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Temporal change in the benthic biota and the demersal fish composition in the heavily exploited fishing ground on the continental slope off the Pacific coast of northern Japan, between the 1950's and recent years

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Abstract

We examined the physical oceanographic condition, the macro-benthos composition, and the demersal fish composition in the continental slope (300-800m in depth) off the Pacific coast of northern Japan in summer of 2002 and 2003, and compared with the data collected and published in the 1950's. Macro-benthos was collected by the Niino's dredge and the Smith-McIntyre bottom sampler, and fish was caught by the bottom trawl. No clear difference in the physical condition was observed between the 1950's and recent years. In 1955, Annelida (mainly Polychaeta) and Mollusca (mainly Bivalvia) frequently appeared in the macro-benthos composition. In 2002, however, only Annelida was much and appearance frequency of Mollusca became low. Demersal fish composition was remarkably different between the 1950's and recent years. Fishing target species, namely, Scorpaenidae (Sebastes and Sebastolobus) and Pleuronectidae (mainly Clidoderma) frequently appeared in the 1950's. But, in recent years, fishing target species decreased, and Zoarcidae (mainly Bothrocara and Zestichthys), Macrouridae (mainly Albatrossia and Coryphaenoides) and Synaphobranchus increased alternately. This difference in the demersal fish composition must result from high fishing intensity in 50 years. And, change in the fish composition might influence the benthic fauna through their feeding habits. Our results suggest that direct and/or indirect impact of fishing should be taken into consideration for conservation of the marine environment and ecosystem.

Introduction

Modern trawl fisheries began in about 1900, and had operated on the continental slope after the 1920's -1930's, off the Pacific coast of Hokkaido, northern Japan (Hokkaido Fisheries Experimental Stations, 2001). Then, after the Second World War, the continental slope has been exposed to the strong fishing intensity. Recently, impact of the trawl fisheries on the seafloor and the benthos is discussed (Hall, 1997; Norse & Watling, 1998; Pauly et al., 2002). We examined the 50 years change in the heavily exploited fishing ground on the continental slope, and investigated the impact of the trawl fisheries on the benthic community.

Materials and methods

We measured water temperature and salinity in the bottom layer (300-800m in depth) of the Erimo area by the memorized salinity, temperature and depth profiling system (MSTD, Alec-electronics Co.) in 2002 and 2003 (Figure 1). In 1955, water temperature, salinity and dissolved oxygen were measured in the Erimo area (Hachinohe Branch of Tohoku National Fisheries Research Institute, 1956). And, dissolved oxygen was measured in the Erimo area, in 2000 (Miyake et al., 2002).

Macro-benthos was collected by the Niino's dredge in 1955 (Hachinohe Branch of Tohoku National Fisheries Research Institute, 1956), and by the Smith-McIntyre bottom sampler in 2002, in the Erimo area (Figure 1). Demersal fish was caught by the bottom trawl in the both of the 1950's (Hachinohe Branch of Tohoku National Fisheries Research Institute, 1955) and 2002-2003, in the Donan area and the Erimo area (Figure 1). We estimated the macro-benthos composition and the demersal fish composition by the number of individuals.

All data were collected in summer (June to September).

