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NATURAL HISTORY NOTES ON SOME BEAUFORT, N. C., FISHES, 1910–11.

No. I. Elasmobranchii—with Special Reference to Utero-gestation.

BY E. W. GUDGER.

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The personal observations recorded in this paper were made between May 25 and July 28, 1910, and between May 13 and July 15, 1911, while the writer was at work as investigator for the United States Bureau of Fisheries at its laboratory at Beaufort, N. C. The fishes studied were in part collected by the seining crew temporarily employed for the writer's work on the gaff-topsail catfish, but the larger number, especially of the rays, was obtained by visiting the drag-net fishermen up Newport River, and particularly Messrs. J. E. Lewis and Charles L. Willis of Morehead City, whose continued kindness it is a pleasure to acknowledge.

The observations recorded other than the writer's own are chiefly those of Mr. Russell J. Coles, a sportsman of Danville, Va., whose fishing experiences at and about Beaufort and whose gifts of specimens to the laboratory cover nearly a decade. In another paper of this series more definite mention and acknowledgment of Mr. Coles' collections will be made.

Carcharhinus (species unknown).

On July 12, 1910, two small sharp-nosed sharks were taken at the Narrows of Newport River. On attempting to classify them it was clear that while they plainly belonged to the genus *Carcharhinus*, it was equally clear that as to species they were neither *obscurus* nor *milberti*, the forms heretofore reported from Beaufort. Director Aller, to whom the classification was referred, thought it a matter either of immaturity or of varia-

tion, since he finds that Beaufort sharks rarely correspond in all details with the diagnoses given in Jordan and Evermann's Fishes of North and Middle America or in Smith's Fishes of North Carolina.

Mr. Peter Okkelberg, of the University of Michigan, while dissecting one of these sharks, called attention to the apparent absence of the spiral valve from the large intestine. On opening the other shark, the same condition was found. Director Aller, however, pointed out certain obscure twists in the wall of the intestine which he thought represented such, and later called attention to the following statement in Parker and Haswell, Vol. II (1897), page 164: "A spiral valve is always present in the large intestine (of the Elasmobranchii), though its arrangement varies considerably in the various families. In some cases (e. g. *Carcharias*) the fold is not a spiral one, but, attached by one edge in a nearly longitudinal line to the intestinal wall, is rolled up in the shape of a scroll."

Earlier in the season of 1910 the writer had the following interesting experience with a sharp-nosed shark some three miles up Newport River. He had visited some fishermen just as they were finishing clearing their net. They had thrown into his rowboat some female rays and a few small sharks. The former were autopsied for eggs and embryos and thrown overboard, and then a pair of jaws from one of the sharks was cut out and cleaned off. The fragments of this fish were likewise thrown overboard and presently the bloody water was bailed out and the boat washed. All this was done on a falling tide in a locality well known for sharks and rays.

Presently the dorsal fin of a large shark could be seen coming against the ebb tide. Standing in the stern of the skiff, the writer watched the shark "nosing around" in the water like a bird dog working a field for quail. Having arrived within 10 feet of the boat, it suddenly saw him for the first time, backed water in a perfect panic and disappeared in a flurry of mud and sand. Its length was about 8 feet, and from its large girth it was probably a *Carcharhinus* rather than a *Scoliodon*. This incident illustrates both the voracity and the cowardliness of this scavenger of the sea.

It may be noted in passing that during the summer of 1911 a number of sharp-nosed sharks were taken in the laboratory pound net and seine. Only the smallest of these, a male *Scoliodon terra-novae* 43 inches long, was identified. The others, ranging from 6 to 7½ feet in length, were taken from 3 to 7 miles from the laboratory, and because of their size, the smallness of the boat, and the fact that the seining crew was generally out on all-day trips, could not be brought to the laboratory for identification. Since *Scoliodon* rarely grows so large it is quite probable that these were *Carcharhinus*.

The largest shark taken at Beaufort in 1911 was brought in by some menhaden fishermen before the writer arrived at the laboratory. Capt. Oscar Noe, superintendent of the menhaden fish factory to which it was brought, reported that he found it to be 13½ feet over all. There can be no doubt that it was a *Carcharhinus*.

Squalus acanthias Linnaeus.

PICKED DOG-FISH.

On May 23, 1907, Director Aller obtained from a fisherman an adult specimen of this small shark. He noted, several hours after death, that there were about 44 spots arranged in two rows on the upper part of the body. This specimen was a female (length was not noted) and when cut open 3 young were obtained. This negatives the statement made by Jordan and Evermann (1896) that all of the Squalidae are oviparous.

