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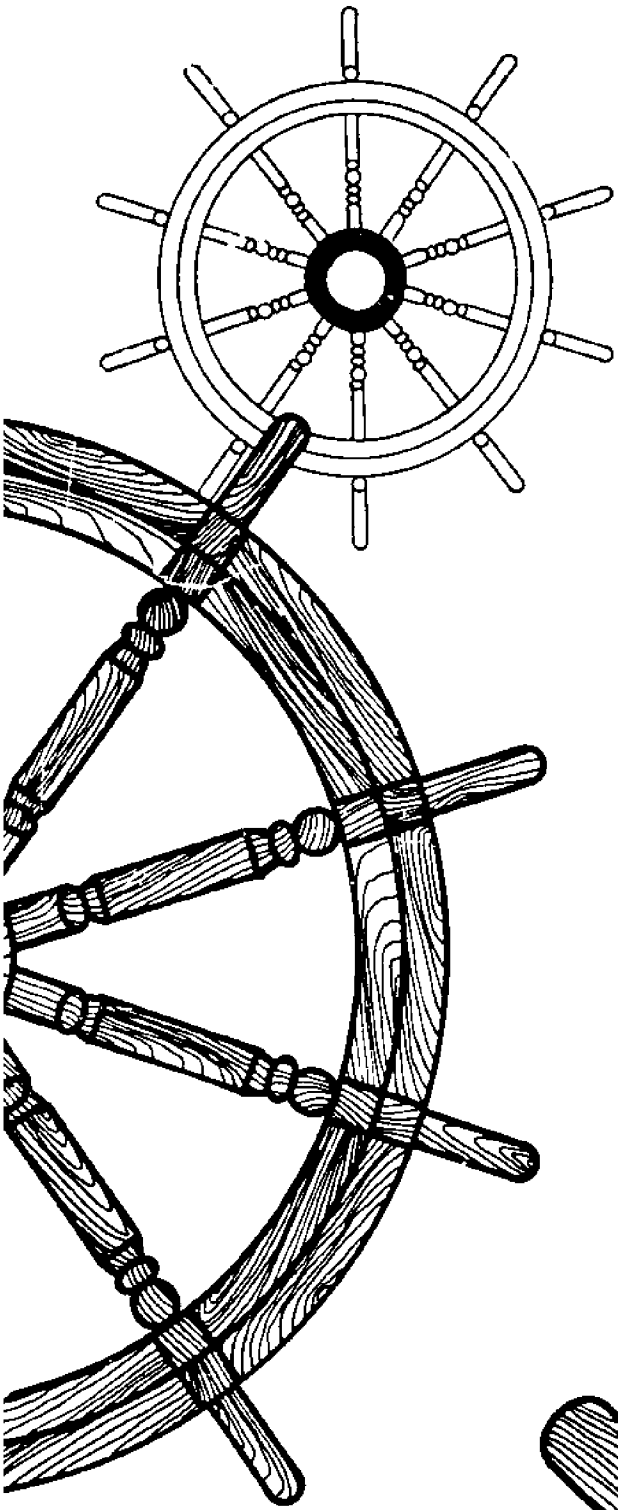

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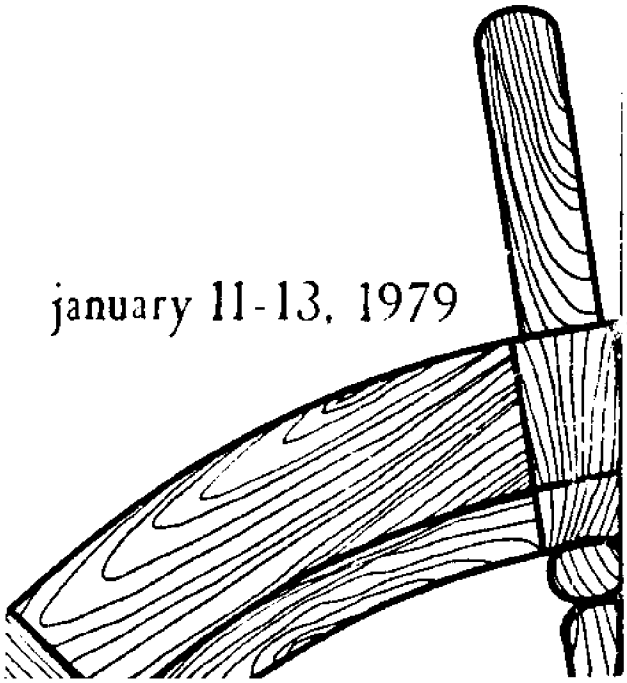

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This volume of the proceedings of the Fourth Annual Student Symposium on Marine Affairs, held on January 11-13, 1979, at the University of Hawaii Manoa campus, contains thirty-four papers prepared by High School students in ten categories: marine transportation and energy, the mining of manganese nodules, marine pollution, aquaculture, ocean engineering, food from the sea, coastal recreation - marinas and preserves, marine biology 1, marine biology 2, and dangers of the sea. (Author extracted)

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Sea Grant Miscellaneous Report
UNIHI-SEAGRANT-MR-79-02

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PREFACE

This volume of the proceedings of the Fourth Annual Student Symposium on Marine Affairs, which will be held on January 11-13, 1979, at the University of Hawaii Manoa campus, contains thirty-four papers in ten categories: marine transportation and energy, the mining of manganese nodules, marine pollution, aquaculture, ocean engineering, food from the sea, coastal recreation: marinas and preserves, marine biology I, marine biology II, and dangers of the sea.

We have not attempted to edit the papers but wish instead to give credit where credit is due, to the forty students and their teachers:

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Rose Pfund, Coordinator
Student Symposium on Marine Affairs

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MARINE TRANSPORTATION & ENERGY

SEAFLITE: WAVE OF THE PAST

by Margaret J. Loggins, Sacred Hearts Academy

ABSTRACT

Seaflite was a form of marine transportation which operated in Hawaii for about two years. Mechanical problems and lack of public response contributed to its failure. In my report, I bring forth some of the incidents which led to its eventual sale. Though Seaflite failed, I still believe that marine transportation is a good, possible alternate to other forms of transportation.

INTRODUCTION

SeaFlite was a form of marine transportation which operated in Hawaii for about two years. Mechanical problems and lack of public response contributed to its failure. In my report, I will bring forth some of the incidents which led to its eventual sale. I am interested in marine transportation as an alternate to other forms of transportation. It is for this reason that I researched the plight of SeaFlite.

SEAFLITE OPERATIONS

On June 23, 1975, in an article in the Honolulu Advertiser, spokesman Bill Henderson said a part that works the steering mechanism broke down and no replacement was available. The "Kamehameha," which suffered the breakdown, was the first hydrofoil in commercial use in the United States. Many more problems were to follow this one. Just one month later on July 5, 1975, the "Kamehameha" was out of commission again. A faulty bearing in the gear box was blamed this time. This was the third breakdown since operation began on June 15, 1975. At this time it is already obvious that something will have to be done if operations will continue.

The "Kuhio" became the next hydrofoil to encounter trouble. On November 25, 1975, it was reported as having trouble with its diesel electrical generator. The "Kuhio" was operating at a 14-knot clip with its hull in the water instead of the usual 42-knots on the hydrofoils. The "Kalakaua" was the last of the hydrofoils to experience misfortune. It had trouble with a bearing that affected water jet propulsion. The "Kamehameha" again ran into trouble. This time it was forced to return to harbor shortly after departure.

After only five months of operation, SeaFlite had encountered enough trouble to force suspension of services. Pacific Sea Transportation, Ltd., which operated SeaFlite refused to give up and tried to resolve all problems. In a January 8, 1976, article in the Honolulu Star-Bulletin, it was stated by P.S.T.L. that gear-box modifications were being made. Besides this problem, seals, bearings, and corrosion caused by salt water were the major causes of the breakdowns. One positive thing which happened during this time was the 7,000 people who joined the SeaFlite club which offered a 15% discount from regular fares. Still, the load of passengers was considerably low to bring in much profit.

On July 9, 1976, the modified jetfoils were reported as being back in service and doing well. Major changes were made to the gear-box. SeaFlite officials were optimistic during this period that Boeing, the company which made SeaFlite, could soon sell their product to others in the world.

But conditions did not improve and on September 16, 1977, LTV Corporation, the big Dallas-based conglomerate, decided to sell its SeaFlite operations in Hawaii. SeaFlite was continuously in the red since its mid-1975 beginning. The mechanical difficulties prevented SeaFlite from reaching break-even operations.

By December 29, 1977, it was thought that SeaFlite would be sold within the next month. Even while negotiations were being made for its sale, SeaFlite was still experiencing trouble. The "Kalakaua" was undergoing repairs for damage from an engine room fire. Also, only 270,000 passengers instead of the expected 350,000 used SeaFlite.

The Public Utilities Commission (PUC) held hearings in January of 1978 on the sale of SeaFlite. Early in 1978 SeaFlite was finally sold. Public interest was affected by the sale.

Many people rode SeaFlite just to experience it. After that, they went back to using air travel. There were not enough people to use it on a regular basis to receive any profit. The mechanical problems were a major cause for its sale.

CONCLUSION

I think it is still a possibility for the future. Many problems have to be ironed out first; but after this is done, it can become a profitable, resourceful business and a good alternative to air transportation.

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OCEAN THERMAL ENERGY CONVERSION

by Janice Dang, Sacred Hearts Academy

ABSTRACT

The content of this paper includes what the process of OTEC is, how Hawaii is involved in this process, its effect on the environment such as the fishes and plants in the ocean, and also Hawaii's advantages if a plant is built in Hawaii.

As the world is looking for alternate resource energies, OTEC plants could be what we want.

INTRODUCTION

An alternate source of energy is Ocean Thermal Energy Conversion (OTEC). This name was given by the National Science Foundation and the Research Applied to National Needs (NSF/RANN). In OTEC plants there is a 40° temperature difference between the warm surface and cold deep ocean water, which acts as the fuel source. The temperature difference causes a rankin cycle to generate electricity at a depth of 2000-3000 feet.

In the search for an experimental plant, Hawaii seems to have the advantage. For one thing, Hawaii is the only geographically isolated area with the structures, features and problems of modern western societies available within the United States. Also, Hawaii appears to have the most attractive water and climate conditions closest to the shore and a scientific community already involved. Although Hawaii is probably the best place to build a plant, many problems are being faced. Another question that needs to be discussed would be, how will Hawaii be affected?

OCEAN THERMAL ENERGY CONVERSION

Ocean thermal energy is a form of solar energy in which the fuel source are ocean gradients used in rankine cycles to generate electricity. It requires large quantities of cold waters of 2000 to 3000 feet deep. The end use of the energy is changed into electric power. It could also be used for marine harvest or to produce hydrogen gas for water. The resulting fuel is free; however, the efficiency of a system is extremely low due to the small temperature difference. The capital cost would be $3000 to $4000/KW.

The Process of OTEC

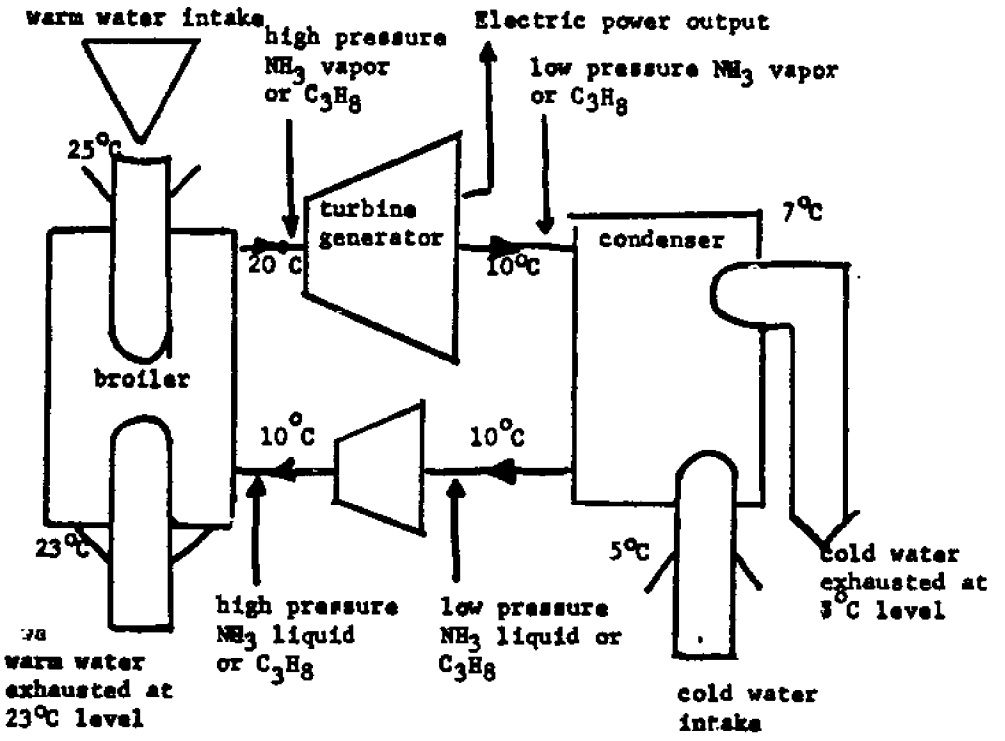
Ocean thermal energy is nothing more than a form of a heat power plant. Basically, it deals with a fluid which is called a process fluid that goes around in a circle. It is a fluid which can be evaporated. It is done in an evaporator where a burner produces some form of heat and raises the temperature of this fluid, causing the fluid to change to a gas or to a vapor state.

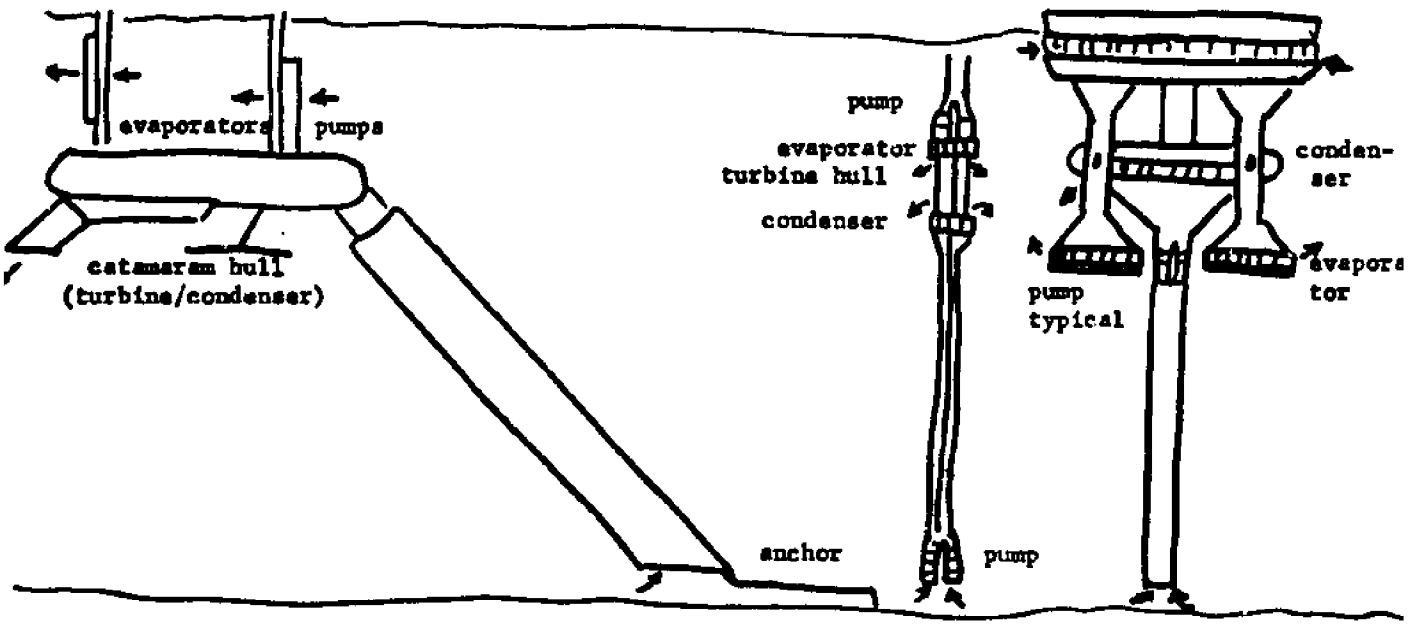
In Ocean Thermal Energy there are two concepts: the open cycle concept and the closed cycle concept.

In the open cycle, the warm surface water of the ocean is the heat source and the cool deep water of the ocean is used for heat rejection. Unlike the closed cycle, the ocean water itself is the working medium.[1] The warm surface water is pumped into a flash evaporator which depends on the maintenance of a partial vacuum for efficient operation. The vaporized water drives a turbine Then it drives a generator that produces electric power. After going through the turbine, the steam is condensed by the colder ocean water. This water, with the condensed steam, is returned back to the ocean.

In the closed cycle, the principal difference is that heat exchanges are an integral part of the closed system. That is, a working fluid other than ocean water is being used and this fluid is constantly being recirculated. The warm

Schematic Diagram of Closed Rankine Cycle for
Ocean Thermal Energy Conversion Power Plant





Concept A - University of Massachusetts (Grant NSF/RANN/SE/GE-34979) Heronemus et al.

Concept B - Carnegie-Mellon University (Grant NSF/RANN/SE/GI-349114) Zener et al.

Concept C - Anderson and Anderson

Three OTEC System Concept Configurations

surface water enters the plant and is pumped through a heat exchanger evaporator and expelled to the ocean. The working fluid is vaporized within the heat exchanger from the heat of the surface water. Then it drives a turbine, which is coupled to a conventional electric generator. The fluid that has vaporized then enters the heat exchanger condenser. It is cooled to a liquid state by the deep, cold water. It returns to the heat exchanger evaporator for recirculation.

The closed cycle has practical efficiencies on the order of 2%. This is dismally low when compared with the 35 to 40 percent practical efficiencies of conventional steam turbine plants today.[2] There is a great difference in engineering economics between CTEC plants and the conventional plants. Conventional plants must optimize capital, operating and fuel costs, whereas OTEC plants have no fuel cost and a practically inexhaustible fuel source. Although OTEC plants are theoretically feasible, OTEC's technical and economically feasibility is still under questioning. That is, an OTEC plant of low practical efficiency might be feasible if its capital and operating cost can be kept low enough.

OTEC in Hawaii

In Hawaii, the University of Hawaii recently received a grant of $50,000 from the National Science Foundation for research on the socio-enomic, enviromental and engineering feasibility of a site on the Island of Hawaii at Ke-ahole Bay, near Ke-ahole Airport, for an ocean thermal energy conversion facility.[3]

Ke-ahole Bay in Hawaii is a fine area to carry an OTEC facility. As a test site, it fits the requirements. There are deep cold waters near land, the temperature differences with the warm surface water are 40° to 45°F and Ke-ahole Bay is a strong technological support base.

Advantages

The experimental program in Hawaii, if there is a possibility, would offer a great chance of success. There are several reasons why: (1) because Hawaii is

not exposed to hurricanes that would damage the test platform as in the Gulf of Florida; (2) Hawaii also has a sufficient ocean water temperature difference all year round, therefore making research all year long possible; (3) the temperature difference exist all year round and so power can be sold on an economic basis to the local utility company; (4) Hawaii has been well researched and and documented; and (5) the water quality in Hawaii is the best available.

Another reason Hawaii would offer great success is that the cost would be the least in Hawaii. A project in Hawaii would require a shorter cold waterpipe. Since Hawaii is an island, colder water can be obtained closer to shore that other sites located near a continent. Also, because Hawaii is not exposed to hurricanes, it would be possible to design a simpler test platform for OTEC I. Not only that, engineering costs in Hawaii are cheaper than the U.S. engineering costs in the mainland.

If an experimental plant is constructured in Hawaii, Hawaii can make use of the power generated at an earlier stage in the program development because the site in Hawaii is relatively close to the shore and the economic and engineering problems in running a cable to shore and feeding power into the utility grid are simpler. Also the existence of the year round thermal resource will permit the early use of power from OTEC to replace shore based generating capacity in Hawaii.

In Hawaii economic cost of operating an OTEC plant would be least because of its year round water temperature difference. This will also reduce dependency on foreign oil with constant generating electricity. This chance would give and create employment opportunities.

Envirgmental Consideration

There are two accounts we must take in consideration with the enviroment when applying the OTEC process. Since OTEC will involve massive amounts of water, two major concerns are (1) its effect upon the oceanic thermal balance and (2) the large quantities of nutrient rich cool water that are brought into the realms of

tropical oceans.

In the deep-ocean "waste water which is rich in plant nutrients must be disposed of in the best possible way." Requiring skillful engineering and advance research, four alternatives have been taken into consideration:

1.) The nutrient rich water be returned to the ocean in such a way that evident biostimulation is avoided,

2.) The nutrient rich water be returned to the ocean to produce uncontrolled, but enviromentally acceptable biostimulation,

3.) Controlled biological filtration of the deep water nutrients that is prior to discharge into the ocean surface,

4.) Utilize the deep water nutrients for aquaculture, agriculture or other uses.[5]

Problems To Be Solved

OTECis now one of a number of important alternative energy concepts being developed by the U.S. Department of Energy (DOE). They study the problems that must be solved before ITEC can supply part of our energy. An obvious problem is the corrosion of metal components in salt water. Biofouling of heat exchangers and other equipment by marine organisms is another problem.

Before constructing an OTEC plant, the construction of huge boilers, pipes and other parts, as well as their assembly at sea, will require new techniques. A question being brought up is the stability of giant OTEC plants in heavy seas as in the feasibility of laying and maintaining long undersea transmission lines. Another question concerns the long range effect of removing heat from the ocean. Still other questions are those thaat concern the threats on the enviroment such as ammonia leaking into the sea, causing corroding of metal parts as well as danger to marine life.

Although OTEC scientists generally feel that as heat is withdrawn, the ocean water will retain additional solar heat to maintain its temperature; DOE must

be sure there are no adverse effects such as a change in ocean temperature or even harmful local changes.[6]

CONCLUSION

The OTEC process as an alternate energy in Hawaii has been discussed; however, engineering problems, economic feasibilities and enviromental implications makes building difficult to upkeep after construction as well as during construction.

If an experimental plant is built, it would have much success as becoming an energy exporter providing a 24-hour-a-day yeararound power source. It would also be a way of gaining energy without pollution to the waters.

One recommendation which has been brought up has been the organizing of a small team of businessmen, statesmen, professionals, and academicians as a function of the Hawaii Natural Energy Institute. This team would be funded by local contributions and would receive enthusiastic encouragement and support from Hawaii's senior statesmen and scientific committees.

FOOTNOTES

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ACID POWER: OUR NEXT NEW SOURCE OF ENERGY

by Santiago Angelo and Mark McGough, Honokaa High School

INTRODUCTION

Alternative resources for Hawaii is an area which has drawn much attention during the past few years. As oil is fast running out as the prime source of potential energy, man has to rely on other means of tapping the earth's huge amount of both potential and kinetic enery. The largest of the potential energies are of the sun's. Yet we have the oceans here on earth, which is the greatest resource on our planet. Here is found a great deal of potential energies, one of which will be discussed here. But the problem is to find one which would suit Hawaii's needs. One which one day may render us oil free to light our homes.

Many problems will be encountered in applying this idea. Yet, Thomas Jefferson did not quit until he found the right filament for his light bulb even after many failures.

Alternate sources of energy to meet our needs from the ocean does not seem probable in the immediate future. However, some resources are worth investigating on a long range basis as alternate means. One of these is the use of nitric acid, water, and sea water upon which this paper will propose.

NITRIC ACID/SEA WATER HEAT PRODUCTION

Not too long ago we came across an idea which facinated us. It was an idea with imagination and it also included some factual data. It came out not too long ago in the September, 1976, issue of Mechanix Illustrated magazine. The idea was one which involved nitric acid(HNO3), water(H2O), and sea water. The problem was to provide a steady source of heat which might have an industrial use.

This is what the article said:

Acid Power

A new way to extract energy from the ocean has been proposed by engineers at Yokohama National Univ. Their method involves adding nitric acid to water, which raises the solution's temperature 68 degrees F. The heat would then be drawn off. The nitric acid would be reconcentrated by warm sea water and mixed again for yet another heat boost. Repeating the cycle would produce a steady flow of low-level heat. Several secups in tandem could add heat until 212 degrees F would be reached, thereby providing steam for a turbine.

Now that the idea has been presented to you, let's look at the involving factors associated with chemistry.

What is nitric acid?

Nitric acid is a strong mineral acid which is colorless in it's pure form. It has a density of 1.52. It freezes at -47 degrees C and boils at about 63 degrees C. How it is made is not important

at this point, but it can be said that it is a very expensive material to use for industrial purposes. Nitric acid also decomposes in water.

How about water and sea water?

The factors affecting thereof are very important. Boiling points and density for example have a very large role in this idea.

Water has a freezing point of zero degrees C and boils at 100 degrees C. It has a density of 1.

Sea water is an aqueous solution of salts of constant composicion of elements. The basic properties of sea water, such as density, specific volume, compressiblity, viscosity, sound velocity, surface tention, and others depend on temperature, salinity, and pressure.

Also, the basic properties of pure water are remarkably changed by it's salt content. Factors such as the colligative properties (osmotic pressure, lowering of the freezing point, raising of the boiling point, lowering of vapor pressure) depend only on the number of molecules in the solution.
And as the composition of salts of sea water is nearly constant, the colligative properties depend only on the ratio of dissolved salts to solvent(pure water).

The density of sea water varies as to temperature, pressure and salinity. But we can can assume it to be in a range of $1.022 \leq x \leq 1.027$. The density that we will use as a base is 1.024, as a round figure.

APPLICATION

Using the information given: How to use it to create some sort of workable energy? For instance to run a generator to create electricity.

Essentially speaking, the following is what we think can be done.

A mixing chamber for both water and nitric acid is needed. In this chamber water would be added and nitric acid would be injected. The inside pressure would have to be greater than normal to keep both water and acid from turning into gas. A pressure of about 250 pounds per square inch would be sufficient. The solution would then be mechanically mixed. Thereafter the temperature would rise about 60 somewhat degrees F. (We cannot assume the full temperature change as few systems are not 100% efficient) The solution would then be pumped into a heat exchanging unit as figure 1 shows.

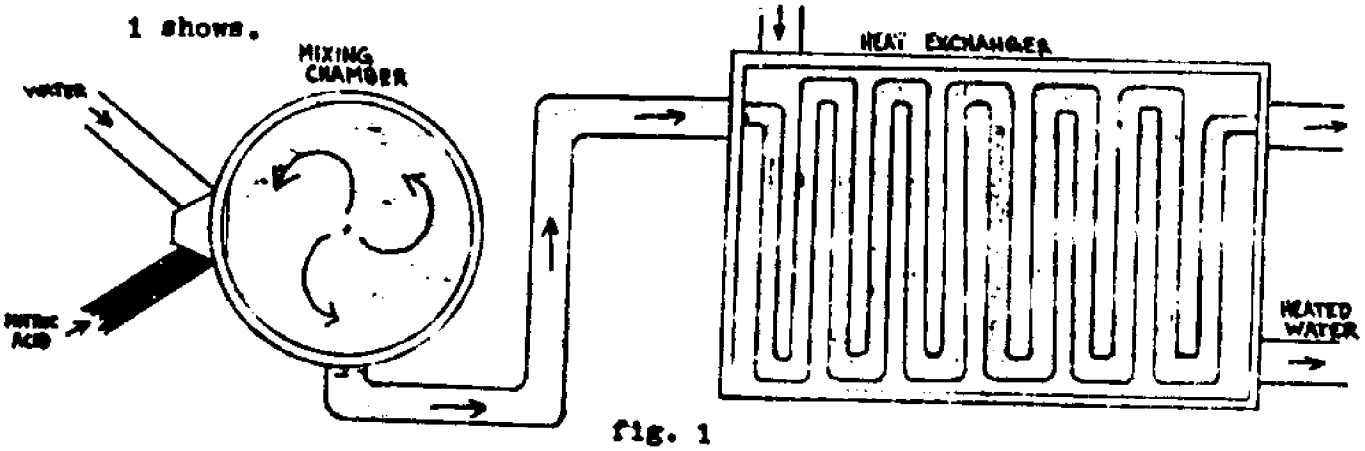

fig. 1

Thereafter going into a separation unit where warm sea water would be added to reconcentrate the nitric acid. Since there is a difference of density, the nitric acid being 1.52 and the water/sea water mixture at $1.024 \leq x \leq 1$, the nitric acid will readily sink

to the bottom of this chamber.

In this separation chamber it would then be just a process of draining the nitric acid out first and the water/sea water mixture out second.

The nitric acid would have to go through a cooling unit first, because of its very low boiling point, then it would go to a holding chamber for injecting once more. This is shown in figure 2.

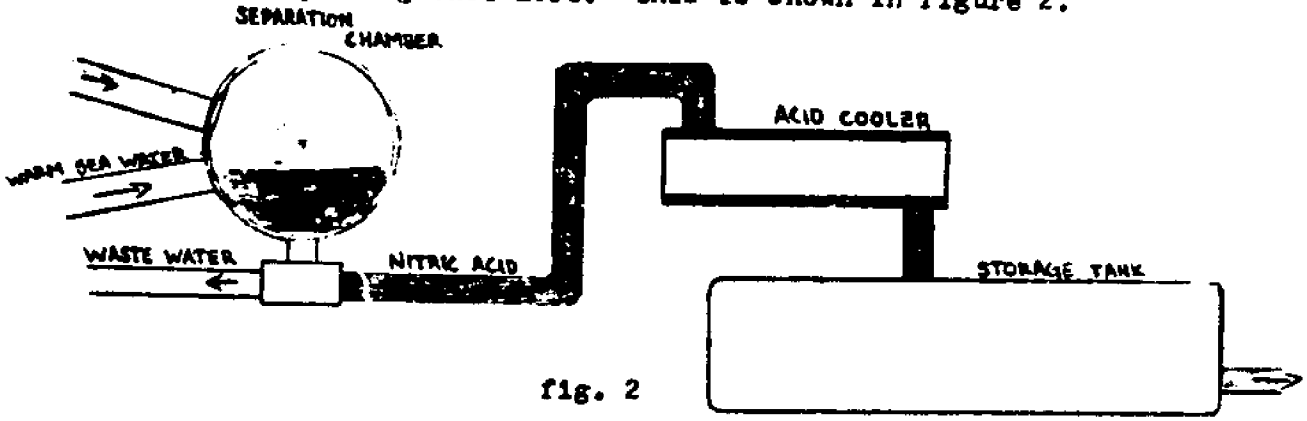

fig. 2

The water from the heat exchanger would then be pumped into another mixing chamber where the process would be done again and again until the minumum 300 degrees F, needed for industrial use, wouldbe obtained.

At this point the water from the heat exchanger would be transferred to a "boiler feed water" by a pump of sufficient pressure to keep the pressure in the boiler at a preset pressure.

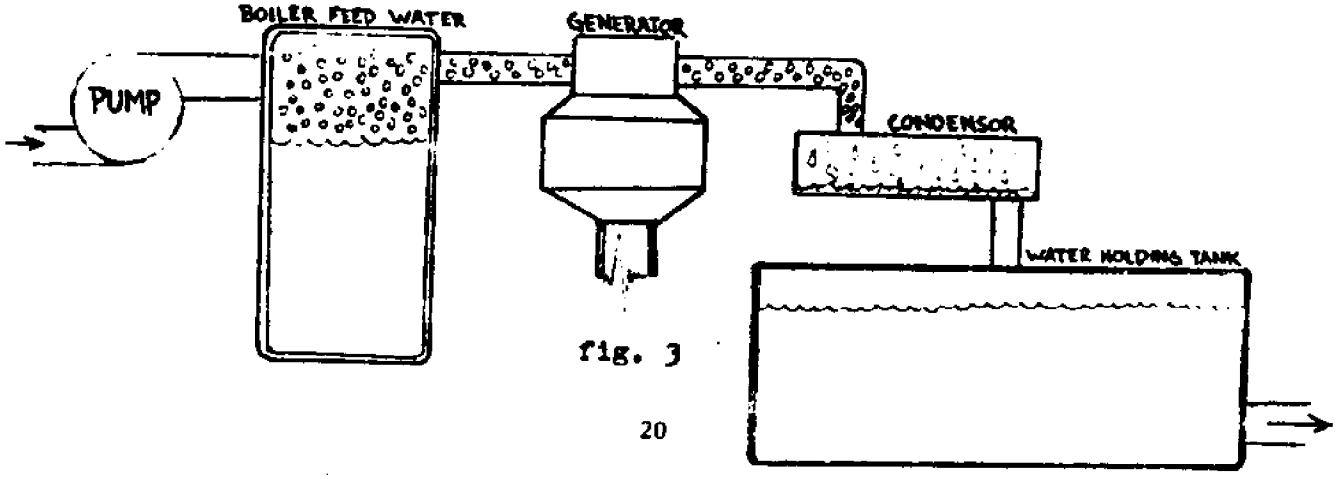

fig. 3

The boiler would provide the steam to run the turbine to produce electricity. The steam would then proceed to a condenser where it would be condensed to saturation point and therefore used again. This is shown in figure 3.

SUMMARY

To provide enough water for the boiler, it may take several of these systems. Also the deterioration factor is very high. Nitric acid will dissolve almost anything, including steel and copper piping. Unless lined with glass, gold, or some other metal which resists this acid, it will not be practable to use this system. Nitric acid does decompose in water. How the warm sea water recomposes and reconcentrates the acid, we could not find out in time before the deadline for this paper. Again we say it is very expensive now. Yet this idea may prove to work out in another way in the future some day. For this reason we cannot deem this an idea that is improbable, but one we must wait for.

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THE MINING OF MANGANESE NODULES

MANGANESE NODULES

by Alice Jean Motooka, Hana High School

INTRODUCTION

For hundreds of years the ocean has been a great resource to our nation. The ocean has been dissolving minerals from the solid rocks of the land and sea floor. Animals and plants have been dying and falling to the bottom of the sea floor for hundreds of millions of years and have produced deposits of mineralized sediment hundreds of feet thick. These organic remains have produced sources of natural gas and oil.

All the mineral resources of the world are available somewhere beneath the ocean floor. Great amounts of manganese nodules that are walnut sized pieces of ore are scattered over the ocean floor may someday become the world's economic sources of nickel, cobalt and copper.

RESULTS OF RESEARCH

In 1870, a British oceanographic vessel, the CHALLENGER, dredged to the ocean bottom and discovered lumps of minerals that resembled blackened potatoes. Those nodules were later proven to be rich in manganese, copper, cobalt, nickel and iron.

Recently, during the International Geophysical Year, great quantities of nodules were rediscovered on the ocean floor. These nodules grow in layers like onions and have taken millions of years to form. The majority recovered have ranged in size from a few inches in diameter to two cubic feet. However, it has been reported to weigh up to almost a ton. The rate of growth is approximately 1mm in a thousand years. There are so many nodules multiplying continuously that they could supply our major needs and growth rate for many years.

Approximately 1,000 miles south of Hawaii lies a rich deposit of nodules. Several consortiums of U.S. businesses are discussing the mining of these nodules in the near future.

In the processing of mining these little stones the U.S. companies are willing to take on an incredible expense simply because of the rich concentration of precious metals they contain. Manganese makes up more than a quarter of the nodules, but they are not normally mined for manganese. Rather, they are mined for nickel and cobalt, which constitutes only about two per cent of the nodules.

Hawaii is the closest location to the rich nodules beds and many have assumed that Hawaii is the best choice, at least for primary processing.

There are a lot of problems to consider: Number one, the processing requires huge amounts of energy. On the Big Island, off shore thermal energy conversion and geothermal energy are being considered but at the present time these are far from completion. Without such new sources of energy, petroleum would have to provide the needed power.

"A major environmental problem is that 97 per cent of the manganese nodules is waste product, meaning 97 per cent of the material brought to Hawaii would have to be disposed of, either on land or by dumping it into the already overabused ocean cesspool." (Gaffney-4)

It has been estimated that nodules mining and processing may produce revenues of $277 million dollars/year, equal to the present income from Hawaii's sugar industry. However, we must also consider, will the 1,200 jobs be available for the people of Hawaii or only the outsiders with highly technical training?

The environmental consequences of nodule processing must be accurately determined before such major industry will take place in Hawaii. It will surely generate vast amounts of waste products producing air and water pollution. Dumping large amounts of metals and acids in the ocean waters may create turbidity and less light can penetrate, thus interfering with phytoplankton life processes.

Little knowledge is available about the inter-relationships of life in the deep ocean floor. In addition to the possible air and land pollution, nodules are found at the deep ocean bottom. Just mining may create a problem, too. The food chain related to up-welling may be affected causing damage to the fishery.

After all the work is done in Hawaii, the products will be shipped to other areas of the country which have a better developed technology. These metals are not used in Hawaiian industry.

CONCLUSION

By the compiling of information we must consider all the factors involved in the mining and processing of the nodules. The advantages are: more jobs will be provided in Hawaii, more MONEY coming in to our state, more metals for the U.S. instead of importing it. We must also consider the disadvantages: more people to Hawaii due to need for highly trained technical workers, pollution on land, air and ocean, turbidity on the ocean floor, the possible environmental impact of developing large energy sources.

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THE SYSTEM: A NEW LOOK AT MANGANESE

by Scott D. Snider and Chris Rafael, Pahoa High School

ABSTRACT

So far men have been exploring the possibilities of mining Manganese nodules and to date no one has come up with a pollution free method to extract nodules from the bottom of the ocean. We have really thought through the problems of mining and we have come up with new ideas. Isn't preserving the ocean for further use what Marine technology is all about?

INTRODUCTION

For decades men have been trying to harvest natural resources from the sea and now it has been found. these nodules consist of 2% nickle, 2.5% copper, .2% cobalt and 35% Manganese.

Up until now not much has been done to mine the vast resources of nodules on the bottom of the ocean. It lies there waiting for someone with a creative mind to find a way to get it off the bottom in the most pollution free manner possible.

There has not been a sysyem yet developed to effectivly mine the nodules. We have come up with a ship and a idea to get nodules off the bottom. These next few pages will show how we went about it and what we found out about the mining of Manganese.

METHODS OF REASEARCH

Since the concept of Manganese nodule mining has nto been yet fully developed the material availiable to us was limited, so we had to use the few books and phamplets we could find. These These sources, however, were enough to make this report possible. This is what we have found.

RESULTS OF RESEARCH

The conventional is not too good because it uses amodified ship and a dredger that pollutes the ocean. The conventional dredger must have a pump strong enough to pick up nodules, also sucking up nodules will take up a large deposit of sediments that are found on the ocean floor. The problem is that when the nodules Reach the ship they will be cast overboard and thus polluting the

sea.

The way plants and animal are killed is by the sediments being spread by the currents on thier way down from the ship. The sediments land on plants stop them from carrying on photosyn thesis. They kill animals like coral just by blanketing them so thick with the sediments that they can no longer function. The only way to stop the destruction is to not spread the sediments.

Is this pollution of the sea worth the Manganese? We think not. We have taken this into account when we tried to design a pollution free mining device for mining Manganese.

MNM

The first machine of our system is called the MNM, standing for Manganese Nodule miner. It will have the same basic frame as the conventional dredger[1]. The nodules will be guided onto a conveyer belt by means of a fork like projection that will funnel and rake the nodules and dump them into a metal box 15 ft. above the ocean floor. This way will the powerful suction needed for lifting the nodules to the surface will not suck the sediments up to the Ocean Miner I. The paddles on the conveyer belt will be made of grated steel so as not to take any silt to the metal box, which will also be made of grated steel.

From the box they will be sucked up through a 10" pipe which is bigger than the standard 7" pipe. This allows more nodules to bemined.

1 See page

THE SHIP

A ship has not yet been made for the sole purpose of harvesting the nodules. A couple ships, however, have done experimental tries such as the DEEPSEA MINER II and the GLOMAR EXPLORER. This is my design for a ship.

OCEAN MINER I

600 ft. long

Beam: 53 ft.

Power: 8,300 HP. deisel engine

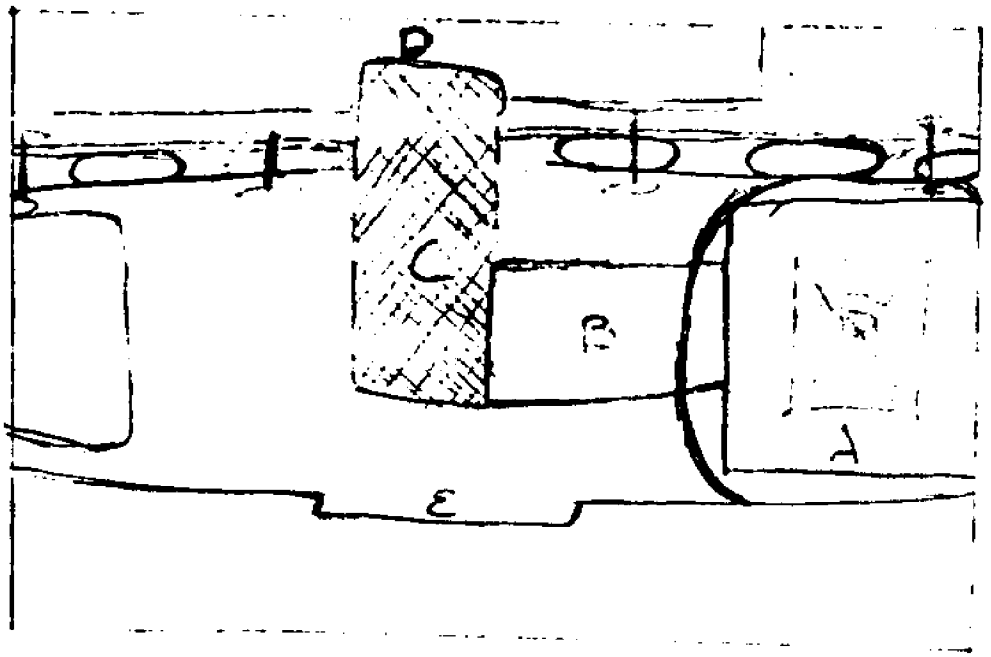
Average speed: 16 knots

In the middle of the ship there is a 75 ft. high, 55ft. diameter geodesic dome that provides weather protection for a derrick. The derrick is a gimble-mounted derrick that is 65 ft. high and can support 1.2 million pounds of dredge pipe. The dredge head will be lowered through the middle of the ship through a hole called a moon pool. The nodules will be sucked up to the ship by a hydraulic pump system.

