

MEMORANDUM

UNIVERSITY OF HAWAII

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Department of Zoology

April 17, 1972

TO : Zoology Staff  
FROM : Ernst S. Reese  
SUBJECT : Research possibilities with sea turtles

Dr. Ernest Ross of Animal Science (Henke Hall 119, Extension 8334) called me to say that over the next year or two he will have sea turtles, probably both hawksbills and greens, in his laboratory. They are studying the nutrition of these animals.

He said that he would welcome collaboration by any of our staff or by grad students working toward an MS or PhD who wished to work on the behavior and/or physiology of the animals.

If you are interested, please contact him directly.

Mahalo,

*Ernie Reese*

P.S. It might be a good idea to keep this possibility in mind for projects of our incoming fall group of grad students.

## TENTATIVE PROJECT OUTLINE

PROJECT TITLE: The nutrition of the Pacific green turtle (Chelonia mydas agassizii Bocourt)

### JUSTIFICATION:

Dr. Archie Carr, the leading world expert on sea turtles states: "The green turtle is the most valuable reptile in the world, and yet it would be difficult to name any animal, comparable at once in economic importance and the depletion in numbers that it has suffered, that is so poorly known. The situation is particularly astonishing in view of the fact that a relatively small amount of basic research would almost certainly provide data on which a proper conservation programme would be founded and green turtles could be restored to huge areas from which they have been virtually extirpated." In the 20 years since these words were penned virtually no basic information has become available. In 1967, Dr. Carr further stated: "A technology of green turtle husbandry will have to be developed. Once that is worked out, it will be a double blessing--people will be fed and species will be saved."

The development of any sort of animal husbandry is predicated on the ability to feed the animals. The 4 billion dollar poultry industry did not develop until poultry flocks could be confined and confinement was not successful until sufficient information was obtained on the nutritional requirements of poultry so that they could receive a complete diet.

The conservation of Chelonia and other sea turtles may well depend on the development of nutritionally complete diets that may be formulated from inexpensive feed ingredients.

### PREVIOUS WORK AND PRESENT OUTLOOK:

A number of books and a considerable number of scientific papers have been written about Chelonia mydas. The bulk of these publications report of observations, tagging experiments, and the danger of extinction. Apparently, some dedicated conservationists are feeding hatching turtles for varying periods of time to increase their survival rate when released. While these individuals have met with varying degrees of success using shrimp, fish, etc., there appears to have been no attempts to define the nutritional requirements of the hatchling and to develop nutritionally complete feeds which provide optimum growth at minimum cost.

The application of nutritional knowledge gained with poultry together with some of the husbandry techniques could well result in the development of a turtle technology envisaged by Dr. Carr.

OBJECTIVES:

1. To develop growth curves for Chelonia mydas from date of hatch to sexual maturity utilizing natural foodstuffs, e.g., shrimp, fish, squid, etc.
2. To determine the optimum protein requirement of Chelonia mydas at different stages of growth utilizing a nutritionally complete formulated feed consisting of readily available feedstuffs.
3. To determine the optimum energy requirement of Chelonia mydas at different stages of growth.
4. To determine the optimum calcium:phosphorus ratio of Chelonia mydas at different stages of growth.
5. To study various techniques of feeding sea turtles.

PROCEDURES:

*Insert I*

Hatchling turtles will be assigned at random to experimental groups consisting of 5 to 10 turtles per group in 15 gallon aquaria fitted with subsand filters as well as with dyna flow outside filters. All hatchlings will be fed initially on a natural diet of shrimp, fish, and squid. Body weight, as well as carapace length and width will be determined bi-weekly. When all hatchlings are eating well and show more or less uniform growth the experimental diets will be fed.

Growth data will be taken weekly and an attempt will be made to determine feed consumption. Preliminary experiments will be carried out to make dry pelleted feed that will either sink or float. In addition, studies will be made of prepared food such as the Oregon moist pellet trout food. Work will also be attempted on the formulation of a semi-solid or paste feed that would not dissolve readily in water.

A control group will be maintained on the natural food and growth curves prepared. From the weekly growth figures obtained from the experimental groups the optimum protein level will be determined at different stages of growth.

Similar procedures will be followed in future experiments to determine energy and calcium and phosphorus requirements.

When the turtles outgrow the aquaria, they will be moved into larger tanks and subsequently into ponds at the Hawaii Institute of Marine Biology on Coconut Island.

*Insert II*

DURATION: 5 years.

PERSONNEL: Ernest Ross, Poultry Scientist, Department of Animal Sciences, University of Hawaii; George Balazs, Jr. Marine Biologist, Hawaii Institute of Marine Biology, Coconut Island, University of Hawaii.

PACIFIC GREEN TURTLE (CHELONIA MYDAS) EGG HATCHING PROJECT

G.H. Balazs  
E. Ross

- Turtle No. 202- 99 eggs June 6, 1972 ( day 6 ) ; 60 eggs deposited in sand pit at Coconut Island; 39 eggs placed in artificial incubator. On day 50, eggs removed from incubator and examined for signs of development. All appeared infertile. 6 of these eggs were transferred to Dr. Benedict, Microbiology Dept. U-H campus for antibody study. 60 eggs in pit were removed on day 72 and examined. Although still moist and pliable , no sign of development observed. 5 of these eggs are being analyzed for mercury and 5 for pesticide residue.
- Turtle No. 201- 98 eggs June 6, 1972 ( day 6 ) ; All eggs deposited in sand pit at Coconut Island; All removed on day 72 and examined. No sign of development observed. Eggs moist and pliable. 8 eggs sent to Benedict for antibody study. 5 sent for mercury and 5 sent for pesticide residue analyses.
- Turtle No. 62- 84 eggs June 6, 1972 ( day 6 ) ; All eggs deposited in sand pit at Coconut Island along with temperature probe and microphone. Definite noises heard in tape recordings on day 72. Sand removed to top of egg mass during evening hours. 3 eggs removed and sand immediately replaced. Examination of eggs showed 1) no sign of development 2) small dead embryo-10 mm long- estimated at 5th to 8th day of development 3) live but grossly abnormal embryo measuring 40 mm long. Animal died shortly after opening. Between day 72 and day 83 recording showed increasing levels of activity. On evening of day 83 nest was again excavated to top of egg mass. Two live and healthy hatchlings were removed and nest recovered. During the daylight hours of day 84 continued noises were recorded from the nest. On the evening of day 84 nest was completely excavated and all eggs carefully removed. Six live and healthy hatchlings were found along with 3 eggs with partially broken shells each of which contained a fully developed dead animal. Remainder of eggs were gently palpated. Of the 70 eggs, 12 were positively felt to be non-viable, thus 58 eggs were returned to the nest along with the microphone and reburied. Upon internal examination the following was determined: 9 showed no visual signs of development ; 3 showed dead embryo measuring 15 mm in length. Monitoring of egg mass on day 85 revealed no obvious noises. Five of the non-developed eggs are being analyzed for mercury and pesticide residue. All of the live hatchlings were cleaned, weighed and measured before being sent to the rearing facilities on Manoa campus. It is extremely unlikely that any of these 8 hatchlings could have made the ascent to the surface on their own.

Commanding Officer  
USCG LORSTA, Box 48  
FPO San Francisco 96610

5700  
17 September 1972

University of Hawaii  
Hawaii Institute of Marine Biology  
Cocoanut Island  
P. O. Box 1067  
Kaneohe, Hawaii 96741

Dear Mr. Balass:

In regards to the queries in your letter of 5 September 1972, concerning the Sea Turtles received from this unit, the answers are as follows:

- 1) The first group of 51 turtles were caught at approximately 2200W (local time) on the evening of 5 August 1972. The second group of 72 turtles were captured at approximately 2100W on the evening of 31 August 1972.
- 2) Each group of turtles was from a single, separate nest.
- 3) No food was offered to the hatchlings due to lack of knowledge. This information was requested from the Fish and Wildlife Service who informed us to keep the turtles shaded and cool and do not expose to the sun.
- 4) The turtles usually begin hatching around 2100. If they are born any where near the station buildings, the hatchlings are attracted by the bright lights and are found scampering in and around the barracks. The beach areas are then combed for turtles using a collection bucket and a flash light or lantern which also attracts the hatchlings. The location of the nest is usually no problem since the various beachcombing, station personnel are aware of the location of the turtles nests from the tell tale signs left by the female turtle when the eggs were layed.

Many of the station personnel enjoyed doing this project; it was something different from the normal. If I may be of further assistance, do not hesitate to contact me. Best of luck with the project.

Sincerely,

Mark A. O'HARA  
Lieutenant (jg), USCG  
Commanding Officer  
USCG LORAN Station  
French Frigate Shoals

*George  
lets ask him in  
future to excavate nest  
for count of infertile + dead  
embryos.*

Turtles hatched 2/14/72 received 2/8. Fed fish & shrimp & squid until 2/23 when started on 305 + 303. one feeding of 305 & one of fish squid / day. 4/17 Ben 3 (20) switched to Oregon-jellies

2/9 = 16.4g

2/23 p 1 = 24.0(4) 305

2 = 23.25(4) Control

3 = 25.0(4) 303

4 = 27.5(3) Control

2/21 = 2 weeks

2/23 = 22.1(4) 0.37 de

Ben 3

303 → 4/17 Oregon-jellies

5/8 changed to 305 Visc.



September 25, 1972

Dr. Jim McVey  
P.O. Box 1000  
Koror, Palau  
Western Caroline Islands

Dear Jim:

Just a note to let you know I haven't forgotten you. I have delayed answering your last letter in the hope that I would be able to arrange with you for the shipment of some hawksbill hatchlings. In May, I had filed an application for a permit to import several hundred hawksbill hatchlings for research purposes. Since these are on the endangered list, such a permit is necessary to bring the hatchlings in legally. I just had word that my application has been denied, so there has been a temporary setback. I am going to appeal the decision and will let you know the outcome.

However, we have been able to obtain two small lots of green hatchlings which are presently on experiment. It's too early to tell the results, but we are encouraged by the fact that they are accepting our experimental diets and growing. Mortality has been limited to a few weak hatchlings. We are learning a lot about the care and feeding of sea turtles and hope that we will be able to make a contribution in the area of turtle nutrition. When we get to the point where large scale testing of our rations is necessary, we will certainly consider your offer.

George and I will also be getting some nutritional studies under way with macrobrachium pretty soon.

If you ever come through town, please let us know so we can show you what we are doing.

Sincerely,

Ernest Ross  
Poultry Scientist

ER:esm

P.S. --- Please let me know at what time of the year hawksbills normally hatch down your way.

PPS --- How are your chickens doing?



