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A SECOND BARN-DOOR SKATE, *RAJA STABULIFORIS*, WITH PECTORALS NON-ADHERENT TO THE HEAD

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It is interesting to note that two specimens of the same skate, having exactly the same type of abnormality, have been captured in the same general locality, Woods Hole, Massachusetts, by the same collector, Mr. Robert A. Goffin of the Bureau of Fisheries station. Moreover, both fish are males. The first was taken in 1924 in a fish-trap in Menemsha Bight, east of Gay Head in Vineyard Sound. The second was captured with an otter-trawl on December 1931, about 20 fathoms down and about 25 miles southwest of Nantucket Island. The first specimen is in the collections of the U. S. National Museum at Washington. With the permission of the officials of the Bureau of Fisheries, the second specimen was presented by Mr. Goffin to the American Museum, and is now in my keeping.

THE FIRST DEFORMED SKATE

The first specimen (1924) was identified by Mr. Lewis Radcliffe and was described by him in an article published in *Natural History* in 1928.¹ It will be well briefly to redescribe this first specimen, shown herein in dorsal and ventral views in figures 1 and 2, in order that direct comparisons may be made of it with the present specimen.

As the figures show, it is an immature male with the pectorals separated from the head by deep and wide notches. The complete measurements of this specimen will presently be set alongside those of the second fish. Here it is enough to say that the fish shown in figures 1 and 2 is 20.5 inches long over all, and 12.75 inches wide; while the length of the head, from tip of snout to the midpoint of line joining the bases of the right and left notches, is 5.25 inches. The right notch is slightly deeper than the left—5.5 inches right and 5.25 inches left. From this, and from the figures, it is seen that the fish is slightly asymmetrical. This asymmetry is even more plainly seen when one considers the relative position of the gill-slits as shown in figure 2. On the left

¹Radcliffe, Lewis, 1928. 'A Barn-door Skate (*Raja stabuliforis*) with Abnormal Pectoral Fins.' *Nat. Hist.*, XXVIII, pp. 58-63, 7 text-figs.

side two slits are shown anterior to the notch where head and pectoral meet, while on the right there are three slits above the notch. Other than in these points named, this young ray seems entirely normal.

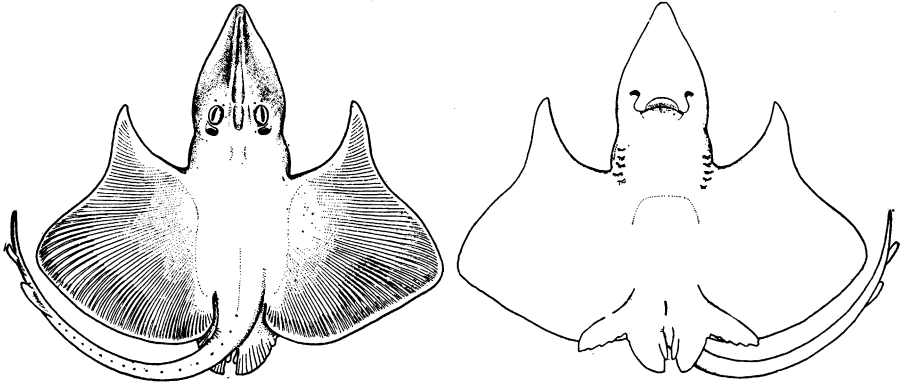


Fig. 1

Fig. 2

Fig. 1. Dorsal aspect of *Raja stabuliformis* (No. I) from Woods Hole. The head and pointed pectorals are separated by wide notches, that on the right being deeper.
After Radcliffe, 1928.

Fig. 2. Ventral view of abnormal barn-door skate No. I. The right-hand notch has three gill-slits above it; the left notch has but two.

After Radcliffe, 1928.

THE SECOND MALFORMED SKATE

The second ray is shown in both dorsal and ventral view in figures 3 and 4. It is also an immature male, as the very small claspers indicate, and is in the same stage of development as is the preceding. It measures 19 inches over all, and 12.25 inches in extreme breadth. The head from the extremity of the snout to the midpoint of a line joining the notches is 4.75 inches long. Like fish No. I, the right-side notch is deeper than the left—5.25 inches compared with 4.9.