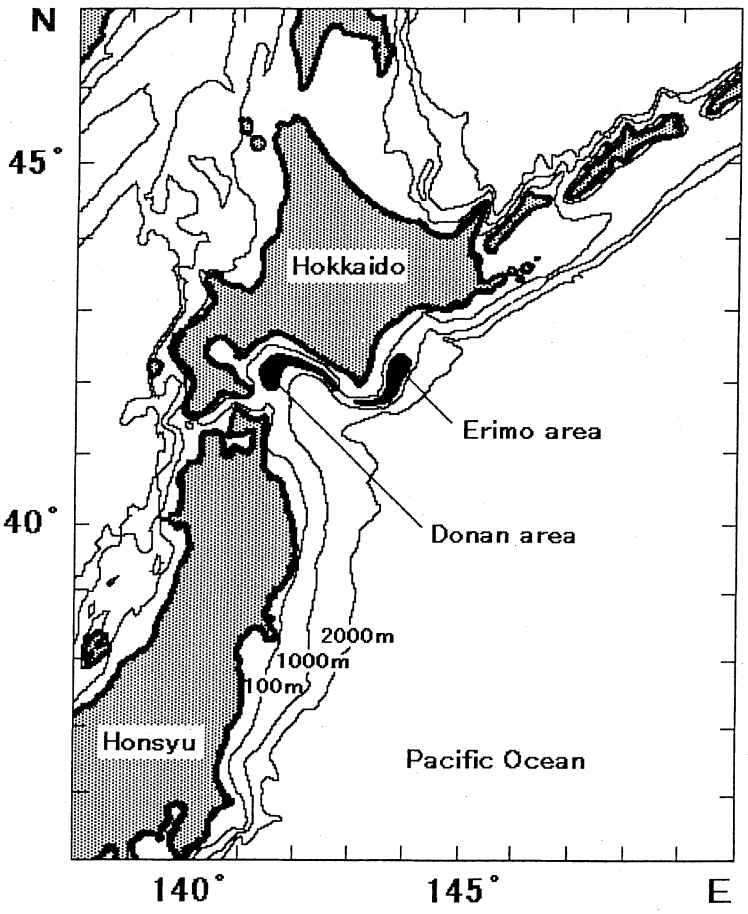

Figure 1 Pacific coast of northern Japan. Physical oceanographic condition and the macro-benthos composition were examined in the Erimo area. Demersal fish composition was examined in the Donan area and the Erimo area.

Results

In 1955, water temperature and salinity were 2-3 ℃ and 33.7-34.0 in the bottom layer (300-800m in depth) respectively, and dissolved oxygen was about 3.5 ml/l in the depth of 300m, in the Erimo area (Hachinohe Branch of Tohoku National Fisheries Research Institute, 1956). In 2002 and 2003, water temperature and salinity were 2-3℃ and 33.7-34.3 in the bottom layer (300-800m in depth) respectively, in the Erimo area. And, dissolved oxygen was about 3.5 ml/l in the depth of 300m of the Erimo area, in 2000 (Miyake et al., 2002). Therefore, no clear difference in the physical condition was observed between the 1950's and recent years.

In 1955, Annelida (mainly Polychaeta) and Mollusca (mainly Bivalvia) frequently appeared in the macro-benthos composition (Hachinohe Branch of Tohoku National Fisheries Research Institute, 1956; Figure 2). In 2002, however, appearance frequency of Annelida became over 90%, meanwhile that of Mollusca was very low (Figure 2). Appearance frequency of Echinodermata (mainly Ophiuroidea) ranged 4-8 % in the both period of 1955 and 2002 (Figure 2).

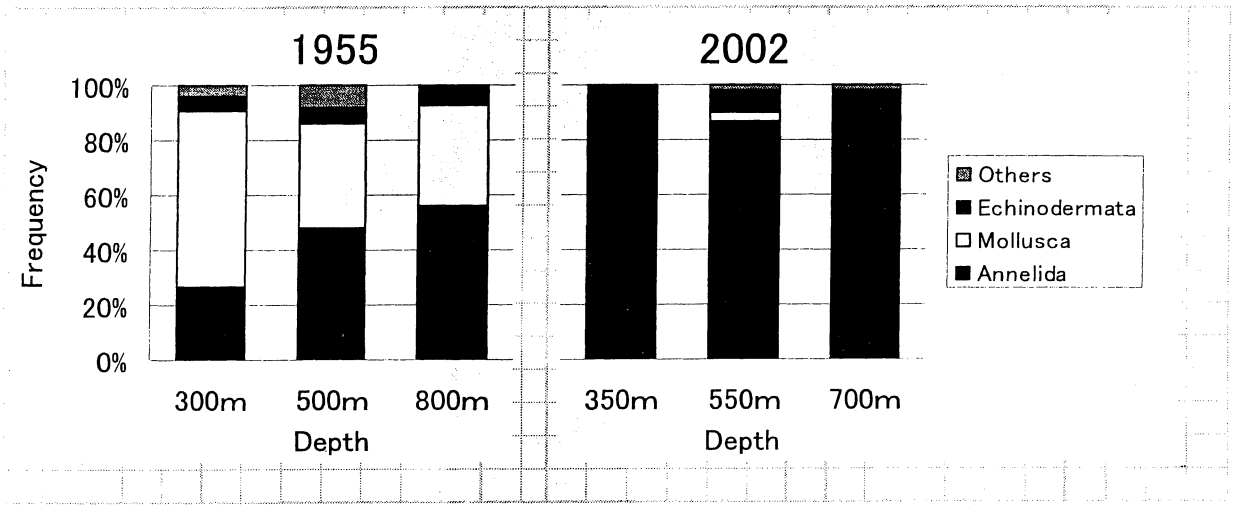

Figure 2 Difference in the macro-benthos composition in three sampling stations identified by depth, between in 1955 and 2002, in the Erimo area. Data on 1955 were cited from Hachinohe Branch of Tohoku National Fisheries Research Institute (1956), and data on 2002 were cited from Ohmura (2004).

