

7-25-83

JAPAN GRANT AND COOPERATION
PROJECT INFORMATION SHEET

1. NAME OF PROJECT:

Experimental Project on the reproduction and culture of the hawksbill turtle (Eretmochelys imbricata) in the Republic of Palau.

2. LOCATION OF PROJECT:

Malakal Island and Auluptagel Bay, Republic of Palau, Caroline Islands.

3. OUTLINE OF PROJECT:

- I. Construct turtle hatchery at the Micronesian Mariculture Demonstration Center at Malakal and holding pens at Auluptagel Bay.
- II. Collect turtle eggs from the wild and raise the juveniles in captivity.
- III. Release some cultured turtles to the wild and keep others for:
 - (a) slaughter when adult.
 - (b) production of more eggs for hatchery.

4. PROJECT COMPONENTS:

There are three (3) basic components in the proposed turtle culture system. These are facility construction at (1) the MMDC headquarters, (2) at Auluptagel Bay, and (3) an operational component.

The development of a large scale turtle farm in Palau must be viewed as a long range project. The present proposal seeks funds to carry out the initial phase of this which will run for two years (1983-1984).

During this first phase of the project hatchery facilities will be constructed at the MMDC laboratory and a temporary enclosure will be built at Auluptagel Bay. When the success of hatchery and growout techniques have been ascertained, additional funding will be requested to establish permanent facilities and breeding beaches at Auluptagel Bay. During 1983-1984, hatchery reared turtles will be kept at the Auluptagel enclosure. Since several years are required for turtles to reach reproductive maturity, breeding beaches will not be necessary during the initial (1983-1984) phase of the project.

MMDC Box 359
Koror, Palau
Caroline Islands 96940

4 August, 1983

Mr. George Balazs
National Marine Fisheries Service
Honolulu Laboratory
P.O. Box 3830
Honolulu, Hawaii 96812

Dear George,

Thank you for your letter of 13 July and the very valuable reprint set. I really admire the work you have been doing on turtles.

My own work involves mariculture of commercially important molluscs. Right now I am raising trochus and giant clams, with support from the Pacific Tuna Development Foundation.

There is a hawksbill headstarting project underway in Palau, and it is under the direction of Mr. Becky Madraisau, a Palauan mariculture technician. Eggs are collected from beaches in nature, brought back to the laboratory for incubation, and the hatchlings are reared in a flow through raceway for about 6 months before being released. Until recently none of the turtles were being tagged, but this year a group from the Japanese Tortoise Shell Association sent a small number of plastic tags for testing. Tagging is not yet an integral part of the program, though.

There are two things that concern me about the project. One is that our staff has very limited expertise in this area, and is largely unaware of the activities of other workers in the field. However, it is extremely unlikely that the government of Palau would appropriate funds for the hiring of a professional turtle biologist to head the project.

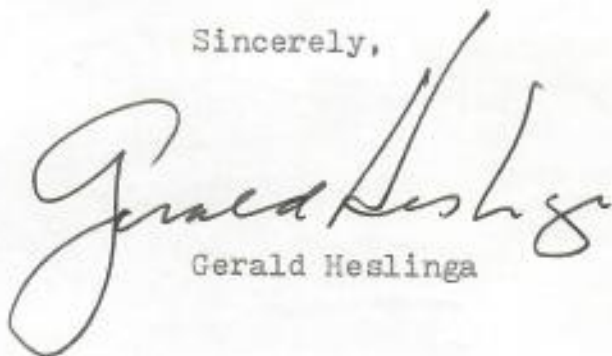
The second problem is that the Japanese Tortoise Shell Association has approached the government of Palau with a proposal to start a commercial turtle farm here. They have already donated \$10,000 to the MMDC and appear intent on starting a farming venture. It seems clear that the local government views this as a positive development and will welcome the investment. Whatever effects the commercialization of the headstarting program will have on the resource seem to be of minimal concern at the moment.

I hope you will treat this information as confidential. You undoubtedly understand that in developing countries, many or most decisions regarding resource use are politically and economically motivated. I think that in this case the Japanese turtle people will gain control of the resource simply because they are making the highest bid.

My intent in sending a notice to the Marine Turtle Newsletter was to attract the attention of professionals like you who might be in a position to come to Palau and evaluate the situation. Little or no work has been done on hawksbills here and I think the situation would be much improved if a serious biologist spent some time out here. It would then at least be possible to present the government with a status of the resource report and to suggest alternatives ^{to} commercial turtle farming. At present they don't seem to have much choice other than to accept the Japanese proposal.

I enclose two proposals regarding the commercial farming concept in Palau. These are my only copies and I would ask that you return them when you are finished.

Sincerely,


Gerald Heslinga

George,

Thanks for the loan. Objectives of the project are rather transparent and deceptive. No mention though of direct harvest of turtles from the wild.

Peter

Since hawksbill turtles require about seven (7) years to reach marketable size, no cultured turtles will be caught until 1990, when the catch will be roughly 885 head. In 1991-1992 the catch will increase to 5,700 head. Full scale business is to start in 1993, and starting in 2001 annual catch is expected to be 8,000 head. At 2.2 lbs. of shell per head, annual export will be approximately 17,600 lbs. of tortoiseshell.

A detailed break down of each project component, including cost, is given in Table I.

5. OBJECTIVES OF PROJECT:

(1) Establish a hawksbill turtle culture center in Palau capable of exporting 8 tonnes of tortoiseshell per year to Japan.

(2) Through a system whereby some cultured turtles are slaughtered and others are released to the wild, we hope to stop the decline in numbers of wild hawksbill turtles in Palau.

(3) Strengthen Palau's economy by developing industries related to the production of turtle shell. These industries will include:

- a. Turtle meat production possibly leading to the construction of a cannery.
- b. Increased tourism (especially from Japan) as a result of the interesting nature of the turtle culture facility at Malakal.

(4) Establish and maintain a program of basic research on the ecology of hawksbill turtles. Increased knowledge of hawksbill turtle ecology will help protect this valuable species.

6. RELATION TO SOCIAL AND ECONOMIC PLANS:

The Republic of Palau is an island nation, and consequently our greatest potential wealth lies in the sea around us. However, this wealth must be developed in the form of industries which generate capital and provide employment for our people.

The development of a turtle culture industry in Palau will aid this nation's economy in several ways. First, the profits from sales of turtle shell, meat and skin will generate capital which can be used to finance further industry in Palau. Secondly, the project will generate employment opportunities for Palauan people. This will be true not only at the turtle culture center, but also in

The related industries previously mentioned. Thirdly, the Palau tourist industry will benefit from the development of a turtle culture center in Palau.

Social relations between Palau and Japan will also be favorably affected as a result of this cooperative effort. Although Palau's tourist industry is relatively small, currently ongoing airport improvements should result in a major increase in tourism. Because of the relatively short distance between Palau and Japan, and because of the historical relationship between the two countries, we expect a major increase in Japanese tourism within the next decade. The proposed turtle culture center in Palau would serve as a major attraction for these tourists.

7. BACKGROUND INFORMATION OF PROJECT:

The hawksbill turtle (Eretmochelys imbricata), like its relative the green sea turtle (Chelonia mydas), is a commercially valuable species which has suffered greatly as a result of habitat destruction and overfishing. Although hawksbill turtles and their eggs have traditionally been an esteemed component in the diets of Pacific Island peoples, until recently, men and turtles have managed to live in coexistence. However, recent development of Pacific Islands has reduced the number of suitable beaches available as breeding sites for turtles, and the advent of the motor boat has made access to previously remote beaches much easier for fishermen and turtle egg poachers.

The Republic of Palau is the site of some of the world's best hawksbill turtle breeding grounds, and the potential destruction of this species (primarily due to illegal poaching of turtle nests by local people) is of great concern to the Palauan Government. Consequently, the Micronesian Mariculture Demonstration Center in Palau has embarked on a small scale conservation program (aided by the Tokyo Metropolitan Government) involving laboratory rearing and eventual release of turtles hatched from eggs collected in the field.

The worldwide decline in hawksbill turtle stocks has also had a detrimental effect on Japan's tortoiseshell industry. With the ratification of the convention on International Trade in Endangered species of wild fauna and flora (Washington Treaty, adopted in April, 1973) by the Japanese Government, the Japanese tortoiseshell industry, which depends completely on imported hawksbill carapace for its raw material, has had difficulty ensuring a stable supply of shell. As the hawksbill turtle has

been listed in Attachment I of the Washington Treaty, its trade for commercial purposes has been regulated. However, according to Article 7 of the Treaty, species that have been bred for commercial purposes are regarded in the same way as species listed in Attachment II and therefore may be traded commercially.

Consequently, the Japanese tortoiseshell industry has been examining the possibility of stimulating the growth of turtle culture facilities in the tropical western Pacific. Cultured turtles could then be legally exported to Japan once the administrative authorities of the country of export issued a certificate stating that said species was bred for commercial purposes.

During 1980 and 1981, the Japanese tortoiseshell industry, with the aid of the Japanese Government and the Tokyo Metropolitan Government, conducted surveys to identify a suitable location for hawksbill turtle culture. As a result of these surveys, the Republic of Palau was chosen for an experimental project on reproduction and culture of turtles.

The Government of Palau is very interested in working with Japan to develop a turtle culture industry in Palau. We have, in fact, been carrying on our own limited turtle research program and were happy to receive a \$4,000 turtle research grant from the Japanese tortoiseshell industry in 1982 and an additional \$6,000 grant in 1983. Much of the infrastructure required for a large scale turtle culture program is already in place at our marine biological facility (Micronesian Mariculture Demonstration Center), and we have personnel already trained in turtle culture practices.

We hope that by working together, we can develop a program which will both provide the Japanese tortoiseshell industry with the raw material it needs and preserve the hawksbill turtle as an economic and esthetic resource for future generations in Palau.