Chelonia - one pair of prefrontal scales  
Mandible of lower jaw coarsely toothed  
" upper " with strong ridges on surface  
Lateral laminae 4

Eretmochelys - two pairs of prefrontal scales  
Mandible

laterals in 4 pairs  
precentral not in contact with 1st laterals  
snout elongate, narrow not terminally toothed  
floor of mouth deeply excavated at the mesiodistal  
symphysis  
laminae of carapace usually conspicuously  
imbricated

August 25, 1972

Dr. Peter C. H. Pritchard  
Marine Turtle Specialist Group  
Zoology Department  
University of Florida  
Gainesville, Florida 32601

Dear Peter:

Thanks for the reprints and the information. I'll drop Hendrickson a line when I get a chance and see what he has going. Mariculture apparently is keeping its information to itself; at least it was a year ago when I ran into one of their consultants.

I think IUCN should take a closer look at "head starting" as a conservation measure. Bill Travis in Western Samoa has been "headstarting" hawksbills for a year or so, releasing several thousand one-month-old hatchlings. They have had sightings of the first two releases. The first hatch comprised 72 turtles and when they were spotted 13 months later, they counted 59 in the group and there may have been some stragglers. Old timers in the area had never heard of such herds (flocks?) of turtles. Samples of the herd were measured and compared with some from the same hatch that had been held back. The released turtles averaged about 25% greater growth and weight than the hand-fed turtles.

I find it extremely hard to believe that started hatchlings would not breed and reproduce after release. Even if this were true, the thousands of turtles released should certainly relieve some of the pressure on the nesting beaches.

Don't get me wrong. I am well aware that protection of egg laying adults and their nesting beaches should remain the highest priority of conservationists, but increasing the numbers of surviving hatchlings will also help.

From a practical standpoint, I would think a 71½" leatherback would be hard enough to handle without looking for bigger ones--but good luck anyway.

Aloha,

Ernest Ross  
Poultry Scientist

ER:esm

# Marine Turtle Specialist Group

of the

I.U.C.N. SURVIVAL SERVICE COMMISSION

From the Executive Officer:  
Peter C.H. Pritchard, M.A., Ph.D.  
Zoology Department & University of Florida  
Gainesville, Florida 32601 U.S.A.  
2792 S.E. 27th Avenue  
Gainesville, Florida 32601 U.S.A.

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U.S.A.

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Mexico

DR. P.C.H. PRITCHARD  
U.S.A.

MR. G.S. de SILVA  
Sabah

DR. J.P. SCHULZ  
Surinam

Dr. Ernest Ross  
University of Hawaii  
College of Tropical Agriculture  
Honolulu  
Hawaii 96822

August 17 1972

Dear Ernest:

Many thanks for your letter; it was nice to establish contact with you again, and please give my best regards to Mary.

I am enclosing - or rather sending separately - a packet of sea turtle reprints which I hope may be of interest. I am afraid nutrition of turtles is a field of which I am somewhat ignorant - as the enclosed paper on 'The Sun and the Turtle' will reveal! However, you should certainly make contact with John Hendrickson and with Mariculture, if you haven't already done so. Both are currently working on turtle nutrition, the former on the pure science basis at present, but the latter on a large commercial scale. Mariculture are having numerous problems of various kinds at the moment, I understand, but nevertheless you should get some kind of reply to your letter. The addresses are: Dr. J. Hendrickson Dept. of Biological Sciences, University of Arizona, Tucson, Arizona 85721; Mariculture Ltd., Grand Cayman Island, West Indies.

Incidentally, the current IUCN policy is to treat 'Head-starting', i.e. raising of baby sea turtles for some months or years before releasing them, as a purely experimental procedure that should not be looked upon as a definite conservation measure. This is because it is possible that baby sea turtles have to go through an entirely natural life cycle if they are to breed successfully, and in the right places, when they mature. On the other hand, this may well be an over-cautious policy, and several recent recoveries demonstrate that yearling green turtles will at least survive and grow when released, though we are still not sure that they will reproduce.

I got back from French Guiana just a few days ago. We did a month's tagging and ~~had~~ tagged 649 leatherbacks, 20 greens, 18 ridleys, and 4 hawksbills. The smallest leatherback was only 51 inches, the two largest both 71½ inches, but in four years and thousand of turtles measured, I have yet to find a six-foot leatherback!

All the best,

  
Peter C.H. Pritchard

July 11, 1972

Dr. Peter Pritchard  
University of Florida  
Gainesville, Florida 32601

Dear Peter:

Ever since we got involved with raising those loggerhead turtles that Mary found on the beach at Daytona, I've been wanting to do some nutritional research with marine turtles. I finally got Dr. Bardach, Director of the Hawaii Institute of Marine Biology (HIMB) to at least consider sea turtles as an aquacultural possibility, and I have arranged with the Bureau of Sports Fisheries and Wildlife to bring some green turtle eggs and, hopefully, some hatchlings from the Leeward Islands where they maintain a refuge. We have about 300 turtle eggs set at the present time, although I'm not too optimistic about how many will hatch.

I have written a research project to cover the work I will do. Initially, it will involve working with hatchlings in an effort to characterize their nutritional requirements, and, at the same time, to attempt to satisfy these requirements utilizing commonly available feedstuffs. Hopefully, then, we will be able to develop an inexpensive diet that will promote optimum growth. Such a diet could be used by conservationists who are attempting to increase the dwindling numbers of sea turtles by raising the hatchlings beyond the helpless stage, and also as the basis for feeding turtles as an aquacultural endeavor.

Unfortunately, I have been unable, as yet, to convince our college administration that sea turtles are a legitimate animal for the Department of Animal Sciences to be working on, so what little I am doing at the moment is with the help of the HIMB. They have provided tanks and filters, etc.

I have a few hatchlings that I have been doing some preliminary work with, and I am beginning to realize how little we know about these animals compared to chickens, for example. But they are a lot of fun to work with, and I hope to be adding to our knowledge of them.

July 11, 1972

Although I haven't been down to the Honolulu Aquarium to visit them, the 3 loggerheads we sent back from Florida apparently are getting along well. The musk turtle that you gave us for our friend in Honolulu had an interesting history. Shortly after arriving, she laid 2 eggs, 10 days apart which were put in moist sand and forgotten. The turtle died within 2 or 3 weeks of laying the eggs and much later (about 9 months) when the sand was about to be thrown out, a baby turtle was found to have hatched out. Unfortunately, the much admired baby was a victim of its existence. It drowned when an admirer replaced its resting stone on top of it.

I would appreciate any reprints that you may have on sea turtles. Especially anything dealing with the physiology or nutrition. Also, I would appreciate knowing of anybody who is also working on the nutrition of turtles.

Please be sure to give us a call if you should be coming through this part of the world.

Aloha,

Ernest Ross  
Poultry Scientist

ER:esm



GOVERNMENT OF WESTERN SAMOA

July 14, 1972

John L. Ball  
University of Hawaii  
Dept. of Marine Sciences  
Honolulu, Hawaii 96822

APIA, WESTERN SAMOA

Dear John:

In reply to your letter dated June 13th to Bill Travis.

The Western Samoa Turtle Project is primarily concerned with the re-stocking of Samoan waters with the hawksbill turtle, the turtles are kept in concrete tanks for 1 month prior to releasing. During this month the turtles are fed fresh sea food only, the average hatchling weight is 12.8g and 25.5g after a month.

I experimented with sun dried banana/fish meal cakes and found them satisfactory provided certain improvements were made. The cakes are hand cut into small squares, they are dry and sink. If not eaten quickly the cakes disintegrate and discolor the water, preventing feeding to continue.

I hope this sufficiently answers your letter to Travis.

tofa,

sharon,

W.N. Witzell  
turtle manager

Please send zeroes to:  
✓ Dr. Ross, Animal Sciences  
George Baldez  
and return original to me.

JUL 17 1972

## TENTATIVE PROJECT OUTLINE

PROJECT TITLE: The nutrition of the Pacific green turtle (Chelonia mydas agassizii Bocourt)

### JUSTIFICATION:

Dr. Archie Carr, the leading world expert on sea turtles states: "The green turtle is the most valuable reptile in the world, and yet it would be difficult to name any animal, comparable at once in economic importance and the depletion in numbers that it has suffered, that is so poorly known. The situation is particularly astonishing in view of the fact that a relatively small amount of basic research would almost certainly provide data on which a proper conservation programme would be founded and green turtles could be restored to huge areas from which they have been virtually extirpated." In the 20 years since these words were penned, virtually no basic information has become available. In 1967, Dr. Carr further stated: "A technology of green turtle husbandry will have to be developed. Once that is worked out, it will be a double blessing--people will be fed and species will be saved."

The development of any sort of animal husbandry is predicated on the ability to feed the animals. The 4 billion dollar poultry industry did not develop until poultry flocks could be confined and confinement was not successful until sufficient information was obtained on the nutritional requirements of poultry so that they could receive a complete diet.

The conservation of Chelonia and other sea turtles may well depend on the development of nutritionally complete diets that may be formulated from inexpensive feed ingredients.

### PREVIOUS WORK AND PRESENT OUTLOOK:

A number of books and a considerable number of scientific papers have been written about Chelonia mydas. The bulk of these publications report of observations, tagging experiments, and the danger of extinction. Apparently, some dedicated conservationists are feeding hatching turtles for varying periods of time to increase their survival rate when released. While these individuals have met with varying degrees of success using shrimp, fish, etc., there appears to have been no attempts to define the nutritional requirements of the hatchling and to develop nutritionally complete feeds which provide optimum growth at minimum cost.

The application of nutritional knowledge gained with poultry together with some of the husbandry techniques could well result in the development of a turtle technology envisaged by Dr. Carr.

OBJECTIVES:

1. To develop growth curves for Chelonia mydas from date of hatch to sexual maturity utilizing natural foodstuffs, e.g., shrimp, fish, squid, etc.
2. To determine the optimum protein requirement of Chelonia mydas at different stages of growth utilizing a nutritionally complete formulated feed consisting of readily available feedstuffs.
3. To determine the optimum energy requirement of Chelonia mydas at different stages of growth.
4. To determine the optimum calcium:phosphorus ratio of Chelonia mydas at different stages of growth.
5. To study various techniques of feeding sea turtles.

PROCEDURES:

Eggs obtained from the Leeward Islands will be placed in fenced pits at Coconut Island, using either the same sand brought back from the original nests or sand of a similar consistency. A small number of eggs will be used for artificial incubation studies. Data will be collected on fertility and hatchability of all eggs.

Hatchling turtles will be assigned at random to experimental groups consisting of 5 to 10 turtles per group in 15 gallon aquaria fitted with subsand filters as well as with dyna flow outside filters. All hatchlings will be fed initially on a natural diet of shrimp, fish, and squid. Body weight, as well as carapace length and width will be determined bi-weekly. When all hatchlings are eating well and show more or less uniform growth the experimental diets will be fed.

