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Preliminary report on histology and incidence of
pseudobranch tumors in Atlantic cod (Gadus morhua)
in the German Bight

Burkard Watermann and Volkert Dethlefsen
Bundesforschungsanstalt für Fischerei
Institut für Küsten- und Binnenfischerei
Toxikologisches Laboratorium
Niedersachsenstraße
2190 Cuxhaven
F. R. Germany

SUMMARY

The incidence of pseudobranch tumors in the Atlantic cod (Gadus morhua) was found to be 2.1 % in the average in the western and southern North Sea. The histology of the tumors is described in comparison with previous reports and it is supposed to call these tumors chemodectoma.

RESUME

L'incidence des tumeurs pseudobranchies dans la morue (Gadus morhua) apparait avec une moyenne de 2.1 % dans l'ouest et le sud de la mer du nord. L'histologie des tumeurs est décrits en comparaison de rapports antérieurs. Les tumeurs sont supposés, chemodectoma ressemblant tumeurs.

INTRODUCTION

There are only few reports on pseudobranch tumors of Atlantic cod (Gadus morhua). Peyron and Thomas (1929) described two cases of pseudobranch tumors of Atlantic cod from the French Atlantic coast. Lange (1973) and Lange and Johannessen (1977) investigated several cases from Norwegian waters and called the tumors chemodectoma. Morrison et al. (1979) found 1.1 % of the cod from Atlantic waters near the Scotian Banks to be afflicted with pseudobranch tumors with a higher frequency of inshore cod. The present report gives results on histology and prevalence of pseudobranch tumors which were sampled during fish disease surveys in the German Bight and the North Sea.

MATERIAL AND METHODS

Cod were collected on cruises in January and July 1979 and in January, February and June 1980 with RV "Anton Dohrn". During these cruises stations were randomly distributed over a wide area of the German Bight with special attention to dumping areas, 1. sewage sludge dumping area, 2. dumping area for wastes from TiO_2 production. In addition samples were collected in Dutch coastal waters and the Dogger.

For light microscopy the tumors were fixed in 10 % buffered formalin and embedded in paraffin. For electron microscopy material was fixed in 6 % phosphate buffered glutaraldehyde and embedded in Epon. The paraffin sections were stained in Delafields haematoxylin and azan. Semi thin Epon sections were stained with toluidine blue and ultra thin sections for electron microscopy were stained with lead citrate and uranyl acetate.

RESULTS

Histology

The tumors were predominantly found at the locus of the pseudobranch, mainly appearing bilaterally and symmetrically. Additionally to these tumors about 50 % of the infected cod showed tumoral growth on the dorsolateral edge of the operculum. The tumors were occurring uni- or bilaterally. In one case a unilateral pseudobranch tumor was connected with a tumor on the nose of the infected cod. In a second case a tumor under the dental plate was found in front of a symmetric pseudobranch tumor. In a further case one cod was found with numerous small tumors distributed all over the gill lamellae.

The size of pseudobranch tumors varied from a light swelling of the pseudobranch up to 4.0 x 2.5 x 2.5 cm. External surfaces were lobulated, smooth and pale yellow in colour covered with red remnants of the pseudobranch. Their consistency was very smooth with a tendency of liquefaction in the greater stages.

In light microscopy all pseudobranch tumors were very similar in their histological texture. They were predominantly composed of "X-cells". These "X-cells" are characterized to be hypertrophied cells with large pale nuclei and prominent nucleoli. Most of the tumors were covered with a normal epidermis. The remnants of the pseudobranch showed different stages of degradation. Some of them appeared to be normal pseudobranches with heavy convoluted rudimentary gill filaments and gill capsule. In other cases cells of the pseudobranch appeared to be swollen and less convoluted with an extension of the connective tissue. The greater stages of the tumors were covered by necrotic remnants of the pseudobranch infiltrated with all types of blood cells.

