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Prevalence of skin pseudotumors in starry flounder (*Platichthys stellatus*) and pleuronectid hybrids in a brackish-water lake, Hokkaido, Japan

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Abstract Starry flounder (*Platichthys stellatus*) and Oshoro flounder, hybrids of starry flounder and stone flounder (*Kareius bicolaratus*), collected in the brackish-water Lake Kuccharo, Hokkaido, were examined for skin pseudotumors. The disease was found in Oshoro flounder, which represents the first record of skin pseudotumors from pleuronectid hybrids. In starry flounder, only small fish (less than 10 cm in body length) had skin pseudotumors, and prevalence of the disease sharply decreased with fish size. No predatory fish was caught in the lake. It thus seems likely that small starry flounder die due to skin pseudotumors in the lake.

Key words: pleuronectids, prevalence, skin pseudotumors, starry flounders

INTRODUCTION

Skin pseudotumors are known to occur on the skin of pleuronectids from Japan (e.g., Ito *et al.*, 1976; Oishi, K *et al.*, 1976; Yamazaki *et al.*, 1978a, 1978b; Katsura *et al.*, 1984; Fujimoto *et al.*, 1986; Freeman, 2009; Freeman *et al.*, 2011) and other regions of the world (e.g., Wellings *et al.*, 1976; Peters *et al.*, 1978; McCain *et al.*, 1979; Diamant and McVicar, 1989). Currently, Miwa *et al.* (2004) reported that X-cells found in the skin pseudotumor of flathead flounder (*Hippoglossoides dubius* Schmidt) from Japanese waters are parasitic protozoans. Freeman *et al.* (2011) also stated that X-cell parasites cannot be placed in any established protist phylum and the same X-cell parasite can infect more than one species of Japanese pleuronectids.

The starry flounder (*Platichthys stellatus* (Pallas)) is distributed in the northern North Pacific Ocean and its adjacent seas, including the Sea of Japan, the Sea of Okhotsk and the Bering Sea (Froese and Pauly, 2012). This species has been frequently reported to have skin pseudotumors in Japanese waters (Awakura, 1974; Oishi, K *et al.*, 1976; Yamazaki *et al.*, 1978a; Shinkawa and Yamazaki, 1983; Katsura *et al.*, 1984; Kato *et al.*, 1990) and off the west coast of North America (McArn *et al.*, 1968; Brooks *et al.*, 1969; McArn and Wellings, 1971; Wellings *et al.*, 1976; Campana, 1983). The lesions have the characteristic X-cells (giant cells) (Yamazaki *et al.*, 1978; Katsura *et al.*, 1984; Brooks *et al.*, 1969; McArn and Wellings, 1971; Wellings *et al.*, 1976), and the disease has been diagnosed as epidermal (or skin) papillomas (Yamazaki *et al.*, 1978; Katsura *et al.*, 1984; McArn *et al.*, 1968; Wellings *et al.*, 1976; Stich *et al.*, 1976) or X-cell pseudotumors (Kato *et al.*, 1990).

In Japan, starry flounder occur along the coast of northern Honshu and Hokkaido, but skin

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pseudotumors are known in individuals from Hokkaido, where the disease is present in three surrounding seas (the North Pacific Ocean, the Sea of Okhotsk and the Sea of Japan). Although prevalence of the disease in starry flounder populations varied among localities, high prevalences (up to 40.0%) were recorded from the coast facing the Sea of Okhotsk (Katsura *et al.*, 1984). Based on an epidemiological study of the disease in a population of the species in the brackish-water Lake Mokoto on this coast, Kato *et al.* (1990) found that, within the same age groups, affected fish were smaller and fed less abundantly than fish without the disease and also that prevalence of the disease decreased with increasing fish age. This observation is important in terms of natural mortality of the fish because it has been suggested that starry flounder with skin pseudotumors die young (Campana, 1983). Considering the information from these studies, we investigated the occurrence of starry flounder with skin pseudotumors in the brackish-water Lake Kuccharo which is located on the same coast as Lake Mokoto. In this study, we also found the disease in Oshoro flounder, hybrids of starry flounder and stone flounder (*Kareius bicolaratus* (Basilewsky)), collected in the same lake, which is herein reported.

MATERIALS AND METHODS

Lake Kuccharo (45° 09' N, 142° 20' E) is one of the largest lakes (13.30 km^2) found along the Sea of Okhotsk coast of Hokkaido. The Kuccharo River flows from this lake and empties into the sea. The maximum water depth is 3.3 m. The bottom is mud. The salinity fluctuates due to the inflow of the sea water, ranging from 7.8-29.0 psu (J. Ogasawara, unpublished data).

One hundred and thirty-eight starry flounder and two Oshoro flounder were collected using a beach seine in the inshore region on June 9 and October 26, 1983. Eight specimens of Oshoro flounder were also sampled with the same gear on August 26, 1982. These fish were fixed in 10% formalin soon after capture and brought to the laboratory, where they were processed by recording the body length (BL, mm), the presence or absence of skin pseudotumors, and, when present, their locations. No age determination was made for the fish.

