

MEDDELELSER

FRA

KOMMISSIONEN FOR HAVUNDERSØGELSER

SERIE: FISKERI · BIND V

Nr. 1. JOHS. SCHMIDT: MARKING EXPERIMENTS WITH TURTLES IN THE DANISH
WEST INDIES. WITH 5 TABLES AND 11 FIGURES

KØBENHAVN

I KOMMISSION HOS C. A. REITZEL

BIANCO LUNOS BOGTRYKKERI

1916

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KOMMISSIONEN FOR HAVUNDERSØGELSER

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BIND IV

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TOME IV

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SERIE: FISKERI · BIND V · Nr. 1 · 1916

MARKING EXPERIMENTS WITH TURTLES

IN THE DANISH WEST INDIES

BY

JOHS. SCHMIDT

WITH 5 TABLES AND 11 FIGURES

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ALBION PRINTING CO. PHOTODUPLICATION SERVICE

1000 Locust Street, Philadelphia, PA 19106

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I. INTRODUCTION

IN the winter months of the year 1913—1914, the "Kommissionen for Havundersøgelser" made investigations in regard to the fishery conditions in the Danish West Indies, (St. Thomas, St. Jan and St. Croix). An important item of the programme was to investigate the possibilities for improving the conditions for turtle-catching. It is a well known fact that the yield of turtle-catching at the present time is far less than in former years. Every report on fishery conditions in the West Indies¹ mentions this, and there is a concensus of opinion that measures must be taken to prevent this important industry from dying out. The necessity for such measures in the Danish West Indies has been clearly portrayed by TH. MORTENSEN (l. c.).

As no records have been kept of the number of turtles caught in the Danish West Indies, either recently or in the past, it is impossible to cite figures showing the decrease in the size of the catch. I am therefore forced to quote—unfortunately very incomplete—expressions of opinion from various people living on the Danish islands. These were officially collected in 1901, and put at my disposal by the Honorable Mr. HELWEG-LARSEN, Governor of the Islands.

St. Croix.

Information given by a turtle-fisherman, a man fifty years old, considered an authority on fishing, and from boyhood accustomed to fish for turtles near St. Croix. He tells that in his youth large numbers of turtles might be caught in certain of the bays about the island. Turtle meat was daily fare. Now four or six weeks can elapse without a single turtle being caught.

St. Jan.

Information given by "old practiced turtle fishermen". They agree that in former days there was a very important turtle fishery about the island, especially off the eastern coast, but that it is greatly diminished, presumably on account of the wanton destruction of the eggs.

St. Thomas.

Information given by turtle fishermen. They suggest that since the greatest number of turtles are caught during their spawning season, when they should be protected, a close-season from March 1 to October 31, eventually from April 1 to August 31, would be advisable and that taking the eggs be absolutely prohibited. If no close-season is established, turtles will soon disappear entirely from the neighborhood.

All seem to agree that wanton destruction is the cause of the decrease in the yield. Even though this cannot be proved, it is probably true, and the question remains as to how the condition may best be

¹ TH. MORTENSEN: "Om Fiskerierne paa vore vestindiske Øer", ("Atlanten", Hefte 43, p. 139—142, København 1907).

J. BOEKE: Rapport betreffende een voorloopig onderzoek naar den toestand van de Visscherij en de Industrie van Zee-produkten in de Kolonie Curaçao, 1, p. 121, Haag 1907.

See further: RALPH M. MUNROE: The Green Turtle, and the possibilities of its protection and consequent increase on the Florida coast (Bull. U. S. Fish Commission, vol. XVII for 1897, p. 273—274, Washington 1898).

remedied. Should a close-season be established? If so, at what time? A legal size-limit? If so, what size? Would some totally different scheme be better for attaining the desired end? Are turtles so stationary that the establishment of a close-season and a size-limit for a few islands could have any effect? Such considerations bring us face to face with difficulties which seem insurmountable so long as practically nothing is known about the conditions for which regulations are to be made. Almost nothing is known of the rate of growth, age or migrations of turtles. There is a difference of opinion as to the spawning season of the different species, which are often wrongly confused with each other.

From these causes alone it is easy to understand that no results have come from the negotiations started in the beginning of this century, on British initiative, between those nations interested in turtle fishing in the West Indies. To attempt to introduce international regulations for the protection of turtles on the basis of our present knowledge, or ignorance, is to work without aim.

Therefore there is all the more reason for attempting to gain the required information as soon as possible, and the "turtle question" occupied an important place among the investigations planned by the "Kommissionen for Havundersøgelser" in the Danish West Indies in the winter 1913-1914.

The most important facts to be determined are the rate of growth of turtles and their migrations. As is known, marking experiments are very extensively used in modern fishery investigations in order to determine the rate of growth and migrations of fish. Our problem was to test to what an extent, and with how valuable a result, marking experiments might be used for the turtles of the West Indies.

In what follows, I will describe the work we have done along this line, for although the experiments are far from being extensive enough, yet they are sufficiently so to indicate that results may be obtained by this method. This seems to me to be of very special interest, and is the reason why this little report is published now. It is my hope that its appearance may contribute toward awakening interest for this question in the Danish West Indies, and toward introducing a work similar to ours in other parts of the West Indies. For it is my opinion, that only on a basis of solid tested facts, is it possible for the various nations interested in West Indian turtle fishery to frame regulations, by which the stock of turtles in these waters may be used in a more rational way.

I take this opportunity of expressing my indebtedness to all those who have assisted me in the work, both here at home and in the West Indies. I wish to thank cand. mag. A. STRUBBERG, stud. mag. P. JESPERSEN and Captain G. HANSEN for assistance of various kinds, and Professor Dr. H. E. JUNGENSEN and Professor Dr. J. E. V. BOAS for lending me specimens of turtle young from the collections under their charge.

I owe the Hon. Mr. HELWEG-LARSEN, Governor of the Islands, many thanks for his help in the arrangement of the marking experiments, and for the interest he has shown in the work.

I wish to give special thanks to Lieutenant V. ARNTZ, harbor assistant in St. Thomas, for the great care and perseverance with which he has carried out the extensive work connected with the continuation of marking experiments in the West Indies.

II. THE VARIOUS SPECIES OF TURTLES AND HOW TO DISTINGUISH THEM

These investigations deal only with the green turtle, or edible turtle (*Chelone midas*).

However, all the existing species of turtles, 4 in number, are to be found in West Indian waters.

In our study of the biological conditions we must discriminate very sharply between the various species, for they are animals that differ greatly from each other, and under no considerations are to be grouped under one heading. Let me give a single instance of this. The green turtle is an herbivorous animal, while the three other species are carnivorous. It is therefore reasonable to expect that the species may differ in other biological conditions that are of interest to us, but which are at present unknown or known but inadequately (breeding season, rate of growth, migrations, age etc. etc.)

From what we have said above it seems advisable, in a few words to tell how to distinguish the four species of turtles. This is very easy even without previous zoological training¹. Referring to the figures I will limit myself to pointing out those distinguishing characters found in the carapace, which in all probability will be that part of the turtle most easily acquired for investigation.

A turtle's shell consists of the dorsal "carapace" and the ventral "plastron". Each is composed of a number of bony pieces (plates), which may or may not be covered with horny "shields".

In the majority of species the carapace has the following plates and shields.

Along the median line there is a row of plates fused with the vertebrae, called "neurals"; the foremost plate is the "nuchal". The neurals are surrounded on each side by the "costals" which are fused with the ribs. The costals are surrounded by the "marginals", which form the outermost edge of the carapace.

The arrangement of the plates (respectively the shields) is to be seen from the figures (cf. fig. 1, p. 5).

The following species of turtles may be found in the West Indies, and in all tropical waters as well, though perhaps in various subspecies or races.

1. **Leathery Turtle** also called **Luth** and in the West Indies **Trunk Turtle** (*Sphargis coriacea*).

This species differs greatly from the other three, among other points in that the carapace is soft and not fused with, but free from the vertebrae and ribs. It consists of numerous small polygonal plates and is covered with leathery skin without any epidermal shields (cf. fig. 7).

The leathery turtle is the largest of all the species. The shield in any case attains a length of about 4 ft. The weights recorded vary from $\frac{1}{2}$ to 1 ton (GADOW). The flesh is supposed to be unwholesome and the species is of no commercial value.

2. **"Loggerhead Turtle"** or **"Lantern-back"** (*Thalassochelys caretta*).

The shell has 5 pairs of costal shields (see fig. 2 and 8). Large specimens have a shell about $3\frac{1}{2}$ feet in length (GADOW). The loggerhead is carnivorous

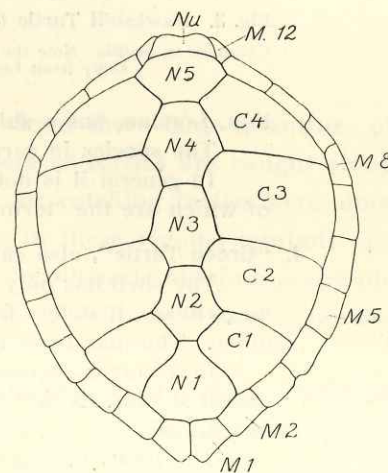


Fig. 1. Green Turtle (*Chelone midas*).

Carapace, showing the arrangement of the various shields.
 N_1-N_5 : neural shields. Nu: nuchal shield.
 C_1-C_4 : costal shields. M_1-M_{12} : marginal shields.
 (Specimen from St. Thomas, Danish West Indies).

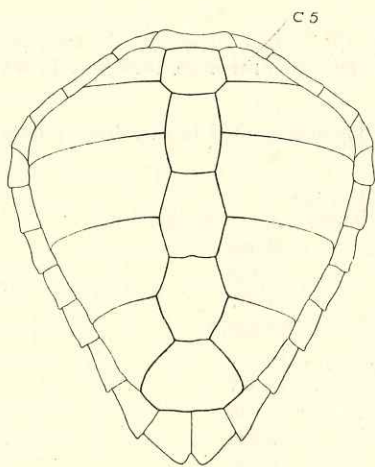


Fig. 2. Loggerhead Turtle (*Thalassochelys caretta*).

Carapace of a specimen caught in the Mediterranean ("Thor", Station 432, July 10, 1910). C_5 : Costal shield No. 5.

¹ Those who wish further information in regard to the anatomy of the turtle, see HANS GADOW: Amphibia and Reptiles, The Cambridge Natural History, vol. VIII, London 1901. The larger part of the diagnoses given here, are taken from that book.

and commercially of no value. It is very migratory, often wandering outside tropical waters, found for instance, in great numbers in the Mediterranean. Concerning its rate of growth. cf. foot-note page 18.

3. **Hawksbill Turtle** (*Chelone imbricata*).

The shell has only 4 pairs of costal shields, (see fig. 9), and by this may be distinguished from the loggerhead.

The horny shields of the carapace are more fully developed than in the green turtle. Moreover they differ from the shields of the latter in that they strongly imbricate or overlap each other from before backwards (cf. fig. 3). The margin of the carapace forms at first a deeply serrated sharp edge, the serrations disappear gradually on the front portion, but remain on the posterior half of the shell.