Masses of tumors were subdivided by fibrous septa into several compartments and also the pseudobranch was always separated from the tumor by these septa. Blood vessels were seen in these compartments to appear in a parallel or branched pattern. "X-cells" located near these capillaries were showing a light cytoplasm with few granules, while those more distant from the capillaries showed dark and densely granulated cytoplasm and prominent nucleoli in each nucleus. In greater tumors necrotic forms of "X-cells" with highly vacuolated or foamy cytoplasm were found in central areas. Around these different stages of "X-cells" very small envelope cells were detectable. In some compartments numbers of "X-cells" appeared as floating in interstitial fluid displaying amoeboid shapes without any envelope cells.

In electron microscopy finely dispersed chromatin electron dense particles were found to be distributed throughout the nucleus beside the prominent nucleoli. In the cytoplasm numerous membrane bound dense granules, most of them with loose fitten membranes, were seen in correspondence to the light or dark granular cytoplasm in light microscopy. The mitochondria of the "X-cells" appeared to be tubular but most of them were only poorly developed (Figure 1).

Under the heavily coated outer membrane of the "X-cells" several layers of membranes appeared to be connected with the endoplasmic reticulum.

Distribution

Cod infected with pseudobranch tumors were predominantly found in the German Bight, an area where population density of cod of the respective age is high. On the Dogger or near the Dutch coast tumor incidence was lower. In these areas population density was low and cod of the normally affected lengths groups were seldom.

In Januar 1980 the mean length of affected fish was between 26 - 40 cm and in June 1980 it was between 12 - 25 and 30 - 44 cm (Figures 4 and 5).

The distribution of diseased cod in the German Bight seemed to be diffuse and no geographical accumulation could be detected. An overall average of the infection rate of cod with pseudobranch tumors in the German Bight was calculated to be 2.1 % (Figures 2 and 3).

DISCUSSION

The pseudobranch tumors of cod from the North Sea consist of essentially the same cell structures as those found in Atlantic cod from Scotia Banks and the Oslo Fjords. Also it seems to be of the same histological structure as those tumors found in Pacific cod (Lange, 1973; Lange and Johannessen, 1977; Morrison et al., 1979; Alpers et al., 1977).

The predominant cell type of these tumors are so called "X-cells" which are either transformed fish cells or unicellular organisms. In those tumors investigated from the North Sea there are some features as pale nucleus with dispersed chromatin, the free floating ameboid forms and building of granuloma like fibrous septae and the tubular appearing mitochondria, suggesting that the "X-cells" are of unicellular origin. But the mean bilateral appearance the high degradation of all cytoplasmatic organelles especially in the mitochondria the occurrence of envelope cells and the membrane bound cytoplasmatic granules which are apparently the same as the argyrophil granules described by Lange and Johannessen (1977) suggest, that "X-cells" are transformed fish cells. According to Lange it is proposed that pseudobranch tumors of cod are very similar to chemodectoma in man.

Taking into consideration the function of the pseudobranch as chemoreceptor for O_2 and CO_2 tensions it has to be taken into account that wide areas of the German Bight show oxygen depletion and high concentration of dissolved CO_2 (Rachor, pers.comm.; Weichart, 1975) the latter induced by acid wast dumping from titaniumdioxide industry. In the Behring Sea for example where high prevalences of pseudobranch tumors of Pacific cod have been demonstrated (Wellings, et al., 1977) oxygen depletion in relevant depths seems to be very common (Hattori, 1975).

Unfortunately there is no investigation of the tumor prevalence in the northern part of the North Sea, so the connection between the origin of these tumors and environmental factors remains very speculative. It has to be considered that the relevant age groups of cod in the German Bight stay in this area most of their life time (Lamp, 1973).

