



*STATUS OF THE  
PRECIOUS CORAL INDUSTRY IN  
JAPAN, TAIWAN, AND OKINAWA:*

*1970 CIRCULATING COPY*

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*Sea Grant Depositor*  
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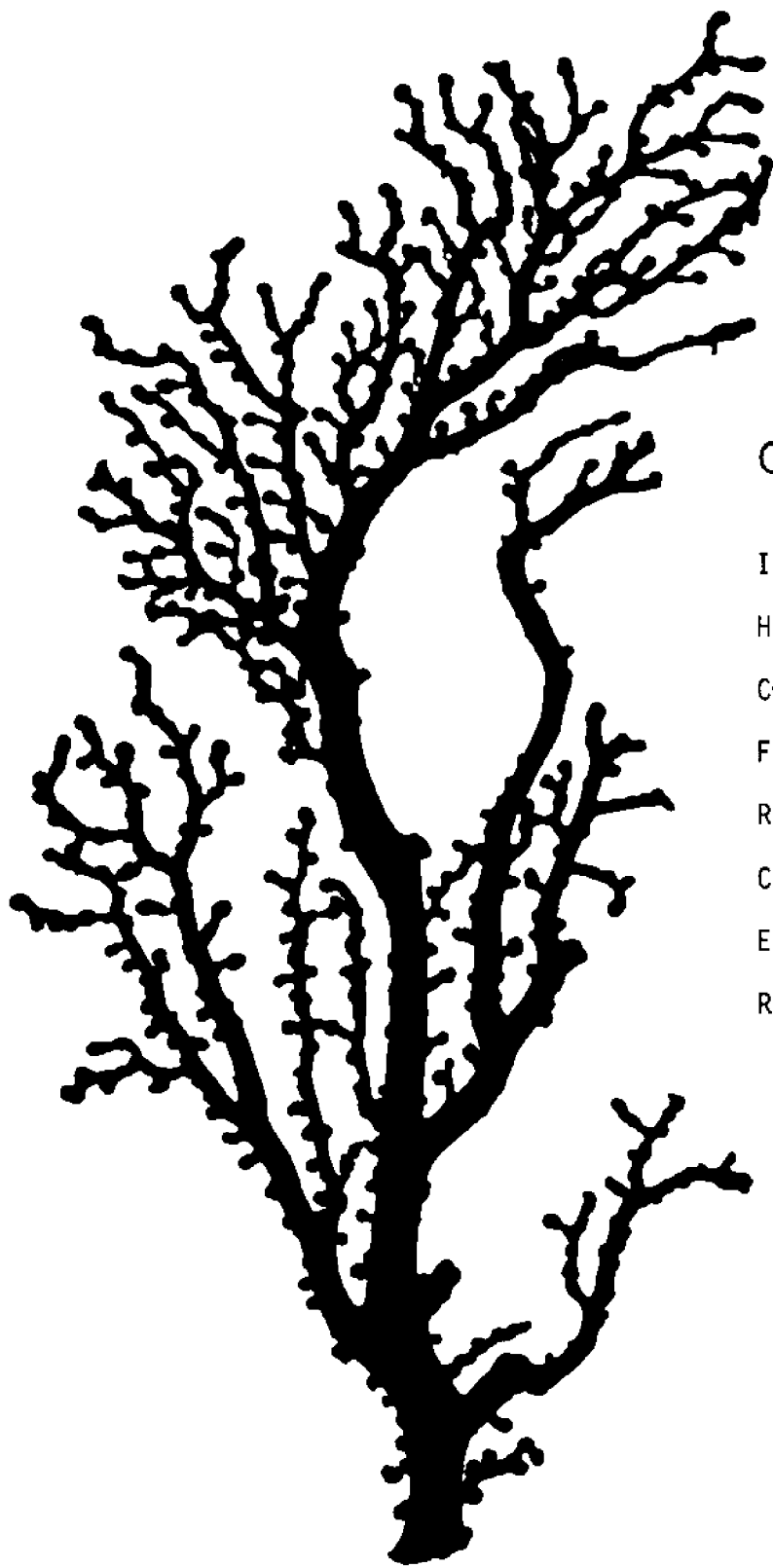
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## CONTENTS