The crews quarters are located in the fromt of the boat directly under the bridge. It has the accommodations for a crew of 43. The kitchen and the galley are also located in this section of the ship.

The rear of the ship hold the more important things. The vidio screens where the progress of the dredge head is always monitored. Underwater radar and other important things are also kept here. Recreation rooms and bathrooms will be located here too.

TOP VIEW



A-Derrick

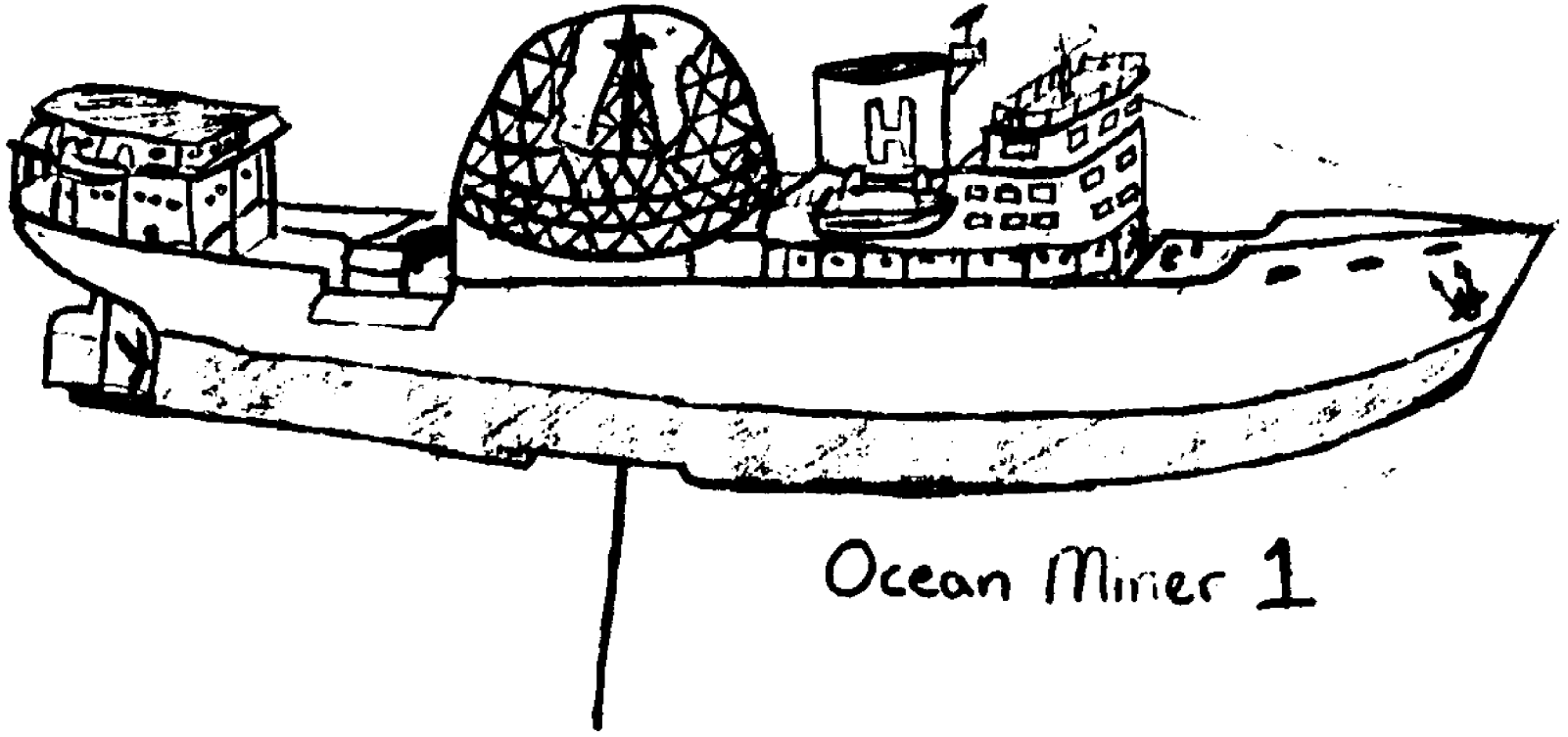
B-First shute

C-Grilled coveyer belt

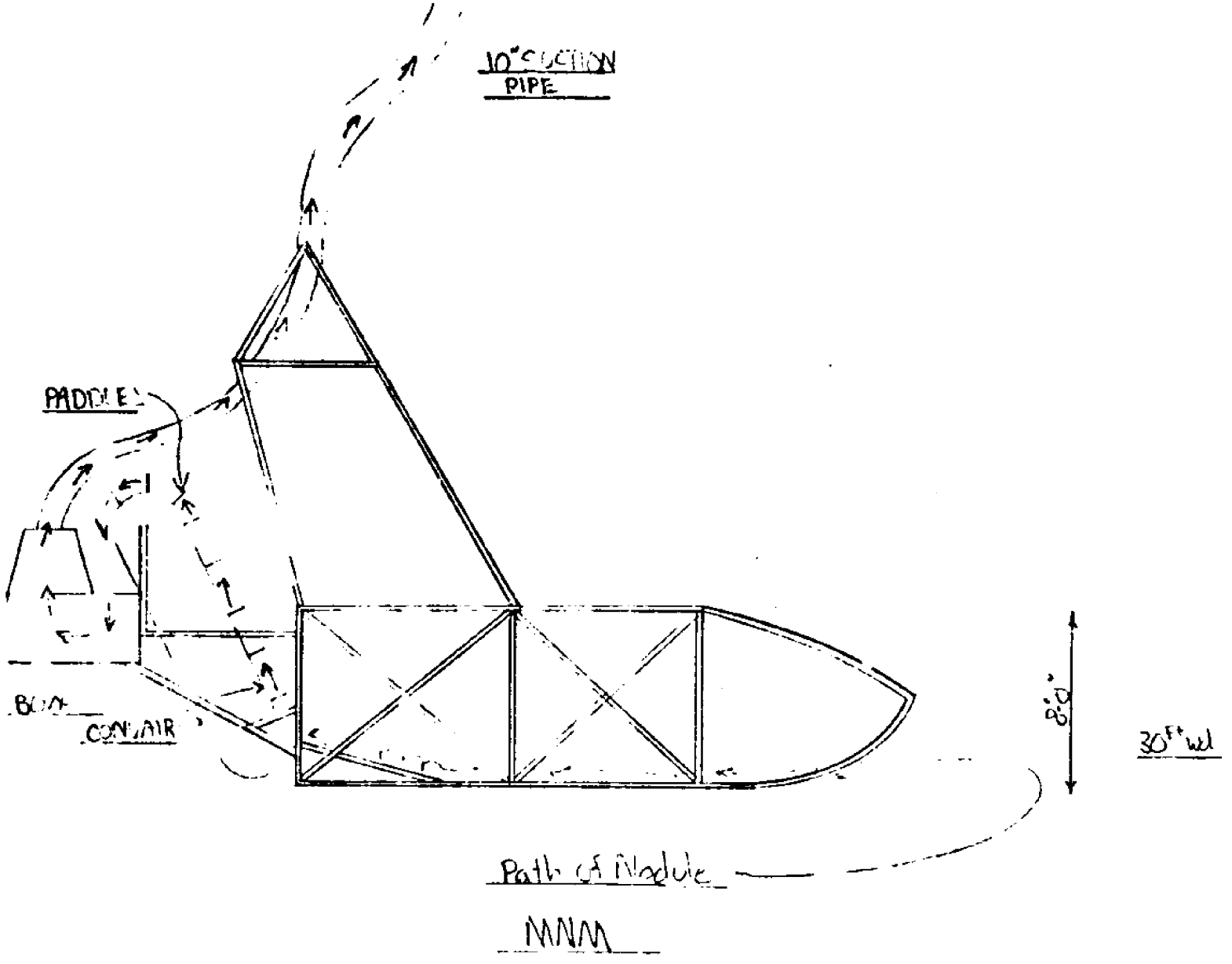
D-Bardge

E-Water Shute

Once the nodules have brought up to the ship they go through a series of channels. Since the only way to get the nodules up the suction tube is to have the tube full of water at all times. Ther must be a coventional way of getting rid of the water. When the nodules reach the top of the suction tube"A" they are sent down a shute"B"with the water. When they reach "C" a wire meshed conveyer belt all the water is drained and flows overboard via shute "E". The nodules are then carried over and dumped onto a bardge"D" for transport to the next stage, processing.



Ocean Miner 1


10" SUCTION
PIPE
PADDLES
BOAT
CONCRETE
8'-0"
30' wl
Path of Module

CONCLUSION

There is also the possibility of using the MNM with hinged sections so it could get more off underwater mounds. Maybe there could be a way to have the MNM pulled by an underwater submersible or have its own engines to propell it. Maybe the Ocean Miner I could be equiped with equipment to process the nodules on board.

The possibilities are endless but the practical use would be a goal in the mining of the nodules. I hope the system can be put to use or an idea with a similar approach so the further pollution of the ocean ca ocean can be stopped. Would you rest easy knowing that the last frontier on Earth was bieng destroyed? We dont think we could.

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MANGANESE NODULES IN HAWAII

by Lisa M. McPherson, Pahoa High School

ABSTRACT

As Hawaii's population grows larger everyday, the increasing demand for more jobs intensifies, but there are just not enough jobs to go around. A maganese nodule processing plant could partly solve one of Hawaii's biggest problems, but will it cause others? What will happen to our air, the ocean floor, marine life, and our way of life?

INTRODUCTION

Just below the state of Hawaii lies the richest maganese nodule deposit known to man. These nodules contain many different types of minerals. The minerals that have the most significant commercial value are: nickel, copper, cobalt, and maganese. Ever since this discovery there has been much research ranging from developing a device to gather the nodules off the bottom to seperating and processing the minerals.

Right now plans are being made to develop a major maganese nodule processing plant in the Puna district on the island of Hawaii. Such a plant could cause economical, environmental, and social impacts. When such a plant is put together all of these impacts have to be taken into account to determine if this new industry is suited for Hawaii and its people. At Campbell industrial park on the island of Oahu a pilot maganese nodule processing plant is being developed to determine the economic feasibility of a large scale industry.

As you all know there has been much controversy concerning maganese nodule mining in Hawaii. I am interested in this topic and have often wondered how it would help Hawaii. Therefore, the purpose of this report is to present to you some of the facts of this new industry.

RESULTS OF RESEARCH

The first thing that comes into most people's minds when they hear about maganese nodules is "What is it and why is it so important?". Basically a nodule is composed of maganese and iron, with smaller amounts of copper, nickel, and cobalt.

They are usually potato shaped and range in size from less than an inch to nearly a foot in diameter. Nodules are formed by deposits attaching themselves around such objects as bits of bone, sharks teeth, and volcanic glass. It takes many years for these nodules to form. For a one inch nodule it takes approximately 25,000 years to develop, for the larger, millions.

The reason why these nodules are so important is because of the metals they contain. The United States is almost completely dependent upon other countries to supply nickel, cobalt, maganese, and a smaller but significant amount of copper. Nickel ranges in use from the manufacture of stainless steel to ceramics. Cobalt is used in high strength steel alloys, telephones, etc. Copper is used in electrical equipment, motors, plumbing supplies, and certain automobile parts. Maganese is used in iron and steel to prevent brittleness and steel cannot be made with out it. A nodule usually contains 25% maganese by weight and their content is approximately 3% nickel, copper, and cobalt. It has also been discovered that the grades of metals mined from the sea are greater then those mined on land.

The first step in the production of maganese nodules is mining them. So far there is no set method that will be used, but there are several ideas. The technology for a device to lift nodules off the bottom is advanced but is still in the experimental stages. Thus far, nodules have been mined only for testing, not for commercial use. One method used is a vacuum cleaner-like device that sucks the nodules up off the bottom

using a jointed steel pipe 18" to 20" in diameter and most of the time miles long, since nodules are some times found as deep as 18,000 feet. Some other methods used is a hydraulic lifting device, continuous line buckets for rough terrain, and a dredging system fully equipped with T.V. cameras.

When mining maganese nodules there is surely to be some disturbing of benthonic sediments, therefore causing its redistribution, this cannot be avoided. During dredging operations sediments would be raised into the water column with each dredge. Because of this a blanket of sediment could cover unmined areas, benthonic organisms, and make it difficult for any visually guided dredge head. Opponents of this industry say that ocean mining would destroy the ocean floor. It has also been said that when sediments are discharged back into the ocean, it would create a cloud of murky water taking decades to reach the bottom again.[1] All of this is speculation, therefore none of it has ever been proven. Since this is one of the major problems as far as mining is concerned, a mining system that would avoid bringing up sediments would probably prove to be the most economical and beneficial to the environment.

Back in 1970, a mining test was conducted by Deepsea Ventures to determine the potential effects of discharged water. When nodules are hoisted to the surface, bottom waters, sediments, small nodule fragments, and macerated benthonic organisms are brought up also. All of these are separated from the nodules then discharged back into the water column. During these tests, it was discovered that this mixture, not including large

particles, stayed in the upper layers of the ocean. The results from these tests led them to believe that this mixture could cause an increase in phytoplankton growth, but this is possible only if this concentration, if mixed with surface waters, has a resulting mixture of more than 10%.[2]

After the nodules have been brought to the surface the second step is to separate the minerals from each other. Since these nodules are unique in shape and chemical composition from any other type of ore being mined today, a special processing method must be designed. The method used should meet certain requirements in technological feasibility, environmental standards, and production size. The processing of nodules is the most important phase of a maganese nodule industry, since the cost will tend to be greater then that of mining operations.

So far there are many different alternatives that could be used, but the method to be used depends greatly on what metals are to be extracted from the nodules. One company says they would only recover nickel, copper, and cobalt, while on the other hand another says they would recover nickel, copper, cobalt, and maganese. Therefore, whatever is eventually decided on will show the necessity to match metal gathering capabilities and quantity against the total capital investment for the processing plant.

In Hawaii there is no set method that would be used, but in a study conducted for the NOAA-Office on Marine Minerals five good possibilities were brought up. To recover only three metals (nickel, copper, and cobalt) the methods that could be

used are: high temperature sulfuric acid leach, reduction/ammonia leach, and cuprion/ammonia leach. For recovering four metals (nickel, copper, cobalt, and maganese) the possibilities are: smelting, and reduction/hydrochloric acid leach. In Hawaii the use of geothermal energy for a maganese nodule processing plant is seriously being considered.

For this report I've used the reduction/ammonia leach process as an example in all of the following information regarding environmental and economical impacts. As you have already read, this method is used to recover only nickel, copper, and cobalt. The procedures of this process are as follows:

Step 1: In this step the nodules are ground and dryed. The ground nodules are heated in the presence of producer gas to the temperature of 1,157°F. This step is called reduction, it consist of breaking down the metal oxides in the nodules in order to free the metals.

Step 2: This step is called the leaching process. It takes the reduced nodules and dissolves them in water containing 10% ammonia and 5% carbon dioxide at a slightly elevated temperature of 104°F. In this step approximately 98% of the metals are removed.

Step 3: The metal-bearing solution is then poured gently to allow the sediment to separate from the liquid. The sediment is then placed in an organic liquid ion exchange reagent. In this phase copper and nickel is selectively and separately removed.

Step 4: These metals are then removed again and placed in acid aqueous solutions, where the metal products cathods nickel and copper, are produced by electro deposition.

Step 5: Now that the nickel and copper has been removed the next step is to remove the cobalt. This is a much more complicated operation. In this process cobalt and a small quantity of nickel are removed in powdered form by precipitation using hydrogen sulfide. The precipitated solids are then dissolved with sulfuric acid at the high temperature of 212°F. From this acid solution the metals are removed by selective reduction by using hydrogen at a pressure of 34 atmospheres and a temperature of 365°F.

Step 6: The nodule residue is then steamed, removing the ammonia and carbon dioxide. The ammonia and carbon dioxide are then joined together with the aqueous ammonia/carbon dioxide blend, where cobalt was removed. This mixture will be recycled and used to remove metals from reduced nodules. Now that the nodule residue has been steamed and stripped, they are placed with smaller quantities of liquid waste and process solids. This mixture is called tailings.

Now that you know more or less how one method of processing maganese nodules functions, you can begin to understand and realize the potential impacts. The first type we will review,

is the environmental impact. The following information is based on the probability of this processing plant being constructed near Keaau in the Puna district.

The land to be used is estimated to be approximately 200 acres, with an additional 50 feet for planting pipeline from port-to-plant. Since Puna has a lot of undeveloped land, a maganese nodule processing plant's interference with other land uses is not anticipated. When viewing the outer features of this plant, it looks very much like a modern oil refinery. The plant itself will include several buildings, tanks and pipes for holding and transporting chemicals, ponds consisting of tailings, and stockpiles storing materials like limestone. The estimated height of the plant is about 3 to 4 stories. The approximate noise level generated, on the site, is at about the same level as automobile traffic on a freeway. Another thing to consider is how will a maganese nodules processing plant look like compared to the natural environment of Puna. Since this area has a large amount of open space, this plant could be constructed not to interfere with neighborhoods, tourist attractions, and recreational facilities. In addition the overall design of this industry will make it possible for land scaping, therefore improving the general appearence.

An important concern often brought up, when ever an industry such as this is developed, is the potential air pollution. The causes of pollution could result from emissions from the processing plant, from power producing techniques such as fossil-fuels, or geothermal power production, and pollution caused

by vehicles used, tending to be greater during the construction phase. The air in the Puna district is low in pollution. This is because of the dominant trade winds coming from the northeast. These winds could blow away most particles and chemical contaminants.

The major environmental problem concerning a maganese nodule industry, is the disposal of process wastes, called tailings. A process such as reduction/ammonia leach, which recovers only three types of metals, will produce over two million tons of waste a year. Such a considerable amount of tailings could contain large quantities of toxic metals. But if these toxic metal elements where chemically bound in such a manner making it impossible to release anything into the environment, then there would be no threat.

There are two proposed ways of disposing of nodule tailings. One method would dispose of them on land for agricultural use. In the other method they would be dumped into the ocean. The potential impacts of these methods are not yet completely known. Much more tests have to be done before a suitable method can be chosen.

In ocean dumping clouds of suspended tailings will occur. It is not known how fast or how slow they will take to settle. In the upper layers of the ocean lives the majority of our marine life. Thus far, it has been proposed that a pipe, several hundred feet long, be used to dump the tailings at a deeper level, avoiding these animals. Since ocean dumping remains to be an unknown subject, all of this is uncertain.

At present we do not know for certain how the problems caused by maganese nodule mining, processing, and dumping would affect Hawaii, but through modern technology many of these problems could

be resolved.

A maganese nodule processing plant in Hawaii will also have strong social and economical impacts. An industry as large as this will have an annual total gross product of $311.5 million in Hawaii county alone, and a state wide product of $335.9 million. Since Hawaii has an unemployment problem this industry will help greatly by providing many needed jobs.

For this report I've decided to only discuss the protential jobs, and the many changes that will occur in the Puna district, for these are my major concerns in this area.

During the construction phase about 5,029 new jobs will become available in Hawaii county, and about 1,051 new jobs will be created elsewhere in the state. The majority of these jobs will occur in the construction industry, reaching an estimated total of 2,990. In retail trade, about 629 new workers will be hired, and approximately 304 in wholesale trade. There would be many new jobs in banking and finance, education, and restaurants. In addition jobs will be available in other parts of the state besides Hawaii county, such as retail trade, education, health services, real estate, etc. This phase, as estimated, would last three years.

After the construction phase is completed, the next step would be the operation phase. In this step the employment compared to the construction phase will decrease. During processing operations, there would be about 1,707 jobs in Hawaii county, and 708 jobs elsewhere in the state. Many industries will acquire much business from a maganese nodule processing plant. Such

industries would include: electricity, gas, and sanitation utilities, quarries, and the chemical industry. In other sectors of the economy other than the State and County Governments, the production phase could cause only a slight increase or a decrease in jobs. The construction industry will lose about 3,000 jobs. This would be a sharp decrease, unless a carefully planned decline is designed. Retail trade will lose approximately 400 jobs, and other industries will suffer simular job loses.

The town of Keaau is small and rural in character, consisting of a few retail stores, an elementary and intermediate school, a few gas stations, and a police and fire department. A maganese nodule processing plant could completely change Keaau town. The small town life style would be gone for good, being replaced with major supermarkets, restaurants, and gas stations. Many of the residents now living in Keaau and other parts of Puna stay because of the quiet, country atmosphere.

An industry such as this would cause more homes to be build towards the south, where the subdivisions remain very empty. Such an increase in new homes could prompt the extension of water services and sewage treatment plants. Right now water tanks and cesspools are used. The new population of homes could start looking towards Pahoa town for their basic retail needs.

These potential social and economical impacts are an example of what could possibly happen if one maganese nodule processing plant is built in Hawaii. They would be extremely different if more than one plant is built.

CONCLUSION

Before starting this report, my knowledge of maganese nodules was very limited, but I now have a clearer and better understanding of it.

My research showed a maganese nodule industry in Hawaii to be a promising solution to part of our unemployment problem.

The aspect of this paper that mainly concerns me is the potential social effects. At present the island of Hawaii has a great deal of uncluttered open space. Many of the residents in the Puna district have moved there for this reason. As a resident of Pahoa, I would not want to see such drastic changes occur.

The possible affect it will have on our environment as yet is not too certain, but I am confident that solutions and alternatives will be found to the problems. Hawaii could greatly use the new jobs that would develop, therefore helping our economy.

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MARINE POLLUTION

POSSIBLE ENVIRONMENTAL EFFECTS OF MANGANESE NODULE MINING AND WASTE DISPOSAL

by Moses H. Adams and Randall R. Holt, Kamehameha Schools

ABSTRACT

For millions of years, manganese nodules have been forming on the ocean floor. Not until recently has speculation been made towards the development of this natural resource. Recent developments in technology have made it possible for the manganese nodules to be mined in an economically feasible way. Although we have the technology to develop this resource economically, there are many possible environmental drawbacks. In the mining phase, the major problem is the sedimentary clouds produced during the dredging and vacuuming. For the disposal of processed waste, there are two major options, ocean dumping and land disposal. The major environmental hazard arising from ocean dumping would be the effects of precipitating sediment clouds on the photic and benthos regions. For land disposal the major environmental hazard would be the possible leaching of toxic materials, affecting local water supply.

INTRODUCTION

Manganese nodules are one of the most common mineral deposits on the deep ocean floor. They were first discovered in 1873 when the HMS Challanger expedition dredged nodules near the Canary Islands in the North Atlantic.[3] The geologic setting and degree of nodule cover which exists on the sea floor between Hawaii and North America are shown in Figures 1 and 2. The outlined section is the area being considered for development of nodule mining, due to its high degree of nodule deposits.

Manganese nodules are dark, pea to potato sized concretions, which are composed mainly of metal oxides. These oxides have accumulated over long periods of time forming a crust around a nucleating object such as sand grains or shark's teeth. The average chemical composition of ore-grade nodules is shown in Table 1.

The primary useful metals in the nodules are nickel, copper, cobalt, and manganese. On land, these metals are either very rare or they come in such a low grade that mining them for a profit is not economical. Mining the nodules from the ocean floor could mean that the United States would not have to import as much of these metals, and eventually become self-sufficient in terms of these metals. Table 2 will show projected U.S. mineral self-sufficiency in terms of deep sea mining of manganese nodules.

For a number of years, mining companies have speculated as to the possibility of mining manganese nodules. Only in the past three or four years has any research been done on this. At this time practical research is being conducted on the mining and processing of manganese nodules. However, at this time very little research has been done on the disposal of the manganese waste products.

Statement of the Problem

This paper will cite some possible environmental hazards due to mining and waste disposal methods. The authors will recommend the methods of mining and waste disposal based on available data which should have the least undesirable effects.

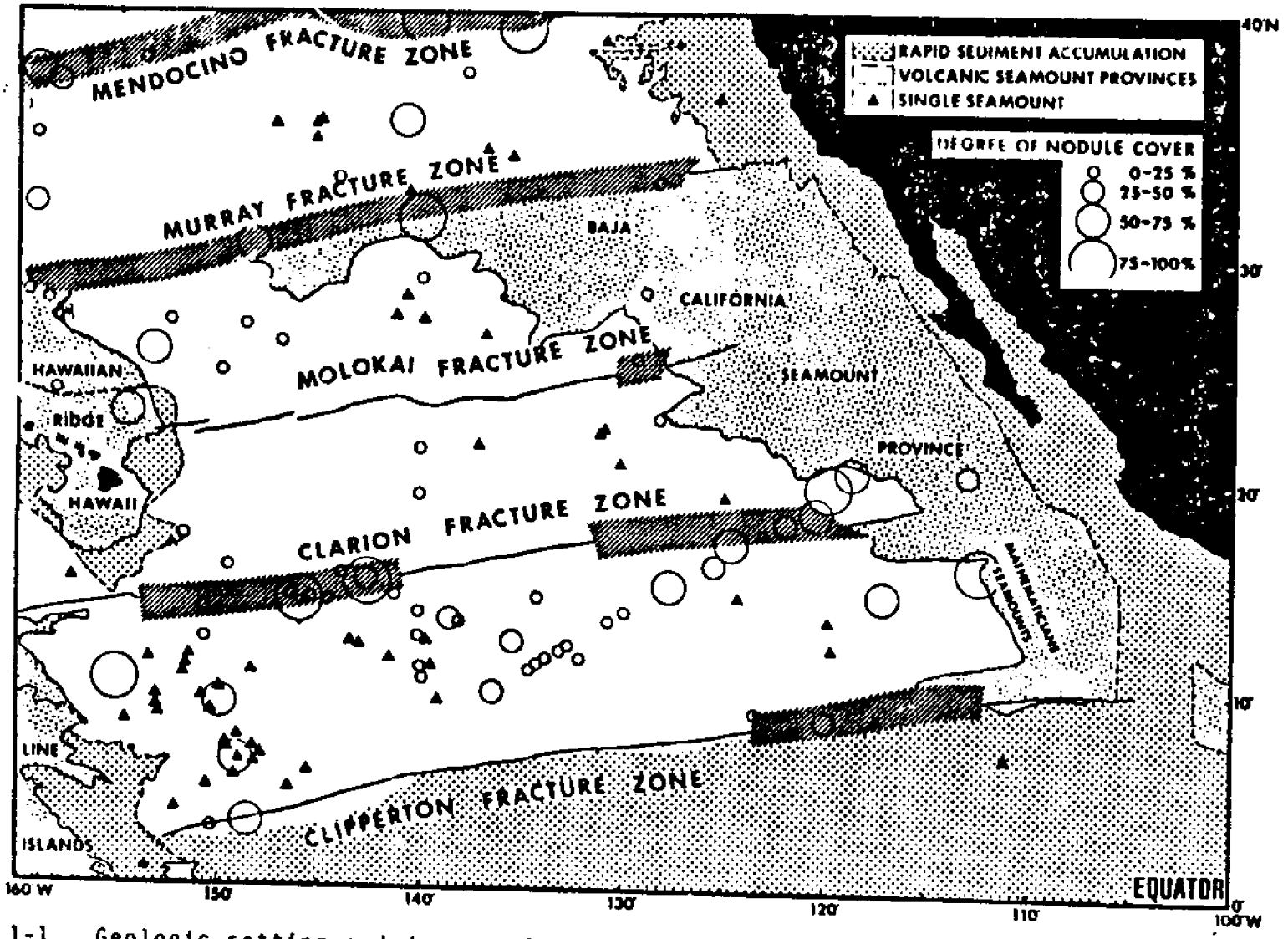

Fig. 1-1. Geologic setting and degree of nodule cover on the seafloor between Hawaii and North America. Degree of nodule cover determined by bottom photography. Largest circles (75-100% coverage) represent areas of the seafloor that are completely or nearly completely covered by manganese nodules. (From DPED Report)

FIGURE 2

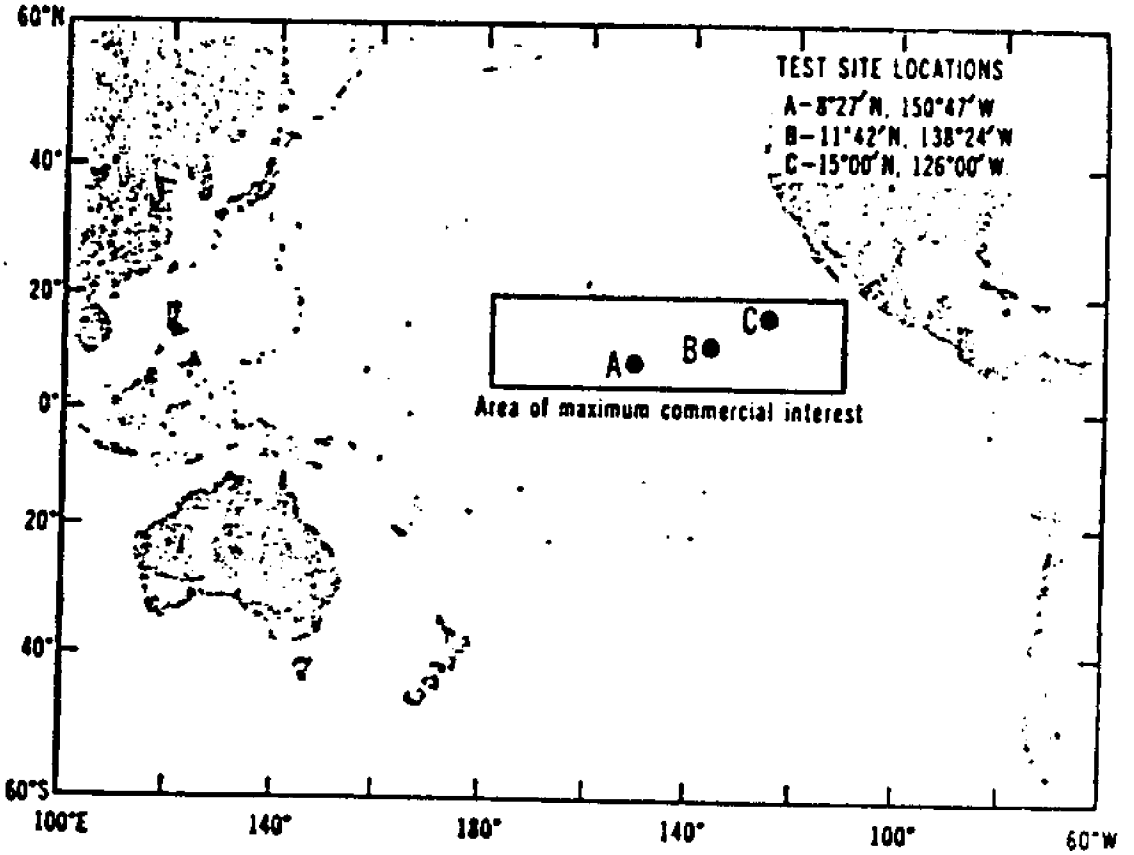

Fig. E-1. Baseline study sites A, B, and C of Deep Ocean Mining Environmental Study (DOMES) Project.

From DPED Report

Table 1

Average Chemical Composition of Ore-Grade Nodules

Manganese	25 - 30%
Iron	6%
Nickel	1.5%
Copper	1.3%
Cobalt	0.25%
Water	30%*

*After air drying

From DPED Report

Table 2

. Projected U.S. Mineral Self-Sufficiency with Deep Sea Mining

	1976 Imports	Estimated Self-Sufficiency with Ocean Mining Year 1990	Estimated Self-Sufficiency with Ocean Mining Year 2000
Cobalt	98%	Self-sufficient	Surplus
Copper	15%	90%	Self-sufficient
Manganese	98%	Self-sufficient	Surplus
Primary Nickel	90%	70%	Surplus

From DPED Report

Table 3

Estimated Quantities of Toxic Elements in Two Million Tons of Pacific Ocean Manganese Nodules

Element	Concentration in Nodules (ppm)	Number of Analyses	Estimated Quantity in $2x10^6$ tons of Nodules (kg)	Estimated Quantity in $2x10^6$ tons of Nodules (lbs)
Lead	200-3600	123	4.0×10^6	8,800,000
Arsenic	65-200	18	2.6×10^5	572,000
Thallium	<1-180	7	1.4×10^5	308,000
Cadmium	3-21	32	2.4×10^4	52,800
Gallium	2-30	54	2.0×10^4	44,000
Beryllium	2-5	7	6.0×10^3	13,200
Selenium	0.4-0.8	10	1.2×10^3	2,640
Mercury	<0.1-0.8	7	6.4×10^2	1,400

From DPED Report

METHODS OF MINING

There are two ways in which the nodules are mined, the first is scoop dredging,[4] and the second is vacuum dredging.[3] Scoop dredging consists of a large scoop or bucket that scoops up the nodules from the ocean floor and brings them to the surface. When mining is done in this manner, great plumes of sediment are stirred up burying sea anemones, clams, and other benthic forms on the ocean floor.

The vacuum mining operation consists of a visually guided dredge head that is drawn along the ocean floor. A hose from the dredge head is attached to the mining ship and the nodules are sucked up to the ship. This method is more efficient than the scoop dredging method because more nodules can be mined with less sediment being produced. During this mining method, sediment is also stirred up which could bury benthic life but not as much sediment is produced as in scoop dredging. This plume of sediment could also cause difficulties for the visually guided dredge heads.[1] When the nodules are brought to the surface, they are accompanied by bottom water (rich in nutrients), sediments, tiny nodule fragments, and macerated benthic organisms. These things are separated from the nodules and dumped back into the water.

> According to Bill Reich of the Hawaii County Energy Advisory Committee,
>
> "the nutrient rich water introduced to the surface could cause a 'red tide'; known for destroying all fish and other life forms in its way."[1]

The 'red tide' is a red colored toxic substance secreted into the water by a certain protozoan when it is agitated. Mr. Reich also states that,

> "dumping the wastes (sediments) could create a cloud that would float over all the oceans, blocking sunlight from the water."[1]

If this sedimentary cloud does block out the sunlight, this could mean that there would be less photosynthesis taking place within the phytoplankton thus affecting the food chain. If less photosynthesis is taking place, the amount of phytoplankton would drop considerably. This in turn would result in less food for the whales and other fish. Consequently their numbers would drop.

Another effect of the dredging is that all but the most mobile swimming fish will be engulfed by the dredge and killed. A mined site will probably not be depopulated completely but it is not known how long it would take to repopulate a mined site. Constant dredging of the ocean floor could destroy massive amounts of deep sea life and create gigantic sedimentary clouds. It is not known exactly what the results of this might be.

The nodules would be mined at depths of 15,000 - 17,000 feet. At this depth, the life forms consist mostly of sea anenames, sea worms and cucumbers, crabs, and deep sea fish like rattails.

Recommendations

Mining the manganese nodules from the ocean floor can provide jobs and important metals for Hawaii and the United States, but it could possibly destroy the deep sea environment. The author feels that until technology comes up with a method to mine the nodules without disturbing the marine environment, the mining should be posponed.

METHODS OF WASTE DISPOSAL

The disposal of process waste is undoubtedly the major environmental problem arising from a nodule operation. A processing operation, involving only the extraction of nickel, copper, and cobalt, must be able to cope with millions of tons of residue. Only 2 to 3% of the nodules by weight are recoverable in this three metal process, the remaining 97% contains manganese and other toxic metals in oxide form.[3] (See Table 3).

Disposal of the process waste must be done in a manner that would least affect the environment. At this time there are two major options available, ocean dumping and land disposal.

Ocean dumping is the most feasible for several reasons. First, the barges need to make round trips. After unloading their nodules at the terminal, it would be economical to load them with tailings to be disposed of on their way back to the mining site. Second, the dumping would take place on the high seas beyond national jurisdiction, and this would

simplify legal matters. Third, nodules are composed of elements which are already present in the ocean, and therefore their re-deposition should cause minimal environmental harm.[3]

Land disposal is also an alternative. First, sealed slurry ponds could be used, provided techniques authorized by Federal and State environmental laws are followed. Second, process waste could be disposed of for commercial use such as agricultural land fill or for the extraction of manganese left in the tailings.

In either method of disposal, there may be environmental drawbacks. The chemical state in which the toxic elements exist in the tailings must be considered. But in ocean dumping, the environmental impact would be far more complex than the question of toxicity. Process waste would be discharged at the ocean surface by barges on their return trip to the mining site. These discharges form plumes of suspended material for a year throughout the water column.[4] The potential problems include local disruption of the sea floor ecosystems. Also, sediment might alter chemical balances both in the mone populated surface waters as well as the surface. In addition, discharged process waste material at or near the surface would have an impact on the photic region which is penetrated by sunlight. This is where most of the oceanic life processes occur.[6] However, very little is known about the effects of dumping process waste, so the subject of environmental hazards remains speculative.

In land disposal, options depend on the question of the toxicity of elements within the process waste. If the tailings are determined to be hazardous, slurry ponds would be the only type of land disposal allowed. But improper storage could result in leaching which would affect the local water supply. If the tailings are determined to be non-hazardous, they could be used for agricultural land fill. In which case the tailing must be thoroughly tested and evaluated to determine if rainfall or other natural phenomena could cause leaching that might possibly affect the local water supply.

Recommendations

Ocean dumping of process waste may have an impact upon the marine environment.

Whether it would be hazardous or not and to what extent is unknown to researchers at this time. But whatever the effect, only a relatively small area would be affected. On the whole, the total effects of the ocean dumping of process waste would be insignificant.

Land disposal of process waste would have to be carefully regulated by Federal and State agencies. Miscalculations or accidents could have disastrous effects upon our environment.

Therefore ocean dumping seems to be the most economical and environmentally feasible process and the only alternative that would not be directly hazardous to humans. Although long term effects have not been researched, ocean dumping would appear to be the best alternative at this time.

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EFFECTS OF WATER POLLUTION ON THE ENVIRONMENT AND SEA LIFE

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ABSTRACT

Oceans become polluted by rivers going into the sea, these rivers carry sewage, fertilizers, pesticides, mill wastes, detergents, radioactive wastes and many other pollutants. Most of the pollution of the oceans takes place at the margins, where man's activities take place.

There are six kinds of pollution: 1. sewage and related organic substances from agricultural, industrial and domestic sources, which remove oxygen from the water. 2. synthetic chemicals, both organic and inorganic, found in pesticides, detergents, mine runoff, such as acids and minerals and radioactivity from fallout, nuclear fuel, etc. These pollutants may be toxic to all forms of animal life, including man. 3. disease carrying infectious agents from domestic, agricultural and industrial sources. 4. heat, temperature increases from cooling water used in power plants and industrial operations. Thermal pollution can injure plants and fish directly and also reduces the oxygen content of the water. 5. sediments 6. chemical plant nutrients such as phosphates in detergents and human excreta, which accelerate the growth of awuatic plant live, thus increasing the oxygen demand in water.

Sewage and Solid Waste

Sewage is the liquid wastes from homes, schools, commercial buildings, hotels, hospitals and industrial plants. Sewage contains papers, organic material from feces and urine, soaps and sometimes dead animals, fruit skins, old shoes, collar buttons or anything else that finds its way to sewers. The greatest harm produced by sewage is the reduction of oxygen in the water. The oxygen is used up by bacteria as they destroy organic water. Overfertilization or eutrophication is another result of sewage. Excess of nitrogen, carbon and phosphorous(three chief nutrients in water)causes the growth of algae to grow faster, thus increasing the oxygen demand. Sewage pollution kills kelp but sea urchins feed on sewage. Now there is an overabundance of sea urchins and not enough kelp. Sewage also makes fish unfit to eat. Oysters and clams being exposed to sewage were found to have hepatitis, (a fatal liver desease). Sewage also causes plagues and cholera. Many clams and oysters being contaminated also contribute to getting typhoid. Thousands of acres of oyster and clam beds in the U.S. have been closed down due to the sewage. The water os so polluted in most of the nation's estuaries that people cannot go swimming for fear of desease, and the possibility of epidemic. Many sea birds, ie. (herons, egrets, sandpipers and loons) are dying from a mysterious desease which inflames the intestines and gives the birds bleeding ulcers. Scientists say causes may be from toxic agents or bacteria and viruses from sewage. Solid wastes is another form of sewage pollution which causes the death of plankton and lower forms of fish and reduces oxygen. Sewage and industrial wastes are the main causes of water pollution.

Chemicals

Chemical pollution include both inorganic and organic compounds, such as dairy, textile cannery, brewery, and paper mill wastes, ensilage, detergent wastes, manure, wood fibers, pesticides, acidmine drainage, and slaughterhouse wastes. These contain proteins, carbohydrates, fats, oils, resins, tars and soaps. If these pollutants are not excessive, they will be stabilized by the self-purification process. If they are excessive, death of fish and offensive odors can result. Also oxygen will be depleted by the growth of weeds and algae, caused by plant nutrients as phosphates, nitrates and potassium. Toxic chemicals reach the sea and oceans annually by way of rivers entering the sea and fallout from the winds.

Mines are major polluters of streams and rivers through acid drainage. Both active and abandoned mines pour out large amounts of water which has mixed with sulfur bearing minerals within the mine to form sulfuric acid. This acid destroys all kinds of life in streams. The sulfides, sulfites, ferrous salts from mines and industrial plants also deplete the oxygen in water.

"Each year the rains and rivers "rinse" about 5,000 tons of mercury from the land and carry it to the sea." Man using mercury in his industrial processes, releases about 4,500 tons of mercury into the environment yearly, and most of it ends up in the oceans. In humans, mercury poisoning can cause br in damage to unborn babies. The mercury destroys the brain cells. A case of highly toxic mercury poisoning was in the Minumatu Bay on Kyushu Island, Japan. One hundred people were known to have died during 1953-60 from the deterioration of mental and nervous systems culminated either in death or complete insanity. In 1970(Dec.), millions of cans of tuna was found to contain dangerous levels of mercury, and also

in some swordfish.

