A Preliminary Study of the Sea Turtles in The Gulf of Thailand

by

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Preface

The author would like to make it clear at the beginning that he is neither a biologist nor a zoologist. This preliminary study on the Sea Turtles was just an attempt made by the author merely to satisfy his curiosity. Information and conclusion contained in this paper may therefore in some parts be conflicting or misleading.

The author would like to express his sincere thanks to Lt. Comdr. Swarng Charoenphol who was very helpful in explaining many technical terms and also in collecting information on sea turtles at Ko Kra. Thanks also due to Dr. Tom Harrisson of Sarawak Museum and Dr. Hendrickson of the University of Malaya, from both of whom the author was given many valuable information. A study on the biological development of various stages at exact age would not be possible without the kind cooperation from Prof. Sudh Sangvichian of Siriraj Hospital to whom full credit should be given for his artificial hatching of the turtle's eggs and also for his photographs of embryos.

Abstract

A preliminary study of the Green Turtle (*Chelonia mydas*) and the Hawksbill Turtle (*Eretmochelys imbricata*) at Ko Kram and Ko Kra, made during the years 1956-57, of their

1. a paper presented at the Ixth Pacific Science Congress, Bangkok, Nov. 1957.

breeding and embryological development, including their distribution in the Gulf of Thailand.

1. Introduction

The collecting of turtle eggs in Thailand can hardly be called an industry. Nevertheless, there is a high market demand for these eggs which usually fetch about twice the price of hen's eggs.

Prior to 1950 the egg collecting was done by private individuals who applied for the right to collect in a given area and, if the application was successful, were required to pay a considerable sum as revenue to the Department of Fisheries.

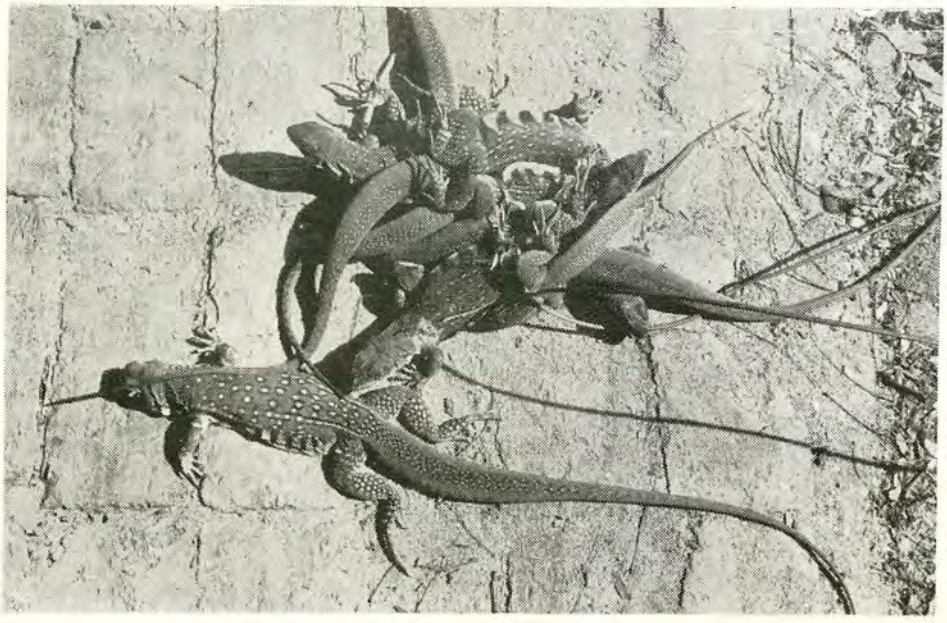
The terms of the collecting license require the licensee to allow the hatching of a certain number of young turtles each year, but it is somewhat doubtful whether the figures reported by the licensees were in fact accurate.

In some areas within the Gulf of Thailand the Green Turtles are slaughtered for meat and the Hawksbill Turtles are captured for their ornamental scutes, or "tortoise shells". It is feared that uncontrolled slaughtering and capture may in fact lead to a serious decrease in the population.

There have been few observations concerning the habits and development of sea turtles in the Gulf of Thailand, and the only information on record is the statistial compilation derived from the licensed eggs collectors.

Considering the large size of the Gulf of Thailand, it is fortunate that the concentration of Sea Turtles occurs on the small beaches of some islands which are under the control of the Naval Training Station at Sattahip (see chart). Three years contract was granted by the Department of Fisheries to the Navy for the right of colllecting turtle eggs on these islands, and after the expiration of this a new contract was duly granted. There is also an agreement to keep aside 30% of total profit from the sale of turtle eggs to be used as a fund for the study of the Sea Turtles.

One of the beaches at Ko Kram, which are frequented by Sea Turtles.



Inhabitants of Ko Kram, *Liolepis belliana* (*Gray*)

Digging one of the nests for eggs.

The Oceanographic Division of the Hydrographic Department has kept a permanent staff of collectors on one island, Ko Kram, and the rest are subcontracted to private individuals under the supervision of its staff. Even being aware of the need to make a systematic study of its nature and development with a prime objective of increasing the population of the Sea Turtles, the work was not started until the beginning of 1956, partly owing to the lack of scientific staff and also of facilities for carrying out the study.

During the past two years a preliminary study has been made according to the plan outlined below:

1. To collect information pertaining to the distribution and breeding of sea turtles in Thai waters.
2. To collect egg specimens, embryos and live specimens of both young and adult.
3. To study the breeding season.
4. To study the embryological development.
6. To make a census of the turtle population by tagging.
6. To study their migration.

Owing to the lack of personnel specially instructed to make field observation, only some parts of the plan could be carried out. The belief that the Sea Turtles if disturbed, when coming on to the beach to lay eggs, will not come there again, also prevented us from tagging them as planned. A new four years project has been made for an extensive study of the Sea Turtles in Thai waters, inclusive of census by tagging. Future study will need full collaboration with other institutions which have similar interests, such as Sarawak Museum and the University of Malaya.