INTRODUCTION	3
HISTORY OF THE FISHERY	4
COLLECTING TECHNIQUES	6
FISHING GROUNDS	7
RECENT PRODUCTION	8
CORAL PREFABRICATION	13
ECONOMIC OUTLOOK	13
REFERENCES	14



## INTRODUCTION

The University of Hawaii is conducting a study of the ecology of precious corals and the development of precious coral fisheries in Hawaii. One of the major goals for this program is to survey the existing coral jewelry industry, which currently is almost exclusively dependent on the Japanese market. This report describes the results of a three-week trip in the summer of 1970 to Japan, Taiwan, and Okinawa, where interviews with fishermen, merchants, and scientists were held. Information gathered included observations of vessels, gear, fishing technique, and coral jewel factories and data concerning the history of the fishery, location and depths of fishing grounds, ecology of various species, and catch and market statistics.

The term "precious coral" classically refers to the red corals of commerce. These species are all placed in the family Corallidae, order Scleractinia, subclass Octocorallia, class Anthozoa, phylum Coelenterata. At present there are 20 species known to inhabit the Indo-Pacific, six of which occur in Hawaii and seven in Japan (Bayer, 1956). Species of commercial importance in the Orient include the red coral or aka-sango, *Corallium japonicum* and *C. nobile*, the pink coral or momoiro-sango, *C. elatius*, and the white coral or shiro-sango, *C. konojoi*.

## HISTORY OF THE FISHERY

Early history of the coral fishery in Japan has been reviewed by Kitahara (1904), who dates the first record of coral fishing in Japan as approximately 1831. Extensive fishing, however, did not begin until after the Meiji Reform in 1868. Prior to 1868 collecting coral was prohibited because the Daimyos (local rulers) were forced to present all coral to the Shoguns (regional rulers). Shortly after 1868 about 100 boats began collecting coral, soon exhausting the known grounds. Subsequent fishing efforts and catches were very sporadic, depending primarily on the discovery of new grounds. This pattern characterized the fishery until World War II (Figures 1 and 2) when fishing effort dropped by about 80%.

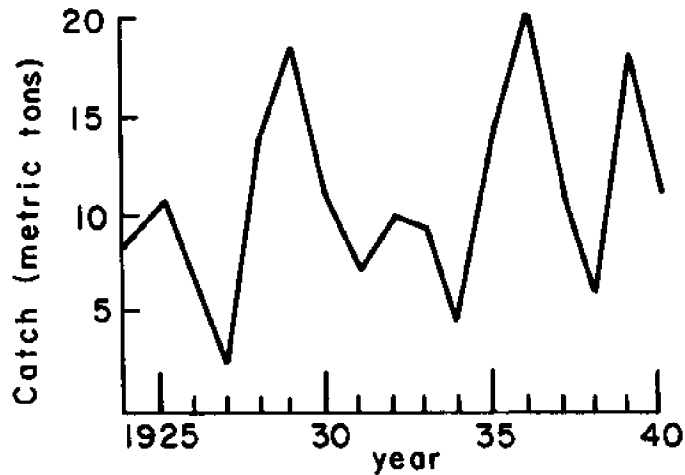


Figure 1. Catch of precious coral at Taiwan, 1924-1940 (Anon, 1956).