"When tetraethyl lead was introduced as an "anti-knock" constituent of gasoline in 1925, there was about 0.01 to 0.02 microgram of lead per kilogram of seawater. This contaminating mineral had been washed from the earth by rivers and deposited naturally in the oceans. Today there is about 0.07 microgram per kilogram in the seawater, man has succeeded in more than tripling the amount of lead in the water in just a few decades!" Lead is toxic to almost all organisms. Lead concentrates in the surface waters, where most sea life exist.

Estuaries support many of man's principal food animals. for example, oysters, crabs, scallops and shrimps. They serve as nurseries for commercial and game fish, like flounder, fluke, bluefish, trout and bass. Estuaries, Bays and coastal lagoons not only support fisheries but also serve as nurseries for the eggs and yound stages of fish found offshore as adults. Chemicals like nirex washed into estuaries have caused the death of millions of shrimp and blue crabs. Chemicals deoxygenate the water, discolor the flesh of fish and kill phytoplankton who are sensitive to chemical poisoning. The organisms in estuaries have the greatest danger of being exposed to toxic chemicals. They are more directly exposed to the steady flood of persistent toxic chemicals. Commercial fishing can be wiped out by depletion of oxygen and the foul taste of fish. There is also the danger of absorbing bacteria which might change their behavior patterns.

Pesticide-"A chemical used to cause the death of non-human organisms considered by man to be "pests", ie, inimical to human interests." Insecticides and pesticides enter water in many ways, chiefly through runoff from treated areas, erosion of land, waste discharges from industries or from aerial spraying. Estuaries and coastlines receive the most of insecticides, pesticides and fertilizers washed into streams from agricultural fields. Modern agriculture is dependent on pesticide and fertilizers and will become more dependent on

it as the population increases. The damage to the environment by pesticides is massive. It changes the structure of the food chain by wiping out some important phytoplankton. This might change the upper levels of the food chain that comprise large fish and mammals of the sea. It slows down the growth of marine plants. Any decrease in plant growth threatens the supply of oxygen in the ocean and atmosphere. Pesticides, Insecticides and fertilizers can poison an organism's vital life processes, interfere with its feeding and reproductive behavior, interfere with mating and migration seasons and make it more suseptible to disease and predators.

DDT is a very effective pesticide against insects and other harmful pests. It is a mixture of DDE compounds and other compounds including DDT. Much of the DDT is broken down to DDE so most of the DDT in the environment and in living things is DDE. DDE takes longer than DDT to break down. It remains in the environment for long periods of time causing damage to those who consume it. In fish eating birds, their body tissues were found to contain DDT, for example in reproductive organs and nervous tissue. Birds were found to produce less offspring. One known effect of DDT and associated chemicals is that the thickness of eggshells is so thin and fragile that the female cannot incubate them. The sex hormones are also affected which leads to infertility. That is the reason for the decrease in bird population. For some species, there is the threat of extinction. Some fish eggs do not reach maturity which causes a population decrease, some even lead to extinction. Crustaceas are very sensitive to DDT causing them to die within twenty days. The serious effect DDT or DDE have on mollusks is the growth rate which is slowed down. Zooplankton and phytoplankton are highly sensitive to DDT. It enters plankton through their cell walls and is stored in their fatty parts and reduces cell division. It is slower to dissolve in fats than in water. It also makes phytoplankton

incapable to carry out photosynthesis. Phytoplankton produces 70% of the world's atmospheric oxygen. Coral reefs are now dying from pesticide and dredging of the land. The dead coral accumulates algae all over it and the floor is a brown to white color instead of the green and speckled color of living algae.

Pesticides saved billions of dollars worth of crops and livestock which helped many hungry people from starvation. It saved many lives from malaria, tynhus, cholera and many other diseases, without which, many would have died.

Radioactivity

Radioactive pollution results from the mining and processing of radioactive ores, from the use of refined radioactive materials in power reactors, and for industrial, medical, and research purposes, and from fallout following nuclear weapons testing. Most radioactive wastes are in the form of a liquid.

Fish living in the Atolls were found to have radioactivity from eating the algae. During WWll, nuclear weapons were tested in the Pacific Atolls, today there is still evidence of radioactivity in the atolls and it will take many more years for the affects to disappear.

Thermal Pollution

"Thermal Pollution is the heating of streams caused by the discharge of water used for cooling purposes in industrial and power generation plants". When thermal pollution is unchecked it can alter the ecology of a stream, lake or parts of seas. One result would be when a road is built or a field put into agrivultural production, the trees are cut down thus removing shade and the runoff water is warmer when it reaches the water causing a rise in the temperature of the water. The total ecological cycle, microscopic, plant and animal life may be permanently altered by the heat man adds to his waters. It may prompt animals to leave the area which then will cause an over abundance of plant life. The result of thermal pollution on fish is unbelieveable. The fish metabolism, feeding habits, growth rate, and reproductive patterns were all affected causing early deaths. If the fish do survive they may not produce offspring for generations more to come. Heat reduces the capacity of water to absorb oxygen and other gasses. Warm water cannot hold as much gas as cold water can. Fewer living things will be found in the water because of a lower oxygen content, and water becoming more toxic. Extra heat in the water is less capable of fulfilling its natural function of decomposition and purification thus the pollution increases. In estuaries thermal pollution disrupts marine food chains, and oxygen is less soluble in salt water than in fresh. In warm water, certain toxins and disease organisms are more lethal to fish and shellfish.

Ocean Dumping

Ocean-dumped wastes affect marine organisms in a number of ways. Sewage and polluted dredge spoils which are decomposable organic wastes deplete the water of oxygen. Bacteria and viruses from sewage cause infection and disease. Dumping reduces the light penetration necessary for photosynthesis, destroys spawning areas and suffocates fish and shellfish.

Industries constantly dump anything from radioactive substances to both solid and gaseous containers of industrial chemicals. For example, nerve gas, the government has been constantly dumping pressure cylinders into the oceans. There is a possibility that these canisters have already rusted through and the nerve gas has slowly found its way into the ocean and has been already absorbed by the environment. Yet on the other hand it may not have rusted through. If these cylinders should break, it could cause massive damage to fish and marine life as the gas is highly soluble in water.

Some industrial wastes can be beneficial to the marine environment and to the life which inhabit it. Artificial reefs are being constructed from dumped scrapped cars. The cars provide shelter from predators, forms of algae, barnacles, and sea anemones grow on it. Fish and plant life double in a short period of time.

Oil Pollution

There are many sources of oil pollution which are oily wastes from oil fields or refineries near the coast. It either comes from tankers and ships or from offshore oil wells.

The sea does not absorb oil because oil and water are chemically and structorally different, have little affinity for one another. If the water is cold, the rate of absorption will be slower. In the warmer waters, tar balls form because of the roughness of the sea, unless the oil is washed onto beaches. Another form of oil pollution would be submarine seeps or natural seeps which fouls the seas and the beaches. But marine organisms which have survived these natural seepages will also survive oil pollution caused by man.

The effects of oil pollution on marine life and animals is horrible to think about. A single oil spill kills thousands of birds. Their feathers insulate them from the cold but allows them to float in water. Being penetrated with oil, they freeze to death or drown. With feathers stuck together it is impossible for them to fly. Even with individual care, only a per cent live.

Oil pollution kills marine plants and surface plankton by coating and asphyxiating them on contact. Phytoplankton are responsible for the production of 90% of the living material at sea. Produce 70% of the oxygen on the earth. It also kills marine animals by fouling the respiratory passages until they choke to death, too, oil sticks to their fur, some are fortunate to survive but many die. Fish found near oil refineries were found to have cancer of the mouth. Also fish obtained in the North Atlantic Ocean were found to have an oily taste from having ingested the tar balls. Shellfish were found to be contaminated or killed, scallops and oysters in some areas were found to have an oily taste. Oil pollution can destroy the food sources of marine life;

reduce the resistance of marine organisms to infection and other stresses; interfere with reproduction of animals; penetrate and remain in sediments and persist in the sea. More and more oil lumps are being found on the surface of the deepest seas far from land. Oil components can enter the food chain and create devastating results.

Dr. T.B. O'Neill,(a microbiologist) at the Navy's Civil Engineering Laboratory, Port Hueneme, Calf., experimented with marine bacteria that can eat oil. It is called Pseudomonas. It can devour oil in forty-eight hours and the population increases greatly; 10,000 microorganisms per milliliter to 20,000,000 per milliliter. Fifty to seventy-five percent of the oil is broken down into smaller harmless compounds. The bacteria is most effective against marine diesel oil, crude oil is the most difficult to digest. This bacteria might provide themselves as a source of food for larger marine organisms. The Navy hopes that these bacteria will prove a highly effective agent in reducing the damage from future oil spills.

Sediments

Sediments causing pollution reduce fish and shellfish populations by covering fish gills, causing them to smother to death. It also causes hazards for aquatic animals as they depend upon sight for finding food. Sediments cause a decreased rate of photosynthesis, thus decreasing the level of oxygen in the water. Bottom feeding fish and filter feeding mollusk have been found to contain tumors where in unpolluted areas the fish did not have any tumors. It is very possible that sedimentary pollution causes tumors.

CONCLUSION

97.2% of the earth's supply of water is in the oceans. 2.15% of assessible water is found in glaciers and icecaps. Everyday 940 cubic kilometers of water evaporate from the surface of the sea and pass into the atmosphere and eventually fall as rain. About 80 cubic kilometers supplies the land with water, the rest falls back to the sea. Therefore, the sea is not only the source of all marine life but of all life on earth.

In the future, man must depend more and more on the resources of the sea to sustain his many needs. Not only is the sea our last untapped resource, it is also the final sink for all products, natural or man-made. Modern technology has made man into a geomorphological and geochemical force. Some of the materials that end up in the ocean are beneficial but most are detrimental and they are changing the marine environment. Though the process of evolution continues through changes caused by volcanoes, earthquakes or tsunamis, or slow changes in temperature and salinity, can man someday affect the fitness of the marine environment in a way that it becomes unfit for the continuance of the process of evolution? Can man pollute the sea?

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RED SOIL RUNOFF AND ITS EFFECT ON CORAL

by Wayne Randall, Kubasaki High School

Statement of purpose

The purpose of this paper is to point out some destructive effects on coral caused by red soil runoff in the waters around Okinawa and suggest the necessity of further research to provide effective control of the problem.

Introduction

I have been on Okinawa now for nearly 10 years, and in that time period I have seen reefs decay from a thriving park for fish,.divers, and coral, to bridges of dead coral waiting for the pounding waves to knock them apart. This and many other sad things happening to the oceans today have inspired me to investigate some of the destructive problems of the oceans and to pursue a career in marine biology.

The area of investigation of this paper is the bay Kocha-Katabaru in Onna-son, Okinawa. At one time the bay had an abundance of live coral and fish which were vital to the nearby fishing villages. Kocha-Katabaru now has hardly any live coral and practically no fish. The only apparent cause of this problem is red soil pollution.

The three main causes of the red soil pollution in the bay are mountain strip quarrying, poorly planned roads, and runoff from pineapple fields. (See chart No. 1.)

Kocha-Katabaru is one of the many areas of Okinawa's oceans affected by the red soil pollutants, but at this time it is the only area in Okinawa prefecture on which research is being done. Because the problem has just begun to be researched, only one report about the problem has been published

on the problem.[1] One more is soon to be published.[2] The amount of study of red soil effects on coral is small and the reasons why red soil kills coral is yet unanswered.

This paper is an attempt to show the results of some tests that have been run on how Ph effects the water and the red soil tolerance of coral. Some of my personal experiments, observations and opinions are also noted, and some future research that should be done is pointed out.

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Personal Research on the Status of Red Soil Pollutants on Kocha-Katabaru

On October 16, 1978 at around 4:00 P.M., I went to Kocha-Katabaru. The tide was just beginning to come in. Two days before, there had been heavy rains and high winds and on the day before there had been light showers and a stiff breeze. These factors may have changed my research findings, showing more negative results than usual. The day I collected the samples for research, however, was sunny with only a slight breeze.

My immediate observations of the bay were that the water was red and muddy and that there was no live coral and no fish in sight. I took samples from an area about 600 meters out from the shore. I took samples of the sediment from the ocean floor as well as samples of the water, being careful not to stir up the water. From the samples I attempted to find out the amount of suspended particles in a set amount of water, and if red soil was dissolved in the water, how much red soil could be suspended in the water. I also attempted to find out how much red soil was in a fixed amount of the bottom sediment. Not all of my experiments were successful. The amount of red soil in the sediment was not found out because of my lack of knowledge on soil separation.

For my experiment on the amount of red soil particles suspended in the water, I took 700 ml of the water sample and filtered it. The purpose of the experiment was to see the effect of motion on the suspension of red soil in the water. The water in the bay from which I took the sample was constantly in motion because of whirlpool currents which I will mention in more detail later. I found the dry weight of the sample to be 0.1 g.

When testing to see how much if any red soil was dissolved in sea water, I boiled off all of the water. When I did I found no red soil dissolved in the sea water.

On my last successful experiment I tested water motion and soil sediment to see how much red soil could be suspended in fresh water. I took six test tubes and filled each with one gram of red soil and 10 ml of fresh water. I shook each test tube for one minute. I then let test tube 1 settle for 10 seconds, test tube two for 20 seconds, three for 30 seconds, four for 40 seconds, five for 50 seconds, and test tube six for one minute. The results are in the following chart.

Test tube number	No. of seconds shaken	No. of seconds left to settle	No. of grams suspended
1	60	10	.1 g
2	60	20	.05 g
3	60	30	.02 g
4	60	40	Below 0.00 g
5	60	50	"
6	60	60	"

I have two possible reasons why so many red soil particles can be suspended in the ocean water, and so few particles in my experiment with fresh water. One is that the ocean water provides much more bouyancy than fresh water, and two is that the currents of the ocean keep the soil stirred up, so that soil which would otherwise settle to the ocean floor is kept flowing. So when the water is moving, it would not be a real danger to coral unless the soil was carried to an area which had less current. I believe the chances of the suspended particles being deposited on a different area are entirely possible. The question is why weren't the suspended particles actually carried elsewhere!

This experiment tends to confirm the visual observations I made at Kocha-Katabaru. I found that nearer to the beach where the water was swift, the beaches

were hard with little sediment, but further out where the velocity of the water had been slowed down, the bottom was soft and had a deeper accumulation of red soil.

Experiments and Research findings of Okinawan Scientists

One question studied by the Okinawan researchers was that of Ph change and damage to coral. The Ph change brought about in the water because of the presence of red soil is one question in debate. In an interview with Dr. Tutsuno Higa, a professor of Ryukyu University, he stated that the CO_2 content of the water is reduced by the acidic red soil and that some corals on Okinawa have algae growing on them and the corals feed from the algae. The lack of CO_2 can cause the needed algae to die.[3] However, further research and tests were conducted by the Okinawa Prefecture Counter Measure Committee and "it has been found that the Ph is not changed enough to cause coral to die."[4] The Ph at the mouths of the rivers at Kocha-Katabaru bay after a 9mm/day rain showed the Ph to be around 8.17-8.27, and on a clear day, 8.21-8.32.[5] We can see that there is a definite influence on the Ph level, but not enough to make a difference in coral growth. (See charts 2 and 3).

A different kind of experiment on red soil damage to coral was done by the Okinawa Prefecture Fisheries Research Facility in Itoman. It was a water pass experiment. In the experiments four sets of ten species of coral placed in four experiment stations were used. For each test the specimens were placed in lab dishes 10 cm in diameter and 2 m tall. A uniform amount of red soil was added to each dish at the bottom of each experiment station. The sections each had 30 liters of ocean water passing through a 5μ filter. The red soil

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3. Interview with Dr. Tatsuno Higa, Prof. of Chemistry, University of Ryukyus.
4. Interview with Dr. Sakiyama, Director of the Okinawa Prefectures Fisheries Experimentation Station.
5. Fujiyama, Tomoya, ed. (Trans.) "Okinawa Counter Measure Committe on Red Soil Research and Situation," Research on the Pollution Effects of Red Soil on Fishing Grounds, p. 13

particles used were less than 250μ in diameter. Section A had 0.0g/liter of red soil passing through it, section B had 0.1 g/liter, and section D had 10 g/liter. After 48 hours of running water, the specimens were placed in a concrete water tank 24 more hours before being observed. This experiment proved that red soil is capable of damaging and/or destroying coral life after certain periods of time. The table below shows the results of this experiment.[6]

Corals \ g/l	0	0.1	1.0	10.0
Seriatopora hystrix (Dana)	0	0	△	X
Pocillapora damicornis (Linnaeus)	0	0	0	△
Acropora spicifera (Dana)	0	0	△	X
Acropora echinata (Dana)	0	/	△	X
Montipora foliosa (Pullas)	0	0	0	0
Fungia scutaria (Lamarck)	0	0	0	0
Porites studeri (Vaughon)	0	0	0	0
Favites complanata (Ehrenberg)	0	0	0	0
Platygyra sinensis (Miline Edward & Haime)	0	0	0	0
Echinopora lamellosa (Esper)	0	/	△	X

O:Living △:Partially Dead X:Dead

Another factor of whirlpool currents was also observed. At Kocha-Kataoaru "strong whirlpools are formed where the rivers flow into the bottom of the bay."[7] Because of the currents and whirlpools the red soil generally stays within the bay causing a remarkable accumulation of red soil. "Because the rate of flow and spread of red soil is slow compared to Nakada-Kataoaru (and other areas) these pollutants remain a comparatively long time and contribute to the deterioration of the biological environment."[8]

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6. Research on the Pollution Effects of Red Soil on Fishing Grounds, p. 119.
7. Ibid, p. 143.
8. Ibid.

Future research is needed to help determine some of the reasons why red soil harms the marine life. "There is a necessity to determine definitely the amount of SS (Suspended Substances) in red soil contaminants."[9] Further detailed conditions research of the oceans bottom resulting from red soil flow is needed. "More research is needed in determining the percentage of red soil contained in the water."[10]

The writer thinks the effect of blocking out sunlight is a necessary study also. A heavy accumulation of red soil like that at Koch-Katabaru[11] could possibly block out most if not all sunlight. Dr. Higa pointed out in the interview that sunlight is necessary for photosynthesis which in turn is necessary for coral to live. Dr. Sakiyama also felt that blocking out of sunlight effected the coral but as yet no way of testing this has been devised.

Red soil pollutants do seriously effect the marine environment. The question "why" is still to be answered.

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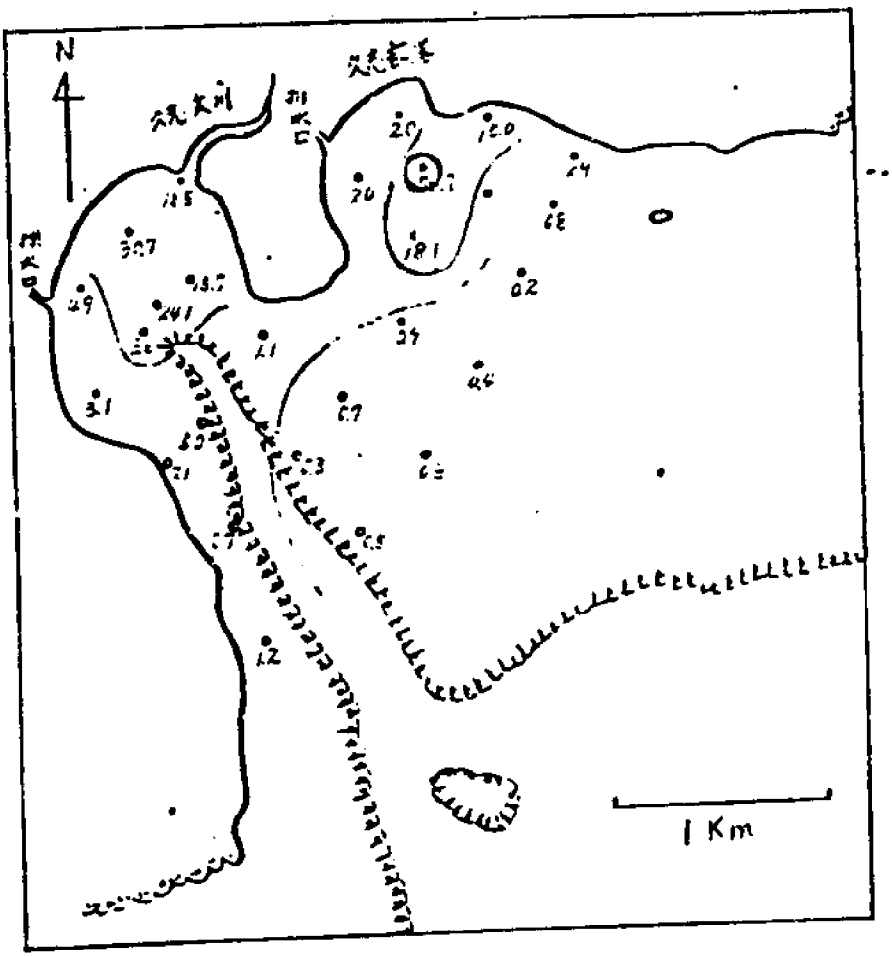
9. Conditions of Okinawa's Marine Resources, p. 41
10. Ibid.
11. See chart no. 1.

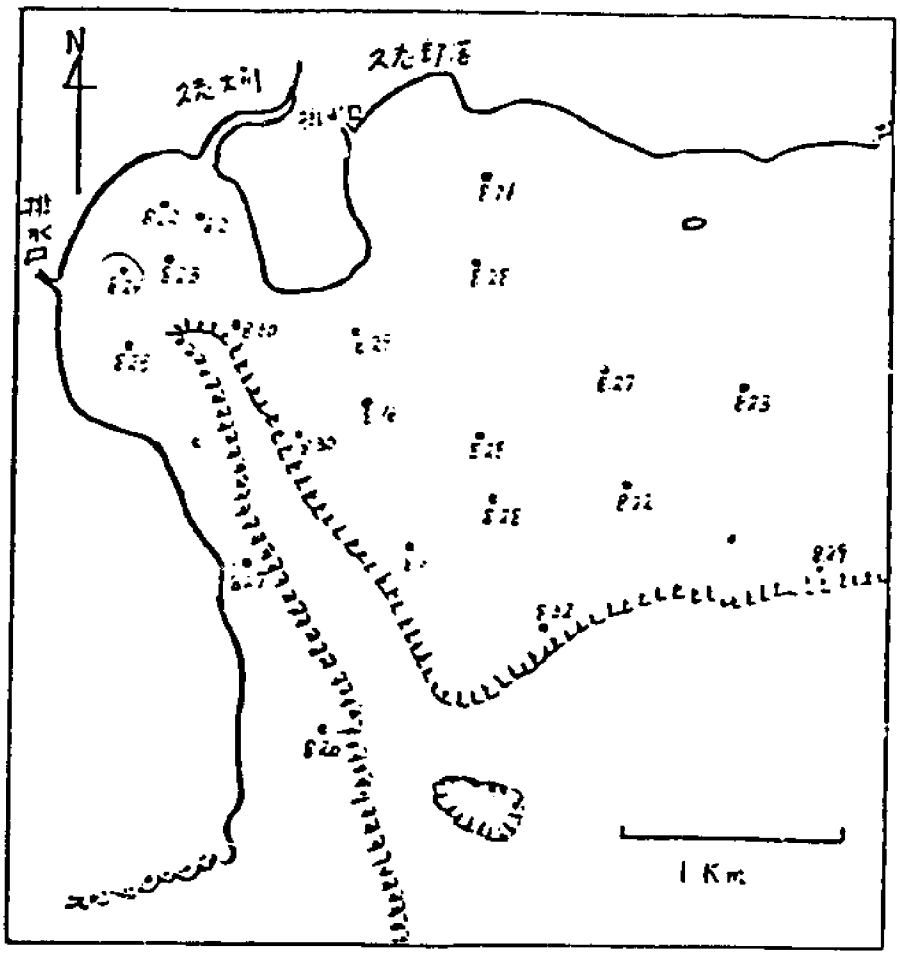
Chart No. 1



図一二二 古知屋瀉原沖における0～5cm層の赤土含有率(%)

Kocha-Kutabaru, (%) percent of sea bottom layer containing up to 5 cm of red soil pollutants. (Transl.) From Conditions of Okinawas Marine Resources, p. 32.

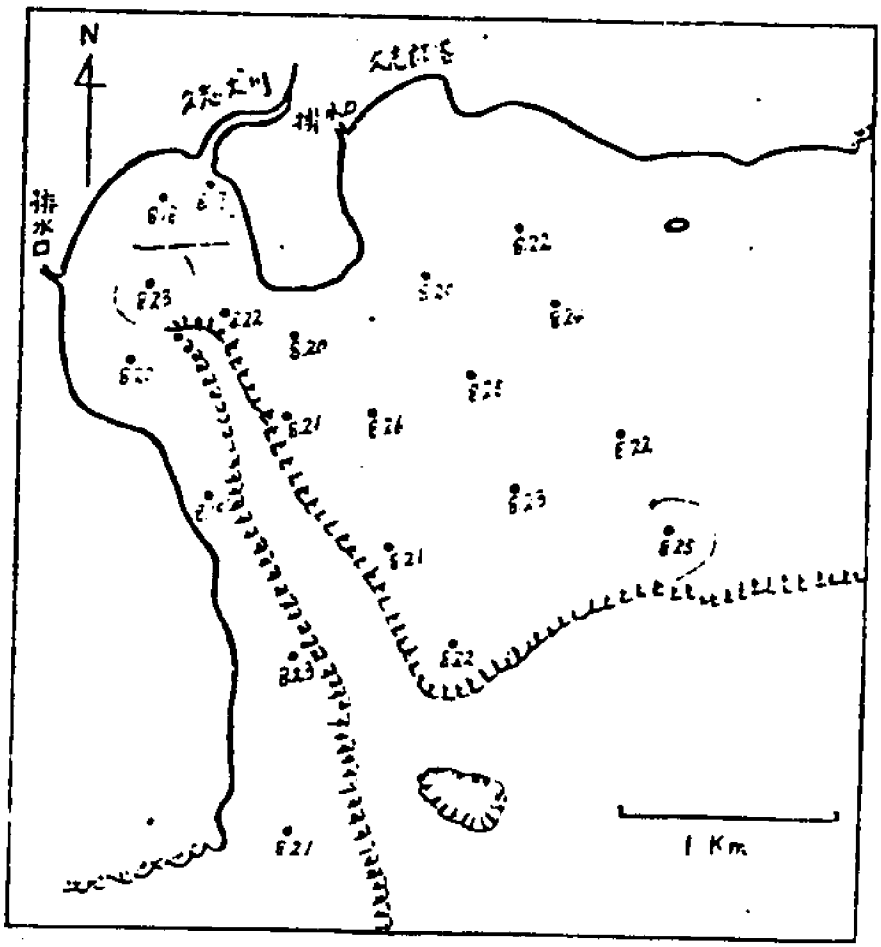
Chart No. 2



図一ノ 古知屋潟原[illegible] ph. [illegible]

Kocha-Katabaru, Ph. on a clear day. Oct. 4, 1977 (Transl.)
From Conditions of Okinawa's Marine Resources, p. 27

Chart No. 3



図－2 古知屋潟原における降雨後のPh 11月7日

Kocha-Katabaru, Ph on a day after rain. Nov. 7, 1977.

(Transl.) Conditions of Okinawas Marine Resources, p. 28.

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AQUACULTURE

AQUACULTURE: UTILIZATION OF MARINE ALGAE

by Allison K. Fujimori, Ka'u High School

Introduction

"The American layman's usual experience with marine algae is in accord with the implications of the word "seaweed", as a useless or even noxious plant of the sea."[1] It may have appeared unsightly to him--littering lovely beaches, entangling his fishing line, rotting the bottom of his boat, or even causing him swimmers' itch. He may not realize he uses it practically every day of his life, and that it is a natural resource that has become fundamental to numerous industries today.

This paper will briefly discuss historical uses of these marine plants in various parts of the world and how these simple uses have evolved into important industrial productions that touch the lives of millions of people today.

Statement of Problem

This particular subject was selected because many people are not aware of the numerous potentials of marine algae.

Results of Research

Many seaweeds are edible and have been entered as vegetables into the diets of human beings. Earliest records of this come from the Chinese who mentioned food plants as "Laminaria" and "Gracilaria" in their medical journals. Aboriginal man must have experimented with marine algae found along sea shores and results of this experimentation have evolved into established custom.[2]

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[1]Elmer Yale Dawson, Marine Botany: An Introduction, p. 302.

[2]C. L. Duddlington, Beginner's Guide to Seaweeds, p. 161.

An interesting example of this kind of experimentation is Porphyra". "Porphyra" is a common plant found in the North Pacific. It grows in the waters of the Gulf of Alaska to California. Anthropologists report it was brought by Indians when they came from Siberia. The Indians disliked salt and used "Porphyra" to supplement themselves.[3]

The Japanese ate "Porphyra" as a healthful supplement to their rice diets. It became widespread not only in Japan, but in China also. The demand for "nori" has grown steadily and production has reached huge proportions. Other well-known marine algae of the orient are "Undaria" and "Laminaria" found in the cold waters surrounding Hokkaido, Japan.[4]

The most diversified use of marine algae as food was by the Polynesians in Hawaii. "Limu", as the Hawaiians referred to it, was considered a necessary staple to their daily diets. Because there is less quality and quantity than in Japan, marine algae of small quantity and limited habitat were tended to in royal "limu" gardens. Choice delicacies were served only to royalty. Glass provided "look boxes" for unaided water supervision.[5]

Marine algae as food is not so extensive in the European areas as in Japan, Phillipines, Hawaii, Malaysia, or Indonesia, but several did achieve significance. "Rhodymenia palmata", known in Scotland as "dulse", Ireland as "dillisk", and Iceland as "sol", is marketed in British Colombia. The best known food algae in Western Europe is "Chondus crispus" (Irish moss or carrageen). This food alga is seasoned with milk and vanilla and is made into a dish called blancmanges. The use of this food alga was brought by colonists.

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[3] Op. Cit., p. 303.

[4] Harold E. Schlichting, Algae, p. 35.

[5] C. L. Duddlington, Beginner's Guide to Seaweeds, p. 161.

The raw seaweeds were imported to Boston before it was noticed that the best growths of "Chrondus crispus" occurred along the New England Coast. The jelly-ing qualities of this food alga, the result of etherial sulfate in its cell walls, gave it an early food use. The extract is now known as caragheen.[6]

Seaweeds are not of high nutritive value because they are not easily digested. However, they do stimulate appetite, provide necessary salts, and furnish important vitamins and trace elements. A general improvement of health may follow a diet supplemented with seaweeds.

The Europeans used marine algae as fodder. In Iceland and Scandinavia in the British Isles along the coast of France, cattle have been allowed to wander along shores during low tide. "Rhodymenia palmata" and "Alaria esculenta" are favorites of goats, cows, and sheep. They are often selective of "Rhodymenia" and "Alaria" and avoid others adjacent to it. Cattle and sheep are fed "Rhody-menia" and "Alaria" almost exclusively. However, milk does not taste of algae nor is meat inferior because of the seaweed diet. Animals nourished on seaweeds for several generations show ability to digest it better.[7]

The shortage of grain in Europe during World War I led to the experimenta-tion of marine algae as fodder. Factories were built in France, Norway, and Germany. Methods of treating and reducing seaweeds for this purpose were developed. Favorable results in Europe led to the processing of the Pacific-Coast kelp "Macrocytis" in Los Angeles for several decades. The high mineral C content made it possible for supplanting poultry and animal rations as dried fish and oyster shells.[8]

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[6]Harold E. Schlichting, Algae, p. 35.

[7]C. L. Duddlington, Beginner's Guide to Seaweeds, p. 162.

[8]Ibid., p. 162.

The value of marine algae as fertilizer was discovered in coastal Asia and by the ancient colonizers of the coasts and islands of Northwestern Europe. Driftweeds provided the most convenient supplies and were either introduced directly into soil or on farms to partially disintegrate. In Britain, the cutting of rockweeds became so extensive that it became necessary to regulate it by laws now in effect for 100 years.[9]

A small area in which seaweed fertilizer is the primary support of its population is Arran Island, off France. Rocky, barren land was built up for potato production by kelp deposits in rock clefts.[10]

Before the United States recognized its potash content, marine algae was employed by thrifty farmers of New England. Not only its chemical fertilizer use but water holding capacity proved effective. Furthermore, marine algae decay slowly forming humus.

As agriculture developed on a mechanized scale in the nineteenth century, the United States became increasingly dependent on German potash supplies from the Straussfurt Mines in Germany. By 1910, $12 million worth were imported annually. When the availability of these supplies was threatened, the United States initiated an investigation of their own Pacific-Coast kelp groves. In 1912, reports with mapped beds and an estimate of tonnages were put out. When these supplies were cut off completely during World War I, the harvesting and rendering of California "Macrocytis" began. During 1917, about 30,000 tons were produced, and harvesting and drying methods were developed. During successful decades, these developments have led to the establishment of a permanent industry.[11]

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[9]Elmer Yale Dawson, Marine Botany: An Introduction, p. 306.

[10]Ibid., p. 306.

[11]C. L. Duddlington, Beginner's Guide to Seaweeds, p. 165.

Medicinal uses are almost as old as their food uses. The Chinese used "Sargassum" and various Laminariales in treatment of goiter and other glandular problems. "Gelidium" was used for stomach disorders and heat-induced illness. The swelling of "Laminaria" strips gave it use as a surgical tool. The orientals employed the same technique for expansion of the cervix in childbirth.[12]

Probably the most longest and widely used marine algae come from the Agarphytes including "Gelidium", "Pterocladia", and "Gracilaria". The word "agar-agar" means "jelly". This jelly is the resulting liquid obtained by boiling seaweeds. Agar was used for stomach disorders and as a laxative and dietetic.[13]

It was originally produced and market in China until Japan took over in 1622 and maintained a world monopoly until 1940. The most significant date in the history of agar is 1881, when Robert Koch proved its value in the cultivation of bacteria. Since then, it has been used in hospitals and laboratories throughout the world.[14]

Irish moss ("Chrondus crispus") has a long history in Europe as treatment for diarrhea, urinary problems, and chronic pectoral infections. It brought about the establishment of the moss industry in Scituate, Massachusetts in the United States. It is still used in Ireland for pulmonary distress.[15]

Modern industry has developed numerous medical and pharmaceutical applications. Linnaeus, the ancient Greek scholar, knew the alga "Corallina officionalis" as a popular vermifuge in medieval times. In 1775, however, a Greek scientist discovered a small red alga ("Alsidium helminthochorton") with vermifuge qualities on the island of Corsica. It was considered the same vermifuge

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[12]Harold E. Schlichting, Algae, p. 37.

[13]Encyclopedia Americana, p. 551.

[14]Elmer Yale Dawson, Marine Botany: An Introduction, p. 307.

[15]Op. Cit., p. 554.

plant used by the Greeks and is now referred to by Congress as Corsican moss.[16]

Industrialization of seaweeds in Europe began with the production of kelp, the ash derived from burning marine plants. The term still holds in Europe, but in the United States has come to apply to the large brown seaweeds. Kelp production was begun in the seventeenth century by French peasants and spread throughout northwest Europe. Driftweeds, then cuttings, were used. "Laminaria" and "Saccorhiza" in north Britain became of major importance. Kelp ash was bought by industrialists for the manufacturing of soap, glass, and alum. During the eighteenth and nineteenth centuries, demands became great and large amounts of seaweeds were handled. In the British Hebrides, 20,000 tons were produced annually, requiring the cutting of 400,000 tons of wet weed.[17]

The kelp industry in Britain reached its peak in 1810, when barilla soap became a competitor. A decline set in, but industry revived when high iodine yield in seaweeds was discovered. Industry continued favorably until 1873, when iodine from Chilean nitrate sources became a competitor. Industry declined steadily until 1930, when it practically ceased in most areas. The only area now producing seaweed iodine commercially is Japan.[18]

A rapid industrialization of the Pacific-Coast "Macrocytis" beds was brought about in the United States during wartime in 1917-1918. Mechanical harvesters were developed, and 400,000 tons were cut annually. Even after the close of the war, utilization of seaweeds for other purposes were soon realized. Inventions and discoveries led to the beginning of the algin industry.[19]

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[16] Op. Cit., p. 307.

[17] C. L. Duddlington, Beginner's Guide to Seaweeds, p. 163.

[18] Ibid., p. 164.

[19] Op. Cit., p. 165.

Algin means hydrophilic or water-loving. Sodium alginate is the most commonly known algin. It is a cell-wall constitute found in brown algae and Laminariales. Kelco Company of San Diego, California is the primary producer of "Macrocytis" algin.[20]

"Macrocytis" is harvested by a barge equipped with a mowing machine and crane. The load is brought directly to the factory for washing and processing. The kelp is chopped, shredded, and placed in a soda-ash digester. The ash is diluted, alkanized, and purified by filtering or centrifuging, and is then treated with calcium chloride. The result of this processing is calcium alginate, which can be treated with acid and converted into alginic acid for specific uses.[21]

Algin has water-absorbing qualities that make it useful in numerous industries for thickening, suspending, stabilizing, emulsifying, gel-forming, or film-forming. For example, algin provides ice-cream with its smooth texture by preventing the formation of ice crystals.

A few years ago, when decline in supply along southern California kelp beds occurred, the State surveyed kelp bed ecology in order to prevent any such loss again. More than a quarter-million dollars have been spent on research. Experimental studies on the effects of pollution and grazing organisms are continuing. Calcium oxide is now being used to fight the grazing of sea urchins.[22]

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[20]Elmer Yale Dawson, Marine Botany: An Introduction, p. 308.

[21]Op. Cit., p. 308.

[22]Harold E. Schlichting, Algae, p. 43.

TABLE 5

Systematic Arrangement of Useful Seaweeds and Seaweed Colloids, Showing Phycocolloids, Acids, and Salts Derived from Various Marine Algal Genera (after Teeng)

Brown Seaweeds (Phaeophyta)

- kelps
  - leaf kelps
    - "Laminaria"
      - laminarin
      - fucoidin
      - algin
        - alginic acid
          - sodium alginate
          - ammonium alginate
          - calcium alginate
          - chromium alginate
  - giant kelps
    - "Macrocystis"
      - algin (as above)
- fucoids
  - gulfweeds
    - "Sargassum"
      - algin (as above)
  - rockweeds
    - "Fucus"
      - fucoidin
      - algin (as above)

Red Seaweeds (Rhodophyta)

agarphytes

"Gelidium" (California, Japan, China)

agar (gelose)

agarinic acid

sodium agarinate

potassium agarinate

calcium agarinate

magnesium agarinate

"Gracilaria" (Australia, South Africa, North Carolina)

agar (as above)

"Pterocladia" (New Zealand)

agar (as above)

"Ahnfeltia" (Sakhalin, Siberia, White Sea)

agar (as above)

carrageens

"Gigartina"; "Chrondus"

carrageenin

carrageenic acid

potassium carrageenate

calcium carrageenate

others

"Phyllophora"

agaroid

"Iridaea" ("Iridophycus")

iridophycin

iridophycinic acid

"Gloiopeltis"

funorin[23]

Conclusions

This paper has shown many uses of marine algae, not only as food for human consumption, but as fodder, fertilizer, medicine, and industrialization.

The future for the utilization of marine algae has tremendous potential and it is hoped that further studies will be made.

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[23]Elmer Yale Dawson, Marine Botany: An Introduction, p. 311.

EUCHEUMA: A POTENTIAL AQUACULTURE CROP

by Marjorie J.L. de la Peña, Kapaa High School

INTRODUCTION

The Hawaiian Islands are surrounded with water They also have many water resources inland. Our motto "Ua-mau-ke-ea-o-ka-aina-i-ka-pono" (The life of the land is perpetuated in righteousness), totally disregards one of our most important resource, the water.

Today, some people are trying to utilize this resource to its fullest extent. These people are cultivating crops that can only be grown in water. One of the crops grown in aquaculture is prawn (Macrobrachium rosenbergii). Prawn aquaculture is rapidly growing in Hawaii. In Kilauea, Kauai, C. Brewer and Company is developing approximately 300 acres into one of the world's largest prawn farm. The growth of this industry would greatly boost the State's economic base.

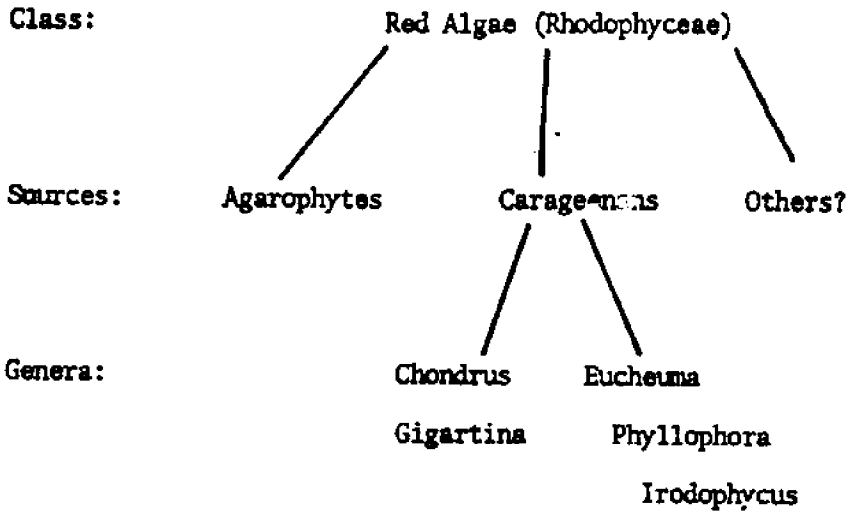
Others are seeking a way of increasing our economy by putting our waters into other productive uses. Dr. Maxwell S. Doty and his colleagues at the University of Hawaii are researching and encouraging the culture and farming of certain marine algae from the genus Eucheuma. Would Eucheuma be a good or feasible aquaculture crop for Hawaii?

THE GENUS EUCHEUMA

The genus Eucheuma belongs to class Rhodophyta (Red Algae), and to the sub-class Florideophycidae (Fleshy Red Algae). The various species of Eucheuma are among the largest of the fleshy red algae. Various thalli have weighed over 10 kilograms and one was recorded to have been 2 meters long weighing 15 kilograms even after several pieces were broken off. Eucheuma species contain carageenans. Carageenans contain a high proportion of gelatin which is used for cooking, textile sizing, making cosmetics and essential substances for the modern dairy and other industries. Carageenans can not be replaced by synthetic chemicals.

