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ECOLOGY AND POTENTIAL ECONOMIC IMPORTANCE OF SHRIMP OF THE GENUS ACETES IN THE CARIBBEAN

by

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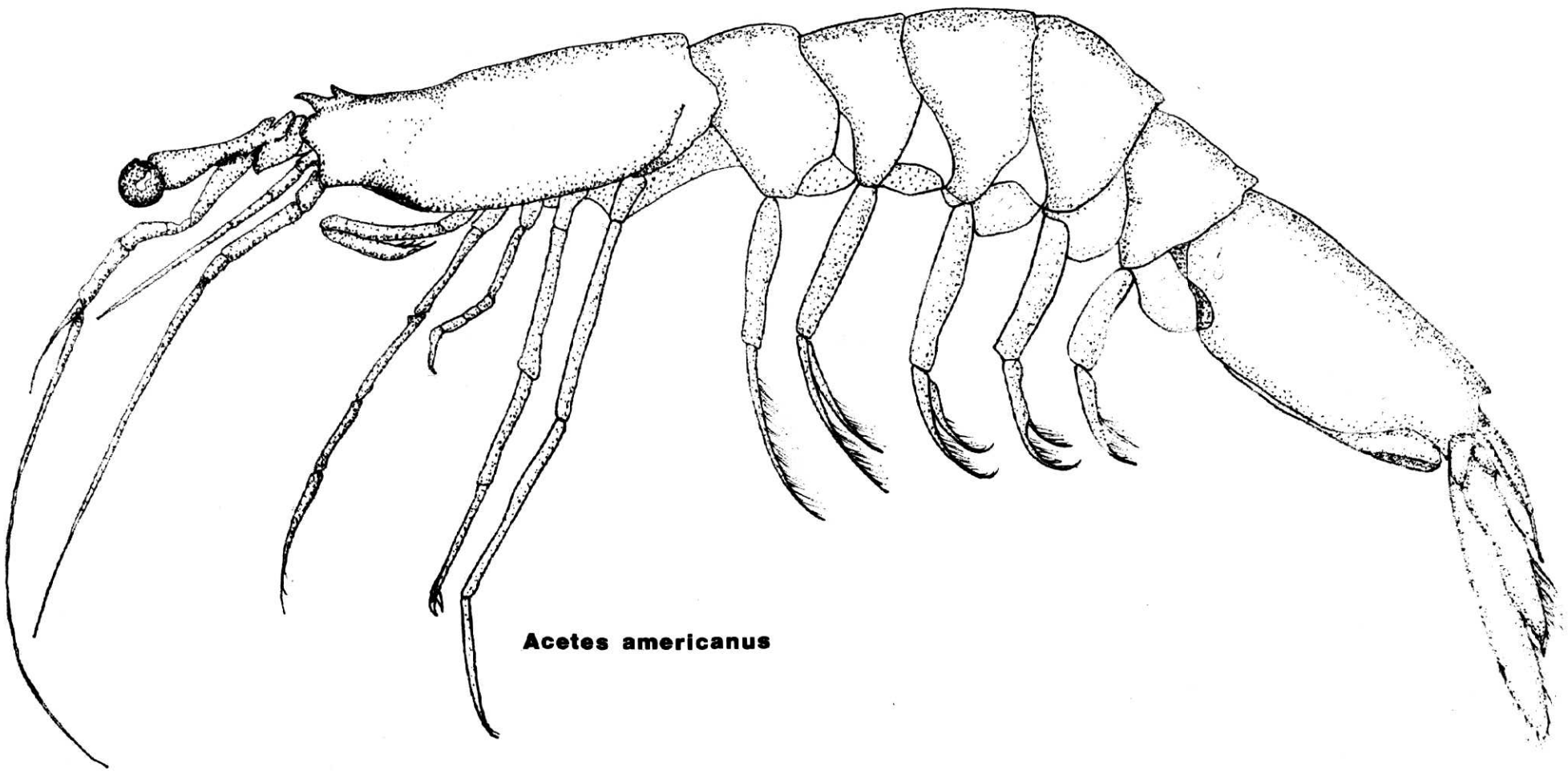

Acetes americanus

ECOLOGY AND POTENTIAL ECONOMIC IMPORTANCE OF SHRIMP OF THE GENUS *ACETES* IN THE CARIBBEAN

ABSTRACT:

During the period 1972-75 five specimens of the planktonic shrimp *Acetes* were collected near Puerto Rico. Collection was incidental to other efforts and raises the question of a potential fishery with proper exploration.