2. Distribution

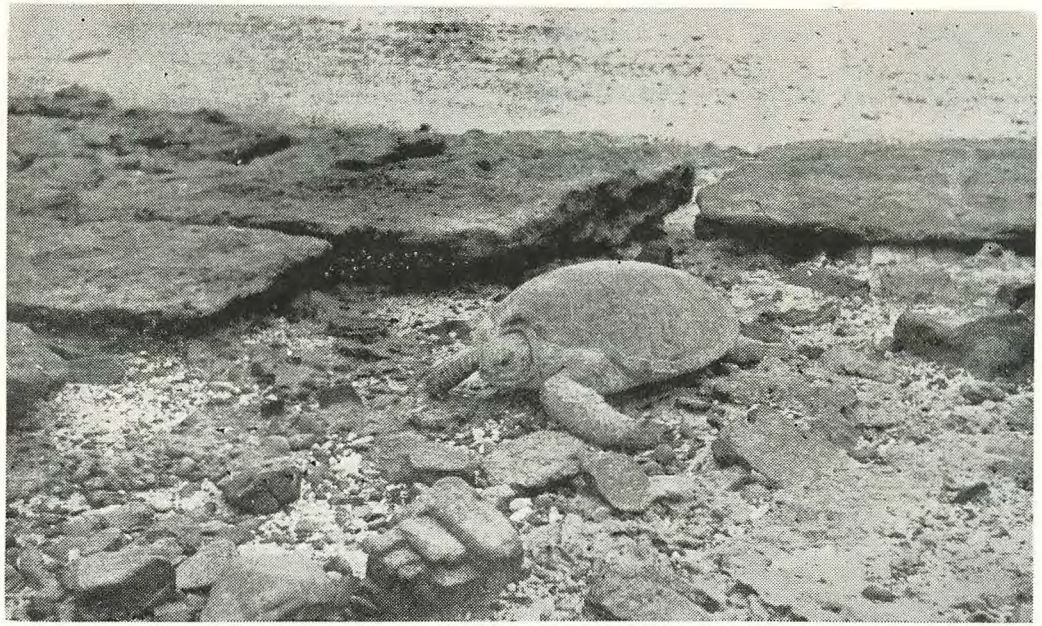
Sea turtles could be found almost on all sandy beaches along both coasts of the Gulf of Thailand. They are also found occasionally in off-shore areas. However, within the Gulf of Thailand there are two locations which have a high concentra-

tion of sea turtles. The first one is at Ko Kram whose shore is mostly surrounded by sandy beaches and with coral reefs in the foreshore area. The second one is at Ko Kra, a small isolated island about 40 miles from the shore, with few small sandy beaches and typical coral reefs in the foreshore area. So far it has been found that in the Gulf of Thailand there are only two species. They are the Green Turtle (*Chelonia mydas*) and the Hawksbill Turtle (*Eretmochelys imbricata*). At Ko Kram information shows that the ratio of the Green Turtles to the Hawksbill is as high as about 4 to 1, while at Ko Kra it is estimated to be only 5 to 3. Loggerhead Turtles were also reported but the information has not been verified, and during the last two years none have been found.

It would not be out of place to also mention the distribution of sea turtles in the Pukhet area (on the eastern coast of the Malay Peninsula). Information gives an indication of the existence of four species, but only three could be identified from the local names given to those three. They are Green Turtles, Hawksbill, and Leathery Turtles. The remaining one is called Red Eyes Turtles which likely is the Loggerhead turtle. Specimens are not available and only egg specimens of the Leathery Turtle were received. Other egg specimens of smaller size were also sent to us, but there is no identification whether they are Hawksbill Turtle's eggs or the unknown turtle's eggs. Future programme includes extensive study of sea turtles in this area in order to settle this point.

Accompanying chart shows distributions of sea turtles in the Gulf of Thailand as well as in Pukhet area.

The sizes of Green Turtles coming up onto the beach at Ko Kram range from 75 cm. to 105 cm., and of the Hawksbill range from 55 cm. to about 90 cm.



Green Turtle (*Chelonia mydas*)

Track of turtle on beach

3. Laying Season

Information collected during the last two years is still meagre, but it leads to a conclusion that there is no restricted laying season for the sea turtles in the Gulf of Thailand. Records of numbers of eggs collected on various beaches at Ko Kram (see chart) during the past few years show that the sea turtles lay in every month of the year. Tables I and II, show respective numbers of Green Turtle's and Hawksbill Turtle's eggs collected on fourteen beaches in each month of 1956. The monthly total number of eggs of both collected indicate a corresponding peak in June. Diagram showing number of eggs collected each month from 1955 to 1957 also shows that the three peaks lie in different month. However, it may be assumed that the peak laying season at Ko Kram starts from March to September with peak around June. The records also show that the Green Turtle and Hawksbill Turtle around Ko Kram has the same laying season. At Ko Kra from which information tends to lead to a conclusion of having a definitive laying season from December to February. Since Ko Kra is an isolated island and it is therefore impossible to assign collectors to this island longer than a short period of a few days unless one vessel be stationed there. Most information came from interviews with fishermen of small vessels occasionally taking shelter there. Information on sea turtles in Pukhet area (on the eastern coast of the Malay Peninsula) indicats that the peak season starts from December to January, which closely corresponds with the peak season at Ko Kra. The laying season of sea turtles in Pukhet area usually starts from October to April, but they also lay occasionally during the other months of the year. The author is still of the opinion that sea turtles have no definite laying season. However, after further study it may be possible to find that the sea turtles in the Gulf of Thailand have two breeding

grounds and two seasons or that they change their breeding grounds according to the monsoon.

It would be worth while to mention the breeding season of sea turtles in Sarawak, whose statistics show that they also lay in every month of the year. It is also shown that in 1950 the peak season started from April or May to November.

The peak laying season of sea turtles, which differs from area to area, may have some bearing on the condition of the sea, which changes according to the prevailing wind and the feature of the coast. Whether the sea turtles of different species frequenting the same area have the same laying season is still to be investigated.

4. The Nests

During the past five or six years the turtles came onto the beaches to lay only in dark hours; also occasionaly but according to previous reports they laid in day time. This may be from the fact that after we had assigned collectors to various beaches and our motor launch had to visit these beaches every day to collect eggs and supply fresh provisions, they were scared away.

Usually the oviferous turtle will emerge from the sea during the high tide and select a suitable place for her nest, which in most cases is just beyond the high water line. She will start digging the hole. If the wall of the hole collapses owing to the low percentage of moisture content of the sand, she will select other places and again test the sand. If the tests indicate that the sand is too dry, she will then turn back in to the sea. At this point, it should also be noted that the peak laying season at Ko Kram corresponds to the rainy season.