The demand for carageenans increased as the industries utilizing it expanded and increased. The natural beds of Eucheuma in the Southeast Asian countries where the supply of carageenans is imported from, soon decreased in productivity due to over-harvesting. To be able to continue supplying carageenans, the people of these countries started to cultivate Eucheuma, but the demand is now greater because of the ever expanding industries.

Figure 1: Algal Classification[1]



(1) Chapman, V.J.; Seaweed and Their Uses, Copyright 1970 p. 131.

EUCHEUMA AS A POTENTIAL AQUACULTURE CROP

The climate of the Hawaiian Islands is almost the same as that of the Soutneast Asian countries where Eucheuma grows wild. If Eucheuma is grown in the Hawaiian Islands as an aquaculture crop, the United States does not have to import as much carageenans. As we know, the United States' balance of trade is in a deficit, suffering greatly because of the greater value of products which are imported compared to those that are exported. So, by raising Eucheuma we can help increase our State's economy as well as reduce the nation's trade deficit.

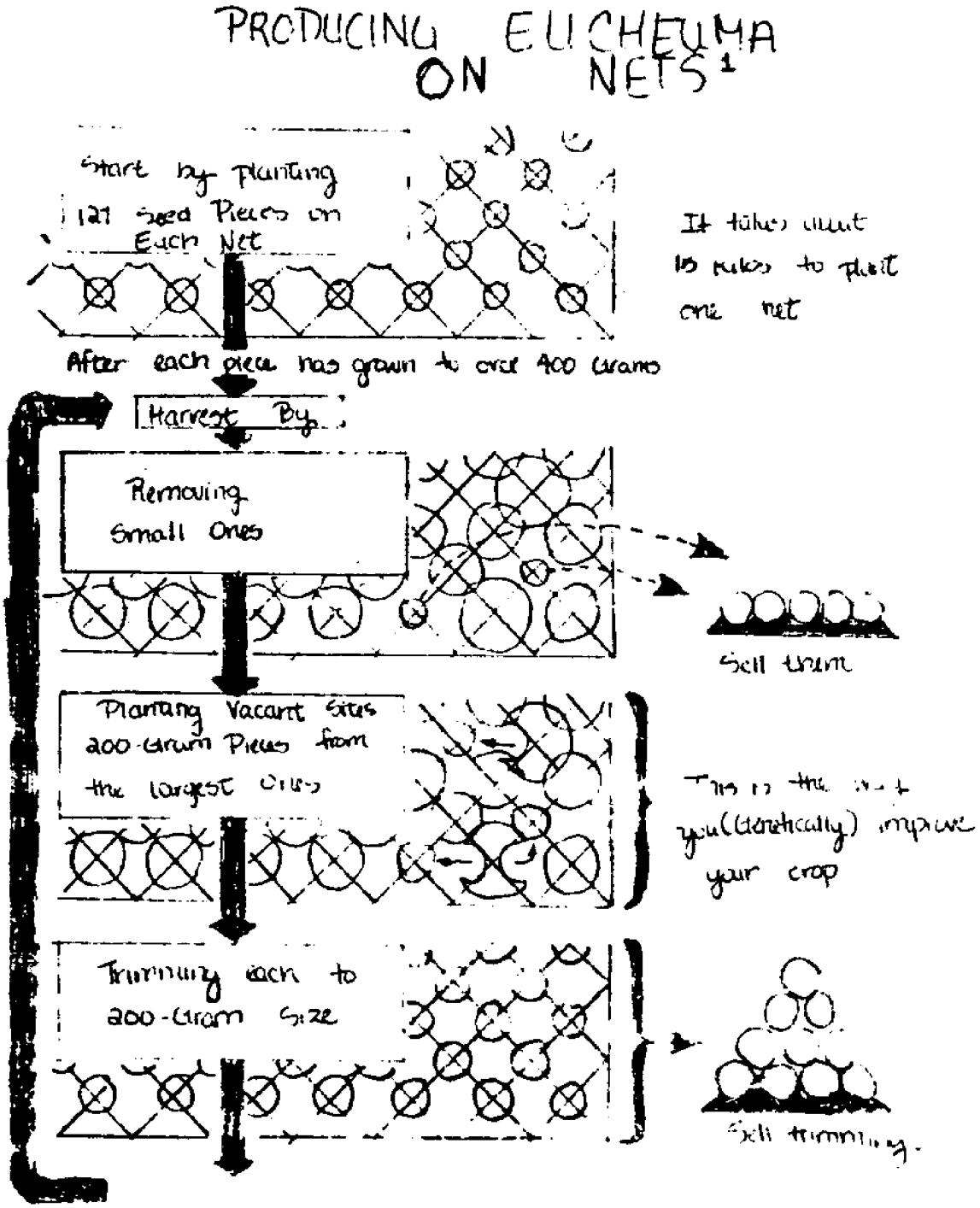
The State's Department of Planning and Economic Development (DPED) has published a manual on aquaculture for Hawaii. The biological, biotechnical, market, resource, economic and legal/social considerations are given. Out of the 54 considerations given, 42 were favorable to aquatic algae and 9 were problem areas of aquatic algae. The remaining 3 considerations show no problems or benefits (figure 2).

Figure 2. Favorable (+) and Problem Areas (-) of aquatic algae as an aquaculture crop in Hawaii[1].

Biological Considerations	
Reproduction in captivity	+
Broodstock maintenance	+
Reproductive cycles	+
Cultural stocking material	+
Survival to time of stocking	+
Diseases and parasites	+
Hardiness	+
Growout time	+
Survival to harvest	+
High density culture	+
Feed conversion efficiency	+
Trophic level	+
Maturation	+
Cannibalism	+
Biotechnical Considerations	
Broodstock maintenance	+
Mass rearing of stocking material	+
Mass growout	+
Broodstock feeding	+
Larval feeding	+
Juvenile feeding	+
Adult feeding	+
Harvesting	-
Transporting	+
Processing/Purging	+
Larval nutritional needs known	+
Juvenile and adult nutritional needs known	+
Larval rations developed	+
Year-round cultured stocking supply	+
Year-round cultured market supply	+
Market Considerations	
Identifiable local market	-
Identifiable mainland market	+
Identifiable international market	+
Potential local market	-
Market Considerations (cont)	
Potential mainland market	+
Potential international market	+
Wholesale price - Hawaii	-
Subcultural preference	+
Recreational potential	-
Inter-regional competition	?
Catch fisheries competition - Hawaii	+
Economic risk	+
Resource Considerations	
Site	-
Water	+
Expertise required	+
Economic Considerations	
Past performance	?
Likelihood of institutional funding	-
Potential profitability	?
Confidence in profitability estimate	?
Time to develop industry	?
Legal/Social Considerations	
Legal barriers to import	+
Legal barriers to culture	-
Legal barriers to sale	+
Social barriers to import	-
Social barriers to culture	+
Social barriers to sale	+

? Indicates no distinct problem or benefit.

[1]Department of Planning and Economic Development, Aquaculture Development for Hawaii, copyright 1978, Pp. 45-50.

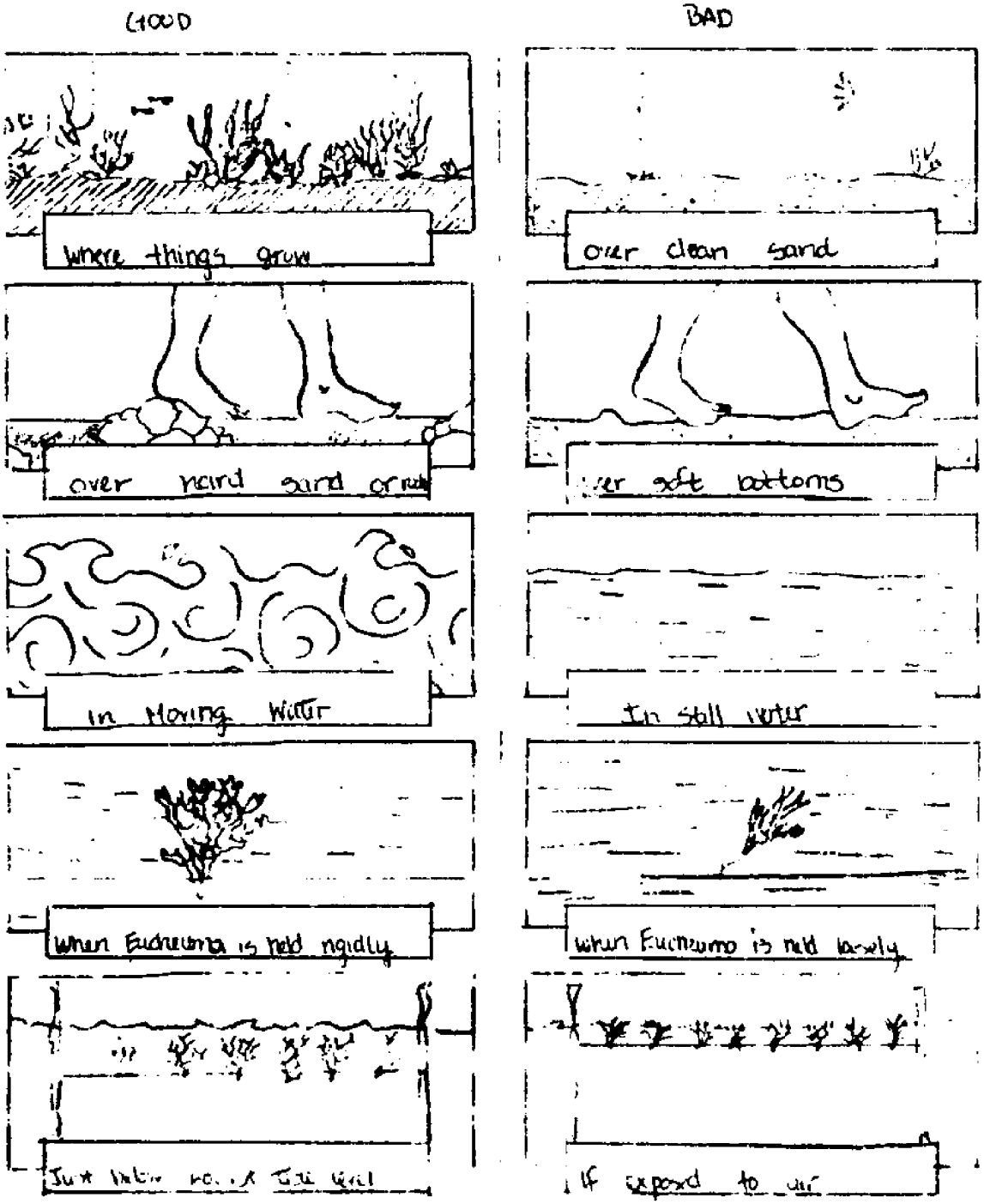


[1] Doty, M.S. and Alvarez, V.B., Seaweed farms: a new approach for U.S. Industry copyright 1973

Figure 3
Method of producing Eucheuma

Figure 4 Eucheuma Farm site recommendation-

FARMS ARE [1]



[1] Doty, M.S. and Alvarez, V.B., Seaweed Farms A New approach for U.S. Industry Copyright 1973

CONCLUSION

Based on the given information, I conclude that Eucheuma species would be favorable materials as aquaculture crops. They are sturdy and will grow well under the climatic conditions in Hawaii. Furthermore, I feel that the demand for carageenans will grow as the industries that utilize carageenans expand to meet the needs of the world's growing po population.

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"Seaweed Culture, Technology With No Place To Go?" Sea Grant Newsletter Vol. 8 No. 5 and 6

FRESHWATER MANINI: A NEW POSSIBILITY FOR AQUACULTURE

by Raymond W. Richards and Lyla N. Aniban, Pahoa High School

INTRODUCTION

The surgeonfish "Manini" is an excellent food fish in Hawaii. It is delicious fried or over charcoal. But, it is fairly hard to come by. A few months ago, this fish had to be caught in a net to be sold in a market. Now, speared fish may be sold also so the manini is a little more easy to buy. But there still isn't enough of the fish to go around.

The "Manini" or "convict tang" is a surgeon fish. It has an oval, compressed body with a small mouth. It's scales are very small; it's lateral line is arched high in front, slightly curving toward the tail. It has a dull greenish-grey color, darker above and lighter below. It has five to seven vertical black stripes along its body length. It normally grows up to seven inches but we have seen larger.

It is found all over Hawaii, swimming in large schools over the coastal reefs. It is also found throughout the pacific islands. It is usually found in waters up to fifteen feet in depth. It can be found in water up to thirty-five feet deep. It's principle food is seaweed.

STATEMENT OF PROBLEM

The Manini is a good food source. If it could be farmed, then maybe there would be enough of this great food fish to go around, for everyone to enjoy alot more than they do now.

Farming a salt-water fish is fairly difficult. Farming a freshwater fish is alot easier. So we came up with the idea of trying to change the salt-water Manini into a freshwater fish. In our experiment we tried to do just that.

MATERIALS AND METHODS

Our materials included: one twenty gallon aquarium, an undergravel filter, a corner filter, and decorative materials such as plastic plants and a ceramic deep-sea diver.

We used approximately 6.5 kilograms of ocean water and 6 maninis, one aholehole and a butterfly fish.

Our methods were simply taking measured amounts of water from the established aquarium and replacing it with filtered rain water.

We originally planned to start with 100 mls at a time, but because of the lack of time we stepped it up changing 1500 mls more at a time for example 4000, 5500, 7000, 8500 and so on. After we changed 8500 mls we decided to change the water every other day when possible instead of every day as when we started. The following data are what we recorded:

DATE

Oct 30: We started the aquarium using a twenty gallon tank, one set of undergravel filters, one corner filter, ocean gravel and approximately 53 to 55 liters of ocean water from Kapoho Bay in Puna. We caught six maninis, one Butterfly fish for good looks and one aholehole (which we didn't know we had until we set up the aquarium) and put them all into the tank. Time: 9:30pm.

Oct31: Observations; fish are doing very well. They seem to adjust to their surroundings very quickly. Added 14 drops of "organi-cure" to protect against marine disease. Time: 1:30pm.

Nov 1: Observations; fish appear to be doing well. We tried to feed them but didn't observe any feeding activity. Time: 12:30pm.

Nov 2: Observations; fish appear well enough that it looks like they will live long enough for the experiment. Added fourteen drops of "organi-cure". We fed them and observed some feeding activity. Time: 1:15pm.

Nov 4: We started the transformation. We took 100 mls of water from the tank and replaced it with 100 mls of fresh filtered rain water. Observations: no change in fish behavior. Also fed them. Time: 6:45pm.

Nov 6: Took 150 mls of water from the tank. We replaced it with 150 mls of fresh filtered rain water, fed fish. Observations: no change in fish behavior; they feed also. Time: 9:35 am.

Nov 7: We made a mistake that might cost us the experiment. We miscalculated and instead of changing water by hundreds of mls, we must change them by thousands at a time.

Nov 8: Took 4000 mls of water from the tank. Replaced 1000 mls of it with 1000 mls of filtered rain water. No change in fish behavior. Time: 8:34am. Added 1000 mls of filtered rain water to tank. No change in fish behavior Time: 10:48am. Added 1000 mls of filtered rain water at 12:20pm. and 1000 mls. of filtered rain water at 1:10pm. no immediate change in fish behavior.

Nov 9: Took out 5500 mls of tank water. Replaced 1000 mls with filtered rain water. Time: 9:40am. Added 4500 mls a 1000 at a time throughout the rest of the school day. Observations: fish appear to be unbothered by water changes. They are also eating well.

Nov 10: Took 7000 mls of water from the tank and replaced all 7000 mls with filtered rain water. Observations: No change in fish behavior. Time: 7:15pm.

Nov 11: fish are doing very well. They seem not to notice the water changes. Also fed them.

Nov 12: No data because of weekend.

Nov 13: Took 8500 mls of water from the tank. Replaced it with 8500 mls of filtered rainwater at untimed intervals throughout the school day.

Nov 14: We decided to change the water every other day so the changes will not affect the fish so much. Observations: fish are doing very well. There are no changes in fish behavior. They also eat whenever we feed them.

Nov 15: Took 10,000 mls of water from the tank. Replaced it with 10,000 mls of filtered rainwater throughout the school day. No change in fish behavior.

Nov 16: fish are doing very well.

Nov 17: Took 11,500 mls of water from the tank. Replaced it 11,500 mls of filtered rainwater throughout the school day. Also, no change in fish behavior.

Nov 18: No data because of weekend.

Nov 19: Brought six freshwater guppies from a rainwater pond and put them into the Aquarium. The Butterflyfish immediately started attacking them. We took the guppies out of the tank and put them into a jar with tankwater to see if they would live in it. Time: 2:00pm.

Nov 20: guppies are alive and well. We've succeeded so far in bringing the salinity of the tankwater down enough for freshwater guppies to survive in. The tank fish are doing very well. We also tested the salinity of 20 mls of the rainwater we were using and the results came to NO salts.

Nov 21: guppies are still alive and well. Tank fish are doing very well except it appears as though they have caught "fin-rot" and "ick".

Nov 22: fish are doing very well. One of the mainii looks a bit "scarred" though. They all appear to be healthy. We threw away the guppies although they were still alive.

Nov 23: It's Thanksgiving Day. We did not check on the fish.

Nov 24-25: No data

Nov 26: Observations: the fish are in good condition. They look as though they will survive even after the experiment is over. We took 14,000 mls of water from the aquarium and replaced it with 14,000 mls of filtered rainwater 4000 mls at approximately 20-25 min intervals. Also before changing the water. We took a water sample to be tested tomorrow. Time: 2:00pm to 3:20pm.

Nov 27: fish are doing very well. Started testing the water using 20 mls of tank water and a chloride test kit. Couldn't finish the test for lack of time.

Nov 28: one manini is dead. Cause of death is unknown but I suspect malnutrition. The rest appear to be okay. No time to finish test-ing the water.

Nov 29: Observations: The rest of the fish appear to be doing alright. Today is the last day for the experiment.

RESULTS OF RESEARCH

We were pleased with the results. We didn't have enough time to complete the whole experiment. We did succede in lowering the salinity of the aquarium enough to permit guppies from a rain water pond to survive in. We had no good way of testing the salinity of the aquarium water. We did try using a chloride test kit but when we did use it, it took too long to get results so we never could finish testing the water because of the short length of a school day.

Of the six manini, one aholehole and one butterflyfish, only one manini died. We believe that the manini died as a result of malnutrition and not as a result of the experiment.

At no time during the experiment did the fish get sick, go into convulsions or any eratic behavior. They always appeared to be happy and we never noticed any behavior change throughout the experiment. Once in a while they would chase each other around the aquarium but it is not known if it was in play or whether they were fighting.

DISCUSSION OF RESULTS

We didn't have enough time to completely transform the fish to living on pure freshwater. We did succede though in bringing the salinity of the aquarium water low enough to allow guppies from a freshwater pond to survive.

We plan to keep on changing the water until the fish are able to survive in a pure freshwater aquarium or until the die. We do not know if the manini will be able to produce offspring, although they should be able to.

We think our way of taking from the aquarium and replacing it with pure freshwater will work with almost any fish. But we recommend that smaller amounts be changed at a time. We had to use large amounts because of the lack of time.

CONCLUSIONS AND RECOMMENDATIONS

Our experiment was to see if a saltwater fish could be changed to a freshwater fish for future aqua culture experiences. Our experiment is not perfect nor exactly scientific but it can serve as a base for future experiments. We have a theory that if our experiment is perfected, a new species of freshwater fish could be made from the Manini. This new species could be farmed and provide a valuable source of food. We intended our experiment to serve as a base for our theory and we hope to someday see that theory become true.

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AQUACULTURE: THE MANY ASPECTS OF THE FRESHWATER PRAWN INDUSTRY

by Lawrence B. Sims, Pahoa High School

ABSTRACT

Aquaculture is a vast and growing area. Thus becoming Hawaii's main area of study. At this time the fresh water Prawn industry has grown imensely from just an experimental and research project to a fully producing fresh water Prawn industry.

INTRODUCTION

This is what I have written on this paper in hope that my idea can be the stepping stone for those planning to go into the Prawn Buisiness. Also in hope that this report will give the individual the basic concept as well as ways to go about starting a Prawn farm.

METHODS OF RESEARCH

My methods of research begins with reading the Honolulu Advertiser and picking out selected articles out of it. Then reading material from past symposium papers and books. Also selected sections out of the 1976 edition- Aquaculture in Hawaii. I have also spoken to my fellow peers and teachers who either have studyed the subject.

RESULTS OF RESEARCH

Many scientists and biologists have taken into much concederation of rasing the fresh water Prawns (Macrobrachium-Rosenbergii). But none have taken more time and much research than Dr.Shao-wenling,(the first scientist to control the life cycle of the Malaysian Prawn.) Dr.Shao-wenling is also known as the father of the emerging fresh water Prawn industry.

MARKETING

There are many aspects one must consider before thinking of raising the Prawns to market size.

First of all the Mulaysian Prawn is a tropical animal that requires warm climate and tempeture.

Second,You will need good aquaculture land or ponds. for example,If you wanted to convert marsh land into an area to raise the Prawns.One would be confronted with various problems.Some of these problems would be the enviromental impact statement and more than likely the conservationalists would complain also.

Third,In order to start your farm you will need the juvenile Prawns.So one must conseder if they are to buy from another farm or begin a hatchery of they're own.

fourth, the basic key of all industrys is good management. Many problems a prawn farmer faces are virtually the same as one would face in basically any other area of aquaculture.

Fifth, the best size for marketing the prawn is between six to eight count to a pound-heads on.

LOCATIONS

There are many possibilities of locations for raising the fresh water Prawns. One of these is the catfish farms, abandoned airstrips, and basically any area where the farm is away from the major pollution and any other influencing factors. The best area of warm climate seems to be Central America and Puerto Rico. This is due to the weather staying the same thoughout the year. Were as Hawaii varies during the winter months. Raishing prawns in areas like South Carolina by careful observation and by harvesting one season crops.

HANDLING THE PRAWNS

The obsticals in handling the product are not that large of a barrier, but merely just an understanding of what is envolved. The prawn has a very active enzyme system. In order to prevent spoilage it has to be stabilized very quickly after harvesting the prawns.

AQAUACULTURE LOANS

Chapter 219 of the Hawaii revised statutes provides for the establishment of an Aquaculture Revolving Loan Program. Originally Sepate bill 38 later to be changed to ACT181 of the 1971 Hawaii Legislature, which states: There is a special fund from which money shall be loaned by the Department of Agriculture under this charter. The program was adopted April 21, 1972. The farm loan division of the dept. of Agriculture was designated as the administrator. The Aquaculture Revolving Loan Program is restricted by the definition of Aquaculture in section 219, part two. Aquaculture is defined as: the production of aquatic plants and animal life for food and fiber within the real property taxes are assesed and are paid by the owner or producer. The loans can be made to any qualified Aquaculturist who is as defined as a person or association of persons, actively engaged in aquaculture farming, aquaculture product developement activities. Persons with provenaquaculture expertise, or otherwise work in the enterprise, may qualify under this definition.

CONCLUSION

I have choosen this area of study of aquaculture because I feel that it is a very promising area of reasearch and production. The real reason why I chose this area of study is because I like to eat prawns but the price is sort of high. So by my efforts maybe more farms will come about, causing the prices to lower, (due to the abundance of the prawns).

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OCEAN ENGINEERING

UPGRADING THE SEA WATER DELIVERY SYSTEM AT WAIKIKI AQUARIUM

by John Y. Hong, Moanalua High School

ABSTRACT

The Waikiki Aquarium displays many different aquatic organisms. The majority require a marine environment in order to survive. The successful maintenance of marine organisms requires a sea water medium of the highest possible quality. The sea water at the Waikiki Aquarium does not lend itself to such a description; it is of marginally acceptable quality. Three methods are proposed to improve the water quality, specifically, to increase O_2 and pH levels and to decrease CO_2 levels:

1. Sending the O_2 tower discharge water directly to the display tanks as opposed to the present system which mixes treated water with untreated water.
2. Installing water-air mixing devices which utilize the venturi effect.
3. Spraying sea water into the display tanks to promote further surface gas exchange.

INTRODUCTION

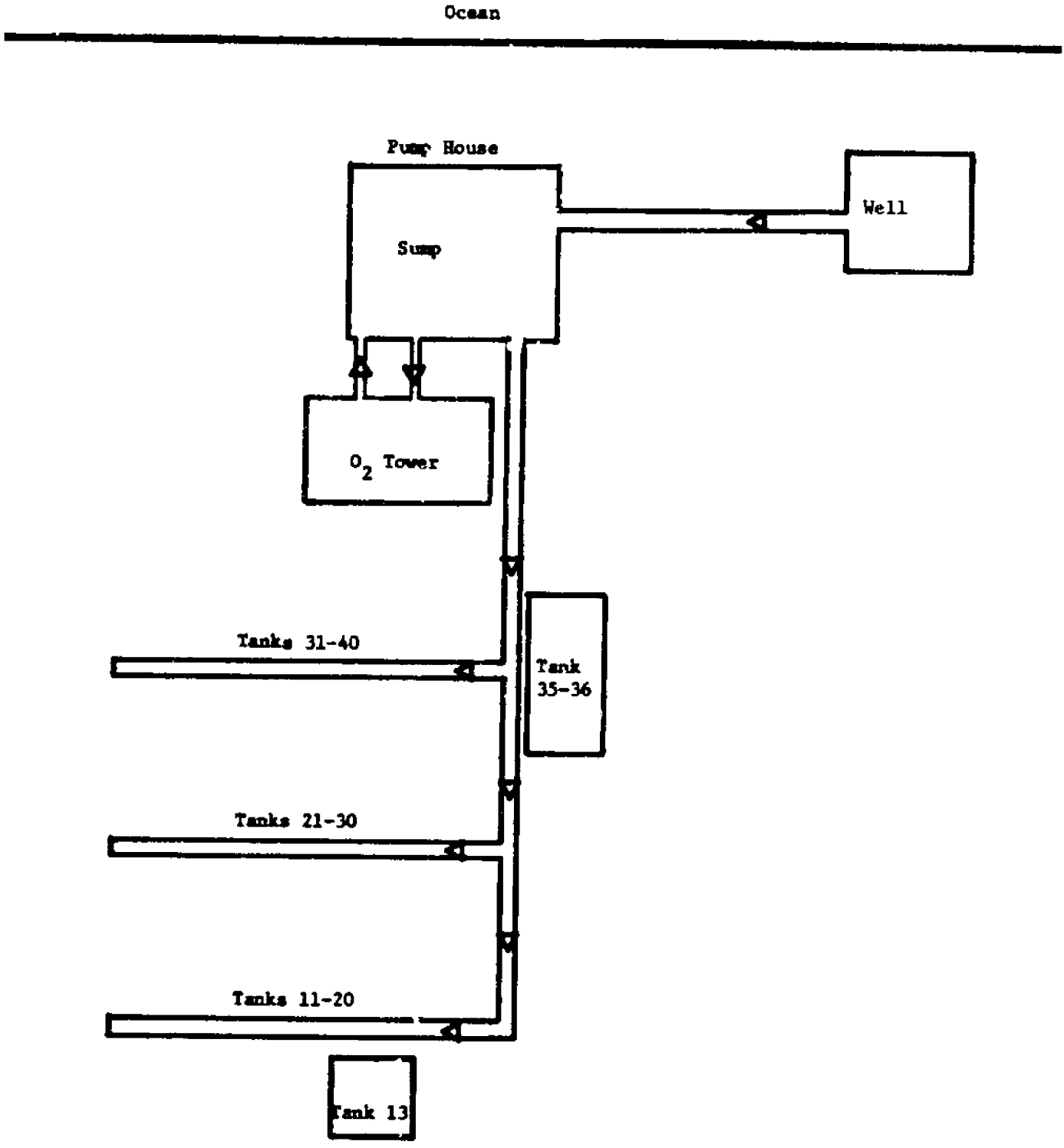
The Waikiki Aquarium is an institution devoted to promoting an increased awareness and understanding of the tremendously vast and complex ocean which surrounds us. It is a part of the University of Hawaii and has been at its present site since 1954. At the Waikiki Aquarium, the people of Hawaii as well as visitors from other lands, can observe many colorful and unique aquatic organisms. Invariably, the common denominator for a healthy and happy existence is water of the highest possible quality. Unfortunately, the sea water at the Aquarium could only be considered marginally acceptable. The situation is not without solution, however. The basework for resolving this problem will be presented in this paper.

PRESENT WATER CONDITIONS

The Waikiki Aquarium utilizes the open system. Fresh sea water constantly flows through most of the display tanks. This reduces the possibility of sudden pollution and increases the carrying capacity as compared to a closed system.

The sea water at the Aquarium is first drawn into a 80 foot deep well. In order to reach the well, the sea water must pass through a calcium carbonate strata which filters the sea water. Normal sea water has a pH of approximately 8.3 and an O_2 concentration of at least 4 ppm. The well water has a pH of 7.6 and an O_2 level of .25 - .50 ppm. The sea water flows from the well to the sump. When it arrives, it has an increased O_2 level of 3.5 ppm and a pH of 7.6. Sea water is then pumped from the sump to the O_2 tower, the display tanks, and the seal pool. The two display tanks used to monitor water conditions indoor are tank 35 - 36 and tank 13. Tank 35 - 36 is a double tank and the first tank on the line, tank 13 is one of the last. Tank 35 - 36 had

The Waikiki Aquarium Sea Water System



a pH of 7.6 and an O_2 level of 5.0 ppm. Tank 13 had a pH of 7.6 and an O_2 level of 6.0 ppm.

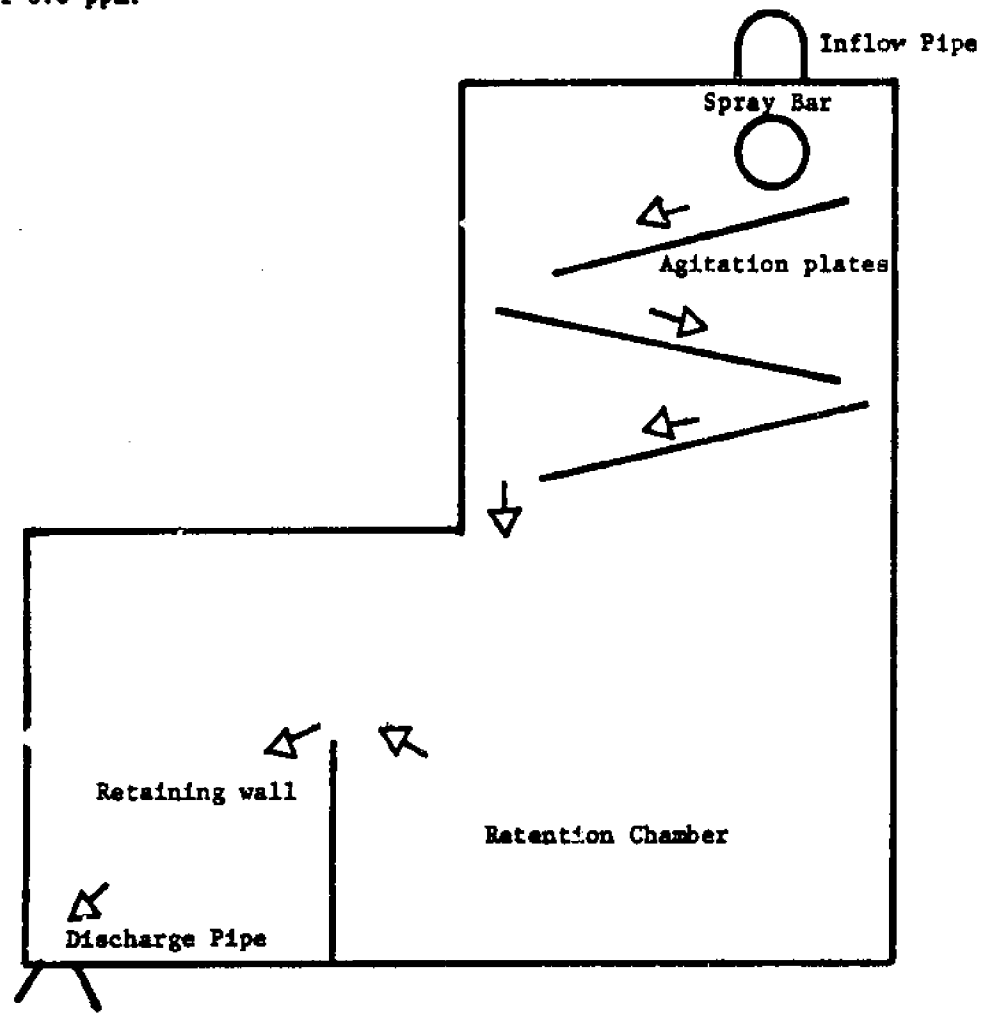


Diagram of O_2 Tower

The O_2 tower is simply a means to increase the O_2 concentration of the sea water used at the Aquarium. Sea water is pumped to the top of the tower, ejected through a spray bar, guided over three agitation plates, into a retention chamber, over a retaining wall and out a discharge pipe back into the sump. Unfortunately, returning this treated sea water to the sump compromises the quality of the sea water delivered to the display tanks.

WATER CHEMISTRY DATA

Oxygen (probe)

Date	Area	Reading
3/21/77	Well	.25 - .5 ppm
3/21/77	Sump	3.5 ppm
3/21/77	Tank 35-36	5.0 ppm
3/21/77	Tank 13	6.0 ppm

Oxygen (hach kit)

Date	Area	Reading
11/19/78	Tank 35-36	5.8 ppm
11/19/78	Tank 13	6.2 ppm

pH (hach kit)

Date	Area	Reading
3/21/77	Well	7.6
3/21/77	Sump	7.6
6/18/77	Tank 35-36	7.5-7.8
6/18/77	Tank 13	7.5-7.8

Carbon dioxide (hach kit)

Date	Area	Reading
6/18/77	Tank 35-36	20 ppm
6/18/77	Tank 13	20 ppm

Desired Conditions

O_2 7 ppm pH = 8.3 CO_2 5 ppm

In 1977, the Water Resources Research Center analysed the Waikiki Aquarium's water supply. At that time, the O_2 tower was operating at a lower level of efficiency. The flow rate was approximately 70 gallons per minute and the spray bar had not yet been installed. The increased O_2 levels measured on 11/19/78 are the result of the installation of the spray bar and an increase in the flow rate to 225 gallons per minute. Unfortunately, the new CO_2 and pH levels have not been measured due to non-availability of test equipment. However, the water quality is still below par. The two new O_2 levels in tank 35-36 and tank 13 are 5.8 ppm and 6.2 ppm, respectively. This falls short of the desired concentration of 7.0 ppm by more than .8 ppm.

The proper testing equipment is due to arrive in mid-December. At that time, all areas previously tested will be retested and all other required test data acquired.

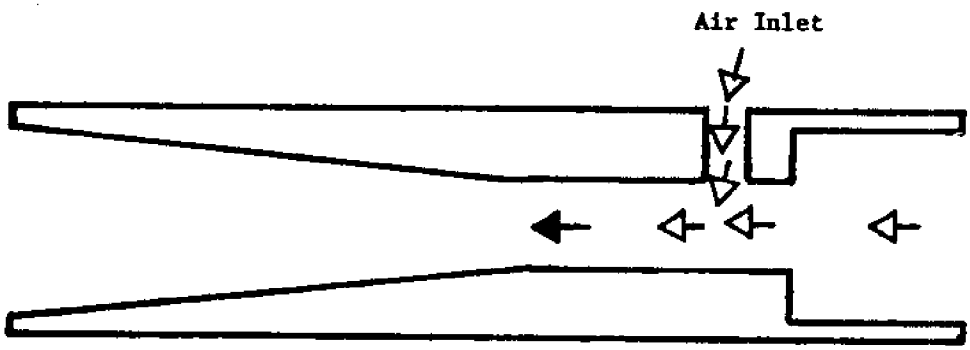
PROPOSED MODIFICATIONS

There are three possible methods by which to improve water quality. They could be used in combination or alone. The most efficient combination will have to be determined.

1. Eliminate mixing of O_2 tower discharge water with sump water. The sea water leaving the O_2 tower may meet or exceed the conditions desired. Either another pump will have to be installed or the entire O_2 tower could be moved to the roof of the Aquarium and the discharge water fed to the tanks below.

2. Installation of spray bars over each tank which will eject water into the tanks under pressure. This will agitate the surface and increase the available surface area for gas exchange and result in increased O_2 and pH levels and a lower CO_2 level.

3. Installation of water-air mixing devices in the sump which utilize the venturi effect. The venturi inspirator is capable of producing an extremely high concentration of dissolved O_2. Water flowing through the inspirator draws in air through the quarter-inch opening. Air and water are mixed together and sprayed out.



Cross Section of Venturi Inspirator[1]
(Full Size)

Due to budgetary and time restrictions, the actual installation and testing will be done during December 16 - 31 and the results will be presented at the Marine Affairs Symposium on January 11, 1979.

1 See Bibliography

ACKNOWLEDGEMENTS

I am very appreciative of the assistance extended by the following people:

Mr. Ralph Alexander, Waikiki Aquarium

Mr. Calvin Ito. Moanalua High School

Mr. Robin Otagaki, Moanalua High School

My mother, Mrs. Alice Hong

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AUTO REPAIRS; SORRY, NO CARS

by Kevin D. Snider, Pahoa High School

ABSTRACT

Your probably wondering what an auto repair article is doing in this book well the "Auto" stands for automated.

This paper is written so that maybe through my idea there could be a money saving device, so as not to draw more money than that which can be given to marine science related projects.

This paper is a discussion of 'Auto', a remote control under water mini sub, which I have designed, and its basic missions will consist of repairs under the ocean.

INTRODUCTION

Money is the prime factor for big projects such as Manganese nodule mining. To make up for such big costs, the miners have to mine a certain amount of manganese nodules each time they go out, and if something goes wrong below the surface, they have to stop the whole operation and haul the mining equipment up to where they can service it. It takes a long time to raise the equipment up from depths of 15,000 feet, and could cost the production valuable time. My Auto, is designed to go down and repair, if possible, the damage saveing time and money.

METHODS OF RECEARCH

My methods of research are few but the sources are good. The first thing that I did after I made my topic AUTO REPAIR, was to design a mini sub that would acomplish the task of Auto. The next thing I did was to read a booklet put out by the American Mining Congress, and look in the encyclopidia for different types of radio control systems and hydraulics that can be used for under water. Mostly this paper is application of my ideas on Auto.

With these combined efforts, I have come up with this paper.

RESULTS OF RESEARCH

First I will try to explain what my Auto does, and does not do. Auto can go down to great depths and still operate, because of the high pressure housing, and the long rage radio equipment onboard.

Auto can not go for long times of over 5 hours under water, because she runs on batteries, and these run down and can only be charged for a maximum of 5 hours because of the limited space. Auto can go down just for sampling Manganese nodules, or for a look to see which way the harvestor should go. Auto can not, or I should say should not go down again once it comes up, because of the ballast. The ballast should be loaded every time the Auto comes up to help the electric motors get Auto to the Bottom. Auto can be stored easily because of its small size, measuring only 6.5 ft long, by 3.5 ft. wide by 2.5 ft high, and light enough for two men to carry. Auto can see by the use of 4 radio control cameras, so the operators can see what is going on down under.

On the next page is a few drawings showing the workings of Auto, and views of various parts.

The following is a list to help you under stand the drawings.

Letter of Item	Description of Item
P	Receiver, for Radio control equipment, runs on batteries
X	Engine, runs on batteries, 5 hp. s1, and x2, 3 hp each, runs on batteries
Z	Batteries, 12 volt, rechargeable
O	Radio Control Equipment, operates all other equipment, runs on batteries
A	Arm hydrollics, 3 ft long fully ex., 1.5 ft long taken in
C	Camera equipment, runs on batteries, radio controlled, 4 cameras
CT	Camera transmiter, runs on batteries, transmits radio signals to operators
WC	Wire cage, for samples of manganese, or for broken parts**
B	Ballast hatch motor, runs on batteries, radio contr lled, helps with ascent and descent*
L	Lights, runs on batteries, each camera is equipt with one, radio controlled
R	Rudder, runs on batteries, radio controled***

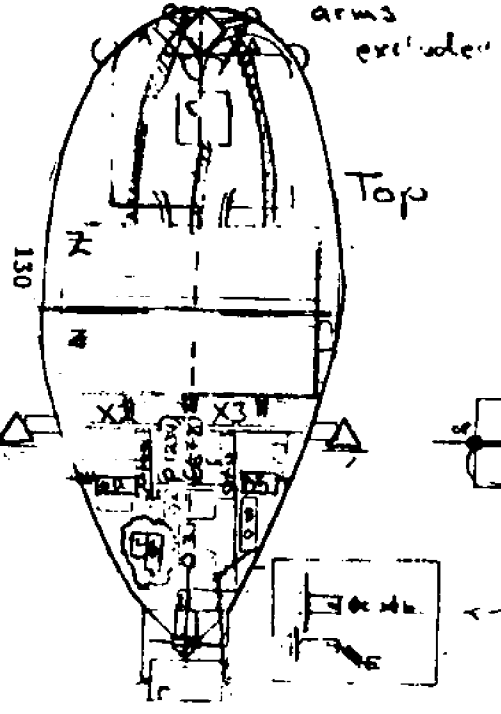
*Ballast is lead shot, and should be replaced after every use

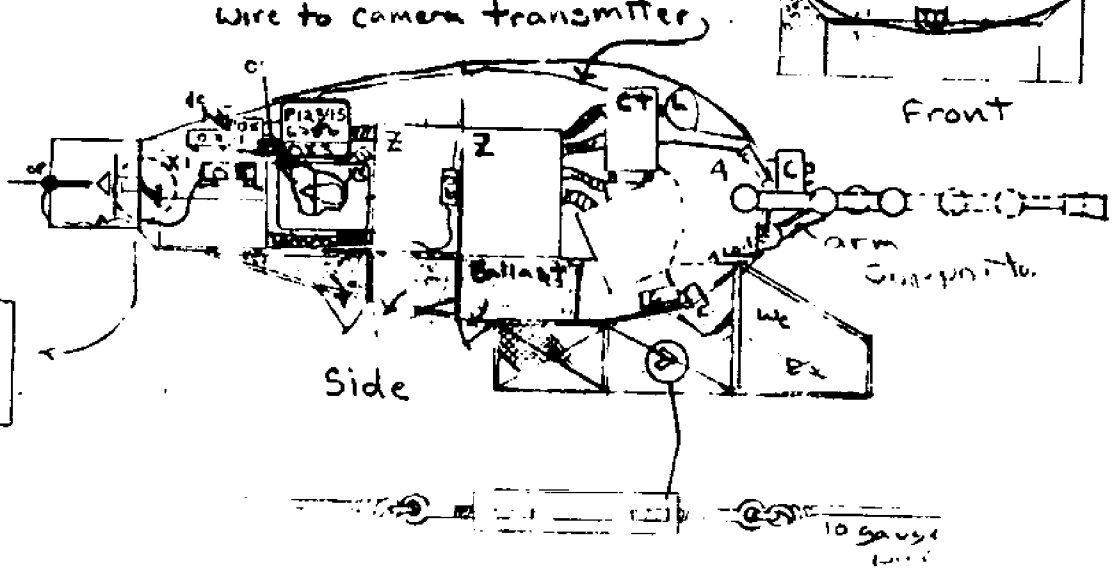
**Wire cage can carry broken parts, if they are able to come off so the whole harvestor will not have to be brought up. Or it can bring dive tanks down to divers

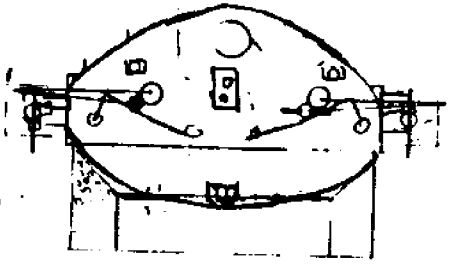
***Rudder only stears up and down motions, for right and left movement the engines 1 and 2 are turned higher or lower

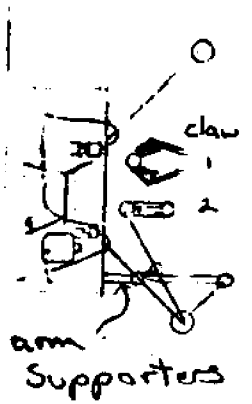
A U T O

by Kevin Snider









CONCLUSION

Since the early 1960's, commercial mining intrests in the United States and in other countries have made large investments to identify, explore and develop manganese nodule mine sites in the deep ocean. U.S. industry has invested over $150 million in this effort to date.

