

THE EELS, *ANGUILLA* AND *HISTIOBRANCHUS*, PHOTOGRAPHED ON THE FLOOR OF THE DEEP ATLANTIC IN THE BAHAMAS

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A B S T R A C T

The first record of an adult eel of the genus *Anguilla* in the deep sea is reported from nearly 2,000 meters on the bottom of Tongue-of-the-Ocean, Bahamas. The record is based on photographs taken from the submersible ALVIN. Whether it represents *Anguilla anguilla* or *Anguilla rostrata* cannot be determined.

The basis of the identification is discussed and comments are provided on other eels of the region especially *Histiobranchus*, a synphobranchid eel also photographed in Tongue-of-the-Ocean. Comments are provided concerning the significance of this discovery to our knowledge of the distribution and biology of *Anguilla*.

The life history of the American eel, *Anguilla rostrata*, in the North Atlantic has been a longstanding puzzle, and although the freshwater phase is well known, the whereabouts and behavior of maturing eels after they enter the ocean remains a subject for conjecture and debate. The best recent summary is that by Tesch (1977).

Several species of eels were observed and photographed during submersible dives in Tongue-Of-The-Ocean (TOTO), a deep sea trough in the Bahama Islands. We identify one of them as the common eel, *Anguilla*, and another as the deep sea synphobranchid *Histiobranchus*.

METHODS AND MATERIALS

The submersible, ALVIN, was engaged in running measured bottom transects and taking qualitative and quantitative data by visual and photographic methods, of benthic and benthopelagic fishes and larger invertebrates.

ALVIN is operated by the Woods Hole Oceanographic Institution. The series of dives during which the present observations and photographs were made were manned by D. M. Cohen, National Marine Fisheries Service, NOAA; D. Pawson, Smithsonian Institution; and J. C. Staiger, Rosenstiel School of Marine and Atmospheric Science, University of Miami; and supported by the Manned Undersea Science and Technology Program of NOAA.

The eel photographed in Figure 1, which we identify as *Anguilla*, was seen during ALVIN dive 703; Lat 24°54.9'N, Long 77°41.1'W (between Andros and New Providence islands); transect 5; 2,085–2,045 m depth; 12 January, 1977, 1324–1339 h; pilot: D. Foster; observers: D. Cohen, D. Pawson. The picture was taken by Cohen through the port side viewing port with a hand-held 35 mm camera. When the eel was first sighted it was on the port side of ALVIN, swimming toward the submersible, which was traveling over level bottom at 28 m per minute. The eel seemed unaware of ALVIN until startled by the strobe, at which time it swam away rapidly.

A second photograph of an *Anguilla* was taken 15 to 20 min later during transect 6; 2,045–2,006 m depth; with a Benthos externally mounted 35 mm camera. It shows an eel swimming away from, rather than toward, the camera and allows additional perspective. The second photograph is not reproduced here due to its relatively poor quality. It is unlikely that the same fish was photographed during transects 5 and 6. Notes taken during both transects record the presence of several large "Synphobranchus," which in fact may have been *Anguilla*.

The eel in Figure 2, which we identify as *Histiobranchus*, was photographed during ALVIN dive 702; Lat 25°23.9'N, Long 77°11.4'W (in Northeast Providence Channel); transect 12; 2,873–2,837 m; 11 January, 1977, 1506–1517 h; pilot: L. Shumaker; observers: J. Staiger, D. Pawson. The picture was taken by Pawson through the starboard viewing port with a hand-held 35 mm camera.

IDENTIFICATION

The floor of TOTO is one of the best sampled areas for fishes of any region in the world at the same depths. The fishes from these collections are stored at the University of Miami, where the eels in particular have been well studied and have been used as a basis for identifying our deep sea photographs.

We identify the eel in Figure 1 and in the unpublished photograph as *Anguilla* for the following reasons: a sloping superior mouth; well-developed pectoral fins; the position of the dorsal fin well forward of the midpoint of the head and body (especially evident in the unpublished tail-first photograph); and the general proportions of the head and body. Careful study of projections of the transparency from which Figure 1 was enlarged show an inflection in the shadow of the fish, which we interpret as the location of the anus or anal-fin origin, posterior to the dorsal-fin origin. Species of *Synaphobranchus* have the dorsal-fin origin much farther back, posterior to the level of the anal-fin origin and have a distinctive, pointed snout; the mouth is not visible from above. *Simenchelys* has stouter proportions and the dorsal-fin origin very far forward, nearly above the tip of the pectoral fin. *Histiobranchus* has a more forward dorsal-fin origin (Fig. 2). Its head shape is rather characteristic of other genera of Synaphobranchidae except that it is flatter and wider, with a more oblong eye. Other synaphobranchid genera such as *Haptenchelys* and *Ilyophis* and the nettastomatid *Venifica* are much more elongate and generally too different to merit further comment. *Acromycter perturbator*, a congrid, is also elongate with an inferior mouth and is a much smaller species. In fact, the eel in Figure 1 looks like *Anguilla*, and we know of no other eel captured in TOTO that is a more likely candidate.

