

Article II.—NOTES ON THE EMBRYOS OF SEVERAL SPECIES
OF RAYS, WITH REMARKS ON THE NORTHWARD SUMMER
MIGRATION OF CERTAIN TROPICAL FORMS OBSERVED
ON THE COAST OF NORTH CAROLINA.¹

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PLATE III.

In this paper, I give an account of the embryos of two species of rays, *Aetobatus narinari* and *Rhinoptera bonasus*, collected for the American Museum of Natural History at Cape Lookout, North Carolina, in the summer of 1912. I also comment briefly on the embryos of two other species noted at various times in the same region; and discuss the northward summer migration of several species of rays as observed at the same locality.

I. NOTES ON THE EMBRYOS OF SEVERAL SPECIES OF RAYS.

It is necessary, first, to describe a method I have devised for securing embryos, and which accounts for the difficulty zoölogists have hitherto had in obtaining them, although the mother fish were in several species fairly common. In the summer of 1912, after having examined a number of fast swimming rays, I became convinced that they must have expelled their embryos while being captured, and while struggling to escape from the seine. In these struggles, which I several times observed from a boat, the ray would lift the lead line of the seine. This would account for the rather small catch of fish in a seine entangling a large ray. The young, if capable of swimming, probably also escape in the same way. To counteract this, I at first used a second seine immediately back of the first, with the idea of catching any fish and young that escaped from the first; but the results were not satisfactory and at best would have been incomplete, since extruded eggs, and embryos incapable of swimming, would sink to the bottom and be lost. I then devised a different method of saving the young from being lost. As the seine containing a ray was being drawn into shallow water, I would jump in, and striking the ray with a knife in the region back of the head, so as to stun it, would hold on to the handle of the knife with one hand and close the vent with the other. I would then

¹ I am indebted to Dr. L. Hussakof, of the American Museum of Natural History, for assistance in the preparation of this paper.

drag the specimen to shore or be dragged in with it in the seine. On releasing the vent, the young would emerge on the sand. By this method, I collected the embryos of *Aetobatus narinari* and *Rhinoptera bonasus* described in this paper. The method is sometimes dangerous, especially with very large rays. For instance, in the case of an *Aetobatus narinari* 7 feet,

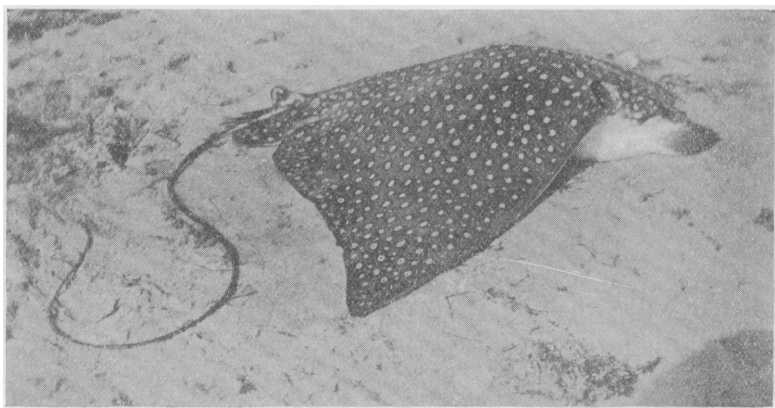


Fig. 1.— *Aetobatus narinari* (Euphrasen); female, 7 ft. 7 in. in diameter.

7 inches in diameter, the seine broke and the ray almost pulled me under as I was struggling with her in deeper water. This ray (Fig. 1) emitted a loud, harsh sound while struggling in the water. She was finally dragged to the beach, but on examination appeared to have expelled her embryos.

