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NATIONAL MARINE FISHERIES SERVICE SOUTHWEST FISHERIES CENTER TIBURON LABORATORY 3150 PARADISE DRIVE TIBURON, CALIFORNIA 94920

SEPTEMBER 1985

REPORT ON TRIP TO JAPAN AND TAIWAN

By

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U.S. SOUTHWEST FISHERIES CENTER
NOV 15 1985
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ADMINISTRATIVE REPORT T-85-01

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Southwest Fisheries Center Administrative Report T-85-01

REPORT ON TRIP TO JAPAN AND TAIWAN

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October 1985

NOT FOR PUBLICATION

REPORT ON TRIP TO JAPAN AND TAIWAN

I travelled to Japan and Taiwan in May, 1985, to learn about various aspects of catching, handling, processing and marketing fish, particularly those applicable to California fisheries. This is an account of my trip, including my own observations as well as summaries of discussions I held with researchers and industry persons on a wide range of topics. Names and affiliations of these people are available on request.

My itinerary was as follows:

10 May--Left San Francisco
11 May--Arrived Tokyo
16 May--Left Tokyo, arrived Taiwan (Taipei, Keelung, Suao)
21 May--Left Taiwan, arrived Tokyo (Tokyo, Shimizu, Odawara)
29 May--Left Tokyo, arrived San Francisco

Some highlights of my trip include learning about:

1. A method for softening hard parts of fish so that they are virtually undetectable when eaten.

2. Recent advances in on-board freezing technology, using calcium chloride instead of sodium chloride brine, so solution temperatures of -45°C can be achieved.

3. A developing gill-net fishery for slender tuna (*Allothunnus fallai*) in the southern hemisphere.

4. Uses and prices for the flesh and organs of ocean sunfish; intestines bring about $10.00/lb ex-vessel in Taiwan.

Rather than give a chronological account I will relate my activities by subject matter.

METROPOLITAN WHOLESALE FISH MARKET, TSUKIJI, TOKYO

The Tsukiji market is run by the city of Tokyo, which collects a fee of 5-1/2% of the sale price of each item sold. Auctions are conducted by primary wholesalers who either buy fish outright from producers or brokers, or handle the items on consignment. Secondary wholesalers and representatives of large supermarket or restaurant chains participate in the auction. The approximately 1,300 secondary wholesalers have stalls in the Tsukiji market, and the prices I present here are those charged by these wholesalers, whose customers are retailers and others in the food service industries. Generally, primary wholesalers work with a profit margin of around 3% while secondary wholesalers have a 10% margin or so. According to one secondary wholesaler, only around a third of the firms make money; one third lose money and the other third hold their own.

The stalls located in convenient sections of the market have an advantage, and those are coveted by all. Assignment of stall spaces is decided by lottery each 4 years, and this was one of the years. The move was effected on the weekend of May 18-19.

As usual, whenever I visit Tokyo I spend most mornings at the Tsukiji market. I was fortunate to be able to tour parts of the market in the company of Dr. Tokiharu Abe on two occasions; on one morning, Ing. Luis Kasuga O., former Director of Instituto Nacional de Pesca in Mexico City also came with us. Probably no one in Japan knows the market like Dr. Abe, who formerly worked for the Tokai Regional Fisheries Research Laboratory in Tokyo. About 150 species of fish are sold each day, and in the course of a year around 600 species can be found here. Some 3,000 tons of fish are sold each day except Sunday. Dr. Abe keeps track of any new fishes in his series "New Faces of Fishes", which is intended primarily for consumers.

The last time I visited the Tsukiji market was in 1979. At that time the most significant recent change had been the switch from wood to styrofoam containers. The whole market was a sea of white fish boxes, and the squeal that resulted from boxes rubbing against each other was strange to hear. This time I think the biggest change (since 1979) was the growth of the live-fish section. Before, one found mostly live eels, and a few halibut, sea bass, yellowtail and sea bream, in addition to crustaceans and mollusks. Now the numbers of all these are far greater, and many other species have been added, including sculpins, jacks, and octopus.

I paid particular attention to techniques for immobilizing and bleeding fish we could apply in the U.S. I also noted the various ways in which fresh and frozen shrimp were packed. I was especially interested in the so-called "ama-ebi" (sweet shrimp) group, mostly Pandalus and closely allied genera, as these are high-priced, and also occur in California.