This specimen, taken in Beaufort harbor, is the first recorded from North Carolina. However, Coles took two with hook and line at Cape Lookout in 1910, but saw none in 1911. The local name for this fish is *Bone-shark* in allusion to its dorsal spine.

Sphyrna tiburo Linnaeus.

BONNET-HEAD.

The best find made by the writer in 1911 was a female bonnet-head shark taken at the Straits about 7 miles east of Beaufort, on June 30, 1911. This fish measured 50 inches over all, and was 7½ inches between the eyes. The spread of her pectorals was 18 inches, the horizontal gape (width) of her jaws 3¾ and the vertical gape 3½ inches.

The two bilateral oviducts were in the usual position and were united behind in a short tube opening into the cloaca. Slightly back of the shell gland, each oviduct was enlarged to form a uterus 8 or 9 inches long and 1½ or 2 inches in diameter, slightly larger at the anterior end. Each uterus contained 5 eggs, 4 of which had on them embryos measuring about 50 mm. long, the egg nearest the posterior end in each vessel being infertile.

The exterior wall of the uterus was firm, tough, and muscular. The lining mucous membrane was very crinkled, folded, and plaited. Between the two was a layer of connective tissue so loose in its arrangement as to resemble a mass of fluffy cotton. One purpose of these structures is evidently to allow for the expansion necessitated by the growth of the embryos.

The embryos were about 50 mm. long and quite well developed. Protruding from the gill-slits were large bunches of long external gill filaments measuring 15 to 18 mm. The embryos were attached to the flat oily yokes by umbilical cords some 45–50 mm. long. These latter were thickly beset with what Alcock (1890), in describing the allied *Zygæna blochii*, the Indian hammer-head shark, calls "appendicula," like the tube feet of echinoderms.

The eggs lay separate from each other in spindle-shaped depressions or compartments. Each egg was enclosed in a shell composed of very thin but tough and elastic material highly iridescent in appearance and curiously crinkled and plaited at the ends. In all respects they were very like those previously reported for the butterfly ray, *Pteroplatea maclura* (Gudger, 1910). The compartments were similar to those described by Alcock (1890) for *Carcharias melanopterus*, and the other structures were

almost identical with those found by the same author in *Zygæna blochii* above referred to. It is the intention of the writer to give later a fuller description of these structures with illustrations.*

In 1902 Mr. Coles brought to the laboratory at Beaufort a female bonnet-head 6 ft. long from which 8 young were obtained. The writer had the good fortune to be present on that occasion and to assist in the dissection.

Pristis pectinatus Latham.

SAW-FISH.

The saw-fish has never, so far as the records show, been taken in Beaufort harbor. It is however occasionally captured at Cape Lookout in deep drift nets used for catching Spanish mackerel, *Scomberomorus maculatus*. It is a bottom-living fish and is generally found entangled in the lower part of the net. The fishermen dread it very much, partly because of its size and activity, but more because when thoroughly entangled in their nets the only way to get rid of it is to cut out a part of the net and set the creature free. This is of course a very expensive procedure. If, however, only the "saw" is entangled, the fish is hauled alongside, a rope is made fast to the saw and when this is cut off the fish is turned loose.

In the summer of 1902, there was brought to the Beaufort laboratory a saw 37 inches long having 28 pairs of teeth. Reckoning the saw at about ¼ of the whole, the total length of this fish must have exceeded 12 feet.

In 1908 Coles took one at Cape Lookout 13 feet 10 inches long. Its saw had 26 teeth on the right and 25 on the left side. On another occasion Coles netted another fine specimen but was only able to save the saw which was nearly 4 feet long. A smaller saw in his possession is 34 inches long and has 24 teeth on the right and 26 on the left side. He reports that the length of the adult fish at Cape Lookout runs from 13 to 15 feet.

Dasyatis say (Le Sueur).

STING-RAY.

In 1910 a considerable number of *Dasyatis say* were obtained from the drag-net fishermen in Newport River. These rays, when in the bunt of the net, were generally speared with a beardless harpoon or pike and thrown into my skiff where they were for prudential reasons either deprived of their tails or knocked on the head with a long-handled hatchet provided for the purpose. The shock of these operations usually brought about delivery of the young, particularly if these were pretty far advanced. This took place in five separate cases.

