Difference of Lipid Contents in Migrations of Pacific Saury

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Difference of Lipid Contents in Migrations of Pacific Saury

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Summary

The seasonal change of the lipid contents was analyzed in the saury of the northeastern sea of Japan during a period from March to December.

The lipid content was lower in the northward migration (March to July) than in the southward migration (August to December). The lipid content increased with the growth in the southward migration but not in the northward migration. A difference of the lipid contents was observed in the north area and the south area(upper and under) in the southward migration. The difference of the lipid contents might be dependent on the migratory routes.

The correlation coefficients between the lipid contents and the fatness indexs were calculated. The results indicated that a positive correlation was present in only the large-sized saury of the southward migration, but not in the middle-sized and small-sized saury.

Pacific saury, *Cololabis saira*(BREVOORT), is one of the migratory fish exploited in the northwestern Pacific Ocean. Abundant ecological works have been done in terms of distributions, migrations and so forth (1-3). The saury move northward in the northwesten pacific Ocean following the rapid northward expansion of the Kuroshio Current in Spring. The fish cross the Oyashio Front in Summer, and then the fish start the southward migration from the waters near the Kurile Islands. The saury move southward along the inshore and offshore of northern Japan and major fishing grounds are first formed between southeastern Hokkaido and northern Sanriku in Autumn. Then the fish move more southward and cross the Oyashio Front. The saury approach the Joban area near the Kuroshio Front and disperse from late Autumn to early Winter.

There are several reports showing that the lipid content of the saury varies with the fishing seasons (4, 5). Furthermore, the correlation between the lipid content and the fatness index is well known. Hata and Tashiro (6) described a

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positive correlation between the lipid content and fatness index in the saury caught from August to December in the northeastern sea of Japan. But they also observed that the saury caught from November to December had a lower lipid content than the saury caught from August to October, though the fatness index had no difference between the two seasonal groups. Nagakura (7) reported that the lipid content which had been high at the beginning of the fishing season decresed toward the end of it, although the size of fish increased.

The purpose of this work is to analyze in detail the seasonal change of the lipid contents in the saury caught from March to December, and to establish an equation between the lipid content and the fatness index.

Materials and Methods

The saury samples used in the present study were caught in the waters extending from Lat. 33°N to 47°N and from Long. 134°E to 162°E during the period from May in 1979 to June in 1980. Fig. 1 shows the sampling locations and the catching months. After measuring body lengths, body weights and gonad weights, the lipid was individually extracted from ordinary muscles by employing the Folch's method and the lipid content was determined. The fatness index (K) was calculated from the body length (BL) and the body weight (BW) by the following equation (8).

$$K = BW(g)/BL^3(cm) \times 10^3$$

The saury samples were divided into two groups catching seasons. First was the fish caught from March to July (the northward migration) and the second was

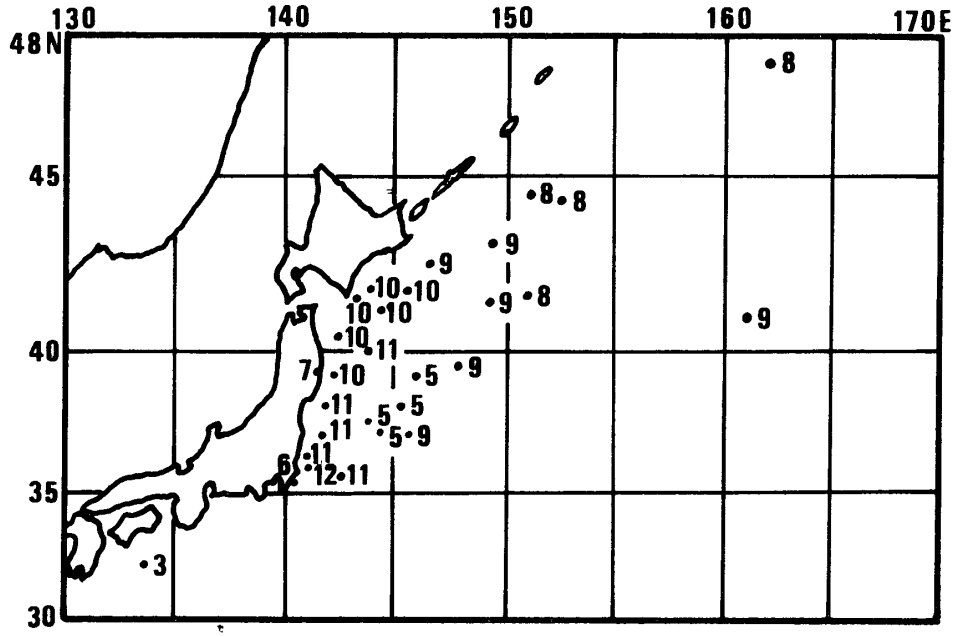

FIG. 1. Locations where samples of the Pacific saury were collected and months when they were caught.