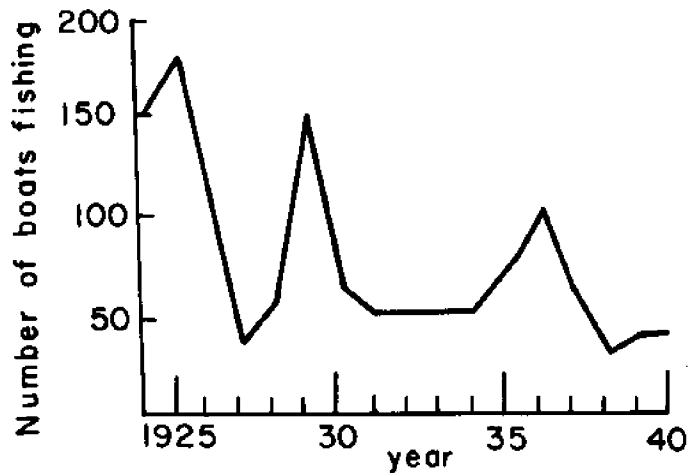


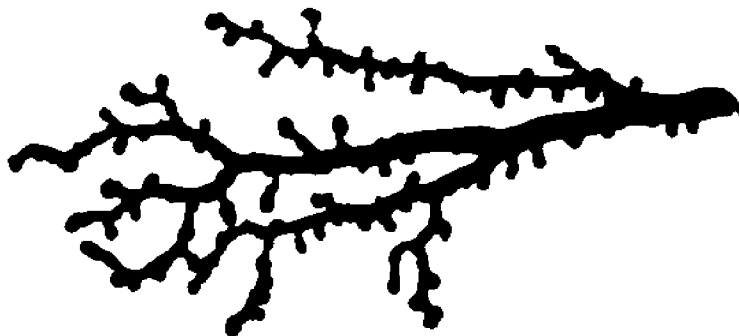
Figure 2. Effort of coral fishing in Taiwan, 1924-1940 (Anon, 1956).

After the war there were several efforts to restore the fishery to its former level. In 1954 the Taiwanese Fisheries Research Institute and the Taiwanese Coral Industry cooperated in conducting surveys to assess the economic feasibility of coral dredging. Despite the fact that during the survey only 19% of the dredge hauls over known grounds were successful and that the costs were about ten times the value of the coral that was collected, it was concluded that Taiwanese waters were rich in coral and that the future of the industry was bright (Anonymous, 1956). It was further recommended that exploration for new grounds be conducted.

Until quite recently, the extent of exploration for new coral grounds apparently was rather limited. For example, the rich coral beds on the Oza Banks about 100 miles south of Okinawa were not discovered until 1963. More extensive exploration by Japanese fishermen in late 1965 resulted in the discovery of Milwaukee Banks, an extremely rich ground about 500 miles northwest of Midway Island. These finds resulted in a large increase in catch in the years 1963-1966.

Records from Okinawa show that the peak year there was 1963. Unfortunately, production records are not available from Japan proper: the coral association is not connected with the Fishery Agency (as it is in Okinawa) and, therefore, records are not available to the government. Personal communications with Japanese fishermen, however, indicate the peak year in Japan was 1966, when the majority of the coral was collected from the Milwaukee Banks. In the last several years, fishing effort on the Milwaukee Banks has declined sharply. According to Mr. Yotsuga, a coral fisherman in Nagasaki, in 1966 about 100 coral boats were operating in the Midway area compared with only 8 at the present time. Most of the beds are reported to be nearly exhausted, and because of the great distance involved, rough operating conditions in this area, and the quality coral (80% white, 20% pink), each year fewer and fewer fishermen return to this region.

Recent production records in Taiwan and Okinawa (Table 1) show that the catch in these areas is also declining. For this reason, in all of the Orient fewer boats are currently operating. Many, in fact, dredge for coral only 3 to 4 months out of the year, relying primarily on more predictable fisheries as a main source of income. Those ships which fish exclusively for coral are now exploring waters in the East China Sea and near the Philippines and Australia. Thus, the nature of the coral fishery in the Orient has recently changed from a local operation, based on many small boats, to one in which most of the coral is collected by fewer and larger boats capable of remaining at sea for periods up to six months.