The species of the genus *Acetes* are small planktonic shrimp living mainly in the estuaries and coastal waters of the tropical and subtropical regions. Fourteen species and five subspecies are recognized. Ten species are distributed in the Indo-West Pacific, and the Indo-Malayan region is particularly rich in species. One species is restricted to Pacific America and two species are found in Atlantic America and the Caribbean. No species are known either from East Atlantic-Mediterranean or from the islands of the Central Pacific. Available information on geographic distribution is summarized for each species. Specific relationships, biogeography, fishery and economic potential for the Caribbean are discussed.

Acetes affords a major source of protein to some of the people in Asia and East Africa. Present status of the *Acetes* fishery in various countries is reviewed. The shrimp is mainly fished with various kinds of push nets and bag nets set near the shore against the flow of the tide. Boat seines and shore seines are used, too. The average world catch is estimated at 170,000

metric tons per year or about one-half the potential sustained yield. It accounts for 26% of the total shrimp catch in the Indo-West Pacific and 15% of that of the world. Only a very small proportion of the catch is sold as fresh shrimp, but the greater proportion is dried, salted or fermented with salt for food in various ways. A shrimp paste is manufactured extensively throughout Southeast Asia. The products represent a high quality protein supplement.

The fishery is characterized by a restricted fishing season during the year and the catch fluctuates considerably. The fishing season corresponds with the swarming season in the area where the Acetes fishery is carried out. During the season local catches may exceed a ton a day with small boats.

The Caribbean and South Atlantic fishery is estimated, on the basis of area of suitable habitat, at about one-third that of the world fishery or 60,000 metric tons. With a dock-side price of 40¢ per kilogram as a lower limit, the fishery value would run $24,000,000 per season. The parameters of the fishery potential and the need for further information are discussed.

BIOGEOGRAPHY AND ECOLOGICAL NOTES

Ten of 14 existing species in the genus Acetes are found in the Indo-West Pacific, and the Indo-Malay archipelago region is particularly rich in species. The latitudinal range is between 41°N and 34°S. Acetes chinensis occurs as far northward as Po Hai (Gulf of Chihli), China, whereas A. sibogae australis is distributed along the coast of New South Wales, Australia. No species have yet been recorded from New Guinea and the Persian Gulf areas, but this may be largely due to the lack of survey. Three species, A. americanus, A. marinus, and A. paraguayensis, are restricted to Atlantic America, the last species occurring in fresh water. The latitudinal range in the Atlantic is between 35°N (A. a. carolinae) and 32°S (A.a. americanus). In Pacific America A. binghami is recorded from the Gulf of Panama and the Gulf of Guayaquil. No species are known either from East Atlantic-Mediterranean or from the islands of the Central Pacific including Hawaii and New Zealand.

FLEMINGER and HULSEMANN (1973) state that epiplanktonic copepods occurring in the lower equatorial latitudes, i.e. species with their breeding range restricted to lower latitudes between the equator and 20-30°north and south, tend to show regional provincialisms. A similar tendency emerges from the distribution of Acetes whose northern and southern limits fall roughly between the 30° parallels. All species of Acetes are

restricted to either Atlantic, Indo-West Pacific, or the eastern tropical Pacific Ocean. In addition to continental barriers to the spread of the species, the coastal habitats favored by Acetes may be equally or even more significant in isolating populations and in producing short-range species and subspecies.

Morphological characters of the species of the genus Acetes indicate that all present species were derived from two common precursors. One gave rise to the erythraeus group and the other produced the japonicus group. Probably the precursor of the erythraeus group was associated primarily with equatorial (tropical) waters and that of the japonicus group with tropical-subtropical (tropical-warm temperate) waters. It is considered that the two precursors were distributed widely in the Tethys Sea, both in the Indo-European province and American province, during the Eocene and Oligocene. Because of the late tertiary climatic deterioration, however, these precursors disappeared from East Atlantic-Mediterranean. The formation of the land-bridge between Asia and Africa also divided their habitat into two regions, namely Atlantic-East Pacific and Indo-West Pacific (UMBGROVE, 1930). After that they developed gradually on different lines in the two separate regions.