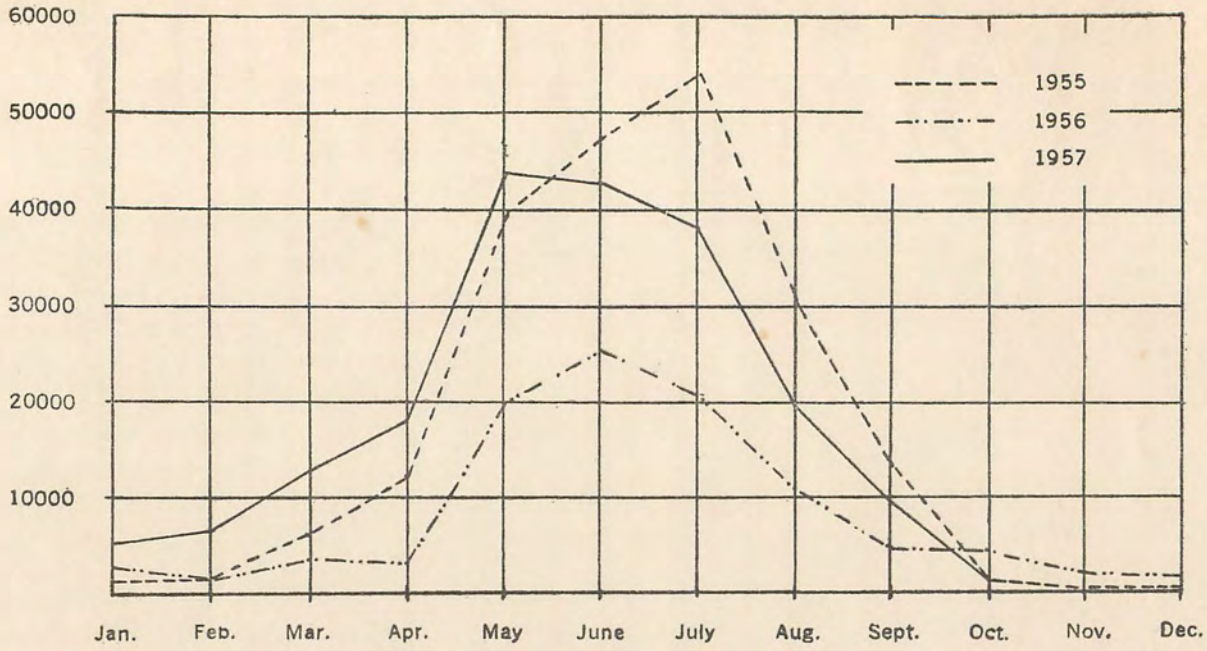
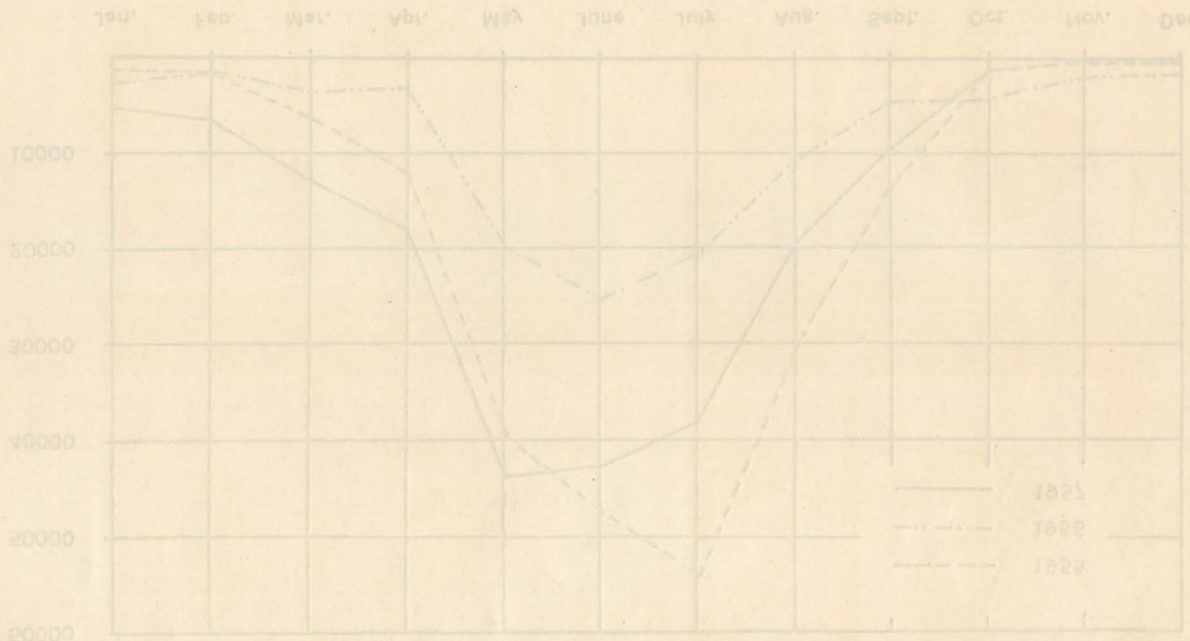


DIAGRAM SHOWING MONTHLY AMOUNTS OF EGGS COLLECTED AT KO KHRAM DURING THE YEARS 1955 TO 1957



14 days 22 $\frac{1}{2}$ hrs.

16 days $\frac{1}{2}$ hrs.

16 days 20 $\frac{1}{2}$ hrs.

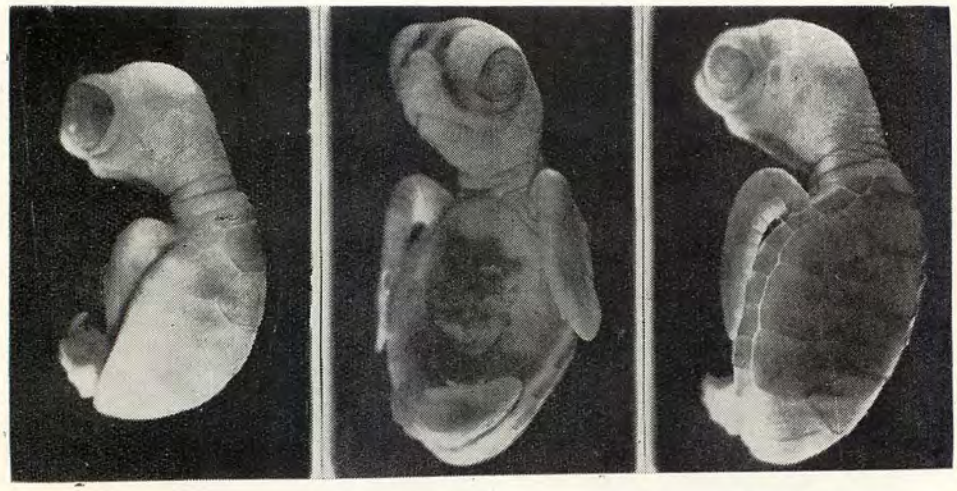
18 days 19 $\frac{1}{2}$ hrs.

