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The Greenland halibut, a round flatfish or a flat roundfish?

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One of the most interesting flatfishes from a behavioural and physiological point of view is the Greenland halibut (Reinhardtius hippoglossoides, Walb.). There are indications for the ambivalent character of this species with respect to its swimming positions: mostly horizontal, but when swimming freely it adapts a vertical position. However, to prove the roundfish-like behaviour is rather difficult since there is little direct observation of this behaviour e.g. that by P. Hansen (in Jensen, 1935). He observed during his tagging experiments, "Apparently the Greenland halibut swim like ordinary fishes with the dorsal edge upwards; we observed this when the fish were liberated". Therefore we have to list all available information which may elucidate this typical behaviour and draw our final conclusions from circumstantial evidence.

1. Body form: the body is very elongated and not much compressed, both sides being equally muscular (compressed fusiform). The more active the fish, the more its shape will come to terms with its motion through water and so its streamline will be developed. Of all the flatfish species, the Greenland halibut is best adapted to an active life in this respect.

2. Coloration on the blind side (adult): the blind side of adult fishes is completely pigmented, the blind side being only slightly paler than the eyed side. This is also known of the witch (Glyptocephalus cynoglossus L.), here the blind side has some pigment giving it a slightly smoky appearance. The degree of this coloration is, however, not comparable with the coloration found on the blind side of the Greenland halibut.

3. Coloration on the blind side (juvenile): pigmentation on the blind side starts already in the juvenile bottom stages and becomes gradually more pronounced as the fish grows older (Jensen, 1925, 1935). Pigmentation on the blind side is also known of very young bottom stages of the halibut (Hippoglossus hippoglossus L.), however, in this species it disappears completely already in the first year (Tåning, 1936). The juvenile stages of the witch lack pigment on the blind side (Holt, 1893).

4. Position of the eyes: the eye of the left side is situated on the dorsal ridge of the head, though rather inclining to the right side. Consequently its field of vision must be considerably greater than if both eyes were on the same side (Jensen, 1935). Of the hornyhead turbot (Pleuronichthys verticalis. Jordan and Gillbert), the right eye protrudes a little over the edge and consequently it can search the bottom close to its head for food. The position of the eye, however, is completely different from that found in Greenland halibut.

5. Food: Greenland halibut is a fish-feeder, mostly feeding on capelin, polar cod, small redfish and prawns. There is a shift in food and food size when the fish become older, length appr. 10 cm. mainly small decapod crustacea and length appr. 50 cm. mainly fish (de Groot unpublished data). Capelin is the most interesting food species, because this species lives in shoals far above the bottom. Greenland halibut, therefore, has to leave the bottom in its pursuit. Halibut (Hippoglossus) also a fish-feeder, feeds in the North Atlantic mainly on redfish, decapod crustacea and cephalopods (McIntyre, 1953).

6. Line fishing: In spring the long-line fishery may be a failure, whereas during the same period hand-lines are very profitable. Both types of lines are used in places with a depth of about 300 m, but long-lines lie on the bottom and hand-line fishermen have only 200 m line out,

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therefore the Greenland halibut does not live at the bottom (Jensen, 1935). Interesting is the observation made by a Dutch skipper, that when hauling long-lines, large specimen of the halibut (Hippoglossus) often followed the hooked cod up to the surface, but swam in the way flatfishes normally do. (pers. comm.).

The aim of our investigation was to find out if there are anatomical clues supporting the hypothesis that Greenland halibut under certain conditions behave like roundfish. We therefore compared cross-sections of the body musculature of following species: Greenland halibut (♂, 68.5 cm); halibut (♂, 53.0 cm); plaice (Pleuronectes platessa L., ♀, 54.0 cm); cod (Gadus morhua L., ♂ 58.5 cm); roach (Rutilus rutilus L., ♂, 31.5 cm) and bream (Abramis brama L., ♀ 35.0 cm). Cross-sections were made a) 1 cm. behind the pectoral fin; b) in the middle of the fish; c) through the caudal peduncle (See Plate I, figs 1 - 6). The cross-sections of the Greenland halibut show more or less the pattern of the muscle-segments of the compressed fusiform roundfish e.g. bream; however, they have also much in common with the picture we observe in halibut. Unlike the Greenland halibut the halibut shows no tendencies towards ambivalent behaviour (vide observation of the Dutch skipper). This may be owing to the latter's great size which prevents it from swimming in the way of roundfishes and in the flatfish way alternately.

It seems likely that it will some day be possible to prove the ambivalent behaviour of the Greenland halibut, although many difficulties have still to be overcome.

From a physiological point of view the ambivalent behaviour of the Greenland halibut has its consequences. Roundfish uses the utriculus as a gravity receptor and the sacculus and lagena as sound receptors, whereas flatfish use their sacculus as gravity receptor (Schöne, 1964) and the function of the utriculus is not yet understood. The most obvious peculiarity of flatfish is the position of both eyes on the one side of the head. The optic nerves and the larger size of the olfactory lobe and nerve of the eyed side show asymmetry, the brain of the adult flatfish, however shows no marked asymmetry and is essentially similar to that of an ordinary roundfish. Therefore the stato-acoustical organ is still in the same anatomical position as in roundfish. Greenland halibut in consequence must have the ability to use both utriculus and sacculus for gravity perception depending on the way it swims, whether horizontally or in a vertical position.

