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Reproductive Ecology of a Shad, *Konosirus punctatus* in Ariake Sound-I

Distribution, Body Condition, and Maturation*

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In order to know the reproductive ecology of a shad, *Konosirus punctatus* in Ariake Sound in western Kyushu, an examination on landing records and measurements of fish bodies and gonads of the shad were done, and the following results were obtained.

The adult of the shad in Ariake Sound lives in comparatively oceanic and deep areas near the mouth of the sound in winter, and from spring to autumn they are mainly in the innermost area.

Standard length compositions of the shad collected from March to June in 1974 prove that the mean standard lengths of one and two years fish were 148 and 189 mm, respectively.

Every age-group spawns. Temporal changes in gonad indexes which were high in April and May suggest the intensive spawning in these months. Changes of gonad indexes with time corresponded to those of fatness. One-age shad began and ended the spawning slightly later than the older ones.

Ariake Sound in western Kyushu is known as spawning and nursery grounds of fishes (Uchida and Tsukahara, 1955). A kind of shad, *Konosirus punctatus* (Japanese name, KONOSHIRO) is one of the fishes which spawn and grow in young stage in the sound. It is caught abundantly and occupies an important position in the fisheries of the sound. As for the ecology of the shad, several papers have been published about ones in Tateyama Bay (Kamiya, 1916), Kumihama and Yosanai Bay (Kuwatani, 1958; Kuwatani et al., 1956; Kuwatani et al., 1958), and Hamana Bay (Ai, 1968; Matsushita and Nose, 1974), but the knowledge about the shad in Ariake Sound is merely fragmentary. This research was done to know the reproductive ecology of the shad in the sound, and some results about distribution, body condition, and maturation were obtained by means of the examination on landing records and measurements of fish bodies and gonads.

**Materials and methods**

The catch data of the fish used for the examination of the distribution and the movement were referred to the statistical publications in 1957-59 by Ariake Regional Fishery Adjustment Executive Office (Anon., 1959, 1961). The data, although quite old, are the ones recorded on the days when the fisheries for fishes in the innermost area of the sound were more active than today's, and seem to reflect the distribution of fishes more accurately.

Specimens of the shad including mature ones were collected with pound nets and gill nets on fishing boats from March to
June in 1973, 74 and 75. The gill nets were operated in the innermost area of the sound from early in the afternoon to the early morning. The pound nets used for the collection were set at the coast of Oura in Saga Prefecture (Fig. 1). They were usually operated at low tide during night and early in the morning.

![Map of Ariake Sound](image)

Fig. 1. Map of Ariake Sound. Shaded areas show the fishing ground of gill net used for the collection.

**Results and discussion**

Distribution of the adults: The Ariake Sound is an arm of the sea which penetrates into western Kyushu, being surrounded by four prefectures, Fukuoka, Saga, Nagasaki, and Kumamoto. It is about 1700 km² in extent. There are two shallow areas in the innermost region, one of which is off the coasts of Fukuoka and Saga, and another called Isahaya Bay is an arm penetrating into Nagasaki Prefecture. Generally the basin of the sound becomes deeper from the shallow innermost region to the mouth. In the intermediate area between the innermost and the mouth, shallow waters develop more in the east (Kumamoto Pref.) and it is deeper in the west (Nagasaki Pref.). The sound is connected with the open sea through a strait of 4.5 km wide in the south. Along the north and east coasts many big rivers drain into the sound. Accordingly, there is a clear decline of sea water concentration generally from the mouth towards the innermost and the east coast (Anon., 1974).

The shad is caught anywhere in the sound. In order to see its movement, the landing records were examined seasonally and regionally. The landings in the sound are recorded separately for five regions. Seasonal changes of the shad landings to two regions, Saga and Amakusa are examined. The former faces the innermost area and the latter the mouth of the sound. Monthly relative changes of the mean landings from 1957 to 59 in each region are shown in Fig. 2. Although fisherboats of these regions operate sometimes in the waters of the other regions, and land to own regions, most of the shad landed are

![Graph of Monthly relative changes of mean shad landings](image)

Fig. 2. Monthly relative changes of the mean shad landings from 1957 to 59 in Saga (S) and Amakusa (A) regions.
regarded to be caught near their own regions, and the record of each seems to reflect the distribution in front of the region.

The figure shows high ratio of the catch in the innermost area from March to August, whereas low in the mouth area, it also shows high ratio of the catch in the mouth area in winter when the ratio is low in the innermost region. The landings to Fukuoka region show the same change as those to the Saga's. Nagasaki region faces both the mouth and the innermost, and the landings cannot reflect the regional distribution. Tendency of large catches in spring and autumn is said by fishermen in Kumamoto region, which is situated between the innermost and the mouth, although such a regular change by season as shown in the innermost region is not recognized in the landing record. These regional and seasonal changes of the catches and landings suggest the seasonal movement of the shad. That is, the shad stays mainly in the shallow less saline innermost region from spring to autumn, and in winter they are in comparatively deep area near the mouth.