19 days 21 $\frac{1}{2}$ hrs.

20 days 22 hrs.

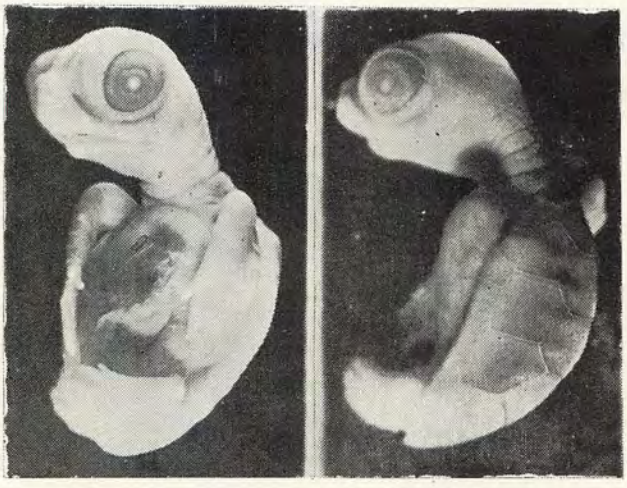
21 days 18 $\frac{1}{2}$ hrs.

22 days 22 hrs.



23 days 21 $\frac{1}{2}$ hrs. Ventral view Dorsal view

Age: 25 days 19 hrs.



Ventral view Dorsal view

Age: 26 days 20 $\frac{1}{2}$ hrs.

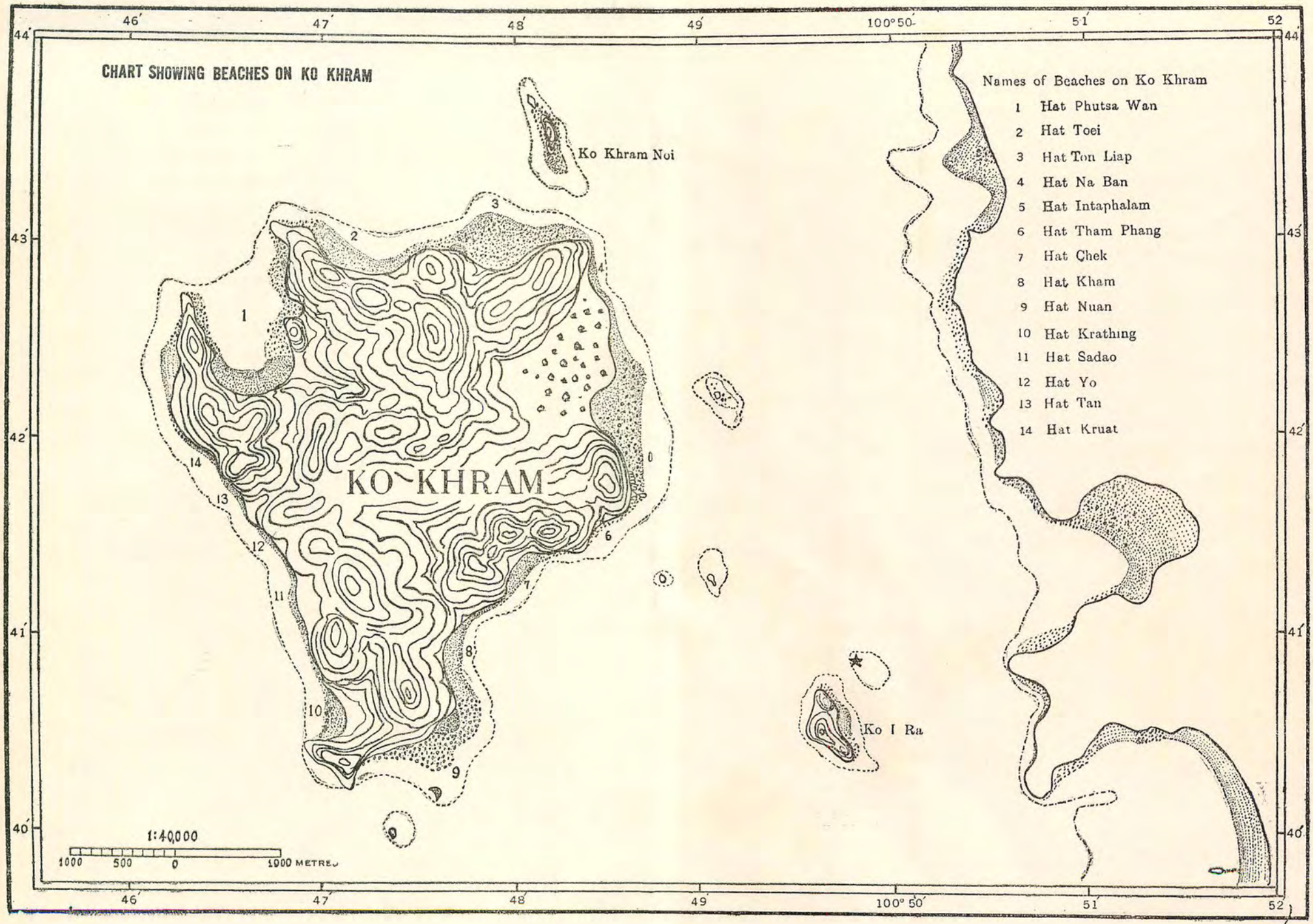


CHART SHOWING BEACHES ON KO KHRAM
Names of Beaches on Ko Khram
1 Hat Phutsa Wan
2 Hat Toei
3 Hat Ton Liap
4 Hat Na Ban
5 Hat Intaphalam
6 Hat Tham Phang
7 Hat Chek
8 Hat Kham
9 Hat Nuan
10 Hat Krathing
11 Hat Sadao
12 Hat Yo
13 Hat Tan
14 Hat Kruat
Ko Khram Noi
KO KHRAM
Ko I Ra
1:40,000
1000 500 0 1000 METRES
46′ 47′ 48′ 49′ 100°50′ 51′ 52′
44′ 43′ 42′ 41′ 40′

The nest hole is about from 25 to 35 cm. wide and from 60 to 80 cm. deep. A small amount of mucus will then be discharged to the bottom of the hole and after that the eggs will follow. The mucus may be a kind of protective coating to prevent excessive moisture in the sand. However, if the nest is flooded all the eggs will be spoiled. At Ko Kra, many nests were found flooded with sea water. It is also observed that the sand on the beaches at Ko Kra is finer than that of beaches at Ko Kram. This may be the reason why the depths of most nests found at Ko Kra are shallower than those at Ko Kram.