Growth data will be taken weekly and an attempt will be made to determine feed consumption. Preliminary experiments will be carried out to make dry pelleted feed that will either sink or float. In addition, studies will be made of prepared food such as the Oregon moist pellet trout food. Work will also be attempted on the formulation of a semi-solid or paste feed that would not dissolve readily in water.

A control group will be maintained on the natural food and growth curves prepared. From the weekly growth figures obtained from the experimental groups the optimum protein level will be determined at different stages of growth.

Similar procedures will be followed in future experiments to determine energy and calcium and phosphorus requirements.

When the turtles outgrow the aquaria, they will be moved into larger tanks and subsequently into ponds at the Hawaii Institute of Marine Biology on Coconut Island.

The Bureau of Sports Fisheries and Wildlife will be consulted during the course of the study as well as at the termination concerning the disposition of surplus animals. The Bureau will also be provided with semi-annual progress reports.



DURATION: 5 years.

PERSONNEL: Ernest Ross, Poultry Scientist, Department of Animal Sciences, University of Hawaii; George Balass, Jr. Marine Biologist, Hawaii Institute of Marine Biology, Coconut Island, University of Hawaii.

UNIVERSITY OF HAWAII

Marine Programs

MEMORANDUM

Ernie Ross,

I just received this letter from Bill Travis in Western Samoa. You'll notice that the released turtles "seem" to be doing okay.

Also you'll notice that he is wondering out loud about automatic feeders. What do you know about these? Construction, purchase, cost etc.?

There is an outside chance that we could get some equipment to Western Samoa via American Samoa with a fellow who is going down in a little while. John

June 15, 1972

C. R. Jones  
Super Supplement, Inc.  
301 W. 11th Street  
Kansas City, Mo.

Gentlemen:

Please send information concerning the use of smectite vermiculite in feeds to improve pelleting. We are particularly interested in something that will improve water stability of pellets fed to various marine organisms.

Sincerely,

Ernest Ross  
Poultry Scientist

ER:cym



TRUST TERRITORY OF THE PACIFIC ISLANDS

MARINE RESOURCES DIVISION HEADQUARTERS

P. O. Box 1000

Koror, Palau, Western Caroline Islands, 96940

May 9, 1972

Dr. Ernest Ross  
Poultry Scientist  
College of Tropical Agriculture  
Department of Animal Sciences  
1825 Edmondson Road  
University of Hawaii  
Honolulu, Hawaii

Dear Ernest:

Thank you for your letter with the information on the chickens. I also received a letter from George and I will try to answer your questions.

The twenty turtles were placed in identical 12-foot diameter tanks and kept there for a period of 6 months. They were then released as part of our conservation project. So far we have not kept them beyond 6 months. We think that the turtles are large enough at this age to fend for themselves.

We had about 40% mortality until we covered the tanks with screens to keep the birds and dogs out. The experimental group used in food conversion study suffered no mortality. Birds were still a threat up to four months of age.

I agree with you that Chelonia mydas is by far the best candidate for Mariculture activities. We are concentrating on hawksbill here in Palau because no greens breed in our island complex. I am trying to start a turtle project at the Ulithi atoll where there are many green turtles. Perhaps when we get that going we will have many green turtles to work with.

There is still no good way to mark turtles as far as I know. We are trying to flipper clip them (cut a notch in the flipper). We have no idea if it will work or not.

May 9, 1972  
Dr. Ernest Ross  
Page 2.

Thanks for the tip on using gentian violet. I have also used it but have had limited success.

I believe I can send you some hatchlings turtles if you will allow some time to locate them at my end. How old do you want them? Shall I hold them for a week or so, until they get stronger? Let me know what packing procedure you have found best- remember that we may have a few hours layover in Guam.

Our food sources here consist of scrap tuna from Van Camp Fisheries and different sea grasses and algae that we can find. Coconut is fairly abundant as is taro, tapioca and bananas.

That is all the information I can think of now - Keep in touch.

Sincerely,

*James P. McVey*

James P. McVey, Ph.D.  
Fishery Biologist

JPM/at

~~Regulations~~

Regulations regarding the fishing of sea turtles (Chelonia mydas) in the territory of French Polynesia.

In the Session of Dec. 23, 1971.

Article 1. Fishing of sea turtles whose shell is less than 65 cm long at the longest axis is prohibited in all of the Territory of French Polynesia.

Article 2. Land capture of turtles smaller than regulation size is prohibited from Nov. 1 to January 31.

Article 3. Capture at sea of turtles smaller than regulation size is prohibited from June 1 to January 31.

Article 4. Zones of concentration of turtles are made available for fishing subject to a quota for each zone fixed by decree taken in Government council on a ~~suggested~~ <sup>proposal</sup> by the Chief of Fisheries services.

Article 5. Holding of live turtles for periods over 10 days is authorized only in ponds where adequate protection from sunlight has been provided.

~~XXXXXX~~. Live turtles being transported must be protected from the sun, and must not be subject to unnecessary suffering.

Article 6. Land collection of mature turtle eggs is prohibited.

Article 7. Special permits regarding capture of turtles of all sizes and collection of mature eggs may be obtained from the Chief of Fisheries for the purpose of scientific research.

Article 8. Slaughter of turtles must be done under sanitary conditions (without flies, dust or materials that are either pollutants or infectious).

Article 9. Sale of sea turtles is prohibited in all of French Polynesia.

Article 10. n Punishments

Violators will be punished according to decree No. 2792/AA of Oct. 24, 1968 for the 5th category of infraction

a) whoever collects mature eggs on land and

b) whoever sells whole turtles or turtle meat without authorization.

4th category for whoever

a) has fished turtles of less than regulation size during the fishing season

b) whoever has captured females on land prior to their having laid their eggs

3rd Category-- whoever

a) captures turtles at times other than the lawful period

2nd

Category

a) whoever goes against any other obligations set by this resolution

## I Inactivation & hatching

(a) artificial (?)

(b) transfer - duplicate

Fertility

Hatchability

D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub>, D<sub>4</sub>

## II Nutrition (Mgt)

a) in-fertile

b) growing

c) adult - reproduction

1) Nutritional requirements  
Protein  
(amino acids)

Energy

Vitamins

minerals

fat

marine

2) Natural feeds

fish

octopus

3) Commercial ingredients

4) Marine plants

a) animal waste - fish

turtle conditions

100 eggs

30 turtles

70 don't hatch  
infertile  
bad genes  
etc.

MST

Management of sea  
turtles: I Nutritional  
requirements.

15  
20  
25  
30 70

20-21

Vit-min. mix



Regulations regarding the fishing of  
Sea turtles (*Chelonia mydas*) in the  
Territory of French Polynesia.

In the Session of Dec 23, 1971

- Article 1 . Fishing of sea turtles whose shell  
is less than 65 cm long at the  
longest axis is prohibited in all of  
the Territory of French Polynesia.
- 2 - Land capture of turtles smaller  
than regulation size is prohibited  
as of Nov 1<sup>st</sup> to January 31.
- 3 - Capture at sea, of turtles smaller  
than regulation size is prohibited  
from June 1<sup>st</sup> to January 31.
- 4 - Zones of concentration of turtles  
are made available for fishing  
subject to a quota for each  
zone fixed by decree  
taken in Government Council on  
a proposition by the Chief of  
fisheries services.

5- Holding of <sup>live</sup> turtles for periods over 10 days is authorized only in ponds where adequate protection from sunlight has been provided.

6- Live turtles being transported must be protected from the sun, and must not be subject to unnecessary suffering.

6- <sup>hand</sup> collection of mature turtle eggs is prohibited.

7- Special permits regarding capture of turtles of all sizes and ~~the~~ collection of mature eggs may be obtained from the chief of fisheries for the purpose of scientific research.

8- Slaughter of turtles must be done under sanitary conditions (without flies, dust, or materials that are either pollutants or infectious).

9- Sale of sea turtles is prohibited  
in all of French Polynesia.

10-

Will be punished according to  
decree N° 2792/AA of Oct 24 1968  
for the 5th category of infraction

a) whoever collects mature eggs  
on land and

b) whoever sells whole turtles  
or turtle meat without  
authorization.

4th category for whoever

a) has fished turtles of less  
than population size during  
the fishing season

b) whoever has captured females  
on land prior to their  
having laid their  
eggs.

3<sup>rd</sup> category -

wherever

- a) captures turtles at times other than the lawful period.

2<sup>nd</sup> category -

- a) wherever fees against any other alligators set by this Resolution.

~~Regulations~~

Regulations regarding the fishing of sea turtles (Chelonia mydas) in the territory of French Polynesia.

In the Session of Dec. 23, 1971.

Article 1. Fishing of sea turtles whose shell is less than 65 cm long at the longest axis is prohibited in all of the Territory of French Polynesia.

Article 2. Land capture of turtles smaller than regulation size is prohibited from Nov. 1 to January 31.

Article 3. Capture at sea of turtles smaller than regulation size is prohibited from June 1 to January 31.

Article 4. Zones of concentration of turtles are made available for fishing subject to a quota for each zone fixed by decree taken in Government council on a ~~proposal~~ *Proposal* by the Chief of Fisheries services.

Article 5. Holding of live turtles for periods over 10 days is authorized only in ponds where adequate protection from sunlight has been provided.

~~XXXXXX~~ Live turtles being transported must be protected from the sun, and must not be subject to unnecessary suffering.

Article 6. Land collection of mature turtle eggs is prohibited.

Article 7. Special permits regarding capture of turtles of all sizes and collection of mature eggs may be obtained from the Chief of Fisheries for the purpose of scientific research.

Article 8. Slaughter of turtles must be done under sanitary conditions (without flies, dust or materials that are either pollutants or infectious).

Article 9. Sale of sea turtles is prohibited in all of French Polynesia.

Article 10. n Punishments

Violators will be punished according to decree No. 2792/AA of Oct. 24, 1968 for the 5th category of infraction

- a) whoever collects mature eggs on land and
- b) whoever sells whole turtles or turtle meat without authorization.

4th category for whoever

- a) has fished turtles of less than regulation size during the fishing season
- b) whoever has captured females on land prior to their having laid their eggs

3rd Category-- whoever

- a) captures turtles at times other than the lawful period

2nd

Category

- a) whoever goes against any other obligations set by this resolution

règlementant la pêche de la tortue de mer  
(CHELONIA MYDAS) dans le Territoire de la  
Polynésie française.

