and 1955), and more recently by Ramírez (1963).

Of the species listed above, only the portunid crab *Callinectes similis* proved to be important in terms of total biomass (Table 3). This crab was captured in most of the offshore stations located on the 10- and 20-fm isobaths. *C. similis* occurred in tows made in daytime and nightime, though largest catches were usually obtained at night. Fifteen successful tows yielded well over 1000 individuals, weighing approximately 60 kg. The maximum CPUE was recorded in the area enriched by the river's discharge, adjacent to Laguna de Términos (Fig. 8).

Some of the remaining species of brachyuran crabs displayed an interesting distributional pattern mainly influenced by the two topographic provinces recognized on the west and the east of the area of study, respectively: (a) deltaic plains (Shepard, 1948; Pierce, 1954) and (b) carbonate environment or limestone banks (Trask, 1948). The first province extends from the state of Campeche to Tabasco and Veracruz. This is an area of active depostion, where due to the outward gradation of sediments sand is found near shore and mud offshore. The second province essentially encompasses the continental shelf of Yucatán Península. This a biogeneous environment, whose hard limestone is covered with rich detrital material.

Table 2. Species of brachyuran crabs captured during Cruise OPLAC-1

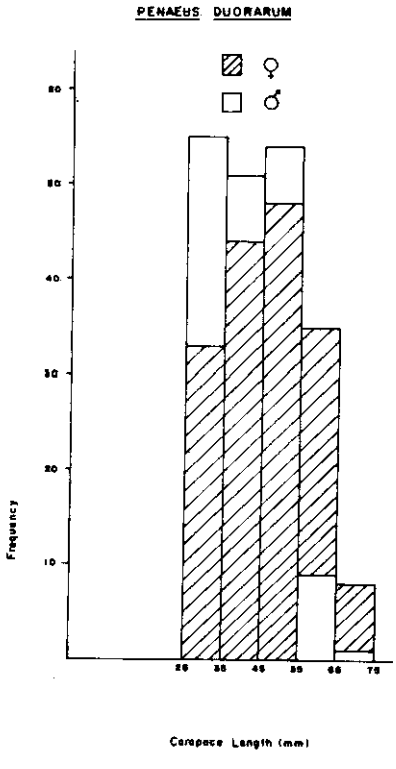
Porcellana sayana	*C. sulcata*
Petrochirus diogenes	*Hepatus epheliticus*
Raninoides louisianensis	*Callinectes similis*
R. lamarcki	*Portunus spinicarpus*
Dromidia antillensis	*P. spinimanus*
Hypoconcha sabulosa	*Stenorhynchus seticornis*
Persephona mediterranea	*Anasimus latus*
Iliacantha subglobossa	*Libinia dubia*
Calappa flammea	

Table 3. Biomass (g) /tow

Species	1N	2N	3N	4	5	6	7	8	9N
Penaeus aztecus	35	2,500	2,500	60	360		80		
P. duorarum					60		80	120	4,500
P. setiferus					40	210	1,000	37	120
Trachypenaeus similis		52		30					
Solenocera vioscai			500						
Sicyonia dorsalis		860	120		136		327		500
Portunid crabs		15,500		480	2,112	1,000	600		3,000
Biomass (g)	35	18,912	3,120	540	2,738	1,210	2,087	157	8,120

Table 3. (continued)

10N	14N	15	18	19	22N	23N	24N	25	Tot./Biomass (g)
									5,535
8,00	4,250	73	85	118	250	4,000	73	38	21,647
385	3,750	68		135	37	65	400		6,247
380	285			70	133	318			1,268
									500
1,850	3,390	100		2,112	360	7,000	120		16,875
17,000	7,000	1,700	1,600	2,300	2,500	2,437	2,000	87	59,316
27,615	18,675	1,941	1,685	4,735	2,980	13,820	2,593	125	111.39kg



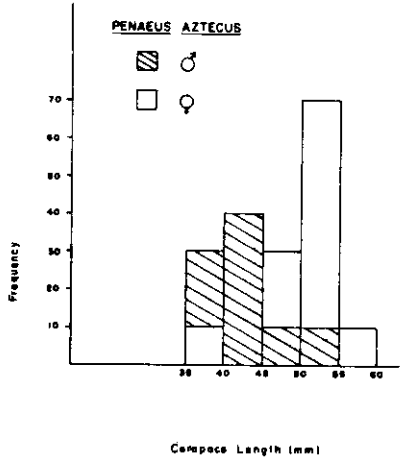


Figure 10. *(left)* Carapace length-frequency diagram of *Penaeus duorarum.*
Figure 11. *(right)* Carapace length-frequency diagram of *Penaeus aztecus.*

The following species of brachyuran crabs found confined to the deltaic plains were *Raninoides louisianensis, R. lamarcki, Persephona mediterranea, Iliacantha subglobossa, Stenorhynchus seticornis* and *Anasimus latus.* The species restricted to the carbonate environment were *Porcellana sayana, Dromidia antillensis, Hypoconcha sabulosa, Calappa sulcata, C. flammea, Hepatus epheliticus* and *Libinia dubia.*

DISCUSSION

Due to our limited knowledge of the fluctuations in distribution and density experienced by the shrimp stocks currently under exploitation on