The total number of eggs in one nest usually ranges from 70 to 130.

5. The Hatch

Development varies with the heat of the sun. At Ko Kram the eggs are hatched in 45 to 50 days. The heat from the sun penetrates the sand and affects the upper eggs more intensely than the lower ones, and thus a period of 24 to 48 hours elapses between the exit of the first and the last turtlet from the nest; hatches of 90% or more could be expected at Ko Kram.

6. Embryological Development

Embryos at various stages were collected from the nests for studying purposes. Artificial hatching was also attempted by Professor Sudh Sangvichian of Siriraj Hospital, to whom the author is highly indebted for his kind assistance. Embryos from artificial hatching at various stages were also studied by the author. The temperature of the incubator was automatically controlled, but the moisture content of the sand continually varied. This might be the cause of the variations in the developments of embryos of the same stage. However, comparison had also been made between the embryos hatched naturally and artificially. It was found their linear dimensions were very close except in some cases the natural ones were slightly stouter.

Embryos at various stages resulting from artificial hatching were as follows:—

6.1 Age 14 days 22 ½ hours.

Dimensions were as folows:

Total length (curved)	13 mm.
Carapace length	5 mm.
Carapace width	4 mm.
Length of head	4 mm.
Width of head (including eyes)	4 mm.
Length of orbit	2 mm.
Fore limb	1 mm.
Hind limb	1 mm.
Tail length	2.5 mm.

At this stage the columella auris was distinct. Eyes were globose and prominent with very feeble annular eyelid. Genital organ already developed and recognizable. Posterior limbs did not touch the tail which was elongated with a small terminal kink. The plastron was ill defined. The carapace had each lateral margin defined as a ridge which was separated from the other by a cleft. The limbs possessed terminal discs. Embryos of this stage were poorly proportioned.

In comparison with embryos from natural hatching, it was found that the development was slightly advanced.

6.2 Age 16 days ½ hour.

Dimensions were as follows:

Total length (curved)	14 mm.
Carapace length	10.5 mm.
Carapace width	5 mm.
Length of head	4 mm.
Width of head	4 mm.

Table 1. Number of Green Turtle's eggs collected on various beaches of Ko Kram in each month of 1956.

Month	B E A C H E S																										Total Monthly	
	1. Poodsawan		2. Taey		3. Ton Liab		4. Na Ban		5. Intapalum		6. Tham Pang		7. Check		8. Kham		9. Naul		10. Kra Ting		11. Sadao		12. Yor		13. Tal		14. Kruat			
	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs
January	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	80	2	157	4	385	–	–	–	–	–	–	7	622
February	–	–	–	–	–	–	–	–	–	–	–	–	1	75	–	–	1	75	–	–	–	–	–	–	–	–	–	–	2	150
March	–	–	2	229	–	–	–	–	–	–	–	–	2	180	3	276	3	275	5	508	1	110	–	–	1	118	–	–	17	1696
April	–	–	1	119	–	–	–	–	–	–	1	115	5	534	3	335	1	95	4	378	4	443	–	–	–	–	–	–	19	2019
May	–	–	7	800	–	–	–	–	1	93	12	1352	17	1945	28	2876	12	1295	39	4104	21	2309	1	100	1	100	–	–	139	14974
June	6	536	13	1346	1	80	1	80	1	95	20	2051	23	2267	29	2947	13	1325	66	6884	28	2879	3	245	1	190	1	14	206	21039
July	18	1747	1	103	1	60	–	–	1	105	7	718	22	2197	27	2817	12	1191	55	5636	28	2777	10	1033	2	180	–	–	184	18564
August	5	443	3	298	7	710	3	250	–	–	9	905	15	1667	8	752	14	1295	16	1525	28	2458	–	–	3	312	–	–	111	10615
September	2	250	–	–	–	–	1	90	–	–	3	288	8	776	2	145	5	410	1	85	13	1108	1	95	5	450	–	–	41	3697
October	–	–	–	–	–	–	–	–	–	–	3	370	3	307	11	160	3	238	7	502	6	575	–	–	–	–	–	–	33	2952
November	–	–	–	–	–	–	–	–	–	–	1	95	4	389	6	502	–	–	8	622	1	110	–	–	–	–	–	–	20	1718
December	–	–	1	72	–	–	–	–	–	–	–	–	1	110	2	140	1	105	5	445	1	102	–	–	1	83	–	–	12	1057
Total yearly	31	2976	28	2967	9	850	5	420	3	293	56	5894	101	10447	119	11750	66	6384	208	20846	135	13256	15	1473	14	1433	1	14	791	79102

Table 2. Number of Hawksbill's eggs collected on various beaches of Ko Kram in each month of 1956.