Sea urchin roe is now exhibited in a refrigerated container room for inspection before the auction, which starts at 0520--yet another bit of evidence of the insistence of the Japanese in maintaining high quality standards.

The following are some wholesale prices (per pound, unless other units are given) calculated using an exchange rate of 250 yen to the dollar: gutted salmon shark (with head on), $0.73; pandalid shrimps and close relatives, $5.45-12.73; California sea urchin roe, $8.00/tray; mussels, $0.82; small tanner crab (cooked, whole), $2.91; pickled or boiled octopus, $2.90-3.27.

Discussions with some wholesalers revealed their interest in the following California products: squid, shrimps, sablefish, mackerels (if fatty), fish eggs, and marine snails. Some wholesalers are willing to try marketing some of our nontraditional species.

SUPERMARKET PRICES

I priced several products in two Ginza supermarkets, whose prices are probably a bit higher than most retail shops: a dozen peeled pandalid shrimp tails (about 1 oz), $2.00; geoduck, sliced, $2.40/tray (1/4-1/3 lb); squid mantles, sliced in strips for sashimi, $1.60/tray (about 1/4 lb); dried Sergestes shrimp, $27.00/lb; marinated sablefish, $1.20/steak (about 1/4 lb); dried herring, $1.60 each; dried flatfish (10-in), $1.20 each; dried jack mackerel (9-in), $1.52 each; smoked mullet roe, $20.00-40.00 for two skeins; channel rockfish, $7.27/lb; tilefish, $15.00/lb; needlefish, $18.00/lb; Pacific mackerel (10-12 in), $1.20 each; (the previous four fish were gilled and gutted, with heads on); boiled octopus, $5.45; pollock roe, salted, with chile pepper, $10.90/lb.

Prices (per pound) for some meat products, for comparison: hamburger, $7.27; stew meat, $8.18; sirloin steak, $18.00-54.00; other steak, $10.00; boneless pork chops, $4.54-6.36; chicken breast without skin and bone, $3.09; ham, $6.36; salami, $8.17; wieners, $5.09.

BONE-SOFTENED FISH

I visited the Suzuhiro Kamaboko plant at Odawara (50 miles south of Tokyo) to learn about a new processing method for softening hard parts of fish, first described to me by Sunee Sonu of the NMFS Southwest Region. People at the plant--including an old friend, Minoru Okada (formerly of the Tokai Regional Fisheries Research Laboratory)--have experimented with this method, and the firm has recently established a new plant to produce bone-softened sardines and triggerfish, both species for which traditional markets are inadequate for the supply. With the new process, the fish are headed and gutted and the tail is removed. The fish are then immersed in a brine solution which apparently adds flavor, reduces odor and helps retain moisture. Then the fish are cooked in an autoclave under pressure until the hard parts are softened. Even the stout dorsal spine of the triggerfish is reportedly softened. The product can then be used in various ways--shredded for salads, deep-fried, fish patties, etc. The Japanese government is reportedly allowing the sale of this bone-in fish in school lunches. Previously the abundant sardine resource (catch around 4 million tons) could not be used for this purpose because the bones were dangerous for kids. I tasted a deep-fried portion of sardines and found it delicious. Its texture was good and the smell, though typical for sardines, was not overly strong. We will definitely look into introducing this technique in California, for use with abundant, underutilized species like shortbelly rockfish, Pacific whiting and others.

FISH PROCESSING AND HOLDING

At the Far Seas Fisheries Research Laboratory in Shimizu, I learned that some Japanese tuna fishermen now use calcium chloride ($CaCl_2$) rather than sodium chloride for brine-freezing fish, both in immersion tanks as well as in spray-brine systems. Because the solution remains liquid even when chilled to -45°C, the freezing time, and hence cost, are reduced