Some of these young, thus brought into the world, were carried alive to the laboratory in buckets of water. Placed in running salt water they lived 10 hours. They moved around rather freely but had difficulty in staying right side up, lying for hours on their backs; nor did righting them better matters, for, if they attempted to swim about, they in-

* A report on this shark was made by the writer at the meeting of the American Society of Zoologists in December, 1911. See Gudger, 1912.

variably came to rest with their ventral surfaces uppermost. One, however, when placed in the normal position on the bottom of the aquarium, showed, in the lifting of the body and in the motion of the hinder edges of the pectorals, the characteristic breathing movements of the adult.

In this connection it may be interesting to note that Waite (1901) writes that 7 young, removed by a Caesarian operation from a female *Hemiscillium modestum* Gthr. when put in a pool of water swam about freely, so also did 23 young excised from *Orectolobus barbatus*. Later, 19——, he quotes a writer in the "Sydney Mail" that the young of *Carcharias brachyurus* Gthr. when cut out and thrown into water swim about even with the yolk sac still attached. So Alcock (1890) states for the young of *Carcharias dussumieri*.

On June 17, 1910, two female *Dasyatis say* were taken in the same haul. One was 25 inches wide over the pectorals, and 25 inches long to the end of the ventrals; the width between eyes (outside edges) was 5¼ inches, between spiracles (inside measurement) 4½ inches, mouth (transverse) 2¼ inches. This ray gave birth to 4 young, 3 males and 1 female, all of a light brown color. Two were 12 inches long, one 12⅛ and the other 12⅜. All four were 5 inches wide. The three males had tails 7⅝ inches long. The female, which was also the longest bodied, had a tail measuring 7$\frac{11}{16}$ inches. One had the yolk sac and umbilical cord gone leaving a slight navel. Two had these reduced to mere warts, while those of the fourth were slightly larger.

The second ray measured 36 inches wide by 35 long, and was 62 inches from snout to end of tail. The outside measurement between eyes was 7 inches, the spiracles were 5⅜ inches apart, and the mouth was 3 inches wide. This very powerful fish, on being speared while in the bunt of the net, lashed out with her tail and drove the spine into the side of the boat where it was broken off.

Two young were obtained, but being absolute twins only one was brought in and measured. This was 14¾ inches long, 5¾ wide, with a 9½ inch tail. While considerably larger than the young of the first specimen, it was much younger, being practically devoid of color and having attached by an umbilical cord a yolk bag nearly an inch long. It would seem that the larger the mother the larger the young to which she gives birth.

The embryos taken were, except in one case, found bathed in a substance of the color and consistency of rich yellow Jersey cream. The exceptional case had the uterus filled with a clear yellowish watery fluid.

The older embryos had the large intestine filled with a chlorine-yellow substance, evidently the milk-like food secreted by the villi and taken in probably through the spiracles. Notwithstanding the fact that the umbilical cord entered the alimentary tract at the junction of the small with the large intestine, and that the material in the anterior part of the large intestine was lighter in color than that in the middle and hinder regions, it is reasonably sure that it was not yolk. In an embryo 12 inches long and 5 wide it equaled about 60 per cent of the volume of the yolk when the egg was in segmentation. Examined microscopically it

appeared as a finely divided flocculent material grading from particles so small as to show the Brownian movement to large plate-like masses. The enormous increase in size of the young is proof indisputable that the young feed on the milk during the period of gestation. It is probably absorbed at first by the long external gill filaments, but as the young ray grows these disappear and the spiracles become functional and the "milk" is taken in by them. There can be no reasonable doubt that this is the manner in which the young of *Dasyatis say* and *Pteroplatea maclura* are nourished.

The following data were noted in 1910 in regard to the functioning of ovaries and uteri and their relation to each other in 8 specimens of *Dasyatis say*. Two had both uteri gravid with ovaries insignificant. One had both uteri empty and reduced but the left ovary full of fairly large eggs. Five had the left uterus only with young. Of these five, two had the right uterus almost indistinguishable. One of these two and one other of the five had the right ovary reduced to a mere shred. Not one had the right ovary with eggs of any size. Four of the eight had the left ovary with eggs approaching maturity, and three of these four had the left uterus only with young.