Dans sa séance du 23 décembre 1971:

*capture at sea*  
*outlawed*  
*Nov 1 - 31*  
*capture at sea for*  
*birden hit*  
*June 1 - Jan 31*  
Article 1er. La pêche de la tortue de mer (Chelonia mydas) dont la carapace présente une longueur inférieure à 65 cm <sup>dans</sup> dans son plus grand axe est interdite sous toutes ses formes dans tout le Territoire de la Polynésie française.

Article 2. La capture à terre des tortues de taille réglementaire est interdite du 1er novembre au 31 janvier.

Article 3. La capture en mer des tortues de taille réglementaire est interdite du 1er juin au 31 janvier.

Article 4. Les zones de concentration des tortues sont livrées à la pêche suivant un quota réservé à chaque zone et fixé par arrêté pris en Conseil de Gouvernement sur proposition du Chef du Service de la pêche.

Article 5. La détention pendant plus de 10 jours de tortues vivantes n'est autorisée qu'en vivier dans lequel aura été aménagé un abri contre le soleil.

Le transport des tortues vivantes doit obligatoirement être effectué à l'abri du soleil et en tous cas sans mauvais traitement susceptible de leur occasionner une souffrance inutile.

*collection of*  
*mature turtle*  
*eggs for birden*  
Article 6. La récolte à terre d'oeufs de tortues matures est interdite.

Article 7. Des autorisations exceptionnelles concernant la capture des tortues de toute taille et la récolte d'oeufs matures pourront être délivrées par le Chef du Service de la pêche à des fins de recherches scientifiques.

Article 8. L'abattage des tortues doit être effectué dans de bonnes conditions d'hygiène et notamment à l'abri des mouches, de la poussière et de toutes matières polluantes ou infectieuses.

Article 9. La vente de tortue de mer est interdite dans toute la Polynésie française.

Article 10. Sera puni des peines prévues par l'arrêté No. 2792/AA du 24 octobre 1968 pour la 5ème catégorie d'infraction, quiconque aura récolté des oeufs maturés sur terre sans autorisation et quiconque aura vendu des tortues entières vivantes ou de la chair de tortue.

Sera puni des peines prévues par l'arrêté No. 2792/AA du 24 octobre 1968 pour la 4ème catégorie d'infraction, quiconque aura pêché des tortues dont les tailles ne sont pas réglementaires pendant les ouvertures de pêche et toute femelle sur terre qui n'a pas accompli sa ponte d'oeufs maturés.

Sera puni des peines prévues par l'arrêté No. 2792/AA du 24 octobre 1968 pour la 3ème catégorie d'infraction, quiconque aura pêché des tortues durant la période de pêche interdite.

Sera puni des peines prévues par l'arrêté No. 2792/AA du 24 octobre 1968 pour la 2ème catégorie d'infraction, quiconque aura contrevenu aux autres obligations de la présente délibération.

Article 11. La présente délibération est prise pour servir et valoir ce que de droit.

UN SECRETAIRE

Tetuaura OPUTU

LE PRESIDENT

John TEARIKI

April 27, 1972

Dr. James P. McVey  
Fishery Biologist  
P.O. Box 1000  
Koror, Palau  
Western Caroline Islands 96940

Dear Jim:

Thanks for your letter and the copy of your paper on the growth rate and food conversion in young hawksbill turtles. This information will be helpful in providing a guideline against which we can measure our progress.

As you probably know, George Balazs is working with me on the turtle nutrition project. Our studies are in the early stages in which we are testing different forms in which to feed a formulated diet, the problem being to get the food into the turtle before it dissolves or fouls the water. I suspect that this is a much greater problem with very young turtles than with the older animals. At any rate, we have not reached the point where we have any rations for you to test at your field station, and probably won't have until we complete some of the basic studies on digestibility, digestion rate, etc. to carry out this work we have to hold the turtles in close proximity to our laboratories. For this reason, we hope that it may be possible to obtain 50 or 100 hatchlings from you from time to time.

If you will let us know what type of feedstuffs are available on Palau in addition to tuna scraps, we will try to use them in some of our formulations to see if we can come up with a balanced feed.

There were a few questions concerning your paper:

- (1) You placed about 20 turtles in a 12" diameter tank at one day of age. At what age or weight did you find it necessary to thin them out?
- (2) Are you keeping them beyond 6 months?
- (3) As a conservation measure, at what age would you recommend release?



April 27, 1972

- (4) What sort of mortality did you encounter? Due to injuries and/or other causes?
- (5) At what turtle age were they still being attacked by herons and kingfishers or other birds?
- (6) I can understand your concern for the Hawksbill, because it is on the endangered list, but as a possible aquacultural enterprise wouldn't Chelonia mydas be preferable?
- (7) How are you marking your turtles?

You may be interested to know that we also found 1% gentian violet satisfactory in treating injuries.

Sincerely yours,

Ernest Ross  
Poultry Scientist

ER:esm

Encl.

P.S.---I'm enclosing a bulletin which gives some information on raising chickens. I'm not sure this is the answer to the high price of eggs. Unless well balanced feeds are available, I'd say forget it. If you have specific questions, please write and I'll try to answer them for you.

# Turtle egg hatching

Burstein & Greenbaum  
Ecology 49(2) 269-276  
1968

Hatched OK at

27°C - 81°F

30°C - 86°F

32°C - 90°F

Did not hatch at

15°C - 59°F

20°C - 68°F

38°C - 100°F

Temp. of nest at time of construction: 25°C - 77°F

Hatchlings (malaya) 28°C - 30.4°C

6°C rise during incubation

Arr + Hatch (ascension) 27.8-28°C init: 2.3°C rise

# 100 to 1

By EDWARD J. PHILLIPS

This article is based on the records and on the experience of the Caretta Research Team of Sanibel-Captiva Islands, Florida. Discussed are the many dangers to *Caretta caretta* which cause disheartening annual losses.

**A**lthough this article deals with hypothetical situations, it is based partly on the records and mostly on the experience of the Caretta Research Team of Sanibel-Captiva Islands, Florida.

On a warm moon-lit summer night on the Gulf coast of Sanibel Island, Florida, a female loggerhead sea turtle (*Caretta caretta*) ascends the beach as her species has done since the beginning of time to lay her eggs, thus continuing the cycle of life.

This night she will deposit an average clutch consisting of 110 eggs. She gives no thought as to what the odds are against the survival of the eggs, or the hatchlings they may become, of reaching maturity, and returning as she did to nest. All she knows is that her part has been completed.

The raccoon is the most dangerous predator of freshly-laid eggs. A family of raccoons will devour or destroy a complete clutch of eggs at one sitting. Inspection of an island south of Sanibel showed that over 90% of all nests had been destroyed by raccoons. Sand crabs will dig a tunnel into a nest and destroy the clutch. Man is also another predator of these nests, either out of curiosity or for consumption, as is, or for use in pastries. These three predators of freshly-laid eggs will account for at least a 50% loss and thus reduce the clutch to 55 eggs.

High tides, heavy rainfall, beach erosion, and the roots of vegetation, primarily those of sea oats, will account for another 50% loss. Although the nest is between the mean high tide line and beach vegetation, a tropical storm may cause an abnormal tide, thus flooding the nest and destroying it. If the rainfall from the storm is 1½ inches or more, this will also flood the nest, killing the developing embryos. The constant beach erosion is responsible for a number of nest losses. This past season a complete clutch of hatchlings was found to be trapped in the nest by the roots of sea oats that had grown across the nest forming a barrier through which the hatchlings were unable to pass. Because the date of the nesting had been recorded, the due date was known and when the hatchlings failed to emerge within several days after their due date, the nest was opened and this particular clutch was saved. These hazards of nature have now reduced our clutch to 27 eggs.

Infertile eggs and late-hatching eggs will account for 50% of the remaining clutch. Several days after the emergence of the hatchlings from the nest, the nest in the hatchery operated by the Caretta Research Team is dug up by hand. This past season, 5 nests were dug on one particular day and

(turn to p. 37)

## 100 to 1

a total of 101 hatchlings were saved. When a clutch hatches, the turtles must come up as single units by scraping at the ceiling of the nest, causing the sand to filter down through them and raising the floor, allowing them to continue their journey to the surface. The late hatches have nowhere to put the sand above them so they remain trapped in the nest. Our clutch has now dwindled to 13.

Probably the most disheartening loss will come next as the hatchlings scramble to the sea after emerging from the nest, usually after dark. Here they are eaten by raccoons who will only bite off the head, discarding the rest, by birds and sand crabs as they make their way down the beach to the sea and what might be safety; but this is not a sanctuary for them either. As they start their frenzied swim straight out into the ocean, they must contend with the fish, some of which are snook, jack fish, sharks, and some birds, as they come to the surface for air. Our clutch suffers a 50% loss and is now down to 6.

Assuming that these have reached adulthood, one would think that they were safe, but they still must face disease, parasites and poisonous jelly fish. Dangers of such things as the red tide, which may not poison them directly, but will affect them through their food chain, will cut our clutch in half again. This past season several male loggerheads washed ashore dead during the red tide and, upon inspection of their stomachs, it was presumed that they died from the results of having eaten crabs and pen shells that had been affected by the poisonous water. There were no visible wounds or marks that would show if they were attacked by a shark or other predator. Our clutch now consists of 3 turtles.

Last, but not least, as adult turtles they still face enemies such as sharks, being entangled in fishermen's nets and drowning, being caught and used for their hide and their oil for cosmetics, and still the most disgusting predator, man as a poacher, who will not even have the decency to kill the turtle when poaching her on the beach as she comes ashore to nest. He will often put her on her back and cut off the front flippers and leave her there to die. Our clutch of 110 to begin with has now dwindled to 1 and this is a conservative estimate of the survival odds of the Atlantic loggerhead.

## Rx Health Hints

Health hints in this issue are concerned with humans rather than turtles. We ask that you read the article on salmonella infection that begins on page 4 and then continue on to the following recommendations:

1. *Always* wash hands when through with one chore before going on to another. (After cutting up meat for the frying pan, do not prepare the lettuce salad without washing hands.)

2. Never heat "convenience" foods, such as frozen dinners, or canned soups, etc., until just warm. *Make sure they come to a boil* and simmer for several minutes.

3. Keep pets' feeding areas clean; wash their dishes separately and rinse with boiling water.

4. Orthophenyl-phenol products that are available in spray cans and liquid form are advised for cleaning surfaces.

5. Never permit toddlers or young children to excessively handle or kiss any household pet.

6. Feed turtles in container other than aquarium so that uneaten food may be disposed of within 30 minutes.

7. If turtle water is changed in the kitchen sink (as it must be in the case of many apartment dwellers), always, when finished, pour a kettle of boiling water around sink and drain area.

8. Change water in tanks frequently and periodically scour tanks thoroughly and leave in sun for several hours.

9. Never put hands in one tank and then in another without washing hands between operations.

10. Do not permit children to eat canned cat or dog food, biscuits, dried ants, turtle or fish food, or to eat from pets' plates.