8. ROUGH COST ESTIMATES NECESSARY FOR EXECUTION OF PROJECT:

Table 1 is an outline of cost estimates for the implementation and operation of the preliminary 2 year phase of the proposed turtle culture project.

We are asking for funds to construct, maintain and operate the holding facility at Auluptagel Bay and the hatchery at MMDC. Palau's share in the implementation of the project will be the free use of existing MMDC facilities.

9. NECESSITIES OF PROJECT:

The necessities of the project are those items listed under "Project Components".

Construction of a hatchery facility at MMDC is necessary to the success of the project because it is here that eggs will be incubated and hatched under carefully controlled conditions. Laboratory hatched turtles too young to be released in the enclosure at Auluptagel Bay will also be raised at the MMDC hatchery. Hatchery construction costs will be kept to a minimum by utilizing existing MMDC infrastructure.

Facilities at Auluptagel Bay are also necessary for the success of the project. The function of the Auluptagel Bay station is to provide a large yet enclosed area where turtles raised at the MMDC hatchery can be farmed to commercial size. Provision will eventually be made for captive turtles to lay eggs in the enclosed bay. These eggs will then be taken to the hatchery at MMDC.

Table 1. Project Components And Their Costs

Component	Cost
I. Facilities at the MMDC headquarters	
I-1 Laboratory house w/thermostatic system	\$ 28,000
I-2 Residence for researchers	40,000
I-3 Rearing Tanks 2 30 x 4 x 4 ft. tanks	40,000
I-4 Boat for egg collection	10,000
I-5 Toyota truck	4,000
I-6 Seawater pump	2,000
	Total..... \$124,000
II. Enclosure at Auluptagel Bay	
II-1 Temporary net enclosure	\$ 12,000
	Total..... \$ 12,000
III. Operational Component	
III-1 Wages for 2 Palauan technicians (1983-1984)	\$ 32,000
III-2 Maintenance costs	10,000
III-3 Fuel	4,000
	Total..... \$ 46,000
Total funds requested	\$182,000

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Report on Basic Research in Technical
Cooperation Concerning Experimental
Farming of the Hawksbill Turtle
(*Eretmochelys imricata*^b in Micronesia
^
Waters)

- 1981 -

JAPAN TOTOISE SHELL ASSOCIATION
Nagasaki Japan

I. General Description

1. Purpose of the Cultivation Investigation

The Treaty of Washington become effective on November 4, 1980, but the ratification of the article concerning "Hawksbill Turtle" (which is used as material for the production of tortoise shell) was deffered to. Nevertheless, the Import Quota System has come into effect since May of 1980 to exercise rigid control over an unlimited import of Hawksbill turtles.

Under such conditions, it is assumed that a stable supply of raw material for tortoise shell may become more difficult in the future. According to the Treaty, certain species of sea turtles that can be cultivated are included in the items for free trading. Hereupon, our industry carried out in 1980 an investigation on the habitats of Hawksbill turtles and suitable cultivation sites Micronesia and, at the same time, explored the possibilities of the promotion of technological cooperation between Micronesia and Japan, so that a stable supply of raw material can be secured a medium- and long-term basis.

2. Member of Research

Yoji Kurata	Director of Ogasawara Fishery Center Branch of Tokyo Metropolitan Fishery
Goro Osawa	President of Osawa Tortoise Shell Co., Ltd.
Shigeshi Maeda	Chairman of Maeda Tortoise Shell Co., Ltd.
Takeda Tochimoto	Member of <u>Himeji Aquarium</u>
Eiichi Isayama	Trainees at Ogasara Fishery Center
Koichi Yamasaki	Ohara Shells Trading Co., Ltd.
Kazuo Horikoshi	Tokyo University of Fishery Graduate student

3. Items of the Investigation

- (1) Research on living and egg-laying habits of Hawksbill turtles
- (2) Research on the present state of spawning ground protection, cultivation, and propagation facilities for sea turtles
- (3) Research on the artificial Hawksbill turtle cultivation facilities and on the management and oper-

ation of them

- (4) Research on the Hawksbill turtle with regard to artificial incubation and liberation, the results of farming, and living habits; research on a joint investigation in cooperation with research workers and/or institutions on the spot
- (5) Research on the suitable Hawksbill turtle rearing areas
- (6) Research on the determination and construction of cultivation and hatching facilities; research on the management and operation of such facilities
- (7) Research on the Hawksbill turtle protection measures taken or to be taken by the Governments on the spot

II. When the Region Was in German Possession

In 1884 when Keikun Suzuki went on a South Sea expedition including Micronesia and Polynesia, he found a large number of sea turtles around the Marshall Island in Micronesia and wrote his impressions as follows:

(The words in parentheses are notes by the present writer)

"There are a vast number of sea turtles around the islands in this region, especially around the islands of Bikar and Jemo. If you make camp by the seaside at night, you cannot sleep because of the sea turtles that come up to swarm around you. The noise made by the turtles is very distributing and will keep you awake all night. If you want to catch any of them, pitch camp by the beach and wait there until daybreak. You may see numbers of sea turtles scattering around on the beach like stones. Catch them one by one with the aid of your friends and put them on the beach with their faces turned up. They cannot right themselves with their flippers since their backs sink in sand, so you can catch more than two hundred of them in one night if you try hard. You can eat them if you want by cooking them in the appropriate manner. they include a species of sea turtle (Hawksbill Turtle -- *Eretmochelys imbricata*), from which tortoise shell can be obtained, and

another (Green Turtle -- *Chelonia mydas*), which swim in the sea during the day come up on the sand at night. The shell obtained from the former (Hawksbill Turtles) is known as "Honkoo" or real tortoise shell, while the shell obtained from the latter (Green Turtles) is known as "Wakoo" or Quasi-tortoise shell. Real tortoise shell vary greatly in price. The best quality is sold at the price of 70 dollars per kin (1.323 lbs.), while even the most inferior quality one is sold at 12 dollars per kin. In those days when I went over to the island, they could catch sea turtles for nothing. These days, however, when the region is in German possession, I think they have to pay taxes to their local chieftain for each turtle they catch".

The marine products exposed from Micronesia when the region was in German possession were shark fin, totoise shell, sea cucumber, and shellfish. Table 1 shows the export of hawksbill turtle (*Eretmochelys imbricata*) when the region was in German possession.

The east shown in the table stands for the East Caroline Islands and the Marshall Islands, while the West in the same table stands for the West Caroline Islands. It can be seen from the table that trade was brisker in the East than in the West, since the center of regional development in these days was Ponape Island. In the West,

Hawksbill turtles were used only for the production of finished accessories (such as tortoise shell dishes known as "toruku" in Palau Island) as the private property of women, or for the production of fish-hooks as an essential article, but they were rarely used for any other purposes. In the East, Hawksbill turtles had not been considered as a tangible property with a market value until Japanese began to settle there. In other words, they have come to be highly valued since that time. Judging from the above, it can be assumed that Hawksbill turtles were found in abundance as natural resources in the East but not necessarily in the West. In any case, it is an established fact that the eggs, meat, shell, and the like (in the case of the Hawksbill turtles) have been used for many years in the daily life of Micronesia.

Some islands in the Western Caroline Islands, such as the Palau Islands and the Tokobeti Islands located to the southwest of Palau Island, and the islands in the Central Caroline Islands and the Marshall Islands have been well known since very early times as places suited for the propagation of sea turtles or in which sea turtles abound.

Table 1 Exports of Hawksbill turtles When
the Region was in German Possession

Year	Eastern caroline			Western caroline	
	Rared shell	fin of shark	Sea shells	Rared shell	Cucumber
1902	3,000	4,000	6,000	---	10,000
1903	3,000	1,000	1,000	5,000	2,000
1904	3,000	7,000	22,000	---	20,000
1905	3,000	5,000	33,000	---	10,000
1906	2,000	1,000	162,000	---	3,000
1907	3,000	6,000	71,000	2,000	5,000
1908	2,000	2,000	31,000	---	---
1909	2,000	1,000	76,000	---	6,000
1910	2,000	---	122,000	---	13,000
1911	3,000	1,000	133,000	---	11,000
1912	4,000	1,000	33,000	---	4,000
1913	353	---	---	700	---

2. When the region Was in Japanese possession

Tortoise shells the Palau Branch of Nanyo Trading Co., Ltd. purchased at Palao in 1912 amounted to Appropriately 200 pounds in value. With a yearly increase in the number of visitors from Japan proper since 1914, Nakajima reported (in 1920) that tortoise shells were highly treasured as the only souvenir from the region and, as a result, the catch of sea turtles rapidly increased while the number of sea

turtles that could be found around each island in this region steadily decreased.

Following the precedent established by the German Government, the Japanese Government decided to levy an export duty of five marks per kilogram upon tortoise shells.

Table 2 shows the output (in terms of yen) of Hawksbill turtles and Green turtles during the period from 1922 through 1941 (the output shown here in the table stands not for the catch but for the market value of the shipment. The table also shows the output of Hawksbill turtles in terms of their number during the period from 1934 through 1941. It can be seen from the table that the output of Hawksbill turtles gradually decreased, though the decrease in the early 1920s is not particularly noticeable.

Table 3 and 4 show the output in 1913, 1938, 1939, and 1941 classified by islands. The catch was especially large in the following three cases: 115 Hawksbill turtles from Ponape in 1939, 138 Hawksbill turtles from Kosuræ in 1939, and 153 Green turtles from Truk in 1941. The reason for this is not clear. Was each of these years a good year for sea turtles around each of these islands or was a special effort exerted in order to meet greater demand created in these years? In 1935, an extraordi-

narily large number of Green turtles were captured around Ponape. This was probably because Green turtles were canned on a large scale in that year.