The summer of 1911 was marked by poor success in getting sting rays with embryos. Three were obtained with young approaching the hatching stage. One, 24 inches wide, had 3 young measuring $5\frac{1}{4}$ inches in width, 13 inches long (to end of tail), and $5–5\frac{1}{2}–5\frac{3}{4}$ inches from end of snout to end of ventral fins. The other measured 26 inches in width and bore four young. These were 6 inches wide, 6 inches long to end of ventrals, and 15 inches over all. The third, which measured $25\frac{1}{2}$ inches between points of pectorals, gave up 3 young averaging $6\frac{1}{4} \times 6\frac{1}{4} \times 14\frac{3}{4}$ inches, the greatest variation in their measurements being $\frac{1}{2}$ inch.

In addition to the above, 3 individuals were taken with eggs in early stages, but these were unfortunately lost. These fish were 23, 33, and 35 inches wide respectively. They were large, heavy, and active. In striking them with a hatchet to quiet them, and in throwing them from the bunt of the seine into the small boat in which they were dissected, the uteri were evacuated and the eggs thrown out into the bloody water. The yolks were in some cases recovered, but all the embryos were lost.

Sixteen non-breeding * females, ranging in width from 12 to 33 inches, had the left ovary from twice to three times the size of the right, while 13 breeding females, varying in width from 13 to 35 inches, had the left ovary functional and the left uterus greatly dilated, the corresponding organs on the right side showing no signs of fertility. Only 6 of these bore eggs or embryos as described above. One having early eggs showed by the condition of the ovary that ripe ova had left this organ but a short time previously. One of those with embryos nearly ready to be born had eggs measuring 12 to 15 mm. in diameter. Another had in the ovary 3 eggs measuring 17, 17, and 18 mm. in diameter. The left uterus of this fish was swollen and very villous. Another had in the left ovary 3 eggs,

* That is with uteri showing no signs of enlargement.

17, 17½, 18 mm. in diameter respectively; the uterus on the same side was greatly swollen, and shaggy with villi. Two others had the left generative organs as above, although the eggs in the ovary were not quite so large, measuring from 12 to 15 mm. only.

In no right ovary did the writer, in 1911, find any large or even distinct eggs, and in no fish did he find a right uterus functional. In this connection it is pertinent to note that Haswell (1888) states that in *Urolophus testaceus* the left oviduct only is functional. Alcock bears like testimony of *Trygon bleekeri* (1892); "... in all the pregnant rays that I have since dissected, where only one oviduct is pregnant it is always the left."

From this data the following conclusions may be drawn. First, that *as a rule* the left ovary and left uterus only of *Dasyatis say* are functional. Secondly, that as the eggs ripen the uterus enlarges and becomes villous to receive them. Thirdly, that this ray may give birth to a second set of young each season.

During the season of 1911 the writer dissected a number of sting rays to determine their food. In all specimens in which digestion had not gone too far, this was found to consist of annelid worms of two kinds. The first of a small-sized red worm found everywhere. The other of a splendid large green worm. These rays are bottom feeders. Beaufort harbor and the surrounding waters are filled with hundreds of acres of sand and mud flats in which live millions of tubiculous worms. These thrust out their heads from the mouths of their tubes as the flood tide covers the sand flats and at this time the rays come in over the shoals to feed.

The following incident may be related as showing how early the defensive instinct manifests itself in this fish. On June 30, 1911, there was taken in a haul of the seine a young female ray 6¾ inches wide, 6½ long to end of ventrals, and 12 inches to the end of the tail. This was probably not more than a week, possibly not more than 2 or 3 days old. When first picked up it lashed out with its tail and struck the point of its sting in the writer's thumb, whereupon it was dropped into the boat. In order to ascertain whether this was a purposed action or accidental, it was again picked up, whereupon it again lashed out savagely with its tail. It is probable that one taken from the uterus at the time of parturition would do the same thing.

During 1911 there was taken by the writer a number of sting rays whose caudal appendages had suffered abbreviation. Among them was the young one above referred to. In addition 3 good-sized ones were taken which were tailless. A 12-inch wide female had the tail completely gone. An 18½-inch male had a stump one inch long. Lastly a 20-inch male had a 2-inch stump. For a possible explanation of how this condition in these rays has come about, the reader is referred to a previous paper by the writer (Gudger, 1907), in which it is shown that sting rays form no inconsiderable part of the food of the hammer-head shark, *Sphyrna zygæna*. It may be conjectured that a hammer-head had been chasing these rays. They lashed out with their tails and fixed their spines in its head or jaws, whereupon the shark incontinently bit the tails off.

Pteroplatea maclura (Le Sueur).

BUTTERFLY RAY.