RESULTS

Skin pseudotumors were found on 18 (13.0%) of the 138 starry flounder examined. The disease was found only in fish (16.7%) caught in June 1983 (Fig. 1). Prevalence of the disease was dependent on fish size. In the sample caught in June 1983, all fish of 40-49 mm BL were affected with the disease, but prevalence decreased with increasing fish size. No skin pseudotumor was found on fish larger than 100 mm BL. The number of skin pseudotumors per fish ranged from 1-3 (mean 1.7). Of the 31 skin pseudotumors found, the majority (22, 71.0%) occurred on the fins (caudal fin, 8; dorsal fin, 7; anal fin, 7). The remaining 5 (16.1%), 3 (9.7%) and 1 (3.2%) were found on the head and the ventral and dorsal trunk, respectively.

Four (40.0%) of the 10 Oshoro flounder (46-102 mm BL) examined had skin pseudotumors. The external appearance of the lesions was identical with that of starry flounder observed in this study. The affected fish were relatively small (46-87 mm BL). The number of skin pseudotumors per fish ranged from 1-8 (mean 4.3). Twelve (70.6%) of the 17 skin pseudotumors found occurred on the fins (anal fin, 8; caudal fin, 3; pectoral fin, 1). The remaining 3 (17.6%), 1 (5.9%) and 1 (5.9%) were present on the dorsal trunk, the head and the thorax, respectively.

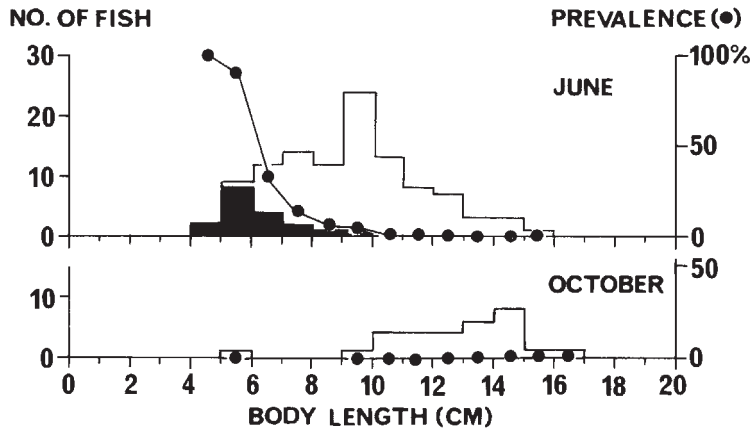

Fig. 1. Size frequency distributions of starry flounder with (black area) and without (open area) skin pseudotumors collected in Lake Kuccharo, Hokkaido, in June (top) and October (bottom) 1983. Prevalence (%) of skin pseudotumors in each size class of the fish is also shown.

DISCUSSION

The question from this study is whether small fish with skin pseudotumors die with increasing fish size. Since the regression of skin pseudotumors was proved to be negative for starry flounder from Hokkaido (Kato *et al.*, 1990) and Washington (Campana, 1983), the observed decrease in prevalence of the disease with fish size and from June to October is considered to have resulted from loss of affected fish in the population and/or movement of those fish to other areas. The latter possibility, however, may be negligible even if it occurs, because only affected fish are not likely to have moved to different places, especially to the sea. It is thus likely that the starry flounder with skin pseudotumors were lost from the population within the lake. Kato *et al.* (1990) also found that, in the nearby Lake Mokoto, many of the small starry flounder with skin pseudotumors disappeared from April to June. These authors suggested that predation was partially responsible for this disappearance but could not obtain data to prove it. In this study, we did not collect any predatory fish at our sampling sites in Lake Kuccharo. Based on these facts obtained by us and Kato *et al.* (1990), it may be reasonable to consider that small starry flounder die due to skin pseudotumors in the lake.

Campana (1983) indicated that, in Bellingham Bay, Washington, starry flounder with skin pseudotumors die in late spring. As stated above, many of small fish with the disease also disappeared from spring and early summer in Lake Mokoto (Kato *et al.*, 1990). Our study area, Lake Kuccharo, is covered with the ice during winter, but the bottom water temperature increases to 12° C in June and up to 23° C in August (J. Ogasawara, unpublished data). Although our fish sampling was not conducted at monthly intervals, the fact that prevalence became zero from June to October 1983 may have been caused by mortality of diseased fish during this period. Experimental work is desirable to evaluate the impact of various water temperatures on the survival of small fish with skin pseudotumors.

This paper is the first to report the occurrence of skin pseudotumors in Oshoro flounder, hybrids of

starry flounder and stone flounder. Since Oshoro flounder widely occur in coastal waters of Hokkaido (cf. Hikita, 1952), they may have the disease in other localities as well.

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北海道の汽水湖に生息するヌマガレイとカレイ類雑種における皮膚偽腫瘍の発生状況

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要　旨　北海道オホーツク海沿岸のクッチャロ湖からヌマガレイとオショロガレイ（ヌマガレイとスナガレイの雑種）を採集し，体表の皮膚偽腫瘍の発生状況を調べた。本病変はヌマガレイとオショロガレイともに見られ，カレイ類雑種からは初記録である。ヌマガレイでは，体長10cm 未満の小型魚にのみ病変が認められ，魚体長の増加とともに病変の発生率は減少した。この湖にはカレイ類の魚類捕食者が見られず，また病変の退行や病魚の湖外への移動が考えられないことから，病魚は死亡すると推定した。

キーワード：カレイ類，ヌマガレイ，発生率，皮膚偽腫瘍