Table 2 The Catch of Hawksbill Turtles When the Region Was in Japanese Possession

Year	Hawksbill turtle		Green turtle	
	Number	Yen	Number	Yen
1922		6,776		3,564
1923		4,628		3,585
1924		5,349		2,076
1925		3,087		7,653
1926		9,386		11,565
1927		7,353		13,875
1928		4,807		8,341
1929		3,391		8,194
1930		2,438		7,298
1931		2,075		4,564
1932		1,674		2,526
1933		2,181		2,403
1934	240	1,321		769
1935	234	1,473		418
1936	250	1,841		-
1937	129	1,440		-
1938	165	2,539		-
1939	176	2,898		-
1941	75	2,162	171	2,633

Table 3 The Products of Hawksbill turtles shell in each division

Year	1913		1938	1939	
	Number	Mark	Number	Number	Yen
Saipan	-	-	-	-	-
Yap	3	65	-	-	-
Palau	18	288	19	-	-
Truk	1	25	31	20	257
Ponape	10	400	115	18	295
Kusaie	-	-	-	-	-
Kosuræ	(169kg)	375	-	138	2,345
Total	32 +169 ^{kg}	1,153	165	176	2,898

Table 4 The products of turtle in each division

1941

Island	Green turtle		Hawksbill turtle		shells article	
	Number	Yen	Number	Yen	Number	yen
Saipan	18	338	-	-	2,537	2,173
Yap	-	-	42	882	-	-
Palau	-	-	-	-	-	-
Truk	153	2,295	32	1,280	400	1,800
Ponape	-	-	-	-	950	3,325
Total	171	2,633	74	2,162	3,887	7,298

III. The State of Hawksbill Resources

1. Distribution of Sea Turtles in Micronesian Waters

The Micronesian Waters extend 2,700 nautical miles from east to west and 1,300 nautical miles from north to south to cover an area that is equivalent to that of the American Continent. The sea turtles reported so far to be distributed in these waters can be classified into the following four species:

Green turtle (*Chelonia mydas*),
Olive ridley turtle (*Lepidochelys olivacea*),
Leatherback turtle (*Dermochelys coriacea*), and
Hawksbill turtle (*Eretmochelys imbricata*).

Of these, Hawksbill turtles and Green turtles are well known, since they have been used as food or accessories. However, there is little known about the Leatherback turtle.

In Micronesia, languages vary with the locality or with the area. Accordingly, the names of sea turtles vary with the area. For example, when there is a certain dialect name given to a certain species of sea turtle in a certain island, this means that existence of sea turtles of that species was actually recognized

in the waters around that island. According to the report made by Asano (in 1938), there were Leatherback turtles living in the waters around the Palau Islands. MaCcoy reported (in 1974) that the existence of Leatherback turtles was recognized in the waters around Satawal. As to Olive ridley turtles, Homura said (in 1979) that only a very small number of them could be found. According to the report made by Ezaki and Murakami (in 1937), Red turtles were known in Palau by the dialect name of "melop". Research conducted since that time revealed, however, that no Red turtles were found in the waters around Palau and that the sea turtles called "melop" in Palau were in effect Green turtles. This shows that the Red turtles mentioned in the report by Ezaki and Murakami may have been Green turtles. Table 6 shows the records and specimens of sea turtles that were collected by a research ship cruising in Micronesian Waters in response to a request made by the present writer. Fig. 2 shows the results obtained beforehand in addition to the above.

Table 5 Dialect Name given to
Species of Sea Turtle

Region Species	Palau	Yap	Trak	Ponape
A generic name of turtle	uel		pua pua	calop
Green turtle	melop	won		calop
Hawksbill turtle	ngasu	mau	urimoso	
Leatherback turtle	siusugal	wongera	irichien	
Red turtle	bobu			

Fig. 2 Distribution of Sea turtle
in Micronesia

- Hawksbill turtle (*Elatoncelis imbricata*)
- Ridley turtle (*Lepidochelys olivacea*)
- ▲ Green turtle (*Chelonia mydas*)
- ☆ Leatherback turtle (*Dermodochelys coriacea*)

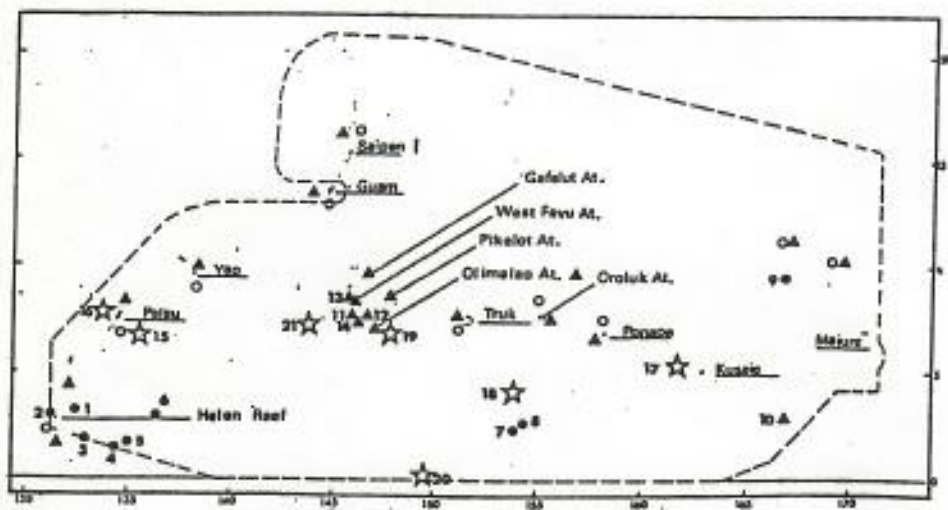


Table 6 Location on Micronesian Waters where Sea Turtles Were Caught

Lepidochelys olivacea

No.	Date	Latitude	Longitude
1	1947. 9-13	3° -08' N	132° -33' E
2	14	3° -04' N	131° -14' E
3	15	2° -02' N	132° -07' E
4	17	1° -26' N	134° -21' E
5	17	2° -12' 5" N	135° -09' E
6	18	3° -33' 5" N	136° -20' E
7	1977. 7- 1	2° -2' N	154° -13' E
8	2	2° -3' N	154° -14' E
9	1979. 3-11	6° -30' N	167° -25' E

Chelonia mydas

No.	Date	Latitude	Longitude
10	1979. 5-10	3° -12' N	167° -05' E

Dermochelys coriacea

No.	Date	Latitude	Longitude
15	1927.	7° -30' N	134° -20' E
16	1937. 9- 6	7° -10' N	134° -30' E
17	1968. 7	4° -30' N	163° -00' E
18	1968. 7	4° -20' N	154° -15' E
19	1970. 9- 2	7° -25' N	147° -20' E
20	1971. 7	7° -25' N	145° -50' E
21	1973. 10	0° -10' N	149° -30' E

2. Physical Size of Hawksbill Turtles

With an increase in the number of Japanese people coming to Micronesia after the region passed from German possession to Japanese possession (1914), Nakajima reported to the effect that (in 1944 and 1950), considerable demand for Hawksbill turtles had resulted in excessive hunting. Consequently, this undesirable situation meant that Hawksbill turtles with a shell length of more than 78.8cm could only rarely be found around there.

In 1936, the Government-general of Palau carried out an examination on based on specimens of 141 stuffed Hawksbill turtles preserved in Palau with the purpose of placing restrictions on the capture of Hawksbill turtles according to their shell length. Of these, the largest specimen was 73cm in shell length. Those which had a shell length of more than 60cm were only 23 in number, while those which had a shell length of less than 45cm totalled 29 in number. Fig. 3 shows the results of the study which was carried out.

Fig. 4 shows the result of the survey carried out this time (1981) with 19 specimens of Hawksbill turtles. The comparison between the results of the two examinations shows a tendency for Hawksbill turtles generally

found in this region to become smaller over the past years.

Fig. 3 Comparison of Captured Hawksbill turtle in Palau adjacent

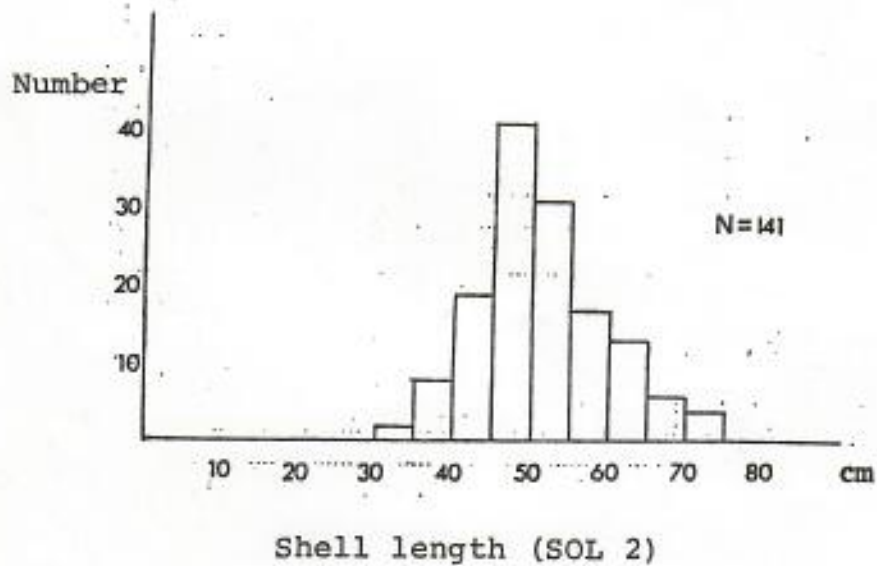
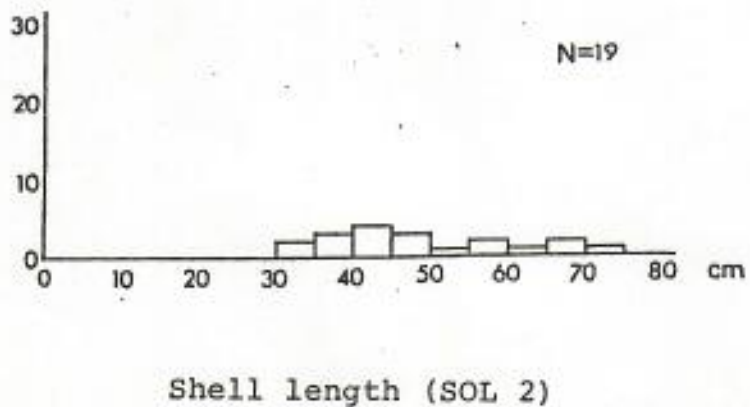


Fig. 4 Comparison of Captured Hawksbill turtle in Palau adjacent



3. Spawning Period and Hatching Rate of Hawksbill Turtles

The Fisheries Control Regulations once established by Nanyo Cho (the South Sea Governor-General) provided that the periods from February through May and from September through October every year should be preserved as the spawning period, and that the capture of Hawksbill turtles should be prohibited during these periods.