Month	B E A C H E S																										Total Monthly	
	1. Poodsawan		2. Taey		3. Ton Liab		4. Na Ban		5. Intapalum		6. Tham Pang		7. Check		8. Kham		9. Naul		10. Kra Ting		11. Sadao		12. Yor		13. Tal		14. Kruat			
	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs	Nests	Eggs
January	–	–	–	–	3	316	–	–	2	230	3	362	2	240	–	–	4	415	2	237	2	205	–	–	–	–	–	–	18	2005
February	–	–	–	–	1	210	–	–	1	170	–	–	2	235	–	–	7	893	–	–	1	85	–	–	–	–	–	–	12	1593
March	–	–	2	234	3	377	–	–	2	216	–	–	1	133	3	381	5	560	1	112	–	–	–	–	1	117	–	–	18	2130
April	1	110	1	136	–	–	–	–	1	161	1	139	2	270	1	105	1	125	–	–	1	105	–	–	–	–	–	–	9	1151
May	–	–	2	215	4	489	3	380	5	561	1	130	2	230	3	365	6	725	2	223	5	554	2	255	4	495	1	120	40	4742
June	8	906	11	1305	6	664	2	230	5	548	2	250	1	110	1	120	9	1025	1	105	7	820	4	450	4	435	–	–	61	6968
July	4	380	–	–	4	507	–	–	1	105	2	250	1	85	4	525	6	775	1	145	7	771	2	210	4	420	1	145	37	4318
August	–	–	1	80	3	299	–	–	–	–	–	–	–	–	1	125	5	445	–	–	3	325	–	–	2	220	–	–	15	1494
September	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	120	1	76	1	83	–	–	3	279
October	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	75	–	–	2	225	–	–	–	–	–	–	–	–	3	300
November	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
December	–	–	–	–	–	–	–	–	1	107	–	–	4	427	–	–	3	330	–	–	–	–	–	–	–	–	–	–	8	864
Total yearly	13	1396	17	1970	24	2862	5	610	18	2098	9	1131	15	1730	14	1696	46	5293	9	1047	27	2985	9	991	16	1770	2	265	224	25844

Length of bridge	6 mm.
Length of orbit	3 mm.
Fore limb	2.5 mm.
Hind limb	2.5 mm.
Tail length	5 mm.

At this stage, which was about 26 hrs. later than the former, the dimensions had changed considerably. Total length was only slightly increased, but the carapace length had been extended to double of the former, and the vertebrae were wider than long. The two iliac prominences had disappeared. Carapace scutes were not very well defined. The annular lid covered a little more of the eyeball than before. The snout was stronger and the lower jaw was relatively slightly larger and failed to close the aural opening. Columella auris was slightly less distinct. Head and tail flexed to the plastron.

6.3 Age 20 days 22 hours.

Two embryos of the same stage were studied, and their dimensions were as follows:

	A	B
Total length (curved)	15 mm.	13 mm.
Carapace length	12.5 mm.	10 mm.
Carapace width	9 mm.	6 mm.
Length of head	8 mm.	7 mm.
Width of head (including eyes)	8 mm.	7.5 mm.
Length of bridge	4.0 mm.	4.0 mm.
Length of orbit	3.5 mm.	3.0 mm.
Fore limb	5.5 mm.	5.0 mm.
Hind limb	4.5 mm.	3.5 mm.
Tail length	5.0 mm.	3.7 mm.

After 4 days and $21\frac{1}{2}$ hrs these two embryos were more stout and slightly greater in length. Limbs were well developed; fore limbs of embryo elongated into paddles, the end of first digit of each projected beyond the margin, while embryo B was the same but with no digit projected. Hind limbs pressed over

the tail which hooked inward. Annular eyelid was more distinct and covered more of the eyeball on both embryos. Cranial prominences and columella-auris were less prominent, but the latter was still easily recognized. Snout was stronger, and the lower jaw almost completely closed the aural opening. Carapace was not yet well defined. Genital organ was almost the same as in previous stage.

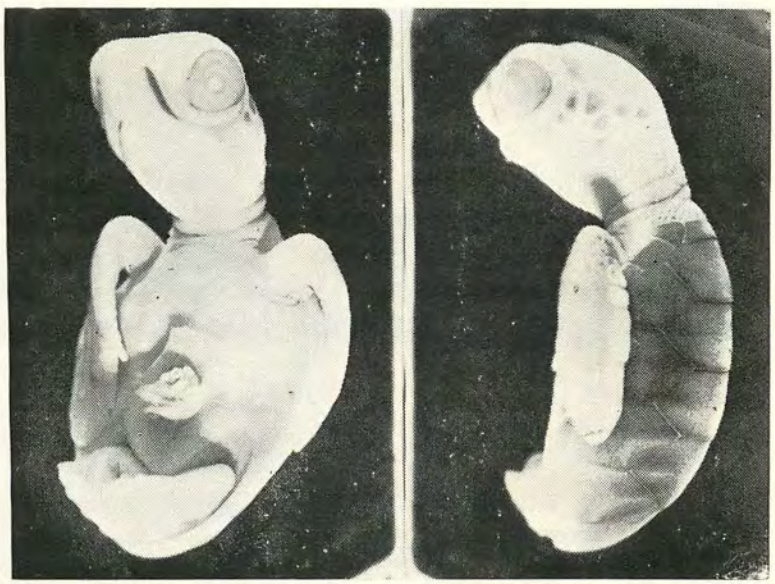
6.4 Age 23 days 21 $\frac{1}{2}$ hours.

Two embryos of this stage were also studied, and their dimensions were as follows:

	A	B
Total length	22 mm.	20 mm.
Carapace length	17 mm.	15 mm.
Carapace width	13 mm.	10 mm.
Length of head	11.5 mm.	10 mm,
Width of head (including eyes)	5 mm.	5 mm.
Length of bridge	5 mm.	5 mm.
Length of orbit	5.5 mm.	5.5 mm.
Fore flipper	8 mm.	7 mm.
Hind flipper	5 mm.	4 mm.
Tail length	7 mm.	6 mm.

