# Preliminary results of seasonal change in diets of the swordfish, *Xiphias gladius,* in the subtropical and the transitional waters of the western North Pacific

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## Introduction

The swordfish, *Xiphias gladius*, is one of the largest pelagic fish distributed worldwide in the subtropical and tropical waters (Sakagawa and Bell, 1980; Nakamura, 1985). This species is thought to be playing an important role in pelagic food-web as a top predator for larger squids and finned fishes (Scott and Tibbo, 1968; Stillwell and Kohler, 1985; Hernandez-Garcia, 1995).

Although considerable knowledge of the food habits of swordfish has been accumulated in the North Atlantic (e.g. Scott and Tibbo, 1968; Toll and Hess, 1981; Stillwell and Kohler, 1985; Moreira, 1990), those in the North Pacific especially in the western area is still restricted (Markaida and Sosa-Nishizaki, 1998; Moteki et al., 2001).

Watanabe and Yokawa (2002) have reported diets of this species caught in March and May in 2000 in the subtropical waters of the western North Pacific. They revealed that neon flying squid, *Ommastrephes bartramii*, and Pacific pomfret, *Brama japonica*, were the most dominant prey for the swordfish during spring season. Afterwards, additional materials have been brought to our hands that made us possible to evaluate seasonal change in diets of the swordfish in the western North Pacific form spring to early autumn.

## Materials and methods

Samples were collected in the subtropical and the transitional waters from 11 March to 23 September during 2001 and 2002 in the western North Pacific (Fig. 1). Sampling localities generally shifted to northward with seasons due to summertime migration of swordfish (Fig. 1). Swordfish was caught in the upper ca. 100 m depth at night by commercial vessels using long line. Stomachs were removed and frozen at

–30°C for further analysis in the laboratory. A total of 194 individuals ranging from 100 to 252 cm in eye-fork length were examined for stomach content analysis. We identified each prey item in the stomach to the lowest possible taxonomic level and counted for each taxon. We also measured total length, dorsal mantle length (DML), and standard length (SL) for prey species of crustaceans, squids, and fishes, respectively.

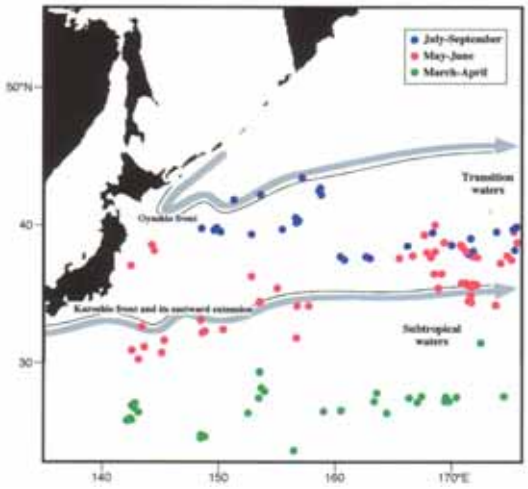


**Fig. 1. Sampling localities of sword fish in 2001 and 2002**

## Results

The swordfish fed mainly on cephalopods and fishes from spring to early autumn (Fig. 2a). Among the cephalopod prey, neon flying squid, *Ommastrephes bartramii*, was the most common and accounted for 58 % of the total number of cephalopod prey in March-April (Fig. 2b). The importance of *O. bartramii* in the diet decreased with seasons, i.e. they accounted for 28 % in May-June and 14 % in July-September. Alternately, transitional and subarctic squids, such as *Onychoteuthis banksii*, *O. borealijaponica*, *Gonatopsis borealis* and *Gonatus* spp. accounted nearly 40 % of the total number of cephalopod prey in May-September.