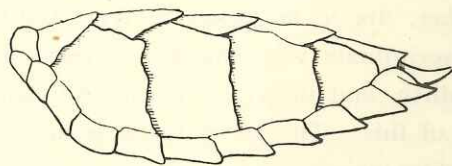


Fig. 3. Hawksbill Turtle (*Chelone imbricata*). Carapace in profile. Note the overlapping shields. Copy from Leunis.

The jaws form a hooked beak. (Thence the name, "hawksbill").

In young specimens, under 1 foot in length, there are 3 rows of keels, converging towards the posterior end of the shell, and formed by the neural and costal shields (see fig. 9).

The limbs have 2 claws (see fig. 9).

The largest specimen measured, found in the National Collection, London, has a shield 85 cm (34 inches) long. (GADOW).

The species is carnivorous.

In general it is not eaten, but it is of great commercial value on account of its shells, the horny shields of which are the "tortoise-shell" of commerce¹. A large specimen yields up to 8 lbs. (GADOW).

4. **"Green Turtle",** also called **"Green Back",** and **"Edible Turtle"** (*Chelone midas*).

The shell has only 4 pairs of costal shields (see fig. 1, 4, 5, 6 and 10). In this respect it differs from the loggerhead. It differs from the Hawksbill in that all the shields are juxtaposed, fitting closely into each other. The margin of the carapace is smooth or but indistinctly serrated.

In younger specimens the carapace has one feeble keel following the median line formed by the neural shields. Newly hatched specimens, have, however, 3 keels, but the middle one only is clearly defined (see fig. 10).

The limbs have generally only one claw (see fig. 10).

The species is herbivorous and in this differs from the other turtles.

For its size see later.

This species is the "edible turtle", and of great commercial value.

With the help of the short description given above and the figures, it is a simple matter to differentiate between the various species of turtles, which, as has been stated, are all to be found in the Danish

¹) In the year 1870, 49,332 lbs of tortoise shell, valued at 32,503 £ were imported into the United Kingdom. In the year 1898, 76,760 lbs were offered for sale in London, practically all of which were sold. The import to France in 1876 was 42,306 kilogrammes with a value of 2,078,910 francs (R. L. in "Nature", March 2, 1899.)

Complete figures from the Danish West Indies are lacking, but the two firms in St. Thomas quoted below, have kindly given me a summary of the tortoise shell sold by them during a period of years.

Ch. Delinois & Co.			Louis Delinois.	
Year	lbs	Value (Dollars)	Year	Value (German marks)
1903	116	686	1898	16,060
1904	184	915	1899	15,459
1905	140	1180	1900	14,007
1906	105	772	1901	13,620
1907	116	651	1902	14,027
1908	200	786	1903	15,007
1909	175	775	1904	8,920
1910	232	1512	1905	9,937
1911	160	865	1906	10,020
1912	180	1260	1907	9,954
1913	100	700	1908	9,927
			1909	12,425
			1910	10,698
			1911	9,047
			1912	4,896
			1913	7,509

West Indies. Provided the species are kept distinct from each other, every observation made by people living on the islands in regard to the biological conditions of the turtles (breeding season, laying, development, size etc.) will be of value, as our knowledge of the subject is so incomplete. But just so long as people say "turtle", as the case is now, without discriminating between the species, such observations are of but small, or no value.

III. TURTLE-CATCHING IN THE DANISH WEST INDIES AND ADJACENT WATERS

The center of the turtle-trade in the West Indies is Jamaica, and from there large quantities of turtles are exported, especially to London¹. Nowadays the greatest numbers of turtles are caught along the "Mosquito coast" in Central America, whereas formerly the best places for catching turtles were more northerly (Florida, the Bahamas, Cuba etc.). The history of turtle-fishing in these regions reminds one of the British Trawl-fishery, which must ever seek more and more distant localities to obtain a profitable yield, as in the more adjacent fishing-places the number of large valuable specimens seems gradually to diminish.

The region of special interest for us, is the group of islands lying in the shoal which, stretching east from Porto Rico to the Virgin Islands, encompasses the two Danish islands St. Thomas and St. Jan and the islets surrounding them (see fig. 11).

We have though, almost no information on the subject from the Danish island, St. Croix, lying about 30 miles south of the shoal.

I am unable to state with certainty which of the 4 species of turtles is most commonly found at the Danish islands for the trunk turtle and loggerhead, having no special commercial value, are never the objects of organized fishing. Probably, though, the eggs of both species are collected and sold, in any case those of the first. Of the two remaining species, green turtle and hawksbill, which are both very valuable, the former on account of its meat, the latter on account of the horny shields of the shell ("tortoise-shell"), every specimen, however small, which falls into a fisherman's hands is landed and killed.

According to all information gathered on this subject, and according to what I have personally seen during my stay in St. Thomas in the winter 1913—1914, it seems a positive fact that far more green turtles are caught than hawksbill, probably 10 times as many, if not more.

Unfortunately we have no statistics in regard to the turtle-catch in the Danish West Indies, so no statement can be made as to the numbers or value. By request from the "Kommissionen for Havundersøgelse", the government, through the butchers in St. Thomas, collected various data during the year 1914—1915. These are given in Tables IV—V, p. 20—21. Even though incomplete, and therefore powerless to give an entirely correct picture of the extent of the turtle-fishing in the Danish islands², yet they give a certain impression of the situation which is of interest to us.

¹ DUERDEN: The Marine Resources of the British West Indies (West Indian Bulletin, II, 1901). In this we find that in the year 1900, turtles were exported from Jamaica to the value of about 10,000 £.

² It was particularly striking that on the butchers' lists, practically no small specimens (*e. g.* under 10 lbs. weight) were found. However when we advertised that we wished turtles for marking we obtained such specimens from the fishermen. The explanation lies probably in the fact, that the fishermen, for the most part, sell such small specimens directly to private individuals, while only the larger ones come into the hands of the butchers.

Turtles are caught, sometimes in the sea, sometimes on land, when they have gone ashore to lay their eggs. In St. Thomas, the French speaking white fisher-folk, living due west from the town, Charlotte Amalie, form that part of the population which is most interested in regular turtle fishing in the sea. I have the following facts from these people, who are popularly called the "Cha-Cha's".

Various kinds of wide-meshed nets are used for the catch. When the nets are set out, a wooden block, or decoy, shaped like a turtle, is fastened to the head-rope. This attracts the turtles; especially the males, and they become entangled in the nets, which are examined at frequent intervals. For catching "hawksbill", nets are used which are 16 fathoms long and 2 fathoms deep, for green turtles, nets of the same depth but only half so long. The "Cha-Cha's" consider Sail Rock, Little St. Thomas and Frenchman's Cap especially good places for catching hawksbill. The green turtle is to be caught in bays, especially where the bottom is overgrown with "turtle-grass" (*Thalassia* and *Cymodocea*).

While turtle-fishing with nets is carried on throughout the year, turtles are caught on land only during the period in which they lay their eggs. The fishermen have various opinions as to when this period occurs, but it is between the months March to November, and probably varies in the case of the different species of turtles.

Those places near the Danish Islands in which information was to be had through literature on the subject, are Porto Rico and the islands, Vieques and Culebra. The last mentioned lie very close to the Danish islands, belonging to the same general division, and one may expect to find that the conditions there and in the Danish West Indies are similar.

In the report "Investigations of the Aquatic Resources and Fisheries of Porto Rico", made in 1899 by the U. S. Commission of Fish and Fisheries¹, turtles are thus mentioned in passing by B. W. EVERMAN, p. 25: "Turtles are also uncommon. The species represented are said to be the hawksbill and green turtle, which are rare, except at the east end. The scarcity of turtles is doubtless due to the absence of large areas with sandy bottom". P. 49—41 of the same report, W. A. WILCOX says:

"About Vieques and Culebra islands and the east end of Porto Rico as far west as Arroyo is the region where turtle fishing is carried on to the greatest extent. At Arroyo turtles are found at all seasons, being most plentiful from September to the last of December, during which time they deposit their eggs in the sand of the beach. In the latter part of November, 1898, this section was fished by two small vessels from the English island of Tortola, who used large-meshed nets to which wooden decoy turtles were attached, the nets being set near the coral reefs off the harbor of Arroyo. The vessels remained two weeks and it was reported that a fair catch was made.

A few turtles are caught about the small islands near Hucares, chiefly with gill nets. During 1898, 400 pounds of hawksbill turtle shells were taken and sent to New York, where the best brought \$ 5 a pound in gold. The nets used about Vieques and Culebra islands are 27 feet long, 8 to 12 feet deep, and of 12-inch square mesh. A few turtles are taken on the beaches, but the catch is principally by nets which, with their wooden decoy turtles, are anchored near the coral reefs; the nets are visited once or twice a day during the turtle-fishing season, which is said to be in May, June, July and August.

The hawksbill, green sea, and loggerhead turtles are reported more plentiful in this vicinity than elsewhere about Porto Rico. The catch, however, is small, only 75 hawksbill turtles having been taken in 1898. The shell of the hawksbill is said to average from 3 to 5 pounds, and brings from 75 cents to \$ 4 a pound in gold at St. Thomas. The loggerhead turtle is used only for its oil. The meat of the other species is sold for food at 6 cents a pound".

I have not been able to obtain information as to the conditions on the British Virgin Islands, lying east for St. Thomas and St. Jan (Tortola, Jost van Dyke, Anegada, Virgin Gorda, etc.). From the

¹ U. S. Fish Commission Bulletin for 1900, Washington 1901. Concerning turtle catching in the Dutch Leeward Islands (St. Martin, St. Eustatius and Saba) see BOEKE l. c. p. 123—124.

statistics which the government of the Danish West Indies, at the request of the "Kommissionen for Havundersøgelser" had drawn up by the butchers in St. Thomas it appears that an important part of the turtles sold in trade in St. Thomas originate in the British Virgin Islands (see Table V, Page 21).

IV. THE BREEDING SEASON OF TURTLES, ETC.

I can give no information about the breeding season of turtles, deduced from personal investigations, as my stay in the islands was not during the breeding season. I am therefore forced to confine myself to facts obtained from the fishermen and information of older date from a work on the reptiles of the West Indies by J. REINHARDT and C. F. LÜTKEN¹, published in 1863.

I must mention that in certain instances the facts furnished by the fishermen were somewhat contradictory, so that I have only made use of those which seemed to me plausible.

The fisherman from St. Croix, already mentioned on page 3, says, (according to notes given to me by the Governor of the Danish West Indies, Mr. HELWEG-LARSEN):

"Three species of turtles are to be found in our waters: the hawksbill, the green back and the trunk turtle. The species first mentioned lays its eggs during the months June—October, inclusive. The eggs are laid high upon the beach in the dry sand. The place is easy to find for those who have had a little experience, and the eggs are therefore found and collected without difficulty. Green back turtles lay their eggs in so low a part of the beach, that the water, constantly lapping over the place, washes away all traces. Therefore these eggs are found only by chance and are very rare. The exact date for the breeding-season of this turtle is unknown, though it is the most common species along our coasts. The trunk turtle lays its eggs during the months March—May inclusive. The meat of this species is inedible and can only be used for oil. This turtle attains an enormous size. The shell of the hawksbill is valuable, but that of the other two species has no value".