the fish caught from August to December (the southward migration). Moreover, the samples were subdivided into four groups by body size referring the Odate's report (9). The large-sized, middle-sized, small-sized and young saury were more than 29 cm, from 24 to 29 cm, from 20 to 24 cm and less than 20 cm in body length respectivelly.

Results

A total of 189 saury samples were collected from the northeastern sea of Japan during a period from March to December. The samples were from 15 to 34 cm in body length and the lipid contents of muscles of the individual fish varied from 0.8 to 19.2 per cent. The lipid contents of the individual fish were plotted by body lengths (Fig. 2). That showed that the greater the body lengths of the saury the higher the lipid contents became and the more the plots scattered. The fatness indexs varied from 3.2 to 5.9. In parallel with the lipid content, the fatness index increased according to the increase of body length (Fig. 2).

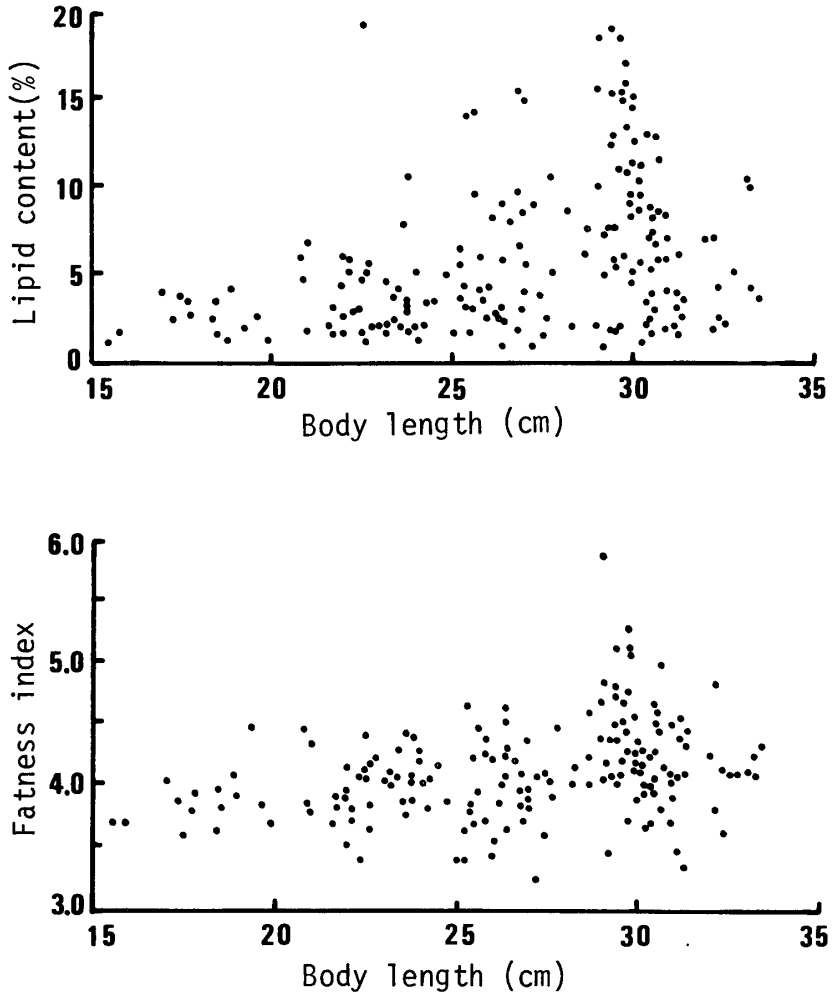

FIG. 2. Relations of lipid content and fatness index according to body length.