## COLLECTING TECHNIQUES

Fishery techniques have varied little in the past 100 years. At first, rectangular nets attached to bamboo sticks were dragged across the bottom, breaking and entangling the coral. About 1890 this gear was modified by attaching more tufts of netting at the rear of the rectangular net, thus increasing the tangling area. Sometime before 1925 fishermen found that dragging stones with attached nets was a more effective means of collecting coral. Rocks weighing about 20 kg were wrapped with heavy wire which provided attachment sites for the towing line and nets (Figures 3 and 4). Tangle hanks were made from used salmon nets with a mesh stretch length of about 10 cm. Four or five hanks about 5 feet long were attached to each stone. Usually one stone (sometimes two) was attached to each towing line, which generally consisted of 1/2-inch hemp or polyethylene. This type of gear is currently used by all Japanese fishermen.

Fishermen locate the coral grounds using a fathometer to determine depth and triangulation to fix position when land is in sight. Less precise ways of fixing position must be used when operating out of sight of land. When the boat is in position over the appropriate depth on a bank, it is steered perpendicular to the current and allowed to drift. Based on the strength of the current and the number of line-haulers on the boat, from 1 to 16 sets of the gear are paid out over rollers on the side of the boat and lowered to the bottom. When currents are weak, the ship can pull only a few sets of gear. The line-haulers (Figure 5), fastened amidships, can pull up to 8 lines each. Normally each line is tended by one man.

Ship power is never used to dredge for coral, because when a ship is moving under power, the gear must be paid out from the stern--meaning that fewer lines can be cast (smaller area), rougher working conditions are encountered (more pitch), and more expense is involved (fuel). Some fishermen who have tried dredging under power complain further that the gear does not effectively drag the bottom, but rather misses vertical faces of outcrops where the coral is thought to grow most abundantly.

Dredging is generally done upslope; however, currents sometimes vary so this procedure is not strictly followed. A ratio of 1.2 to 1.5 between rope out and water depth is maintained; as the boats drift upslope, rope is constantly taken in. The gear is usually dragged on the bottom for 20 to 60 minutes. When it is hauled on board, the nets are replaced and quickly lowered back to the bottom, so that dredging is nearly continuous. Precious coral and associated fauna are picked from the fouled nets by hand. Gear hang-ups on the bottom are common. On very rough bottoms, some gear is lost on as many as 50% of the hauls. For this reason at least twice as much gear as would be used, assuming no loss, is taken aboard.

In the past, ships remained at sea no more than a few weeks. Now local supplies are nearly exhausted, so ships must travel hundreds of miles to reach coral grounds--often spending up to 6 months at sea. Accordingly, larger and fewer boats are being built. Ships operating in the Midway area average 100 tons; older ships, operated locally, average 10 to 40 tons. The larger vessels carry a crew of about 16 to 20 men. About 400 stones and 2000 nets are taken aboard on long trips. The fishing season varies with the location of the fishing grounds. In general, spring and summer months are favored. Near Japan, Okinawa, and Taiwan, typhoons and winter storms limit fall and winter fishing.

## FISHING GROUNDS

The fishing grounds in Japan consist primarily of banks and insular slopes of islands of two major island archipelagos--one between Taiwan and Japan and the other between Japan and the Bonin Islands. Some fishing has also been done on the continental slope of China near Taiwan, where presently fishing effort is centered around the Senkaku Islands. Beds that were especially rich in the past, but are now nearly exhausted, include the Peng-hu Islands near Taiwan and continental slope areas near the southern tip of Taiwan, Oza Bank near Miyako Island, the Danjo Islands near Kyushu, Japan, banks off Tosa, in Shikoku, Japan, and Smith Bank, Torishima Island, and Sofu Island located nearly centrally between Japan and the Bonin Islands.

Depths where coral of commercial value is found range between 90 and 260 m. Experienced fishermen consider that the zones of maximum abundance of the three major species are different. Shiro-sango is considered shallowest, aka-sango intermediate, and momoiro-sango deepest. On the Milwaukee Banks, commercial-grade coral is found much deeper, between 400 and 450 m, and is limited to white and pink varieties.