Embryo of Aetobatus narinari.—Of this species I captured five females and three males. Only one, a 7 ft. 2 in. ray, contained embryos; another (the 7 ft. 7 in. ray referred to above) had apparently expelled her embryos before she was brought to shore. Embryos of this species are very rare. I am informed by Dr. E. W. Gudger, who is preparing an extended paper on the natural history of this ray, that the only reference to an embryo is by Klunzinger,¹ who mentions the fact that “the foetus of *Aetobatus narinari* [taken in the Red Sea] is 12 cm. wide.” In 1910, I recorded having seen a ray of this species giving birth to four young.²

The embryo here described was obtained from the specimen 7 feet, 2 inches in diameter referred to above. The ray was seized after the seine had been dragged into shallow water and the vent was closed; it was wounded to lessen its resistance, and the writer and the fish were dragged together in the seine to the beach. This ray gave birth to four young at

¹ Synopsis der Fische des Rothen Meeres. Verhand. K. K. Zool. Botan. Gesell. Wien, XXI, p. 686.

² Bull. Amer. Mus. Nat. Hist., XXVIII, p. 340.

intervals of a few seconds between the birth of each. They were alive, each rolled up lengthwise; they quickly unfolded, but died in a few minutes. Judging from their immature condition, they would have reached somewhat larger size before birth. The ray and the four embryos are illustrated in Plate III. It will be noted from the figures that this specimen shows a

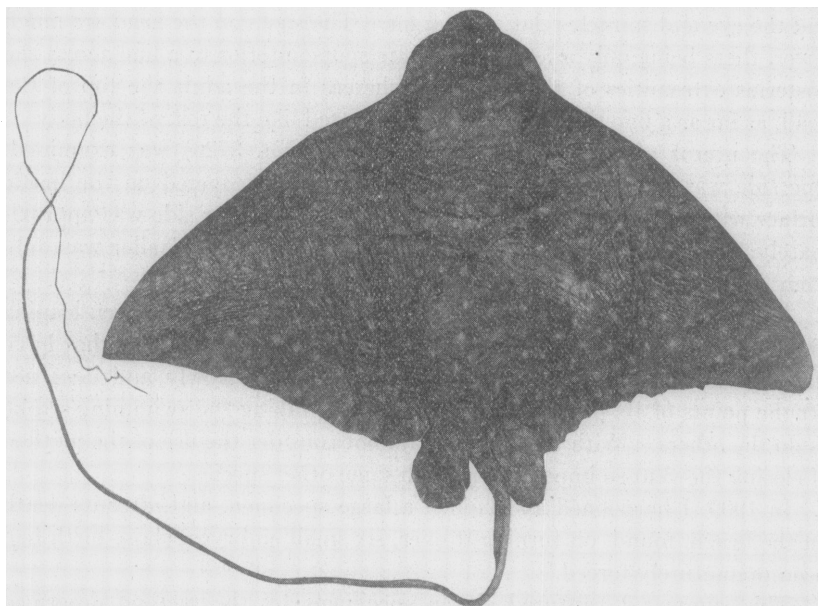


Fig. 2.— Embryo of *Actobatus narinari* (Euphrasen). $\times \frac{1}{4}$. One of four embryos obtained alive from the ray shown in Plate III. Amer. Mus., No. 3725.

remarkable type of coloration, inasmuch as the spots, which are usually solid white, are partly in the form of white rings with a dark center. This condition was also noticed in the ray shown in Fig. 1, but never in the many others that I have seen.

One of the four embryos (Fig. 2, Amer. Mus. No. 3725) was carefully measured, and its principal dimensions were as follows:¹

	Mm.
Width across the disc	286
Tip of snout to origin of caudal	171
Length of caudal	634
Head (tip of snout to posterior edge of spiracle)	60
Diameter of eye	6½
Spiracle, long diameter	23
Claspers	6
Length of free portion of spine	10

¹ The measurements of the embryos, as well as of the uteri discussed in this paper, were carefully made from the specimens in the American Museum, by Dr. L. Hussakof.

The yolk stalk, except for about 3 mm., was entirely absorbed. The spine was still flexible and enveloped in membrane; the edges were quite sharp, although not serrated.

A comparison of the embryo with the adult of the same species shows that it differs chiefly in the following points: The snout is relatively shorter, and the eye and spiracle relatively larger. The spots on the head are much fewer, there being only a few vague white spots anterior to a line across the posterior extremities of the spiracles, whereas in the adult the top of the head, as far as a line through the eyes, is spotted like the rest of the body.