Table 7 shows the results of the on-the-spot investigations conducted in the past and this time with regard to the discovery of eggs of sea turtles and hatched-out young turtles.

On the Palau Islands, eggs were found during the periods from the last third of January through the middle third of March and from the middle third of May through the middle third of June. On Truk, where the investigation was conducted this time, eggs were found in the first third of February. On the Palau Islands, hatched-out young turtles were found during the period from the first third of February through to the last third of April. On the Uliti atolls of Yap, they were found in the last third of March. On Truk, they were found in the first third of February when the investigation was conducted this time. According to the re-

port made by Richard (in 1979), they can usually be found on Ponape during the periods from December through January and from June through July.

On the basis of the number of days required from the Discovery of eggs to their hatching on Palau, the number of days required on the average for hatching can be estimated to be 68 days (Table 7). On the assumption that this number of days is substantially correct, the spawning time calculated backwards from the date of the discovery of young turtles is as follows (Table 8); on Palau, it is during the period from the last third of November through the first third of February; on Truk, it is in the last third of November.

Judging from the above, the eggs of the Hawksbill turtles may be laid twice a year, that is, from November through March and from May through June.

Nakajima reported (in 1920) that he witnessed a Hawksbill turtle laying eggs in the middle of April. Putting what he heard from the aboriginals in Palau together, he also gave his observation as follows: "It seems that Hawksbill turtles do a lot of egg laying especially in February and March and then July, August, and September. Furthermore, they may keep laying eggs somewhere on the Palau Islands almost the whole year round." We are planning to clarify this point by con-

ducting further investigations.

Table 7 shows the hatching rate for Hawksbill turtles.

4. Shape of the Eggs

The eggs of the Hawksbill turtle are smaller than those of the Green turtle. Judging from the fact that the native people of Palau and Truk, when the current investigation was conducted, did not know about Olive ridley turtles, the eggs discovered by the investigation may be those of the Hawksbill turtle, not of the Olive ridley turtle.

Table 8 shows a comparison between the eggs of the Hawksbill turtle found in the past and those found this time. The eggs found on Kiku Island of the Truk atoll, having an average diameter of 32.6mm, and are smaller than those found on any other island.

Table 7 The Hatching Rate for Hawksbill turtles

Island	Date	No. of Eggs Laid	No. of Eggs Planted	Hatching Date	No. of Hatching	Percent of Hatching	Note
Palau Neco	Jan. 19	117					Kurata (1981)
Truk Lauvergne	Feb. 3	103					
Givry	Feb. 4	85					
Givry	Feb. 4	125		Feb. 4	67	53.6	
Pukuelion	Feb. 4	175					
Kikujima	Feb. 6	86		Feb. 6	21 (4)	29.1	
Kikujima	Feb. 6	132					

Eggs with a diameter of 34.0mm to 40.0mm could be obtained by restoring the eggshells after hatching which were discovered in an old nest on Palau. Eggs several days after being laid as well as addled eggs were found on Truk. These eggs are equivalent in diameter to those found in other places.

No eggs that can be considered as those of the Green turtle could be found. Judging from the size of nests discovered by the current investigation and of the footprints found around the nests, the eggs mentioned above cannot be considered to be those of the Green turtle.

Table 8 A Comparison between the eggs of the Hawksbill turtle

Island	No.	Diameter	Ave. (mm)	Weight (g)	Ave. (g)
Palau	5	33.3~49.5	43.6	22.5~24.4	23.3
"	5	34.0~40.0	36.1		
Truk	4	34.0~36.0	35.0		
Truk Kikujima	17	31.5~36.0	32.6		20.8
Australia	10	32.8~38.9	36.4	22.5~30.5	26.4

Table 9 Comparison of Records of Hatching

Island	No.	Range (C.P.L.)	Range (G.P. W.) Ave.	Weight (Ave.)	Note
Truk	34	3.10-4.15cm	2.90-3.30cm	13.89	Kurata (1981)
Palau	5	4.09-4.24	3.18-3.33	13.5	Nakajima (1920)
"	5	3.93-4.24	3.33	12.8	"
Australia	10	3.91-4.39	4.12	14.6	Limpue (1980)

5. Hatched Young Hawksbill Turtles

Hatched young Hawksbill turtles were found in two nests on the Truk Islands. In one nest, 58 addled eggs and 67 hatched eggshells or 125 eggs in all were found. The number of young turtles found there totaled 36. This means that 31 young turtles had already succeeded in reaching the sea. At the other nest, 86 eggs were found but many of them were addled, showing a low rate. Four of the 25 young turtles found in the nest were dead (they may have been killed due to their legs being caught by the roots of trees). The other young turtles that had been alive were set free into the sea after the length and the width of their shells was measured. It has been revealed by taking measurements that these turtles are as large in shell length and width as those discovered in other waters. Table 9 shows for information purposes the measured values of the hatched young turtles found in the Palau Islands and Australia.

6. The Quality of the Sand in Hawksbill Turtle Spawning Grounds

The bedrock of the Palau Islands mainly consists of andesite, while that of Ponape and the Truk Islands is made of mainly of basalt. None of these volcanic islands produce sandy beaches. Instead, the beaches are formed from white coral sands.

Table 10 shows the grain size of the coral sands of each of these three Islands. No correlation can be found from this table between the quality of sand and the place of spawning. This may be clarified by collecting further data in the future.

7. Eating Habits of the Hawksbill and Green Turtles

The contents of the stomachs of Hawksbill turtles and Green turtles could be examined at several points on the Palau and Truk Islands. The identification of these contents is now being made by experts. It seems that the Hawksbill turtles live on sponges. Approximately 97 percent of the contents of the stomachs of the Hawksbill turtles examined this time were sponges. The remainder consisted of pieces of Madreporaria, Halimeda, and traces of other organisms that may have come into their stomachs along with the sponges. These Hawksbill

turtles and those found around the Izu Island and the Ogasawara Island (a report has been prepared by Kurata but is unpublished) are related to each other by common eating habits. According to (Carr, 1952), Hawksbill turtles in the Caribbean Sea live on lime-type sponges. Table 11 shows the contents of the stomachs of the Hawksbill turtles found around the Truk Island (in 1981).

Main food for Green turtles around the Palau Island is phanerogamous plants such as Enhalus, Halophila, and Diplanthera, two types of marine plants belonging to Thalassia, and Cassiopeian medusae, all of which are abundant in coral reefs. Green turtles found in the Truk atolls also live on phanerogamous plants.

These marine plants usually grow at a depth of zero to two meters in sandy water between the mangrove zone and the Madreporarian zone. In the Madreporarian zone itself, however, they are hardly ever found. They grow gregariously over a wide area, e.g., the eastern and the western lagoons and the southern rocky mountains of Babelthuap Islands, the northern Ngaraangl atolls, at the bottom of sand or mud and in sandy places in the western zone of Peleliu Island and the southwestern zone of Angua Island. In places, they extend directly from the shore toward the open sea in the form of a marine iris zone. The widespread, vigorous growth of these plants is amazing.

Table 12 shows the amount of these plants growing in each region. Phanerogamous plants are taken as food not only by Green turtles but also by Dugongs. The distribution and growth of these plants should be carefully studied for the future propagation and farming of Green turtles.

Table 10 Analysis of the Sand in Hawksbill
Turtle Spawning Grounds

Unit : %

Sand (mm)		$\phi > 1$	$1 > \phi > 0.5$	$0.5 > \phi > 0.25$	$\phi < 0.25$
Island					
Palau	Auron	0.1	0.3	11.3	88.3
	Seventu	3.19	17.32	59.56	19.92
	" №2	2.14	9.11	50.15	38.59
	Neco №1	29.82	37.67	27.94	4.56
	" №2	6.39	21.9	53.8	17.9
	Lock	0.35	3.17	25.88	70.59
	Angur NE	1.57	23.38	72.09	2.96
	" S	0.29	8.46	77.41	13.83
Ponape	Paul	0.93	5.76	67.22	26.09
	Lauvergnel	46.07	45.5	7.62	0.81
	South	8.4	71.45	19.85	0.29
Truk	Pukuelion	50.03	40.42	8.84	0.71
	Givry	4.00	47.70	40.40	7.89
	Torres	21.98	58.74	17.76	1.51

Table 11 Gastric Contents of Hawksbill
turtles Were Caught

Type	Demosponigia spp			Scleractinia spp	Halimeda spp
	D. spp A	D. spp B	D. spp C		
Weight (g)	37.0	45.8	22.2	2.8	0.2
Ratio of weight (%)	34.25	42.2	20.55	2.59	0.25

table 12 Amount of Marine Plants
Growing Around Palau and Coror

Place	Depth	Water Temp.	No. of Stump	Amount of Plants
Imosuk 1	0 m	28.0	38	0.48kg/m ²
2	0 - 1	28.6	55	0.65
Arappu	Cal	28.0	140	1.0
Ngadarak	1 - 2	28.0	440	1.25

8. Changes in the Farming of Hawksbill Turtles in
Micronesia

Dr. Yaichiro Okada, a herpetologist, contributed a paper about 60 years ago to a scientific fisheries journal in Japan on the good prospects for the farming of Hawksbill turtles in Micronesia. When he made a tour of Micronesia in 1914, he met a gentleman called Mr. Shoben Mori, a leader in the farming of the Hawksbill turtle (who went to the region in 1889), on board a ship and heard the surprising information from him that young turtles hatched in the past grew to a size of some 33 to 35cm in two years.