In making observations and collecting data for a study of viviparity in the butterfly ray, the writer was so fortunate in 1910 as to get a good amount of embryonic material, in fact fully half the stages necessary for the life history. The most interesting of these is a young ray with the pectorals so far developed that they have coalesced with the head stalk, with long, filamentous gills projecting from the gill slits, and, what is most remarkable, with a tail nearly equal to the length of the body and having its hinder two-thirds expanded into a broad paddle-like fin.* When it is remembered that the adult ray has a very short and insignificant tail utterly devoid of any fin structures, the importance of this discovery in the phylogenetic history of the animal is apparent.

The writer's earliest collecting in 1910 was done on May 27. The uteri of the first ray caught on that day were both pregnant, one egg being found in each. These eggs each had a thin straw-colored transparent shell much crinkled and plaited (bellows-fashion) at the ends but not twisted as in the eggs noted in my paper for 1909. One end of each shell was long and clear, the other end short and crushed,—"telescoped" is the way the notes put it. One egg had a selachian embryo, the other an invaginating blastoderm.

Waite (1901, 1902) quotes letters from Haswell that the viviparous *Hemiscillium modestum* has around its egg a thin shell which is soon thrown off, and that *Galeus antarcticus* has chitinous bodies in the uterus consisting, as proved by chemical analysis, of the identical material as that composing the egg shell of *Cestracion* and of other viviparous Elasmobranchs. These bodies Haswell considers as several vestigial shells run together. Later, Waite (1909) took several female *Galeus australis*, of the family Carchariidae, in which were found numbers of young, each in a thin membranous envelope contained within the uteri. One female contained 34 young equally divided between the 2 uteri.† Parker and Haswell (1897) on p. 168 of Vol. II say: "In some of the viviparous forms (of Elasmobranchs) a distinct, though very delicate, shell, sometimes having rudiments of the filaments, is formed, and is thrown off in the uterus." The chalaza-like structures, seen by the present writer in 1909–'10–and '11, were in all probability these vestigial filaments. These structures have been described above for the bonnet-head shark also.

The uteri of every one of these rays, as in *Dasyatis say*, had the interior villous, and all save three were filled with milk. Two of these, opened as soon as the female was caught, were enormously distended with a clear liquid which showed no signs of milk, while the third, after being in formalin some hours, was found to have a buttery precipitate in a clear supernatant fluid. There can be but little doubt that the purpose of the long external gills is to absorb this "milk" and that after the disappear-

* See Gudger (1911) for an abstract of a report on this larva made before the N. C. Acad. Sci.

† See also Alcock (1901) as quoted in my Notes for 1909 (Gudger, 1910).

ance of these gills this is taken in through the spiracles as Alcock (1901) conjectures for the congeneric *Pteroplatea micrura* of the Indian Ocean. Indeed on July 17, while handling the just-dead, advanced embryos of the butterfly ray, a considerable amount of flocculent material, *i. e.*, coagulated milk, was discharged from the mouths of two of them. These two young rays, when taken from the uteri, had their pectorals rolled up like those of the sting ray, but in reversed fashion, *i. e.*, ventrally.

One of the large females referred to in a preceding paragraph had the tail gone from its point of junction with the ventrals. Calling the attention of my head fisherman to this, he remarked that it was rare to find a butterfly ray so mutilated. In this connection he added that in very large and old specimens of this ray occasional ones were found to have stings. In 1911 this statement was repeated by other fishermen, men like the former, in whom I have confidence. I have examined for such a spine nearly every large butterfly ray I have ever taken, but so far have never found any indication of one. Its occurrence must be rare. On this point Smith (1897) says "spine usually (always?) lacking."

All of the females taken in 1910 had embryos in each uterus. The two largest ones, 32 inches wide by 19 long and 30 inches wide by 18½ long, had in addition their left ovaries *only* filled with eggs from 5–10 mm. in diameter. These were taken July 16. From these facts the conclusion may be arrived at that the butterfly ray may give birth to two sets of young each season, and that if so the second set will probably be borne in the left uterus only. However, this matter needs further investigation. In the ovaries of these rays, as in those of *Dasyatis say*, the lumina were filled with an abundant yolky material which probably came from the breaking down of some of the ova. In all these ovaries, however, there were large eggs approaching maturity.