The uterus of this specimen (Amer. Mus. No. 3726) was examined. One side was much larger than the other and was covered on the inside surface with large villi, about 25 mm. long. The larger side was approximately $13\frac{1}{2}$ cm. in diameter and 24 cm. in length. The smaller was only 6 cm. in diameter and 15 cm. in length.

Embryo of Rhinoptera bonasus.— This species I have never seen leaping high out of the water as the other rays with which I am familiar, that have sharp pointed pectorals, do. It swims much more slowly and does not lift the points of its pectorals nearly so high in taking the swimming stroke as do the others. With this species I do not consider the use of the method of closing the vent so important as with some other species.

In 1909, I harpooned and landed a large specimen, and after its death on the beach, found, on turning it over, six small embryos whose birth had been prematurely forced.

This summer I captured eleven specimens by the method described above, but only one of them contained embryos. On releasing the vent of the ray on the beach, two embryos emerged, rolled up together in reverse positions, *i. e.*, the head of one and the tail of the other rolled together. In the same way two other pairs were born, or a total of six embryos.

The embryo in the American Museum (Amer. Mus. No. 3728), a male, has the following measurements:

	Mm.
Width across disc	203
Tip of snout to origin of caudal	124
Length of caudal	335
Head (tip of snout to posterior edge of spiracle)	45
Claspers	4
Yolk stalk remnant	6

The upper surface of the embryo is a uniform light brown, somewhat darker on top of the head. The under side is pale gray, but the tips of the disc are more or less dusky; the tail is black. One spine is present, which is still flexible and covered with membrane; its edges are not serrated.

The uterus of this ray (Amer. Mus. No. 3729) was approximately 10 cm. long and 5 cm. in diameter, and was provided with the typical villi which occur in some other rays. The villi were densely distributed, and covered the entire inner surface. They varied in length from about 15 to 25 mm. It may be noted that this uterus, when placed in a weak solution of formalin, gave a deep red extract. The same was true after it was rinsed in water, on reaching the museum, and was placed in alcohol.

Remarks on embryos of other species of rays.—Females of *Mobula olfersi* with embryos are very rare in the region of Cape Lookout. Out of a total of over fifty specimens which I examined during 1910, 1911, and 1912, there were only three that had an egg or an embryo although I found more than a dozen that had apparently expelled an egg or early embryo during capture. I have found only a single egg in these cases. In one instance I found an embryo about two inches in diameter, with a large yolk sac, but it was accidentally lost. I regard closing the vent of this species essential to securing accurate data.

I have also observed *Rhinobatus lentiginosus* expelling early eggs while it was being captured.

Of *Narcine brasiliensis*, I was fortunate in securing, during 1912, three specimens with early embryos. The uteri of these are preserved in the American Museum (Amer. Mus. 3721). There were fifteen embryos in the two uteri of the best preserved specimen examined at the Museum. Bean and Weed,¹ in a note on the embryos of this species, record finding fourteen embryos in one specimen.

II. THE NORTHWARD SUMMER MIGRATION OF CERTAIN TROPICAL RAYS ON THE ATLANTIC COAST.

Since 1909, I have recorded the dates of capture of various species of fish which I have taken in the bight of Cape Lookout, N. C. From these it seems that certain species appear annually in this locality on approximately the same dates; that during this period they are fairly common, but that at other times of the year they are never seen. The observations indicate that these species, which are mostly tropical ones occurring on the coasts of Brazil and the West Indies, migrate northward during the summer months. My notes are especially complete in regard to two species of rays: *Narcine brasiliensis* and *Mobula olfersi*.

I will first discuss the electric ray, *Narcine brasiliensis*. In 1909 I began to use nets and seines (prior to that I had used only rod and reel) and to keep records of the species taken each summer. In 1910 I noted with

¹ Proc. U. S. Nat. Mus., XL, pp. 231-232.

interest that the first and last specimens of *Narcine brasiliensis* were taken on exactly the same dates as the year before. This appeared a peculiar coincidence; but when the same thing occurred again in 1911, I believed that it was not merely a coincidence, but that this sub-tropical ray migrates northward during the summer, reaching Cape Lookout about the same date every year. I have closely questioned the fishermen along the coast of North Carolina and find that none have seen *Narcine brasiliensis* north of Cape Lookout, and none have ever seen it in that locality at any other time but approximately the dates given in the table below. This table shows dates of capture of specimens which I have taken, and does not include numbers taken by native fishermen during the same period.