appreciably. Fish frozen in calcium chloride are called "B-1" fish, and usually command a higher price than conventionally frozen fish. The product is acceptable for sashimi, and is comparable to tuna blast-frozen at -55°C. I tasted some raw skipjack tuna which had been preserved in $CaCl_2$ brine and found it excellent in taste, texture and appearance. After 45 minutes or so, however, the cut slices turned darker and unappealing, though the taste remained good. This method is applicable to any tough-skinned whole fish, and would seem to be particularly good for freezing albacore which are now starting to be marketed frozen in the U.S. In the Atlantic, perhaps blackfin tuna can be handled this way and exported to Japan or used domestically as sashimi. At any rate, calcium chloride brine-freezing should be looked into here. Dick Nelson of the NMFS Northwest and Alaska Fisheries Center tells me some work has already been done in the U.S., with promising results. [According to information I have received since my trip, spray-brine $CaCl_2$ is no longer used in Japan. Also, only tuna longliners and not purse seiners are now using $CaCl_2$. Skipjack tuna is thus not normally frozen with this method.] JAMARC (Japan Marine Fishery Resource research Center) has been experimenting with calcium chloride freezing since 1981, but the final verdict is not yet in for this method.

Another on-board holding technique, also used to transport fish onshore, is to maintain them at a temperature of -3°C (26.6°F). I heard about this method from a number of persons connected with the Tsukiji fish market. Some of the claims I heard are that crabs can be kept in a dormant state for long periods at this temperature, and that dead fish can be held for a month without losing quality. (I'm not prepared to believe the crab story, though). The low temperature apparently slows down autolysis as well as bacterial action. Presently, research on this method is being carried out at the federal Tokai Laboratory in Tokyo, and at a prefectural lab in Tottori prefecture. Perhaps our swordfish, shark, and albacore fishermen, as well as groundfish and shrimp fishermen could use this method to advantage.

SLENDER TUNA FISHERY

A fishery development project being carried out by JAMARC appears to be heading toward a successful conclusion. JAMARC has uncovered a large resource of slender tuna, *Allothunnus fallai*, in the southern hemisphere, generally between latitudes 20 and 30 degrees south, almost across the entire Pacific Ocean. It is also found in the Atlantic. Catch rates have been around 10 tons a day, using surface gill nets. The fish are similar in size to skipjack tuna, probably averaging less than 15 pounds. The 10-m deep gill nets are made with 160-mm stretched mesh, and are set on the surface at dusk. Hauling starts around midnight. By-catch is apparently low, and most species are marketable (mako shark, skipjack tuna, albacore, a few billfish). Although fishing trials have proved successful, studies on product forms and marketing are still continuing. In well-publicized taste tests conducted by JAMARC, both sashimi and canned (in oil) *Allothunnus* were judged good, except for the color. The canned product is darker than albacore, with a yellowish brown tinge. The sashimi reportedly tasted fine, but the appearance of the raw flesh turned unappealing after a time. (The fish may have been held in calcium chloride brine.) The taste

and texture of "solid pack" Allothunnus canned in oil, which was served to me in JAMARC's Tokyo headquarters, was similar to albacore in my judgement. In addition to testing product forms for Allothunnus, JAMARC is also searching for a good market name for the species. It seems to me that we should also be looking into the fishery potential of Allothunnus, as it may constitute a sizable scombroid resource.

JAMARC is a quasi-governmental research organization whose primary mission is to develop fisheries for underutilized species. Most research funds are provided by the Japanese government, but the fishing industry also kicks in both money and personnel. The catch resulting from experimental fishing cruises is sold to help defray research costs, so it is helpful for JAMARC when projects result in lucrative fisheries. However, once it has been established that a commercial fishery is feasible, JAMARC is discouraged by industry from doing further work on that fishery, thus ironically eliminating JAMARC's chance of increasing its research coffers. A fairly recent example of this is JAMARC's work with the Antarctic krill fishery, which now lands some 20,000 tons of product per year. Incidentally, the newly named Managing Director of JAMARC is an old acquaintance, Dr. Koya Mimura.

CRAB FLAVORS

Prior to my trip, I sent samples of four species of crabs to Hasegawa Kohryo in Tokyo, requesting that the firm appraise them for their value as ingredients for "crab flavor" or "crab essence". This type of flavoring is commonly used in imitation crab made from surimi, which is popular in the U.S. I also asked that one species, pelagic red crab (Pleuroncodes planipes), also be examined as a possible source for food coloring. In Tokyo I visited with Mr. Ishikawa, Chief Flavorist of Hasegawa Kohryo, who set up a taste test with flavoring made from the four species I had sent (pelagic red crab, red rock crab, box crab, sheep crab) plus others used for comparison. The extracts were diluted with warm water to make a broth. We agreed that among the four species, box crab and red rock crab had good flavor, and that the other two were distinctly inferior. The box crab essence, however, has a gelling quality, so that purification is difficult and costly. This left the red rock crab (Cancer productus) as the only likely candidate species. We plan to do further joint work with this species, though it may ultimately turn out that export of crabs to Japan will be too costly. We may still be able to use it domestically, however.