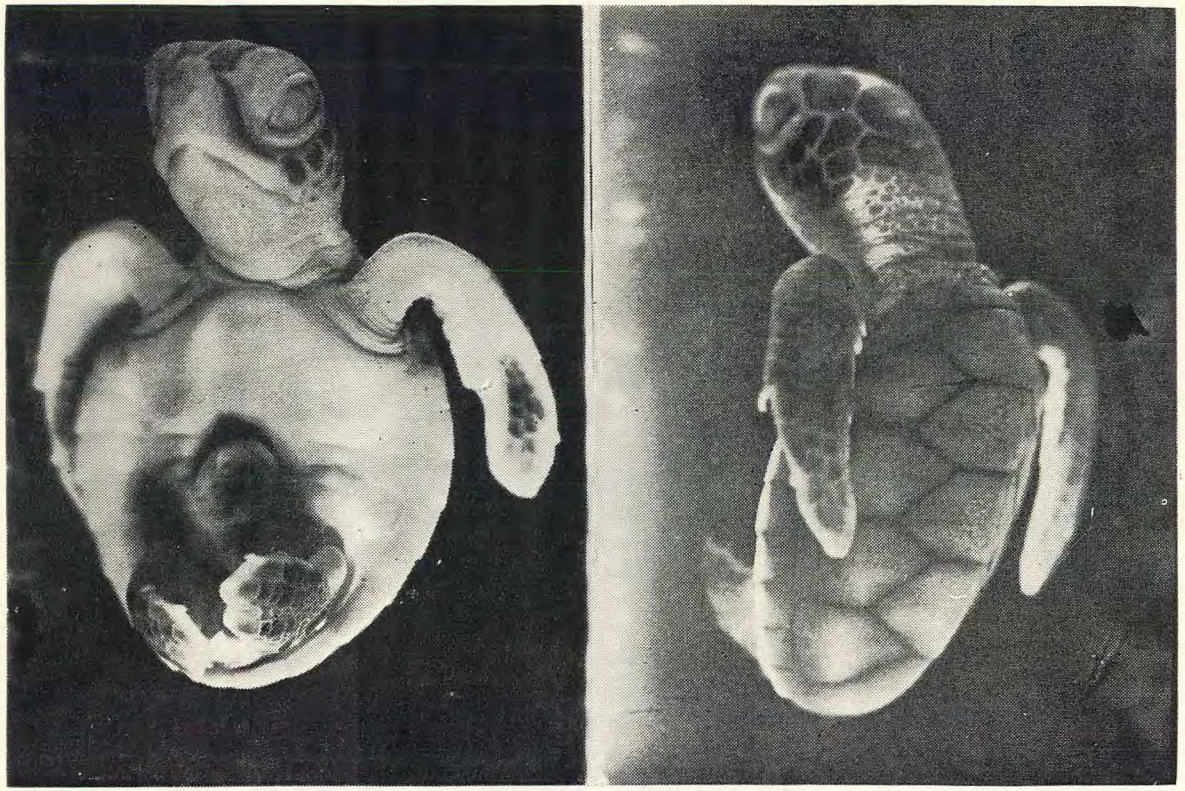
It could be seen that about 3 days later, the size of the embryo was changed considerably. At this stage pholidosis was developed, and the carapace was also lightly pigmented. Hind limbs were still in the same positions. First and second digit of fore limbs of both embryos projected beyond the margin. The plastral scutes were recognizable.

An embryo 22 days old was taken from one nest and being compared with embryos of the preceding and present stage under discussion. Exact age to hours was not possible; but however, the development of embryo extracted from the nest seems to fit in between these two stages. It is stouter and more extended in length than in the embryo of 20 days 22 hrs. old.



Ventral view Dorsal view

Age: 27 days 20 $\frac{1}{2}$ hrs.



Ventral view Dorsal view

Age: 30 days 20 $\frac{1}{2}$ hrs.

6.5 Age 27 days 20 ½ hours

Dimensions were as follows:

Total length (slightly curved)	35	mm.
Carapace length	22	mm.
Carapace width	18	mm.
Length of head	12.5	mm.
Width of head (including eyes)	9.5	mm.
Length of bridge	5.5	mm.
Length of orbit	6.0	mm.
Fore limb	14	mm.
Hind Limb	8	mm.
Tail length	8	mm.

Exactly 4 days and 23 hours later, the major changes noted were the pholidosis which was almost complete except around the cranium and columella auris almost disappeared. There are two claws on each fore limb and one claw on hind limb. Dorsal surfaces of the limbs show incipient pigmentation and plastron scute well defined. Carapace has a dark olive colour. Each fore flipper is pressed to a corselet bridge while the hind flippers are pressed against the base of the tail. Lower jaw closed aural cavity completely.

6.6 Age 30 days 20 ½ hours

The dimensions were as follows: Total length (slightly curved) 40 mm., length of bridge 5.5 mm., length of plastron 19 mm., length of head 15 mm., width of head at eyes 9 mm., length of orbit 5 mm., length of fore flipper 19.5 mm., length of hind flipper 13 mm., and the length of tail 7 mm. The carapace scutes are very distinct. Plastral scutes are recognizable. The vertebrae are wider than the costal scutes. Each fore flipper is pressed to a corselet bridge while the hind flippers are pressed against the base of the tail. The genital organ is prominent but relatively smaller. Pholidosis is almost

complete except upon the top of the head. The carapace and the head are pigmented. Carapace colour is dark olive; the dorsal surfaces of the limb show incipient pigmentation. Ventrally it is white. Each vertebra is now as wide as a costal together with the attached marginal scute.

The eyelids are annular, the lower jaw closes the aural cavity completely, and the columella-auris has now completely disappeared.

6.7 Age 36 days 20 ½ hours.

The dimensions of a specimen were as follows: Total length (curved) 38 mm., length of carapace 36 mm., width of carapace 31 mm., length of bridge 14 mm., length of plastron 23 mm., length of head 19.5 mm., width of head at eyes 12 mm., length of orbit 5 mm., length of fore flipper 30 mm., length of hind flipper 20 mm., length of tail 7 mm., width of first vertebral scute 7 mm., width of fifth or last vertebral scute 9 mm., width of first costal scute 7 mm., width of fourth costal scute 7 mm.

The plastron in still bent into two. Pholidosis is complete. There are three longitudinal carapace ridges of which the neural is the strongest. There are two claws on each fore limb and two on each hind limb. The tips of the digits were formed into points along the margin of each limb.

Further study on the development of embryos at various stages will be made in the future in more detail. Experiments will also be made on the artificial hatching of the turtles in relation to variable factors, temperature and moisture content of the sand.

7. Baby Turtles

The newly hatched turtle has small egg yolk attached by umbilical cord, through which the baby turtle absorbed its preserved food. In most cases this umbilical cord will be

Collecting turtle's eggs at Ko Kra

Young turtles in captivity

detached within a few days. The rate of absorption of its preserved food seems to give an indication to the state of health in early stage of its life. From our small experience we had found in our first attempt to rear 10 newly hatched turtles that some of them could live for 12 days without food, while the others needed food after about a week. Shrimp cut into small pieces seems to be their most favourite food. Of the first 10 turtles reared by us, many had to be feeded by hand, after it had been observed that they did not take the food at all and spent most of the time floating limply or laying very quietly on the dry portion of the rearing tank.