In my Notes for 1909 * the fact is recorded that the young of the cow-nosed ray, *Rhinoptera bonasus*, come into the world rolled up like a piece of paper, one pectoral inside, and one out. The young of the common sting ray have the pectorals turned upward and rolled inward and downward toward the median line, like two hands placed wrists together, palms uppermost, fingers closed to touch palms. While in a preceding paragraph it is noted that the young of the butterfly ray are born with the pectorals held in reverse fashion, *i. e.*, turned downward and rolled inward. Hill (1862) has figured and described the young of the Jamaican *Cephaloptera massenoides*, a ray probably near to *Aodon hypostomus* or *Mobula ölfersi*, with pectorals folded on the dorsal surface, one overlapping the other. Earlier, however, than any of these writers, Galard de Terraube (1799)† described the young of a long-tailed ray of Guiana (name not given) as coming into the world rolled up like waffles (gauffres),—like the young cow-nosed ray. It seems that these differences find explanation in the supposition that the young rays in the uterus of the mother are able to change the position of their pectorals just as the young teleosts in the egg are able to shift their tails from right to left side of the egg or vice versa.

* Gudger, 1910.

† Tableau de Cayenne ou de la Guiane Francaise, pp. 131–2.

During 1910 the writer noticed for the first time that the claspers of both the sting and butterfly rays have a kind of knuckle joint at the basal end and that they can be rotated on this joint until they point inward and forward, thus enabling the rays to lie belly to belly, heads forward, while in copulation. Further it was noticed that in the female genital opening there are two little pockets placed laterally, in which the claspers are evidently received. Later it was found that Agassiz (1871) had expressed the same idea some 40 years ago.

For some unknown reason comparatively few butterfly rays were taken at Beaufort by the fishermen during the writer's stay in the summer of 1911. The laboratory seining crew made a number of trips especially for them, but only one of breeding age was taken. This had both uteri enlarged and each contained an egg with a selachian embryo. Each egg was enclosed in a thin transparent yellowish shell with chalaza-like twisted terminals as reported in 1909. Curiously enough the end of each shell at the posterior part of the embryo was much larger and more noticeable.

Aetobatus narinari (Euphrasen).

SPOTTED STING RAY.

Three perfect specimens were obtained in 1910 and two of them studied while alive. On June 30, while up Newport River, two fishermen* caught and kindly gave me a specimen which measured: length of body to end of ventrals, 19 inches; tail only 33 inches; all over 49 inches; width over pectorals 28½ inches, between eyes 4 inches, between spiracles 2⅝ inches (both inside measurements); projection of snout from a line joining anterior roots of pectorals, this being also a line joining the anterior edges of the spiracles, 4 inches. This fish weighed 11½ pounds and had two spines, the anterior equal to the length of the base of the dorsal fin, the posterior only half so long.

When alive it had for its ground color a dark chestnut brown with spots of a rich yellow cream. The spots on the head were smaller than elsewhere, and in the posterior region showed a tendency to run together. In life no bands, as shown in Jordan and Evermann's figure,† could be found, but after death they showed up faintly and the spots showed a tendency to become white. Where the skin was exposed to the sun it turned a rich velvety black, the epidermis then peeled off, leaving the ground color brown, and the spots turned blue.

The two other rays of this species were taken in the channel connecting the inner and outer harbors at Beaufort on July 4 and 7, 1910, and were presented to the writer by Messrs. Charles, John, and William Wheatley of Beaufort, to whom he is also indebted for specimens of other fishes.

The smaller of the two, a fine specimen, measured: length 18½ inches, tail only 39½ inches, all over 54¼ inches; width 27½ inches, between eyes 3¾ inches, spiracles 2½ inches (inside measurements); length of

* Henry Congleton and John Harrell of Beaufort.

† Fishes of North and Middle America, Vol. IV, plate 15.

head from line joining front edge of pectorals and spiracles 4¾ inches, length of snout proper 2½ inches. The color was a chocolate brown with whitish spots.

The larger specimen came into the writer's possession while yet alive and flapping on the beach, and the measurements and notes were made within an hour after its capture. Its body length was 26½ inches, tail only 27¾ (this had plainly been amputated in some way), all over 49½ inches; width 37 inches, between eyes 5 inches, between spiracles 3½ inches; longest diameter of spiracles 1¼ inches. It had three spines. Its weight was over 25 pounds, the limit of my little spring balance.

The general color of this fish was a dark chocolate brown with the spots of a cream color; some of these, however, turned a faint bluish-green after death. The spots were decidedly smaller on the head, and over each eye there was a row of three. Along the anterior edge of each pectoral they were arranged in a very definite succession, while on the scalloped posterior part of each fin there was a row of very small ones. In the posterior dorsal region a number were confluent, making dumb-bell shaped markings, and even in the spiracular openings small spots could be seen. There were no striations visible in this fish while fresh. The spiracles of this specimen, the largest the writer has seen, opened forward into the mouth and backward into the gill chambers, and communicated with each other. The spiracular valves swung backward and upward into recesses. The alimentary canal was full of clams without a trace of shell.