The climatic change after middle of Miocene took place on the American side, though it was not so catastrophic for the tropical fauna (EKMAN, 1953: 71). However, it might have caused immigration of tropical-subtropical species (the Americanus subgroup) to the lower equatorial latitudes, and forced the equatorial species (the paraguayensis subgroup) to take refuge

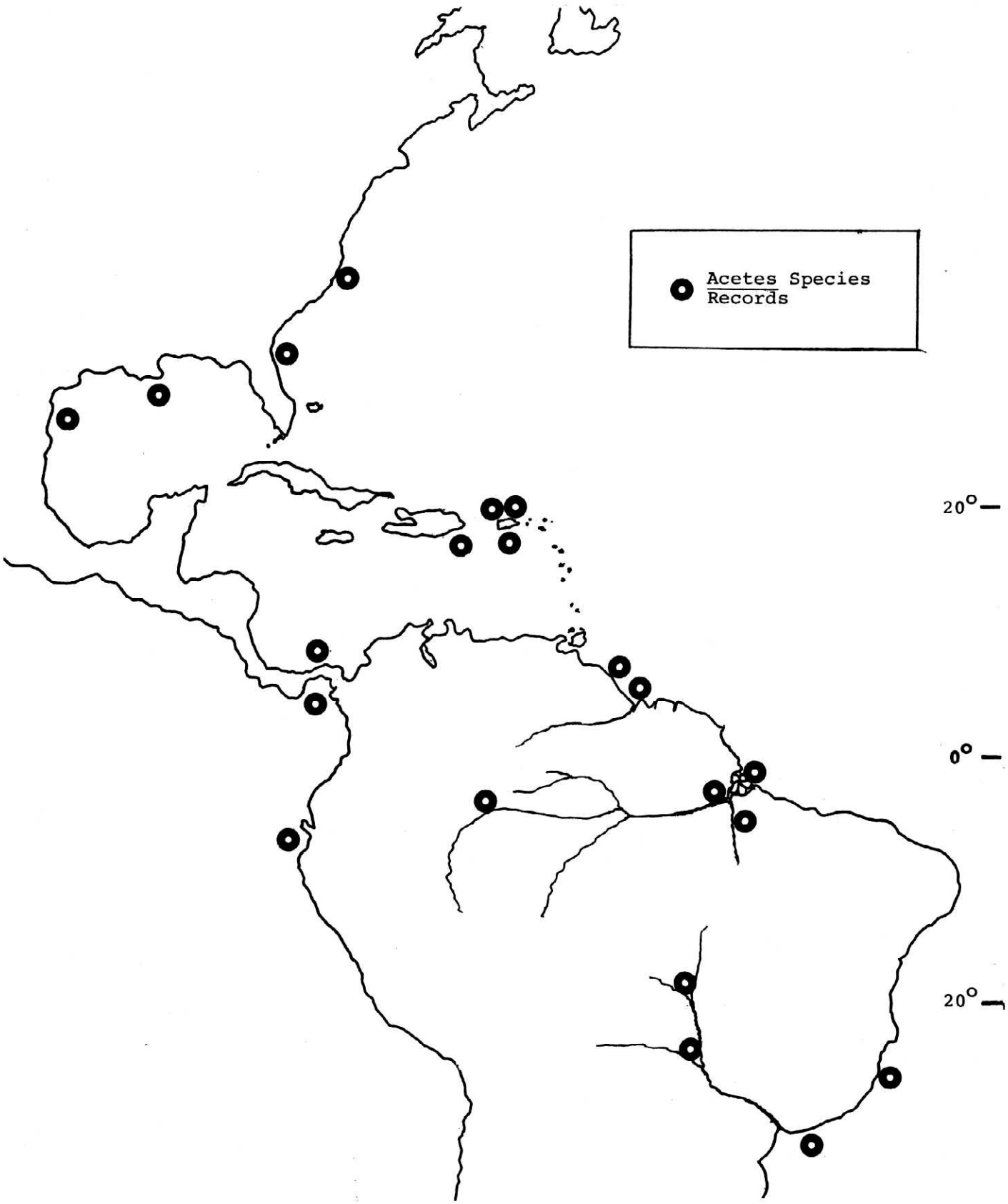

Figure 1. Distribution records for Acetes species in the new world.

in rivers and estuaries of central and northeastern South America. Acetes paraguayensis in the Parana basin could have been introduced directly from the upper region of the Amazon basin without passing through the sea.

The fact that A. binghami shows stronger morphological affinity to A. Americanus indicates that they must have been recently derived from a single subtropical precursor. JORDAN (1908) introduced the term "geminate species" or "twin species" for amphi-American species having a common ancestor. Until Pliocene the Pacific had a direct connection with the Atlantic across the present Central America. Presumably, simultaneous development of A. americanus and A. binghami occurred after formation of the Panama Isthmus.

Attention has often been called to the faunistic resemblance between the Indo-West Pacific and Atlantic America and the faunal richness of the Indo-Malayan region, as demonstrated in Acetes, as well as various other common families and genera such as the decapod shrimp genus Lucifer, the squid genus Sepioteuthis and the eel genus Anguilla. The faunal richness of the Indo-Malayan region is sometimes explained by the assumption that this region is a center for the generation of marine organisms. However, EKMAN (1953:79) notes that the explanation is rather that, in contrast to the Atlantic, the Indo-Malayan region has been able to preserve this inherited richness until the present time, and that in addition new forms have been able to develop continuously.