11. Change and thoroughly wash kitty litter boxes every other day at least. See that dog blankets are washed weekly and that the area where pets sleep is kept clean at all times.

12. Be sure that all household pets are given vitamin supplements to insure continued good health. At the first sign of illness in any pet, isolate the animal until veterinary assistance and appropriate medication are given.

Ross

Vol 6, no. 1

Leatherback  
P.O. Box 45555, L.A. 90045

A full moon glares down on the beach, spreading its platinum light over the sand, while the fierce wave of a spring tide roars up and quietly recedes onto the next impatient wash. As the waves encroach and slip away, a large shadowy form becomes visible, lying still on the sand as water splashes around it. Eventually, it begins a slow progress away from the waves and up onto the higher sand of the beach.

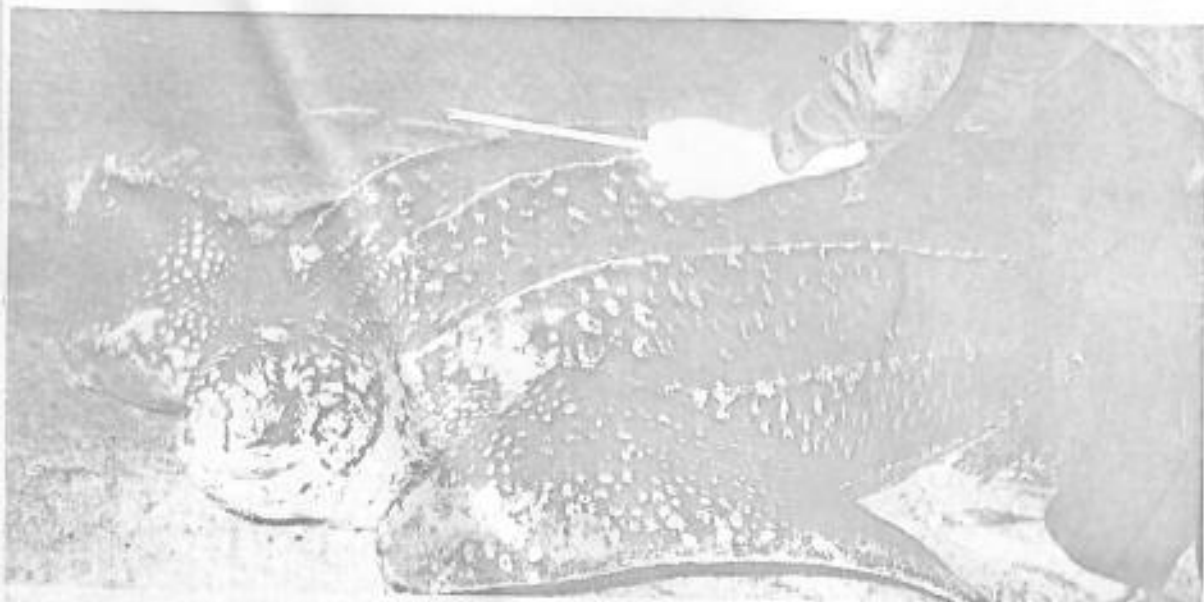
It is a leatherback sea turtle, beginning its trek into the unaccustomed terrestrial environment to which it is bound for reproduction. An emerging leatherback is an impressive sight, looking like some prehistoric sea creature appearing in the foaming dark waves. Its behavior is much like that of its smaller brethren, a slow, cautious advance from the sea, marked by an apparent "testing" of its surroundings by smelling the beach. But its size adds to the effect of a

scene that is memorable with any species of sea turtle.

There are not many places in the world where one can be fairly certain of encountering a nesting leatherback on the beach at night. Fewer still are those beaches where they are to be seen in any numbers. There are only two beaches where leatherbacks are known to nest in quantity. One of these is at Trengganu, in Malaysia. The other, hosting by far the most turtles, is a remote and forbidding stretch of beach on the coast of French Guiana, not far from the mouth of the Marowijne River separating that coast from Surinam. There are no populations of nesting sea turtles anywhere, except for the arribadas of ridleys, exceeding those of the French Guiana leatherbacks.

Organabo, as the beach has come to be called among turtlers, is actually twenty miles or so from the mouth of the Organabo River, near a point of land jutting out toward Surinam, *Pont Isere*. It is a vacillating, inhospitable place fronted by a rough, viscous, and shark-filled sea, and bordered behind by a shallow, peculiar swamp full of dead trees but almost devoid of living vegetation.

It is difficult to be sure of the exact nature of the changes, but the coastline there gives an impression of losing a battle with the sea.



Leatherbacks such as one being measured by Peter Pritchard have unusual ability to reach shore.

Great stretches of forest have been inundated with salt water and stand now only as dismal cemeteries of dead trees, solitary spires having lost even their branches, thousands rising out of the beach and swamp. The beach itself is underlain by an unstable clay foundation, which slumps from time to time, leaving pits in the sand, edged by small cliffs and surrounded by unsettling cracks suggestive of future sinkings.

During July of last year, Dr. Peter Pritchard, the Executive Officer of the Marine Turtle Group of the IUCN, his wife, Sybil, and I stayed for three weeks at Organabo, tagging and studying leatherbacks. Dr. Pritchard and William Greenhood, an anthropologist, had first investigated the area three years earlier, having heard rumors of a tremendous nesting aggregation of leatherbacks on the French Guiana coast.

The beach is not as far from human habitation as it seems when one is there. But arriving at the place is no uncomplicated feat for anyone who has never done so. The sea is too rough for secure landings by boat, so the dead swamp is a safer, however uninviting, point of entry. The Mana River, flowing more or less parallel to the sea before emptying into the wide mouth of the Marowijne, separates the swamp from a Carib village, Awara.

Given transportation by the Surinam

Dienst Landsbosbeheer, the Forestry Department, we were carried in a large dugout canoe to Awara, where we stopped for only a few minutes to engage the services of Ernest, a Carib Indian who had been hired on previous occasions to help in the camp. Even though we appeared in Awara with no advance warning, Ernest was obligingly ready to leave within ten minutes, as though it were the sort of thing he might expect to be called on to do any day of the week.

From Awara, a single cluster of coconut palms is visible across the river, indicating the site of a previous settlement that has since been abandoned. That is the point of embarkation into the swamp, and serves as a good point of reference, since palms may also be seen from the beach.

There is a peculiar zone separating the swamp from the Mana River. It is a strip of high, dry and sandy soil, only several hundred yards wide, hosting thick grasses and clumps of tall cactuses. It is a superb ecological niche, totally different from its bordering environments. We never had any time to spend there, crossing it only to reach the swamp and again on our return to the river. Its ecology must be quite distinct; someone could probably have a rewarding time studying that one strip of sand, providing the hordes of voracious mosquitoes could be overlooked.

*Thousands of dead trees rise out of dismal beach which is devoid of almost all living vegetation.*



The heat was as intense as the mosquitoes, and we hastily transferred our small mountain of supplies over the sand dune to the edge of the swamp. There is a narrow, treeless bay separating the forest of dead trees from the dune. Beyond it lies the seemingly lifeless maze, the corpse of a jungle. And discernible on the horizon, a green shield of low, thick mangrove trees muffles the faint song of the sea, heard as a vague whisper in the shadow of the wind.

Crossing the swamp is not as difficult as one would suppose on seeing it, but the experience is not an especially pleasant one. Ernest pushed a small, rotting dugout canoe loaded with part of our supplies and Sybil, while Peter and I walked through the mud, photographing and occasionally helping to push the cargo when it bogged in the muck. Each step was difficult due to the thick layer of black, slimy sediment below the shallow water.

I had slithered on through the ooze ahead of the rest, and at last set foot on hard sand. The transition from the swamp to the beach is quite abrupt; one foot can be on firm ground while the other is still mired in the swamp. By this time the ocean's roar was loud, but I could not yet see it through the stand of low trees on the beach. The forests of live mangroves along the beach end abruptly where the swamp begins. Without

them, it would be a dimly bleak place. The sea is only about a hundred yards from the swamp, and in a moment I was looking over its rough, cloudy water. But in spite of the forbidden aspect of the Atlantic, and the decaying swamp, it is not a bad sort of place to be. Compared with Bigi Santi beach, in the Wia Wia Nature Reserve over in neighboring Surinam, where I have spent weeks battling blood-thirsty legions of mosquitoes, the French Guiana site is an offbeat kind of paradise.

We unloaded the dugout, and within a few minutes Ernest had stoically returned across the swamp to bring the remainder of our luggage. In the meantime, Peter and I set about building a camp. By the end of the day, using driftwood and saplings, we had constructed a sturdy frame over which a large tarpaulin was tied, giving us shelter from rain. In the course of the next few days we located enough planks to partially board off the windy seaward side of our camp. A long strip of plastic sheet more or less completed the waterproofing, giving us a comfortable abode safe from much direct wetting, except during heavy rainstorms, when the tarpaulin would leak.

On our first night there, we walked a couple of miles along the beach, finding signs of nesting activity, but only one turtle, in front of camp. The following night, Peter

*Campsite, with live mangroves in background, on leatherback beach a hundred yards from swamp.*



and I left Ernest and Sybil in camp and began the trek to the main beach. During the previous summer, there had been moderate nesting on the small beach on which we were camped, but most of the turtles came ashore on a longer beach reached after a twenty minute walk through a wooded area, where the surf washed up over the trees at high tide, leaving no place for the turtles to nest.

That coastal area experiences marked changes in character during the passage of a year. This year, on coming to the end of the small beach, no living forest awaited. Instead, as far as we could see in the moonlight, stretched a gallery of dead trees, limbless spires rising from the sand, some fifty feet tall. At the surf a thick tangle of stumps and roots of dead trees began through which no turtle could pass.

We walked through the bleak, lifeless morgue for twenty minutes, expecting to come onto the main beach at any time. But the only change was that the swamp crept in closer to the sea, leaving a strip so narrow that at high tide the sea washes over into it.

There is something disquieting about such a place, in which one is surrounded by thousands of dead trees, but where not a single twig of any living vegetation is visible. Were someone to be washed ashore there, he surely would suppose himself to have been carried to the end of the earth, or perhaps that he was the remaining survivor of some holocaust. When the moon is full, the eerie effect is enhanced. Each tree, casting a shadow, becomes a strange black silhouette against the cold light reflected in the miasmatic night.