Not so apparent as the wide notches between head and pectorals, but even more interesting, is the number and position of the gill-slits. On the left side there are five, decreasing somewhat uniformly in size from front to rear, the fifth being only about half as wide as the first. Unlike those of the first specimen, which has two gill-clefts anterior to the notch, all these are located well behind the notch on the left side. Those on the right side, however, are only four in number, and two of these are located above the notch, the third slightly below the base of the notch, and the fourth well behind this. Slits one and two on the

right side are about of a size, and only about half the size of slit number three; the largest, number four, is also about equal in size to numbers one and two. Most remarkable of all is the fact that, in the hinder wall of gill-slit number four, there is the rudiment of the last (fifth) right gill-slit. The opening is there, as may be seen in figure 4, about one-third as wide as is that of gill-slit number four. This slit ends in a blind sac about one-

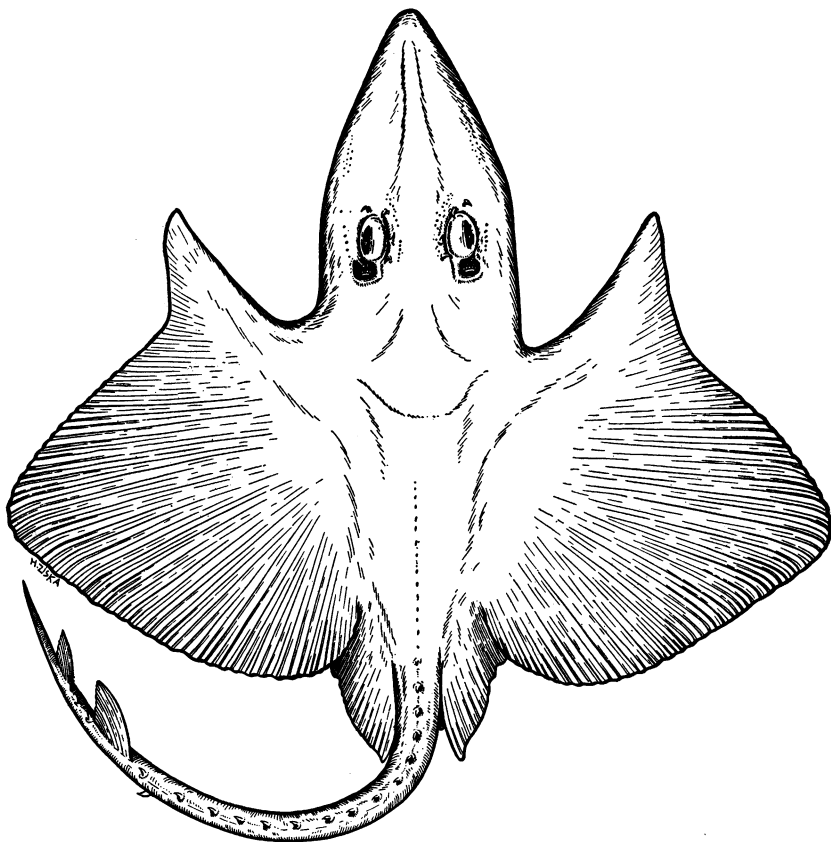


Fig. 3. Dorsal view of barn-door skate No. II from Woods Hole. The abnormality is identical with that of specimen No. I, the right notch being deeper.

fourth inch beneath the surface. It should be noted before leaving these structures that the right gill-slit of fish No. I is of about the same size and width as right gill-slit three of the present specimen.

The base of the notch on the left side of specimen No. II is 4.9 in. from the end of the snout, while the first gill-slit on that side is 5 in.

from the same point. The base of the right notch is about 5.25 in. from the tip of the snout, and the first gill-slit is about 4.9 in. from the same point of reference. Gill-slits number two are about the same distance from the tip of the snout, and are about opposite each other (see Fig. 4). The gill-slits on the right seem nearer the tip of snout because of the deeper cleft on that side.