Acetes is a typical neritic, epipelagic shrimp and it is common in estuaries and backwaters where fresh water from the land greatly influences the situation. It can withstand a great change of salinity. For instance, adults of A. erythraeus are found in water where the salinity fluctuates seasonally between 1.5 and 35.0°/00 (LE RESTE, 1970). Other common environmental features correlated with appearance of the species are: 1) the sea is shallow for a great distance from the shore; 2) the area is separated from the open ocean by a peninsula, submarine sills or numerous islands; 3) the tidal range is considerable; 4) the bottom is covered with mud or sandy-mud. Acetes is generally distributed in depths shallower than 50m; swarming and gregariousness are usually found from the surface to a depth of 20m. The swimming activity of the shrimp becomes highest at night. In the shallow area of the Seto Inland Sea (10-20m in depth), A.japonicus often intimately associates with the bottom during daytime, but in Toyama Bay where the bottom slope is very steep, the species aggregates at depths of 40-90.

It is probable that Acetes produce a steady emission of greenish-blue light. Fishermen in various localities always point out the occurrence of massive blue-green glows from swarms of Acetes. No instrumental method has yet been developed for swarm location based on the glow.

Catches of pelagic crustaceans like sergestids, galatheids, euphausiids, and mysids are not recorded in the FAO's "Yearbook of Fishery Statistics" as a result of the lack of statistical data on these fisheries. Therefore, it would be worthwhile to estimate the amount of commercial catches of Acetes at present and to evaluate the potential of Acetes as a fishery resource. Approximate average annual catches of Acetes and their proportions to the catches of total shrimps in seven Asian countries are summarized in Figure 2. The catches of Acetes in the table total 130,000 tons, but these records must be considered as minimal because reliable statistics are only available for a few of the larger markets. Although data is not complete as yet, Acetes certainly supports a subsistence fishery of considerable importance in North Korea, Taiwan, Hong Kong, Philippines, North Viet Nam, Cambodia, Burma, Singapore, and Indonesia. It is probably fished in Bangladesh, Pakistan, and Sri Lanka. Catches from Kenya, Tanzania, Mozambique, and Madagascar may not be ignored. In South America, a small amount of A.americanus is consumed in Surinam and French Guiana (HOLTHUIS, 1959). I would judge the Acetes harvest from areas not reporting regional fishery statistics to exceed 40,000 tons per year. Therefore, the world catch of Acetes is estimated to be at least 170,000 tons per year.

Figure 2

Approximate Recent Annual Catches of *Acetes* and Their Contribution to the Shrimp Fishery in Seven Asian Countries

Country	Year	*Acetes* (tons)	Total Shrimps (tons)	Other Crusts.* (tons)	*Acetes* to ttl. Shmps.%	*Acetes* to ttl. Crust.%
China	1955	71000	———	———	———	———
South Korea	1965-68	10700	13700	3900	78.1	60.8
Japan	1968-72	800	57700	92300	1.4	0.9
South Viet Nam	1972	10000	54300	———	19.4	———
Thailand	1968-72	13600	75000	35700	18.1	12.2
Malaysia (West)	1970-72	9400	52200	2000	18.0	17.3
India	1959-68	14500	81700	3000	17.7	17.3

*Natantia

**Panulirus, Portunus, Scylla, Paralithodes, etc.

The annual catch of total shrimps (Natantia) excluding planktonic forms reached about 474,000 tons in 1970 in the Indo-West Pacific; it was 930,000 tons in the world (FAO, 1971). If the present estimate is correct, *Acetes* accounts for 26% of the total shrimp catch in the Indo-West Pacific and 15% of that in the world. Furthermore, *Acetes* probably exists in potentially exploitable quantities in other areas but is not fished due to lack of appropriate method of food processing, the richness of other fishery resources, and/or the small size of the local market.

The life span of Acetes is less than 3-10 months and the adult dies soon after spawning. Thus, the adults represent an emphemeral stock with very rapid turnover, new individuals being consistently recruited from the nearby waters. Since planktonic shrimps such as Acetes, Peisos, and Lucifer often occupy a key trophic level in neritic communities (OLIVIER et al., 1968; AMORI, 1974), the exploitation should be carefully managed so that it is not excessive and does not unbalance the food web. However, it seems reasonable to conjecture that a potential world fishery of 50,000-100,000 metric tons of Acetes would not be excessive. The potential New World fishery probably does not equal the Asian fishery, and may be as little as 20,000 metric tons. No data exists for making a reasonable estimate.