Dates of Capture of Narcine brasiliensis at Cape Lookout, N. C.

Year	Total number caught	First specimen caught	Last specimen caught
1909	2	June 29	July 4
1910	11	" 29	" 4
1911	4	" 29	" 4
1912	16	" 27 ¹	" 8 ²

In 1912 I captured my first two *Narcine brasiliensis* on June 27, but the first specimen caught in the bight of Cape Lookout, a large female, was taken on the morning of June 29. Thereafter I caught from one to five *Narcine* each day up to the night of July 4, and although nets were hauled many times during the day and night of July 5, no others were secured. I continued to haul seines both north and south of the bight, and early on the night of July 8, I caught one *Narcine brasiliensis* three miles southwest from the bight.³

The conclusion from these facts is that *Narcine brasiliensis* migrates northward each summer as far as Cape Lookout, arriving there toward the end of June, and that this is the farthest northern point of its migration. From the early stage of the embryos taken in specimens of this species, it appears probable that this species returns to southern waters before giving birth to its young.

Mobula olfersi also appears to have a northward summer migration. In

¹ Two specimens, caught two miles southwest of the bight of Cape Lookout.

² One specimen, caught three miles southwest of the bight: all others caught in the bight.

³ So confident had I become of the date of appearance of this species that, at my suggestion, Dr. Maud L. Monten of Western Reserve University, who was engaged in studying the electric apparatus of this ray, arrived a day or two before my first capture of this species, which occurred promptly on the date anticipated. The results of this study will shortly be published by Dr. Monten.

1911 I first noted that the dates of its arrival and disappearance coincided with those of 1910.

Dates of Capture of Mobula olfersi at Cape Lookout, N. C.

Year	Total number caught	First specimen caught	Last specimen caught
1910	9	July 6	July 9
1911	14	" 6	" 29
1912	11	" 7 ¹	" 29

In 1912, as the date approached on which the appearance of this ray had been recorded in previous years, I asked the fishermen along the coast to keep an eye out for this species. On July 4, it was reported that a school of *Mobula olfersi* had been seen ten miles southwest from the bight of Cape Lookout. Two of them had passed close to a boat.² They were seen in the bight from July 6 to 9, and the first were caught on the 7th. On July 10 and 11, I saw this species leaping in the breakers of Lookout shoals, and on July 12 they were noted in the breakers several miles north of Cape Lookout. I received word that they had been seen on July 15 at Cape Hatteras. I also saw them several miles north of Cape Lookout on July 21, and at various other points until the morning of July 24, when I caught two in the bight of Cape Lookout. Thereafter I caught five more specimens, the last being taken on July 29.

From these facts it appears that a school of *Mobula olfersi* migrates northward along the Atlantic coast during the summer; that they occur on the North Carolina coast between July 6 and 29. Cape Hatteras appears to be the northern limit of this migration.

I have also secured considerable data on the dates of appearance and disappearance in the bight of Cape Lookout of other species in addition to *Narcine brasiliensis* and *Mobula olfersi*, but the evidence is not quite so conclusive and its publication must for the present be deferred.

¹ They were seen on the morning of July 6 in the bight of Cape Lookout, but none were caught on that day.

² Reported by Capt. Orrie Willis of the boat 'Dolphin.'



AETOBATUS NARINARI AND EMBRYOS.

Aetobatus narinari (Euphrasen); female, 7 ft. 2 in. in diameter, and the four embryos to which she gave birth at intervals of a few seconds, on the beach. Cape Lookout, N. Carolina.

Fig. 1.— Seen from the side. Fig. 2.— From in front. Fig. 3.— From below. Note the unusual coloration consisting of ocelli instead of white spots, shown in figure 1.