The following is an excerpt of the paper published by Dr. Okada: "The region of Micronesia seems to be a promising field for starting a Hawksbill turtle farm. Without doubt, this region is capable of meeting almost all the essential conditions for the promotion of a turtle farming industry. A general description of the existing conditions in this region is given here. It is rather easy to collect young turtles to be cultivated. Find a place where the adult turtles lay their eggs and cover it with a wire net or the like to keep out natural enemies before the hatching time. In due course, young hatched turtles can be readily caught. The number of eggs laid at any one place varies with the age of the parent turtle.

It is said that a younger parent usually lays 140 to 160 eggs at a time while an older parent lays 200 to 250. If one succeed in finding several egg-laying places, therefore, it is easy to collect a considerable number of young turtles. For turtle feed, shellfish and fish are found in abundance here. When buttons are made out of button shells (*Tectus maximus*), the shells are used as the material for the buttons but after the live contents are removed they naturally rot. It is wasteful to use the shells in such a way. The contents should be removed while they are alive and used as feed for turtles before the shells are used as a material for the production of buttons. The work of removal of the contents may be ideal as casual work for local people. The contents of other shellfish (such as Giant alams -- *Tridacna gigas* -- and Goose barnacles) and small fish can all be used as turtle feed. It will be quite some time before turtle feed is in short supply.

In the middle of these natural surroundings, the construction work required for a Hawksbill turtle farm here can be accomplished at low cost. Coral reefs on the bottom of the sea are strong enough to provide the raw material to build an embankment. It may safely be said that the embankment thus built in a still inlet of a coral island with reefs is capable of withstanding

almost any rainstorm. (some part is imitted here)

X /
Totoise shells obtained in this region are usually reddish brown with a lot of spots on them. Accordingly, they are not suited to the taste of Japanese people, but a high demand for them can be expected in Europe and America. When exported to those countries, tortoise shells of superior quality may be sold at a price of five yen a pound, while those of average quality three yen a pound. On average, a little above one pound of totoise shell can be obtained from a turtle with a shell nearly 70cm long. As can be seen from what I have mentioned above, Hawksbill turtle farming in Micronesia may not be profitable enough when carried out as a principal occupation. as a side line, however, it may be very interesting and relatively profitable."

After this, the Fishery Research Institute of Nanyo Cho (the South Sea Government-General) conducted farming experiments in 1930 and again in the period from 1935 through 1937 in order to cope with the depletion of Hawksbill turtle resources due to excessive hunting.

The results of the experiments conducted by collecting natural eggs are as follows:

- (1) In a rearing period of one year, hatched young turtles grew up on average to be approximately

- 20cm in shell length and 800g in weight (1930).
- (2) In a rearing period of 335 days, hatched young turtles grew up on average to be approximately 18cm in shell length and 663g in weight.
 - (3) In a rearing period of two years, hatched young turtles grew up on average to be approximately 28cm in shell length and 2,455g in weight (1935 through 1937).
 - (4) Many of young turtles died approximately 100 days after being hatched. In some cases, they devoured one another.

It is said that Mr. Yoshimitsu Hori tried in an area on and around Auluptagel Island of the Palau Islands in 1939 to collect eggs, rear young turtles, and harvest adult turtles on a commercial basis but discontinued the attempt before putting it into practice (a report was prepared but unpublished by Okajima).

After World War II, the Fishery Propagation Center in Palau was said to have conducted artificial Hawksbill turtle incubation and releasing experiments during the period from 1968 through 1971 by stocking the sea with 6,000 turtles (with a shell length of 15 to 18cm). We tried on the spot to obtain the results of the experiments, but that was not realized.

Spawning and Habitat Area of Green and Hawksbill turtles in the Central and Pacific Ocean

Area	Item Species	Spawning Area		Habitat Area	
		Green turtle	Hawksbill turtle	Green turtle	Hawksbill turtle
Palau					
	Babelthuap	○	○	○	○
	Helen Reef	○			○
	Mérir	○			
	Pulo Anna	○			
	Seventy Is.		○	○	○
	Western Lagoon				○
	Ngaraagl	○	○	○	○
	Peleliu	○	○	○	○
	angur		○	○	○
Central Calorine					
	Ulfti	○			
	Gaferut	○			
	Olimarao	○			
	West Fayu	○			
	Pikelot	○			
	Ngulu	○			
Truk		○	○	○	○
Ponape		○	○	○	○
	Oroluk	○			
American Samoa					
	Swains	○			
	Rose Atoll	○	○		
Marshalls					
	Ujeland	○			
	Jemo	○			
	Bikar	○			
	Bikini	○			
Hawaii		○		○	

Relative abundance and socio-economic importance of marine turtle in various U.S. territories and possession and associated island groups in the central and western pacific ocean

Area	Green turtle	Hawksbill turtle	Leatherback turtle	Olive turtle	Socio-economic importance
Guam	A	L	?	?	2.00
Northern Mariana	L	L	-	-	-
Palau	M	A	L	L	2.50
Micronesia	A	L	L	L	3.00
Marshall's	A	M	L	L	2.75
Hawaii	A	L	L	-	1.00
American Samoa	M	A	?	?	2.00

A = Abundant

3.00 = High

M = Moderate

2.00 = Medium

L = Low

1.00 = Low

(?) = Not seen

- = No data

IV. Sites Proposed for Putting the Hawksbill turtle Farming Project into Practice

It is difficult and still premature to determine the sites for conducting Hawksbill turtle farming experiments, basing on the data obtained through the current investigation carried out in a limited area. Table 13 shows the prevailing farming conditons arranged by areas after disregarding problems that may exist in universtigated areas.

Table 13 The previling Farming Conditions

Condition	Palau	Ponape	Truk
Cooperation of Government	+ + +	+ + +	+ + +
Medical facilities	+	+	+
Local scholar	+ +	-	-
Research facilities	+	+	-
Usefull institution	+ +	-	+
Supplies of adults for collecting eggs	No data	No data	No data
Collection of natural eggs	+ +	-	+
Collection of feeds	+ +	+	+
Natural feeds	+ +	+ +	+ +
Comparison of Division proposed for artificial turtle hatchery and farm	+ + +	+	+ +

1. The Republic of Belau

The Palau Islands are the largest in Micronesia, consisting of more than 200 islands in a sea area that is situated at 7°36' north and 134°30' east. A great barrier reef from Babelthuap Island (the main island of Palau) to Peleliu Island in the South or it extends over a distance of 140km in the direction from the north-northeast to the south-southwest. The islands stretching from north to south of the barrier reef, such as Palau main islands, Coror, Arakabesan, and Malakal, are all volcanic islands. The rocky mountain island and the islands extending to Peleliu Island in the South and Angur Island that is isolated at the south of the above islands are all made up of uplifted coral reef limestone to form a fringing reef.

It is said that the egg-laying sites of the Hawksbill turtle and Green turtle are located on the Ngaraangl atoll in the northern extremity of the Palau Islands, the rocky mountain island in the south of Coror, Nanajyu Island, Peleliu Island, and Angur Island. The results of the investigation and the 21 investigation sites are shown in the investigation data at the end of this report. In all these 21 sites, there was evidence to show that these sites had been used as egg-laying places, but it was only at six sites that we could find demonstrative proof of the fact because the time was not suitable for the investigation

we conducted and because of the pilferage of eggs. It is estimated that it is possible to collect 5,000 to 10,000 eggs if we collect them largely from the rocky mountain islands.

(1) Cooperation from the Government and People

President Belau (Japanese descent) made it clear that he would actively cooperate with us and try to promote the farming project. The mayor of Coror city, who held the additional post of the great chieftain of the South at the same time, also made it clear that he would cooperate with us in the project, expressing his idea of developing the farming facilities as a tourist attraction. The feeling of the ordinary inhabitants toward Japan is very good.

(2) Medical and Transport Facilities

In Coror City, there is a national hospital that is capable of giving general medical examination and treatment. For special treatment, patients go to Hawaii, the continental U.S., or Japan. A flight service is available either to Japan or to the United States by way of Guam.

(3) Research Installation (Usable Installation)

The Micronesian Marine Development Center (MMDC) is provided with land-rearing and laboratory equipment and sleeping accommodations for visitors.

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The Micronesian Marine Development Center (MMDC) is provided with land-rearing and laboratory equipment and sleeping accommodations for visitors.

(4) Research Worker on the Job Site

There is a research worker at the MMDC, who has had experience in artificial incubation and marked liberation of 6,000 turtles, so that joint research may be conducted.

(5) Supply of Parent Turtles for the Collection of Eggs

It is possible to secure parent turtles around the Helen Reef in the southwest of the Palu Island.

This reef is well known as a good habit for sea turtles and giant clams. Poaching boats from the Palu Island, Taiwan, and Indonesia are said to have been often seen off the coast of the reef. When we visited Palau to undertake the current investigation, we observed one poaching boat from the Taiwan and three or five poaching boats from Indonesia detained at the port of Palau after being captured around the Helen Reef. It can be seen from the photograph of seized Hawksbill turtles that a great variety of Hawksbill turtles, including small ones as well as large ones, are living in the water around the reef.

(6) Collection of Naturally Laid Eggs

Naturally laid eggs can be collected in an area within a distance of 23km from the cultivation site if they are collected with special stress laid on egg-laying sites of the rocky mountain islands. The number of

eggs that can be collected cannot be estimated without further investigation.