Abundant as have been the writer's opportunities for study of this interesting fish, those of Coles have been far more.* While fishing at Cape Lookout in July, 1909, he saw hundreds and killed 50. During the same month in 1910, at the same place, he says he probably saw 40 or 50 and collected 8. The largest captured was 5 feet 9 inches wide, 3 feet long, tail 5 feet 9 inches, total length 8 feet 9 inches, weight 132 pounds. In July, 1904, he captured a huge ray of this species which was not measured and could not be weighed, but which was estimated at 500 to 600 pounds.

In 1911 Coles found these rays very scarce at Cape Lookout, not more than a dozen being seen. This paucity, where he had before found them in considerable numbers, he thinks to be due to the scarcity of clams, their chosen and apparently only food. The largest caught weighed 90 pounds and was 5 feet wide, 2 feet 8 inches long, and had a tail 5 feet 6 inches in length. Another and gigantic specimen was harpooned, but, before it could be killed, it dragged the boat into the breakers where its struggles attracted a number of sharks which dismembered it before it could be secured. Its weight was estimated at 500 pounds or more.

In comparison with such giant specimens as these the writer's are plainly immature, only the last one being anywhere near grown. The opinion expressed in Notes for 1909 concerning the rarity of this fish at Beaufort needs some modification. It is rare in Beaufort waters, but not so much so as had been thought, Cole's observation for the open Atlantic at Cape Lookout, 12 miles away, to the contrary notwithstanding. Further-

* See Coles, 1910.

more the bight at Cape Lookout, where his catches were made, forms a natural fish trap for all sorts of rare southern forms carried into it by the set of the Gulf Stream and the steady southerly winds. This is especially true of the shallow water fishes like the rays.

Before leaving this ray, it might be well to add that Mr. W. H. Shelton of Beaufort gave the writer the tail of a very large spotted sting ray of which unfortunately no measurements had been made. The tail, of which it is plain that the hinder portion was lost by some accident, is 4 feet 3 inches long. It bears 4 spines, and the evidence is rather clear that another has been torn off. The only other caudal appendage of a spotted sting ray comparable to this is the 5-spined one taken at Guam, described and figured by Quoy and Gaimard (1824), and deposited in the Museum of Paris. This tail had also suffered amputation and the length of the abbreviated portion is not given, nor is the description of the ray at all full, the drawing having been lost, but on account of the unusual and extraordinary number of spines these authors call it *Raja quinqueaculata*.

Nothing definite was known about the mode of reproduction in this ray until Coles published his paper in 1910. He tells us that the young are born, that is, are expelled from the uterus, while the mother is engaged in leaping high above the water. This he witnessed twice. His observation definitely proves that it is viviparous, and we may confidently expect on later investigation to find the female rays with villous uteri as in the forms previously described.

Rhinoptera bonasus (Mitchill).

COW-NOSED RAY.

On July 16, 1910, the writer took three young rays of this species in one haul at the Narrows. One was a female 20½ inches wide, 13¼ from snout to end of ventrals, tail 17 inches, length over all 27 inches, weight 5 pounds. The second, a male, measured as follows: width 20½ inches, length 13, tail only 21½ inches, total length 33 inches. The third, likewise a male, was 19¼ inches over all. The first male had one spine, the second two, and both had very short sexual appendages.

Since the present writer has taken from the uterus of the mother young 13½ inches wide and 8½ long (Gudger, 1910), and Bleeker (1852) in the same manner obtained from a *Rhinoptera javanica* 2 young measuring 240′′′ and 280′′′ wide (20 and 20.3 inches), he is led to believe that these rays were certainly not older than two years, and possibly were born not earlier than 1909.

These observations also show conclusively that the cow-nosed ray is viviparous, like all the other Beaufort rays studied by the writer. Viviparity, however, is not effected by means of a yolk-bag placenta, but by milk secreted by the villous lining of the uterus.

Manta birostris (Walbaum).

DEVIL FISH.

This goliath of the ray order has been reported from Cape Lookout and for years Coles has kept a close watch for it, but has seen it only once.