Research and exploration have determined that many billions of tons of manganese nodules are available for deep ocean mining recovery. Estimates of more than 300 prime mine sites offer an opportunity for development and nodule recovery.

This means that big amounts of money has to be spent, and every dollar has to be spent wisely.

My Auto, which I designed and developed, is an answer to the problem. It answers part of the problem, not all, but with the rising costs of mining every part helps.

My Auto does not cost alot to produce, and it would save valuable time and money.

With the Auto the miners can fix the harvestor in less time than origanly took, and maybe my idea has other uses too. Such as diver rescue and recover operations. Recovery of lost objects of the navy or independant research organizations.

It could possibly be modified to clean the bottom of ships, saveing time and making it easyer on big ships, allowing them to be cleaned in the water.

My Idea was thought up by me, I did not look in a book for the Idea of Auto. I even designed it before I researched, so when I did find more about Auto, I had to redesign it somewhat. I feel that if more people invent "work hourses", like Auto, mans jobs and life would be less complicated, and easyer in the long run.

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UNDERWATER HABITATS:
PROBLEMS, QUESTIONS, AND ANSWERS

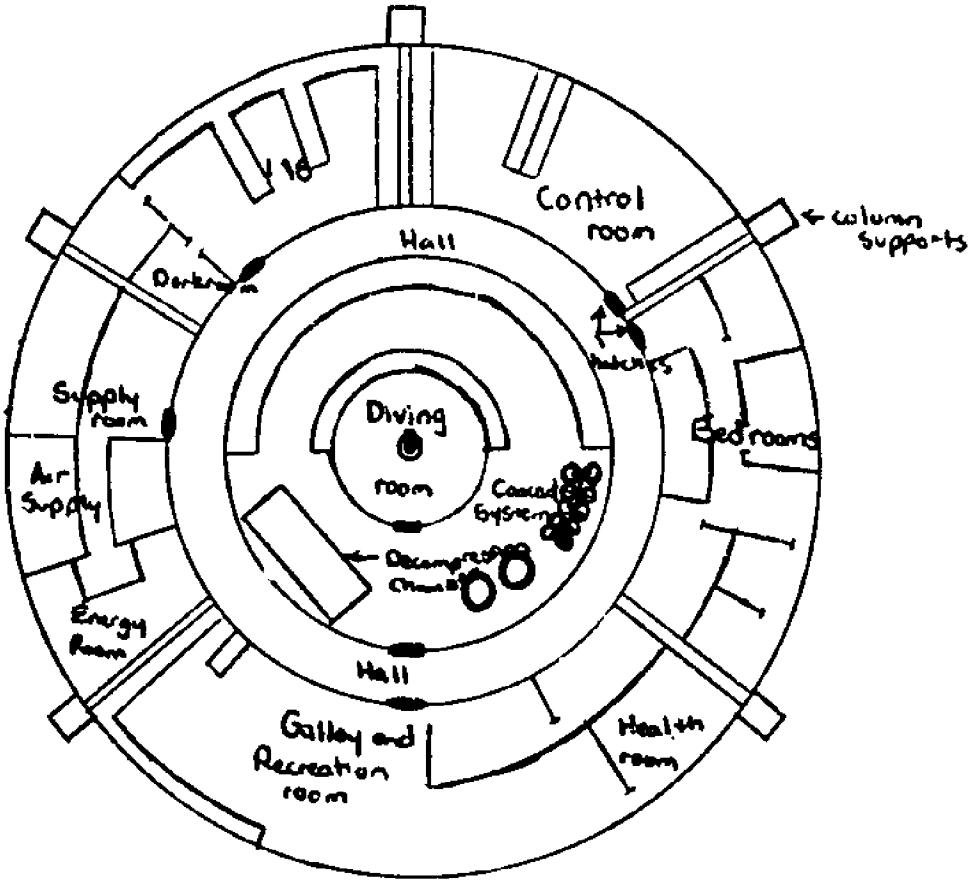
by William L. Krumpelman II, Kubasaki High School

INTRODUCTION

To give new ideas on the subject of ocean engineering is the purpose of this paper. The ocean engineering that I am concerned with in this paper is in the field of underwater habitats. A underwater habitat is a house underwater where man learns more about himself and the creatures around him. In this paper I will discuss problems and answers on such projects in ocean research.

With mans growing population he will be seeking pleasure, work, and shelter within the sea. This paper is about a way in which man can seek shelter and study the ocean within its own environment. The knowledge taken from such a project would give man a chance to better his understanding of his surrounds on the mother earth. There is no reason why men should not start now to build a permanent underwater housing unit or a laboratory for scientific studies.

Diagram 1



This floorplan layout is an example of things that may be used in the actual habitat. Rooms may be changed to fulfill the needs of the user. Blocking a room would have great advantages, because it would help in case of a water leak in the structure. Also it would provide safe movement in all other rooms. Computers and a T.V. monitoring system would set off an alarm if a structural break should occur. The breakage would be collected on sensors throughout the habitat. Thick glass windows would be installed for better observation in the habitat. A small special tank that is built in to the superstructure of the habitat will provide close observation on different experiments. It would be connected to the outside seawater.

Diagram 2

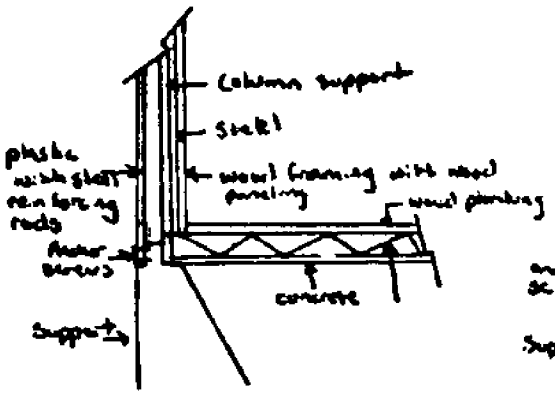
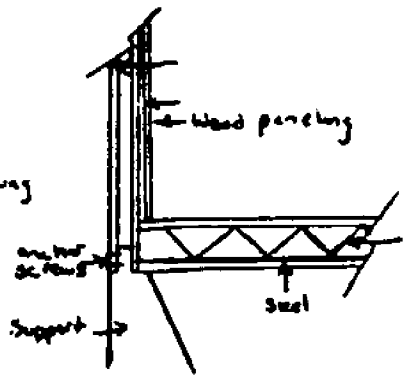
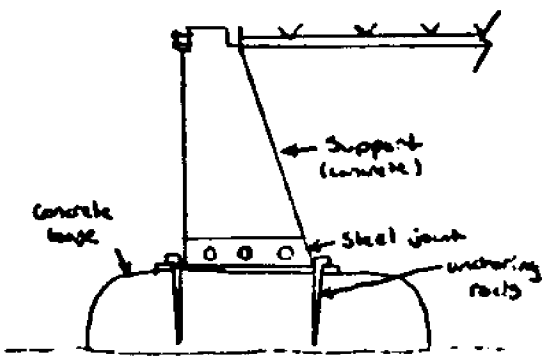


Diagram 3



In my analysis of the ways of constructing a habitat, I noticed that most habitats only stay down for short periods of time (2 or 3 months). In my investigation I am trying to find ways of habitats and peaple staying down permanently and without problems. Corrosion is one factor in which we have to place emphasis on when staying down long periods of time. Costs of building such habitats must also be involved while trying to find a cheaper and safer way of experimentation. The keeping up with and securing the habitat will cost money.

Diagram 4

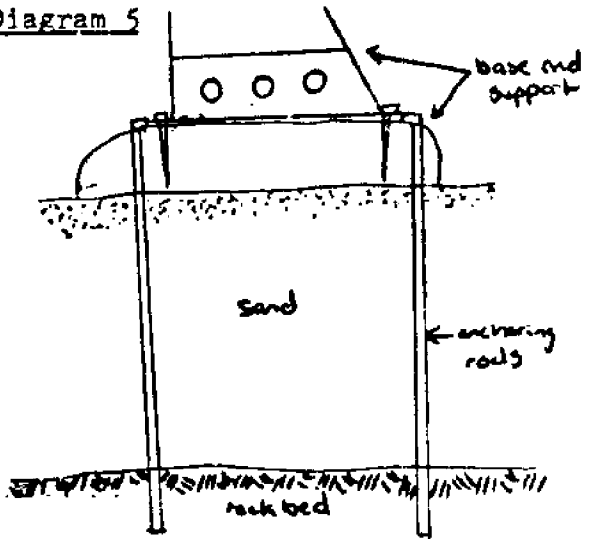


Construction and bringing the habitat to its site is a big problem. Trying to keep it self-sustained is another problem. The Cost of building one large cylander and its base would run at about $700,000 per duplex. For a 3-story, 24 man habitat, it would run to about $1.8 million. It would be a costly experiment but if it works, all the information gathered by the experts in the habitat, may be very useful. "If man could learn to master the depths of the sea, he could possibly be a assured of a large measure of good health, an unlimited food supply, climate control and a gigantic quantity of minerals and metal."[1]

In other words the money spent on such a large project would more than likely come back by research findings and experiments.

The ideal site for such a habitat as I have designed would be in the Gulf of California. The Gulf of California has a sandy bottom with a rockbed underneath. This would be ideal for my design of anchoring the habitat down (Diagram 5). Depth is also a limiting factor in my design. Anywhere form sea level to 180 feet of water is where the habitat may be set. A 20 feet safety margin must be made to make sure the structure can withstand the pressure.

Diagram 5



The Gulf of California is an ideal spot because there are not enough factors such as currents, storms, ect. to oppose the construction and every day living on the habitat. Alternate sites can be made in the Gulf of Mexico, in the Bahamas, and in the East China Sea. Some areas in the ~~south~~ South Pacific are good because of the warm waters and sandy areas.

Construction of my design of a habitat must be on land, where all the fine articles can be installed with no problem. The habitat would have to be towed out to the site or brought out on a special ship. Then it will be transported down to the location on which it will sit. Diagram 6 shows one method in which the habitat may be lowered. This type of lowering system is almost like an elevator. Also in my system of construction the single habitats can be stacked and scattered throughout the sea bottom all connected to each other.

Diaram 7&8 shows how this may be done and how they would be connected. This method would make it possible to be like an underwater ocean city. This system could be a milestone to many such construction works and laboratory systems. The structure would have to be built to withstand obstacles for many years to come. It would have to be built as a thing to last permanently.

Diagram 6

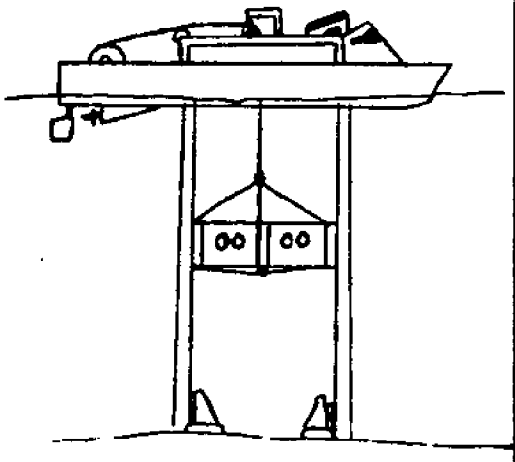


Diagram 7

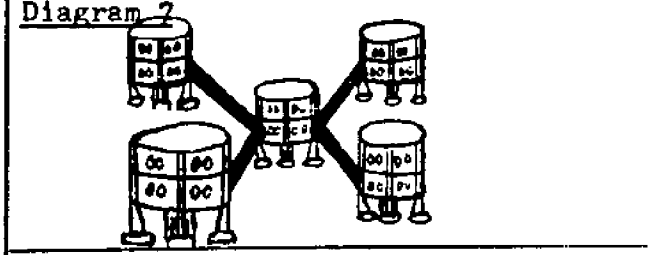
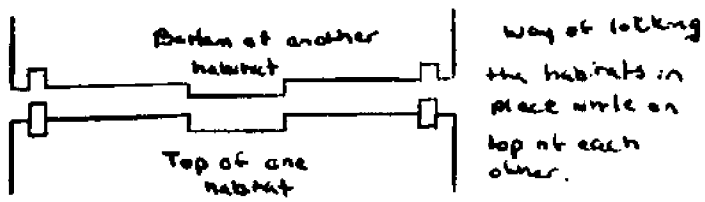


Diagram 8



Here are five different energy sources to supply the habitat. Battery packs can be used on the habitat and can be recharged after short periods of time. This would be a costly manuever and would hamper the everyday living by having to be changed in short periods of time.

Solar energy could be used in great extents in the habitat if it were located in Baja, California. This is because it is near the equator, where most of the sun hits. The sandy peninsula of Baja would be an ideal location for putting up a solar energy paneling center for producing electricity for the habitat. This would be costly at first but then would be refunded back by the progress in the habitat. This method would more than likely be a great success.

Geothermal energy can be also used on land and in underwater faults. Geothermal energy is getting energy from the earths faults, hot water springs, and other things having to do with underground heat. Also underground springs and currents can be used by going through a turbine engine which produces the energy. Wind energy can be used above the habitat, rotating a turbine, which in turn turns the turbine producing the energy. This and the others would have to be built in a way so that they will not effect the environment's way of life in a harmful way.

A nuclear energy reactor can be used for an indefinite time if it is very expensive, well cared for, and is made to do the job. It would be very expensive at first, but it would not have to be changed after periods of time. The only problem would be that if a break in the reactor may occur, the radiation would spread throughout the habitat killing the inhabitants. So precautions must be administered in order to keep the habitat safe. A nuclear reactor is used in todays submarines and is very sucessful. It would be very costly, but the labor cost, running cost, and parts cost can be deducted in the end and would end up being a profitable buy.

A) For a structure that is not thick enough to hold the pressures at a certain depth.

If the structure is not thick enough to hold the pressures of deep depths, then the air pressure inside would have to be the same as outside in order to keep the habitat from caving in. The air would have to be a Helium, Nitrogen, Oxygen mixture. The people in the habitat could only talk like Donald Duck. So these long experimentation projects could physiologically have problems in the peoples' minds.

The habitat could only go down so far because if the pressure inside is the same as outside, the pressure may kill. The habitat can have air administered three ways, air cables from land, a snorkel method, or by a cascade system. The cables would have to be highly pressurized at all times in order to keep the flow from land to the habitat going. But a minor few meters on a gauge can mean a life and death situation. The snorkle method can be used with a compressor in the habitat to suck the air into the habitat from the surface and distribute it throughout the rooms. Highly usable except in rough seas, this method would have to have a backup system. The cascade system can be used as a backup for the snorkle or for the main use on the habitat. The cascade system is a system in which bottles of compressed air are used to let out air in the habitat. Almost like the use of a scuba tank. The pressure in the habitat must be the same as outside, so a computer base in the control room has a detector to tell if there is a change in pressure. A buzzer would go off alarming the inhabitants that they are in an emergency situation. The pressure inside will keep the water out of the bottom hatch if it was opened down underwater.

B) For structure that enough to withhold pressure at a maximam o of 200 feet.

If the structure of the habitat is thick enough to withhold the pressure of 200 feet and less, then the air inside would only have to be the same as sea level (14.7). My structure of A212 grade B steel .375 inch thick would be just suitable for 200 feet and less (Same construction of submersable STAR I). The snorkle system with a cascade backup system would be just right for the size of a structure.

Once divers go down more than 33 feet they start collecting Nitrogen in the skin cells. This process after a period of time is called saturation. When a diver becomes so saturated, he must decompress

in order to let the excess nitrogen out of the skin. If a diver comes up toofast under a saturated condition, the nitrogen does not have time to get out so it collects in joints causing the diver to get "bent". To keep this from happening we have a Cachalot diving system which consists of a decompression cylander on a support ship and a smaller transfer vessel to bring the people from the habitat to the decompression cylander. Peaple living 200 feet down must decompress about one full day in order to be safe. Once the people are saturated they may stay down permanently as long as they do not come to the surface of the ocean.

Air can be produced from a cable system from land, a snorkle from the surface or a cascade system in the habitat. For the snorkle method a air conditioning system can be used. In the grids of the air conditioning ducts, could be a substance that will break up CO_2. This is done in some submarines to help the air situation. Fans can be used in the habitat if the pressure inside is the same as outside, and a 70 degree F temperature would be most suitable in both different types of habitat structure. The air compound in the habitat, which has the same pressure inside as outside, would be made up of Helium, Nitrogen, and Oxygen.

Corrosion can be a damaging thing underwater to a permanent structure for use every day. Because of this I tried to find other ways of trying to defend our structure. In the second elevation on page 2 (Diagram 3) the outside coating is plastic or plexiglass with a wire mesh for reinforcing the plastic. The bottom is made of concrete, for extra protection. Concrete Plastic, and Plexiglass does not corrode but may collect few barnacles. These would not harm the everyday living of the habitat. On my drawing (Diagram 3) the pressure inside

would have to be the same as outside making the inhabitants breath Helium, Nitrogen, and Oxygen compounds and talk like Donald Duck.

Another way to stop corrosion is to put zinc plates on your metal structure to help keep away corrosive items. This is used on any submarine, Nuclear or Diesel. An elevation is on page 2 (Diagram 2) showing the structure with its zinc plates.

Safety is always a factor in all things that go underwater and my habitat is not an exception. Rooms may be blocked in case of a break in the structure of the habitat. This would provide safe passage through other compartments. If the super structure is fiberglass or plastic then the pressure inside would have to be the same inside as outside, only if the habitat structure was thick enough to uphold the pressures from the outside seawater. In case of a pressure change the diving room can be air locked or water pushed in to provide acess to divers. This can be done like on Jacques Cousteau's Conshelf in which the pressure is the same inside as outside, leaving easy acess through the bottom hatchway of the habitat. A submarine uses a flooding system which allows the divers to have full gear on and go into the diving room. In the room, when the divers are in full uniform, the outside seawater is let in and when it is all the way full the divers can open the hatch and get out.

A decompression chamber is inside the diving room on the habitat. It can be used in the case of a emergency. For close linkup with the land base and the habitat, a T.V. monitoring system, a phone hookup, and a set of electronic coders are used in case something might happen. Doctors and technicans can stop by every 2 to3 months when the supply ship comes. This is the time when the inhabitants of the habitat are analyzed. If the supply ship does not come on time then, there would

be stored in the habitat enough extras to last at least up to 10 days. One sub is provided for the use in case of an emergency.

Extra food and water will be provided in case of an emergency should occur. A supply ship comes by every two to three months with supplies for the habitat. If a storm or rough seas should be encountered by the supply ship, then this extra supply will be used. Also provided is a submarine for transport and supplies in case a need should arise and someone from the habitat would have to go to the land base.

No smoking or cooking can be permitted in the habitat if the structure is made so that the pressure inside is the same as the outside. This is because the fumes will mix with the pressurized air and make it poisonous to all the inhabitants. Fire gear is provided in the habitat in case of a fire breakout of an electrical circuit or by just common accident. The fumes from a fire could become fatal in a underwater habitat while under pressure and pressurized air.

A shark cage is built in to the opening on the bottom of the habitat. It is used for protection against predators.

In the structure in which the air pressure is the same as the outside pressure, no gas or smoke may be made inside because it would mix with the Helium, Nitrogen, and Oxygen compound and if you had enough of it, it would be poisonous. Therefore no cooking, smoking, or other things doing with smoke or fumes cannot be used in this habitat. In this case all the food must be precooked or concentrated. If you would like your food warmed you may do so if you use an infer-red heater to warm it up(not cook it). Raw fish gathered by the habitat may be eaten with extreme cautior, because they may be effected by the activities around the habitat or they may be the poisonous kind.

Trash and sewage will be stored in a large container on the bottom or the habitat. After long periods of time they will be removed by a supply ship and replaced with a new one. Since they will be using precooked or concentrated foods, there would not be much trash and thus be the minimum.

If the structure permitts 14.7 psi inside the habitat or sea level pressure, then you could smoke, cook ect. This would be worked like an ordinary submarine today. Hot water would be made by a haater and a freshwater supply will be brought by underwater cables to the habitat. An aquaculture farm outside the habitat would help provide both meat and plant foods to the inhabitants of the habitat.

All costs to the making of my plan of a habitat could be refunded by the work in the habitats field and laboratory results. This would help bring mining, aquaculture, and professions closer to the environment and thus making new progress in fields of science.

"In the not too distant future there will be more jobs available for undersea workers- mapmakers, engineers, zoologists, biologists, underwater farmers, salvage workers, divers, miners, mineralogists, and a host of others for persons skilled in oceanography."[2]

" With the crowding generated by our population explosion, it is likely that, in the near future, people may seek more and more of their recreation in the sea. There is no reason at the present why giant, dome-shaped resorts should not be submerged on the white sands of Bermuda, providing fantastic views of the sea life all around, offering easy acess to the sea by a diver."[3]

I say that my plan and my site in the Gulf of California would be ideal for this information in the above paragraph. This could be man's reentry to the sea where he first came out millions of years ago.

FOOTNOTES

[1]Milton R. Machlin, Our Future Under The Sea, 1968, Birk & Co., inc., page 6.

[2]Same as above page 14.

[3]Same as above page 14.

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FOOD FROM THE SEA

THE OCEAN: A NOURISHMENT FOR MAN

by Patricia T. Fernandez, Sacred Hearts Academy

ABSTRACT

The ocean is a rich natural storehouse for man. Man has looked to the ocean for nourishment, energy, medicine, industrialization, and many other things. It has been difficult for man to obtain the harvests, for many obstacles lie in his way. Today there are new equipments and techniques to overcome these obstacles. Several new techniques and devices would be mentioned to get nourishment of the ocean more efficiently, but so that there is a reasonable balance of the species in the ocean to avoid extinction. This is what my project is about.

Introduction

The ocean is a rich natural storehouse for man. It is only in modern times that there has been recognition of the vastness and the variety of richness. Man could find a world in the ocean with everything he needs to maintain living in reasonable comfort if all the resources on the land were to vanish away.

Man has looked to the ocean for nourishment, energy, medicine, industrialization, and many other things. The ocean still has many secrets to reveal. And because of this, it has been difficult for man to obtain the harvests, for many obstacles lie in his way. Today there are new equipments and techniques to overcome these obstacles.

Several new techniques and devices would be mentioned in the nourishment of the ocean in which man can still get a great amount of food from the ocean more efficiently, but so that there is a reasonable balance of the species in the ocean to avoid extinction. This is what my project will be about.

The Ocean: A Nourishment For Man

The ocean has the potential to enrich man in many different ways. The sea's ability to nourish him is a more immediate bearing on his well-being. The rapid growth of the population has created an increasing demand for more food that land resources cannot meet. If new means of food production are not found, then worldwide starvation would draw near. [1] "A former director of the United Nations Food and Agriculture Organization has estimated that before the middle of the next century the amount of food required to feed the world's exploding population will be eight times greater than it is today. And at the same time land resources are falling farther and farther behind in the race to keep up with needs, more land will be taken out of cultivation to provide homes and factories for the great amount of people."

Better use of available land resuorces would help, but there is a limit to the production of the land. It is not a final solution to our future problem. All around us is the answer - the ocean.

Today great emphasis is placed on the scientific methods in the problem of obtaining food from the sea. Marine biologists are putting to use the techniques and devices of oceanography to uncover a new level of efficiency in commercial fishing. [2] "Why do some fishing vessels return with half-empty holds; have the fish migrated to another area? If so, why and where sis they go? What caused them to leave their usual haunts and what attracted them to their new locations? How do salinity, temperature, and other oceanic variables affect fish? Do the various species possess any specila characteristics that would enable them to be harvested more readily by one method than by another? Are there ways to in insure that more fish eggs will hatch and survive to grow into mature animals? Are there certain times when particular species or particular areas should not

[1] Vernon Prizer, The World Ocean, p.139.

[2] Robert Miller, The Sea, p. 302

be fished in order to protect and enhance future harvests?" The answer to these and other basic questions that marine biologists ask and try to answer will drive forward commerical fishing, which has always been a backward industry.

The influence of science is already making itself felt among fishermen. Even though marine biologists have only little information to work with so far, they are achieving a high degree of precision in predicting the times and the places where certain species of fish will appear, and often a full year in advance. As a result of their achievement, fishermen in New England waters have learned to plan their operations around the forecasts issued by the U. S. Bureau of Commercial Fisheries. When oceanographers have gained all the marine animal information they are looking for, long-range fish forecasting services are bound to become more widespread and more accurate.

Besides telling fishermen where to harvest the seas, marine specialists are are showing them ways to fish more effectively. Almost all fishing boats today,even the more modest ones, are equipped with sonar to find deep, large amount of fish by echo sounding. [3] "Shrimp trawls -great sledlike traps that are dragged along the bottom-are now provided with electrodes that shock the shrimp, causing them to emerge from the burrows into which they crawl during the day; thus shrimping has become an around-the-clock operation whereas it once took place only at night." Soviet fishermen lower light sources into the sea to cause masses of fish to come together for easy catching, knowing that light attracts fish. While American fishermen fish in independent single-ship operations, many foreign fishermen operate in fleets that include supply ships and freezing facilities to preserve their catches. This type of operation enables them to stay at sea for an extended period and to bring in great amounts of fish.

[3] Priser, p. 141.

One of the newer techniques making an important contribution to larger catches is purse seining. In this method, as soon as a large group of fish is located, the fishing vessels puts small boats over the side to encircle them with the seine which is an enormously long, wide stretch of netting. [4] "When the small boats have completed their huge circuit of the concentration, paying out the seine en route, they have fenced off the fish behind the netting, the top of which is supported at the surface by buoyant floats and the bottom of which is open. Along the bottom of the seine are metal rings through which a cable is threaded. Now the fishing vessel begins to reel in the cable on its power winches. As the cable is taken up it closes off the bottom of the seine, creating a giant "purse" alive with thrashing fish. So many fishes do these purses scoop up that a number of vessels employ a kind of "vacuum cleaner" -a large-diameter suction hose to inhale them into the hold of the ship."

The whalers are the best equipped and the most mechanized of all the harvesters of the sea. Whaling expeditions are highly organized undertalings centures around factory ships supported by an armada of catchers, tankers, and refrigerator ships. The catchers -small, fast vessels directed by helicopter spotters and armed with cannon that fire explosive-tipped harpoons, are close in fo the kill. The factory ship then takes the catch from the catchers. The catchers then steam off another whale. Meanwhile, the factory ship crew lifts the whale up on the ramp and starts it through an assembly line that efficiently reduces that great enormous carcass into meat, into blubber that is rendered into oil, and into all of its other useful resources.

Increasing the fish catch is very harmful. It must be done with reasonable amount needed in order to preserve reasonable balance among the fish population. If not, then there is real danger of some species becoming extinct. Ruthless hunting of whales has brought them to almost depletion so that international

[4] Prizer, p. 141.

agreement had to be reached to regulate whale catching. There are two opposing elements in putting an influence over the matter of harvesting the beautiful sea. One is the pressing need of a world hungry for protein that is contained in fishes. There is also the need to prevent the more species from coming extinct. There are several means of overcoming the apparent contradiction between these two influences.

One answer is to alter public eating preferences, to increase the varieties of marine foods that people eat. There are hundreds of species that fishermen toss back into the sea because there is not a demand for them. Seventy-five percent of the world's catch is confined to several types of fish. People do not want to try other types of fish that are strange to them because they are used to the other types they have already tried and liked. If a type of program could widen people's eating habits for under-fished species, then it would help preserve the more demanded varieties. Sometimes it is because of the name of the species. But the dogfish is an example of someone with imagination who invented a dish and changed the name into "ocean perch," giving it a better sound to it. People began trying it and liked it. Ever since that incident, it has become a popular species. Now they are called "cutlet fish."

A most promising solution to the world's need for more animal protein is FPC, fish protein concentrate, called fish flour. It is a colorless tasteless, odorless and highly nutritious powder. It is produced from fish of almost all types, including the so-called "trash" fish that are never brought to market. FPC is not eaten alone, but it is mixed with other foods such as milk, soups, or bread. It provides the same nutritional value of a piece of steak, when it is added to ordinary flour and baked into bread. That is, a slice of the baked bread with FPC has the same nutritional value as the steak, and imagine the low cost.

Despite the advantages provided by FPC, there are still problems. Fish flour is still made from the whole fish. Resistance to the use of FPC is based on the fact that it is the product of the whole fish, including the insides. Because of this fact, people claim that the fish is dirty. But these people who assume this do not realize that oysters, clams, sardines, and several other types are eaten whole, insides and all, and nobody considers them dirty. Today the FPC is used for protein for poor nations all around the world.

Another means of getting nourishment from the ocean is through aquaculture. There is no reason why the techniques used to increase the productivity of the land cannot be used to increase the productivity of the ocean. [5] "Why not stake out oceanic ranches where salinity, temperature, currents, and other conditions would support the rapid growth of marine life? Why not fertilize these ranches with the nutrients on which sea animals thrive? Why not stock them with selected types of breeding fish in the same way that landsmen use prime breeders to improve their animal resources? Why not control marine pests to prevent harm to the underwater species?" These things have been done or are already being done to some degree.

The most advanced aquaculturists are the Japanese. For more than half the century they have been producing cultured pearls. Not only do they produce pearls, they also produce large quantities of marine species for food. They raised great amounts of oysters, bass, eel, shrimp, and other types of food. They are also well advanced in different types of seaweed. So for the Japanese, they are well advanced. They will be able to feed their population without harming the balance of marine life.

As for the western world, they are behind the Japanese because they have

[5] Prizer, p. 144.

concentrated only on the raising of fresh-water fish. Salt-water aquaculture has been limited to only oysters and clams. But now these restrictions are changing. Men are now doing more activities in aquaculture. And because of widening their activities, they are advancing more into aquaculture.

World food authorities are pressing for more effective ways of getting nourishment from the sea because they are very aware of the race between man and his supply for food. They are also very aware of the fact that one out of every five persons in the world today lacks sufficient protein in his diet, and if man would use his intelligence to get it from the bountiful sea wisely. They have claimed that the ocean has the potential to provide protein requirements to thirty billion people.. Such is the bounty of the astonishing sea.

Conclusion

The sea has a lot of resources to offer man, if man is willing to discover it. One of the more important riches of the sea is the future food for man. Man is now looking ot the ocean for nourishment because right now in this world th there is starvation. Reasons for this are that the land has a limit to its productions, over population, and high costs.

Man has found new techniques and devices in catching great amounts of fish to try to solve some of his problems. The sonar is used to find schools of fish in deep waters. FPC, a food protein, has been discovered which can feed people at a low cost. Aquaculture has been started in several different cities of the world. And because of aquaculture, man has found new ways to increase the productivity of the ocean.

Now you see why the ocean is bountiful to man in nourishment. And by exploring it, man has overcome several of his problems in survival. Since man has still a lot to know about the ocean, he is still exploring it for further riches for his survival. Man has already progressed and still much further. All man has to do is not to harm the ocean in any way for it might destroy his only future survival. Let the way he has treated his present environment teach him a lesson.

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CAN THE SHARK BECOME A MAJOR FOOD RESOURCE FOR HAWAII

by Scot K. Tsuchiyama, Kauai High School

ABSTRACT

We are now learning how to use our ocean resources more effectively. One resource which might be a future resource is the shark.

The shark could be a food resource for the future but there are barriers in the way. The barriers exist between the fisherman and the retailer, the retailer and the consumer, and the consumer and the shark.

This paper will examine some barriers which exist.

The shark is the legendary terror of the sea. The shark was built up by the media to a point where the mention of a shark would bring about a fear in everyone. The movie makers added to this by producing movies like Jaws, The Deep, and Jaws II. Through these movies the public has seen some of the bad sides of sharks. Like anything else the shark also has a good side. I think the image of the shark is beginning to change and this may open other doors for the shark. One of these doors maybe the developing of the shark into a viable food resource.

It has been proven that the shark has the potential to become a useful food resource. Before 1954 the shark was used by the fishcake industry as a binder in its fishcake. Some sharks were reported to be better binders than others. Some which were favored were the hammerhead, galapagos, sandbar, white tip, thresher, and mako. Legislation was passed that killed off the shark fishery here in the islands. This legislation required that the ingredients going into the fishcake be listed. Between the years of 1944 and 1953 before the legislation was passed, 21,000 pounds of shark were caught per year.[1] This number dropped significantly to 200 pounds in 1954 and 12 pounds in 1955.[2]

Twenty-one thousand pounds of shark per year in 1953 is very good compared to 117,542 pounds of mahimahi and 71,600 pounds of ono caught in 1975.[3] On Easy Rider's two shark catching trips the total amount of shark caught was 2,000 pounds on each trip.[4] This amount could rise if shark were caught on a regular basis. Department of Planning and Economic Development studies have concluded that shark fishing in Hawaii could yield between 230,000 to 325,000 pounds of dressed shark meat. This shows that there are a lot of sharks out in the ocean just waiting to be caught.

The first step in getting this 230,000 to 325,000 pounds of shark to materialize would be to get the shark caught. The fishermen who go out to fish are the first link in the chain which might lead to the materialization of a shark industry here in Hawaii. The first question one may ask is why haven't fishermen fished for shark. There maybe many reasons for fishermen not fishing for shark but to explore every reason in one paper may take too long. I will only give and explain some of the major problems which deter fishermen from fishing the shark.

One reason for not fishing for shark is that shark meat must be cleaned and dressed quickly after it is landed or else it will spoil. After a hard day or hard night of fishing, fishermen are usually too tired to clean and soak the shark meat in brine water. The shark meat must be soaked in brine just in case the meat has a high urea content. Immediately after soaking the meat in the brine solution it must be iced down. The meat must be iced down immediately or it may spoil. Shark meat spoils very fast contrary to popular beliefs.[6]

The cost of catching shark is very high because you must spend money to buy equipment and the return on the initial investment is not very good. The price for shark meat now is between 35 and 50 cents a pound.[7] For a fisherman to make money on a shark he would have to sell the shark for 50 cents or better.[8] Fishermen are willing, however, to lower their price if limitations on size, amount, and species of sharks are not imposed. The fishermen who are willing to lower their prices are those who accidentally catch a shark and bring it to the market. These sharks caught are actually a supplement to the fishermen's income but nevertheless these sharks take up valuable space in a fish box.

This space in a fish box is another reason for not catching sharks. This space can be filled with other fishes with a higher wholesale price.

A ten foot shark weighs about 200 pounds and sells for 50 cents a pound while ahi of the same weight may receive over $1.50 a pound. The price of shark right now is too unstable for fishermen to risk the space in their fish boxes to a shark. A survey was taken by the Department of Planning and Economic Development and it showed that if the State would subsidize the fishermen so that the bottom price for shark meat will be 50 cents a pound, fishermen would be willing to bring in sharks caught accidentally.[8] This idea of subsidies looks like the only way shark fisheries will become a reality.

The restaurants and retail fish outlets also want State money in order to make shark available to the public. The retail fish markets are the main outlets through which customers buy fish. Fishermen are asking 50 cents for a landed shark and a dollar for fillets. The retail stores are only willing to give 25 to 60 cents a pound for a shark[9] which means there's a discrepancy of 25 cents. This discrepancy is caused by the amount of shark which has to be thrown away. The only thing which is useable to the retailer is the shark fillet. The shark head, guts, and fins must be discarded because there is no market for them. The retailers don't want to take the risk of buying shark and to find out later that there is no consumer interest in shark fillet. This is where the State money comes into the picture. The retailers want the State to subsidize them in a shark meat promotion campaign. A recent survey of retail stores on Kauai by the Kauai High School Distributive Education class showed that 60% of the stores surveyed would sell shark.[10]

Seventy-eight percent of the stores would stock their shelves with shark if the State was willing to spend money to promote shark meat.[11] This promotion of shark meat is needed to get consumer interest. After

interest is raised the price of the meat might go up enough so that the fishermen and retailers can reach a price which would suit both parties.

The restaurants seem to be the best outlet for shark at this time. The restaurants and fishermen seem to be more in agreement on the price for shark meat. The restaurants are willing to pay between 50 and 95 cents a pound for dressed shark meat.[12] This price for shark meat seems to meet everyone's demand and the price on a menu might also be reasonable.

Another problem arises though a Kauai High School Distributive Education survey of Kauai restaurants indicates that only 29% of the restaurants surveyed are willing to put shark on their menus.[13] This shows that restaurants are not willing to put shark meat on their menu. This negative reaction, however, is not solely because of public reaction. Public reaction is a big part, then comes personal reaction by the restaurant owners. The Kauai High School Distributive Education survey shows that 40% of the restaurants wouldn't sell shark because of public reaction and 60% gave other reasons which weren't on the survey (the four reasons listed on the survey were price, public reaction, don't know how to prepare, others).[14] The restaurants are willing to put shark on their menus if the State is willing to promote shark meat. On Kauai the 29% willing to put shark on their menu changed to 57% if the State promoted shark meat.[14]

Promotion of shark meat seems to be a vital link in the materialization of a shark meat industry. These promotion campaigns are to persuade the consumer to buy shark meat. The consumer is the last and most vital link in the chain. The consumer at this point has not really overcome the psychological bias it has with sharks. With movies like Jaws the shark is seen as an indiscriminate killer of man.

This psychological bias the public has is totally false. Scientific studies have shown that sharks kill for a reason. One reason is territorial boundaries. Sharks and shark packs all have definite bounderies which they patrol. If someone intrudes a shark will naturally attack. There are more reasons for shark attacks like mistaken identities and the sharks role as a scavenger. These are points which might persuade the public to buy shark meat. The Kauai High School Distributive Education survey has shown that the main reason for not buying shark is the history and public image of the shark.[16] At this point people have not totally accepted shark as a food resource. Forty-seven percent of the people surveyed by the Kauai High School Distributive Education class said they would buy shark.[17] This figure shows that with a little bit more persuation the public would buy shark meat regularly because of the shark's food value.

The consumer also needs to be informed of the food value of shark meat. Shark meat is often compared to delicacies like sword fish, crab, ono, and mahimahi. This is contrary to popular beliefs that shark meat is tough, is bitter, and has an awful smell. Shark meat is a high source of protein which needs to be emphasized more because it is inexpensive. Shark meat is also very low in mercury content. The State law requires that the mercury content be no more than 1 ppm (parts per million) whereas the FDA has set mercury content in fish to be no more than 0.05 ppm. Data compiled during a 1971 shark control program showed that the mercury content of sharks in Hawaiian waters is low compared to other fish caught in Hawaiian waters. In Australia the conclusion has been reached that size and mercury content is proportional. Contrary to this Hawaiian sharks show no corrolation between size and mercury content (see table).

In 1967, under a University of Hawaii program to control and research shark, 100 pounds of shark was sent to Australia. The Hawaiian shark meat was prepared and tested under the supervision of Mr. Norman Levis, head of the East Melbourne Fishing Company. The prepared shark was compared to Australian shark and the results were that the Hawaiian shark meat was quite acceptable as food and that the Hawaiian shark tasted about the same as Australian shark meat.

In Australia, shark is commercially marketed in "fish and chips" a local favorite on menus. Shark is utilized all over the world and also prepared in different ways. Most sharks are camouflaged with other names. In Britan people eat shark in "fish and chips." Chinese all over America support the shark fishing industry by buying shark fins for shark fin soup. Shark meat is sold in Australia under the name of flake fish. In Japan people readily consume shark because of necessity. The Japanese consumer's main source of protein is fish and the demand is so great that the consumers will buy any fish.

One experiment was tried in Hawaii to determine whether shark could be used as prawn food. In the experiment 47 pounds of shark meat was fed to approximately 600 pounds of fresh water prawn. In 24 hours the prawns had eaten all the shark flesh. This shows that shark fillets could have other uses in the future.