In continuation of those facts reported from St. Jan, 1901, and referred to on page 3, the following is given:

"In our waters, only 3 species of turtles are known, the hawksbill, the trunk turtle and the green back. Of these the two first mentioned lay their eggs in the sand along the sea shore, according to report, in the months May—October. The nests are easily found as the tracks of the turtles can be followed in the sand. During the spawning season the hawksbill comes ashore 3 times, laying about 175 eggs each time, in all about 500 eggs. As far as is known, about 20 days elapse between each laying. The eggs of both these species are edible, and are gathered by people who, whenever they come across the turtle kill it, the trunk turtle for the sake of the oil, the turtle being otherwise valueless, the hawksbill on account of its valuable shell. All three species are caught in nets throughout the year. As the green backs lay their eggs along the margin of the sea, they are hardly ever found, but it is presumed that this species lays its eggs during the months May—October, for in these months eggs have been found in the females."

The following facts, in written form, come from a Dane, Mr. ANDERSEN who has lived for several years as a fisherman, and much else, on the little island Lovango Cay, in the sound between St. Thomas and St. Jan. (The facts are quoted from a letter written in the spring of 1914 by Mr. ANDERSEN to Mr. P. JESPERSEN, who worked as assistant with the investigations carried on by the "Kommissionen for Havundersøgelser" in the West Indies in the winter 1913—1914).

¹ J. REINHARDT and C. F. LÜTKEN: Bidrag til det vestindiske Øriges og navnlig til de dansk-vestindiske Øers Herpetologie (Videnskabelige Meddelelser fra den naturhistoriske Forening i København for Aaret 1862, p. 284—290, København 1863).

"The following species of turtle are to be found: green turtle, hawksbill, trunk turtle and loggerhead. I have found them all, except the green turtle, breeding on St. Thomas and St. Jan, about fifty pair. The hawksbill and loggerhead turtles lay their eggs (in the period from June to November), high up on the shore, far in under the bushes. The trunk turtle lays its eggs, (in the period from March to June), quite far from the waters edge, so that the waves cannot reach them. About 700—800 eggs are laid, divided in four batches with an interval of 15—17 days between. They are laid in a hole in the ground and covered with earth or sand. The turtles are usually caught after they have laid their first batch of eggs. Therefore only comparatively few eggs are collected. A greater number of green turtles are caught than hawksbills. Turtle-catching is diminishing. About 100 specimens are caught annually around St. Jan."

We are under obligations to the late apothecary RIISE, in St. Thomas, an enthusiastic naturalist, for the information about turtles quoted by REINHARDT and LÜTKEN, l. c. from the latter part of the last century.

According to RIISE, four species are to be found in the Danish West Indies, hawksbill, green turtle, trunk turtle and loggerhead, or as it is usually called, lantern back. The last mentioned he has not seen himself. He has sent two specimens of the eggs of the trunk turtle found on the British island, Tortola, near St. Jan. These eggs, according to REINHARDT and LÜTKEN, measure 60—61 mm in diameter, and are thus larger than the eggs of other turtles, which do not attain a diameter much greater than 40 mm.

Concerning the two important species hawksbill and green turtle, Mr. RIISE makes the following interesting statements (REINHARDT and LÜTKEN, l. c. p. 228):

"It is usually the eggs of the hawksbill species which are sold and eaten in the Danish West Indies, not the eggs of the green turtle as is commonly supposed. Mr. RIISE, is in fact, prone to believe that the eggs of the green turtles never come on the market, though he will not state this as an absolute fact. According to information he has received, the green turtle does not, as does the hawksbill, lay its eggs on the dry beach, but buries them in the sand further out in the water. . . . In the West Indies, not only the eggs, but also the meat of the hawksbill is eaten, though the latter is not considered as great a delicacy as the meat of the green turtle. The eggs, of which Mr. RIISE has sent some specimens preserved in alcohol do not seem to vary greatly in size. They are spherical in shape, as are all turtle eggs. The largest measures 40.5 mm in diameter, the smallest 39 mm. On Sept. 4, 1861, Mr. RIISE had a large hawksbill specimen killed in his presence. It was about 3 ft. long and 2 ft. broad. In it were found 167 eggs with a white shell of the same consistency as the shell on the eggs already laid. It was presumably to lay these 167, that the turtle had come ashore. 300 yolks were also found inside the turtle, and of these one half was twice as large as the other. The fishermen, who sold Mr. RIISE the turtle, reported that two weeks previously they had taken 150 eggs which this turtle had buried along the beach. The turtle had been caught on its return to the spot where it had come to hide a second batch of eggs. They claimed further that, had the turtle been allowed to live, one half of the yolks inside it would have been ripe and ready for laying two weeks later. According to Mr. RIISE's report the laying period (for hawksbills) in the West Indies lasts from July to October. The males do not come ashore, but are caught in nets."

We must now describe the newly hatched turtles from the Danish West Indies to be seen in the various collections in Copenhagen. These have a certain biological interest, since the discovery of such very young turtles leads one to conclude almost positively that they were hatched on the Danish Islands.

The specimens were measured by Mr. A. STRUBBERG.

1. **Trunk turtle** (*Sphargis coriacea*) from:

Tortola:

- 1 specimen, l. 70.5 mm (Zool. Museum University of Copenhagen).
- 2 eggs.

- St. Croix:
 1 specimen, l. 65 mm., wt. 43 gr. (Zool. Museum, Royal Coll. Agri.)
 (In addition the Zool. Museum University has from Guinea 3 specimens, l. 54, 56 and 67 mm. The largest dorsal shield in the University Museum from St. Thomas measures 144 cm. in length.)
2. **Loggerhead** (*Thalassochelys caretta*) from:
 West Indies:
 No specimens in the museums.
 Realejo, Nicaragua:
 1 specimen, l. 43.2 mm. wt. 15.5 gr. (Zool. Museum University of Copenhagen).
 1 — l. 42 mm. (— — —).
- Malabar:
 1 specimen, l. 41.5 mm. wt. 14.3 gr. (— — —).
 (The largest dorsal shield in the Zool. Museum is from Rio Janeiro, and measures 95 1/2 cm.)
3. **Hawksbill** (*Chelone imbricata*) from:
 Danish West Indies:
 1 specimen l. 50 mm. wt. 26 gr. (sent by apothecary Riise to the Zool. Museum, Royal Coll. of Agri).
 1 — l. 52 mm. (Zool. Museum, Royal Coll. of Agri).
 1 — l. 78 mm. wt. 65 gr. (caught in January 1896 and brought to Copenhagen by Mr. Chr. Löffing, and placed in the Zool. Mus. Royal Coll. Agri).
 1 specimen l. 42.2 mm. wt. 17 gr. (Zool. Mus. Univ. Cop.)
 1 — l. 42.8 mm. wt. 19.5 gr. — — —
 (These two last specimens are of older date.)
 1 specimen l. 51.5 mm. wt. 22 gr. (Zool. Mus. Univ. Cop.)
 1 — about same length as above (Zool. Mus. Univ. Cop.)
 (Both these specimens are marked ØRSTED, 1846.)
 1 specimen l. 46.8 mm. wt. 16 gr. (Zool. Mus. Univ. Cop. 1912).
 1 — l. 80 mm. (— — —).
- Various eggs are to be found in the collections of the Museum. The diameters of the eggs vary from 39—41.5 mm, (REINHARDT and LÜTKEN, l. c.)
4. **Green Turtle** (*Chelone midas*) from:
 West Indies:
 1 specimen, l. 51.2 mm, wt. 23 gr. from St. Croix (Zool. Mus. Univ. Cop.)
 1 — l. 59 mm. wt. 32 gr. (Zool. Mus. Royal Coll. Agri.)
- Java:
 1 specimen, l. circa 52 mm. (Zool. Mus. Univ. Cop.)
 1 — l. 81 mm. (— — —)
- Indian Ocean:
 1 specimen, l. circa 52 mm. (— — —)
- Bonin Islands:
 1 specimen, l. 105 mm. (— — —)
 1 — l. 115 mm. (— — —)

If, based on the facts seen above, we attempt to construct a picture of the biology of the turtles in the Danish West Indies, we find the following to be true.

1. Loggerhead (lantern back).

There is no positive proof that this species breeds in the Danish West Indies. As is mentioned on page 10, an observer of this turtle tells that the laying season for the hawksbill and loggerhead is from June to November. DAVENPORT HOOKER¹, who has specialized in the study of the breeding habits and early life of the young of that species says: "The breeding season of the loggerhead turtle lasts through the months of April, May and June. There seems to be basis for belief that two nests are laid in a season by each female. The number of eggs laid is approximately one hundred. The period of incubation lasts about fifty days".

¹ DAVENPORT HOOKER: "The Breeding Habits of the Loggerhead Turtle and Some Early Instincts of the Young". (Science, N. S. vol. XXVII, p. 490, New York 1908.)

2. Trunk Turtle.

It seems to be established beyond doubt that the trunk turtle breeds in the Danish West Indies. Both the eggs and the newly hatched young are known from Tortola and St. Croix. All reports from the Danish West Indies place the spawning season for this species in the period March—May inclusive, or March—June. The eggs have a diameter of 60—61 mm. (REINHARDT and LÜTKEN l. c.)

Neither of the two species described above has any commercial value. This is not true in the case of the two species which follow.

3. Hawksbill.

Without doubt the hawksbill is that species of turtle, which breeds most prolifically on the Danish islands. At any rate, it is that species whose nests are most frequently found, and whose eggs form the bulk of the "turtle-eggs" sold on the islands.

REINHARDT and LÜTKEN state that the eggs have a diameter of 39—41.5 mm.¹ The spawning-season for this species is later than for the trunk turtle, namely during the summer and autumn ("hurricane season"). The two informants on the subject from St. Croix and Lovango Cay agree in their statement that the spawning season is from June—October, November, and this statement is confirmed by apothecary RUISE's data about the turtle he had killed September 4, and which contained ripe eggs.

Far fewer specimens of hawksbill are caught near the Danish islands than of the following species. When various informants from the Danish West Indies make this general statement that "the ruthless destruction of turtles' eggs is the cause of the decrease of the turtle catch", the statement may be applied to the species hawksbill. It is literally this species that pays the penalty every time turtle eggs are enjoyed as a delicacy. As hawksbill, on account of its "tortoise shell", is the most valuable of all turtles, a well grown specimen often bringing a price of 100 francs (\$ 20) or more, it would be difficult to imagine a more extravagant article of diet than turtle-eggs, even though these are sold for a few centimes apiece.

That the hawksbill breeds very commonly on the Danish Islands is seen, too, from the fact that the newly hatched young of this species are very often found. In any case they are more often found than the young of any other species. These, when hatched seem to be 4 cm. long (carapace) and to weigh about 15—20 grammes.