In July, 1909, he saw one leap three times at a distance of less than 120 yards from his boat. He estimated its width at between 20 and 30 feet, and the distance between the horns at 3–5 feet. This could hardly have been anything else than the great ray above named.

Smith (1907) says that it has been seen a number of times by fishermen at Cape Lookout. It is recorded among North Carolina fishes by several authors but has, it is believed, been seen only by the first of these, John Lawson (1714), whose interesting description is worthy of quotation here. "The Divel Fish lies at some of our Inlets, and, as near as I can describe him, is shaped like a Scate, or Stingray; only he has on his head a pair of very thick strong Horns, and is of a monstrous Size and Strength; for this Fish has been known to weigh a Sloop's anchor, and run with the vessel a league or two and bring her back against the Tide, to almost the same Place. Doubtless they may afford good Oil; but I have not experience of any Profits which may arise from them."

Egg-cases of Unknown Selachians.

It seems well to describe certain elasmobranch egg-cases or "purses" which come ashore on Fort Macon Beach in the lee of the first point south of the concrete breakwater.

First there is the ordinary egg-case known to all frequenters of our coast, and found very abundantly on the beach above mentioned. One of these dried cases of average size and appearance gave the following measurements: extreme length over (curled) tendrils $2\frac{7}{8}$ inches; length measured from center to center of curve between tendrils $1\frac{7}{8}$ inches; width of ends $\frac{13}{16}$ and 1 inch.

Some two years ago the writer found on the same collecting ground as the above a large egg-case. This, after being soaked and dried out as flat as possible, measured as follows: length stump to stump of horns (tendrils gone) $4\frac{7}{8}$ inches, from center to center of curve (as above) $4\frac{1}{4}$ inches; width at narrow end $1\frac{3}{4}$ inches, at wider $1\frac{7}{8}$ inches, of center $1\frac{3}{4}$ inches. This shell has probably lost $\frac{1}{4}$ inch in length by wrinkling.

In July, 1910, there was found another egg-case of like kind on the same collecting ground. This is so much wrinkled and shortened that it has lost from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length, nor has it been possible to flatten it. However, it measures: length over all $3\frac{7}{8}$ inches, from center to center of curve $3\frac{7}{16}$ inches; width at narrow end $1\frac{3}{4}$ inches, at wide end 2 inches, across center $1\frac{7}{8}$ inches.

In 1911 another case similar to these was found lower down (*i. e.* south) on the same beach. Wetted and flattened out as much as possible it measures: length over all $5\frac{1}{4}$, from center to center of curved ends $4\frac{3}{4}$ inches; width at narrow end $1\frac{1}{2}$, at wide end $1\frac{3}{4}$, across center 2 inches.

On none of these cases is there trace of tendrils, these having been broken off short. The stumps, however, are hollow. The first shell is covered with an outer layer of horny material which readily splits up into coarse strands stretching from end to end. The second case has lost most of this covering, showing the polished chitinous shell. The third has hydroids attached to it.

These three large cases differ in yet another way from the small ones. The side pieces of the "barrow" in the small cases are of the same thickness and appearance throughout, being hardly distinguishable from the body walls of the shells. This is not the case in the large "purses." If the side bars be divided into $\frac{1}{4}$s, then the $\frac{1}{4}$ lying at each end is found to be no thicker than the back edge of an ordinary table knife, the middle $\frac{2}{4}$s however gradually thickens from each end toward the center, and in the region of the transverse diameter of the case is $\frac{1}{8}$ to $\frac{3}{16}$ of an inch thick. This is true for both side pieces for all three egg-cases. Each side piece is slightly concave from top to bottom (the shell being placed in a horizontal position) and has running lengthwise in its center a raphe or line of junction. Waite (1909) describes the egg-case of a carpet-shark, *Cephaloscyllium laticeps* Dum, in which the egg-case had similar lateral thickenings 3 mm. thick. However, what is probably the largest case ever found is referred to by Alcock (1901). It was dredged from 824 fathoms off the southern coast of India. This case was $6\frac{1}{2}$ inches long by $4\frac{3}{4}$ wide and contained an embryo too young for identification.

It is not known by what elasmobranchs these large Beaufort egg-cases are laid. The only selachians found in this part of the Atlantic which might have set free these shells are, so far as the writer knows, the Scylliorhinidae or cat sharks. These sharks are said to have large egg-cases with hollow tentacles, and the cases above described clearly fit this description. *Catulus retifer* has been taken off Cape Lookout, and *Scylliorhinus profundorum* off the mouth of Chesapeake Bay.

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