In conclusion I would like to say that the materialization of a shark fishing industry in Hawaii is not very probable. Although the potential is there the money needed to start the industry is scarce. Everyone involved in the materialization of a shark industry is scared to take a loss. Everyone wants State help but to spend so much with little benefits seems to close the door on State funding. Even if the shark were fished extensively the industry might kill itself out. The

shark's reproductive cycle is long and the replenishment of sharks is slow. These are the main reasons why shark fishing may not be feasible. One last reason may be that current interest is due to the shark "craze" or "fad". The movie Jaws and Jaws II have drawn considerable interest in sharks and as a survey by the Department of Planning and Economic Development has shown, people buy shark out of curiosity.

Mercury analysis of flesh of sharks caught during the 1971 Shark Control and Research Program

SPECIES	DATE	AREA	TOTAL LENGTH	MERCURY IN FLESH (ppm)
Tiger	6/4/71	3	6' 3"	.02
Tiger	6/5/71	4	4' 0"	.01
Tiger	7/2/71	21	11' 0"	.09
Tiger	6/6/71	25	14' 6"	.06
Tiger	7/6/71	25	14' 6"	.03
Tiger	7/6/71	25	9' 9"	.07
Tiger	7/6/71	25	10' 4"	.05
Tiger	7/6/71	25	10' 0"	.03
Tiger	7/6/71	25	10' 0"	.03
Tiger	7/8/71	27	9' 6"	.05
Tiger	7/8/71	27	8' 0"	.04
Tiger	7/8/71	27	8' 6"	.03
Tiger	7/8/71	27	14' 6"	.06
Tiger	7/8/71	27	15' 0"	.07
Tiger	7/8/71	27	12' 6"	.02
Blacktip	7/6/71	25	6'11"	.27
Blacktip	7/6/71	25	6' 7"	.14
Blacktip	7/8/71	27	6'11"	.06
Blacktip	7/8/71	27	6' 9"	.07
Sandbar	6/6/71	5	5' 3"	.05
Sandbar	7/8/71	27	5' 5"	.10
Galapagos	6/6/71	5	7' 1"	.05

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THE IMPORTANCE OF ALGAE

by Annette K. Oishi, Pahoa High School

Abstract

Algae, the vegetation of the sea, is as old as history itself. And it's many uses is ever increasing as it is being researched. This paper discusses some of these uses.

Introduction

Algae, seaweed, kelp, and limu. When referred to, they seem to have the same definition. But when researched, a clearer understanding was obtained of the difference between them. First, I will try to give some background information so that when I refer to specific names, they will not cause confusion as it has done me in the past.

Algae is called the vegetation of the sea. It ranges in size from microscopic to a 100 feet or more in length. The algae are grouped according to their colors of blue-green, brown, green, and red. The blue-green algae belongs to the Kingdom Protista. While the rest are considered to be in the Plant Kingdom. The large marine algae are called seaweeds. The seaweeds of cold waters are chiefly brown algae. Those of the tropics are chiefly red algae. Kelp is a kind of brown algae that is found along many seashores of temperate zones. And limu is a Hawaiian name for seaweed.

My reason for research was because the topic, algae, had seemed quite interesting. It had often occured to me that algae were sometimes called "weeds of the sea". Scattered opinions such as being insignificant and generally a nuisance have showed me that a basic study of the prominent "weed" was needed. When researching my first title: Nutritional Values of Algae, I discovered the many other uses of algae. These of which were just as important as it's food value. In my paper, I will try to show what I have learned of the many important uses of algae. And the diversity of these important uses.

Results of Research

The earliest use of seaweeds was probably as food for man and beast. The eating of seaweed has continued to the present day, especially in China, Japan, and Hawaii. Amongst these over forty species are used. Hawaii's past includes limu as a source of part of the Hawaiian diet. "It was the third component of a nutritionally balanced diet consisting of fish and poi, together they furnished the necessary proteins, carbohydrates and meinerals for our adequate nutrition". In Japan, as well as Hawaii, seaweed is a part of their basic meal. Some of the various Japanese foods prepared from seaweeds are arame, which comes from Eisenia bicyclis, hijiki from Hijikia fusiforme, miru from Codiun, wakame from Undaria pinnatifida, and many others. In the Western world, some of the better-known edible seaweeds such as laver, Irish moss, and dulse are used quite extensively.

The seaweed has many nutritional values. It contains large amounts of Vitamin A, in addition to the B-complex, Vitamin E, and Vitamin C. Because of it's fiber content, the seaweed serves as an aid to healthy digestion. "Seaweed has been shone to degrade fats to highly unsaturated oils and may have been partially responsible for the low incidences of coronary occlusion in primitive Hawaii." Many seaweeds contain antibiotic substances that deteriorate the growth of pathological organisms.

Historically, seaweeds have been used for millennia as a folk medicine in various parts of the world. The variety ranges from being an ancient prescription for dropsy to the Irish brew sea moss put in tea to cope with coughs and mild stomach disorders.

The brown algae, kelp,is an important source of iodine. Since seawater is rich in trace elements, these seaweeds are able to absorb them. The trace elements include significant amounts of copper, manganese, phosphorus, as well as iodine. It's iodine content can be particularly valuable in preventing goiter, a disorder of the thyroid. Iodine is still manufactured from kelp in Japan, where Laminaria, Ecklonia, and Eisenia are mostly used. Because of the brown seaweed's minerals and vitamins, the dried plants are ground fine and used as a "body conditioner". Kelp's nutritional benefits include a great share of calcium. Kelp is one of the few listed as having a high calcium content.

The modern kelp industry includes a sticky substance called alginic acid. This substance is extracted from kelp. Algin has been discovered to have many commercial uses because of it's ability to hold several liquids together. Algin is used to manufacture artificial fibres, stabilize ice cream, and thicken cosmetics, food, and other products. Gauze containing calcium alginate, another form of algin, is useful for preventing bleeding and used in various forms of dressing for wounds. Another important use of algin is as a latex creaming agent in the production of rubber from natural sources. Derivatives of alginic acid also have their uses in medicine.

Another important use of algae today is the production of agar-agar. Because of it's gelatin-like substance and ability to resist liquefaction, it is chiefly used in culturing bacteria and fungi in laboratories. "Although agar may be extracted from at least twenty-eight species of red algae, the known source is the algae Gelid'an amansii". Beside being a

culture medium, it serves for a number of other purposes. These include the sizing of fabrics, the canning of fish, the maufacture of paper and glue, the finishing of leather goods, cleaning medium for liquids, the makings of medicines and cosmetics, and the thickening of ice cream.

Seaweed is used as fertilizer because of it's richness in trace elements. It contains nitrogen and potash which is important to the fertility of the land. Seaweeds such as Lithothamnion contain a great deal of lime. These are used on acid soils.

The use of algae for the treatment of sewage has recently developed. We look upon sewage as a waste material when the truth is that it is a potentially valuable raw material. Sewage contains minerals that are much in demand to build up the fertility of the land. Because of algae's process of photosynthesis, the supply of oxygen needed for the bacteria to break down the organic matter is provided. And at the same time they will absorb into their bodies much of the soluble nitrogen, phosphorus, and potash that would otherwise run to waste. After this process of biological oxidation is finished, the algae can be harvested and eaten by man, fed to animals, or used as a fertilizer for the land.

We must not forget that although we do not as of yet nourish ourselves on microscopic algae, we do so whenever we eat fish. All foods that the fish depends on always leads back to the microscopic phytoplankton. Even though the fish does not feed on it directly, there are food chains that show that microscopic algae is responsible for all life in the sea.

Conclusion

Through my research, I have discovered the many important uses of algae, both in the past and in the present. I have also realized the many uses yet to be explored of this valuable resource in our waters. Hopefully, many others have realized too that algae will be of great value in the future.

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USING THE OCEAN AGAINST HUNGER: SEAWEED

by Roxanne C. Kiyabu, Sacred Hearts Academy

ABSTRACT

The content of this paper includes discussion of various types of seaweed, their history as a nutrient, present use made of seaweed in food products, and its potential use.

I Introduction- Man and the Sea

Man has always used the ocean and products from it to keep himself alive. From it he took animals to provide himself with food for his body, oil for his lamps and stoves, and skins for his clothing. He has extracted minerals from it and purified its water to drink. He has travled on it and transported goods on it. He is learning to harness its energy to produce electricity. Unfortunately man has even used the ocean to dump his wastes.[1]

One of the products man gets from the ocean is seaweed. The seaweeds are a large red or brown algae that look like land plants because they have stems and leaves. They have holdfasts instead of roots, so they get their nutrition through their leaves. Seaweed is also called kelp and here in Hawaii, limu. Seaweed could be a very useful item if man could solve some of the problems linked with producing it and using it as a food.

II Statement of Problem- Better Use of Seaweed

Hunger is still one of the world's biggest problems. Even though over seventy per cent of the earth is covered by oceans, only about two per cent of our food comes from the oceans. In the Atlantic and Pacific Oceans there are giant beds of kelp and lots of seaweed in coastal areas and reefs. But man has only begun to use these algae to make life better for himself. This is a big challenge for him.

Some of the questions we should find answers for are:

1- How has man already used the seaweed?
2- How can he make better use of it?
3- Can he learn to grow it as a crop like farmers grow wheat or corn on land?

III Present Uses of Seaweed

Right now, seaweed is being used by the human race in three major areas: Directly or indirectly as food, in drugs and medications, and as a fertilizer.

Seaweed is eaten in some form all over the world. The Eastern peoples prize it much more than the inhabitants of either the

United States or Europe.[2] In countries such as China, Japan, Malaya and a few South Pacific Islands, you are likely to find people who value seaweed as highly as any other food.[3] In 1970, 78,000 tons of seaweed was eaten in Japan, compared to 200 tons in South Wales, the center of seaweed use in England. The Welsh make a substance called "laverbread" from the thoroughly washed and cooked red seaweed porphyra, or laver. The gelatinous bread can then be cooked in fat or formed into small cakes, dipped in oatmeal and fried with bacon and eggs.[4]

Other European nations have developed methods of using the ocean plants in their diets also. Irish moss, or carrageen, dulse, and sea lettuce have been eaten raw or cooked into soups and puddings by the Welsh, the Scots, the Irish, the Icelanders, and the people of other coastal European countries. The Russians have come up with many clever recipes for seaweeds, especially sea cabbage.[5]

Here in Hawaii at least two nationalities rely on seaweeds as an important part of their diets and cultures. The local Japanese cover a rice ball with nori, a dried seaweed, to make sushi, and use nori to flavor soups, just like they do in Japan. Ogo, a red crunchy seaweed, is used in salads, and even arare, a crisp snack made from mochi, is often flavored with seaweed.

Most Polynesian cultures value seaweed highly, and in Hawaii more then forty varieties are considered edible. Seaweed gardens were common among the Hawaiians.[6] Seaweed, or limu as the Hawaiians call it, was a very important part of the Hawaiian diet in addition to fish and poi. Limu contributed variety and interest as well as a large amount of vitamins and trace minerals. Some species were also used medicinally.[7]

Unfortunately, seaweed is not all that nourishing. The nutritional value of seaweeds in the human diet is mostly in their trace elements and vitamin content, although they do provide some protein and very little fat.[8]

Although raw or processed seaweed is not widely consumed, the extracts of seaweed are much in demand as supportive ingedients in

foods, like agar in ice cream, salad dressing, icings, etc.[9] Agar is only one of the products of seaweed that is worth much. Other minerals are obtained from the sea plants, too. Seaweed is burned and then soda, potash, iodine, agar (from red seaweed) or algin (from brown seaweed) are separated from the ash. Algin is used in making ice cream and asprin.[10]

We consume seaweed indirectly in another way. Sea plants form a significant link in the chain of life, that of providing food for vegetarian fish and crustaceans. These are consumed by larger sea animals, who are eaten by us.[11] Seaweed has also been sucessfully used as a source of fodder for animals we find fit to eat, especially sheep and pigs.[12]

Seaweed contains elements that are good for our health, and some of its products are used in the manufacture of medicines. Trace elements found in seaweed are important in preventing deficiency diseases such as anemia, goiter, and digestive ailments. Seaweed can even help the body to eliminate much of the radioactive strontium 90 we ingest that can cause bone cancer and leukimia.[13] The seaweed called laver or nori has larger quantities of the enzyme cholesterose which tears down cholesterol and helps prevent hardening of the arteries.[14] Carrageenin, which is extracted from Irish moss, prevents the formation of gastric ulcers.[15]

Agar is not digested by most bacteria, so it is used as a culture medium to grow bacteria, molds and isolated tissues.[16] Agar has been used to treat diarrhea and other illnesses like at. Pills coated with agar will not be attacked by bacteria and will pass to the lower intestines before releasing their contents.[17]

Seaweed contributes indirectly to man's food supply as a rich organic fertilizer for farmlands. This type of soil enricher, pound for pound, has twice as much potassium as animal manure, but only a third of the phosphorous.[18]

IV Methods of Production- Harvesting and Farming

One way to produce seaweed is by harvesting. In Japan brown seaweed is collected by hand by divers.[19] Gathering by hand is the

most common way, except where the giant kelp is collected in bulk. Off California, giant kelp is harvested by using grapples, which are large hooks, or specialized underwater mowers.[20] The kelp is amazing because its holdfasts are sometimes 300 feet below the surface, and after being cut, it grows at a phenomenal rate of twenty feet in a week of two.[21]

But the greatest advances in seaweed production have been made in farming. There has always been a great demand in Japan for edible seaweed and farms were constructed there to provide these varieties. The Japanese have cultured laver or nori, a popular edible seaweed, for centuries and now have more than 61,000 people raising sea plant crops, and more than 300,000 people employed in the industry.[22]

Since the Japanese were the first people to grow seaweed in artificial conditions, they were able to observe some things about the environments which help to grow seaweed more abundantly. They noted that seaweed needs an appropriate size of stone to fasten itself to. They put stones and bricks in barren places so that seaweed can attach itself to the brick and stone. Japanese call this, tsukieso, or "constructed beach". Americans would call it a low profile reef or as artificial reef or farm.[23] Another observation was that laver has a growing season unlike that of land crops with the best growth during winter. If the monospores settle on a substantial surface during autumn, they grow rapidly, and leaves may be harvested in a few weeks. This process continues until March when the plants disappear. The laver is harvested by hand.[24]

Some significant factors which influence the growth of seaweed on a low profile reef are current, light depth, and wave action.[25] Artificial reefs must have good foundations or they might become sunken in mud, like some early Japanese experiments, or be washed away in strong current.[26]

In 1957 Michio Takata of the Hawaiian Fish and Game Division used aqua lung divers to carefully observe and count fish both before and after the artificial reefs were created using concrete shelters. The artificial reef in shallowest water was destroyed by surf, but both others showed a dramatic increase in fish life, especially the

one in the barren area. The amount of fish increased there 1,910 per cent.[27] A later experiment in Hawaii used 916 shells of automobiles at a depth of 80 feet. Kelp and eel grass were planted and thrived. The quantity of fish increased from 36 to 1542 pounds per acre, and a better quality of fish for eating began to inhabit the area.[28]

V Conclusion

From this data, it may be concluded that seaweed can become a more important part of the world's diet than it is now. It is my guess that seaweed can be grown in a greater quantity than it is now on aquatic farms. Seaweed aquaculture might be one of the answers for a hungry world.

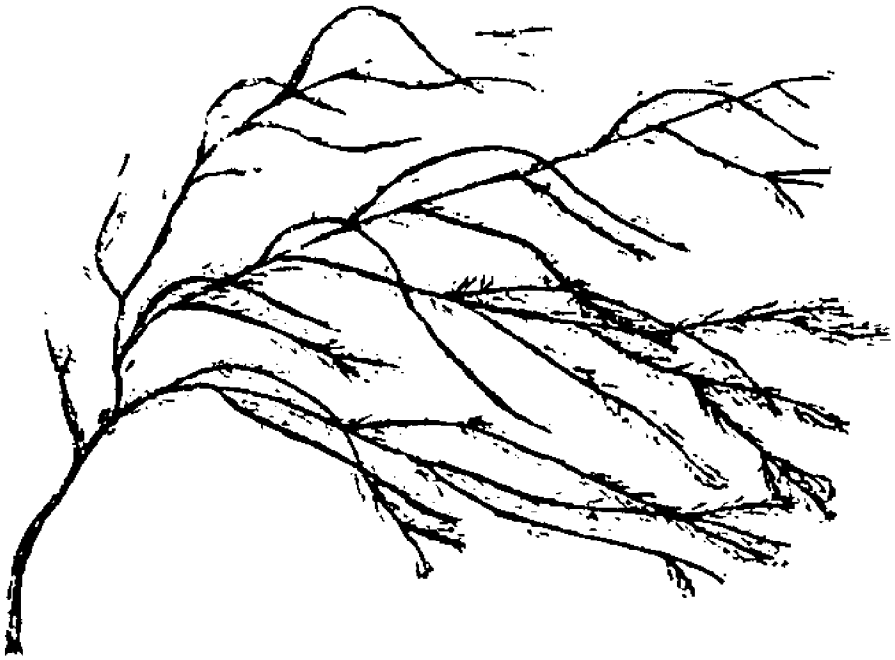
VI Recommendations

In order to have seaweed as a greater part of the earth's diet, it would be necessary to educate the population in its advantages and uses. Home economists would have to find new and more delicious ways of cooking it. Scientists should experiment with trying to increase the nutritional value of seaweed, especially in building up its protein content. Some effort to increase the yeilds of algae growing in enclosed sea areas, such as bays, fiords, and lochs, have been started by using fertilizers, made from land elements. This type of fertilization must be confined to enclosed areas or the enrichers would be diluted throughout the oceans.[29]

Lastly, I would hope that man can continue to learn to farm the sea as he farms the land, using methods of planting and transplanting from fertile to barren areas.[30] Experimentation in this area is still vital, and we must see that our government at the state and federal levels (especially the president) will pass an aquaculture bill to set aside funds for this.

BROWN SEAWEED
from the coast
of Massachusetts

KELP from the
Atlantic and
Pacific Oceans



Red Seaweed

from [illegible]

Red Seaweed from New York Harbor

FOOTNOTES

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COASTAL RECREATION: MARINAS & PRESERVES

HAWAII KAI MARINA

by Gloria R. Paet, Sacred Hearts Academy

ABSTRACT

This paper deals with the development of the Hawaii Kai Marina. Being the first residential-marina community in Hawaii, the Hawaii Kai Marina had many aspects to be considered, including rights and management of its coastal zone and waters.

INTRODUCTION

I decided to do a project on tha Hawaii Kai marina because I feel that the project is a very unique one. Hawaii Kai is unique due to its development concept, and its being the first residential-marina community developed from a fishpond in the state of Hawaii.

In the years that I have lived there, I have seen many of the advantag s that the residents of Hawaii Kai have with its marina-community environment. Not only is there the recreational (boating,water-sports) side of the marina's existence, but the marina gives the community a splendor that you just don see everywhere.

So my project is basically an overall description and history of the Hawaii Kai marina--- an informative report on the Hawaii Kai marina, which I have found to be an interesting topic .

Work on the Hawaii Kai marina began in 1959 with the dredging of a channel to the Kuapa Pond by the Kaiser-Burns Development Company. The trustees of the Estate of Bernice Pauahi Bishop made a development and lease agreement with Kaiser-Aetna to develop the 521 acre Kuapa Fishpond into a residential area having a marina with a series of channels separated by fingers of land and little islands. The peninsula, islands, and foundations of house sites were constructed using the material dredged from the pond during construction of the marina.

At present, the Hawaii Kai development includes a 267.7 acre marina which has an approximate shoreline of 12 miles, and a depth of about 5-8 feet, and a surrounding residential community. The marina has two openings into Maunalua Bay that pass beneath bridges on Kalanianaole Highway and traverse a narrow strip of coastal land separating the marina from the bay. The main opening into the lower basin of the marina is large enough to permit boats, which have superstructures not greater than 13 feet above the waterline, to pass beneath the bridge during high tide. The main opening and entrance channel were dredged, bridged, and improved by Kaiser during the years 1965-67 under permits from the Department of the Army(DA). The other opening near Kuliouou(dredged in 1959) is too low to permit passage of boats having tall superstructures.

About 90 percent of the marina shoreline is protected with mortared rock walls, which have a crest elevation of about 3-plus feet above sea level, and extend 5-10 feet below sea level. The remaining 10 percent of the marina shoreline is not walled, and the shoreline slopes gradually to the water. In some areas that are unwalled,and places where the walls have failed or are failing, wind-wave erosion of the shoreline is taking place.

THE MARINA AND ITS USES

The marina is used primarily for recreational boating and water contact sports, such as water skiing,sailing,fishing,and crabbing. There are several areas of corporate and private boat launching ramps, docks, piers, and pilings located along the developed areas of the marina.

DISPUTE OVER THE PRIVATE OR PUBLIC NATURE OF H-KAI MARINA

In the early part of the 1970's, a dispute involving the public or private nature of waters in the Hawaii Kai marina was started by the U.S. Army Corp of Engineers. Their basis of argument was the fact that the Hawaii Kai marina, once a swampland, may have been improved so much that it should be declared a public waterway. But the residents believed it was private property.

The marina is maintained by the 1400 residents who live on the water's edge and by all other Hawaii Kai residents who use the facilities.

Kaiser-Aetna, which is the H-Kai developer, then became concerned over the invasion by people who weren't residents when the U.S. Corps of Engineers and the Coast Guard ruled that the pond was a navigable waterway.

Aetna's Position:

Waters are private and for exclusive use of the marina residents and other authorized people licensed by Kaiser-Aetna.

Corp's Position:

With the Corp's ruling, Kaiser-Aetna would have to have government approval before it could further improve what it believed to be private property.

Public interest had to be protected, but it had to be remembered that a lot of money was spent by the developers to improve the waterway.

REP. SPARK MATSUNAGA

Representative Spark Matsunaga introduced a bill to restrict access of Hawaii Kai Marina to the residents of Hawaii Kai. He reintroduced a measure to prevent the Army Corp of Engineers from designating the marina as a navigable waterway and thus open it to public traffic.

MATSUNAGA'S POSITION:

The people who developed the area and the people who own homes in Hawaii Kai, particularly waterfront property--are entitled to their own private water recreation site and marina. He also pointed out the concern about the threat of interlopers and vandals expressed by the residents.

FINAL DECISION ON PUBLIC OR PRIVATE NATURE OF MARINA

Final decision on the dispute over the public or private nature of the Hawaii Kai Marina was left to the courts. Based on the information brought into court by the Corp of Engineers, the courts decided that, in the public interest, to declare the Hawaii Kai Marina a public navigable waterway. With this decision, the waters would therefore be under public use and control.

Developers are now required to get authorization by the Army Corp of Engineers for any actions involving the marina because of the decision of the courts.

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FURTHER DEVELOPMENT OF KA'ANAPALI

by Lee H. Taylor, Lahainaluna High School

ABSTRACT:

Tourism is Maui's as well as the state's largest industry. Chris Hemmeter asked the Maui Planning Commission for a Special Management Application to build a 750 room hotel in the Kaanapali area. It'll consist of three towers, 6, 8, and 9 floors. The existing site has kiawe trees patches of brown grass and a little greenery. Many people are concerned that the Kaanapali area ia already too crowded, and that the 750 room project known as the "Hyatt Regency", will double the compacity. Some people say that the structure will take away from the beauty and others disagree. I am one who disagrees, I've seen the present site and also the proposed structure and I feel that the structure is a definite improvement to the environment.

INTRODUCTION:

The Hemmeter project known as the Hyatt Regency will consist of three towers with a total of 750 rooms, there will also be resturaunts and other shops, there will also be a swimming pool in the middle of the complex with water-falls and shrubbery to make it look natural. Many people say that Lahaina is already too crowded with tourist and that more rental cars and tour buses will only worsen the problem.They also say that the hotel will take away from the beauty of the environment. I feel at the present time there is no real beauty to take away from, I don't call kiawe beautiful. The extra tourist will be good for the economy of Lahaina, more jobs and probably more shops will open, and all this means that more money will be coming into Lahaina.

PROCEDURE OF RESEARCH:

I went to the Maui County Planning Commission and looked at the files on the Hemmeter Project, and I also got information and the rules and regulations from the Costal Zone Management Department.

RESULTS OF RESEARCH:

Many questions have arisen because the tourist in Lahaina have become a problem esspecially in the middle of town where they stop in the middle of the road, and cross where there is no cross-walk so doubling the compacity will only add to the problem. The community is also concerned that the Kaanapali area

will turn into another waikiki. The main town of Lahaina is already tourist oriented, selling typical hawaiian wear that is made in the mainland, and portraying the stereotype hawaiian. The Environmentalist are against it because they way it takes away from the beauty and blocks the view of the beach and the ocean. Another stipulation is that the homes will be provided for the workers by the company. Most people don't know where these houses are going to be built. Another question is the people that are working at the other hotels will they leave their present job and transfer to the Hyatt Regency? I will answer these question and others in my paper, I will also show the objectives of the Costal Zone Management.

The hotel will be good for the economy of Lahaina. Usually when the economy progresses the ecology suffers but in this case the hotel will beautify the environment. The area of the project will be built on an 18.5 acre parcel of land.

[1]The proposed project is a major resort hotel which will contain approximately 750 guest rooms. Three main buildings, linked together by the lobby floor containging commerical and other accessory uses, will have 6,8, and 9 floors of guest rooms.

A meeting/convention facility; accessory commercial spaces; restaurants and cocktail lounges; recreational facilities (including tennis courts) and outdoor luau area; ample parking and extensively landscaped grounds will also be constructed.

A public beach right-of-way, inchuding outdoor shower, will be provided near the southerly boundary of the property.

The hotel will be managed by the Hyatt Coroporation, which

currently poerates two other hotels in Hawaii -- the Hyatt Regency Waikiki and the Kuilima Hyatt Resort Hotel in Kahuku -- as well as other prestigious hotels throughout the country."

Another concern is the drainage, but there is no real problem. The Kaanapali Resort area has its own sewage treatment plant. The sewage is pumped into the plant and is recycled and used to irrigate the golf course. Some of the discharge is runoff in to the stream and washed into the ocean. This drainage system is the same one they use today. One of the regulations on the Costal Zone Management is that there is at least a 40 foot set back from the shore line. Mr. Hemmeter has his project, about 130 feet from the ahore line and will also landscape the beach with trees and shops,(the shops will be away from the shore line). There are certain impacts that affect the project, one of they is related to soil erosion from water and wind. Grading must also be in according to county standards. There must alsobe provivions for public access. As mentioned earlier there will be two beach-right-of-ways, one will be built by the state and the other by the Hyatt Corporation.

The homes for the workers will be built ont Lahainaluna Road, just befor the Lahaina Intermediate School. The exact number of houses is not positive, but they will be rented at $400 a month. There will be a considerable amount of homes built because this 80 million dollar project will produce 500 - 600 jobs. Now I will show the CZM Objectives.

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1 From the "EVALUATION OF SIGNIFICANT ENVIRONMENTAL CRITERIA"

COASTAL ZONE MANAGEMENT OBJECTIVES:

The Coastal Zone Management Act, enacted by the 1977 Hawaii State Legislature, established the following objectives for the use, protection and development of coastal areas:

1. PROVIDE COASTAL RECREATIONAL OPPORTUNITIES ACCESSIBLE TO THE PUBLIC

   The proposed project will include a public beach right-of-way, together with an outdoor shower. A beach right-of-way is to be developed by Amfac, Inc. immediately to the north of the proposed project site; and a beach park will be deceloped by the County of Maui to the south, accross Hahakea Stream.

2. PROTECT, PRESERCE, AND, WHERE DESIRABLE, RESTORE THOSE NATURAL AND MAN-MADE HISTORIC AND PRE-HISTORIC RESOURCES IN THE COASTAL ZONE MANAGEMENT AREA THAT ARE SIGNIFICANT IN HAWAIIAN AND AMERICAN HISTORY AND CULTURE

   Although the proposed project is generally located within an area of historical and legendary significance relative to hawaiian culture, there are no known historic or pre-historic resources located on the site which can be protected, preserced or restored. Should any such resources be discovered, appropriate governmental agencies will be immediately notified.

3. PROTECT, PRESERCR AND, WHERE DESIRABLE, RESTORE OR IMPROVE THE QUALITY OF COASTAL SCENIC AND OPEN SPACE RESOURCES

   The proposed project will create some intrusion into coastal vistas and open space. However, the major buildings will have substantial setbacks from both the public highway (Honoapiilani) and the beach, as well as generous spacings between buildings.

CONCLUSION:

In view of the information hiven there should be no reason why Mr Chis Hemmeter should not build his hotel. Building the hotel is the best use the the land and the people. The land,will just sit there and the only thing will happen is that more weeds will grow. This way the land is at its best use. It is also good for our economy, more people coming the they spend the better it is for the people of Lahaina.

Kaanapali will never become a another Waikiki like many people are afraid of. Kaanapali of better organized than Waikiki in that the hotels are away from the main town. In Waikiki's situation they have shops on both sides of the highway, and people walking across the street. At Waikiki they just built and made no provisions for landscaping, so by the time what had happened the people in Honolulu ended up with a concrete jungle, but at Kaanapali many provisions are made for landscaping. Mr Hemmeter has met the county's and the state's environmental standards and other impacts. He has also met all of the Costal Zone Management Laws and should be permitted to build.

MARINE PRESERVE AT LAPAKAHI AHUPUAA

by Lorine Fernandez and Bernadette K. Jonolino, Kohala High School

ABSTRACT

There are rapidly disappearing reminences of the old but good Hawaiian ways of living. People are now trying to preserve what is left of the Old ways at Lapakahi. In its preservation the administration wants to extend its water boundaries.

We have captured the essence of the arguments for and against this proposal in our paper.

INTRODUCTION

Lapakahi State Park is a restored fishing village of Ancient Hawaii. It has been preserved so that people today can see how the Hawaiians lived and fished in Ancient times. With canoe sheds, burial sites, a fish shrine and other things, people who go there can definitely leave with some understanding of how the Hawaiians lived before. We as Kohalans take a special interest in Lapakahi because it is located in Kohala and shows how people, maybe even our ancestors lived many hundred years ago.

An important part of Lapakahi and its preservation is Koaie, the bay. There is an abundance of different fish so plans are now being aimed at restoring more of the ocean area.

Right now the administration at Lapakahi is faced with a problem. To state it briefly--The administration is hoping to extend the water boundaries 500 feet but the reef fishermen argue that it's too far.

METHOD

For our project, we consulted the Supervisor at Lapakahi, Marlenajon Stafford; Project Coordinator, Joe Mattos; employees of Lapakahi, Sat Carpio, Charles Tamanaha, and Momi Shontell. Other sources of research were our own knowledge of Lapakahi, interviews with reef fisherman, Marie McDonald, Clayton Javillo, Kaleo Perez, Vance Fujii, and Andy Ragasa. We were under the special guidance of Mr. Gilbert Pagat. Reference materials used were Lapakahi State Historical Park Trail Brochure; Draft 1 of the proposals from the State of Hawaii, Department of Land and Natural Resources, Division of Fish and Game; and North Kohala, Preservation of Historical Resources.

RESULTS

The proposed land area which is around a mile and a half long runs from the Mahukona Lighthouse down toward Kawaihae Harbor.

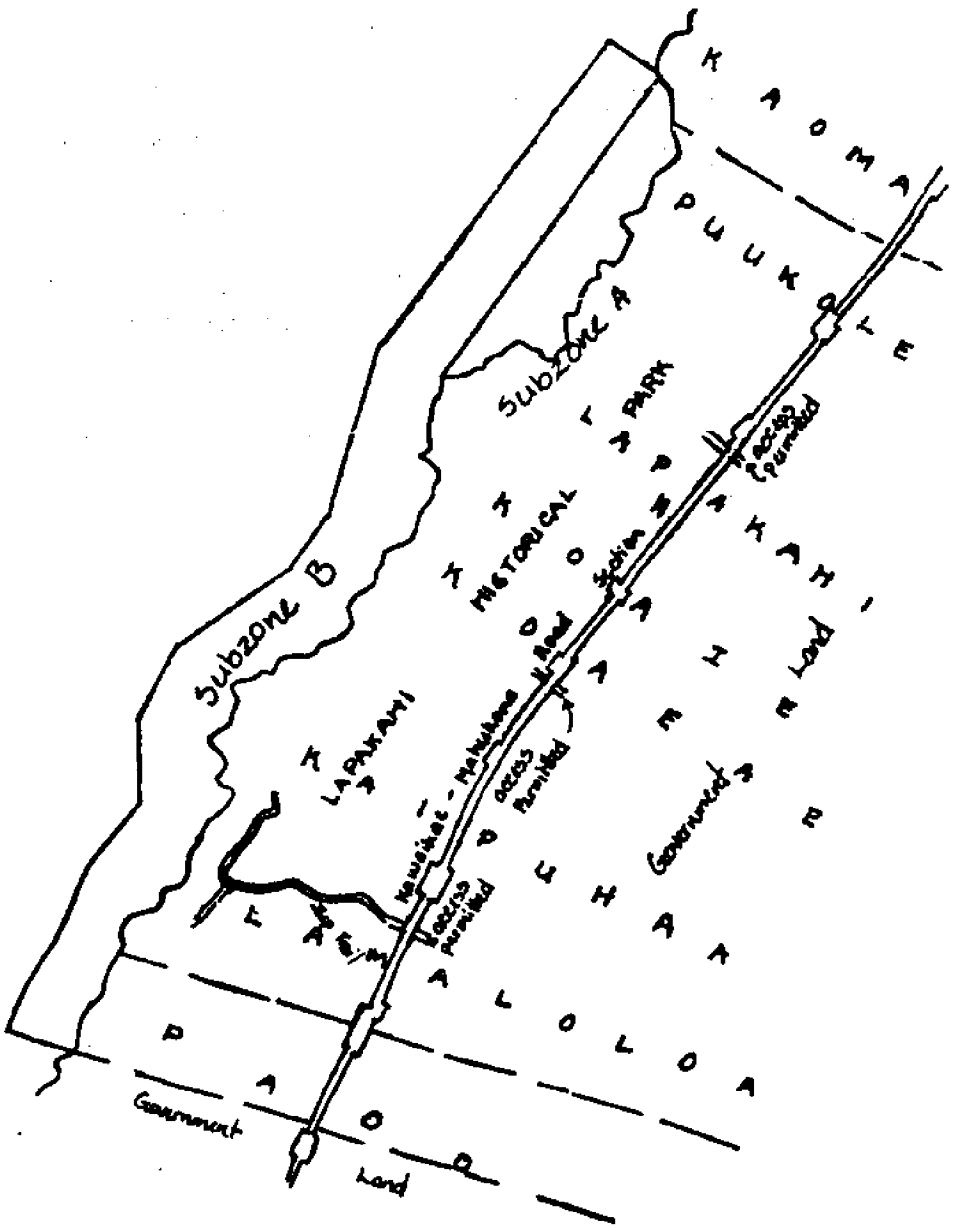
In the proposal the coastal area is divided into two subzones. Subzone A which includes Koaie Bay is around 2886 feet long and extends 500 feet into the ocean. Subzone B which includes the coastal area beyond Koaie Bay is around 8400 feet long. It also extends 500 feet into the ocean. In Subzone A fishing, taking of marine life, changing or destroying land features, possessing gear that can do harm or would aid in the taking of marine life , polluting, constructing something or leaving something in the water without written permission of proper governmental authority and boating is prohibited. In Subzone B some fishing and obtaining of crustaceans is allowed, but there are still some restrictions. The restrictions are as follows: fishing by hook and line methods; net throwing from the shoreline. You are also allowed to possess in the water for protection only any knife, shark billy, bang stick, powerhead and/or carbon dioxide (CO_2) injector.

With a special permit from the Board of Land and Natural Resources, any form of marine life and eggs that were prohibited by law could be taken for scientific, propagation or other experimental purposes.

A person caught breaking a regulation will be guilty of a petty misdemeanor and would be convicted as such.

The reason for a proposal on extending the ocean boundaries is for an ocean santuary to preserve, protect and conserve the marine resources and geological features. There are a variety of sea life in Koaie Bay itself such as akule, opelu, porpoises, sting rays, whales and flying fish. Though there are a lot of them, the workers have noticed that the amount of fishes have lessen.

Figure 1



LAPAKAHI MARINE LIFE
CONSERVATION DISTRICT
SUBZONES A AND B

Marlenajon Stafford, the Supervisor of Lapakahi, is all for preservation. In her opinion Lapakahi is a valuable resource for all people, not only tourists but Kohalans as well. At Lapakahi, in her opinion, a person can actually experience how the Hawaiians used to live. With an ocean preserve the fish will become tame and then people will be able to catch and prepare fish the ancient way.

Joe Mattos, Project Coordinator, gave us his opinion on the subject. He thinks that the preservation at Lapakahi is a good idea but he agrees with the fishermen that 500 feet may be too much. He says that 200 feet would be sufficient because there is not much to see after that and it would interfere with opelu fishing should the extension be any further.

The Lapakahi workers we had the chance to talk to agreed that Subzone A is a good idea in the preservation of ocean life, but Subzone B brought out some disagreement and doubt. They feel that maybe this is asking a little too much of the fishermen to sacrifice because it is restricting too much of the public beaches and ocean.

A fisherman, Leo Tabiolo, gave us his short but penetrating view. He thinks preserving the water is good so that children will be able to come and see the tamed fishes.

Marie McDonald is a Hawaiiana teacher at Kohala High School. She is very educated in the field of Hawaiian history. She is for the preservation of the ocean and also finds it a very valuable place to the people of the Big Island. She feels students and others will be able to gain an inside view of how the Hawaiians used to live. She feels that this won't hurt the opelu fishing but will help it instead. The reason is, as she puts it, if the fish are not harmed in Lapakahi they will be able to

MAP OF LAPAKAHI

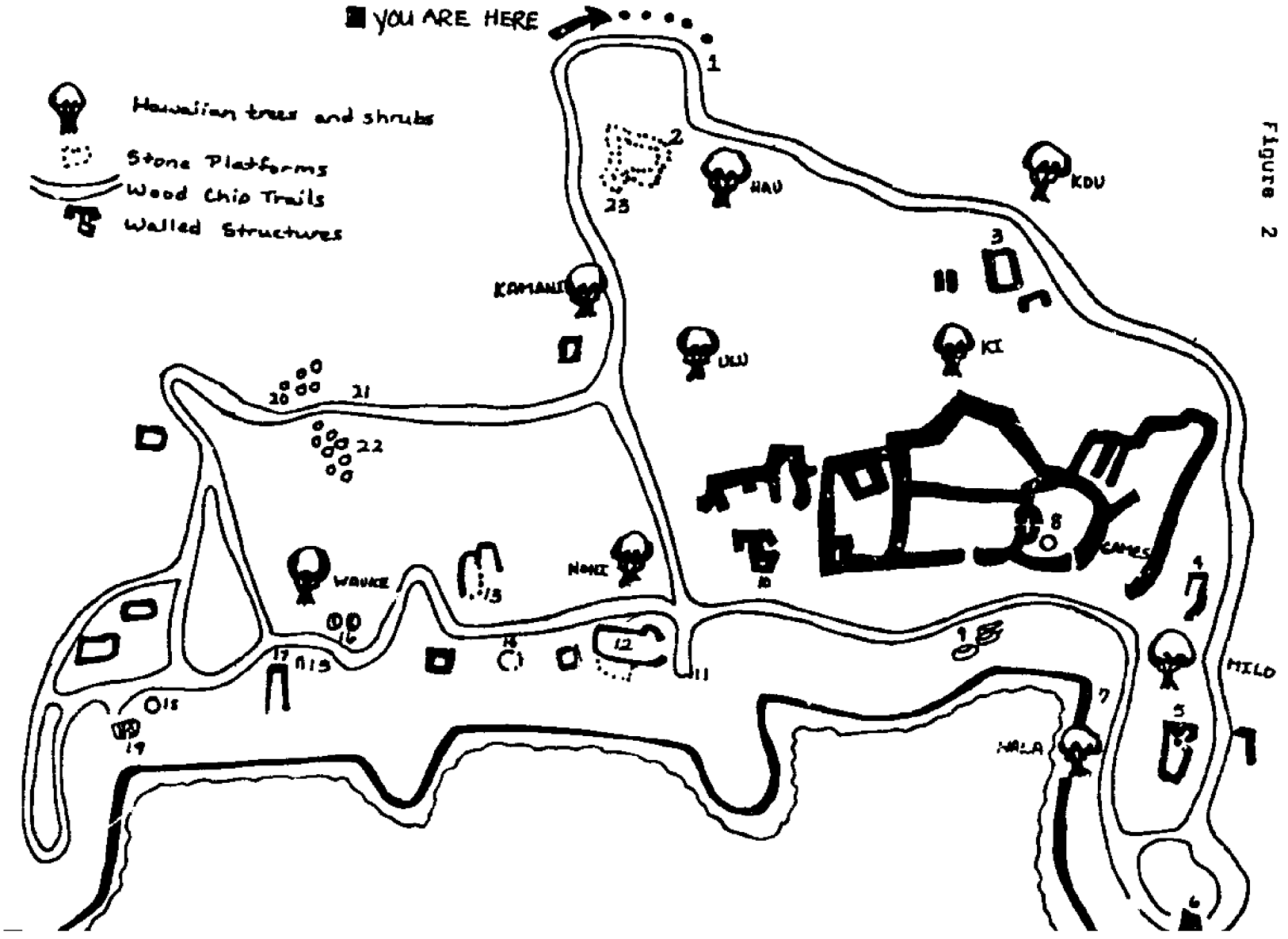


Figure 2

CHART (MAP OF LAPAKAHI)

1. Curbed Trail
2. Multiple Platform Burial Site
3. House and Burial Site
4. Canoe Shed
5. Historic House
6. Fish Shrine
7. Shoreline Fishing (replicas)
8. Well
9. Salt Making
10. Storage Area
11. Fisherman's Tool Kit (replicas)
12. Canoe House
13. Family Heiau
14. Fish Shrine
15. Lamp Stand (Waihona Kukui)
16. Salt Pans (Kahekaheka)
17. House (Hale)
18. Fire Pit (Lua ahi)
19. Game Board (Papamu)
20. Sugar Cane (Kō)
21. Sweet Potato (Uala)
22. Gourds
23. Rock Shelters

reproduce and move on. This way the supply of fish will always exist and have the chance to reproduce.