Two baby turtles were given meat almost entirely for their diet for the period of about a year, and they seemed to be as healthy as the others who were fed with fish or prawn and sometime, with meat.

The rearing of baby turtles made during the last year was not very successful. Even the results obtained from these experiments are not quite satisfactory, but they still encourage us to make further experiment on a wider scale.

The terms of collecting license also require the natural hatching of 10,000 Green Turtles and 1,000 Hawksbill Turtles every year. To give them a better chance of survival from predators and birds, we intend to rear about half the number required under the terms of license until about 3 or 4 months after which they will be released into the sea. A pen covering an area of about 30 square meters had been built for the purpose at Ko Kram. In this pen some turtles will also be reared for the study of their behaviour and growth rate.

8. Food values of turtle's eggs.

The high market demand of turtle's eggs makes it worthwhile to determine the food values of the turtle's eggs. The author had been trying in vain to get information on the nutritive quality of turtle's egg from source books on nutrition. However, the Department of Medical Science had rendered their cooperation

by performing an analysis of turtle's eggs sent by the author. The results of the analysis are given below in comparison to hen's and duck's eggs.

(From 100 gm. of sample)	Hen's Egg	Turtle's Egg	Duck's Egg
Ash - %	0.98	1.11	1.03
Calcium - mg.	125.93	93.58	156.12
Phosphorous - mg.	204.39	227.85	214.46
Iron - mg.	1.60	1.95	0.91
Moisture - gm.	74.88	79.03	69.43
Protein - gm.	12.61	11.80	12.88
Ether extracted - gm.	10.00	8.24	14.32
Carbohydrate - mg.	1.53	–	2.34
Crude fibre - gm.	–	–	–
Calories	146.56	121.36	189.76
Edible portion - %	86.36	92.80	87.37
Vit B 1 - microgram	100 *	453	Undetermined
Vit B 2 - microgram	290 *	442	,,

**From Composition of Foods, by U.S. Department of Agriculture.*

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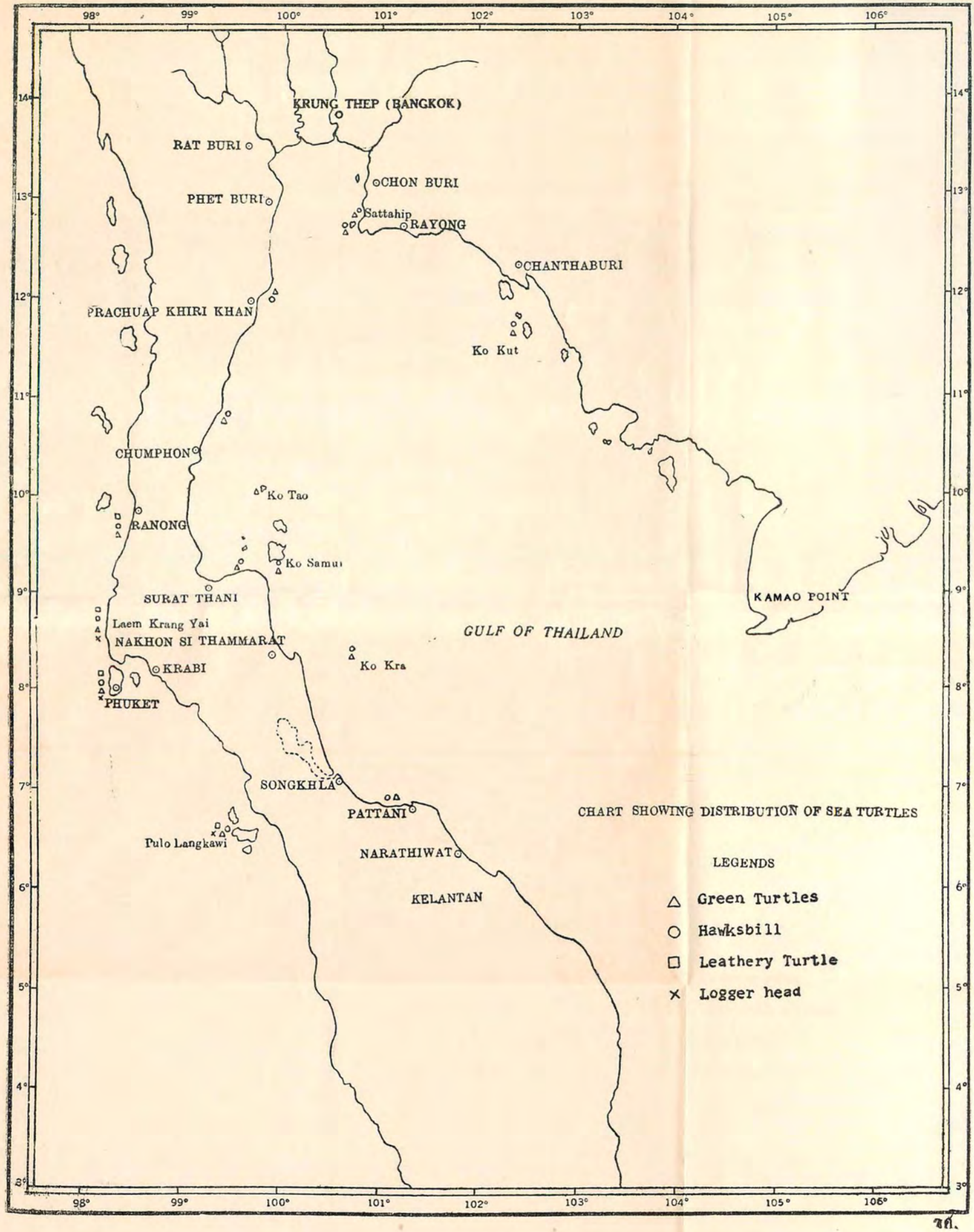
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PHET BURI
Sattahip
RAYONG
CHANTHABURI
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Ko Kut
CHUMPHON
Ko Tao
RANONG
Ko Samui
SURAT THANI
KAMAO POINT
Laem Krang Yai
NAKHON SI THAMMARAT
GULF OF THAILAND
Ko Kra
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PHUKET
SONGKHLA
PATTANI
Pulo Langkawi
NARATHIWAT
KELANTAN
CHART SHOWING DISTRIBUTION OF SEA TURTLES
LEGENDS
△ Green Turtles
○ Hawksbill
□ Leathery Turtle
× Logger head