4. Green Turtle.

The green turtle is without doubt that species of which the greatest number of specimens is caught in the Danish West Indies. The fishermen sell it for about 20 centimes (4 cents) per lb. The turtle can attain a weight of several hundred pounds, though specimens weighing more than 100 lbs. are rare in the Danish West Indies. Strangely enough the eggs have not been found on the Danish islands, so the purported decrease in the number of turtles of this species caught, cannot be due to the destruction of the nests by man.

As has been seen from the facts given by fishermen and stated above, it is generally believed that eggs are not to be found, because they are laid so near the water that the waves wash over the place, effacing all traces made by the mother turtle. An old "Cha-Cha" fisherman on St. Thomas, with whom I talked, had a different theory. He thought that the green turtles do not breed on the Danish islands but come from a long distance. As a matter of fact in the collections in Copenhagen, there are one or two newly hatched specimens of the green turtle from the West Indies, a little over 5 cm. long. One of these is marked St. Croix. This would seem to indicate that if opportunity affords it, this species will breed on

¹ An egg, measured by Mr. STRUBBERG and now in the Zool. Museum of the Royal Agricultural College in Copenhagen, is 43 mm. in diameter, and weighs 30 gr.

the Danish islands. However it is strange that there are so few newly hatched young of this species in our collections, and no eggs whatever, especially since the species is the most common one, whereas the hawksbill which is far more rarely caught, is more fully represented in its newly-hatched stage in the collections. The case is the more strange, as the eggs of the green turtle seem to be found quite commonly other places in West Indian-American regions.

BOEKE (l. c. p. 126—127) states, that according to a report received from Great Inagua, one of the Bahamas, the eggs are collected and hatched and the turtle young artificially fed during a certain period¹. Authors differ somewhat as to the breeding-season of the green turtle. GADOW (l. c.) says that in the West Indian region it falls within the period April to June. AUDUBON, according to LÜTKEN, gives May and June. MUNROE (l. c. p. 273) makes the following statement. "It mates on the Florida coast in the month of May, or thereabouts, the female with eggs, except in rare cases, at once disappearing from these waters, and, until recently, going no one knew where, but it may now be asserted that their hatching-grounds are the beaches of various isolated islands off Central America or the Bahama banks. How this migration is accomplished across the Gulf Stream for hundreds of miles is past comprehension². As high as four hatches of eggs, containing from 130 to 180 each, are believed to be laid by one female during the months of June, July and August . . ."

Although BOEKE (l. c. p. 129) believes that the laying season falls from March to July, he did not succeed in procuring any eggs of the green turtle during this period. However in October, (on the Dutch islands Curaçao and Bonaire) he obtained some eggs, some of which were taken from a turtle, while the others were found in the sand along the coast.

All in all the statements made as to the spawning season of the green turtle are so inconsistent, that one unconsciously begins to suspect that a confusion of the species has often taken place. I think it possible that green turtles' eggs have been found but seldom. This may perhaps be due to the extreme shyness and cunning shown by the female when she comes ashore to lay her eggs. Should BOEKE's find in October month be an ordinary case, there would be but little difference between the spawning season of the green turtle and that of the hawksbill.

V. THE MARKING EXPERIMENTS

A. Method and Plan of the Experiments.

The first intention was to use the two valuable species of turtle, green turtle and hawksbill, for the marking-experiments but, as we soon found that only a few specimens of the latter were obtainable, we decided that the green turtle only should be used.

I had originally thought that turtles could be marked by branding numbers on the carapace, and before leaving for the West Indies we supplied ourselves with several branding-irons, such as are used for branding numbers on military horses. The first turtles marked were branded in this fashion as the

¹ It is possible that these facts only apply to the species hawksbill; whether or not this is the case cannot be seen from the report.

² What right the author has to conclude that it is the same specimens which mate in May on the Florida coast that later lay eggs on the coast of Central America and the Bahamas, is impossible to say.

Marking-experiments, or possibly an intensive study of the various races found in these places, should give an answer to this question.

On the whole, until exact proofs are forthcoming, I am inclined to be extremely sceptical as to the very long migrations the green turtle is supposed to undertake.

figure 5 shows. It is seen that the letters DA (Denmark) are branded on the largest (3rd) right costal shield, while the number 11, is branded on the two middle left costal shields. At first the numbers were very distinct as the figure shows, but I soon saw that there was danger of the marks becoming indistinct

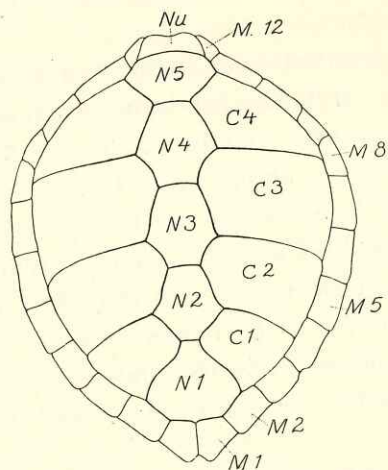


Fig. 4. Green turtle (*Chelone midas*). Carapace, showing the arrangement of the various shields. N_1-N_5 : neural shields; Nu: nuchal shield; C_1-C_4 : costal shields; M_1-M_8 : marginal shields. (Specimen from St. Thomas, Danish West Indies.)

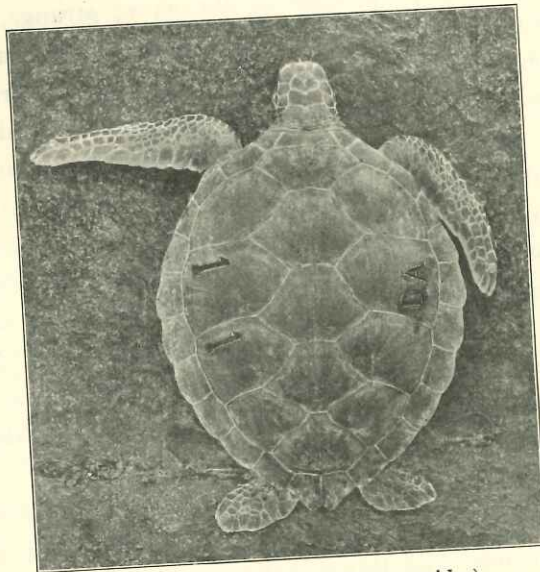


Fig. 5. Green Turtle (*Chelone midas*). Specimen marked No. 11 by branding numbers on the costal shields.

and disappearing. We therefore adopted another method of procedure. This was to fasten to the turtle a piece of flat silver wire, on which was stamped a number and the letters DA. The silver wire (or rather silver tape), was of the same kind as is used for finger rings and found in the shops in St. Thomas.

The marking tape was fastened to the turtle in the following fashion. In one of the posterior marginal shields two circular even holes were made with a drill. The silver tape was threaded through these, and the ends pinched together so that the tape lay tightly against the shield.

Later, as means of marking, in addition to the silver tape holes were bored in the marginal shields. The silver tape is fastened in one of the marginal shields No. 1, in which two small holes have been bored. Other holes that are to indicate numbers are bored in certain marginal shields. (In regard to the terminology of the respective shields,

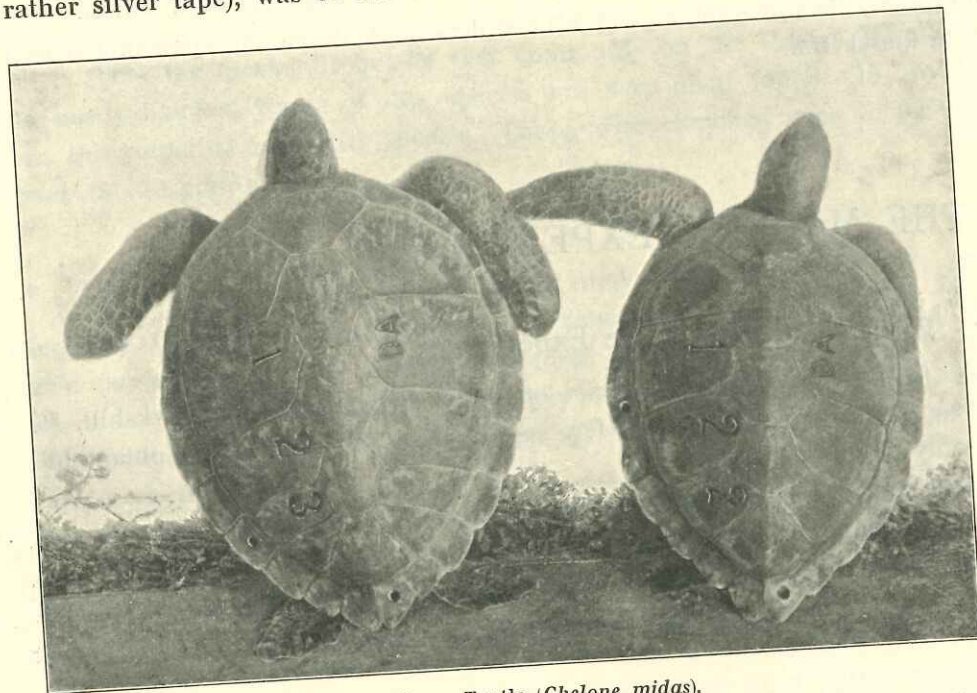


Fig. 6. Green Turtle (*Chelone midas*).

2 specimens, doubly marked, first by branding numbers on the costal shields, secondly by boring holes in the marginal shields. The specimen branded with the No. 123 is marked No. 14 by means of the holes. (The hole in the first right marginal shield indicates 10, the hole in the fourth left marginal shield indicates 4.) The specimen branded with the No. 122 is marked No. 16 by means of the holes, for in addition to the hole bored in the first right marginal shield, a hole has been bored in the sixth left marginal shield.

see Figure 4, where the shields are numbered). These holes are bored in a similar way to that described above, but with only one hole in each shield, and made with a larger drill. The holes in the right marginal shields indicate tens, those in the left marginal shields, ones, and the shield numbers give the ciphers. Figure 6 shows two turtles marked both by branding numbers and by boring holes.

In order to be certain of the identification of the recaptured turtles in this first experiment, where the most important thing was to find a method useful in marking, I let all the marked specimens be photographed. There is so great a variation in the form of the shields (especially the neural shield No. 2), between the various individuals, that by comparing the carapaces sent in with the photographs, a doubt that might have arisen, due to a branded number being almost obliterated, or a silver label being lost, could easily be cleared up.

The result of the marking experiments showed that all the recaptured specimens could be identified with certainty. It soon appeared, however, that branding the figures on the shields was insufficient, for after a few month's the figures could only be read with difficulty, or not at all¹. On the other hand the silver markers seem to prove satisfactory. In one single case the silver marker fell off while the turtle was being handled after being caught. This was probably due to the fact that the two holes in the first marginal shield were bored so close to each other, that the little bridge between them broke. In this case too, the specimen was very small, and the shield in question quite thin. If there is a fair space between the two holes, a repetition of the above accident may be avoided without difficulty. As far as our own experience goes, we find there is good reason to continue the use of silver markers. Possibly for the sake of greater certainty, this method might be combined with drilling holes in various marginal shields. The mark DA is always branded on the largest costal shield, on the right side near the neural shields. When marking-experiments with turtles in the West Indies are made by other nations than the Danish (which we hope soon will be the case), the mark of nationality should perhaps be placed on one of the other costal or neural shields to avoid confusion. It would possibly be better to cut the nationality mark into the shield, rather than brand it.