Carotenoid pigments extracted from pelagic red crab yielded a deep red pigment, but when compared to a standard (a solution of paprika), the crab coloring was much less intense, and thus probably not suitable as a food dye because of economics. The pigment is still useful, however, as an additive to salmon feed in order to obtain red flesh in pen-cultured fish. Chile is presently producing carotene-rich meal from waste products of the "langostino" (species of pelagic red crabs) fishery.

I visited a second firm in Tokyo in the same business, providing flavoring used in many food products. Mr. Miyachi, President of Cassey Company, gave me samples of powdered concentrates of crab, oyster and

shrimp flavor. He also told me that in many cases real animals are not needed, or even desired, in making the flavors. "Aminosan" (a combination of amino acids?) is used instead. When real extract is added, it is usually to enhance the smell, rather than the taste. In any case, by-products such as crab shells, rather than whole animals, are used to make extracts. After the flavor has been extracted, the shells may also be used to make chitosan, which has a variety of applications.

GRENADIERS

Because the Tiburon Laboratory's chief mission is groundfish research, I was interested in learning all I could about one abundant but underutilized group of groundfish, the macrourids (grenadiers). These fish are abundant in deep waters around the perimeter of the north Pacific, and my aim was to learn if a market exists for them, and if a fishery was economically feasible. According to Taiwanese and Japanese researchers, the Soviets have the largest fishery for grenadiers. No one seemed to know what they did with the fish, however. Near Tokyo (Choshi, Yokohama), Japanese bottom trawlers often catch grenadiers in relatively shallow water (800-1,000 m), but they are all discarded, according to University of Tokyo students who are studying these trawl fisheries. Further north (Tohoku district), some species are used and are especially good during winter. They are mostly eaten in fish stews. Most species of grenadiers are used as fish meal, however. In the south (Izu, Kochi), handline fishermen often target for certain species of grenadiers in deep water. These, along with deepwater squaloid sharks, are prized. This fishery has been rather inactive recently, however. I learned from researchers at the Tokai Laboratory that one of our common species, *Coryphynoides acrolepis* (Pacific rattail), has good eating qualities as traditional fillets or steaks, as well as for use in surimi. It is called "ibarahige" in Japan. The giant grenadier (*Albatrossia pectoralis*), a second common species here, is considered valueless, however, because of its high water content, around 90% percent. One person I talked to still felt that with special preparation (including partial dehydration) even this species is not bad eating. It seems clear that this group has only limited local appeal, and only for certain species, so that export to Japan is unlikely at this time.

MISCELLANEOUS NOTES

Some of this information was obtained at the request of particular persons. Other notes I took may be of interest to fishermen, processors, or researchers.

1. Sharks:

   A. Mako sharks are best for "hanpen", a kind of fishcake made from minced fish and rice/yam flour. Blue sharks are inferior, but also used.

B. Squalene, an oil found in the livers of some sharks, is still a valuable item in the cosmetic industry in Japan. Recent tests show that Odontaspis has 20-30% squalene; Isistius also contains the oil, but Somniosis does not. The oil is still also used for "health reasons" in pill form. Best source is basking sharks, whose livers weigh up to a ton or more and which contain 25-50% squalene. Japanese bottom trawlers working in 400 to 500-m depths near New Zealand report catching up to 10 large basking sharks in a single tow. As one can imagine, the fishermen are not pleased to see a net full of sharks, and they usually leave an area if more than a couple of sharks are caught in a tow. As is true of those caught on the surface, the deep-dwelling sharks have small crustaceans in their stomachs. The trawl tows were made during daytime. Present price for basking shark liver is around $2.00/kg, providing the oil contains 50% squalene. Total oil content (including squalene) of livers is around 70%.

C. In the Tohoku area of Japan, Squalus acanthias or spiny dogfish ("aburatsunozame") was one of the chief ingredients of "chikuwa", a type of broiled fish cake. It was also commonly used as fillet or steaks and cooked in various ways. Due to low catches in recent years, it has been replaced by other fishes.