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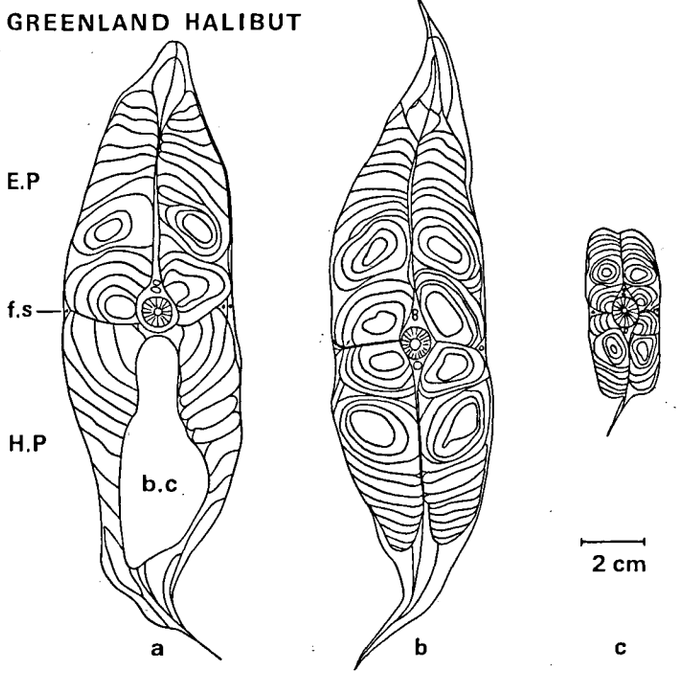
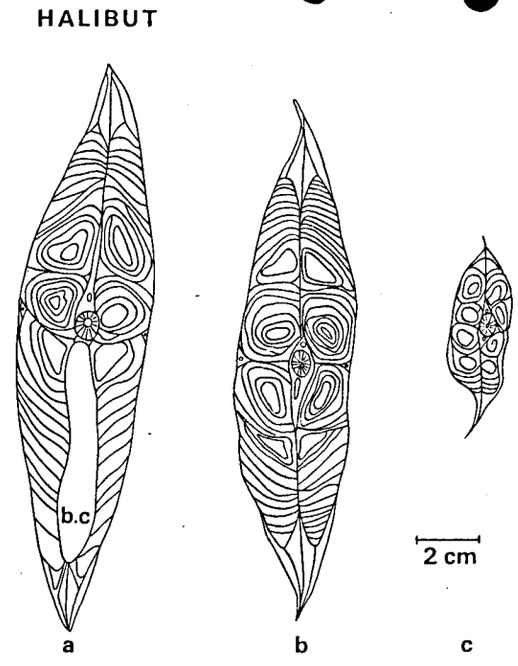


fig.1



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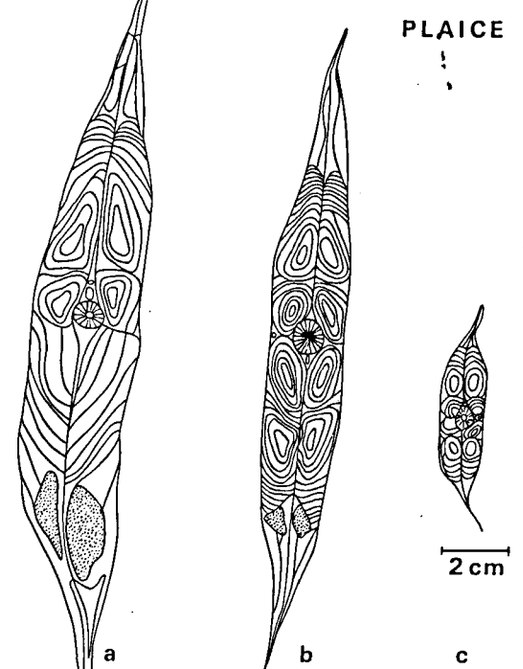

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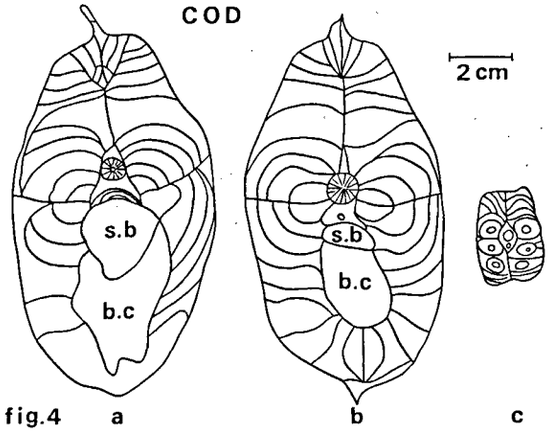

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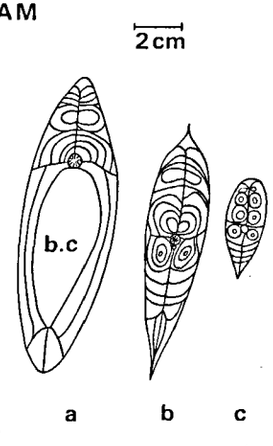

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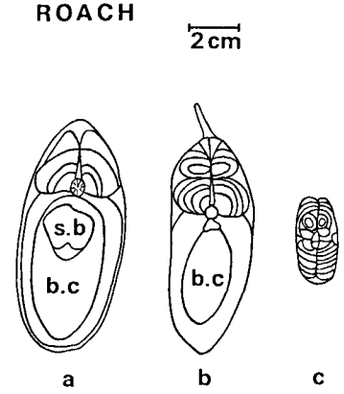

fig.6

Plate 1, showing cross-sections of the body musculature of several species of fishes
a) 1 cm behind the pectoral fin; b) in the middle of the fish; c) through the caudal peduncle
b.c - body cavity, f.s - fibrous septum, s.b - swimbladder
E.P - Epiaxial portion of the musculature; H.P - Hypaxial portion of the musculature