The plan for the marking-experiments was as follows. Before leaving St. Thomas the Commission applied to the government of the Danish West Indies for help in continuing the experiments, and in receiving the recaptured turtles. An arrangement was made with the harbor direction in St. Thomas, whereby the harbor assistant, Lieutenant V. ARNTZ, was to continue the work after the Commission had left, receive the turtles sent in, measure and weigh them, and send their carapaces together with a report to the "Kommissionen for Havundersøgelse" in Copenhagen. Before this Commission left the West Indies, notices were inserted in all the local papers, requesting fishermen, who might catch marked turtles, to deliver the same to Lieutenant V. ARNTZ, and receive a reward. As it was probable that many of the marked turtles would emigrate from the Danish islands, the government of the Danish West Indies wrote to the colonial governments of the islands lying near St. Thomas requesting their cooperation in the work. In a letter dated May 19, 1914, from the Danish colonial government to the "Kommissionen for Havundersøgelse", we find that such cooperation has been promised by the governments of the British Leeward Islands, thereunder the Virgin Islands, the British Windward Islands, the Barbados, Trinidad, Martinique and Curaçao. The letter states that notices in regard to the experiments have been printed in all the local papers, and that those in authority have been requested to assist in every way possible toward gaining the desired information. The government of the Barbados has, on its own account, offered an extra reward of one dollar for each carapace delivered. No answer had as yet been received from the governments of Porto Rico or Guadeloupe.

¹ This was particularly the case, when as in Fig. 5, the figures (letters) are branded on the outer, not bony part of the costal shield. The marks last longer when they are branded on the inner bony parts of the costals, but even so, not sufficiently long, that this method may be used.

B. Results of the Experiments.

The experiments in marking green turtles in the Danish West Indies, described here, are eleven in number, and include 65 specimens in all. Of these, up to date (Jan. 1, 1916), 9 have been recaptured and recorded, that is to say about 14%. It is by no means certain that this number corresponds exactly to the true state of affairs. It is more than possible that over 14% have been recaptured, and that no record has been made of the specimens, could be due either to the fact that the fishermen have not seen the marks, or have not understood their meaning. This might especially be true in the case of specimens caught in waters outside the Danish West Indies, for example those toward the west (Porto Rico, etc.), where we may conclude that the marking experiments are not known (cf. page 15).

Moreover Table 1, page 17, shows that there is a great difference in the various experiments (marked I—XI) in regards to their percentage of recaptured specimens. This percentage varies from 0—100.

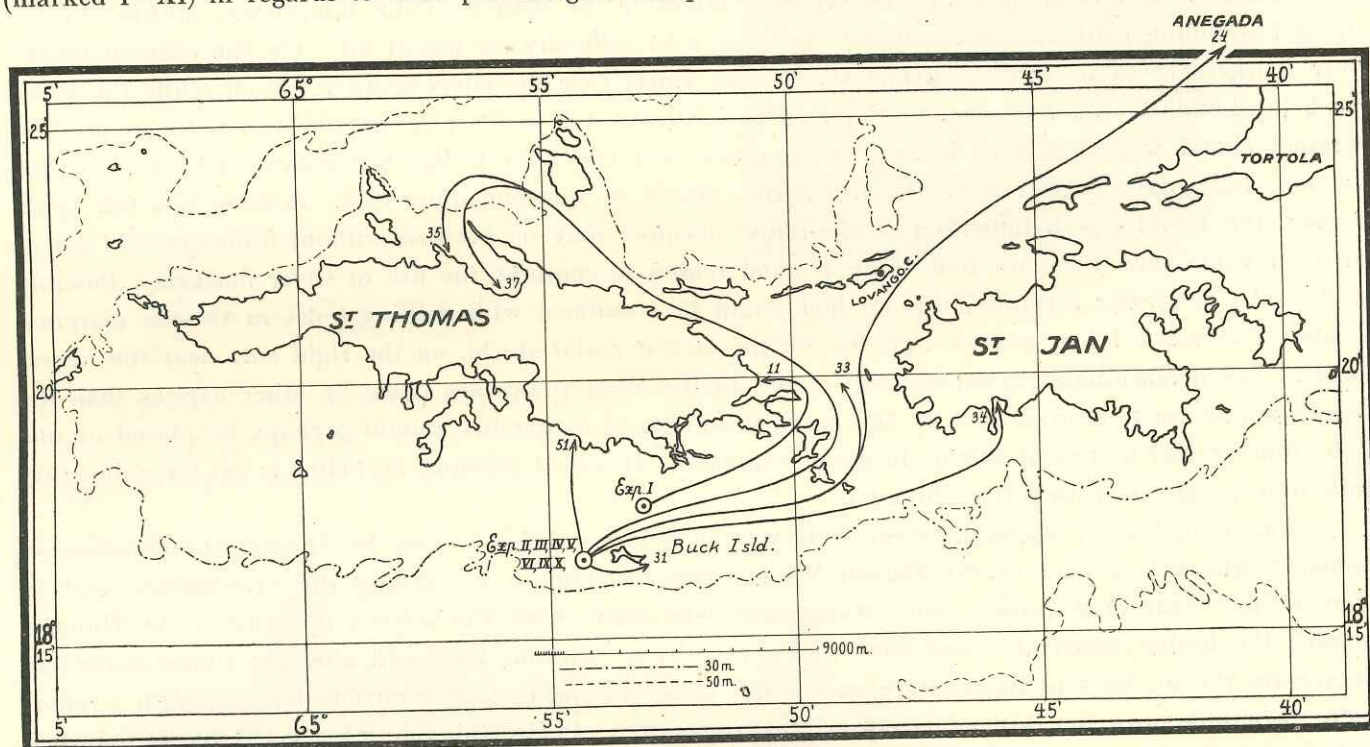


Fig. 11. Chart showing the migration of the marked Turtles (*Chelone midas*).

The Roman number beside the liberating-places indicates the number of the experiment, the Arabic number beside the catching-places indicates the number of the marked turtle. (Cf. Table I, p. 17.)

If we leave out of consideration, experiments Nos VII and XI, in which the turtles were liberated in deep water, north of St. Croix, and experiment No. VIII, in which the turtles were liberated between St. Jan and the British island Tortola, all the remaining experiments (I, II, III, IV, V, VI, IX, X) were carried out in nearly the same locality, that is to say, in shallow water of about 15 fathoms, due south of St. Thomas, and close to the little "Buck Island".

From the table we see that the turtles (with the exception of No. 122, which was caught the day after liberating, and therefore liberated again), have been from 3½—11 months in the ocean before being recaptured.

From the chart, fig. 11, page 16, we see that none of the recaptured specimens have wandered far or quickly. No. 31 has travelled furthest, having gone eastward to the British Island Anegada, a distance not exceeding 50 miles, and for which it has used 10 months, so that the average distance travelled may have been about 5 miles per month. The remaining specimens have wandered but a very few miles, for

Fig. 7—10. Newly hatched young of the various species of Turtles.

All figures about natural size. — Drawings by Miss B. ROHWEDER.

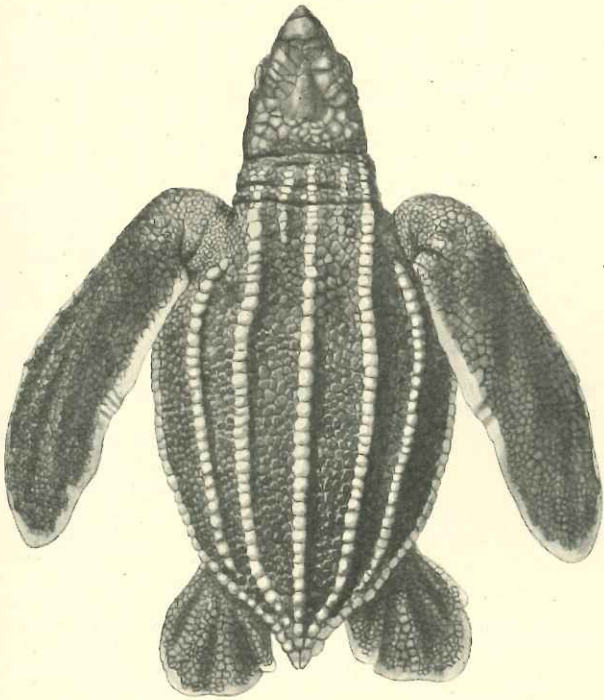


Fig. 7. Trunk Turtle (*Sphargis coriacea*).

Principal distinctive features: Carapace consisting of numerous small polygonal plates. (Specimen from St. Croix, Danish West Indies).

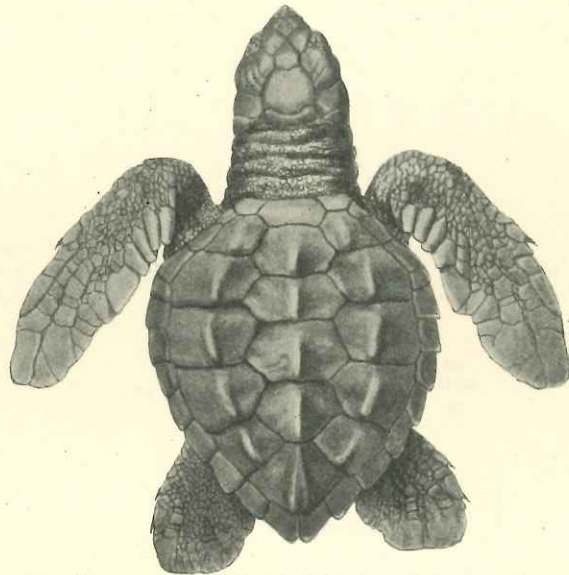


Fig. 8. Loggerhead Turtle (*Thalassochelys caretta*).

Principal distinctive feature: 5 pairs of costal shields. (Specimen from Realejo, Nicaragua).

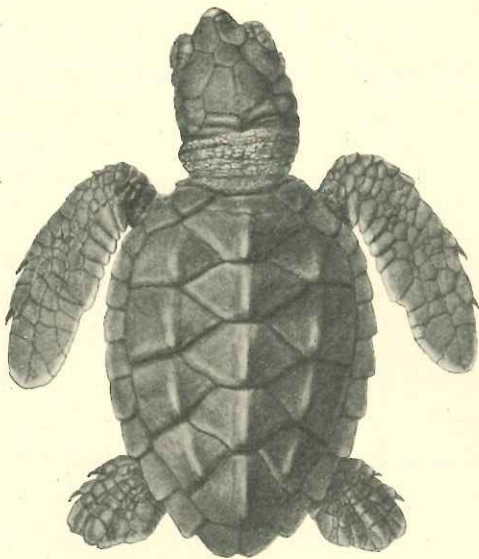


Fig. 9. Hawksbill Turtle (*Chelone imbricata*).