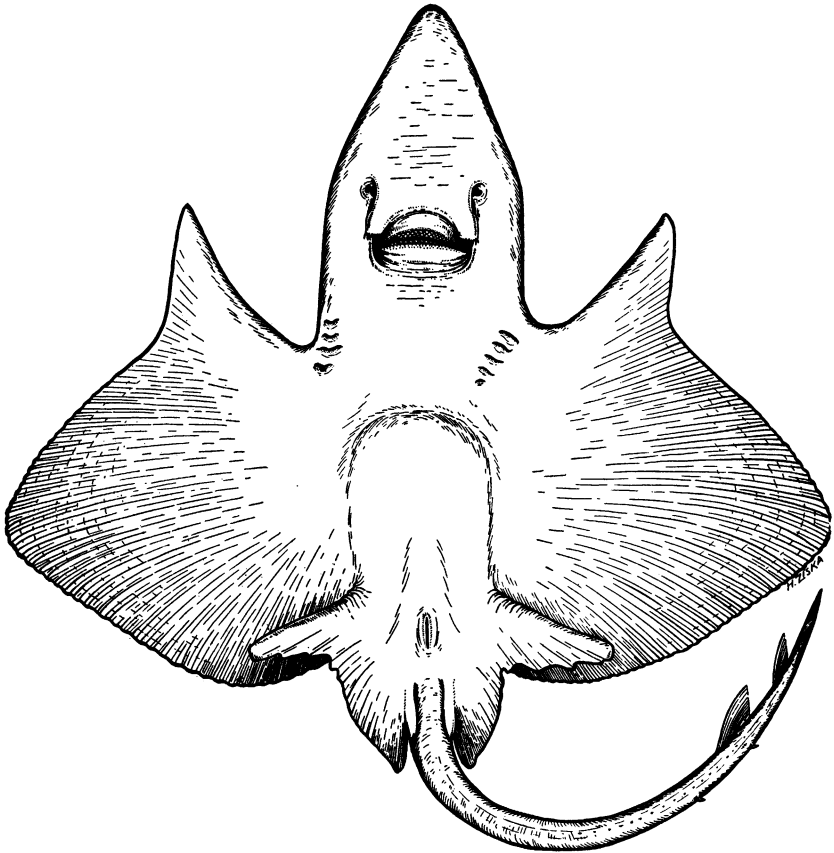


Fig. 4. Ventral aspect of ray No. II. Two right gill-slits are above the notch, the third is even with it, the fourth and the included fifth are below. On the left all five are well below the notch.

Other than in the matter of the notches on the right and left sides of the head, the relative size of the gill-clefts, and particularly in the matter of the rudimentary fifth slit on the right, this second young specimen of the barn-door skate seems normal.

In the table the relative measurements of the two specimens are contrasted. Ray No. I is Radcliffe's specimen, while No. II is mine. The measurements are all made in straight lines and recorded in inches.

MEASUREMENTS OF RAYS WITH NON-ADHERENT PECTORALS

Ray Number	I	II
Length over all	20.5 in.	19.0 in.
Length body proper (snout to hinder edge vent)	9.8 in.	9.4 in.
Length tail (hinder edge vent to tip)	10.7 in.	9.6 in.
Length snout tip to midpoint of line joining notches	5.25 in.	4.75 in.
Length snout tip to right-side first gill-slit	4.9 in.	5.00 in.
Length snout tip to left-side first gill-slit	4.7 in.	4.9 in.
Length right horn of pectoral to base of cleft	3.0 in.	2.75 in.
Length left horn of pectoral to base of cleft	2.75 in.	2.4 in.
Width over all	12.75 in.	12.25 in.
Width head at bottom shallow cleft	3.25 in.	3.25 in.
Width between eyes	1.0 in.	0.9 in.
Width tip to tip horns of pectorals	7.25 in.	7.1 in.
Width tip to tip pelvics	5.6 in.	5.5 in.
Depth snout to base right notch	5.5 in.	5.25 in.
Depth snout to base left notch	5.25 in.	4.9 in.