The saury samples were divided into two groups, the northward and the southward migration by catching seasons, because the lipid content of the former fish was very different from that of the latter. The lipid contents ranged from 0.8 to 4.2 per cent with the average of 2.1 per cent in the northward migration, and from 1.2 to 19.2 per cent with the average of 6.5 per cent in the southward migration (Table 1). It indicated that the fish in the southward migration were fatter than those in the northward migration.

The northward migratory group was subdivided into four groups, large-sized, middle-sized, small-sized and young group by body length. The lipid contents of all groups were low in the northward migration. The southward migratory group was subdivided into four groups like the northward migatory group. The lipid contents from 1.2 to 19.0 per cent with the average of 8.3 per cent in the large-sized group, from 1.2 to 15.4 per cent with the average of 5.6 per cent in the middle-sized group, from 1.2 to 19.2 per cent with the average of the 4.3 per cent in the small-sized group and from 1.1 to 3.4 per cent with the average of 1.9 per cent in the young group (Table 1).

For elucidating whether the difference of lipid contents were present or not with the seasons and the locations, the fish of each sized group in the southward migration were grouped by the the catching months and locations. To divide by location , the boundary of Lat. 42°N was tentatively used. The boundary was near the Oyashio Front in the beginning of the fishing season. Sampling loca-

TABLE 1. *Lipid Content and the Correlation Coefficient with the Fatness Index in the Southward Migration.*

Sample	No. of fish	Lipid content (%)	Correlation coefficient
Whole	189	6.0±4.4[1)]	0.54[2)]
Northward migration	22	2.1±1.0	0.28
Large-size	7	1.7±0.5	—
Middle-size	2	0.9±0	—
Small-size	2	1.6±0	—
Young	11	2.7±1.0	—
Southward migration	167	6.5±4.4	0.49[2)]
Large-size	76	8.3±4.6	0.57[2)]
Middle-size	53	5.6±3.6	0.09
Small-size	34	4.3±3.3	0.28
Young	4	1.9±1.1	—

1) Average±standard division
2) Significant at the 99% confidence level

TABLE 2. *Lipid Content in Each Catching Months and Locations*

Month	Location	Lipid content (%) (No. of fish)		
		Large-size	Middle-size	Small-size
August	North	12.0±4.7[1] (8)	7.5 (1)	4.7 (1)
	South	3.6±1.4 (3)	2.1±0.2 (4)	3.1±2.0 (4)
September	North	10.3±5.6 (5)	8.6±1.4 (2)	6.7±1.6 (2)
	South	5.7±2.7 (13)	2.7±1.9 (4)	— (0)
October	North	11.8±3.6 (20)	8.7±3.4 (16)	7.1±4.7 (10)
	South	4.3±3.7 (5)	6.8±4.1 (8)	2.1±0.3 (2)
November	North	— (0)	— (0)	— (0)
	South	6.6±3.1 (19)	3.1±0.9 (17)	2.7±1.1 (13)
December	North	— (0)	— (0)	— (0)
	South	5.2±3.6 (3)	6.2±0.4 (1)	2.5±0.4 (2)

1) Average±standard division

tions were designated as the north area and the south area. The lipid contents of all sized groups were high from August to October in the north area, but significantly low from August to October in the south area. It is of interest to demonstrate the geographic difference at the same month in the beginning of the fishing season.

The correlation coefficients between the lipid content and the fatness index were calculated and shown in Table 1. The correlation cofficient was 0.52 in the whole samples, 0.28 is the northward migration and 0.49 is the southward migration. The correlations were significant at the 99 per cent confidence level in total samples and in the southward migration, but not in the northward migration. Fig. 3 shows that the plots of the lipid content on the fatness index in the northward migration and each sized group in the southward migration. A significant correlation was observed in only the large-sized group of the southward migration. The correlation was 0.57 and the regression was calculated as $Y=6.3\ X-18.5$. But the correlations were not significant is the other groups.

Discussion

The proportional increase of lipid content to body length was confirmed to be the same as the results of Tsuchiya *et al.* (10). It would be due to change lipid accumulation efficiency in each size of saury.