(7) Feed (Natural Feed - Feed Collection)

Sponges, natural food for Hawksbill turtles, are distributed abundantly around the Palau barrier reef. Fish intestines discharged in large quantities from a nearby dried bonito production plant can also be used as feed for Hawksbill turtles.

(8) Sites Peoposed for Putting the Cultivation Project into Practice

It seems quite reasonable under the conditions shown in Table to choose the inlet of Aulaptagel Island as the most suitable site for the cultivation, since the site is located within 5km of the institution and facilities related to the farming (such as the MMDC, the dried bonito production plant, etc.). The site is surrounded by rocky hills with a height over 60 meters with a water course open to the south. It looks confined at first sight, but the water in the inlet is excellent in quality since it is flushed by the tide. Water pollution can be prevented if proper care is given to the number of turtles cultivated there. The gross water area of the cultivation pond amounts to as much as approximately 800,000m². Each small bay can be readily isolated with a simple partition.

2. Micronesian Federal State -- The State of Truk

The Truk Islands are largest in the Caroline Islands situated from 7°25' to 7° 68' north and from 151°43' to 151°43' to 152°03' east to form a semi-great barrier reef with a diameter of approximately 60km. In the barrier reef, there are the Shiki Islands and the Nanayo Islands which are composed of 14 main islands. The bedrock of each of these islands is basalt. The depth of water in the barrier reef is approximately 60 meters. The exterior reef is studded with a great number of small islands having a sandy beach. The Kimijima Islands, made up of coral islands, are located in the southwest direction near the Truk Islands.

(1) Cooperation from the Government and People

As in the case of the Republic of Belau, the governor of the State of Truk said that he was ready to extend his cooperation not only to our on-the-spot investigation but also to the promotion of the actual farming project in the future. Because of the fact that the land area of all the islands of Truk, together with the sea area in contact with that portion, is in the possession of some private individual, he added, it may become necessary to obtain the cooperation as well as consent from the individual concerned, de-

pending on circumstances.

(2) Medical and Transport Facilities

Truk and Belau are exactly alike in respect of medical and transport facilities. In Truk, however, there is a State hospital in addition to a national hospital. Flight service is available to Japan by way of Guam and to Hawaii and the continental United States by way of Ponape.

(3) Research Installation

There are fishery facilities, but no cultivation facilities.

(4) Research Worker on the Job Site

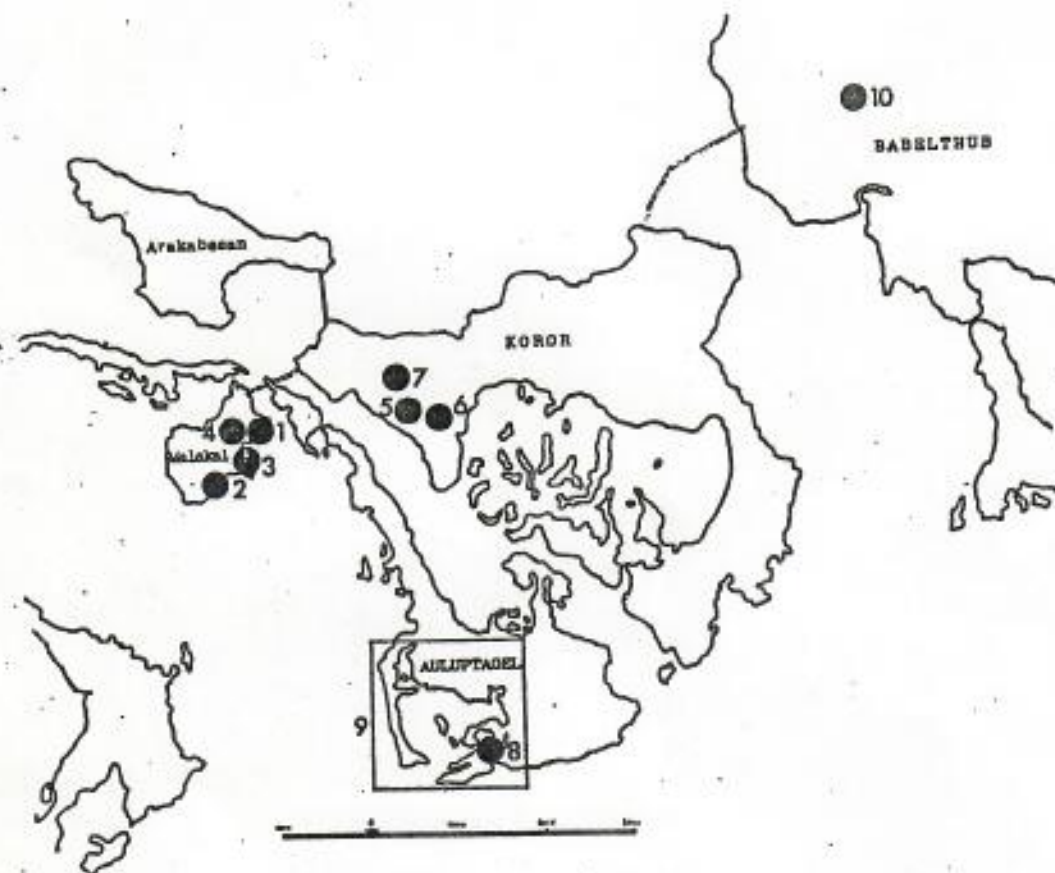
No.

(5) Usable Installations (Sites Proposed for the Actual Farming Project)

Four land concrete water tanks (38m²) constructed by the former Japanese army can be used. It is possible to partition the surface of the sea using the existing piers.

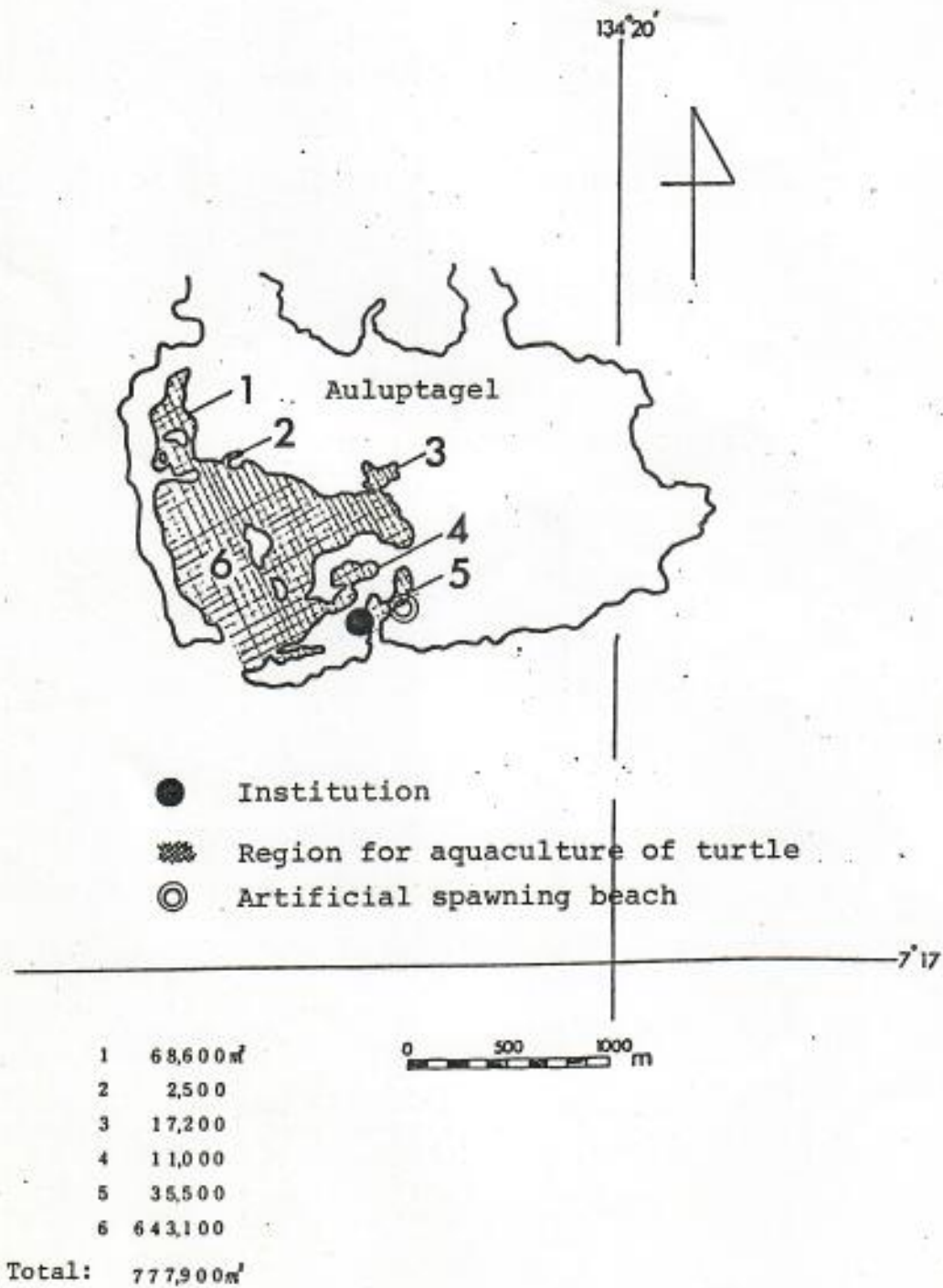
bay of Haru Island is divided at the center with a road. The circulation of seawater between the bay and the open sea is facilitated by the action of the tidal current every morning and evening, so that fresh sea water is always available in the bay to make it possible to cultivate turtles there. As a precaution,

Fig. 5 A site proposed for experimental aquaculture in Palau and Coror



- | | |
|--------------------------------------|--------------------------------|
| 1. Marine resource | 6. Natural conservation office |
| 2. MMDC | 7. Administrative office |
| 3. Palau fishery cooperative society | 8. A site propose |
| 4. Factory of dried bonito | 9. A region propose |
| 5. Hospital | 10. Palau national airport |

Fig. 6 A site proposed for experimental aquaculture of Hawksbill turtle at Auluptagal, Palau



however, further study is required.