D. Fresh salmon shark, Lamna ditropis ("mōka") can bring up to $1.50/pound at Tsukiji (head on, gutted). The price is probably not always this high, however, and frozen mōka is rather low-priced in northern Japan. The heart of this species is reported to be good for sashimi. Although I received conflicting information, I believe mako sharks are probably more valuable than salmon sharks.

E. Koreans living in Japan are the largest users of shark meat. Basking shark flesh is low-priced, and is used primarily fried in Chinese restaurants.

F. Sharks hides are getting more and more expensive, even for those from deep-sea sharks, which are usually small. A British firm reportedly ordered 10,000 hides recently.

G. Swell shark: The Japanese species ("nanukasame") is popular in the Nagasaki (western Japan) area, where the price is around 2,000 yen/kg ($3.60/lb). It is called the "chicken of the sea". Curiously, the flesh of the California species, Cephaloscyllium ventriosum, is reputed to cause diarrhea.

H. Angel shark: The skin of Squatina ("kasuzame") is dried and used for grating radish.

I. A biochemist at the Tokai Laboratory told me that shark flesh can be kept up to 3 weeks if stored at 0°C. At this temperature, bacterial urease is not active, so breakdown of the shark urea occurs very slowly.

2. Hagfish: Korean fishermen use pots to catch hagfish, and their gear often causes conflicts with Japanese trawlers working in the same grounds

in the Japan Sea. The flesh is apparently smoked or broiled, while the skin is used to make leather. Hagfish as well as lampreys are used for food in northwest Japan (Onahama, Akita, Yamagata, Niigata); they are prepared similarly to eels, usually broiled, or steamed and then broiled.

3. Bonito (Sarda orientalis): The Japanese bonito, "hagatsuwo", is considered a good sashimi fish, especially in western Japan, but the flesh becomes soft quickly. Our species, S. chiliensis, could be used as sashimi also, or as a smoked/dried product when the fat content is low. Another possible use is in candied "fish cubes", made from scombrid fishes. If, as suggested by recent studies, a few grams of fisn per day are sufficient to promote good coronary health, chewing on these fish cubes would be an easy way to ingest the required amount. Incidentally, Japanese often use "bonito" when they really are talking about skipjack tuna.

4. Cod: True cod makes good sashimi, but only when perfectly fresh.

5. Sardines: The annual sardine catch in Japan has risen to over 4 million tons. The ex-vessel price can vary from 3 to 300 yen/kg; 10 yen/kg (about $0.08/lb) is considered a good price for fishermen.

6. Tilefish: Some Japanese firms are importing large tilefish from the U.S. East Coast. These fish, called "amadai", command a high price and are especially popular in the Kansai area. (That is, at least the Japanese species are popular; I did not see American tilefish on the market.) Our West Coast species, ocean whitefish, has good potential for the sashimi trade, but it may be better to concentrate on the domestic market rather than Japan, because of inconsistent supply at present.

7. Flatfish: "Sasagarei" is a popular salted and semidried flatfish, usually made from fish with a narrow and long shape. Our rex sole is good for this product, especially when it is full of roe. Dover sole can also be used. Best size is around 15-20 cm.

8. Rockfish: Although large rockfish are being imported for "kirimi" (fillet portions), many people prefer smaller ones, for individual servings. The color is not important if the fish is to be cooked in soy sauce; otherwise, red rockfish are preferred.

9. Surfperch: Rubberlip seaperch (Rhacochilus toxotes) makes good sashimi, and is being imported into Japan.

10. Yellowfin goby (Acanthogobius flavimanus): This species was introduced into San Francisco Bay from the Orient. It is a popular fish in Japan, and is usually eaten deep-fried or cooked in special soy sauce recipes. To export our goby to Japan, it may be best to simply cook it in soy sauce and let Japanese processors make the final product.

11. Squid, shellfish: Freezing softens the meat of most shellfish, so freezing does not necessarily lower the quality. Drip formation is probably the most negative aspect of freezing squid.

12. Fish roe: Many kinds of fish roe are used in Japan. Those with larger individual eggs are generally preferred. Sablefish eggs are considered good boiled, and rockfish eggs are also OK, cooked in soy sauce, with ginger (and usually sugar). Mahimahi roe is also popular.