It was found that the lipid content in the northward migration was extraordinary lower than in the southward migration. One of the causes for the difference of the lipid content would be whether the fish had lived in a fertile area or not (the Oyashio area or the Kuroshio area). The Kuroshio area is poorer in plankton diet of the saury than is the Oyashio area (11). Most of the large-sized and middle-

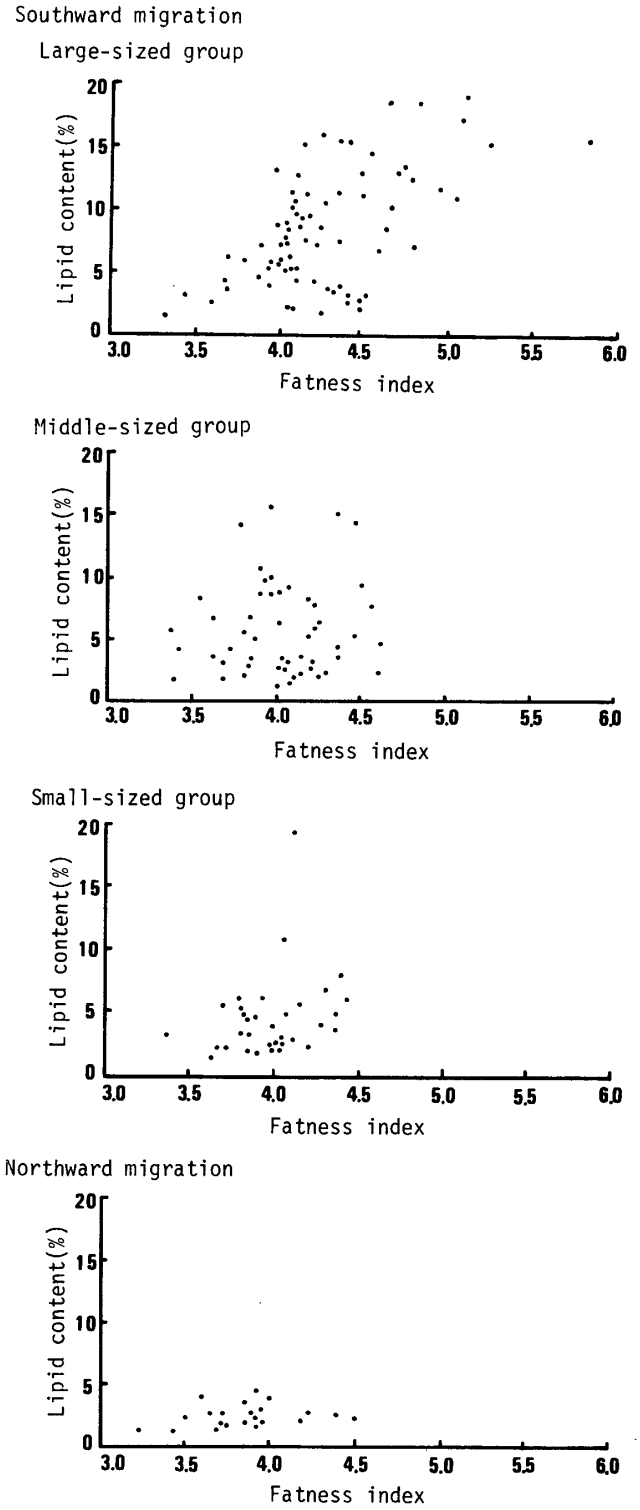

FIG. 3. Correlations between lipid content and fatness index on the large-sized, middle-sized and small-sized group in the southward migration and in the northward migration.

sized saury of the northward migration were matured. It could be considered that the fish consumed enough accumulated lipid for maturing and so might not be physiological able to consume more.

In the lipid content of the southward migratory saury, a tendency to decrease toward the end of fishing season was shown by other reports (4, 5, 7, 10). In other words, the change coinsided with the migration from the north area to the south area. However, the present data showed a remarked difference of the lipid content between the north area and the south area at the same time, but the change of lipid content was not detected in the south area. Whether the high lipid content of the saury in the north area decreased or not with the migration from the north area to the south area is unknown, because the number of sample lots was very few in November and December. In this connection, Hata and Tashiro (6) reported the data that a remarkably low lipid content was observed in some lots in November and December. Thus, the low and high lipid content groups might be attributed to the difference of migratory routes, considering the reports that saury samples could be divided into some groups by the allelic frequency in the isozymic genes (12, 13). The relation between the fish caught in the north area and the south area remain to be solve in future.

A positive correlation between the lipid content and the fatness index present in only the large-sized saury of the southward migration. Thus, the abundant fatness index could be used to clear the relation between the saury in the north area and the south area.

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