Principal distinctive features: 4 pairs of costal shields, 3 distinct longitudinal keels, shields overlapping, two claws on the limbs. (Specimen from the Danish West Indies).

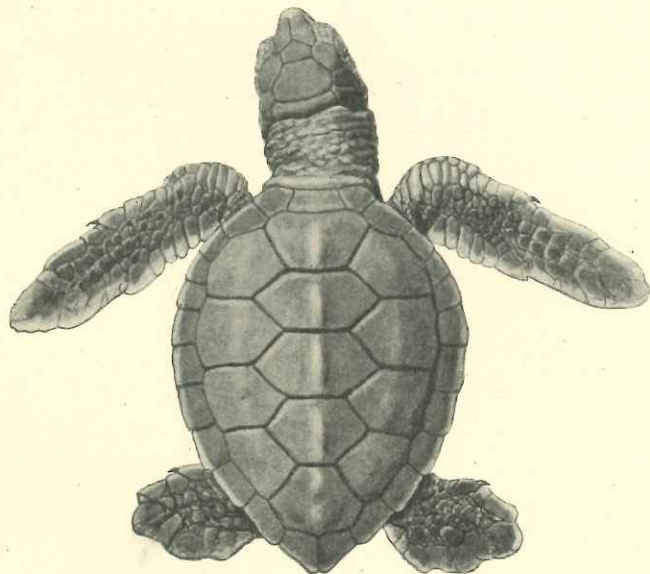


Fig. 10. Green Turtle (*Chelone midas*).

Principal distinctive features: 4 pairs of costal shields, only one distinct longitudinal keel, shields juxtaposed, only one claw on the limbs. (Specimen from the Danish West Indies).

Table I. Marking experiments with Green Turtle (*Chelone midas*) in 1914.

Particulars of liberation (Date, No. of turtles, Locality etc.)	Particulars of Recovery													Received by
	Date	No. on Label	Locality reported	Approximate Position	No. of months between Liberation and Recovery	Initial Length of Carapace	Ultimate Length of Carapace	Initial Breadth of Carapace	Ultimate Breadth of Carapace	Initial Weight	Ultimate Weight	Average increase in weight per month	Percentage of specimens recovered	
I 1914, Feb. 25 12 turtles Off Long Point, St. Thomas depth 12 fms. 18°17,5' N., 64°53' W.	1914, June 25	11	Redhook, St. Thomas	18°19,9' N 64°50,7' W	4	cm. 28.5	cm. 31	cm. 24.5	cm. 27	lbs. 5 gr. 2232	lbs. 7 1/2 gr. 3348	lbs. 0.63 gr. 281	8 %	V. Arntz
II 1914, March 21 7 turtles 18°16' N., 64°54,5' W. depth 15 fms. 1/2 mile West of Buck Island	1915, Feb. 4	24	Anegada, British West Indies	18°40' N 63°35' W	10	45	51.5	40	46.5	lbs. 20 1/2 gr. 9192	lbs. 30 gr. 13393	lbs. 0.95 gr. 442	14 %	W. Faulkner (Anegada)
III Same locality as experiment No. II 3 turtles 1914, May 8	1915, April 7	31	S.E. side of Buck Island, St. Thomas	18°16,6' N 64°53,1' W	11	40.5	47	36	44	lbs. 15 gr. 6696	lbs. 22 gr. 9821	lbs. 0.64 gr. 286	33 %	Louis Catale
IV 1914, June 5 Same locality as experiments No. II and III 4 turtles — — —	1914, Sept. 18	34	Fish Bay, St. Jan	18°19,2' N 64°45,9' W	3 1/2	57	58	52	53.5	lbs. 44 gr. 19643	lbs. 46 gr. 20535	lbs. 0.58 gr. 259	100 %	Herbert Stevens
	1914, Oct. 2	33	Between Goat Point and St. Jan	18°19,8' N 64°49,1' W?	4	48.5	50	44	45	lbs. 26 1/4 gr. 11719	lbs. 28 1/2 gr. 12723	lbs. 0.5 gr. 223		Hubert Richardson
	1915, Feb. 11	35	Magens Bay, St. Thomas	18°22,5' N 64°56,8' W	8	39.5	40.5	37	39.5	lbs. 15 gr. 6696	lbs. 17 1/2 gr. 7812	lbs. 0.31 gr. 138		Louis Quera
	1915, Feb. 11	37	Magens Bay, St. Thomas	18°22,5' N 64°56,8' W	8	35	40.5	32	37	lbs. 11 gr. 4911	lbs. 17 gr. 7589	lbs. 0.75 gr. 335		Louis Quera
VI 1914, July 16 Same locality as experiments No. II, III, IV 7 turtles	1914, Dec. 15	51	Frenchman's Bay St. Thomas	18°18,9' N 64°54,5' W	5	44	44.5	38.5	39	lbs. 18 1/2 gr. 8259	lbs. 20 gr. 8929	lbs. 0.3 gr. 134	14 %	John Joseph Magras
XI 1914, Dec. 24 17°48' N., 64°43' W. 5 turtles	1914, Dec. 26	122		17°48' N 64°43' W	0	33		28.5		lbs. 8 1/4 gr. 3683			20 %	?
V 1914, June 19 Same locality as experiments No. II, III and IV 5 turtles	No specimens recorded up to Jan. 1, 1916.													
VII 1914, July 29 17°50' N., 64°52' W. 7 turtles														
VIII 1914, Aug. 15 Between St. Jan and Tortola 4 turtles														
IX 1914, Sept. 9. Ca. 1 mile W. of Buck Island 6 turtles														
X 1914, Oct. 1 Same locality as experiment No. IX. 5 turtles														

instance No. 31, eleven months after marking, was caught in almost the same spot (liberated 18°16' N., 64°54,5' W., recaught 18°16,6' N., 64°53,1' W.).

All in all, the records made thus far, though few in number, seem to show that the younger specimens of the green turtle, such as those used in the experiments, are very stationary.

As to the rate of growth of turtles, these records, in spite of the fact that they are but few in number, give us valuable and consistent information. This may be seen from Table I, page 17. In explanation, I must add that the length of the specimens is measured (in centimeters), from the foremost edge of the nuchal shield along the longitudinal keel to that point where the left marginal shield No. 1, separates from the right marginal shield No. 1. The measurement is made by means of a tape-measure laid along the middle of the shield, which is arched, so that the measure does not show the distance between the two extremities. In the same way the greatest width of the carapace is measured with a tape-measure. The weight is reckoned in English pounds on a decimal scales, belonging to the Customs House in St. Thomas.

From the Table we see that the monthly increase in weight varies from 0.3 to 0.95 English lbs. (138—442 grammes). In the following little table the specimens are arranged according to their weight at

Table II. Green Turtle
(*Chelone midas*).

Initial weight lbs.	Average Increase in weight per month	
	in lbs.	in % of initial weight
5	0.63	12.6 %
11	0.75	6.8 —
15	0.64	4.3 —
15	0.31	2.1 —
18.5	0.31	1.6 —
20.5	0.95	4.6 —
26.25	0.50	1.9 —
44	0.58	1.3 —

the time of marking, and the increase in weight per month is given in pounds and in percentage of the weight at the time of marking.

From this table we find a very slight difference in the monthly gain between the largest and the smallest specimens, weighing 44 and 5 lbs. respectively. On the whole younger specimens show the largest percentage of gain in weight per month.

If we count on a monthly increase averaging $1\frac{1}{2}$ lb. per specimen, which is too small an increase rather than too large, the monthly increase in value of the small green turtles which we are considering here will be between 10—15 centimes, when prices paid per lb. in St. Thomas vary from 20 centimes (4 cents) to 30 centimes (6 cents).

The season of the year does not appear to exert any special influence on the rate of growth (see Table I), but the seasons in tropical waters¹ are not as clearly defined as they are in northern waters.

It is of great importance to be able to tell the age of a green turtle of such and such a size and such and such a weight. Unfortunately we have as yet insufficient material for making a definite statement in regard to the matter.

¹ In an article, "Sur le développement des tortues (*T. caretta*)" (C. R. Soc. Biologie Paris, tome V. p. 10—11, 1898), S. A. S. Prince ALBERT I OF MONACO reports some interesting observations made as to the growth of 3 specimens of loggerheads, caught near the Azores and placed in a pool filled with salt water at Monaco, where they were fed with fish. The temperature of the water was 21°—23° in the summer, 17° in the winter. It was observed that the turtles ate much more during the summer than during the winter, with a resulting greater growth in summer than in winter. I quote below the results found by weighing.

Specimen A.		Specimen B.		Specimen C.	
23 August 1895	2.30 kg.	3 Sept. 1896	23.1 kg.	23 July 1897	0.68 kg.
26 March 1897	4 -	26 March 1897	25.6 -	18 Sept. —	1.2 -
7 April —	4 -	7 April —	25.5 -	5 Nov. —	1.3 -
25 April —	4 -	25 April —	25.5 -	15 Dec. —	1.36 -
28 May —	4 -	28 May —	26.1 -		
18 Sept. —	5.1 -	18 Sept. —	30.38 -		
5 Nov. —	5.2 -	5 Nov. —	34.1 -		
15 Dec. —	5.3 -	15 Dec. —	35.2 -		

The results found by weighing these loggerheads show quite another condition of weight than that found in our marking experiments with the green turtles, i. e. that not only is there a great difference in the rate of growth between summer and winter, but also between large and small specimens. We see, for instance, that specimen B, in the period from April 25—Dec. 15, 1897 gains 10 kg. in weight, an enormous increase in weight for so short a period, and not to be compared with anything our experiments can show.

Table III. Green Turtle (*Chelone midas*), St. Thomas 1914.

Showing the ratio between total weight and length and breadth of Carapace, according to measurements made by the "Kommissionen for Havundersøgelse" and Mr. V. ARNTZ.