PROCESSING AND UTILIZATION

Many kinds of Acetes products are marketed, but they can be classified into the following types: 1) raw; 2) boiled; 3) dried in the sun; 4) dried after boiling and sometimes processed further by having the carapace removed from each shrimp; 5) pickled in salt; 6) fermented with salt (shrimp paste and shrimp sauce).

Generally, only a very small proportion of the Acetes catch is sold as fresh shrimp, but the greater proportion is dried, pickled or fermented for food in various ways. The dried shrimp is marketed in all countries of Asia and it appears the exclusive use of Acetes in Africa. In Japan "Amizuke" (Ascetes pickled whole in salt and fermented) is

the main product; a similar product is very common in South Korea. In China and Southeast Asia, Acetes is highly desired in the form of fermented shrimp paste and shrimp sauce.

Figure 3

Sample	Water (%)	Carbon	Nitrogen % (dry wgt.)	Ash
Blachan	26.9	32.3	7.9	22.7
Acetes japonicus (8 Aug. 1972: Suruga Bay)	79.8	42.9	11.5	13.3
(25 Oct. 1973: Ariake Sea)	79.1	42.3	11.0	10.7

The paste includes "Xiajiang" in China, "Mam-tep" in Viet Nam, "Blachan" in Malaysia and Singapore, "Gapi" in Thailand, and "Ngapi" in Burma. Blachan is manufactured in the following way. Fresh Acetes is mixed with salt and dried in the sun for 5-8 hours. It is then put through a mincer and packed tightly in a wooden tub which is covered with burlap and set aside for a week to cure. The paste is then removed from the tub and again spread out to dry in the sun. This is followed by a second mincing and again the paste is packed into the tub, covered and allowed to cure for about a month. The process of fermentation, mincing, and drying is repeated at least three times and finally the product is pressed into a hard mass.

Blachan is deep purple in colour and has a salty strong shrimp flavour (Plate 1-e, f). This product remains in good condition for 2 months or more. The biochemical composition of the Blachan from Penang was determined and compared with that of fresh A. japonicus (Fig. 3). The results indicate that about 3.7 kg of fresh shrimp are needed to make 1 kg of Blachan and that Blachan is a highly nutritive product containing 36% protein. In the market 1 kattee (about 600 g) of good Blachan cost 100 yen in 1973. About 80% of the Acetes landed in West Malaysia was used to make Blachan and the amount of production, mainly from Selangor, Johor, and Penang, attained 4,072 tons in 1972. The taste and nutritional value of Blachan is highly favoured by people of Southeast Asia, and a considerable amount is exported from Malaysia to Singapore and Thailand.

DISCUSSION

Little is known about Acetes, its propagation, growth, migration, swarming behaviour, feeding habits, etc. Acetes is assumed to play a significant role in the food web of coastal waters. In particular, it must be important in the dynamics of ecosystems in lagoons, sea-grass beds, and mangrove swamps which extend over vast areas in tropical and subtropical regions.

Acetes certainly affords a major source of protein to some of the people in the Indo-West Pacific. Among 14 species

of the genus, A chinensis, A. Erythraeus, A. Indicus, A. Japonicus, and A. Vulgaris are most important in the plankton fishery. In the report on the crustacean resources of the countries bordering the South China Sea, MISTAKIDIS (1973) mistakenly lists Sergestes spp. in place of Acetes spp. as one of the most important commercial shrimps in the area. No species of the genus Sergestes have so far been exploited in Southeast Asia.

The possibility of using plankton as a food source for mankind has been discussed for a long time. While much interest has focused on the practicality of fishing Antarctic krill, Euphausia superba, few seem aware that planktonic fisheries have existed for many years utilizing the pelagic crustaceans, Acetes spp., Sergia lucens, Neomysis intermedia, Acanthomysis mitsururii, and Euphausia pacifica (see MURANO, 1963; KOMAKI, 1967; OMORI et al., 1973) and the jelly fish, Rhopilema esculenta and Stomolophus nomurai. Harvesting krill is technologically feasible. During 1974/75 season two Japanese exploratory stern trawlers took a combined catch of about 3,000 tons of krill in Antarctic waters. Some scientists suggest that a potential of at least 20-30 million tons of krill exists for the world fishery. At present, however, a satisfactory large-scale method for processing krill for human consumption is lacking, although various possibilities of industrial and agricultural use, e.g. as meal for cultivated animals, as a source of lipids for pharmaceuticals, as a source of protein flour for human consumption, etc., are considered. Solution of this problem is indispensable for development of commercial fishery of Macrozooplankton.

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