We pressed on for another twenty minutes, and still nothing was in sight but the gloomy arboreal cemetery. We were close to abandoning things, thinking that it might be more feasible to return and investigate the area by daylight, when at last we came onto a break in the barrier of stumps. It was shortly closed in again, but was sufficient impetus to spur us on. Soon there were more openings, and less trees, and very gradually the forest thinned out. Within ten minutes we stood on a wide, sandy beach, having left behind the last solitary tree trunk for some distance.

The beach was an inviting place after the wretched forest. As Greenwood has said of the whole coast, but which is especially true of that extinct jungle, there is no better place to feel the presence of "Great Mother Nothing."

The leatherbacks were there, wheezing in the sand. The most we tagged in one night during our stay was seventy-three, but we were late in the season. During May or June as many as three hundred leatherbacks may nest along the main beach and the camp beach in a single night! Only several years ago, it was thought that finding nesting leatherbacks was chancy and sporadic, and anyone seeing three or four would have considered himself doing quite well. Of course, that remains true everywhere except at Organabo, and to a much lesser degree, Trengganu.

Having a camp situated on a leatherback beach can be hazardous. Nothing happened amiss this year, but several years ago one plowed into the camp and flattened several pots. Leatherbacks are not perceptive creatures, and if one happened to be walking in the direction of a main beam of the camp, woe unto those sleeping within!

Having determined the nature of the beach, we established a routine of alternating nights out, in which each of us tagged for two nights and stayed in the third. It was a good system, since by every third night a rest was needed, and it provided that someone would always be in camp with Sybil. There are jaguars and other cats on the beach, which probably present no threat, but nevertheless, caution is better than regret. Many of the turtles have deep scars on their heads from attacks by jaguars. At Bigi Santi, a jaguar was killing green turtles regularly.

The walk was an all night one, depending on the number of turtles to be tagged and measured. We estimated that the total distance covered was at least twenty miles, no easy distance when wrestling with powerful turtles along the way. I am still carrying a scar on my ankle, caused by a slap from an angry turtle. The force of the blow, even though from the flat side of the flipper, was so heavy that the skin just split.

The turtles varied in disposition from one night to another. On one occasion they might be placid and easily tagged, only to be nervous and ready to leap away the following night. The trends were marked enough to allow a general statement regarding the turtles' behavior on a given night. Why it was so can only be conjectured. The state of the moon seemed to bear no relation, nor did atmospheric conditions.

At dusk we frequently found hatching nests, too often by the presence of buzzards,



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A RAKOWICZ-ROFEN ENTERPRISE 

which prey on the young. They do not, as has been suggested, feed only on baby turtles that have died, but are active predators on them. Crabs also take a toll; sometimes at night our flashlights would illuminate a ghost crab skittering across the sand, dragging along the beheaded carcass of a luckless turtle.

Where do they go, those which have beat the odds and made it into the sea and past the hungry mouths of waiting sharks and other fish? As yet, no one knows. Leatherbacks are very seldom seen between hatching size and maturity. They may lead a highly subaquatic life, a possibility supported by a structure in the throat which aids in oxygen exchange.

Wherever they do go, they seem to have been relatively successful there, judging by their numbers in French Guiana, a population suffering almost no human predation. It is not an area that could conceivably become a tourist mecca until every other beach in the world has been ruined. So for the time being, their future seems comparatively secure. Hopefully, they will never be forced into the precarious status of the smaller sea

turtles, which are in danger of extinction because of their value as food and leather. The unusual morphology of leatherbacks is to their advantage; they have soft, easily-torn skin that would make poor leather. Nor is their flesh of even average palatability. For the time being, then, they have quite a favorable chance for remaining out of the legions of animals being herded onto the one-way path to extinction.

### THIS IS YOUR JOURNAL . . .

We continue to try to include a balanced variety of articles, notes, and observations. Exchange of information on hobbyist and scientific levels has proven advantageous to all.

Only through our members' support and actual participation can International Turtle & Tortoise Society Journal continue its valuable work. You are urged to share your experiences, items of interest, and results of scientific investigation with our readers.



GOVERNMENT OF WESTERN SAMOA

Department of Agriculture  
Forests & Fisheries

APIA, WESTERN SAMOA

5 May 1972

Mr John Ball,  
C/- Marine Programs,  
University of Hawai'i,  
Honolulu,  
HAWAI'I.

Dear John,

I understand from Steve Ritterbush that you are in need of some information regarding our turtle-hatchling programme. To wit:

1. Taking of eggs: Always taken within 1 day of laying, usually 4 hours. Extra clutch removed as near intact and undisturbed as possible, Pear-shaped egg-mass loosely glued together with clear mucus. This we try and break-up as little as possible. Eggs reburied in similar sand within 2 hours. at same depth. Hatchery sand same height above M.S.L. as original nest. Well-drained. Fenced to keep out ghost-crabs, and rats. Fencing taken down 2 feet below ground level to prevent crabs etc. digging-under. Pit-traps for crabs placed inside hatchery compound.
2. Pens: Made of rows of hollow-brick placed on cement slab and plastered on inside. Rows of pens 8' x 5' x 2'. Water level. 1' 6". Section as under. Water changed daily (minimum) A pen 8' x 5' can accommodate up to 400 hatchlings up to 1 month old.
3. Equipment: Butchers meat grinder. Chopping board. Pellet-machine for 85% dried fish-meal cake, (cake an additive to raw fresh fish flakes and shell-fish diet). An automatic food dispenser set to a random Operations would be a very good investment. Human/food association built-up in a mere 4 days unless care is taken.
4. Release Age: 1 month. Two reasons:
  - (a) Not enough staff, funds etc, to raise turtles beyond this point.
  - (b) Fear of 'domestications' and possible reduction of their survival capabilities.

Released off beaches of original laying. One or two comparative samples kept from each batch. All releasings marked by clutch-ident nicks in costal margins.
5. Results: Overall hatchery hatchlings = 86% (including infertile eggs) out of some 13,000 to date.
 

This is better than natural rate on a protected, fertile 'wild nest.
6. Reclaims: Since we have only been in operation 14 months little information on this aspect, in fact, only 1 definite.

Original batch hatchling release = 8 February 1971.

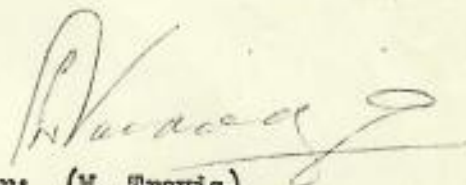
On March 16 1972 fishermen some 18 miles NW of original release point

observed some 54 to 72 small turtles, all of similar size swimming outside reef in a scattered group. Largest 'flock' locals had ever seen. Speared one only (since small size) Ate it. By happen chance I saw the shell next day. Coastal ident. nicks showed it to be one of batch of 73 released on 8th February. Shell showed 27% greater growth than that of its captive batch sibling. From above it appears that:

1. Hatchlings survive.
2. Hatchlings stay together.
3. Released hatchlings have better growth and all-round condition than captive.

There you are John that's all I can say at present.

Yours sincerely,



for: (W. Travis)  
FISHERIES OFFICER

# UNIVERSITY OF HAWAII

College of Tropical Agriculture  
Department of Animal Sciences

April 27, 1972

Dr. James P. McVey  
Fishery Biologist  
P.O. Box 1000  
Koror, Palau  
Western Caroline Islands 96940

Dear Jim:

Thanks for your letter and the copy of your paper on the growth rate and food conversion in young hawksbill turtles. This information will be helpful in providing a guideline against which we can measure our progress.

As you probably know, George Balazs is working with me on the turtle nutrition project. Our studies are in the early stages in which we are testing different forms in which to feed a formulated diet; the problem being to get the food into the turtle before it dissolves or fouls the water. I suspect that this is a much greater problem with very young turtles than with the older animals. At any rate, we have not reached the point where we have any rations for you to test at your field station, and probably won't have until we complete some of the basic studies on digestibility, digestion rate, etc. To carry out this work we have to hold the turtles in close proximity to our laboratories. For this reason, we hope that it may be possible to obtain 50 or 100 hatchlings from you from time to time.

If you will let us know what type of feedstuffs are available on Palau in addition to tuna scraps, we will try to use them in some of our formulations to see if we can come up with a balanced feed.

There were a few questions concerning your paper:

- (1) You placed about 20 turtles in a 12" diameter tank at one day of age. At what age or weight did you find it necessary to thin them out? *the copy was blurred and it may be that I misread inch for foot.*
- (2) Are you keeping them beyond 6 months?
- (3) As a conservation measure, at what age would you recommend release?

April 27, 1972

- (4) What sort of mortality did you encounter? Due to injuries and/or other causes?
- (5) At what turtle age were they still being attacked by herons and kingfishers or other birds?
- (6) I can understand your concern for the Hawksbill, because it is on the endangered list, but as a possible aquacultural enterprise wouldn't Chelonia mydas be preferable?
- (7) How are you marking your turtles?

You may be interested to know that we also found 1% gentian violet satisfactory in treating injuries.

Sincerely yours,



Ernest Ross  
Poultry Scientist

ER:esm

Encl.

P.S.---I'm enclosing a bulletin which gives some information on raising chickens. I'm not sure this is the answer to the high price of eggs. Unless well balanced feeds are available, I'd say forget it. If you have specific questions, please write and I'll try to answer them for you.

P.P.S. — If George + I sometimes seem to be speaking different languages it is mainly because he is out at Coconut Island while I'm on campus + sometimes there is a lag period in our communications.

(ER)

April 7, 1972

Mr. Bill Elwell  
Regional Peace Corps Director  
Yap, W. Caroline Islands  
Micronesia

Dear Bill:

We are getting a research project under way to study the nutritive requirements of sea turtles with the object of developing cheap balanced diets that would provide optimal growth rates. It is expected that the information derived will be of value to those interested in the conservation of the various species of sea turtles as well as to those interested in rearing turtles as an aquacultural enterprise.

Bob Brick indicated that you had an interest in sea turtles, and I am writing to obtain any information that you may have available concerning the results of any previous turtles studies or information of any on-going turtle studies in your area.

We presently have a small number of sea turtles which we have reared to one month of age and have been attempting to develop a feed formula that would provide a balanced diet. Our biggest problem at the moment is to formulate it so that it would hold together and not foul the water without resorting to special binding agents. Any information that you have on the growth of any of the species of sea turtles would be helpful to us in evaluating our progress. Also, any data available on results of feeding hatchling turtles both natural and formulated type diets would be helpful.

Thanks for any information that you can provide.