Length of Carapace	Breadth of Carapace	Weight	Weight	Length of Carapace	Breadth of Carapace	Weight	Weight	Length of Carapace	Breadth of Carapace	Weight	Weight
cm.	cm.	kgs.	lbs.	cm.	cm.	kgs.	lbs.	cm.	cm.	kgs.	lbs.
23	21	1.3	2 ¹³ / ₁₆	35	32	4.9	11	45.5	40	9.2	20 ¹ / ₂
26.5	23	2.1	4 ³ / ₄	37.5	34.5	6.0	13 ¹ / ₂	46	41	9.2	20 ¹ / ₂
26.5	23.5	2.0	4 ¹ / ₂	39	33.5	6.7	15	46.5	41.5	10.7	24
27	23	2.0	4 ⁷ / ₁₆	39	37.5	6.7	15	46.5	43	9.9	22 ¹ / ₄
27.5	25	2.0	4 ¹ / ₂	39.5	37	6.7	15	47	44	9.8	22
27.5	24	2.5	5 ¹ / ₂	40	35.5	7.4	16 ¹ / ₂	47	43.5	11.4	25 ¹ / ₂
28	25	2.5	5 ¹ / ₂	40	38	7.5	16 ³ / ₄	47	43	11.2	25
28	24.5	2.2	5	40	38	7.6	17	47.5	43	11.2	25
28.5	24.5	2.2	5	40	37.5	7.1	16	47.5	43	10.3	23
28.5	24.5	2.7	6	40.5	36	6.7	15	47.5	46	11.3	25 ¹ / ₄
28.5	24.5	2.5	5 ⁹ / ₁₆	40.5	39.5	7.8	17 ¹ / ₂	48.5	44	11.7	26 ¹ / ₄
28.5	25	2.5	5 ¹ / ₂	40.5	37	7.6	17	48.5	43.5	10.7	24
29	25	2.7	6	42.5	38.5	8	18	48.5	44.5	12.1	27
30	27	2.9	6 ¹ / ₂	43	38.5	8.9	20	50	45	12.7	28 ¹ / ₂
30.5	27	3.1	6 ⁹ / ₁₀	43	39	8.5	19	50	45	12.9	29
31	27	3.3	7 ¹ / ₂	43	38	8.5	19	50	45	13.2	29 ¹ / ₂
32	28	3.3	7 ¹ / ₂	44	38.5	8.3	18 ¹ / ₂	50.5	43	12.7	28 ¹ / ₂
33	28.5	3.7	8 ¹ / ₄	44	41.5	9.4	21	50.5	45.5	13.2	29 ¹ / ₂
33.5	30.5	4.2	9 ¹ / ₂	44.4	39	9.2	20 ¹ / ₂	50.5	45.5	13.2	29 ¹ / ₂
34	28.5	5.4	12	44.5	39	8.9	20	51.5	46.5	13.4	30
34	28.5	5.4	12	45	40	9.2	20 ¹ / ₂	55	50	16.5	37
34.5	30.5	4.9	11	45	41.5	10.4	23 ¹ / ₂	57	52	19.6	44
34.5	29.5	4.2	9 ¹ / ₂	45.5	40	10	22 ¹ / ₂	58	53.5	21	46
34.5	30	5.4	12								

A few remarks on the subject may however, be of interest. I will first refer to Table III, p. 19, in which the size and weight of certain specimens of green turtle examined in St. Thomas by the Commission and by the harbor assistant, Lieutenant V. ARNTZ, are given. From these we see that specimens having a carapace 23--30 cm. long, weigh from 3--6 English lbs. A weight of 20 lbs., or thereabouts, gives a corresponding carapace 45 cm. long, and a weight of 30 lbs. a carapace 50 cm. long, and a weight of 45 lbs. a carapace ca. 57 cm. long¹.

It would be possible to find out the age of the turtles here described, did we but know the age of the smallest specimens examined, for by means of the marking experiments we can estimate approximately the subsequent monthly (or yearly) growth.

The question then resolves itself to this. How rapidly do turtles grow in the first period of their life? As far as I know, the literature on the subject gives no information for the green turtle. We must therefore turn to the hawksbill. Here we find several interesting observations from the Danish West Indies recorded by TH. MORTENSEN and published in his article on the Marine Resources of the Danish West Indian Islands (l. c. p. 141). In this he tells how Consul SCHACK in St. Thomas, on April 29, 1905,

¹ The "Kommissionen for Havundersøgelse" have had no access to larger specimens, so no general statement can be made as to the relationship existing between the weight of the turtle and the length of the carapace. There is, however, (on the request of the Commission through the government) a record of the size and weight of the various turtles, made by the butchers in St. Thomas. These measurements are quoted page 20, Table IV. In examining them, many inconsistencies will be found, so they are cited with great reservation.

placed two hawksbill young in a little pool, and later, June 26, a young specimen that was somewhat larger. They were measured again Dec. 18, 1905¹.

The result was as follows.

No. 1:	measured April 21;	length 10 cm.;	breadth 6.5 cm.
—	—	Dec. 18;	— 23 — — 15.0 —
No. 2:	—	April 29;	— 9 — — 6.5 —
—	—	Dec. 18;	— 20 — — 6.5 —
No. 3:	—	June 26;	— 14 — — 11.5 —
—	—	Dec. 18;	— 24 — — 16.5 —

From these observations we see that the small hawksbill young gain on an average 1½ cm. per month, and that in December they had reached a length of 20—24 cm.

Now comes the question, at what season of the year do the hawksbill young come into the world? As I have mentioned before, statements made as to the spawning-season of this species agree very well,

Table IV. Green Turtle (*Chelone midas*).

Size and weight. Records by the butchers, St. Thomas, 1914—1915.

Length of Carapace	Breadth of Carapace	Weight	Weight	Length of Carapace	Breadth of Carapace	Weight	Weight	Length of Carapace	Breadth of Carapace	Weight	Weight
cm.	cm.	kgs.	lbs.	cm.	cm.	kgs.	lbs.	cm.	cm.	kgs.	lbs.
36	29	8.5	19	25	?	6.7	15	38	36	7.1	16
37	29	8.5	19	25	?	6.7	15	43	33	4.9	11
38	34	8.9	20	30	23	8.9	20	43	36	5.8	13
38	34	9.4	21	30	23	8.5	19	48	42	11.6	26
39	32	9.4	21	30	23	8.9	20	51	43	12.5	28
39	35	9.4	21	36	?	8.9	20	53	43	13.4	30
40	36	9.4	21	38	»	8.9	20	56	51	17.4	39
40	35	9.8	22	38	30	13.4	30	56	46	15.6	35
40	36	10.3	23	41	?	11.2	25	56	46	15.6	35
41	37	10.7	24	46	33	13.4	30	64	56	29.0	65
42	38	11.2	25	51	?	13.4	30	69	58	40.2	90
43	41	11.6	26	51	»	13.4	30				
45	42	12.3	27½	53	»	14.3	32				
48	44	17.4	39	56	46	17.9	40				
49	47	13.4	30	56	46	17.9	40				
50	44	13.8	31	56	46	17.9	40				
52	43	11.6	26	61	46	17.9	40				
54	49	14.3	32	61	46	17.9	40				
55	48	17.4	39	66	51	20.1	45				
55	47	19.6	44	66	51	20.1	45				
56	50	14.3	32	66	51	20.1	45				
56	51	14.5	32½	76	58	22.3	50				
60	52	20.1	45	81	?	22.3	50				
60	49	21.9	49	84	»	22.3	50				
66	60	23.2	52	86	»	24.4	54				
71	61	28.8	64½	91	69	26.8	60				
71	61	26.8	60	91	?	35.7	80				
73	62	31.2	70	94	71	27.2	61				
87	79	18.3	41	106	79	31.2	70				
101	86	17.9	40								
114	100	26.8	60								

¹ The measurements were given in inches, but have been here transposed to centimeters.

and it is placed in the period from summer to autumn ("hurricane season"). Without being very far afield, we may place the time for hatching in October¹. We come then to this result. Those specimens, which in April, 1905, measured 10 cm. and in Dec. 1905 20—24 cm. must have been born in October 1904.

This deduction is confirmed further by the fact that the majority of the young of this species,

Table V. List of specimens of Green Turtle (*Chelone midas*),

landed in St. Thomas during the period August 1914—June 1915, with record of the weight and place where each was caught, from the statistics given to the government by the butchers in St. Thomas.

Date	Weight lbs.	Locality	Date	Weight lbs.	Locality
1914			1915		
August 8	30	St. Thomas, North Side	February 19	26	Anegada
— 15	20	— , West End	— 19	21	—
— 22	50	— , East End	— 19	39	—
— 28	32	Anegada	— 24	30	St. Thomas, South Side
September 3	30	St. Thomas, North Side	— 24	32	Tortola
— 4	45	Jost van Dyke	— 26	60	—
— 4	39	—	March 5	41	—
— 18	60	Anegada	— 5	40	St. James
— 25	49	Tortola	— 12	22	Anegada
— 30	21	—	— 12	19	—
October 1	80	St. Thomas, North Side	— 12	24	—
— 2	26	Thatch Island	— 12	45	Smith's Bay
— 8	25	St. Thomas, North East Side	— 19	19	St. Jan
— 9	44	Smith's Bay	— 24	45	Buck Island
— 14	19	—	— 24	35	St. Jan
— 14	20	St. Jan	— 24	11	St. Thomas
— 24	32	Virgin Gorda	— 26	90	—
November 12	31	St. Thomas, South Side	April 7	40	St. Jan
— 13	15	Anegada	— 9	21	Smith's Bay
— 20	70	—	— 14	60	Tortola
— 25	15	—	— 14	35	?
— 27	50	Jost van Dyke	— 16	28	St. James
— 27	64 ¹ / ₂	Anegada	— 17	20	Tortola
December 4	52	Smith's Bay	— 23	25	—
— 4	54	St. Thomas, South Side	— 30	40	St. Thomas, West End
— 6	15	Tortola	May 5	20	—
— 9	39	St. James	— 7	30	Anegada
1915			— 7	27 ¹ / ₂	—
January 8	40	Anegada	— 7	21	—
— 15	20	St. Thomas, West End	— 14	40	Smith's Bay
— 23	65	St. Jan	— 14	23	—
— 29	31	Smith's Bay	— 14	30	St. Thomas
— 29	50	St. Thomas, North Side	— 14	40	Virgin Gorda
February 5	61	Anegada	— 21	70	Savana Island
— 17	27	Tortola	— 28	32 ¹ / ₂	Tortola
— 17	13	St. Thomas	June 4	45	St. Jan

found in the collections in Copenhagen, and presumably newly-hatched, measure a little over 4 cm. in length (see page 11). Moreover we find that a specimen, brought to Denmark by Mr. CHR. LÖFTING, from the Danish West Indies, and caught at the end of January 1896, measures 7·8 cm. (weight 65 grammes).

¹ In the literature on the subject we find that according to some authors the period of incubation lasts 6—7 weeks (GADOW, l. c., according to Agassiz; BOEKE, l. c.), according to others 10—12 weeks (MUNROE, l. c.). These notes, however refer to the green turtle. On an average the period of incubation may be taken to last 2 months. DAVENPORT HOOKER (Science, N. S. vol XXVII, p. 491, 1908) says that for the loggerhead the period of incubation lasts about 50 days.

We may therefore conclude that the young of the hawksbill species, which during the winter were a little over 20 cm. in length, were a little over a year old (between 1—1½ years).

The following shows the rate of growth of the hawksbill in the Danish West Indies during its earliest stages.

	First autumn,	about	4—5	cm.	long
—	winter,	—	7—8	-	—
—	spring,	—	10	-	—
	Second autumn	—	20	-	—

When we try to apply the information we have about the hawksbill, in an attempt to discover the age of the smallest specimen of green turtle examined by us, we meet several difficulties. For the first, nothing is known as to the breeding season of the green turtle. Then too, as it is a different and larger species than the hawksbill, we cannot take for granted that it will have the same size at the end of its first year.

I do not know positively what size the green turtle has when it comes out of its egg, but judging from the smallest specimens found in the collections in Copenhagen, and which are presumably newly hatched, we may place the size at about 5 cm. (cf. page 11), and therefore in this respect does not differ very much from the hawksbill.