We also interviewed four students at Kohala High. Some of the results were very surprising. One boy said that 500 feet maybe a little too far, but he agrees that preservation is a good idea. Another boy is for the idea of preservation of Lapakahi and the ocean all together. The third said Lapakahi's preservation is a good idea but maybe they should make exceptions for opelu fishermen to go at one time of the year to fish. The fourth surprised us by saying he did not think it was a good idea. In his view he said it was not needed to preserve the fish because they will not all be caught.

CONCLUSION

Through our interviews, we found out that everyone has different opinions. Even if they agreed with the conservation part, their opinion on where the boundary should be set differed. Most people felt that the proposal would be accepted if the boundary wasn't at 500 feet. They say that 500 feet is too much and that it should be cut down to 200-25- feet.

By doing research for this paper, we were made aware of the value of Lapakahi and its waters. Lapakahi is like a stage full of props, actors, and actresses; but one thing is wrong with it. It lacks the promise of one of its future props. That prop is a never-ending fish supply. If this proposal is accepted, even if the boundary is moved in to 200-250 feet, we will have our final prop and the stage will always be set. The waters of Lapakahi will become the actors and actresses and we, the visitors and tourist will become the audience. The play would be the "Life of the Ancient Hawaiians in Lapakahi."

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THE NORTHWESTERN HAWAIIAN ISLANDS: ECONOMIC GAIN OR ENVIRONMENTAL LOSS?

by Laurie L. Imbleau, Kamehameha Schools

ABSTRACT

The Northwestern Hawaiian Islands are composed of numerous atolls, shoals, and reefs, little known by much of the general public. Spanning over 800 miles, this area beyond Ni'ihau is protected by state and federal wildlife refuge agencies. Both state and federal agencies have jurisdiction rights in these islands. This has caused much controversy since the State of Hawai'i is proposing future commercial development of the Northwest Islands' marine resources. The federal government is also proposing to obtain full jurisdiction of the islands in order to keep development at a minimum for the protection of the marine wildlife.

Base line data on the potential of marine resources of the Northwest Islands is limited. Presently, a tripartite cooperative survey between state and federal departments is being carried out to research these resources. The results of this research will determine the feasibility of commercial resource development and its potential effects on the marine environment in the Northwestern Hawaiian Islands.

INTRODUCTION

Natural History

From a fault on the Pacific Ocean floor, a sequence of volcanic eruptions over millions of years formed the unique archipelago in which we now live . . . the Hawaiian Islands. This island chain extends in a northwestern to southeastern direction for a length of fifteen hundred miles.

The Northwestern or Leeward Islands include all the islands north of Ni'ihau: Nihoa, Necker, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Lisianski, Pearl and Hermes Reef, Midway, and Kure Island. Starting with Kure, these islands were the first to form as high volcanoes and have now eroded into atolls, low sandy shoals, and reefs.

The southeast islands, specifically the major islands from Ni'ihau to Hawai'i, were subsequently the last of the great volcanoes to have formed. Presently, the youngest island of Hawai'i which is one million years old is in the middle stage of island development as described by Macdonald and Stearns.[7]

The Northwest Islands, on the other hand, are in the final stages of geological development. But even within these Leeward Islands there is great variation in topography and physical characteristics. Nihoa with its 900-foot jagged cliffs and tall Loulu palms differs greatly compared to the sandy Laysan atoll with its low lying shrubs and beach plants.

Turn-of-the-Century Exploitations - The Northwestern Islands 1890-1920

Leased for guano fertilizer mining by two mainland firms in 1890, Laysan and Lisianski were the first two northwest islands to be exploited commercially. In 1891, an observer described Lisianski as ". . . a little paradise." By 1915 it was ". . . dreary and desolate."[6] During this period, the guano diggers had introduced guinea pigs and rabbits to the islands. These vegetarian mammals consumed much of the protective plant covering which led to the deaths of hundreds of thousands of birds from sandstorms.

Plume hunters of the early twentieth century were responsible for slaughter of almost the same number of birds in order to obtain their feathers.

In 1909, President Theodore Roosevelt set aside the Northwest Hawaiian Islands as a bird reservation in one of history's first preservation acts of Congress. The birdlife included terns and petrels as well as the endemic endangered land birds such as the Nihoa finch. In 1940, when the islands became a National Wildlife Refuge, the Hawaiian Monk Seal and green sea turtle were placed under federal protection by the Department of the Interior. The native plants such as the Loulu Palm (Pritchardia remota) which is found nowhere else in the world, were also put under federal protection thus insuring their survival.

Wildlife Resources

The Leeward Islands are home to some of the greatest seabird nesting colonies in the world. Of the eighteen different bird species, the four major seabirds are from the tern, shearwater, petrel, or albatross families. Various species range from the abundant sooty tern (Sterna fuscata) and its relative, the fairy tern (Gygis alba), to the wedge-tailed shearwaters (Puffinus pacificus) and their different family branches.

The four endemic land birds found in the islands originate from two of the islands. The Nihoa finch (Psittirostra ultima), the Nihoa millerbird (Acrocephalus kingii), the Layson finch (Psittacirostra cantans cantans), and the Laysan duck. This duck is considered to be "one of the rarest ducks in the world today."[3] by the United States Department of the Interior.

The Hawaiian Monk Seal (Monachus schavinslandi), like the birdlife, also depends on the living resources of the islands for food. With the Carribean monk seal now thought to be nearly extinct, these rare mammals presently numbering about 1,000 are almost non-existent outside of the Hawaiian archipelago.

The Hawaiian green sea turtle (Chelonia) is found almost nowhere else, just like the monk seals. The monk seals do not migrate outside of the Northwest Islands. The turtles

breed and migrate within the range of the entire island chain, with their last major mating grounds in the Leeward Islands.

Potential Marine Resources

There is almost no information presently obtainable documenting the actual marine resources in the Northwestern Islands. Much of the information has been obtained from Navy reports of their maintenance expeditions within the area and from about eight scientific studies conducted by different agencies over the past decade. A survey done by the National Marine Fisheries Service in the late 1975-76 indicated the presence of lobsters and high trophic level fishes such as sharks and jacks.[8] Since these resources have not been tapped, it may be safe to assume that there is an abundance of these forms.

Natural minerals such as manganese nodules which contain copper and nickel, are thought to be present on the ocean floor in the Leeward Islands.

Coral is another common resource found within these waters although the extent of the coral fields has not been adequately determined.

STATEMENT OF THE PROBLEM

Resource Development of the Northwestern Hawaiian Islands Proposed by the State of Hawai'i

Hawai'i's fishing industry is not the once thriving business it was many years ago. Depletion of the fishing areas found off the main Hawaiian Islands has led State officials to propose an expansion into the waters of the Leeward Islands to rejuvenate Hawai'i's fishing industry. This expansion would help meet food demands for the state's increasing population as well as make available quality recreational fishing grounds.

Precious mineral and coral industries could aid in the diversification of Hawai'i's economy and bring about more jobs for the people.

Therefore, the state feels that the people of Hawai'i would benefit greatly from commercial development of the Leeward Islands.

Jurisdiction and Future Proposals for the Northwest Islands

When the bird reservation of 1909 was redesignated the Hawaiian Islands National Wildlife Refuge in 1940, the Northwestern Islands came under jurisdiction of the Fish and Wildlife Service of the United States Department of the Interior. The major purposes of the service are to preserve the native land and marine resources within the 304,200 acres of islands, submerged reefs, atolls and to insure that these resources are protected against harmful introductions. Presently, only authorized personnel are allowed within the refuge and trespassing is prohibited.

The Department of the Interior is currently proposing to place the Northwest Islands into the National Wildlife Preservation System. This Wilderness Proposal would put the present refuge under the full control of the federal government and would permanently exclude the State of Hawai'i from any jurisdiction in these islands. This proposal would have to be enacted by Congress, and would make the Department of the Interior the sole administrators of these islands.

The State of Hawai'i is against this Wilderness Proposal for a number of reasons. Eleven years after the federal government redesignated the refuge, the State Legislature made the Leeward Islands into a State Wildlife Refuge. This action gave the state certain power within the islands, but it was agreed that the Department of the Interior would have the major control over the islands. Losing all of the state's authority through Congressional enactment of the wilderness would not allow for the state's proposed commercial development of the Leeward Islands since preservation, not development, would be the major goal of this preservation act.

The Department of the Interior does not wish to appear as the "bad guy"[1] in this controversy. The department realizes that the greatest impact from commercial development would be on the delicate balance of wildlife. Their survival depends on the marine resources of the island waters. The question is "If the marine resources are commercially exploited, what would be the effects on the wildlife?"

In order to determine these effects, the base level of marine resources must first be

established. A five-year program to assess the living resources of the Northwestern Islands and to determine the long-range effects of development on the Leeward Islands ecosystem was begun in 1975 by three agencies: The National Marine Fisheries Service, the Department of Land and Natural Resources for the State of Hawai'i, and the Fish and Wildlife Service of the Department of the Interior. This program is entitled the Tripartite Cooperative Agreement for the Survey and Assessment of the Living Resources of the Northwestern Hawaiian Islands. Each of the three departments has specific duties and it is hoped that, based on their research results, intelligent decisions will be made concerning the future of the Northwestern Hawaiian Islands.

CONCLUSION

Miles beyond our islands lie vast expanses of ocean isolating us from the rest of the world. We have been privileged to live here in our unique island state. Natural beauty still prevails in all the main islands; from Hawai'i's volcanoes to the steep cliffs of Kaua'i's Waimea Canyon. But through the activities of man, sections of these main islands have been abused and overdeveloped.

The Northwestern Hawaiian Islands are our last hope for preserving land and endemic forms of plant and animal wildlife. We have a responsibility to future generations of Hawai'i's people to perpetuate the unique unspoiled areas of these islands.

The future status of the Northwest Islands is unsure at the present. Federal officials are not against the usage of the island waters for a fishing area, but they are against this industry if it would have adverse effects on the wildlife and their dependence on marine resources. If it is determined that there are enough resources to exploit, a base line of regulations could be agreed upon between state and federal officials. This list of regulations would allow proper and sensible usage of the resources by the state while protecting the Northwestern Islands wildlife, keeping the delicate ecosystem in balance.

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MARINE BIOLOGY I.

THE TERRITORIAL BEHAVIOR OF THE *BRACHYDANIO RERIO*

by Barbara J. Thompson, McKinley High School

Abstract

Practically no information is known about the behavior of the fresh water Brachydanio rerio (zebra fish). My problem was to find some evidence that the zebra fish has any territorial instincts, and if so are they developed during growth or born instinct. To do this I had to design two experiments to test this idea.

The experiment designed shows (1) that the Brachydanio rerio has territorial and aggressive instincts, (2) that the zebra fish can be classified as either dominant or non-dominant, (3) the dominant zebra fish will be more aggressive towards other dominant zebra fishes that to non-dominant ones, (4) that isolated zebra fishes has shown no aggressive instincts to a different species of fish, which may indicate that the zebra fish response to visual stimuli of its species, but not towards others, (5) that isolation of the zebra fish causes severe aggressive behavior, but no territorial behavior, which may indicate that territorial behavior is developed though growth, and (6) that the control Brachydanio rerio has to a certain degree both territorial and aggressive behavior from birth and that it develops continually through growth.

Introduction

The Brachydanio rerio is commercially known as the zebra fish. The horizontal stripes on the sides correctly defines the name.

In my experiment dominance is judged upon the amount of territory a organism defends. The greater the area the greater the dominance of the fish. The fish with the least amount of area were defined as non-dominant zebra fish. As the experiment advanced, area of the fish were changed to reaction times.

The definition that I used to describe territorialism in the zebra fish is when the defined dominant fish uses its aggressive instincts to repell another fish out of its physically defined area in which it generally confines itself.

Aggressive instincts in my experiment is defined as a physical attack or movements directed to repell another fish.

The definition for a reaction to another fish is when it changes its normal behavior generally being observed in its species.

Fighting methods can be distinguished as: chasing, intraterritorial fighting, or boundary fighting. Chasing and intraterritorial fighting occurs when a fish enters the territory of another fish. Boundary fighting usually happens when neighboring fish fight for territories.

My problem was to design an experiment that could test the zebra fish for territorial behavior (if any) and to find out when developement of this behavior started. Also to see if isolation of the fish is a major factor to this developement.

Materials and Methodology

PHASE I:

In this phase, I obtained ten zebra fish, ten one-gallon tank bottles, ten cardboard squares, and standard fish tank equipment. These materials were used to isolate the fish, and perhaps to fully develope their territorial and aggressive behavior.

First, I placed one zebra fish into each of the bottles. Then I placed the cardboard squares in the middle of the bottles. Then I kept the temperatures, feeding period, and the light the same. Leave the fish in this condition for three weeks.

PHASE II:

In this phase I needed one ten-gallon fish tank, one plastic fish tank divider. I then kept the fish in this condition for five days. Then I removed the divider and recorded the results. Then I repeated this method for the remaining fish.

PHASE III:

In this phase I needed theequipment from Phase II. I needed now to desinate the amount of dominance in the zebra fish. I used my definition from the introduction to do this.

PHASE IV:

This phase of the experiment was used to show the results of adding a third isolated zebra fish to the boundaries of the dominant and non-dominant zebra fish. For materials and methods refer back to Phase II.

This is to test two isolated non-dominant zebra fish towards a isolated dominant zebra fish. Then I again changed the testing fish to an isolated non-dominant zebra fish.

PHASE V:

In this phase of the experiment I wanted to see if a different species would effect the zebra fish. Materials and methods are the same as Phase IV.

PHASE V:

Addition materials are angel fish, swordtails, guppies, and neons. Instead of using testing fish use these fish as replacements.

PHASE VI:

In this Phase I wanted to know what would happen to the fish that are not isolated and are tested in this manner (Phases I-V). I then repeated the phases using non-isolated zebra fish.

PHASE VII:

In this final phase I wanted to know if territorial behavior is developed through growth or is natural instinct. I first obtained zebra fish eggs and then waited till hatching. After birth I put the fish through the same experiments as full grown zebra fish. I then tested the fish every three months. Each group of fish (control, non-isolated, and isolated) contained ten zebra fish.

Results

Date	Phase	Fish Description	Testing No.	Reaction Time Average
6/24/77	IV	Dominant A	Dominant 5D	3.58 sec.
6/24/77	IV	Dominant A	2ND	9.0 sec.
6/24/77	V	Dominant A	Swordtail	8.0 sec.
6/24/77	V	Non-Dominant B	"	9.0 sec.
6/24/77	VI	Dominant A	Angel Fish	9.5 sec.
6/24/77	"	Non-Dominant B	"	9.5 sec.
6/24/77	VII	Dominant A	Guppy	5.5 sec.
6/24/77	"	Non-Dominant B	"	6.5 sec.
6/24/77	VIII	Dominant A	Neon	6.0 sec.
6/24/77	"	Non-Dominant B	"	7.0 sec.
7/01/77	IX	Dominant A	Dominant 5D	4.0 sec.
7/01/77	"	"	2ND	8.0 sec.
7/01/77	X	Non-Dominant B	Dominant 5D	7.5 sec.

Brachydanio rerio (1-3 months)

Date	Phase	Fish Description	Testing No.	Reaction Time Average
3/05/78	IV	Young Zebra Fish	D	5.5 sec.
3/05/78	"	" " "	Nd	12.0 sec.
3/05/78	V	" " "	D	11.5 sec.
"	"	" " "	Nd	10.5 sec.
"	VI	" " "	Angel Fish	12.0 sec.
"	"	" " "	" "	10.0 sec.
"	VII	" " "	Neon	7.0 sec.
"	"	" " "	"	7.0 sec.
"	VIII	" " "	Guppy	7.5 sec.
"	"	" " "	"	6.0 sec.
"	"	" " "	Swordtail	9.5 sec.
"	"	" " "	"	12.0 sec.

Key
D=dominant
Nd=non-dominant

Chi-Test Data

$$\chi^2 = \sum \frac{(\text{observed No} - \text{expected No})^2}{\text{expected No}}$$

DOMINANT

Phase	Chi-Test Results
IV	p = 0.05 (null)
V	p = 0.1
VI	p = 0.9
VII	p = 0.5
VIII	p = 0.5
IX	p = 0.2
X	p = 0.5

NON-DOMINANT

Phase	Chi-Test Results
IV	p = 0.05 (null)
V	p = 0.05 (null)
VI	p = 0.2
VII	p = 0.5
VIII	p = 0.5
IX	p = 0.2
X	p = 0.5

Conclusion

This experiment shows that the dominant Brachydanio rerio reacts faster towards an dominant zebra fish than to a non-dominant one. Reaction time proves this statement. Reaction of the zebra fish towards another species of fish can be summerized as follows:

(1) If the species is larger than the zebra fish and if of a different color no aggressive and territorial behavior was exhibited.

(2) If the species is the same color pattern, but larger, and bigger, the zebra fish appears to display no aggressive action or territoriality.

(3) If the species of the test fish is the same in size, but different in color, the zebra fish showed territoriality and some aggressive action some of the time.

(4) If the species was the same size and color pattern, it showed both territorial and aggressive instincts.

In a community tank (non-isolated), the zebra fish did not appear to establish a stable or set territory. The non-isolated zebra fish, that was designated dominant, reacted faster towards a non-dominant zebra fish than to a dominant one. The non-isolated non-dominant zebra fish reacted faster to other non-dominant zebra fish than did the isolated non-dominant one. It appears that isolation has a definite effect on the territorial instincts of the Brachydanio rerio. Re-isolation has the same effect as that of isolation, with a few exceptions.

In continuing my experiment I have found that the zebra fish has its aggressive and territorial behavior at birth. And that growth of the organism develpes its behavior. Isolating the zebra fish at birth causes a greater amount of aggressive and territorial than through growth. So that scientists wanting greater behavior should use isolation.

SHARKS

by Marvin J. Samiano, Kauai High School

Abstract

This paper discusses the biology of the shark. I will discuss such things as the position of the fins, the differences between the true bony fishes and the shark, shark teeth, shark skin, the absence of the swim bladder, reproduction, their sense of smell, their sense of sight, their sense of hearing, and a special sense organ which measures changes in the water.

Introduction

The shark is one of the most mysterious, as well as the most misunderstood of all the ocean creatures. In this paper, I hope to enlighten some people about this beautiful animal.

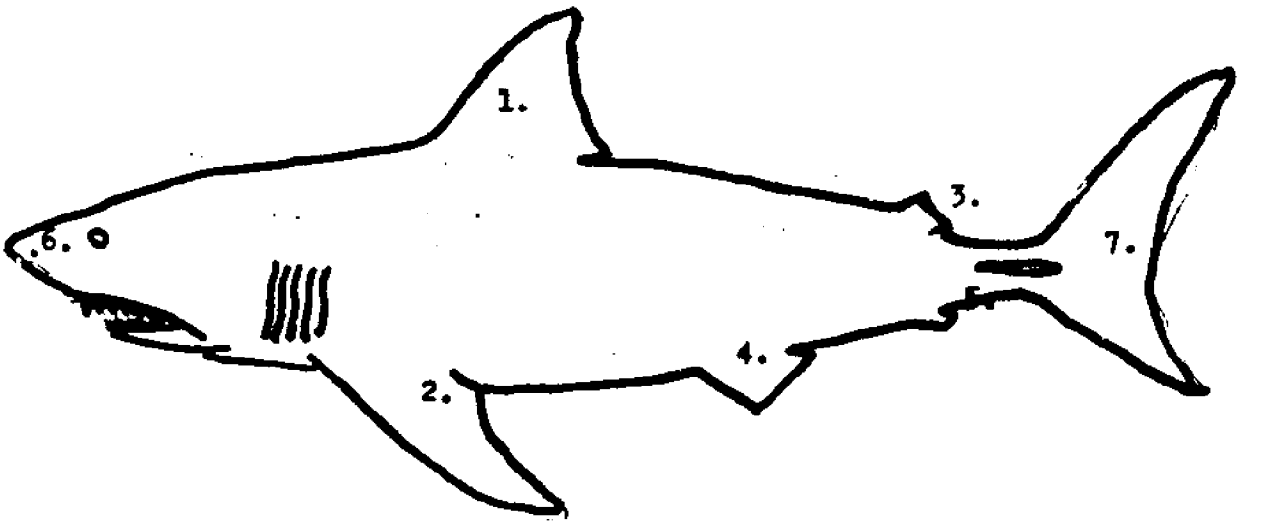
Elasmobranchs are of all sizes and shapes, contributing to their amazing diversification. From the very smallest, just under 25.4 centimeters long, to the rare 12.192- to 14.288-meter giants, the shark has the sleek, supple, torpedo-shaped bodies beautifully designed for swift and graceful propulsion.

Topside from bow to stern there is the first dorsal, second dorsal, and caudal (tail) fin. On the underside we see a pair of the pectoral and pelvic fins. Behind the latter, in the male, are the claspers (reproductive organs) and, just in front of the tail, the caudal peduncle. Five gills are seen in front of each pectoral fin. The eyes are on the side of the head, which in many are covered with a freely moving lid, called the nictating membrane. The opening behind the eye is the spiracle -- part of the breathing apparatus. The nostrils are at the tip of the snout, and the mouth, crescent-shaped when closed, is on the underside of the head.

The position of the first dorsal fin is related to the shark's swimming speed. In the fast, pelagic swimmers, the first dorsal, being rigid and placed well forward, most likely acts as a stabilizer, with the pectoral and pelvic fins checking excessive rolling in swimming. When a shark charges after its prey, the pectoral fins are probably used for steering, and act as brakes at the point of attack.

When man first encountered a shark he must have realized how different it was from other fishes. They also have three unpaired fins: the dorsal, caudal and anal. But instead of the fleshy shark fin firmed up by a framework of gristle threads, the stiff dorsal fin in the spiny-rayed fish has bony rays with needle-sharp

The Shark



Common Name.....Shark

Phylum.....Chordata

Class.....Chondrichthyes

Order.....Elasmobranchii

Parts of the shark:

1. First dorsal fin
2. Pectoral fin
3. Second dorsal fin
4. Pelvic fin
5. Anal fin
6. Nostril
7. Caudal fin

points extending beyond the web of thin, enveloping skin.

The most basic difference is in the type and development of the skeleton. It is made of cartilage, like the tissue that forms and holds the shape of the tip of a human nose and outer ears. Parts of the shark's skeleton, such as the vertebrae, are hardened by deposits of lime, but this does not make it bone tissue. The jaw is calcified as well, but it is still a cartilaginous structure.

A shark has no ribs and its backbone extends all the way into the tail, while in bony fishes it ends where the tail begins. The shark skull is made of one piece, without seams. In other fishes, the skull bones in the embryo are membranes of fibrous tissue that later harden into bones, which finally become firmly united by interlocking slender bits of bone in tongue-and-groove fashion. Another difference in sharks is that the upper jaw is loosely slung onto the skull.

Despite their hardness, sharks' teeth are not made of bone but are specialized scales. The difference between shark teeth and those of other vertebrates is not only one of development but of chemical composition.

Sharkskin has rows of toothlike spikes. These are embedded over the entire body, including the fins. The denticles, or skin teeth, stop growing after reaching a certain size, and as the shark grows, new denticles are added between the existing ones.

The absence of a swim bladder or some similiar organ puts the shark at a distinct disadvantage. Pelagic sharks have to swim continuously to maintain their position at any particular level in the sea. If swimming motions should stop, the shark would sink to the bottom.

The reason that sharks must swim to stay alive, and can not stop to rest, is related to the difference in their gill structure. Lacking operculum as a mechanical aid, the only way active sharks can obtain oxygen is by the flow of water created by the current while they are in motion. A shark is not normally a bottom-dweller and will rest on the bottom of a tank only when it is sick or injured.

In their breeding habits, the shark is more highly advanced than the bony fishes, reporducing more like mammals. The female produces few young, but development of the embryo takes an unusually long time. Their success in populating the ocean waters of the world is at least partly due to their method of reproduction.

An outstanding feature of the sharks is their extraordinary sense of smell. A proportionately large share of the shark's brain is given over to the function of smelling. The forward part has two forks extending toward the nostrils on either side of the snout, and their perception is so delicate that a shark can actually steer itself up a scent trail much as an airplane follows a radio signal. When it first picks up a trace, it may veer back and forth, establishing the direction from which the scent comes.

The sense of sight among elasmobranchs is far less acute, though they are probably not so nearsighted as they were long popularly believed to be. Rather, because their eyes have only visual rods that distinguish between light and dark, but no color-discriminating cones, they probably see only shapes, and detect movement better than precise form.

Like most fishes, elasmobranchs probably hear very little. Their ears are mainly balance organs containing the semicircular canals which inform the fish of changes in direction, acceleration or decelaration and whether it is right side up in the water. There are no main channels to the outside of the head, however, nor is there an eardrum for detecting sound waves.

Concentrated on the heads and faces of both sharks and rays are small sense organs sunk at the bottom of pits, each with a minute pore to the outside of the skin, which transmit vibrations and changes in the flow of water. On the head, these organs are highly modified to form what are called the ampullae of Lorenzini, very deep canals filled with a jellylike substance which apparently register changes in the temperature of the water.

Conclusion

Because the shark is one of the most mysterious animals in the ocean, I feel that we should know as much as possible about them. By knowing more about them, I feel that we can lessen our chances of shark-attack. I hope that this report has helped people to better understand the shark.

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SEA ANEMONE: LIFE AND SYMBIOSIS WITH THE CLOWN ANEMONEFISH

by Vivien Higa, Kubasaki High School

INTRODUCTION

Sea Anemones are often seen anchored to the coral reefs by divers. These bright and beautiful animals resemble magnificent flowers. Clownfish are almost always seen swimming nearby. For some reason that is still unknown to scientists, sea anemones seemingly cannot live without the clown anemonefish.

The reason for the research was to learn about the sea anemone and clown anemonefish's way of helping eah other to survive.

METHODS OF RESEARCH

Information was gathered by researching several books and by personal ob-
-servation. Diving down on scuba, I observed and tested the clown anemonefish's protectiveness of the sea anemone by brushing my knife through the anemone's tentacles.

RESULTS OF RESEARCH

The results of the test turned out useful. The clown anemonefish, residents of the anemone being tested, were very disturbed and immediately started attack-
-ing. They did not appear to be afraid of the large diver that they were up a-
-gainst and they repeatedly charged and nipped at my gloved fingers whenever I returned to within reaching distance of the sea anemone.

DISCUSSION

The sea anemone is an animal with a column base and an opening at the top which is the mouth. Around the mouth are many tentacles which have stinging cells or nematocysts which are hooks that are connected to a venom gland by a hollow filament. This hook is released at the slightest contact and hooks into the flesh of the fish which made contact with the tentacles. When the hook is in the flesh, venom is released and the fish is paralyzed. The fish is then drawn into the mouth with the tentacles. These stinging cells can kill any fish from 4 to 5 inches, except the Clown anemonefish. The Sea Anemone eats small crabs, fish and sometimes sea stars. Mature sea anemones can be $\frac{1}{2}$ inch, or grow to more than 3 feet in diameter. The size varies by the kind of species. They reproduce by budding, dividing into two or by laying eggs. They travel by ri-
-ding on crab's backs or sliding very slowly on rocks. Some species can swim but not effectively.

The Clown anemonefish and the sea anemone exist together in a manner call-
-ed symbiosis. The Clown anemonefish lives among the tentacles of the sea an-
-emone because it has complete immunity against the deadly poison of the sting-
-ing cells. The Clownfish has full protection from it's host. A large fish will not go after a Clownfish hiding among the tentacles of the anemone because the fish would be afraid of the deadly tentacles that could paralyze it. Yet first, the Clownfish must go through a painful introduction with the sea an-
-mone. It brushes against the tentacles and gets stung but gradually develops an immunity to that particular anemone's toxin. If the anemonefish has left that sea anemone for a while and returns, or if it goes to a new anemone, it must go through a reintroduction with that sea anemone.

The anemonefish, while taking shelter among it's host, feeds the sea ane-
-mone. Sometimes it will lure a fish into the sea anemone's tentacles which will then be stung, paralyzed and eaten. The Clown anemonefish feeds off of the scraps. The Clownfish also protects the sea anemone by attacking an int-
-ruder making threatening moves towards it's host, but the sea anemone can de-
-fend itself by curling it's tentacles inward. The Clown anemonefish will use the sea anemone to protect it's eggs by laying them at the base of the sea an-
-emone so that the Clownfish does not have to worry about it's eggs.

CONCLUSIONS:

Through personal observation and researching many articles on the sea an-
-emone and the Clown anemonefish, I conclude that the symbiotic relationship of the two exist and that each depends on each other to do it's part for the life of both animals. That without each other they would probably die out and in time, become extinct.

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THE WAY OF THE SQUID

by Deborah A. Krumpelman, Kubasaki High School

Man who has been forever entranced by the mysteries of the sea, will begin to unravel them until he is fully knowledgeable. Man has progressed but the mysteries still survive. Here I will attempt to describe a fraction of the mystery of the sea through the life cycle of the squid.

REPRODUCTION AND BIRTH

It is fasdnating to see wildlife and birth, therefore when two squids mate one's fasdnation is obvious. Sexual reproduction, more complex than the simple asexual method, is the form used by the squid. This method holds great responsibility on the male species in order for successful fertilization. The male must find a fixed location for mating and not allow the female to leave until the eggs are laid. Afterwards he guards the fertilized eggs. Many of the more advanced species carry internal fertilization which is more successful for fertilization and protection.

"When two squids mate, the male uses one arm to grasp his sperm packets and induce them into the female's oviduct, thus performing internal fertilization." (1)

After fertilization the female squid leaves her young in a gelatinous mass called " dead man's finger's ". This is very unlike her cousin the octopus, who fiercly guards her young until they hatch. Dead man's finger's are cigar-shaped cases that contain hundreds of eggs, which are sometimes found covering the ocean floor. Once the eggs hatch they begin an independent life but few survive, because during the early stages of birth if water temperature is not just right then the eggs will die. Certain crabs and fish also feed on the newly born.

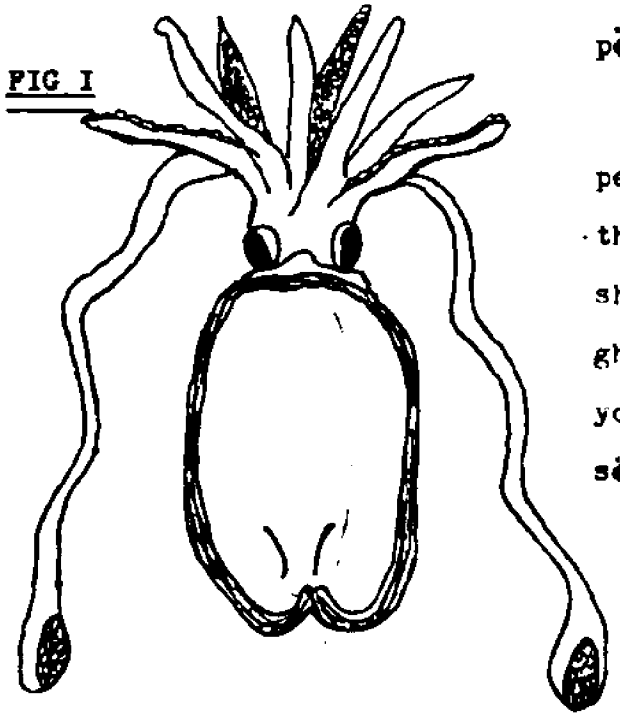
The young who do survive can grow to be from twelve inches to fifty feet long and weigh up to 400 pounds. For example the giant squid of the cold northern oceans are known to be the largest invertebrates. The largest squid ever found was found stranded at Rahneim in Norway in 1954.

(1) Jacques Cousteau, THE OCEAN WORLD OF JACQUES COUSTEAU, Volume 6, p. 48

FEEDING HABITS

The squid locates it's prey with it's highly developed eyes and captures it with tenticals or arms. Squids have five pairs of arms. Eight are called arms and two are called tentacles. The tentacles are twice as long and lighter than the arms.(Fig 1) The underside of the arms are covered with disc-shaped cones that function as suction cups. Attached to the floor of the cups are muscle fibers that help create the vacuume. In the middle of the ten arms is the beak which can bite and tear off large pieces of flesh.

FIG I



The diets of the squid depends on the habitat where they live. Most squids eat shrimp and fish. A squid might dart into a school of young fish and quickly seize a fish.

LOCOMOTION

It is fun to watch squids swimming gracefully through the water. But then one wonders how the squid manages to move so gracefully.

Water is forced through the ventral tubular funnel (Fig 2) thus providing locomotion. The force made by the water leaving

the funnel steers the animal in the opposite direction. This funnel can force water in or out, to make the animal move forwards or backwards. If the animal decides to move faster for excape swimming it simply applies more force on the water it expells.

Squids are very fast and adapted to swimming in water. They are able to dart very fast and some of the movements they create in the water are beautiful. The squid is also able to hover in one place for a long amount of time, that in itself is the reason why squid's attain the highest speeds of any aquatic invertebrate.

INK GLAND AND LUMINESCENCE

The colors in the squid are made by chromatophores in the integument. When the cells expand and contract the color is changed. The cromatophores are controlled by the nervous system with vision as the main stimulus.

FIG I

A lot of the deep sea squid become bioluminescent, which means they have luminescent photophores.

An ink-producing gland and a secreting duct that opens at the rectum just behind the the anus secretes a high amount of melanin pigment which is brown or black. This system of protection fools of bewilders the predator of the squid and enables him to escape it's enemy. The large ink-producing gland is located in the area of the intestines. Whenever the squid is frightened it lets it's gland toss the ink at the predator and quickly escape.

IMPORTANCE TO THE ECONOMY

The most common economic importance of the squid is that it is used as seafood in many parts of the world, I am most familiar with the way in which it is eaten in Japan and the surrounding islands. Squid is eaten most of the time raw. When in soysauce raw squid, in my opinion can be quite tasty. Another way it is eaten is fryed in deep fat, when this is done it is called Tempura.

Other importances of the squid is that Whales which are very economically important eat squid and therefore the squids help keep the whales abundant in most waters. Some sperm whales have circular scars on their bodies from a struggle with a giant squid. Squids are also used as bait for catching certain types of fish.

----Personal research and observation----

I have lived around the ocean for approximatly nine and a half years, this time was spent in the far east on the island of Okinawa. During this time I have been fortunate to learn alot about the creatures of the sea. I have seen squid in the wild and watched their behavior many times while snorkleing. I have found that the squid (In the Far East) are very curious, yet shy and timid. Sometimes when one got very close I would reach out for it and immediately it would dart away while at the same time squirting a cloud of ink in my direction. I have caught a few but none were large enough to use for bait or to eat. Squid are very tasty , many times a member of my family would bring one home and we eat it while it is fresh so that the natural taste remains.

CONCLUSION

Now that I have explained part of the life of the squid as best as I could , I would like to ask all people who live by the ocean and who might visit it tdhelp conserve the beauty of the sea which is probably one of the last of the untouched parts of nature. He who learns from the sea will become wise because he has seen what beauty the world has left.

The squid I think will always flourish. Since the lifes style of the squide permits the continuation of the species by the production of many eggs. So I cohclude this report.

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MARINE BIOLOGY II.

PORTUGUESE MAN-OF-WAR:
"FLOATING FAMILY" OF THE SEA

by Lynda J. Soares, Sacred Hearts Academy

ABSTRACT

At certain times of the year, Portuguese-Man-Of-War wash upon the shores of Oahu. The enemy of any beach go-er, this organism is known for its notorious stinging powers. Although it is the painful sting which warrants its reputation, this organism's complex biological composition deserves much more acclaim. I hope to bring out some of the "lesser" known aspects of this creature's existence. I have not studied this organism thoroughly, but I find it to be one of the most fascinating forms of sea life.

INTRODUCTION

At select times of the year, transparent blue bubbles dot the beaches of Oahu and other tropical and sub-tropical climates. Commonly referred to as "Portuguese Man-of-War," these fragile blue "bubbles" are the enemies of any beach-go-er. As anyone who has ever had a "close encounter" with one of these creatures will attest, it is not an easily forgotten experience. Although it is this animals painful sting which warrants its unpopular reputation, its complex biological composition deserves much more acclaim than it normally receives. This is the basic goal I hope to achieve in this report. I have not covered each physical aspect of this organism completely, but I hope to present more of the "lesser" known information. Therefore, I'll begin here with my report on

"Portuguese Man-of-War;
Floating Family of the Sea"

Functions: Organisms Within an Organism

On the surface, the Portuguese Man-of-War appears as a single organism. In reality, this one creature is really composed of four different "animal" bodies, each responsible for the various life functions of that one organism. A Portuguese Man-of War is a member of the Polyp family; a very close relation to the jellyfish. The four main working bodies of the polyp lie under the blue "float," within or above the Tentacle structures. The organs which work within this community are the Feeding tentacles, the Stinging tentacles, the Digestive organ, and the Reproductive organ. Each colony is dependent on the function of the next. Since each must contribute its service to the whole organism, an interdependent family system is created. These are the Functions which the four colonies provide:

TRANSPORTATION

The fragile blue "bubble" is not only an ornamentation. It functions as the "navigator" for the entire "vessel." The capability of this bubble to inflate and deflate itself controls the speed at which it moves. Longer than it is wide, it may also be flattened or broadened, and contorted to almost any angle. This versatility controls the directional movement. Thus, the tiny blue "sail" is really one of the main organs of the animal. Incidentally, many wonder how the name "Portuguese Man-of- War" came into existence. With the "sail" appearance and obvious painful consequences which follow, these sea dwellers were dubbed after the old world sailing ships of the time. No racial or ethnic connection whatsoever; merely a coincidental "look-a-like".

FEEDING TENTACLES

Under an average bubble of eight inches in length, lie the feeding tentacles. Capable of being lowered to a depth of fifty feet, or retracted to a few inches, these gather the food for the entire body.

These entangle small specimens while floating in the water. As the fish struggles within the tentacle's grasp, tiny poison ducts inject a venomous liquid into the victim's body. The tentacles then retract, bringing the food to the digestive tract opening. These feeding tentacles also work with the stinging tentacles.

STINGING TENTACLES

"Security guards" and "food trappers" of the organism, these work closely with the feeding tentacles. Located on the tentacle forefronts of this colony are small poison capsules known as nematacysts. These capsules will inject poison into any force which threatens the well-being of the organism and its "family."

DIGESTIVE ORGAN

This colony is presented with the food retrieved by the feeding and the stinging tentacles. The digestive organ assimilates and distributes the nutrients proper to all other functioning colonies.

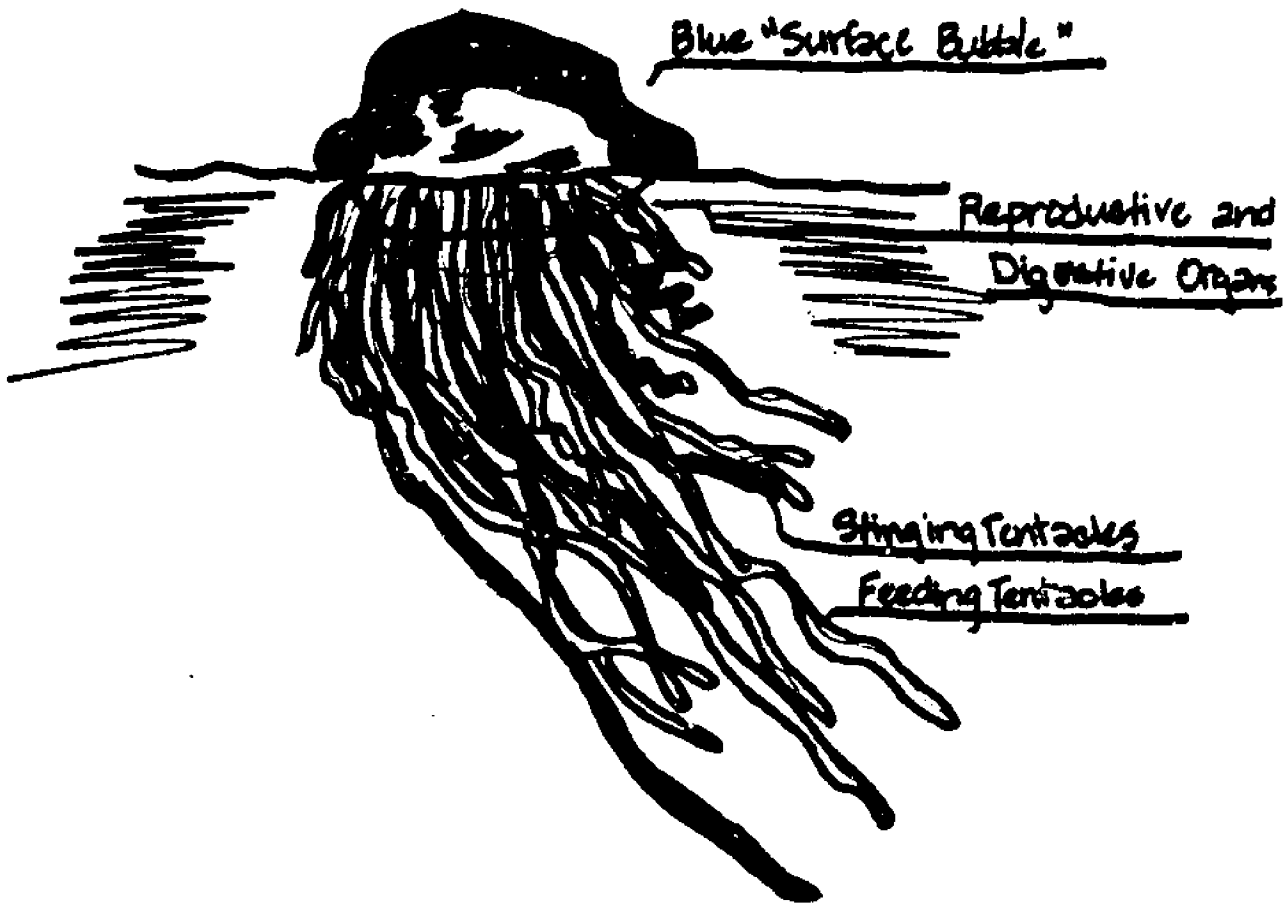
REPRODUCTIVE ORGAN

This is perhaps the most complex of all facets presented here. Although each colony may reproduce through asexual budding, ultimately the whole organism may reproduce sexually. The only difference is this; only the reproductive organ carries out the whole procedure. There is only one example which would illustrate this point: Imagine a single horse responsible for giving birth to all other horses, cows, chickens, and dogs on a farm. That system can be labeled only as complex!