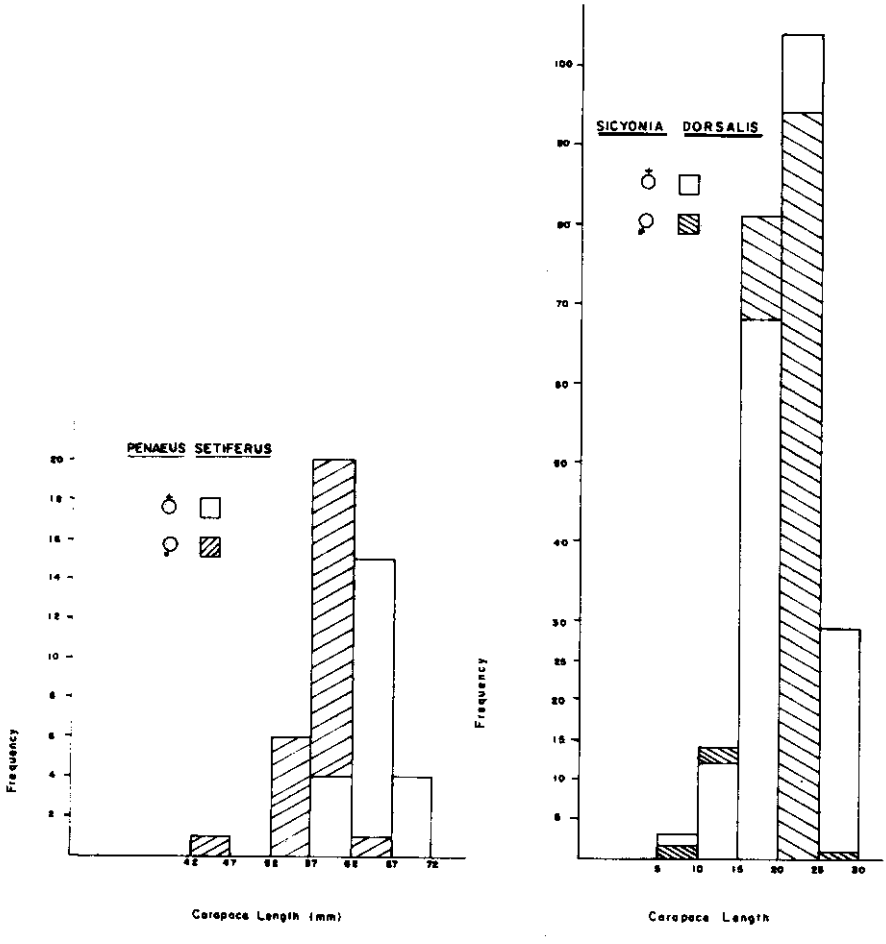


Figure 12. *(left)* Carapace length-frequency diagram of *Penaeus setiferus.*
Figure 13. *(right)* Carapace length-frequency diagram of *Sicyonia dorsalis.*

Campeche Bank, the shrimp trawling operation conducted by the Mexican fleet continues to rely on the skipper's good instincts, rather than on sound scientific information. The average catch rate (day and night fishing) obtained in this survey (6 kg/h) was lower than the values reported by Jones and Dragovich (1977) for the shrimp fishery off the northeastern South America of about 10 kg/h, and the one given by Khander and Lares (1973) for the shrimp fishery practiced in Margarita Island, Venezuela, of 14.4 kg/h. The apparent concentration of the shrimp stocks, during the time of the year in which this survey was conducted, toward the limestone banks of the

Yucatán Península, may account for the reduced catches taken. A fact that seems to support this contention was the large number of commercial trawlers seen operating at night in the vicinity of Arcas Reef. Future surveys of this kind, with a wider network of stations, would prove instrumental in detecting with accuracy fluctuations in biomass of penaeid populations as a function of time, depth and geographic location.

The rock shrimp fishery of Campeche Bank constitutes a viable resource, whose commercial potential has not been adequately explored. Perhaps one reason which has prevented the flourishing of a rock shrimp fishery in the area of Campeche has been the difficulty in processing the tough ridged body of the rock shrimp. Nowadays, the development of shrimp graders and splitter-deveiners has made commercial processing feasible (Bieler et al., 1973). The available stocks of two species of rock shrimp of Campeche Bank, *Sicyonia dorsalis* and *S. brevirostris,* pose an interesting alternative for the local shrimp industry, as a way of expanding its operation by harvesting a different type of shrimp. The prosperous rock shrimp fishery of the state of Florida sustained by *S. brevirostris* (Kennedy et al., 1977) is perhaps the best example of this new approach.

In reference to the brachyuran crabs of the Campeche Bank, estimates of crab resource potential are virtually non-existent; studies of abundance and availability of this resource should be conducted throughout this important area. However, one should not overlook the need to promote industrial research to determine how to process crab products efficiently, and to evaluate potential markets.

ACKNOWLEDGMENTS

The facilities and support provided by Mr. Felice Sambruno, President of Naviera Rex, Ciudad del Carmen, Campeche, are sincerely appreciated. Thanks are extended to Mr. A. Gracia and M. Ramírez for their technical assistance during cruise OPLAC-I, and to R. Cruz, A. Abundes, I. Ramírez and B. Shapiro for their kind cooperation in processing the biological material. The crew of LA NUEVA LEY DE PESCA and the "Dramamine Gang" deserve a special word of appreciation for their enthusiastic cooperation in this survey.

Funds for this research were made available by the Centro de Ciencias del Mar y Limnología, UNAM.

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