It is also necessary to conduct further study on and around the islands surrounded by Suiyo Island, Mokuyo Island, and Kinyo Island.

(6) Supply of Parent Turtles for the Collection of Eggs

It is possible to secure parent turtles in the Truk atolls, but these are few in number.

(7) Collection of Natural Eggs

It is possible to collect a certain number of eggs in the Truk atolls, but further investigation is required.

(8) Food (Natural Food -- Feed Collection)

As in the case of Palau, sponges are available in large quantities. Fish intestines may also be obtained as feed, since bonito fishery is widely carried out.

3. Micronesian Federal State -- The State of Ponape

Ponape Island belongs to the Caroline Island, approximately 680km to the east of the Truk Island. This is a single island and the largest of all the Caroline Island. It has an area of 490km² and a length of 25km from east to west, the bedrock of which is basalt. There is only a small sandy beach on a small area of land along the exterior reef of the island which is thickly covered with

mangroves. Coral reefs encircling the island, especially thick on the south and west sides, form a barrier reef. There are two coral islands in the vicinity of Ponape; Island in the east and Ant Island in the south-east.

(1) Cooperation from the Government and People

They have said that they were ready to give their cooperation to our project, though the President was away when we visited.

(2) Medical and Transport Facilities

As in the case of Truk, there is a State hospital. Flight service is available to Japan by way of Truk and Guam and to Hawaii and the continental United States by way of Majuro.

(3) Research Installation

As in the case of Truk, there are fishery facilities but no cultivation facilities.

(4) Research Worker on the Job Site

There is a research worker, who has experience in artificial incubation and liberation of green turtles on Satawal Island and who is now the chief of the Marine Resources Bureau. He has been undertaking the task of teaching fishery. He showed a keen and active interest in the farming of Hawksbill turtles.

(5) Usable Installation

No.

- (6) Supply of Parent Turtles for the Collection of Eggs
They say that many eggs are laid on Oroluk Island in the northwest of Ponape, though this has not been confirmed. They also say that Green turtles exceed the number of Hawksbill turtles caught.

(7) Collection of Naturally Laid Eggs

A certain number of naturally laid eggs may be collected on Oroluk Island, but few or none on Ponape.

(8) Food (Natural Food -- Feed collection)

As in the case of Palau and Truk, sponges are available in large quantities. An investigation on the collection of feed will be made next time.

(9) Sites Proposed for Putting the Cultivation Project into Practice

No existing facilities for this purpose are available, but new ones can be built by making use of barrier reefs around the island.

V. Settlement

1. Hawksbill Turtle Habitats and Resources in Micronesia

There are four types of sea turtles living in Micronesian waters, but those which are generally accepted as real sea turtles by the natives in this region are only two, that is, the Hawksbill turtle known as the tortoise-shell turtle and the Green turtle known as the large sea turtle.

Hawksbill turtles are living in great number in West Caroline and Marshall, in considerable number in East Caroline, and in small numbers in Central Caroline.

Green turtles are found in great numbers in Central Caroline and Marshall and in considerable number in Central Caroline and East Caroline.

Legally speaking, both Hawksbill turtles and Green turtles are under the protection.

No statistical data on the catch of sea turtles are available for the period after 1941. It is impossible, therefore, to quantitatively understand sea turtles as natural resources. According to the natives, the catch of sea turtles is on the decrease. The reasons for this are mentioned as follows: the migration of people from principal island to outlying islands (to which sea turtles come up to lay eggs) as a result of a steady growth in population, an increase in egg pilferage, spread of

fast-sailing ships and speed boats, excessive turtle hunting with the use of highly developed new implements, and an increase in poaching by foreign fishing boats.

2. dispersing and Homing of Hawksbill Turtles

Why does the scattering in habitat of sea turtles arise as in the description given above ? It may be a key to the solution of this question to clarify the dispersion and settlement of hatched young turtles. Some small groups repeat a cycle of egg-laying - hatching - growing on and around a certain island in a fixed area. Other groups may repeat the same cycle in a vast area, including Philippines and Mindanao located to the west of and New Guinea located to the south of Micronesian Waters.

The relation between the egg-laying islands scattering in the vast area and the marine currents running in Micronesian Waters naturally claims first consideration. It is assumed that the main current in this vast area, such as the Equatorial countercurrent running eastward in the vicinity of the equator in Micronesian Waters and the Mindanao current passing the east side of Philippines and Mindanao and running southward to reach the Equatorial countercurrent, may have transported parts of young turtles hatched on Philippines and Mindanao over a long distance to Micronesian Waters. this should be proved by

a marked liberation. Iriewani (crocodiles) and dugongs living for many years around the Palau Islands in Micronesia are sea life that have been transported over a long distance by marine currents. This is also a key to the solution of the question mentioned above.

3. Growth and Excessive Hunting of Hawksbill Turtles

Experimental farming of Hawksbill turtles in Micronesian, Southeast Asian, and Japanese Waters has revealed that hatched young turtles grow in one year to a size of 20cm in shell length and in two years to a size of 30cm in shell length, but no steady growth is recognized afterward.

In the lagoons of Micronesian islands, newly hatched young turtles and immature turtles more than 30cm long can be found but young turtles about one year old can rarely be seen. Newly hatched young turtles succeeded in reaching the sea may be washed away by strong tides from a lagoon to the open sea through a waterway. Then, they will probably find their way to another lagoon and settle there. When they grow to be immature turtles 40 to 50cm in size, they will be caught by natives and used for food. This size, 40 to 50cm, is said to be most suitable for catching. The shell size of the Hawksbill turtles caught so far tells a great deal about this.

The excessive hunting of immature turtles is seen in Palau and Truk in particular.

4. Protection of the Eggs and Immature turtles of Hawksbill Turtles

during the period of nearly 40 years when the region has been under American trusteeship, the program of industrial buildup by the inhabitants of the islands in the region has made very slow progress. In marked contrast to this, progress this in relation to sanitation and consumer economy is enormous. such a contrast in progress can be seen in each main island of each administrative district. However, the inhabitants of other outlying islands, including Minamoto island of the Truk Islands, have been still living a hunting life for the past four decades as their forefathers did in the past when the region was in Japanese possession.

In principle, sea turtles are under the protection of the Trusteeship Regulations. However, utter disregard of the Regulations, lack of the spirit of resources conservation, and locally-preserved, time-honored eating habit have led to the excessive hunting of immature turtles. "Ishi-yaki" a cooking method transmitted from generation to generation in East Caroline tries far as to burn down the shell of Hawksbill turtles. It seems very

difficult to prohibit the continuation of such locally-preserved eating habit. The adoption of a supervisory structure, a disciplinary punishment, and an educational campaign in combination may be a good, workable idea. The most effective method for the conservation of Hawksbill turtle resources is to collect as many eggs as possible through of artificial incubation and liberation. Under certain conditions, friction may be produced between the party concerned and local inhabitants in connection with the collection of eggs. It may be possible to avoid such friction by working in close cooperation with competent personalities (such as the President, Governor, Mayor, and key persons concerned who promised to lend their help) after selecting appropriate spots to collect eggs.

Once this cultivation project is successfully carried out, Hawksbill turtles in Micronesian Waters may be increased abundantly so that their shell can be used on a commercial basis and, in addition to that, a thinning-out hunting of Hawksbill turtles may become possible.

5. Problems in the Future

(1) Protection Measures

It is the matter to be solved by the Republic

Belau and the Deferal State of Micronesia whether these states accept the "Treaty concerning the International Trading of Wild Animals in Danger of the Extinction of a Species" geneally known the Treaty of Washington.

When the Trusteeship Regulations are to run continuously for the purpose of controlling the catch of sea turtles, it is necessary to strengthen the supervisory structure and promote the educational campaign for resources conservation.

(2) Investigation on the Ecosystem of Hawksbill Turtle as resources

Investigations on the number of eggs possibly collected should be conducted in the following areas, especially during the spawning season, with cooperation obtained from the interested parties on the spot.

Republic of Belau

The rocky mountains islands (in Palau's barrier reefs, the Ngaraangl atolls, and the Tobi Islands

Federal State of Micronesia

Ponape and the Central Caroline Islands

6. Conclusion

Judging from all the conditions mentioned above,

a most suitable place for an investigation in the nearest future possible seems to be the republic of Belau. It is estimated possible to collect 5,000 to 10,000 eggs there. This cultivation project should be gradually promoted from start to finish. First, it is necessary to draw up an enforcement plan with regard to experimental farming, follow-up surveys in coral reefs, marked liberation, and adult turtle rearing, together with a budget estimate, and carefully examine it before exhibiting it to the authorities on the spot.

PROPAGATION OF GREEN TURTLES

- The present Condition and Future -

by Yoji Kurata

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It was very long time ago that the human race began to eat sea turtles. Even now people eat sea turtles in the subtropical and tropical sea areas whether in the West or in the East. When Columbus sailed the Atlantic in 1503, he observed large schools of sea turtles swimming in the Caribbean Sea and the natives there eating them.

In Japan the bones of eaten turtles are unearthed from shell mounds or other places in the coast, and there is an old record that the Japanese who first immigrated to the Ogasawara Island in 1853 made the turtle hunting their principal occupation.

It goes without saying that of seven species of sea turtles in the world green turtles are most important as food and also most delicious. Therefore the penetration shown by the Ministry of Agricultural Commerce of Japan's officials who carried out a project for the artificial incubation and release of these green turtles in the Ogasawara Island in 1910 should be highly admirable. If such a project had been carried out on an international scale in prewar days, there would not have been such decrease of green turtle resources as seen today in the Pacific.

There are two ways to make green turtles additional animal protein resource in Japan or in the world.