13. Canned fish: Shellfish canned in water is popular in Japan. Tuna canned in oil is also gaining popularity; 8 million cases of tuna, including 2 million cases of albacore, were sold in Japan last year. Other canned goods popular in Japan are Pacific mackerel in water, saury in soy sauce, and sardines. A lot of canned sardines and Pacific mackerel is exported. Canned salmon is also well-liked, but high prices discourage greater consumption.

14. Sergestid shrimps: These large planktonic shrimp, called "sakura-ebi", are usually boiled and dried, or used in special crackers and seafood snacks. The retail price of dried sakura-ebi was 300 yen/20 gm, or $27.00/lb. The equivalent wet-weight price would be around $4.00/lb retail.

15. Abalones: Imitation abalone may be the next "seafood analog" to become popularized, following recent successes with imitation crab, scallop, shrimp and lobster. To make the flavoring for this product, it may be useful or necessary to use abalone trimmings, such as the mantle and parts of the foot left after abalones are "steaked".

16. Crab-cleaning machines: Plants in the port town of Sakai reportedly use machines to separate meat from shell of some crab species. The machine apparently works best with soft-shelled crabs like tanner crab. We need one that can extract meat from the hard-shelled sheep crab and rock crab, as well as the softer-shelled box crab.

17. Boat loans: Japanese tuna fishermen are having a difficult time right now, like their counterparts in the U.S. fishery. Many vessels owners are going bankrupt, and causing financial problems for the cooperatives to which they belong. The co-ops usually guarantee 100% of the loans made by members to buy vessels. They in turn buy bankruptcy insurance from a quasi-governmental agency, which only underwrites 80% of the loan amount. Thus when the vessel owners are forced into bankruptcy the co-ops have to come up with 20% of the loan amount. The vessels themselves are not worth much, due to restrictions in the fisheries, and there are few buyers in Japan.

18. Live fish: Most live fish sold at the Tsukiji market are killed by the purchasing secondary wholesaler, often in the presence of his customers. Methods of killing, called "ikishime", vary depending on species of fish, but the common objective is to immobilize the fish quickly so that it does not have a chance to struggle and release certain hormones and enzymes thought to lower the quality of the flesh. Bleeding the fish is secondary, but also important. To kill sea bream (porgies) the tip of a sturdy knife is inserted under the gill cover, and the vertebrae are severed at that point. A small cut is also made in the middle of the caudal peduncle with the point of the knife. The fish is left to bleed in cold water. This results in an apparently whole, unmarked fish. The head of yellowtail, on the other hand, is cut deeply at the nape, and a large cut is also made at the caudal peduncle. In addition, the tail is

sometimes also snapped at the cut area. With some fishes, the head is nearly severed, and a thin wire is used to pith the vertebral column. Flatfish are usually pierced at the head, and the tails are cut for bleeding.

19. Krill: The major use for Antarctic krill (Euphausia superba) is as chum for both commercial and sport anglers. About 20,000 tons can be sold annually at a profit; if the supply is greater, the price apparently drops too low. Some krill is also used for human consumption. The smaller local species of krill, E. pacifica, is mainly used for aquaculture feed, but is also consumed after being salted and fermented. Incidentally, the salt intake of Japanese is thought to be too high, and the government is making an effort to lower salt consumption.

20. Sea cucumber intestines: Salted sea cucumber intestines ("konowata") are still a popular and expensive item, eaten mainly when drinking sake or whiskey. The intestines need to be cleaned of the sand and mud ingested by the seacucumbers, and it is this laborious task which makes the dish so expensive. The cost is in the tens of thousands of yen per kilogram.

21. Monkfish: The liver of monkfish ("anko") is enjoyed by many people, and the Japanese cannot understand why it is not saved by our East Coast fishermen. The liver is usually boiled in salt water, and eaten with a condiment of soy sauce and vinegar.