Relatively strong currents occur over all of the known coral grounds; however, because of the method of harvest which relies on current, it could be argued that this observation is an artifact of the collecting technique rather than an ecological requirement of these species. However, observations made from the submarine YOMIURI, off Tokyo at 100 m and Okinawa at 250 m by Dr. Motoki Eguchi (personal communication), indicate that precious corals are less abundant in areas where currents are weak. His observations also indicate that the orientation of branching is at right angles to current direction.

Several Japanese fishermen believe that substrate type also affects abundance. Because species of *Corallium* require a solid substrate for settlement, it was not surprising to hear that the best grounds are invariably located in areas relatively free of sediment. In this regard, current--in addition to providing food--may also be important in removing sediment. All four species of precious coral in the Orient occur on most solid substrates, even occasionally on objects such as whale bones. The largest catches reportedly are in areas where limestone or shell-sandstone substrates predominate. Basaltic or metamorphic rocks and hard clays on which colonies have been found are often covered by a thin encrustation of calcium carbonate, further suggesting a larval preference for this substance.





## RECENT PRODUCTION

Recent catch statistics indicate that although production is extremely variable from year to year, it is gradually declining (Table 1). As a consequence, and because demand is fairly constant, prices in general are gradually rising (Table 1). The price of precious coral is determined by three factors: color, size, and state. Because precious coral is used primarily for jewelry, its economic value depends somewhat on current demands. Recently (1970) in the Orient, color grades are ranked as follows: pink or whitish-pink (angel-skin), first; red, second; and white, third. The values of intermediate shades fall between primary color categories. Size as measured by branch diameter is sorted into classes of 5-mm increments, the largest being the most valuable. "State" refers to the living condition of the colony, ranging from live standing colonies to those which have fallen to the bottom and are in various degrees of decomposition brought about primarily by the boring activity of polychaete worms. Listed in order of decreasing value, states are described as: (1) live standing, (2) dead standing, (3) first fallen, and (4) second fallen.

Currently the wholesale prices at the Japanese auctions for primary color grades of raw coral of premium size and state are: about \$300/lb for angel-skin, \$150/lb for red, and \$50/lb for white coral. Average values of coral, however, have generally remained below \$100/lb. Because the nets are nonselective, a typical haul generally contains coral of variable quality. Often, in fact, a large fraction of poor-quality coral with no commercial value is collected.

Dredging coral in Japan has always been a financially unpredictable business. For example, in the years 1900, 1901, and 1902 only one in five of the boats fishing for coral made a profit (Kitahara, 1904). Even though operating costs are not great, considerable experience is required before currents can be used to dredge effectively. Luck is also a factor. Two boats operating side-by-side rarely catch the same amount of coral--suggesting that distribution is very patchy. Because catch is difficult to predict and because large colonies often valued at over \$1000 are occasionally found, apparently there is sufficient incentive to keep many fishermen operating in spite of losses. Of course, when new grounds are discovered profits for individual fishermen are very high. Records of the Ryukuan Precious Coral Industry in Okinawa show that in 1963 during the "coral rush" in this area, gross sales per boat of over \$50,000 for 6 months of fishing were not uncommon. Similar profits were made by Japanese fishermen operating on the Milwaukee Banks in the late sixties. Because there have been no new beds discovered recently, profits at the present time are unpredictable and therefore, fewer boats are operating.

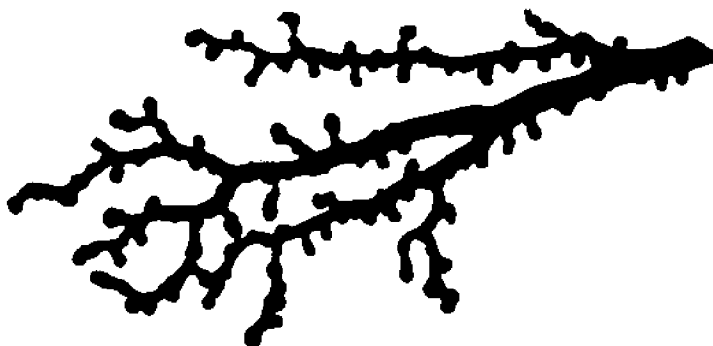


TABLE 1. SALES OF PRECIOUS CORAL IN OKINAWA AND TAIWAN.