Demersal fish composition was remarkably different between the 1950's and recent years (Figure 3, 4). Fishing target species, namely, Scorpaenidae (*Sebastes iracundus*, *Sebastes baramenuke*, *Sebastes flammeus* and *Sebastolobus macrochir*) and Pleuronectidae (mainly *Clidoderma asperrimum*) frequently appeared in the 1950's (Hachinohe Branch of Tohoku National Fisheries Research Institute, 1955; Figure 3, 4). But, in recent years, fishing target species decreased, and Zoarcidae (mainly *Bothrocara molle* and *Zestichthys tanakai*), Macrouridae (mainly *Albatrossia pectoralis* and *Coryphaenoides cinereus*) and *Synaphobranchus kaupi* increased alternately (Figure 3, 4).

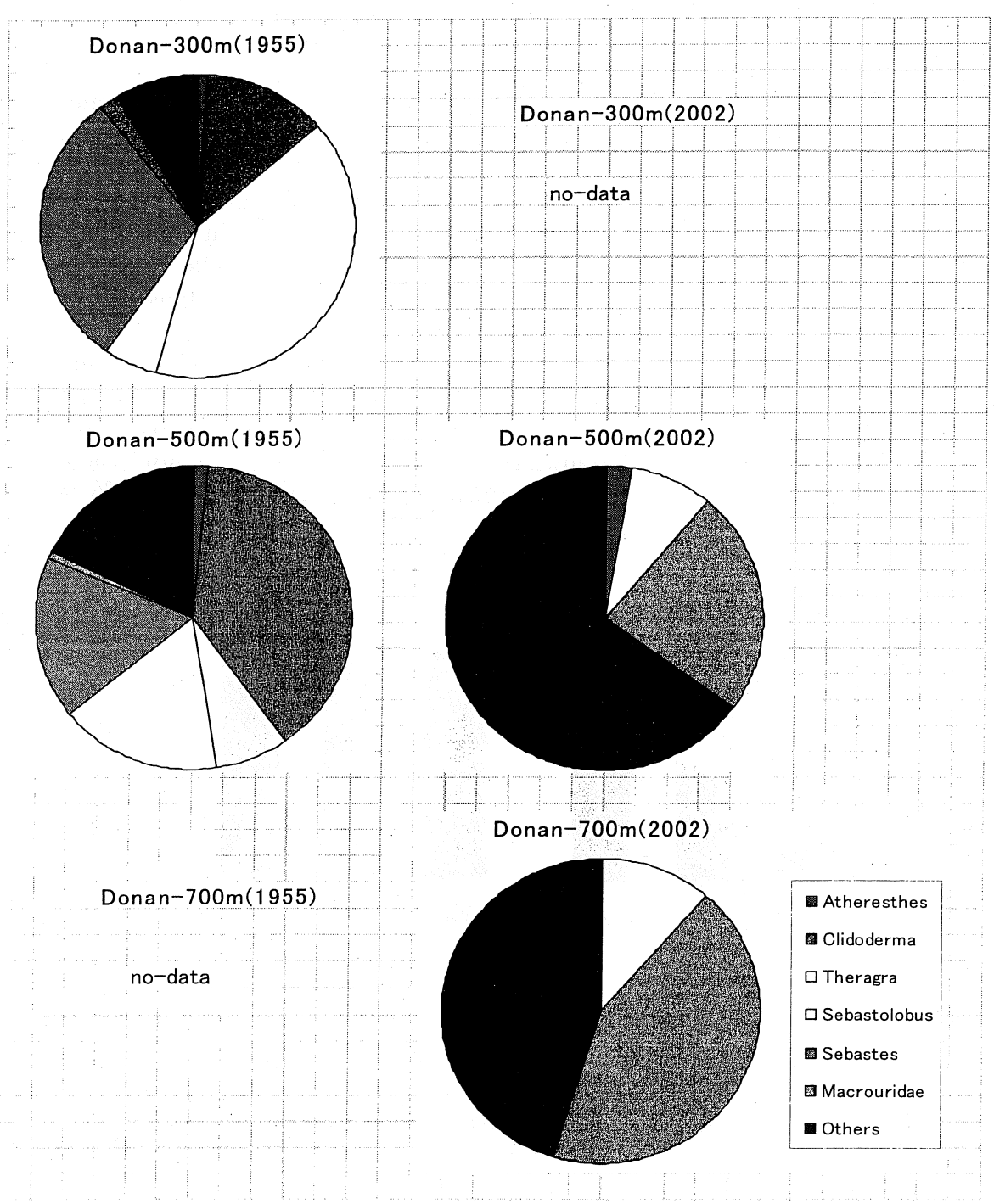

Figure 3 Difference in the demersal fish composition in three sampling stations identified by depth, between in 1955 and 2002, in the Donan area. Data on 1955 were cited from Hachinohe Branch of Tohoku National Fisheries Research Institute (1955).

Discussion

Thrush et al. (1998) observed increase in the density of Echinodermata with decreasing fishing pressure of trawls and dredges. We showed that appearance frequency of Echinodermata was not different between in 1955 and 2002. Response of the benthic community against the trawl fisheries may be distinctive in each fishing ground.