Sincerely yours,

Ernest Ross  
Poultry Scientist

ER:esm

# PEACE CORPS / MICRONESIA

TRUST TERRITORY OF THE PACIFIC ISLANDS

Yap District  
Yap  
Western Caroline Islands  
96943

April 15, 1973

Mr. Ernest Ross  
Animal Science Dept.  
College of Tropical Agriculture  
Hawaii Agricultural Experiment Station  
1825 Edmonson Road  
University of Hawaii  
Honolulu, Hawaii 96822

Dear Ernest:

Thank you for your letter asking for information concerning sea turtles. We do have an interest in the rearing of sea turtles here in Yap but, as yet, that is about as far as we have gotten. I have been working with Dr. James McVey in an effort to involve Peace Corps Volunteers in an up-coming mariculture program in Palau but we don't have anyone there yet. Part of Jim's project will be research in the feeding and rearing of hatchling turtles but if you have begun you are probably in a better position to provide us with information, rather than the other way around!

I would refer you to Jim for whatever information he may have. He has done a limited amount of work with turtles and may have something of value to you. His address is: Dr. James P. McVey  
Division of Marine Resources  
Koror, Palau 96940

Good luck and best regards to Bob. I wish I could be of more help to you.

Sincerely,



William R. Elwell  
District Representative  
Peace Corps Yap/Palau

March 23, 1972

Mr. Eugene Kridler  
Wildlife Administrator  
Bureau of Sport Fisheries  
& Wildlife  
337 Uluniu Street  
Kailua, Hawaii 96734

Dear Mr. Kridler:

The attached tentative project outline gives some of the basic objectives of the proposed research. While the major thrust of the work will be nutritional in nature, we will also be very much interested in all aspects of management. Such factors as temperature, concentration of numbers, light intensity, etc., will also be studied as the availability of animals and the flexibility of the experimental plan permit.

In addition, we hope to make observations on the fertility and hatchability of the eggs and would also like to attempt artificial incubation of some of the eggs in our chick incubators.

We hope that it will be possible for us to obtain some *Chelonia* eggs for these studies, and hope further that it will be a stimulus for others to study the distribution of *Chelonia mydas* and other sea turtles in Hawaiian waters.

Sincerely,

Ernest Ross  
Poultry Scientist

ER:esm

cc: George Balazs  
Dr. Bardach  
Dr. Helfrich



April 7, 1972

Mr. Jim McVey  
Koror, Palau  
Caroline Islands  
Micronesia

Dear Jim:

We are getting a research project underway to study the nutritive requirements of sea turtles with the object of developing cheap balanced diets that would provide optimal growth rates. It is expected that the information derived will be of value to those interested in the conservation of the various species of sea turtles as well as to those interested in rearing turtles as an aquacultural enterprise.

Bob Brick indicated that you had an interest in sea turtles, and I am writing to obtain any information that you may have available concerning the results of any previous turtles studies or information of any on-going turtle studies in your area.

We presently have a small number of sea turtles which we have reared to one month of age and have been attempting to develop a feed formula that would provide a balanced diet. Our biggest problem at the moment is to formulate it so that it would hold together and not foul the water without resorting to special binding agents. Any information that you have on the growth of any of the species of sea turtles would be helpful to us in evaluating our progress. Also, any data available on results of feeding hatchling turtles both natural and formulated type diets would be helpful.

Thanks for any information that you can provide.

Sincerely yours,

Ernest Ross  
Poultry Scientist

ER:esm

# UNIVERSITY OF HAWAII

Marine Programs 7331

SEA GRANT

20 July 1971

Dr. Ernest Ross  
Animal Sciences Department  
Henke Hall

Dear Dr. Ross,

This is a note to keep you appraised of the latest developments concerning turtles. After talking with you and getting my interest re-kindled and after having talked with Dave Olsen of the Bureau of Sports Fishing and Wildlife, I approached Phil Helfrich at Coconut Island. What follows is a summary of information and the present status of the idea.

As the Leeward Islands are designated a wildlife refuge they come under the control of the Bureau. Entry is prohibited save for well developed scientific work under strict control of the Bureau. Dave Olsen outlined these requirements and offered some guidelines concerning the study that we would like to undertake.

The green sea turtle is considered a prime candidate for the "endangered species" list, as you know. As such it will receive extra protection in our refuge system. However, this doesn't necessarily preclude any work with this species. Ours would be a study that would require the removal of small numbers of eggs and/or young over some period of time. The removal of animals, according to Mr. Olsen, entails closer scrutiny and more paper work, but is not prohibited entirely. We will have to develop our ideas in the form of a proposal for the review of Mr. Olsen and Mr. Gene Kridler who is in charge of the Bureau's local office.

Phil Helfrich at HIMB is enthusiastic and proposed that we also consider the same sort of study for the hawksbill turtle which is in roughly the same position vis-a-vis extinction as the green sea turtle. He apparently has access to fish plant offal that the carnivorous hawksbill might be able to use. Where and under what rules these animals are found is beyond me now. It's just a thought.

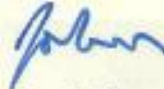
Phil sees the problem as we do, that is, one essentially of nutrition and environmental conditions. We may also need broader

SEA GRANT  
PAGE 2  
Dr. Ernest Ross  
7-20-71

services of the Animal Sciences Department in the areas of diseases and parasites. I don't think facilities will be any problem as space may be available at HIMB, at the Kewalo Facility, and perhaps even at Waialae.

At this point we need to spell out our project, timetables, and requirements in the way of site visits, eggs and/or young, and the like. If you can keep me informed of the requirements and constraints of your particular interest, I will proceed to develop a rough draft of a proposal.

Sincerely,



John Ball  
Advisory Specialist

cc: Mr. Dave Olsen  
Mr. Gene Kridler,  
Phil Helfrich

Family Cheloniidae - Sea turtles

1. genus Chelonia - the green turtles  
Chelonia mydas mydas (Linne) - Atlantic green turtle  
C. mydas agassizii Bocourt - East Pacific Green Turtle

Japanese name  
older name  
for agassizii

2. genus Eretmochelys - the Hawksbill turtles  
E. imbricata imbricata (Linne) - Atlantic Hawksbill  
E. imbricata squamata Agassiz - Pacific Hawksbill turtle

3. genus Caretta - the Loggerheads  
C. caretta caretta (Linne) - Atlantic Loggerhead  
C. caretta gigas Desmognagels - Pacific Loggerhead

4. genus Lepidochelys - the Riddleys  
L. kempii (Garman) - Atlantic Ridley  
L. olivacea (Eschscholtz) - Pacific "

Marine grasses of the genera Thalassia + Zostera

11  
Ethel - Please rough as  
soon as possible  
Hals  
②

Project title: The nutrition of the Pacific green turtle  
(Chelonia mydas agassizii Bocourt)

Justification: Dr. Archie Carr, the leading world expert on sea turtles states: "The green turtle is the most valuable reptile in the world, and yet it would be difficult to name any animal, comparable at once in economic importance and the depletion in numbers that it has suffered, that is so poorly known. The situation is particularly astonishing in view of the fact that a relatively small amount of basic research would almost certainly provide data on which a proper conservation programme would be founded and green turtles could be restored to huge areas from which they have been virtually extirpated." In the 20 years since these words were penned, ~~virtually~~ virtually no basic information has become available. In 1967 Dr. Carr stated: "A technology of green turtle husbandry will have to be developed. Once that is worked out it will be a double blessing: people will be fed and species will be saved."

The development of any sort of animal husbandry

is predicated on the ability to feed the animals.  
The 4 billion dollar poultry industry did not  
develop until poultry flocks could be confined,  
and confinement was not successful  
and raising could not be done until the  
sufficient information was obtained on their  
nutritional requirements <sup>of poultry</sup> so that they could  
receive a complete diet.

The conservation of Chelonia and other sea  
turtles may well ~~rest~~ <sup>depend</sup> on the development of nutritionally  
complete diets that may be formulated from  
inexpensive feed ingredients.

11

Previous work and Present Outlook: A number of books and a considerable number of scientific papers have been written about Chelonia mydas. The bulk of these publications report of observations, tagging experiments, and the danger of extinction. Apparently some dedicated conservationists are feeding hatchling turtles for varying periods of time to increase their survival rate when released. While these individuals have met with varying degrees of success, <sup>using shrimp, fish, etc.,</sup> there appears to have been no attempts to define the nutritional requirements of the hatchling and to develop nutritionally complete feeds which provide optimum growth at minimum cost.

The application of nutritional knowledge gained with poultry together with some of the husbandry techniques could well result in the development of a turtle technology envisaged by Dr. Carr.

### Objectives

1. To develop growth curves for Chelonia mydas from date of hatch to sexual maturity utilizing natural foodstuffs, eg., shrimp, fish, squid, etc.

2. To determine the optimum protein requirement of Chelonia mydas at different stages of growth utilizing a nutritionally complete formulated feed consisting of readily available feedstuffs.
5. To study ~~the~~ various techniques of feeding sea turtles.
3. To determine the optimum energy requirement of Chelonia mydas at different stages of growth.
4. To determine the optimum calcium:phosphorus ratio of Chelonia mydas at different stages of growth.

Procedures: Hatchling turtles will be assigned at random to experimental groups consisting of 5 to 10 turtles per group. <sup>in 15 gallon aquaria fitted with</sup> All hatchlings will be fed, <sup>initially on</sup> a natural diet of shrimp, fish, and squid. Body weight, <sup>as well as</sup> carapace length and width will be determined bi-weekly, when all hatchlings are eating well and show more or less uniform growth the experimental diets will be fed.

Growth data will be taken weekly and an



attempt will be made to determine feed consumption. Preliminary experiments, <sup>will be carried out to make</sup> ~~with~~ dry pelleted feeds that will either sink or float, in addition studies will be made of prepared food such as the Oregon moist pellet trout food. Work will also be attempted on the formulation of a semi-solid or paste feed that would not dissolve readily in water.

A control group will be maintained on the natural food and growth curves prepared. From the weekly growth figures obtained from the experimental groups the optimum protein level will be determined at different stages of growth.

Similar procedures will be followed in future experiments to determine energy and calcium and phosphorus requirements.

When the turtles outgrow the aquaria they will be moved into larger tanks and subsequently into ponds at <sup>the Institute of Marine Biology on</sup> Coconut Island.

Duration: 5 years

Personnel: Ernest Ross, Poultry Scientist, Dept. of Animal Sciences, Univ. of Hawaii.  
George Balazs, , Institute of Marine Biology, Coconut Island, Univ. of Hawaii

Memo to: John Ball, Advisory Specialist  
Marine Program, Sea Grant  
Spaulding 255-2540 Mail Way

From: 

Re: Proposed sea turtle research

As you know, my interest in sea turtles stems from some experience gained in rearing several Loggerhead turtles in Florida during my last sabbatical leave. Our home feeding project subsequently led to a visit to the Carretta Foundation on Sanibel Island where loggerhead eggs were hatched and reared in 3' x 5' tanks. While the objectives of the Foundation were admirable - principally to release large numbers of loggerheads when they were big enough to considerably improve their chances of survival - their methods appeared to me to be primitive and unscientific.