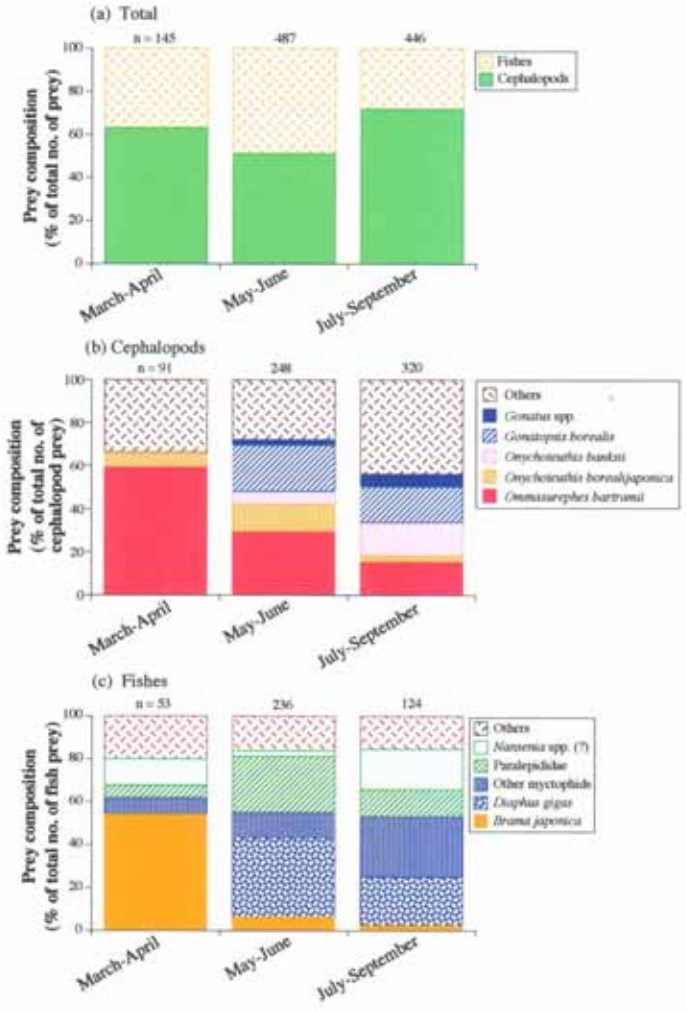


**Fig. 2. Prey composition of swordfish in the western North Pacific**

Among the fish prey, Pacific pomfret, *Brama japonica*, was the most dominant, comprising 54 % of the total number of fish prey in March-April (Fig. 2c). The importance of *B. japonica* in the diet tumbled down drastically to less than 10% afterwards. Alternately, transitional-water myctopid, *Diaphus gigas* and the other myctophids accounted for over 50 % in May-September.

It is apparent that the prey species composition in the diets of swordfish shifted from subtropical components in March-April to transitional components in May-September. The subtropical components were relatively simple, dominating large sized *O. bartramii* (generally 30 to 50 cm DML) and *B. japonica* (30 to 40 cm SL). While, the transitional components were more complex than the subtropical, dominating medium to small sized squids, *G. borealis*, *O. borealijaponica* and *O. banksii*, and small sized myctophid fishes, all of which were generally smaller than 15 cm in DML or SL. This means that the prey size spectrum of swordfish shifts to a smaller range from spring to summer in accordance with the northward migration of the large-sized prey species, *O. bartramii* and *B. japonica*, into the subarctic waters (see Discussion).

## Discussion

*Ommastrephes bartramii* and *B. japonica*, are known to migrate northward from the subtropical to the subarctic waters during spring and summer (Machidori & Nakamura, 1971; Naito et. al, 1977; Shimazaki & Nakamura, 1981; Murata & Hayase, 1993). In March-April, they are sympatrically distributed with swordfish in the subtropical waters and being fed on by swordfish intensively. These prey species start to northward migration prior to swordfish from May and migrate into the subarctic waters during summer. Swordfish also migrates to the north and get into the transitional-waters during summer but rarely migrate into the subarctic waters. Less contribution of *O. bartramii* and *B. japonica* in the diet of swordfish in May-September would be due to their preceding northward migration to the subarctic waters that causes less chance for swordfish to feed on them during summer. Hence swordfish depends mainly on relatively small squids and myctophids restricted in the transitional waters during summer.

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