One way is an artificial incubation and release project which is usually put into practice to propagate marine living things. The rapid propagation of green turtles would certainly be possible if widely migrating green turtles were protected on an international scale under uniformed protective regulations. Natural feeds supporting sea turtles' lives are jellyfish resources in the distant offing and mainly red algal -- material for agar-agar -- and other algal such as brown algal and green algal in the coastal seas. It is difficult to exactly estimate the amount of such algal as turtles' feeds. However, since the amount of algal for agar-agar production in Japan is 200,000 tons, about twice that amount of them can be expected including the amount of them left behind. If you know that the amount of feed required per day to raise a sea turtle is less than 5 % of its weight, you can easily guess how heads of sea turtles can be naturally propagated in the seas near Japan.

The other is the cultured fishery. Like carp and prawn, sea turtles can be throughly raised. This has already been proved by the great achievement of Mariculture, Inc. in Cayman Island of Caribbean Sea in the Atlantic Ocean. At present, 60,000 head of sea turtles are breded there and adult turtles entirely raised there have started to lay eggs. And cultured turtle meat produced by this Company is being supplied to the

Japanese market of breeding project are exactly identical to an idea entertained by the present writer. I am very much chagrined that they went ahead of me on this project, but I would like to praise their great achievement from the bottom of my heart. Regrettably there was a blank period of 28 years in the histories of Japan's administration of the Ogasawara Island because of the delayed return of these island to Japan. The study of sea turtles started soon after the war by Dr. Archie Carr at the University of Florida bore fruit in 1974.

Since the return of the Ogasawara Island to Japan, small scale experiments on artificial incubation, raising, and release had fragmentarily been made for four years. In 1973, however, Fisheries Center was opened in the Ogasawara Tokyo Metropolitan Government Branch Office and experiments on turtles were conducted throughout the year for the first time. The number of turtles raised during one year is 500 head, and experimental results on their nesting, artificial incubation, raising, and release have been steadily accumulated. Its final conclusion is as follows:

A seed supply center must be established in Ogasawara, the only nesting place in Japan now. The most suitable place for this center is Suzaki, the site of the defunct Imperial Navy's airfield in Chichijima. Yearlings produced here can be raised at the southern Pacific coast of Japan as

a side job of fishing village or as a private undertaking in fishermen's cooperative association. And it is also possible to raise them using warm drainage from thermal power plants in all over Japan. In the future, a seed supply center of which scale is equal to or larger than that of Ogasawara's should be built in Ikinawa and seed supply and release should be conducted from there, too. Also in future, seeds will be supplied to Southwest Asia, Micronesia, Polynesia, and Melanesia, and the improvement of breed by crossbreeding with turtles in the Atlantic will be tried. Besides that, technical guidance for seed production and the expansion of facilities in the southern regions will be planned.

If sea turtles are placed on the production line in this way, they can be utilized as animal protein for not only Japanese but also many other people in the world. This possibility depends on the wisdom of the Japanese. For the present, there seem to be little possibility as a Japanese diet. But sea turtles are marine animals which are likely to become popular food, depending on the system of research and development. Therefore, positive research and development should be set forward. I hope that those who strive for the ocean development will give a thought to this suggestion.

図1 図 アオウミガメを併設する
火力 発電所の冷却水用水
経路(図中のABCDは制流水門)

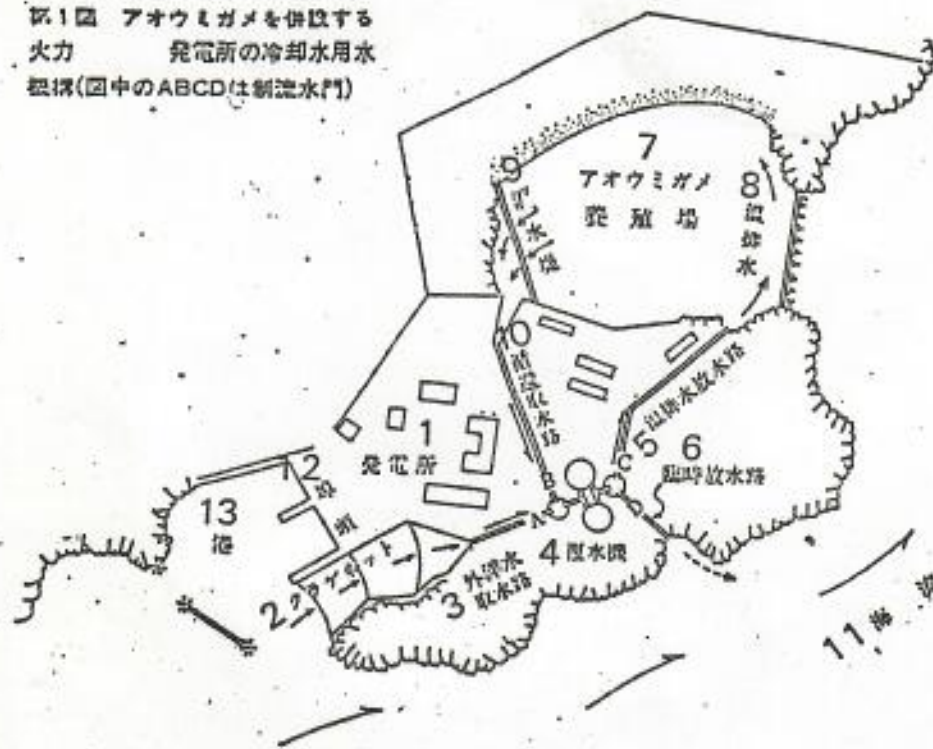


Fig. 1 The structure of cool water system in thermal power station along with green turtle's farm.
(ASCD in a figure are control water gates.)

1. Power station
2. Jellyfish net
3. Intake waterway for the open sea water
4. Pump of returned water
5. Drain waterway of hot water
6. Extra drain waterway
7. Breeding farm for green turtles
8. Hot drain
9. Filter bank
10. Circulation waterway
11. Ocean current
12. Wharf
13. Harbor

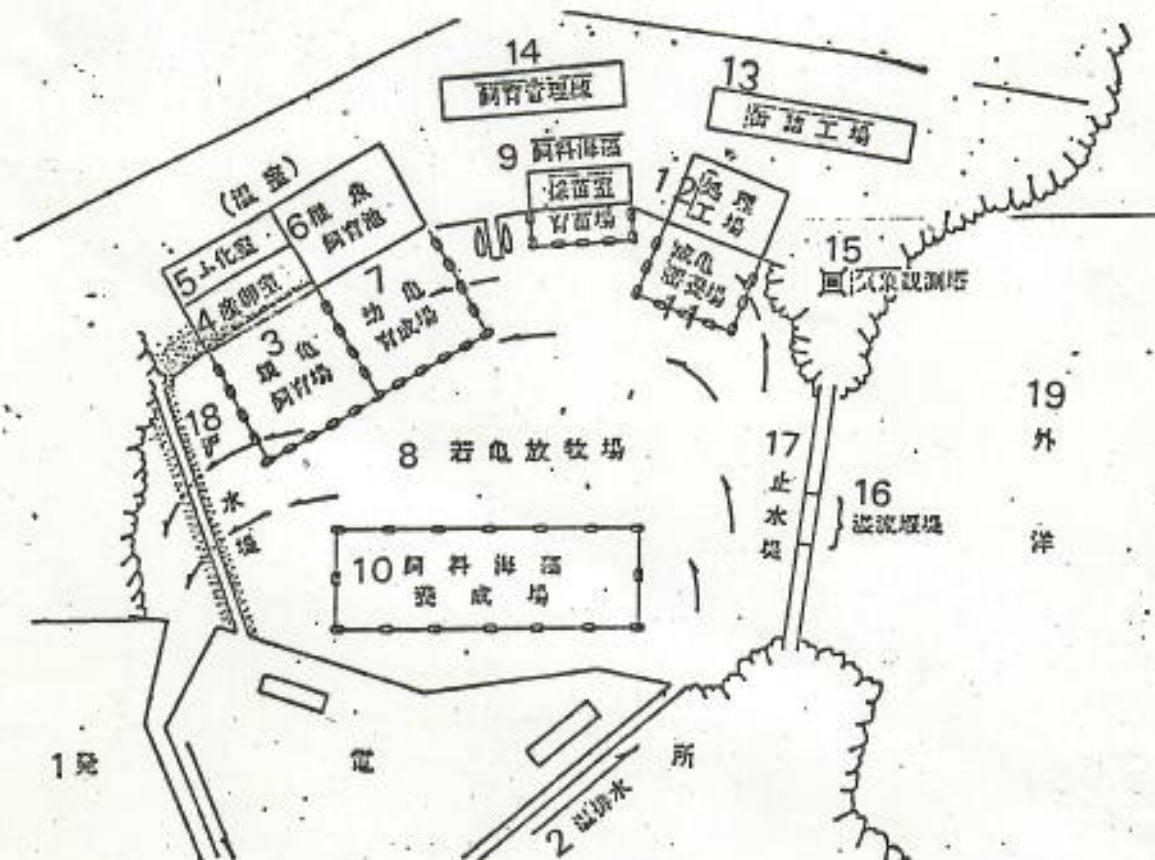


Fig. 2 The arrangement of institution for green turtle's aquaculture farm which belongs to the thermal power station.

- | | |
|--|-------------------|
| 1. Power station | 16. Overflow bank |
| 2. Hot drain | 17. Stem bank |
| 3. Breeding pond for adults | 18. Filter bank |
| 4. Artificial nesting beach | 19. The open sea |
| 5. Hatching room | |
| 6. Tank for hatchings | |
| 7. Breeding pond for juveniles | |
| 8. Breeding pond for subadults | |
| 9. Breeding pond for seed of sea-weeds | |
| 10. Cultivating pond of sea-weeds | |
| 11. Breeding pond for adults | |
| 12. Processing factory | |
| 13. Canning factory | |