CONCLUSION

One of natures's little known wonders, the Portuguese Man-of-War may be the ideal biological balance. The principle of four different, yet vitally fucntioning cellular colonies, composing one organism, is the ultimate example of cell specialization. The reproductive process, though not fully understood, employs both asexual and sexual reproductive methods. Overall, the balanced state of this polyp is achieved only through the combined efforts of its "daughter" organisms. A communal life support system thus establishes the Portuguese Man-of-War as the "floating family" of the sea.

Portuguese Man-of-War



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COMMON CRABS IN HAWAII

by Judy L. Green and Anita B. Tadeo, Pahoa High School

ABSTRACT

In these Hawaiian waters there are about one hundred different types of crabs around the shores and shallow reefs, some even in the deep waters of the islands. Some types of crabs are edible and others are not.

Introduction

Crab is an animal that is covered by a hard shell, and has jointed legs. It lives in shallow waters along the shore, and also in deep waters. Some crabs live in burrows in the banks of salty tidal streams, others live in fresh water.

The smallest crabs are the tiny pea crabs. The female pea crabs live in the sheltering shells of love oysters. The shape and relative size of the big claws of crabs differ greatly among the species. Some crabs are swimmers, and have paddles on their last pair of legs. Many crabs run side-ways on the sand or rocks of the seashore. Crabs eat other small crustaceans and arthropods, and organic matter.

Crabs are taken in nets and wicker traps.

The crustacean most highly prized as food in Hawaii is the Kona crab, Ranina serrata, family Raninidae, called papa'i kua lon. These animals are not abundant and are prized so highly that few manage to get into the markets. Kona crabs are denizens of sandy bottoms at depths exceeding 20 feet. During the day they are mostly buried in the sand, with only the front part of the body, and the eyes visible.

Most crustaceans are nocturnal animals, with secretive habits in daylight, the shore crabs of the family Grapsidae typically crawl along the water's edge during the day. These are known by various Hawaiian name: hihi wai, 'alanihi, and 'a'ama.The 'a'ama is Grapsus grapsus, a crab of the rocky shoreline that was used as a ceremonial sacrifice as well as for food in old Hawaii. Islanders caught this elusive crab with a line baited with 'opihi. Several old chants concern the shore crabs; including:

Black crabs are climbing,
crabs from the great sea,
sea that is darkling.
Black crabs and gray crabs
scuttle o'er the reef.

When you drags a large piece of coral rock out of the water, and breaks it apart on the beach, an amazing number of tiny crabs scurry out from among the debris. Most of these crabs belong to the family Xanthidae. Although most of the one hundred or so Island species of this family are small, one is the prominent crab, Carpilius maculatus may attain a length of 6 inches. Xanthid crabs were eaten by early Hawaiians with the exception of certain poisonous varieties called kumimi, which were used by kahuna in sorcery.

Another prominent group of crabs are the swimming crabs of the family Portunidae. The last pair of legs on these crabs, modified as paddles, so effectively propel them through the water that they are recognized as the most powerful and agile swimmers of all crabs.

Despite this natatory ability, many spend a large part of their time buried in the sand.

Burrowing in the sand is even more characteristics of the box crabs, family Calappidae. The body shells of crabs in the genus Calappa have wide winglike expansions that cover their legs. Several species, whose shells are covered with knobby protuberances, look like rocks until they move.

The ghost crabs, which comprise the family Ocypodidae, are prominent along the waters edge on sandy beaches. The crabs dig burrows in the sand from which they emerge and scavenge on bits of food among the debris that has washed up on the shore. Their burrows are readily recognize by the conical pile of sand next to each entrance. Ghost crabs are highly active animals that scurry accross the sand with amazing agility. They owe their name to their bleached coloration, a feature that serves them well as camouflage against a background of white sand. Significantly, the ghost crabs living on the Islands' black sand beaches are themselves dark grey.

Hermit crabs, papa'i iwi puna, comprise a specialized family, the Paguridae, that is adapted to life in abandoned gastropod shells. Whereas the abdomen of a typical crab is turned under the forward part of its body, that of hermit crab projects backward as a soft, banana-shaped structure that fits into its adopted home. The front end of these crabs has the hard covering typical of other crustaceans, and when the crab has withdrawn inside its shell, its right pincer, larger than the left, serves to close the entrance.

As a hermit crab grows, it must periodically replace its borrowed shell with a larger one. When a prospective replacement is found, the crab carefully examines it with his claws. If the shell is satisfactory, the crab quickly transfers his vulnerable abdomen to the new home. Sometimes one crab will attempt to pull another from a particularly desirable shell.

Many hermit crabs inhabit shallow water, the most common of these being species of the genus Calcinus. These crabs often congregate under boulders are overturned the crabs scurry in all directions. The largest of Hawaiian hermit crabs, Dardanus punctulatus, usually occupies the shell of the tri good aquarium pets. This and other hermit crabs make good aquarium pets. Like most other crustaceans, hermit crabs readily accept bits of fish or mollusk meat, and a single piece, once a week, will keep one well and active.

The common sand crab. A seashore animal called a crustaceans (crus-ta- shans) They are called this because of the hard crust which takes place of bones that are on the outside of the animal. The body of the crustaceans is jointed. Crustaceans are also called "double-jointed animals." this animal is quick and active in its movements. The legs never seem to get in the way of each other. They move forward or sideways its all the same to this speedy sand-racer.

Certain crabs can wander away from the seashore and remain in the air a long time. The gills are so modified that they actually serve as lungs, and the animal can brethe moist air.

Many crustaceans are under loose stones in shallow water. They live among the brown seaweed that grows close to shore. Certain crabs hide among the branches of coral colonies, A little white crab lives in the sand at the water's edge. If it gets uncovered it buries itself again in the wet sand. They always dig in backwards.

The eggs of the mother crab hatch into tiny larvae which swim to surface of the water. The larvae shed their skin several times (molt) and finally change into tiny crabs. They continue to molt during thier growing stages intil they become an adult. When the larvae is swimming alot is destroyed by other animals. A few develope into crabs.

Hermit crabs can be found under stones close to shore. This crab has strange habits. It finds a mollusk shell and backs into it.

Grapsoid crabs have round or squarish bodies. Some of them are out of the water most of the time, or clambering over the rocks near the shore. Others hide under stones in muddy places. A large amount of "rock crabs" are to be found in shallow water. They find concealment under rocks close to shore. In some crabs the carapace is smooth; others, it may be rough or

covered with long hairs. Some rock crabs have flat walking legs with sharp edges.

Crabs with long legs and small bodies are called " Spider Crabs". small ones may be found among seaweeds on the reefs. Larger ones live in deeper water. one taken from Pearl Harbor measured two feet from tip to tip of its legs when spread out. The body less than five inches across.

Among branching coral is a good place to find certain kinds of crabs. smooth-backed ones called Trapezia (Tra-pe-zia) with warm colors brown, reddish, or spotted are not found anywhere else these crabs can give a sharp pinch.

Swimming Crabs

The champion swimmers are known by the shape of the last pair of legs. There flat like paddles. Most of these crabs also have long pairs of legs. Slender legs and capable of running swiftly, as well as swimming.

The "Samoan" crab is a swimming crab. It was introduced from the south seas into Hawaii, where it has multiplied rapikly. Because of its large size and huge claws and legs, it is an important source of food. the crab lives in canals or in th mouths or rivers where the water is not too salty.

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SHARKS

by Debbie L. Kubera, Pahoa High School

INTRODUCTION

Sharks have been around in the oceans for more than 250 million years. Very little is known about these creatures because man has thought of them as dangerous species of the deep sea.

Sharks have no bones in their bodies, but they have a large cartiledge which substitutes for their bones. Their jaws are strong and their stomaches are tough, so their digestive system allows them to digest almost anything.

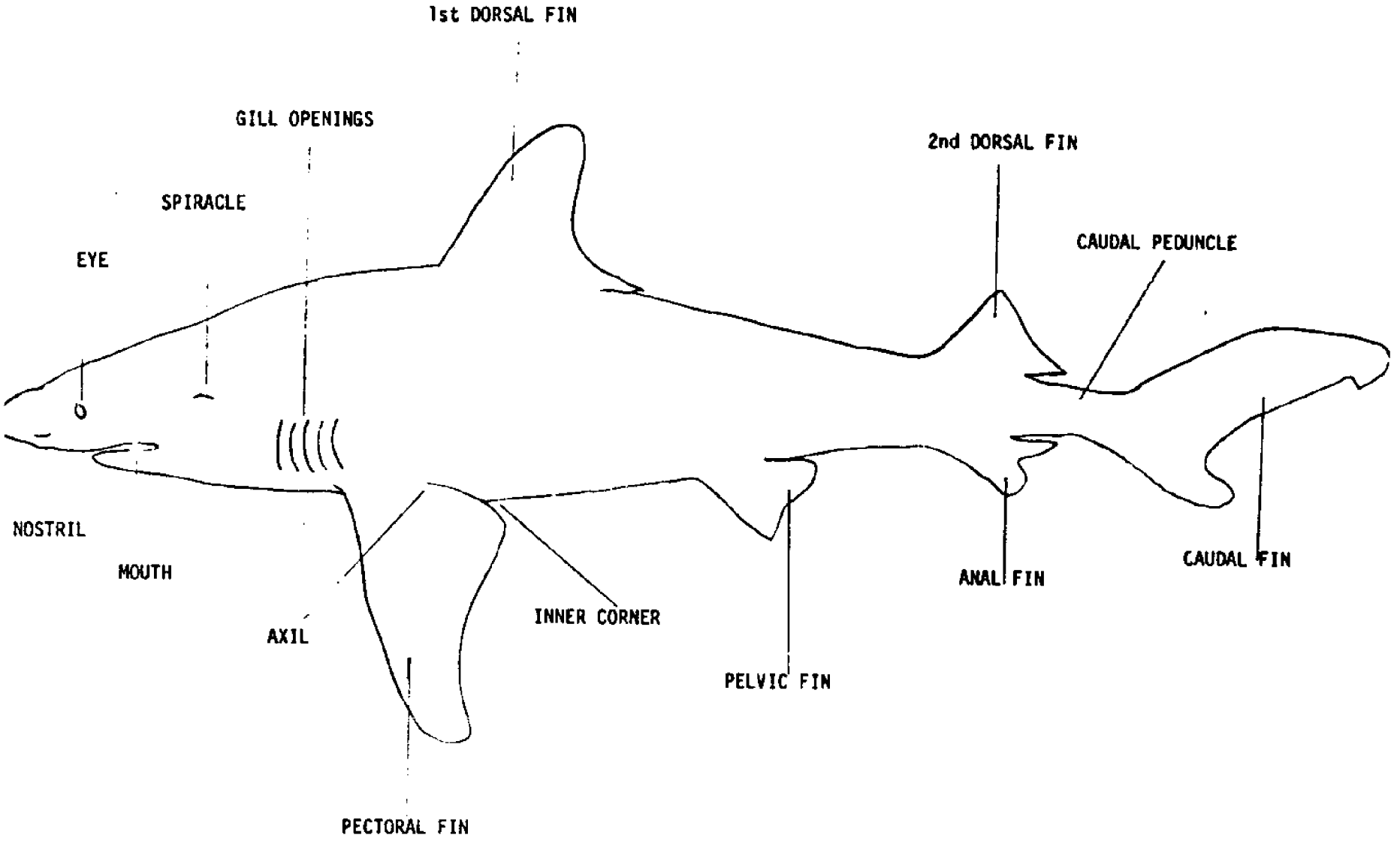
The sharks body can be broken up and used for many useful things such as, soup, oils, jewelry , souveniers, leather, etc...

As a supplement to Hawaii's food supply, the shark need not be imported and therefore prices for shark products would be reasonable. The best shark fishing areas are in southern Oahu, so the industry could easily be based in Honolulu where sales, processing and profits would remain in Hawaii.

SHARKS

Sharks are chiefly marine fishes and are found in all seas, but are especially abundant in tropical and subtropical waters; some species regularly inhabit fresh water. Unlike their close relatives the rays and chimeras, sharks are fish-like in form and have lateral gill clefts. Most of them are of moderate or large size, the largest living sharks attaining a length of over 40 feet; fossils have been discovered of an extinct species of Carcharodon which attained an estimated length of 90 feet. The majority of sharks are gray in color, and have leathery skin covered with sharp, pointed scales which are known as placoid scales. Sharkskin is used in commerce as a source of a form of leather known as shagreen. A shark's mouth is located in the underside of the head, below the anteriory projecting snout, and is studded with numerous sharp teeth similar in structure to the placoid scaled of the skin. The fins are not unusually large; shark's fins rarely protrude above the surface of the water when the fish are swimming close to the surface. The tail has two lobes; the cartilaginous backbone extends into the upper lobe of the tail. Shark flesh is coarse but ediable. The fins abound in gelatin and are used in the Orient in the preparation of a rich, viscous soup. Sharks livers yield an oil which is rich in vitamins A and D.

Most sharks are carniverous, feeding on fishes. A few, such as the basking shark and the whale shark, feed on


1st DORSAL FIN
GILL OPENINGS
SPIRACLE
EYE
2nd DORSAL FIN
CAUDAL PEDUNCLE
NOSTRIL
MOUTH
AXIL
INNER CORNER
PELVIC FIN
ANAL FIN
CAUDAL FIN
PECTORAL FIN

plankton, straining it out of the water with their sieve-like gill rakers. The creatures are active and agile. They do not turn on their backs when about to bite. Although some species are known to attack man, the great majority of sharks are not man-eaters; the basking shark and the whale shark, which are the largest living sharks, are harmless and they do not attack man even when harpooned. Of the man-eating sharks, many are normally timid, attacking only when incited by the smell of blood. One of the dangerous species is a fresh-water gray shark which lives in Lake Nicaragua, Central America, and attains a length of 9 feet.

Shark liver yields valuable oil containing large quantities of vitamin A. The fins are rich in gelatin and are used in the Orient in the preparation of soup. Other commercial products derived from sharks are a durable leather, made from the hide, and meal and fertilizer, prepared from the carcass.

Angelfish is just another different species of the shark family. Either of two raylike sharks of the genus Squantina, known also as the angel angel shark or monk fish. Its pectoral fins are greatly enlarged and resemble wings or a monk's hood, which accounts for the names. The angel shark attains a size of from 3 to 6 feet, and is harmless. Its food consits primarily of shellfish. It is common in the Mediterranean Sea, and may be found near both the eastern and western shores of the warmer parts of North America.

Hammerhead shark , common name for any shark on the genus Sphyrna, characterized by a flattened projection on either side of the crown. The eyes are situated at each end of the rubberlike projections, which enable the shark to maneuver skillfully when chasing its prey. The hammerhead is a voracious, fish-eating shark which reaches a length of 16 feet; it has been known to attack man. It is found in all warm seas and comes as far north along the Atlantic coast of the U.S. as Massachusetts. The female hammerhead incubates its eggs within its body cavity. Five species are known of the Hammerhead.

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DANGERS OF THE SEA

CIGUATERA: SOME BIOLOGICAL AND CHEMICAL ASPECTS AND ASSAYS FOR TOXICITY

by Marion K.W. Ho, McKinley High School

Abstract

This is a report of the biological, chemical aspects and detection methods of ciguatera, a neurotoxic poison or poisons found in marine fishes associated with coral reefs.

Ciguatera poison, ciguatoxin, originates from either a fine alga or a microbial heterotroph; thus, through the food web, ciguatoxin is transmitted and cummulated in great varieties of marine fishes.

Ciguatera poisoning was known since the 16th century. But it was not until the sixties that the toxin was first purified. It is a transparent, light yellow, viscous oil which is unstable. Thus, it is questionable whether the toxin has a tendency to decompose or whether it consists of several closely related compounds. Its empirical formula was found to be $(C_{35}H_{65}NO_8)n$.

The earlier detection methods of ciguatera were bioassays of mice, cat and mongoose, but none of these bioassays used has been completely satisfactory. The most recent and the most reliable method is the radioimmunoassay test.

Introduction

Ciguatera is a neurotoxic fish poison(s) known since the 16th century. Generally, ciguatoxic species are limited to those fish that feed on algae or detritus of coral reefs, especially the surgeonfish (Acanthuridae), parrotfish (Scaridae), and the larger reef carnivores that prey largely upon these herbivores (Banner, 1976).

The symptoms of ciguatera appear from about one to ten hours after a toxic fish is eaten; those most commonly given for the illness are: weakness or prostration, diarrhea, tingling or numbness of lips and hands and feet, confusion of sensations of heat and cold, nausea, joint and muscular pain, inability to coordinate voluntary muscular movements, difficulty in breathing, burning urination, and itching. Probably the most common diagnostic symptom is the tingling sensations in the hands and feet, frequently described as like "pins and needles" or "electric shocks", and the feeling of heat when cold objects are touched or cool liquids are taken into the mouth. Light cases may not exhibit these sensations. The gastrointestinal distress of ciguatera is usually of short duration, but the neural symptoms may last for many weeks (Randall, 1958).

Since ciguatera has some intriguing chemical and pharmacological properties, it is a very challenging research problem. Also, the disease presents a serious threat to the

further economic development of the fishery resources of tropical Pacific (Hessel and Halstead, 1960), especially crucial to Hawaii since its fishing areas are restricted.

Methodology

Most information in this research paper are taken from references in Hamilton Library and McKinley High School Library. Some very important details were obtained through conversation with Dr. Hokama who is in charge of the radioimmunoassay program for detection of ciguatoxin (Dept. of Pathology, University of Hawaii).

Historical Background

The earliest reference to ciguatera was published in 1955 generally credited to Peter Martyr, the first historian of the West Indies. Following reports of the disease were: Spanish explorer Quiros' entire crew was poisoned from eating "pargo" in 1606 in his visit to the New Hebrides, Anderson's doctoral thesis in which he reported on more than 60 species of poisonous fishes of West Indies in 1829, Steinbach's paper of 1895 on the poisonous fishes of the Mashall Islands (Hessel, 1960).

Although ciguatera has been known since the 16th century, researchers knew very little about its pharmacological and chemical properties and nothing about its origin until the 1960's when there were many attempts to purify the toxin and

to develop detection methods (Hessel and Halstead 1960). In 1964, the toxin was first successfully extracted (Scheuer, 1964). More biological investigation into the disease was done by Cooper, Banner, Bagnis, and Randall in the following years of the same decade. In 1976, the origin and transmission of the toxin were completely confirmed by Yasumoto et al (1976). In 1976, a radioimmunoassay, a new and more quantitative detection method, was developed to replace the subjective bioassays of mongoose and cat.

Distinction from other marine toxins

The poisonous fishes of the tropical Pacific have been divided into five major categories. The best known group is that labeled by Halstead (1967) as "Tetrodotoxic" which the toxin is confined within the puffers species, and its chemical structure is completely locid. The second type of intoxication is caused by a toxin produced in the early spoilage of the dark-fleshed tunalike fish by the action of the bacterium Proteus Morganii that reduce histidine to toxic histamine and possibly related products (Banner, 1976). Halstead (1967) called these fishes "Scombrotoxic". The third type of intoxication, less well known and studied, is labeled by Halstead (1967) as "clupeotoxic" and is confined to the suborder Clupeoidae. The fourth type has been named "hallucinatory mullet poisoning," and ciguatera is the fifth type of intoxication, the most intriguing marine toxin.

Unlike tetrodotoxin which is produced by a single family

of fishes (puffers), ciguatera is not confined to any particular species of marine fish. Unlike scombrotoxin, ciguatera is not caused by a bacterium. Ciguatera is distinguished from "hallucinatory mullet poisoning" by the hallucinations and by the lack of gastrointestinal involvement from the various mullet toxicity (Banner, 1960). Also, ciguatera is not confined to the suborder Clupeoidae, so it is not related to clupeotoxin.

The definition of ciguatera is very ambiguous: (1) there is no specific fish as carriers, because Halstead(1967) lists over 400 species as ciguatoxic, including both cartilaginous and bony fishes; (2) there is at least one or more toxic compounds in the ciguatoxic-bearing fishes.

Biological patterns of ciguatoxic fishes

Ciguatera has regional occurrence. The toxic-bearing fishes are limited to the tropics and subtropics and to coral reefs. Although the poison was first reported in the Caribbean, the most recent occurrences are in the Pacific. In both the Pacific and Caribbean, ciguatera seems largely confined to islands and is not found along continental margins. The only major exceptions to this rule are the coastal waters of Florida and the Great Barrier Reef of Australia. In general, almost any of the islands of the Central Pacific, and, to a lesser extent, those of the Indian Ocean and Caribbean Sea may have a few species of fish that may be sporadically toxic (Banner, 1976).

Within a known toxic area in Gilbert Islands, many species

of fish become toxic. Apparently all feed either as herbivores on the benthic flora of the reef or ascarnivores on the benthic feeding herbivores. Most food chains are from fish to fish, but at least one carnivore known to be toxic, Monotoxis grandoculis (Forsskål), feeds on benthix herbivorous invertebrates (Randall, 1958). In Gilbert Islands, a species of fish may known to be highly toxic on one reef and the same species about 100 yards away to nontoxic. The toxic-bearing fishes may disappear from a given area and appear in an area previously free of poisonous fish.

Within a toxic area, not all fishes are equally toxic. Even fish within a population of a single species are not uniformly toxic. The toxicity is correlated with size, the larger the fish the more toxin it may contain. However, a small fish can be strongly toxic, and a large one can be weakly toxic or even nontoxic.

Chemical Nature

Many attempts had been made to purify the ciguatera poison from the fish. Scheuer first successfully extracted a highly purified homogeneous sample of toxin through the solubility series of organic solvents (Scheuer, 1964). He named the extract ciguatoxin. It is a transparent, light yellow, viscous oil which he was not able to crystalize. The toxin is unstable and loses toxicit in contact with air, light, and chromatographic adsorbents (alumina, Florisil, or silicic acid). To some extent, activity is lost even when the sample is stored

in chloroform solution in the dark at -20°C. Although ciguatoxin behaves homogenously on successive thin-layer chromotography (TLC) plates in different solvent systems, it is questionable whether it consists of several closely related compounds or whether it has a tendency to decompose. The combustion data gave the empirical formula of $(C_{35}H_{65}NO_8)_n$ (Banner, 1976). Ciguatoxin may be considered to be lipid containing a quaternary nitrogen atom, one or more hydroxyl groups, and a cyclopentanone moiety (Scheuer, 1964).

Detection Methods

Until 1976, the most effective methods of ciguatera detection were bioassays of mouse, kitten (Hessel and Halstead, 1960) and mongoose (Banner, 1960). A centrifuged aqueous homogenate of the poisonous fish tissue is injected intraperitionally into the mouse and causes a reaction of ciguateric nature, but the problem of false positives and insensitivity of the mouse weaken the accuracy of the result. The kitten feeding test was also proven imperfect. Since the poison causes the cat to vomit its food, the amount ingested is therefore inaccurate. Later, Banner found that the mongoose, Herpestes mungo, reacted with symptoms similar to those of the cat and also similar in some respects to those of the humans, and because of legal restrictions of the use of cats as test animals in Hawaii, he used mongoose for bioassay of the ciguatera. He classified the reactions of the fish tissue to mongoose in five stages,

based on the maximal response in the mongoose within 48 hours after a single test feeding: 0, no reaction; 1, slight weakness and flexion of the forelimbs; 2, slight motor ataxia, more pronounced flexion of the forelimbs, and weakness of the hind limbs; 3, moderate motor ataxia with weakness and partial paralysis of limbs and body musculature; 4, acute motor ataxia and extreme weakness, capable of only limited movement, or coma; and 5, death.

The bioassay using mongoose is very subjective and not totally reliable since it requires a very experience person to determine the differences between a symptom of stage 1+ to a 2+. Furthermore, the mongoose used are not homogeneous since they are captured from the wild, thus they may react differently to the toxin. The mongoose also vomits its food, hence it is difficult to calculate the correct dosage given. Therefore, a new and more precise method is needed to detect the presence of ciguatera in marine fishes.

In 1977, Dr. Hokama developed the radioimmunoassay test: couple the radioactive material to sheep anti-ciguatoxin (^{125}I labelled), count the amount of anti-ciguatoxin ^{125}I bound to the flesh of fishes, and analysis of the antibody bound by the γ-courter. This test examines the toxin in fish tissue (high counts are positive and low counts are negative). Rabbits and sheep were used for raising the antiserum to ciguatera (Hokama, 1977).

The results of the radioimmunoassay and mongoose bioassay

have a fairly good correlation. It was found that counts below 350,000 CPM/gm is a 0 reaction in the mongoose test, between 350,000-399,999 CPM/gm is a 2+ to 3+ reaction, above 400,000 CMP/gm is a 4+ to a 5+ reaction. Thus, the radioimmunoassay is the only method used at present to detect ciguatera.

Conclusion

Inspite of the complexity in many aspects of ciguatera, some facts which were once mysterious and unknown to the researchers are now becoming lucid. Ciguatera occurs from eating ciguatoxic fishes which are associated with the coral reefs and is widespread in the tropical Pacific and Caribbean. Biological research has shown that the toxin originates from an unknown marine organism (dinoflagellate) associated with coral reef and is transmitted through the food web. Ciguatoxin was purified and some of its chemical properties are known. However, its chemical structure is not yet fully understood. In the earlier days, bioassays of mouse and mongoose were used to detect the presence of toxin in fishes, and these tests have been proven to be subjective and unsatisfactory, thus the radioimmunoassay test was developed for its sensitivity and practicality in detection of ciguatera.

Further studies should be focus to simplify the assay for toxicity because the toxin endangers both the public health and the growth of future fishery industry. The ultimate goal is to develop a simple test kit for the fishermen so that they can distinguish a toxic fish from a nontoxic fish readily after the catch.

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STINGS: THE VARIOUS TYPES KNOWN TO OKINAWA

by Janette Spencer, Kubasaki High School

INTRODUCTION

Land and sea share some things in common. As on the land we live, the sea has many dangers. One of the dangers that divers and recreational swimmers encounter are stings from various types of sea creatures. I have concentrated on Okinawa, the Ryukyus Islands, as a main topic to research about the stings that have occured on the island and to emphasize into the wonders of those sea creatures.

The main purpose of this report is to find out more about the sea - its creatures - and about people who may have gotten stung by those poisonous creatures.

The Ryukyus Islands are surrounded by two bodies of water, the East China Sea and the Pacific Ocean. Since there is the ocean there are ocean lovers who love to explore the waters of Okinawa. Some of these people have experienced danger and may have encountered some of the various poisonous creatures of the ocean.

To obtain information about the waters of Okinawa, I have visited the University of Ryukyus to meet Professor Yamazato. I conducted an interview on 21 October 1978 at 11:43 a. m. to 12:14 p. m., in Mr. Yamazato's study office, room 207.

I began my interview by asking about the most common stings that occured on the island.

He replied that to his knowledge, he thought the jellyfish (medusa), a member of the Phylum Coelenterata was fairly common. He discussed a case that occured in July 22 of 1970. A group of students from the Gushikawa High School took the Teruma course for a swimming trip. Soon after the students started to swim, they complained of stinging on their arms and on other parts of their bodies. After close observations, the stinging was found to be caused by a very tiny medusa, approximately 45 mm. in diameter. The creature that stung the students was classified into the Class - Hydrozoa and was called Sarsia. The condition of the stings were much similar to mosquito bites and all students who swam got the infection. According to the students, the pain on the area where they got stung continued for a while and took weeks to recover.

Another well-known stinger is the Portugese man-of-war of Physalia physalia. Actually, they are a colony of polyps. According to Mr. Yamazato, they arrive on Okinawa after the month of September, brought by wind currents.

Another common sting is caused by the coral. Although it doesn't move,

the coral is a living sea creature, too. A slight scrub against one, would cause pain, and cuts that may last a few dyas.

Few of us who walk along beaches can resist picking up and admiring a shell. If it is a large clam shell we may take it home, perhaps to use as a baking dish. If we find lots of tiny shells with holes in them we may string them, to wear as a necklace. Or, some people may be collectors, identifying and saving every type of shell they find.

However, there are dangerous types of shells to be found on Okinawa. The cone shells in the class of Mollusca are one type. They usually attach themselves to areas near the sandy bottoms. Being killed by a cone shell is not so common here on Okinawa. The incident may probably occur only once in about every ten years or more, according to Mr. Yamazato.

When I asked Mr. Yamazato about an interesting creature he quickly responded that the sponges - Porifera are the most primitive of the multicellular animals. And, they are often thought to be the most unusual. Because of their lack of mobility and their plant-like appearance, sponges were widely believed to be plants until the early 19th century. Mr. Yamazato replied that the Zooanthics - in the Class Porifera very much interests him because it is ten times more toxic than the puffer fish.

Another harrassing sea creature is the crown-of-thorns starfish that eat up the large masses of corals formed on Okinawa. The best way to treat a crown-of-thorns ~~bite~~ puncture is to suck the blood from the injured area so that the poison will not go through your skin. It is similar to the treatment of the habu bite.

The condition of the crown-of-thorns ~~bite~~ puncture will vary with the number of spines that attach the skin. There have been no deaths on Okinawa in the past years, from a crown-of-thorns ~~bite~~. However a queer, unusual case was

developed when a man was found dead on the shores of Miyako Islands in 1957. Biologist who've studied the case predicted that it was caused by excessive stinging by crown-of-thorns, but this is not yet proven, and the case still lies unsolved.

According to Mr. Yamazato the toxin that the crown-of-thorns hold in its spines are not yet known.

But it is best not to criticize the crown-of-thorns. Researchers in the University of Ryukyus are actually studying about a~~n excessive~~ way to use the toxin in the hormones of the crown-of-thorns to make a medication to cure cancer! But further information was not available at this time.

There are also types of stinging grass, or sea plants. They are the bluegreen-type seaweed called Lyngunyia, that grows on rock and on areas that the ocean can reach. It is almost like algae and when it makes contacts with the skin, it starts to sting about 8-10 minutes later. The type of seaweed appears thread-like and feels like cotton balls. It is usually red-violet in color or brown. There are also some green ones too. The seaweeds are found in large amounts in Kahaluu Bay in the western area on the Big Island of Hawaii and also on Okinawa.

I was one of the people who have had some experience with these dangerous sea creatures or plants. It was on the summer of 1974. The exact date is July 5, 1974, when I went to a swimming picnic with my family to the Imbu Beach, located in the northwestern part of the island. I was standing in the water when I accidentally lost balance and layed my elbow part of my arm to a rock to grasp for balance and I soon felt something stinging in the weakest fleshy part of the arm. There were six or more green clover-looking things stuck on to my arm. Since I was frightened with shock, I ran to my mother to ask for help in removing the weird sea plant. When my mother

saw the plant, she could not identify the sting, and rushed to a nearby restaurant to ask for vinegar. While doing so, I removed the green particles from my arm myself. After doing so, the wounded area became white and partially shriveled. It was probably an indication that poison was injected in the skin. Soon I began to get chills and I developed a high fever. My mother brought the vinegar and poured it all over the wounded area. That relieved some of the pain but not quite all. Some men suggested to rub sand over the wound to relieve the pain, but according to Mr. Yamazato, this would not have done anything better to remove the pain anyway. I did not get any medical attention and in one day, I recovered from the chills and the fever. But the scar still remains on my right arm.

I've have also had some experience by getting scratches from barnacles. Barnacles belong to the class Crustacea and are called Cirripeda. They are often found in piles by the ocean and attached themselves permanently to a rock where the body of waters will reach them. I've also gotten the chills from barnacles, but the scratches recovered in a week.

Although not too common to Okinawa, Okinawa was invaded by sea wasps in the summer of 1978. This member of the jellyfish family is quite capable of killing people and just may be one the most serious problems to face the waters.

Native to Australia, where many people are killed by this creature each year, they have progressed north over a period of years to become quite common in the Philippines. They exist there in large enough numbers to be a real hazard to swimmers.

Until this year, the sea wasp has been all but unknown on Okinawa. One was sighted near Maeda Point in the summer of 1972, and one was seen near the refinery island on the Pacific side in the summer of 1973. Earlier

in the summer of 1978, reports began coming in of sightings all around the island. Most of them were not single sightings, either, but generally spoke of seeing seven, or four, or some other groupings.

The serious part of this problem is the fact that this creature is highly poisonous and can easily kill a person. An adult sea wasp will have tentacles which are 12 to 24 inches long, and these tentacles contain the stinging cells. When a swimmer touches these cells, he is injected with poison.

The world's foremost authority on the sea wasp is the Commonwealth Serum Laboratory in Melbourne, Australia. They estimate that coming in contact with six meters of tentacles will kill any adult.

The three hits on Okinawa so far this year since the appearance of the sea wasp have luckily been slight brushings with the animals. Two marines and one Okinawan have suffered the excruciating pain that comes from the merest touch of this creature.

The hits here on Okinawa were all in three to four feet of water. The onset of immediate excruciating pain is the main symptom. Almost instantaneous paralysis or coma can result, and death is possible in as little as thirty seconds. The victims here were hit on both the Pacific and the China Sea side of the island. All of them were in sandy bottom areas.

If you or someone else gets hit, DO NOT ATTEMPT TO WIPE THE TENTACLES OFF THE VICTIM. This will only bring more poison darts into action. The tentacles do not die. These pnematocysts are like loaded guns. They remain dangerous and ready to shoot when someone pulls the trigger. The tentacles may be lifted off the victim. Use a towel or some other protective material as cloth, to protect your hands. Bathoming the affected area with methyl alcohol may bring some relief. (not ethyl) other things that might be used

for first aid would be ammonia, vinegar, cola, meat tenderizer, baking soda, or other mild acids. None of these will fix it. The very best you could hope for would be a slight lessening of the pain.

The sea wasp, which has a clear jelly-like appearance, is capable of swimming quite fast for a jellyfish. It has been estimated that it can do two to four knots, which is faster than swimmer can sustain. Luckily it is not agressive. It will not swim after a victim, it does not attack anything, and it is not looking for a swimmer for its next victim. To get hit you must go after the wasp. Since they can be found at any depth, even scuba divers must use caution while diving. Paralysis at 60 feet can be a very serious condition. This has ended my report. Much of the information of the sea wasp and jellyfish were taken from the recent issue of the Okinawa Pastime.

I would like to conclude that from my knowledge, stings are caused by the swimmer's misjudgement, although sometimes they are not. If you don't bother the creatures, the creatures will most likely not bother you.

When you wish to enjoy the waters around Okinawa, think twice and be cautious, and don't make the same mistake as some other swimmers have experienced.

"Swim at your own risk", would be a phrase that I would use to advise those people who enjoy swimming on Okinawa.

SEA PRODUCT ALLERGIES AND THEIR PROBLEMS

by Arlene D. Bazell, Pahoa High School

ABSTRACT

Our oceans, vast and bearly explored, are finally receiving some of the long-overdue research as the field of oceanography opens up. Our oceans are looked toward for food, fertilizers and other minerals, energy and recreation. But with all the good comes some bad. As more time is spent in the ocean by man, and as more sea products and by-products are develpoed, produced, and consumed, the problem of ocean related allergies become apparent. How, if possible, does man overcome this problem? It may be easy to stay out of the ocean or not to eat fish, but what of the thousands of products which use sea by-products as additives, such as toothpaste, puddings, icecream, and cosmetics? Does this open up a whole new field of marine immunology?

INTRODUCTION

When spoken of, the term allergy is often thought of as sneezing or hives caused by hay fever, milk, eggs, or what have you. But as the ocean is turned to as a resource for various supplies, such as food, minerals, energy, etc., another cause of allergy must be considered: The sea product allergy.

Perhaps the most common of the sea product allergy is the allergy to the mollusk and anthropods (generally refered to as "shell fish".) These foods, such as shrimp, lobsters, etc., are usually easily avoided, with strong will power.

Also, generally easy to avoid, is the allergy to all fish as well as shell fish. But the more complicated the allergy, the more complicated it is to avoid. The allergy to sea products and by-products is one. It is thought that some of these patients are allergic to iodine or iodides which are highly concentrated in sea foods and sea life. In this case, contact with the smallest particles of seaweeds or any other sea life would most likely induce a reaction. Thus, even a small cut on what seems to be a clean, ocean rock, may cause a long termed healing and a life long scar.

> Sea by-products may be present in foods without our being aware of them and many such sea products have not been well established as being allergic in nature. Consequently, some allergy patients will realize that they cannot tolerate eating a specific brand of a food, such as icecream, but may eat another brand without difficulties. In these situations, it is often an additive that is used in the food which they are allergic to that gives them trouble.[4]

Whale oil and ambergris are important factors in manufactoring of cosmetics and pharamaceutical products. Thus, just applying make-up or taking certain medications may cause a reaction.

Another comment on the sea product allergies, by Dr. Carl Lehman of Straub Clinic, was that a hay fever type reaction is possible. He suggested that on those days when the ocean can be smelt miles from shore, perhaps what has happened is that particles of sea life may have become air-born. As a person allergic to pollen would get hay fever, so might the person allergic to sea products. Little research on this suggestion has been done, but it is quite possible.

The reaction to sea products and by-products allergies may range from simple indigestion, to hives and swollen joints, to suffercation. Quite often a person may not react one time but another time he may.

> It may be remembered, too, that whereas the reaction to a food allergen may be very prompt and obvious, it also may be delayed for several hours, or perhaps appear only as a cumulative result of repeated feedings...*2

The cumulative type of allergy usually starts off mildly but may worsen with each reaccurance.

When a person comes in contact with an allergen, the allergen stimulates the person's own cells to release histamine. If the person only encounters a small amount of allergen, only

a small amount of histamine is realeased. But prolonged exposure to the allergen, or massive amounts of allergen entering the body will cause large amounts of histamine and heparin to be released. In esence, the allergen is stimulating the body to poison itself--produce an autotoxic condition. The body cells seem to have a memory and each exposure to an allergen may cause a more rapid or a larger release of histamine and heparin. Thus, the allergic response can act in a cumulative fashion. This cumulative response, in some cases can lead to an anaphalatic reaction and even death. So allergies are a greater problem than most people realize.

Generally speaking, an emergency patient is given a dose of adrenaline to speed the blood flow, thus causing the poison to pass quickly. However, as in my allergy case, the adrenaline may cause a patient to go into shock if he is sensitive to the drug. To avoid this, many doctors will administer smaller doses at first and increase it if needed. Another drug which may be used is Terbuline.

Many allergy reactions simply take the form of hives. Home treatment of hives can be a problem. Most important is the prevention or elimination of the itchiness. For this, soothing lotions and creams are sometimes helpful. Soothing baths have been used for many years. Cornstarch, oatmeal, bran, baking soda, tar or potassium permanganate may be added to the bath water in proportions that only should be suggested

by a doctor (particularly when using the tar or potassium permanganate.)

METHODS

The reason I had picked this topic is because, after I was deeply interested in oceanography, I learned that I was seriously allergic to all sea products and by-products. My allergy was the cumulative form and my blood system reacted with hives, joint swelling, itchiness, and adventual suffocation if I am not cautious, with every digestion or touch to an open wound with fish, seaweed, or other sea life. The sea by-products in everyday things, such as toothpaste, puddings, perfumes, and cosmetics would cause hives and sever headaches.

After seeing an immunologist, I went on an elimination diet, aliminating as many sea products and by-products as possible. Once my system was clear of the poison, the diet was not as strict. Fish, shell fish and seaweeds were avoided but the by-products were allowed. This diet works, to this day, with need of an elimination diet only occasionally.

I am one of the rare individuals who has such a strong reaction to sea products, but I could probably very saftly venture to say that many individuals unawaringly suffer from sea product allergies. As we increase our use of sea products medical related problems will come to the surface.

Emotions seem to play a large factor in my allergy, as I imagine it does in other allergy cases too. Allergy attacks seem to come more frequently when my diet is not watched strictly, when I am getting over a cold, spend fatiguing hours cramming for exams, or have had an emotional strain. Physical, emotional and mental conditions tend to have, also, an effect on the severity of the attacks.

RESULTS

With all of this, many of my friends and relatives thought that I wasn't being practical for still persuing an education in oceanography.

But still, I persue my interest and have received considerable encouragement.

> ...high motivation enables many individuals to over come a lot of hurdles...*3

> ...allergic conditions may prevent you from obtaining first hand personal experience with some marine subjects of studies, but we see no reason why it should seriously handicap you in seeking a career in marine biology...*4

I learned through inquireries to numerous laboratories, that there are so many areas to oceanography, that only specific areas require field work. Actually, entering the sea is not totally neccessary! There is laboratory research or technical assistant, aboard a ship or on land, studies done with specimen held in aquaria and handled with instruments or gloves, working with preserved or fossilized specimen, aquaculture or even

studies on the allergy itself! That is only the beginning. There is still marine illustration, textbook writting, education, etc...

CONCLUSION and RECCOMENDATIONS

My education in oceanography, as it could be for others, can be in any of these areas. But, thus far, my education has taught me something else, something I could not have learned if not for my allergy. It has taught me more patience and caution, when handling sea life, to appreciate the sea, even more than I did before, and awareness, of the foods I eat and the additives present in them.

I feel that my allergy was not meant to stop me from my interest in oceanography, but to deepen my respect for the sea. There are ways to overcome such problems this allergy can cause: To be more cautious with the things you handle, use of a wet suit is an added protection, or for an even safer route--to persue interest in laboratory work. But by no means, should it stop you. A sea product allergy, to a student of oceanography, is only a hurdle, and what are hurdles meant for, but to over come?

FOOTNOTES

Pg. 1

*1 Dr. Carl Lehman, M. D.

Pg. 2

*2 H. W. Bottomley, M. D.
<u>Allergy: Treatment and Care</u>

FOOTNOTES

Pg. 5

*3 Albert C. Smith, Ph. D., M. D.
The Oceanic Institute, letter of May 10, 1978

*4 Faith Schaefer
Sea Secrets staff, letter of April 25, 1978

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