YEAR	AMOUNT OF CORAL SOLD (kg)	TOTAL VALUE (US \$)	AVERAGE VALUE/kg (US \$)	NUMBER OF BOATS FISHING (licensed)
OKINAWA SALES				
1959	318	36,110	110.00	1
1960	11,183	470,590	42.33	70
1961	4,287	211,401	49.33	21
1962	7,699	374,845	48.66	20
1963	14,780	1,143,716	77.04	35
1964	9,202	594,637	63.77	67
1965*	4,193	199,340	42.28	65
1966	2,133	208,099	73.40	27
1967	2,162	69,704	93.00	31
1968	1,247	---	---	7
1969	940	---	---	6
TAIWAN SALES				
1967	3,600	198,000	55.00	12
1968	10,800	410,400	38.00	30
1969	30,000	1,440,000	48.00	140
1970				
(1-6)	8,000	496,000	62.00	100
(7-12)	---	---	110.00	60

\*Primarily Midway coral.

- Figure 3. Naturally occurring oblong stones, wrapped with heavy wire, provide attachment sites for the nets and hauling line.
- Figure 4. Modern "coral stones" are made by pouring concrete into molds. Embedded rings act as attachment sites for the nets and hauling lines.
- Figure 5. Line haulers equipped with 2 grooved drums are used to control up to 8 lines at once. One line can be pulled in each groove.
- Figure 6. Coral was cut originally with taut wire bows. In modern times diamond saws are used.
- Figure 7. Grinding wheels are used for detail carving.
- Figure 8. Polishing of intricately carved pieces is accomplished by dipping them in a hot solution of water, hydrogen peroxide, and acid.