In the West Indian waters the spring and summer are usually considered the spawning season for this species. However BOEKE (l. c. page 129) has seen eggs of this species in October on the Dutch islands Bonaire and Curaçao, and MUNROE (l. c. page 273) mentions June, July and August as the spawning-season in Florida. We therefore find that eggs are laid during the greater part of the year.

If we turn to our own material, the young green turtles which we have examined in St. Thomas, we seem to find that the following conditions exist. Small specimens 23—30 cm. in length and 2—6 lbs. in weight are caught for the most part during the winter and spring months (Jan., Feb. and March) while none or but very few of that size are caught during the summer and autumn. I say with emphasis "seem" to exist, for it must be confessed that at present the observations made are too few, and made during too short a period for me to consider the matter settled. If however, the conditions are as above stated, it means most probably that here, as in so many marine animals, a certain periodicity is present, which is due to the young being hatched during a somewhat limited season of the year.

An examination of the small green turtles made in St. Thomas in February, 1914, shows that their average length was 27—28 cm., and their average weight a little over 5 lbs. In connection with what we discovered to be true of the hawksbill (see above), and that turtle No. 11 in 4 months grew from 28.5 to 31 cm. (see Table I), we may perhaps say that these green turtles are a little over a year old, perhaps 1½ years, and in this time they have grown in length from 5 to 27 or 28 cm., and increased their weight from 20 to 2300 grammes.

If this conclusion as to their age is correct, we have the following results (cf. results from our marking experiments).

Green turtles which weigh:	about 5 lbs.	are about	1—1½	yrs.	old
— 12	- - -	—	2—2½	- - -	
— 20	- - -	—	3—3½	- - -	

and we may state in regard to the green turtles young that they are:

	the first summer or autumn	about	5	cm.	in length.
—	winter or spring	—	?		
second	— - -	—	27	- - -	
third	— - -	—	35	- - -	

I hardly need to say that even if there is all probability for the correctness of the above conclusion as to the age of the green turtles, which in February weighed 5 lbs., yet the matter cannot be regarded as settled before exact information has been obtained as to the rate of growth of the turtle during the first year and also the season at which the young are hatched. To settle these two questions seems to me the most important matter with which the study of the biology of the green turtle has at present to deal.

VI. RESUMÉ

In the Danish West Indies all 4 species of turtles are to be found, the trunk turtle (*Sphargis coriacea*), loggerhead or lantern back (*Thalassochelys caretta*), hawksbill (*Chelone imbricata*) and green turtle or green back (*Chelone midas*). Of these, only the two last have commercial value.

We have only proof that the hawksbill and trunk turtle breed on the islands, the former during the summer and autumn ("hurricane season"), the latter earlier in the year, in the spring or early summer. Only in the case of the hawksbill have we so many data that we are able to form a picture of the growth of the turtle during its first year. At the time of hatching in the autumn, the hawksbill young is 4—5 cm. long (carapace). In the winter it attains a length of 7—8 cm., in the spring 10 cm. In the beginning of its second winter it has a length of about 20 cm.

The green turtle is, when hatched about 5 cm. long. After that, we have no specimens smaller than 23 cm. long, (weight a little under 3 lbs.), and we do not know where the specimens of intermediate sizes are to be found. Small green turtles with an average length of about 27 cm. and a weight of about 5 lbs. are quite common during the winter season, and there is much that would indicate that these specimens are between 1—1½ years old.

The marking experiments in the Danish West Indies carried on in 1914 with young and somewhat older specimens of green turtles (weight from 5—45 lbs.) have shown that they gain on an average a little more than ½ lb., (0.58 lbs. or 259 grammes), per month, and corresponding to this there is a monthly increase in value of 10—15 centimes. The average increase in weight per month varies as a matter of fact from 0.3—0.95 lbs., and is proportionately greater for the smaller specimens. As far as the present results of the experiments may be taken as an indication, the rate of growth seems to be the same throughout the year.

Of the 65 specimens used in the 11 marking experiments, 9 specimens or abt. 14%, have been recaptured and recorded. Probably a larger percentage has been recaptured but not recorded. There is a great difference between the experiments in regard to the percentage of recaptured and recorded specimens. It varies from 0—100%. In most cases the recaptured specimens seem to have migrated but little, the only exception being specimen No. 24, which wandered from the waters south of St. Thomas, in a north-easterly direction to the British island Anegada, a distance of about 50 miles, but requiring no less than 10 months to cover the distance. On the other hand, specimen No. 31 has apparently not wandered at all during 11 months, and was recaptured in the same place in which it was liberated after having been marked. All in all, the marking experiments seem to indicate that the young specimens of green turtle are rather stationary.

The relation between the length of the carapace, and the total weight, may in the case of the younger specimens of green turtle be seen from the figures in Table III, p. 19.

No statistics are to be found concerning turtle-catching in the Danish West Indies. However the

records, kept by the butchers in St. Thomas and referred to in Table V on page 21, give an impression of the yield.

Many more green turtles are caught than hawksbills, but the single specimens of hawksbill are far more valuable. A full grown, well developed specimen of this species easily attains a value of 100 francs (₣ 20) or more, on account of its horny shields ("tortoise shell"). In St. Thomas a green turtle brings about 20 centimes pr. lb. Specimens weighing over 100 lbs. are rare. The majority of green turtles captured weigh much less.

That species, which in the Danish West Indies particularly yields the commonly enjoyed delicacy known as "turtle eggs", is the hawksbill. It is therefore very probable that the cause of the alleged decrease in numbers of this species is the great destruction of its eggs. In the case of the green turtle the decrease in numbers must be due to another cause, since the eggs of this species have never been found by the fishermen of the Danish West Indian Islands.

VII. SUGGESTIONS FOR FURTHER INVESTIGATIONS

The object of this work is to begin the collection of such reliable facts concerning the biology of the turtles, as are at present wanting, but which are indispensable when regulations to assist in increasing the turtle catch are to be formed. In certain directions the work has brought in valuable information, but up to the present the observations are too few, and have been made during too short a period for me to be able to give any positive suggestions as to how the turtles should be protected. The work's most important contribution, at present, lies in the fact that through it, it has been possible to define more sharply the information on the subject still needed, and indicate in what way it may best be sought.

When one, like the author, has his residence in Europe, and the opportunity of paying but short visits to the West Indies, and those during the winter, a season particularly unpropitious for the study of the breeding habits of the turtles, it becomes necessary to make serious efforts to arouse the interest of the more intelligent members of the population of the islands in this "turtle question". I do not doubt but that through their cooperation, much valuable information could be gained, which in connection with the continued marking experiments would lead to a desired result.

I wish very briefly to state which particular chapters of the biology of the turtles need further explanation, and toward which, those who have opportunity for, and interest in the work, should in particular turn their attention.

Before going further, I must once again emphasize the fact that it is absolutely necessary to discriminate between the various species of turtles which live in the West Indies. Without such discrimination, all eventual observations will have but small value, for the four species are very unlike, and we must be prepared to find that they vary greatly in their habits of life, growth, and wanderings. An aid in distinguishing between the 4 species is given in section 2, where figures showing the differences are also to be found.

1. Breeding.

First and foremost exact information should be obtained as to which species lay their eggs on the islands, and as to when and where this takes place.

We can hardly state with any degree of certainty whether other species than hawksbill and trunk turtle breed on the Danish Islands. Whether the green turtle, the species most commonly caught, breeds in the Danish West Indies, or whether it first arrives there as specimens 20—30 cm. in length, is strangely enough, unknown, and is a matter of great importance.

Next, information should be obtained as to which species breeds in the greatest numbers on the islands. For instance, if in the course of a season, 10 nests are found in a certain locality, how many of these belong to the hawksbill, how many to the trunk turtle, etc.

As is known, turtle eggs are an article of commerce in the islands. It is very important to know definitely to which species in particular, the eggs bought and sold belong. Every one who buys turtle eggs should, in addition to marking a note of the date, ascertain from where they were taken, how many there were in the nest, and to which species they belong. I must state that trunk turtle's eggs are larger than the eggs of any other species (about 6—6 $\frac{1}{2}$ cm. as compared to 4—4 $\frac{1}{2}$ cm.) but otherwise, as far as I know, there is no way of distinguishing between the eggs of the various species, and it will therefore be a matter of great interest to have the opportunity of examining the turtles eggs, especially those in which young turtles are found. They may be preserved in alcohol (or rum).

2. The Newly-hatched Young.

Exact information is wanting as to the season of the year at which the young of the various species leave their nests, and their size on being hatched. By means of the figures it is hardly a difficult matter for one interested in this subject to decide with which of the 4 species he has to deal. Moreover it will always interest the Commission to have an opportunity of examining such newly hatched specimens of turtle young if exact data as to the date and place where they were found are given. These, like the eggs may be preserved in alcohol (or rum).

Information, moreover, is desired as to the approximate number of young per nest. In the literature on the subject we find that the newly hatched turtles are so hunted by other animals that possibly only 2—3% survive the first period of their life. It is important to have information based on observations as to which animals, in particular, eat the newly hatched turtle young.

3. Undersized Turtles.

Information is desired as to the season and place for finding turtles having a carapace 10—20 cm. (4—8 inches) in length. This applies particularly to the green turtle, and it is very important to ascertain whether specimens of this size are to be found in the Danish West Indies. With the exception of a couple of newly-hatched specimens having a carapace of about 5 cm. (2 $\frac{1}{2}$ inches) in length, found in the collections in Copenhagen, no specimen less than 23 cm. (about 9 inches) long and weighing 3 lbs. is known to have been found at the Danish islands.

In a similar way information is wanted as to the hawksbill young 10—20 cm. long.

4. Mature Turtles.

Information is wanted as to the season of the year during which turtles of the various species, especially the green turtle and hawksbill, contain ripe or nearly ripe eggs. (The size of the largest eggs

should be given.) It is also very important to know how large turtles must be (length and weight) in order to produce young, i. e. to contain ripe or nearly ripe eggs.

Exact information is requested as to the relation between the length of the carapace (measured as indicated on page 18), and the weight as shown in Table III, page 19 (this especially in the case of large specimens¹).

Statistics are requested as to all the specimens of green turtle and hawksbill caught and landed in the Danish West Indies, large or small. For each specimen the length of the carapace should be given, its weight, sex, (or whether the specimen contained ripe or nearly ripe eggs, and their size), and the date and place of capture. If statistics of this kind can be made, which can be done through the friendly coöperation of the butchers, we will be able to give a splendid picture of the size of the turtle yield, and at the same time those points mentioned above under 4 will be explained.

¹ Measuring should take place as soon as possible after the turtle is caught, as turtles lose much in weight when they are kept without food. As an example of this I can state that a specimen of green turtle, which we brought home to Denmark from the West Indies in May, 1914, weighed 34½ lbs. when caught on May 1, but when it arrived in Copenhagen, June 6, 1914, it only weighed 27⅞ lbs. It had lost ⅙ of its weight in a little over a month.

MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER

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