22. Neptunid snails: Some species of neptunid snails are taken commercially off Alaska as well as near the Russian coast. A species of Buccinum found in the Okhotsk Sea is the most prized; the most abundant species in the Bering Sea is Neptunea pribiloffensis, which occurs at least as far south as Fort Bragg, California, where I have obtained samples from a trawl fisherman. It is important to know that some species in this group contain rather deadly toxins in their salivary glands. In the Bering Sea, Japanese fishermen use baited pots to catch N. pribiloffensis and other species in depths of 90-130 m. The traps are spaced 10 m apart on a longline. Apparently only top-opening traps successfully catch the snails. The traps have no destruct panels, but are not equipped with collars, so that animals that crawl in, including the snails, are able to get out. Alaskan pollack makes good bait, but is now too expensive, so sardines are used instead. Catch rate for a 2 to 3-day soak is around 4-5 kg/pot; I don't know if this refers to whole snails, or meat only. The shells are usually cracked at sea, and the meat is cleaned and frozen. Neptunid snails are eaten in various ways--as sashimi (raw), cooked in soy sauce, broiled, and in Chinese cooking. Their chief competition in the market is the Chilean "locos", Concholepas concholepas. The ex-vessel price for N. pribiloffensis meat is on the order of 200 yen/kg (about $0.37/lb). The meat yield is around 28%.

23. Albacore: I was surprised to find frozen albacore loins for sale in a seafood shop. The price was 1,000 yen/kg for a small loin (about $1.85/lb). According to a sign on the display case, the temperature in the case was -40°C.

24. Ocean sunfish (Mola mola): Ocean sunfish ("mambo") meat is well-liked by most people who have tried it. It is usually eaten as sashimi, and the liver is mixed with soy sauce as a condiment. The liver oil is also used

as medication for skin lesions, as well as for intestinal ulcers. Coincidentally, squalene oil from shark liver is also used for the same purpose, so it would be interesting to test if ocean sunfish liver contains squalene.

25. Squid: Japanese squid jiggers are successfully catching Illex argentinus outside Argentina's 200-mile zone. Polish and Taiwanese fishermen are also fishing this resource, using trawls during the day and automatic jigging machines at night. The total catch is on the order of 100,000 tons.

26. Jack mackerel (Trachurus sp.): The Soviets are reportedly catching around 200,000 tons of jack mackerel outside of Chile's 200-mile zone. They are apparently using midwater trawls, fishing from the surface to depths of 200 m. The fish are large, 35-45 cm, and if they contain enough fat content, the Japanese would like to use them as "kirimi", or fillet portions. To maintain quality, the fish need to be flash-frozen. A related genus from Africa, Decapturus, is now being used in place of the Japanese species of Trachurus ("aji"), which is in short supply.

27. Hake: Japan is using large hake for kirimi, either imported or caught by themselves, from Chile, Argentina and New Zealand.

28. Yaizu Fish Processing Center: The Center is comprised of 23 independent companies which produce a variety of products from tuna (including skipjack) in Yaizu, the major landing port for tunas in Japan. The firms operate waste treatment plants jointly and tackle pollution problems together. The biggest problem, as expected, is water pollution, which is serious enough to prevent expansion of plants and production. Together, the plants handle 100 tons of fish daily, using 200 tons of water in the process.

29. Ocean ranching: The Japan Sea-Farming Association is involved in rearing a number of marine species, all for release in the sea. It appears to be having success with a number of species, but is not really able to gauge the contribution of the reared and released animals to the fishery. Blue crabs are an exception, however; studies show that each release of 10,000 young individuals yields one ton of crabs a year later. Red sea bream and Pacific mangrove crabs are being released regularly. King crab rearing is satisfactory, but halibut has some problems, including aberrant color. Sea bass is difficult to rear because imported Norwegian copepods are too large for the larvae, and an alternate feed source is needed. Marking released fish is a big problem. Coded wire nose tags, such as those used for salmon, are impractical, because Japanese usually eat the heads of fishes. Tetracycline labelling of hard parts is being considered.

30. Sea urchin roe ("uni"): According to one wholesaler, some large roe which I thought was California uni actually came from Hokkaido. I had never seen large Japanese roe before. Another wholesaler informed me that some uni was being imported from Canada, and also from Boston, which was a surprise. I don't think uni is presently being sent to Japan from our East Coast, however.

31. Octopus: One person I met wants to start an octopus ("tako") processing plant in the U. S., mainly to supply the demand for it in

Hawaii, where it is used primarily in a dish called "poki". He would like to process a medium-grade octopus, i.e., better than the giant Pacific octopus (O. dofleini)--which is watery and has a low meat yield after boiling--but cheaper than "madako", or O. vulgaris. Best size is around 5-6 kg for O. dofleini, which is common off California, as well as up the coast to Alaska. Other species can be smaller.