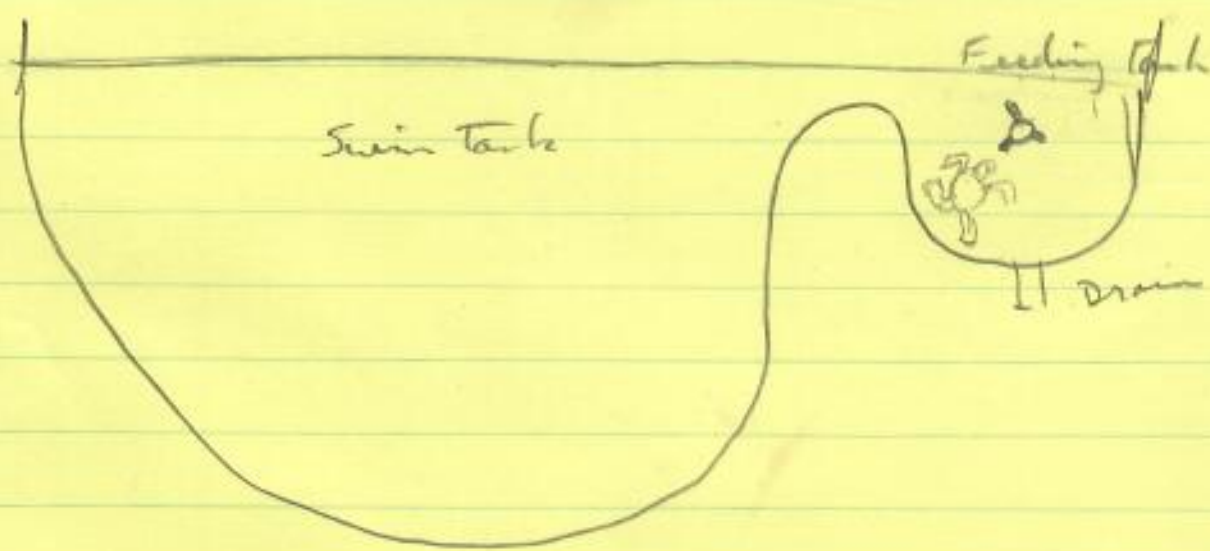
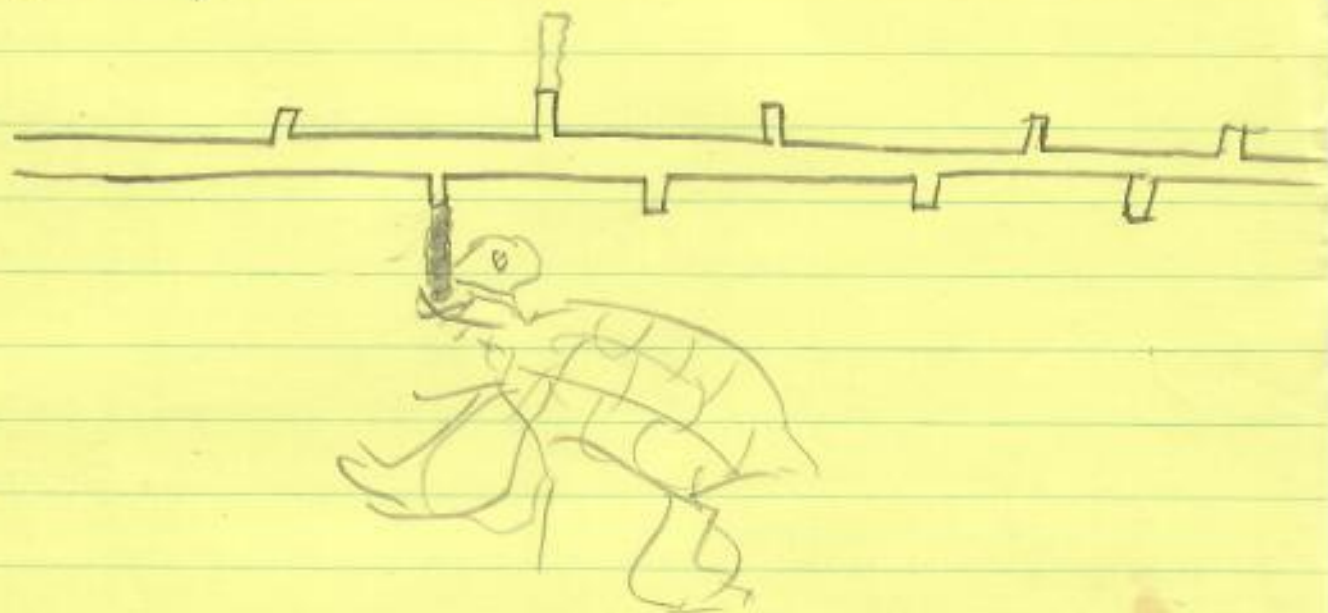
In considering the problem of the nutrition of sea turtles I see two approaches that may be used:

- 1) capture young turtles of different ages and examine stomach contents. A chemical analysis of the stomach contents would give an indication of the nutrient requirements and could be used in 2)

feeding trials. I can see many problems involved in proposal 1, not the least of which is the capture of the necessary specimens. With respect to proposal 2, this could more readily be accomplished, providing the necessary holding pens or facilities and the labor to look after the animals.

~~Self-feeding~~ Suggestion for self-feeding turtles:

1" Plastic pipe with stainless steel nipples (or tough plastic). Pump semi-solid feed through



Kenji  
Mr Ego  
Paul Breeze

Red filamentous  
lime

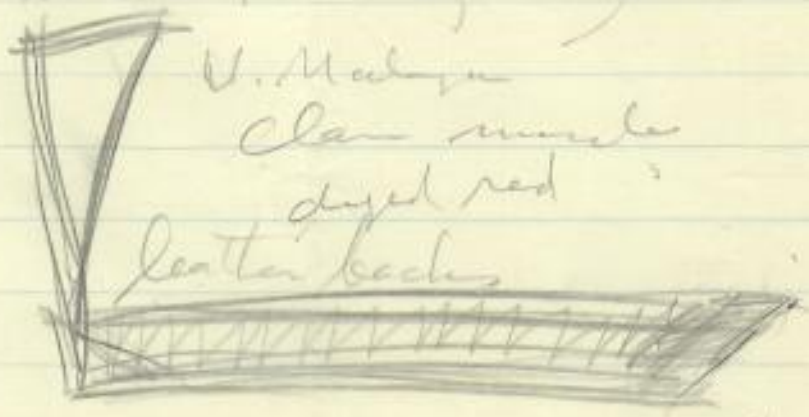
Harold Hirth - Utah  


Johnnie Hendrickson }  
Pantisi sci

Grand Cayman

- Turtle Farming

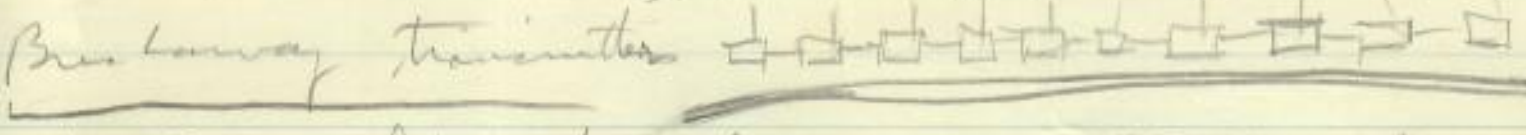
Utah  
Harold



Van Brock

640 tagged  
" returned

10% returned tagged  
50% returned



Coast Guard plane National Marine  
Turtles for Archie Carr? fish-

? Oiler - ~~guarding~~ turtles Allen Banner - drawing turtle

Molokai - found small turtles Hawk bill like  
Halpua rocky coarser sand-gravel  
Nanome beach - greens

November 23, 1970

Mr. Charles LeBuff  
Lighthouse  
Sanibel Island  
Florida 33957

Dear Mr. LeBuff:

Earlier this year, I had the pleasure of visiting with you at your loggerhead research station on Sanibel Island. At that time, you explained your operation and discussed the problem of sexing the young loggerhead turtles. We also discussed the possibility of your sending some of the young preserved turtles to me here to see whether I might be able to assist you in this matter.

I am now back at the University of Hawaii and would be in a position to look at some of the specimens if they are available. It would be helpful to have the specimens grouped or identified according to age and hatch.

Sincerely,

Ernest Ross  
Poultry Scientist

ER:esm

HAWAII INSTITUTE OF MARINE BIOLOGY  
 AQUACULTURE PROGRAM

April 4, 1972

SPECIES	ECOLOGY	REPRODUCTIVE BIOLOGY	NUTRITION	DISEASE	FACILITIES
<u>Caranx</u> <u>mate</u> (omaka)	Larval studies completed	Laboratory rearing through metamorphosis	Studies in progress of nutritional requirements throughout life cycle	Establishment of cell line; basis for study of other fish species	
<u>Coryphenā</u> <u>hippurus</u> (mahimahi)	Location and capture of adults	Seasonal study of gonad development in progress	Studies of nutritional requirements begun		
<u>Gnathanodon</u> <u>speciosus</u> (ulua)	Location and capture of eggs	Laboratory rearing through metamorphosis			
<u>Polydactylus</u> <u>sexifilis</u> (moi)	Studies of adult ecology completed	Field-investigation			
<u>Octopus</u> <u>cyanea</u>	Sufficient data; discontinue studies	Mating occurs in captivity; includes year-round inducement of breeding	Studies in progress of nutritional requirements throughout life cycle; compounded food		
<u>Scylla</u> <u>serrata</u> (Samoan crab)	Sufficient data; discontinue studies	Hatching occurs in captivity	Studies in progress of adult growth response to natural and artificial food; determination of dietary protein and amino acid requirements		

SPECIES	ECOLOGY	REPRODUCTIVE BIOLOGY	NUTRITION	DISEASE	FACILITIES ENGINEER
<u>Panaeus</u> <u>carolinatus</u>	Sufficient data; discontinue studies	Hatching occurs in captivity; refine studies; try out Florida endocrine experiments	Studies in progress of nutritional requirements throughout life cycle; compounded food		Design of mechanize shrimp production c commercial level
<u>Callana</u> sp.	Inventory and evaluation of naturally oc- curring popula- tions planned; natural food and site limitations				

Coordination with other agencies working in aquaculture in Hawaii:

Oceanic Institute: Reproductive Biology Committee; exchange of information and materials, e.g.,  
algae culture, Corychena hippurus

State of Hawaii: Advisory services to Macrobrachium project

Fish Farms Hawaii: Advisory services to several projects; cooperative arrangement in use of ponds  
for Artemia culture