Condition of reproductive population: Standard length of the shad collected from March to June in 1974 are shown in Fig. 3. No sexual difference of the length was recognized. Two distinct mode are recognized in each composition, suggesting the existence of two size groups, one is smaller than 165 mm, another larger than this size. The smallest individual collected was 199 mm long. The shad smaller than the smaller group has not been found in this season from any waters in the sound. The youngs of the year usually begin to be caught with various gears in June and July, and they grow up to the size near to that of the smaller group at the end of the year.

Accordingly, the smaller group being 148 mm in average length late in April is one year old and the larger one is two years old or more.

The larger group had a wide range of standard length in March, with a few numbers of considerably large individuals. Quantity of this large individuals was very small after March in 1974. Duration of the appearance and the quantity of the large individuals changed by year. They were scarce during whole fishing season from March to June in 1975, while in 1976 quite many were caught through the season. The large group is assumed to be three years old from the length and inspection of the scale.

In catches of the pound nets which seems to have rather little selectivity to a special age-group, 1-age shad by far outnumbered older ones, while in quantity 2-age shad much outweighed others. Shad of 3-age was usually very small in number and quantity, and one of 4-age has not been found.

Age and growth of the shad from several localities of Japan have been reported. Standard length of the shad from Kumihama Bay was assumed by inspecting the scales
to be 99.3 mm in 1 year, 155.8 mm in 2 years, 184.4 mm in 3 years, 201.6 mm in 4 years, 214.2 mm in 5 years, and 228.6 mm in 6 years (Kuwatani, 1958). The shad from Hamana Bay was assumed by examining the length composition to be 185 mm in 1 year and about 250 mm in 2 years (Ai, 1968). The latter paper has not described the shad more than 2 years old, whereas 4 years old shad has been recognized in Tateyama Bay (Kamiya, 1916) and Hamana Bay (Matsushita and Nose, 1974). The shad of Ariake Sound was assumed to be 148 mm in 1 year, 189 mm in 2 years and about 210 mm in 3 years of its mean standard length late in April in the case of 1974, showing the large differences of growth and actual maximum size by population.

Fatness (10^3 times body weight in standard length cubed) of the shad was calculated for every sample from March to June in 1974. In weighing the body, most of the internal organs were cut off so that the effects of developing gonad and the contents in digestive organs to body weight might be eliminated. The result of female (Fig. 4) shows that the 1-age shad was fat late in April and early in May, and so was the 2-3-age shad around the middle of April. The male showed the same tendency as the female did.

Gonad index: Gonad index (10^4 times gonad weight in standard length cubed) of the female shad was calculated for every sample from March to June in 1974, and the changes with time are shown in Fig. 5. There is a mode on May 8 in the change of the index of 1-age shad, and on April 18 in that of 2-3-age shad, showing development of their ovaries. The changes of gonad indexes with time are like those of fatness mentioned above. In the period when the gonad indexes were high, there were many ripe individuals with running eggs in each age-group.

It has been assumed that the shad spawns
from evening to midnight and the ovarian eggs develop rapidly in a short time before the ovulation takes place (Kamiya, 1916; Kuwatani, et al., 1956). If these are true, and the volume of eggs to be spawned at a time accounts for a significantly large part in ovaries, the gonad weight must change regularly with time. Fig. 6 illustrates gonad index frequencies of two female samples, one collected from 2 to 5 p.m. on May 12, 1975, and another collected from 4 to 5 a.m. in the next morning, both with gill nets in the innermost region. The gonad index of the shad of each age group collected in the evening varied very much by individual. The shad showing more than 30 of its index value shown in 1-age group was 52, and in 2-3-age group 67. However, most of the shad in the morning show less than 30 of their indexes. In addition to the case shown in the figure, there were always similar differences of maturation according to time that there were well-matured individuals including ripe ones in catch from noon to midnight and only immatures in catch from midnight to morning.

The changes of gonad indexes in Fig. 5 demonstrate the appearance of the individuals with high index value of more than 30 in April and May, suggesting high spawning activity in these months. The fluctuation of the value in these months seems to be brought about by bias of group maturation with respect to sampling time.

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Literature cited

有明海産コノシロの増殖生態—Ⅰ

分布と産卵群の魚体特性

田北 徹

有明海産コノシロ Konosirus punctatus の増殖生態を明らかにする目的で、漁獲統計によって魚群の移動を調べ、魚体測定によって成長と肥満度、成熟度などの魚体の状態を明らかにした。

本種は、冬は有明海西部に近い、比較的外洋的な水域に分布し、春から秋は主に満洲より浅海域に分布する。1974年の調査結果から、平均体長は生後満 1 年で 148mm、2 年で 189mm、3 年で約 210mm と推定した。1、2 年魚が漁獲の大多数を占め、4 年以上のものは認められなかった。

全ての年令群が産卵に加わる。生殖腺重量指数の時期的な変化から、1974年の産卵盛期は 4、5 月と推定した。1 年魚は 2・3 年魚より産卵期がわずかに遅い。

肥満度に、生殖腺重量指数の変化に対応した変化が認められた。