HISTORICAL NOTES

There is a rather extensive literature of this pectoral abnormality in skates and rays. This goes far back, even to the earliest printed works dealing generally with fishes—those great folios in which were laid the foundations of the natural history of fishes. However, this is not the place to figure and describe, or even refer to the bishopfish, monkfish,

or priestfish of Belon (1551), Rondelet (1554), Gesner (1558), and Aldrovandi (1613 and 1640). Some of these figures show the influence of mythological ideas, but were undoubtedly based on such malformed rays as are figured above. Such no doubt is that shown in figure 5, though it has plainly been manipulated by hand and dried to form the monster as portrayed by Aldrovandi. I have seen present-day manipulations produce comparable apparitions. Some day I hope to bring a large number of these figures together, as an interesting chapter in the history of ichthyology.

In modern ichthyological literature there is a large list of such teratological specimens extending from 1810 to 1932. Thus far, I have accumu-

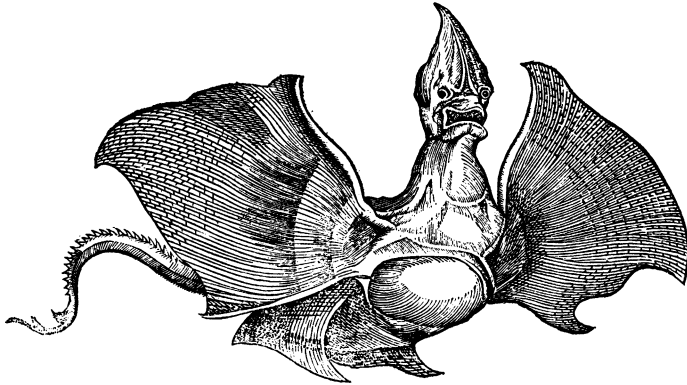


Fig. 5. The priestfish. A malformed, hand-manipulated, dried ray with which the artist took many liberties in his drawing.

After Aldrovandi, 1613.

lated 35 in my file marked "Malformed Rays." Close search through the literature will undoubtedly bring others to light. I hope some time to bring together all these modern accounts with their interesting figures in an article covering the field thoroughly. To do so now is beyond the purpose of this short article. However, it may not be out of place to give three short references, in order to make a historical setting for the malformations of the barn-door skate.

Present-day knowledge of these monstrous forms began with an account of such a ray taken on the coast of Sicily and described in 1810 by that strange genius, Constantine Rafinesque-Schmaltz.¹ He thought it was a distinct genus and gave its characters as follows (free transla-

¹Rafinesque-Schmaltz, C. S. 1810. 'Indice d'Ittiologia Siliciana.' Messina. (*Cephalothurus*, p. 61.)

tion): "Head free and separated from the lateral wings; eye and spiracles united [near to each other] and situated on the side of the head; two fins above the tail, none at the extremity." Then he adds: "This genus is most remarkable because of the characters exhibited by its free head, which in all other genera is united to the lateral or it may be pectoral