DISCUSSION

In the western Atlantic, transformed American eels at sea are known only from 16 examples taken during November and December at four localities ranging from southeast of Cape Cod to southeast of the mouth of Chesapeake Bay between 9 and 82 m of depth (Wenner, 1973; Tesch, 1977). All were in the migratory silver phase.

Figure 1 shows an eel of the genus *Anguilla* that is in or approaching spawning condition as indicated by the dark color, relatively pointed pectoral fins, and bulging belly. The fish must be a female, for males have much enlarged eyes when they enter the sea. Although it is impossible to separate *A. rostrata* from *A. anguilla*, the European eel, from a photograph, it is reasonable, based on our current understanding of the distributions of the two species, to assume that the photograph is of *A. rostrata*. What is the significance of this record?

The northern Bahamas are close to the projected Sargasso Sea spawning area for American eels (Schmidt, 1925; although Vladykov, 1964 gives good reason for supposing the area to be farther south). However, neither adult eels nor eggs ever have been recorded from the area (nor indeed anywhere else). Leptocephali of *A. rostrata* 18 to 22 mm long have been taken in TOTO during April, and 34 to 42 mm in June (Smith, 1968), which might be consistent with a nearby late January spawning. At present there is no direct evidence to indicate that the spawning site of the American eel is in the Sargasso Sea, the deep basins of the Bahamas (which are geologically old), or indeed is restricted to any one area. The American eel occurs in freshwater canals in the Bahamas (Böhlke and Chaplin, 1968:66) and the TOTO eel could represent a local fish spawning in nearby deep waters. Presence of an adult *Anguilla* in TOTO is also consistent with the

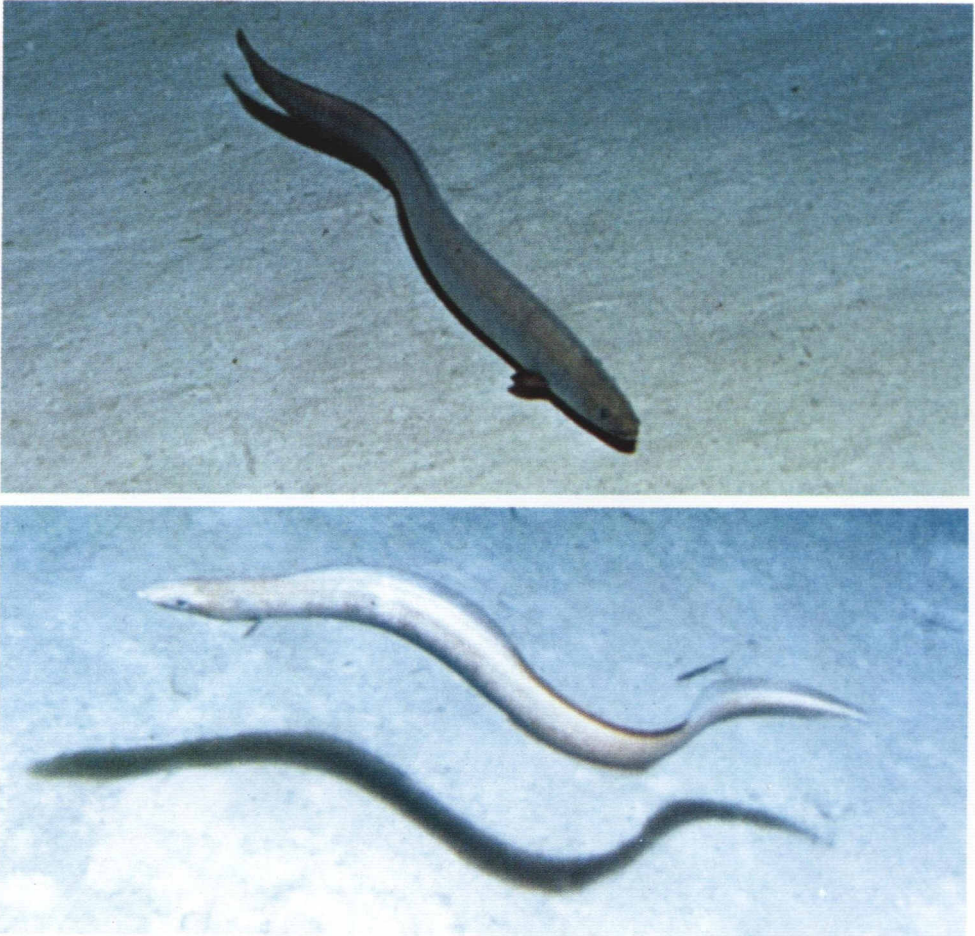


Figure 1. (Upper) *Anguilla*; Bahama Islands, Tongue-of-the-Ocean, 2,085–2,045 m.