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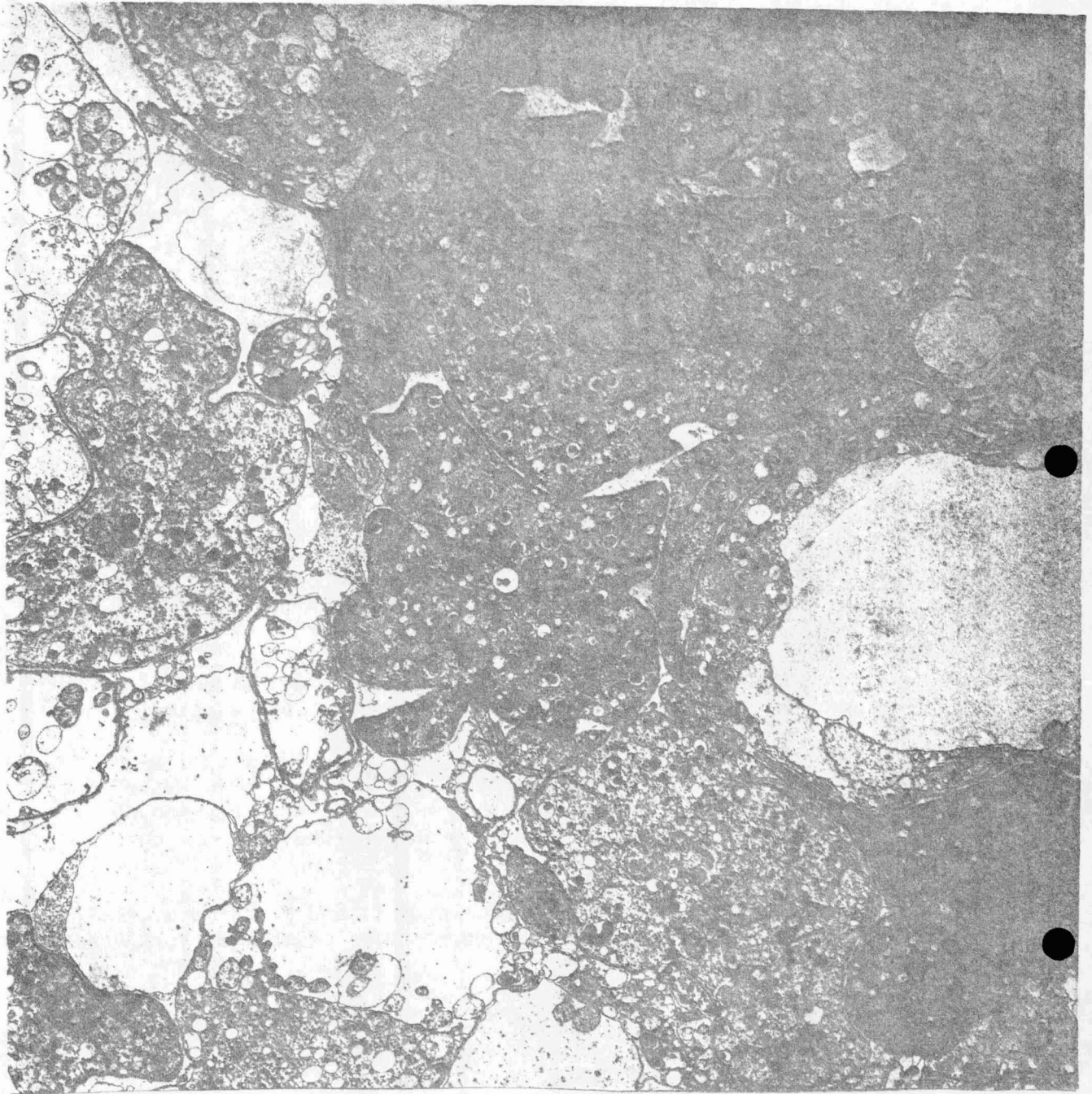


Figure 1

Electron micrograph of "X-cells" in different stages, all containing numerous membrane-bound cytoplasmic granules. Several degraded tubular appearing mitochondria are seen. Between the "X-cells" some envelope cells are detectable.

x 8500

Figure 2

Prevalence of pseudobranch tumors
in cod (Gadus morhua)
North Sea
January/February 1979 and 1980