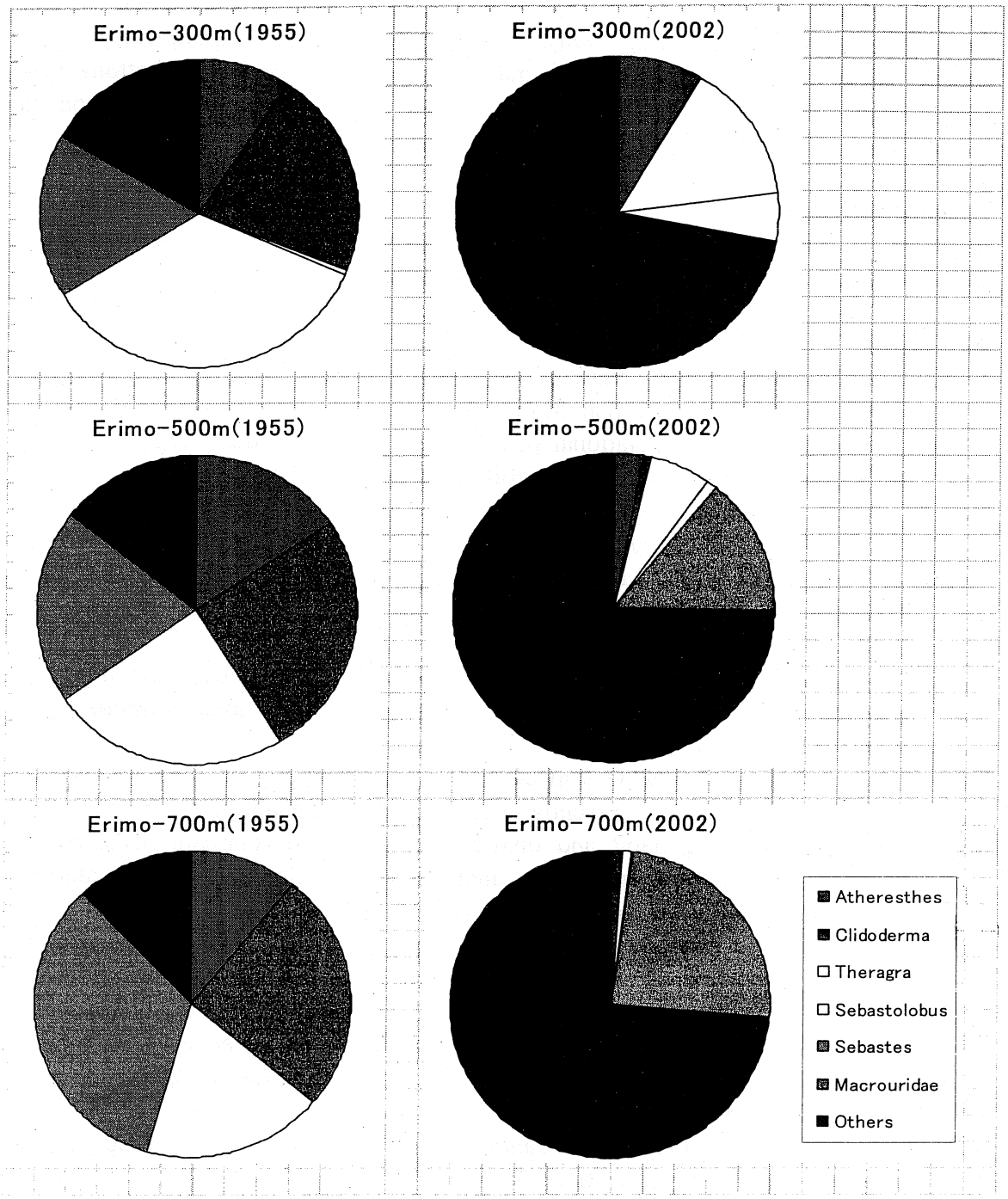

Figure 4 Difference in the demersal fish composition in three sampling stations identified by depth, between in 1955 and 2002, in the Erimo area. Data on 1955 were cited from Hachinohe Branch of Tohoku National Fisheries Research Institute (1955).

Some species of the benthos are used as a food for the demersal fish. And, each species of the demersal fish has specific feeding habits. In recent 50 years, fishing target species decreased on a large scale. Therefore, change in the fish composition might influence the benthic fauna through their feeding habits.

Bottom trawling crushes, buries, and exposes marine animals and structures on and in the substratum (Watling & Norse, 1998). It is also possible that temporal change in the benthic fauna observed in our research may be directly caused by the bottom trawl. Direct and/or indirect impact of fishing should be taken into consideration for conservation of the marine environment and ecosystem.

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