Figure 2. (Lower) *Histiobranchus*; Bahama Islands, Northeast Providence Channel, 2,873–2,837 m.

winter departure time of eels from fresh water in Florida. Conceivably, eels could spawn in or near TOTO late in January or in February (Vladykov and Marsh, 1975, give February to July). Because there is flushing in TOTO, both on the bottom and in the water column, the possibility exists, however, that leptocephali caught in the area may have originated elsewhere.

The supposed spawning depth of *Anguilla* in the Sargasso Sea is 400 to 700 m in midwater (Schmidt, 1925). Hence, the discovery of a mature or near mature *Anguilla* on the bottom deeper than 2,000 m is in itself a surprise. It may lend credence to Tucker's (1959) suggestion that adult American eels ride a deep Gulf Stream counter-current. The fish is swollen indicating that it has not shed its eggs, and its swimming ability and general condition attest to its not being a dying, post-spawning individual that has fallen to the ocean floor.

Although the Straits of Florida and TOTO have been sampled extensively with

bottom trawls at all seasons (including late January and February), *Anguilla* never has been taken. This might indicate that it is rare on the bottom, as large eels of the genus *Synaphobranchus* are commonly captured. Species of *Synaphobranchus*, like many other deep sea fishes, are not strong swimmers and are easily taken by trawls. *Anguilla*, however, has very different capabilities and could easily avoid nets. Very large concentrations of *Anguilla* must cross the heavily fished continental shelf and slope of eastern North America, yet, only four captures ever have been recorded. Thus migrating *Anguilla* are not available to bottom trawls and their absence from TOTO catches similarly may have little significance. Difference in availability to eel trawls of silver eels and earlier stages has been noted in the IJsselmeer by Deelder (1960).

In summary, although this first record of an adult *Anguilla* on the bottom of the deep sea is of high interest, it creates new rather than solving old problems. Eels represent an archaic fish lineage and of 16 species of *Anguilla* only the European eel, *Anguilla anguilla*, is known to have such an extensive migration and localized spawning site, a fact that may relate to the age of this area of the Atlantic and the drift of the continents, an old suggestion recently renewed by Tesch (1977:130). It is neither necessary nor likely that the American eel has a similar migratory pattern.

Additional records are required, as are specimens in hand to confirm stage of maturity. Eels leave the fresh waters of southern Florida in December and January. It would be worthwhile to sample TOTO for eggs and leptocephali during the late winter and early spring months and to repeat submersible dives during late January or February. Other methods of sampling such as midwater trawling with a giant net should be attempted.

Another especially interesting eel that was photographed during this series of ALVIN dives is *Histiobranchus* (Fig. 2), a species that is most often taken under colder surface waters in higher latitudes. It is a deep-dwelling species that is absent from TOTO proper in our experience. The forward position of the dorsal-fin origin distinguishes *Histiobranchus* from *Synaphobranchus*, species of the two genera being otherwise similar in body form. The form of the head differs markedly from that of *Anguilla*.

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LITERATURE CITED

- Böhlke, J. E., and C. C. G. Chaplin. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingston, Wynnewood, Pennsylvania, xxxi + 777 pp.
- Deelder, C. L. 1960. The Atlantic eel problem. *Nature* 185: 589-592.
- Schmidt, J. 1925. The breeding places of the eel. *Ann. Rep. Smithsonian Inst.* 1924: 279-316.
- Smith, D. G. 1968. The occurrence of larvae of the America eel, *Anguilla rostrata*, in the Straits of Florida and nearby areas. *Bull. Mar. Sci.* 18: 280-293.
- Tesch, F. 1977. The eel. Chapman and Hall, London xiv + 434 pp.
- Tucker, D. W. 1959. A new solution to the Atlantic eel problem. *Nature* 183: 495-501.
- Vladykov, V. 1964. Quest for the true breeding area of the American eel (*Anguilla rostrata* LeSueur). *J. Fish. Res. Bd. Canada* 21: 1523-1530.
- , and H. March. 1975. Distribution of leptocephali of the two species of *Anguilla* in the

western North Atlantic based on collections made between 1933 and 1968. Syllogeus No. 6, Natl. Mus. Nat. Sci. Canada, 38 pp.

Wenner, C. A. 1973. Occurrence of American eels, *Anguilla rostrata*, overlying the eastern North American continental shelf. J. Fish. Res. Bd. Canada 30: 1752-1755.

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