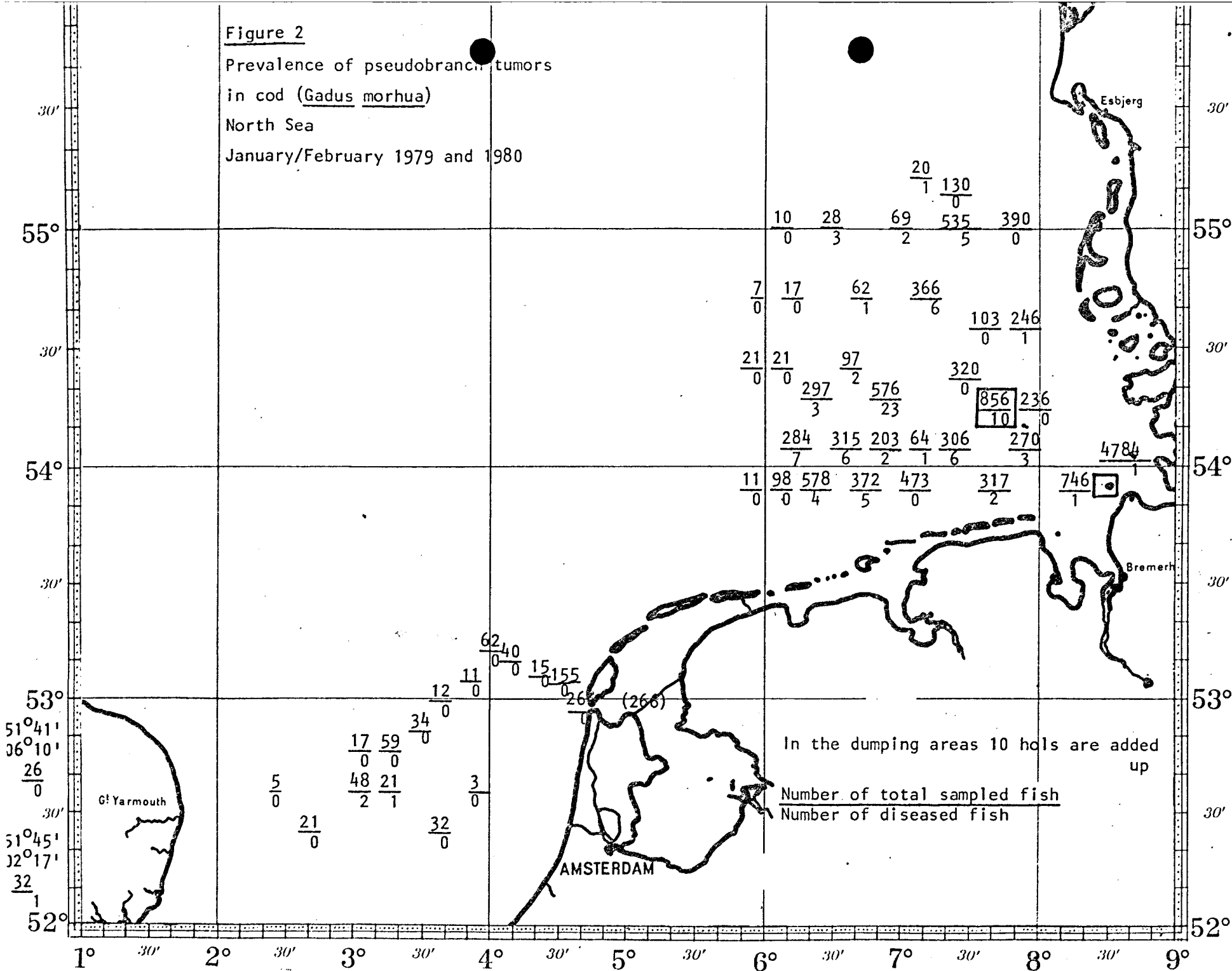


Figure 3
 Prevalence of pseudobranch tumors
 in cod (Gadus morhua)
 North Sea
 June/July 1979 and 1980