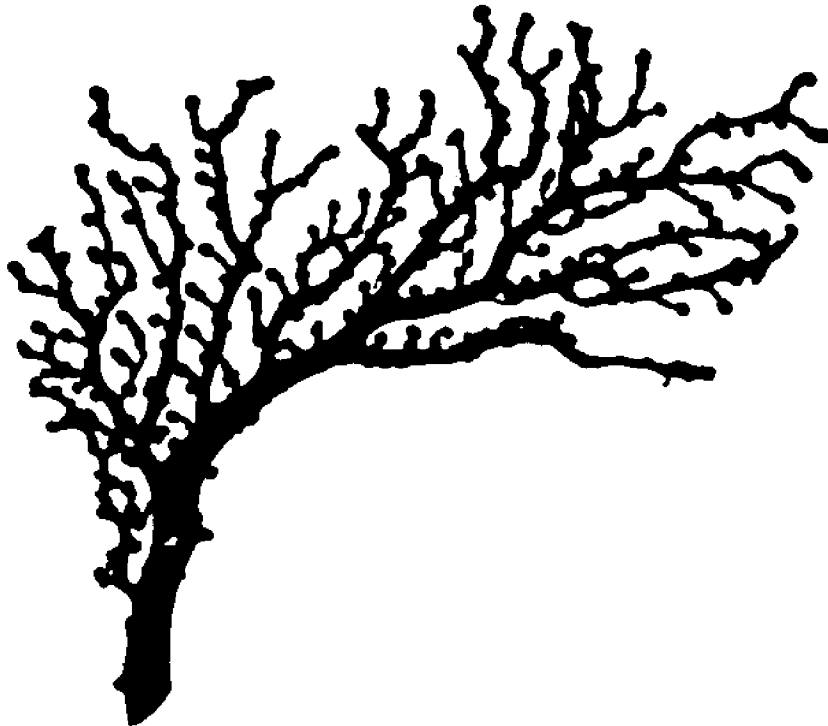




Figure 3



Figure 4

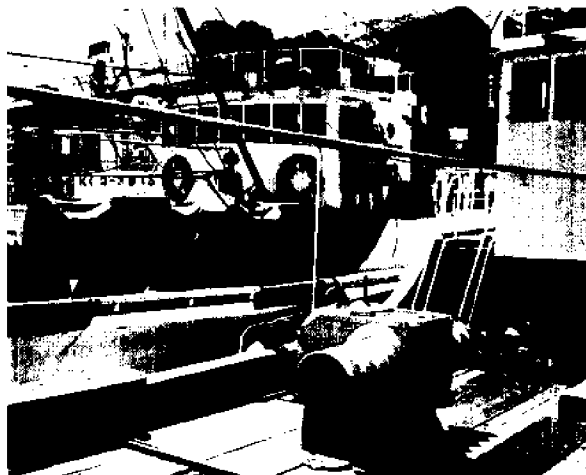


Figure 5



Figure 6



Figure 7

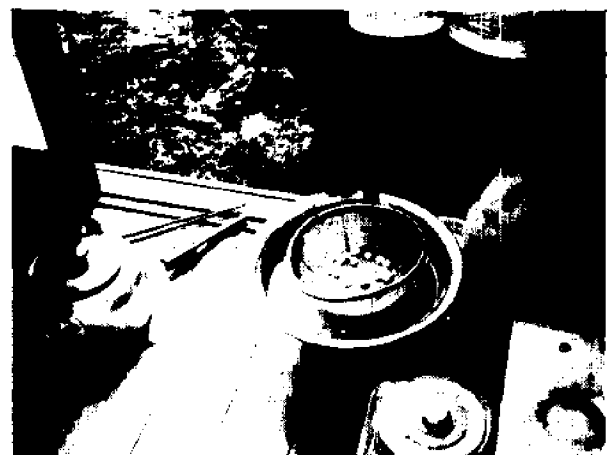


Figure 8



## CORAL PREFABRICATION

For the most part, common lapidary techniques are used to cut, grind, and polish the raw coral (Figures 6 and 7). However, one process which appears to be unique to this industry deserves mention. After grinding or carving has been completed, individual pieces are soaked for about 2 minutes in a hot (90°C) solution of water, hydrogen peroxide, and muriatic acid mixed in the proportions 60:38:2 (Figure 8). When the coral is removed from this bath, it requires only light buffing to attain a high-gloss finish.

## ECONOMIC OUTLOOK

Over-exploitation appears to be the cause of the gradual decline in production. The few efforts to regulate the fishery have failed because of an inability to enforce restrictions. In Okinawa and Japan the governments have attempted to license boat operators; however, landings are not monitored and a considerable amount of stockpiling does occur.

Estimates indicate growth rate is extremely slow. Records of the Fishery Agency in Kochi (provided by Dr. Yogi Kurata at the Fisheries Resource Experimental Station in Tokyo) indicated a rate of about 0.5 cm/yr increase in height, based on actual measurements of individual colonies over a period of 47 years. Observations of fishermen, which suggest that about 50 years are required before an exhausted bed is again productive, are consistent with this estimate. Because of the apparent slow growth rate, future supply will probably depend on the discovery of new grounds. As supply diminishes, prices will probably gradually increase as the present trends already indicate. In anticipation of this market trend, fishermen who can afford to do so are now stockpiling their coral.

As the history of the fisheries has demonstrated, future supply will probably continue to fluctuate, as will prices of raw coral. However, much of the Pacific remains to be explored; therefore it is not unreasonable to expect discovery of many new coral grounds. Mr. Homei Ozawa, managing director of the All Nippon Coral Fishery Union, estimates that the present world market for raw coral is \$5 - \$10 million. Assuming demand does not change markedly, the future of the precious coral industry should continue to be bright. It is likely, however, that large profits will be limited to those vessels engaged in exploration which are capable of remaining at sea for long periods of time.



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