32. Labor costs: Outside of Tokyo, labor costs for processing fish products are surprisingly low, around $2.00/hour. I think this refers to part-time workers, or those hired for specific short-term jobs.

33. California market squid: Female market squid with roe is definitely preferred over males, but the present product from Monterey (around 50% females) is acceptable. If an all-female pack were marketed, it would eventually become a more valuable item. Supermarkets sell the squid thawed, in small tray packs.

NOTES ON TAIWAN

I visited the National Taiwan College of Marine Science and Technology in Keelung (near Taipei, the capital of Taiwan) where an old friend, Dr. George Chen, is an instructor. This is the major school with a fisheries curriculum, and has a student body numbering around 3,000. Many of the faculty members earned their Ph.D.'s at the University of Tokyo, as did Dr. Chen, or at other universities in Japan. As the school's name indicates, both scientific and practical aspects are taught here. Population dynamics seems to be getting a push lately, due to needs arising from both a declining fish catch near Taiwan and an expanding fisheries in offshore and foreign waters. The port of Keelung is home for about 2,000 vessels, including trawlers, seiners, longliners, gillnetters and a variety of artisanal fishing vessels. According to Dr. Chen, only about 20% of the boats fish regularly, because there isn't enough fish around for profitable fishing in nearby waters. I visited the facilities of the Taiwan Fisheries Research Institute, also in Keelung, where federal researchers are engaged in five areas of study and services: fisheries, fisheries biology, technology, aquaculture, and fleet management. The Institute has 130 scientists and five vessels, including a distant water trawler. Their studies have taken them as far as the Antarctic for krill and the Falkland Islands for squid. Incidentally, squid fishing, primarily for Illex argentinus, appears to be excellent near Argentina, with reported catches of 20 tons/day, mostly using automatic jigging machines. Thus most Taiwanese squid vessels have moved from their former fishing grounds near New Zealand where catches were in the order of 3 tons/day.

Aquaculture is a booming business in Taiwan. One of the major concerns of the industry is the growing ability of mainland China to supply marine products to Japan, Taiwan's chief market for the more valuable species. Of particular concern was the competition or perceived competition for cultured eel (Anguilla) sales.

Sending American fish to Taiwan would appear to be very difficult because of the high import duty for most fish products. Duties used to range from 65% to 130%, but I understand that they have been "reduced"

to around 50% recently. Sale of some items may still be feasible, however, because of high demand and price. Scallops, sablefish, herring roe, salmon, mullet and squid are some possibilities. Much of the fish seem to be destined for restaurants and supermarkets that serve the many Japanese visitors and resident businessmen and their families.

With George Chen's help, I visited three landing ports in Keelung and Suao (located about 75 miles south of Keelung, on the eastern coast), and watched fishermen unload frozen shrimp from trawlers, and various fresh fish from seiners, longliners, and harpoon vessels. The facilities were rather primitive, but the frozen shrimp was quickly loaded on trucks, only a couple of which were refrigerated. I don't know how fresh-fish sales were carried out; in some cases, buyers jumped aboard incoming boats as soon as they tied up alongside the pier, and there was a squabble as they vied for the fish on top of the hold, presumably because they were freshest. Most mackerel, marlin and shark were in excellent condition, though as far as I could tell no ice was used aboard the vessels. One fact became apparent very quickly at the fresh-fish unloading areas. Nearly every bit of the larger fishes and sharks was used; in fact only the gills remain after butchering is completed. Surprisingly, internal organs of tunas, billfishes and sharks are rather highly valued, for food as well as medicine. Bluefin tuna liver and gallbladder, for example, may bring $15-30/kg; billfish liver is cheaper, $1.50-5.00/kg. The stomach and intestines of these fishes also cost up to $7.50/kg. Most startling was the price paid for ocean sunfish intestines--$25/kg. (All the above prices are ex-vessel). I have been working on a market for ocean sunfish, which is commonly caught in surface gill nets set for swordfish off California, so this was a pleasant surprise.

All in all, my four days in Taiwan were very well spent. I learned quite a bit, and established contacts with researchers, as well as with several persons who are interested in processing U.S. fish for eventual sale in Japan. All the people I met, without exception, were cordial, generous and helpful. It was especially easy for me because many of the people I interviewed spoke Japanese or English, or both.