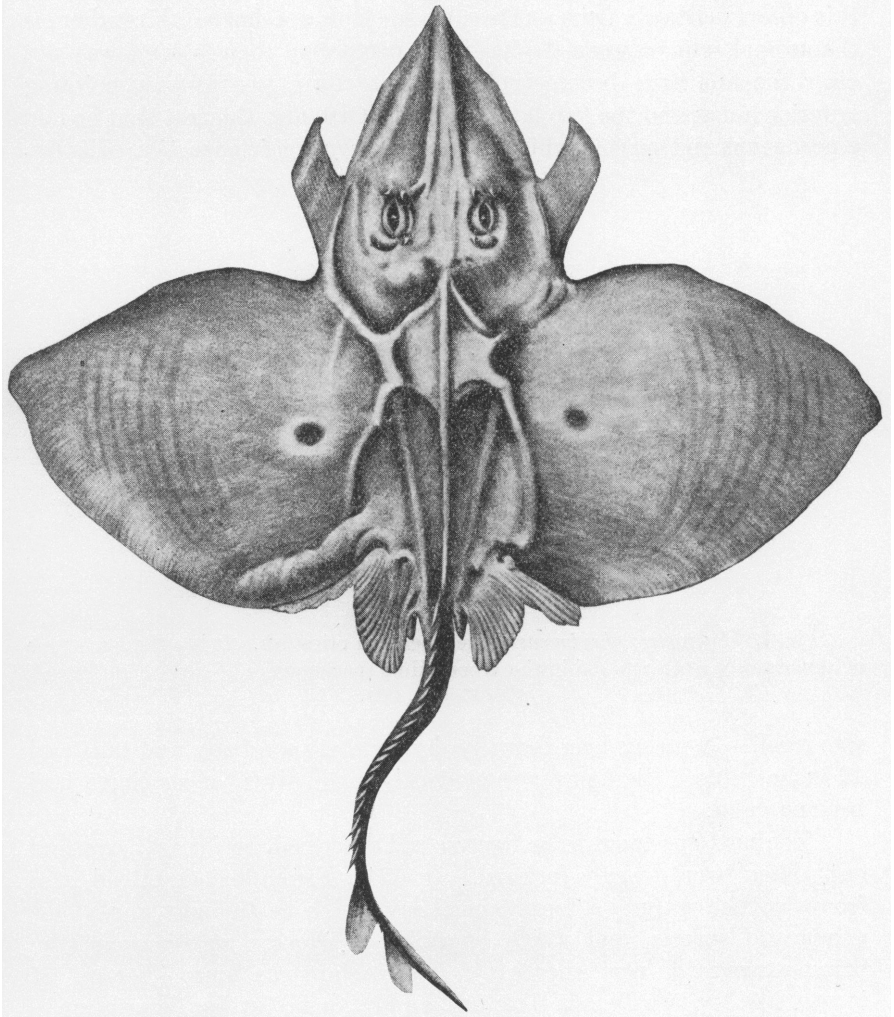


Fig. 6. *Propterygia hypostica*, a so-called new genus and species of ray. Here a second split has divided each pectoral fin into an anterior horn and a posterior fin.

After Otto, 1821.

wings [fins]." He names his form *Cephaleutherus maculatus*, and notes that its head is pointed and that the lateral fins are also pointed. He unfortunately gives neither measurements nor figure.

The next describer was the Breslau naturalist, A. W. Otto,¹ who in 1818 obtained from a fisherman at Edinburgh one of the most greatly malformed rays ever figured and described. As may be seen in figure 6, this differs markedly from our two Woods Hole specimens. First there is the normal split between the head and pectorals; then in some way not clear the fins have become split again to form two forward-pointing anterior horns and the two lateral wings. Otto also thought that he had a new genus and species, which he named *Propterygia hypostica*. His fish

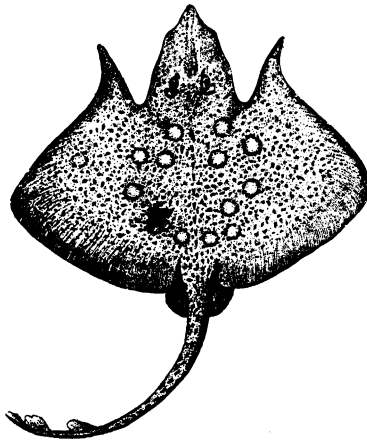


Fig. 7. *Hieroptera abredonensis*, the Aberdeen priestfish. It has the same type of abnormality as that found in the Woods Hole specimens.

After Fleming, 1841.

was small—18 inches long (equally divided between body and tail) and 13 inches wide. His figure was evidently made after the specimen had become dried.

The next specimen to be figured and described (so far as I can find out) dates twenty years forward. In 1841, Flemming² described, also from Scottish waters, a teratological ray which he thought was a new genus and species, and which he called *Heiroptra abredonensis* (the priest-winged fish from Aberdeen). This is shown as figure 7 herein. It is very like the two Woods Hole fish, and needs no further description.

¹Otto, A. W. 1821. 'Ueber eine neue Roche (*Propterygia hypostica*),' etc. Nova Acta Acad. Leopoldino-Carolineae, X, pp. 113-121, 2 plates.

²Flemming, John. 1841, 'Description of a Species of Ray New to the British Fauna.' Edinburgh New Philos. Journ., XXXI, pp. 236-238, 2 plates.

From this time on, the literature becomes too voluminous and complex to be covered satisfactorily in this short article. It is my intention later to collect and present it in definite form with all the interesting figures to show how, only after a period of 75 years, the matter was thoroughly cleared up—by Theodore Gill in 1896.

HOW THIS CONDITION COMES ABOUT

The explanation is to be found in the embryology of the skate. The skates and rays are highly specialized forms of the great group Elasmobranchii—forms which have evolved beyond the sharks by developing modifications for bottom-living. To this end the round body of the shark has become flattened, the pectorals have become enormously en-

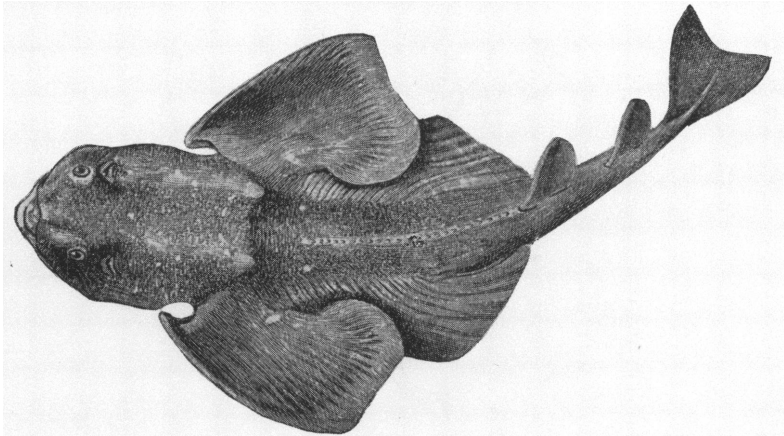


Fig. 8. The angel shark, *Rhina squatina*, an intermediate form between shark and ray. Note the permanent notch between pectorals and head.

After Boulenger, 1904.

larged and have become adherent to the neck and head region. In this process, the gill-openings have been forced from a lateral to a ventral position. In the angel shark, *Rhina squatina*, is found an excellent connecting link. In it, as may be seen in figure 8, the body is much flattened, the gill-slits are on the ventral surface, and the pectorals (also the pelvics) have become greatly enlarged. However, the pectorals are not yet adherent to the head, but are separated from it by conspicuous notches. These are morphologically identical with the notches that separate the "wings" from the head of the specimens of *Raja stabuliforis* from Woods Hole.

This matter will be made clearer by study of figure 9, which was drawn from the larval form of the sting-ray, *Dasyatis say*. This baby ray I cut from the uterus of the mother at Beaufort, N. C., many years ago. In this Cæsarean operation the head was unfortunately torn off. However, there are left the pectorals, widely divergent from the head-stalk. Since this specimen was collected, I have gotten fairly complete sets of stages for other rays, and have personally found, what is of course well known, that in its development the baby ray "climbs its own

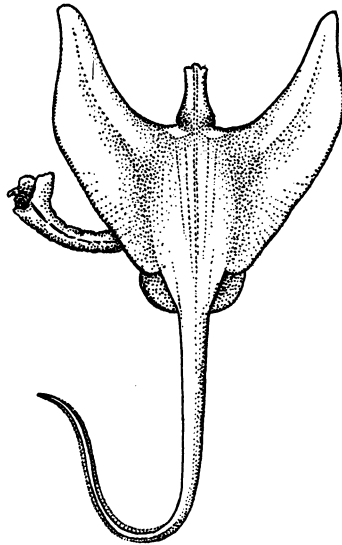


Fig. 9. Larval form of sting-ray, *Dasyatis say*, in intermediate stage of development between shark and ray. The head is lacking but the fins have not yet grown fast to the head-stalk. The yolk-stalk is still present and is shown on the left.

ancestral tree," and in doing so goes through a number of shark stages. As the larval ray grows older, it becomes less shark-like and more like a ray, passing through the stages shown in figures 9 and 8. From this it is clear that the specimens of the barn-door skate described herein are cases of arrested development, of fixed larval forms, directly comparable to the perennibranchiate urodeles among amphibians.