Ecological Studies on the Biological Production of Young Amberfish Community in the Sendai Bay*¹—II Relationships between Food Chains and Fish Fauna

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In order to obtain the distinctive features of fish fauna in typical areas of Sendai Bay, fluctuations in the amount of each species caught by set-nets have been investigated. Comparing the species compositions between areas, the coast of Sendai Bay can be divided into four biological areas. These partitions help to understand the distributive patterns of benthic animals and the water mass in the Bay. This distributive phenomena suggests that there is close interspecies relationship in each of the growth stages of the fishes and are adaptationally connected to several conditions of the nonorganic environment.

In a period of temperature rise, many species of fish appear in each area followed by one after the other, and most of the main species are already in the areas by late August, when the water temperature begins to show a descending tendency. From the view point of the tendency for peaks in the amount of catch, at intervals of ten days, it was recognized that the peaks in catch at any one time is composed of not more than five species at the maximum, and generally two or more species, linked either with predator-prey relationships, and scarcely overlap with each other in a restricted space.

In addition to the amberfish (*Seriola quinqueradiata*) community, we can find many species of fish which prefer the anchovy to other foods, though the formation mechanism of communities is not always identical to that of the amberfish community. Species population show a dynamic life pattern corresponding to several growth stages peculiar to the species, and changes the state of distribution and aggregation. In such dynamic process of life, a species population is connected closely to other species populations owing to predator-prey relationships, and they form a biotic community. This paper deals with a phase of the community constructed by several populations that extend over a wide area. Picking up typical terminal species from fish fauna in the Sendai Bay, the types of community formation, as a part of the whole, have been classified into three classes; waiting type, sojourning type and passing type. These three types of community have the common feature in a point that they include the anchovy as a principal member in a community. However, it is reasonable to consider the main part of the community as separate from other communities in time and space, and that two or more communities rarely hold a common school of the same anchovy population, but connect some definite school of fish.

In the previous paper,¹⁾ the author gave a definition of community as a biotic group that constitutes the production system recognizable through the predator-prey relationships, and it has been realized that carnivorous fishes more or less take the anchovy (*Engraulis japonica*) for food in the Sendai Bay.

A basic unit, constructing the community, is a species population, which shows dynamic life pattern corresponding to several growth stages peculiar to species, and changes the state of distribution and aggregation. Accordingly, the community, observed in such

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restricted area as the Sendai Bay, is regarded as a phase of the community that extends over more wide areas.

Because of the anchovy play an important role as food material for the production of fishes in high food niche, the fish is not only one of the important member of the amber-fish community, but also of the other fish communities. Consequently, it may well be that there are some mechanisms coordinating the interference took place among two or more communities in connection with the anchovy.

The present report describes a general view of the pelagic fish fauna in the Sendai Bay and deals primarily with relation between the fauna and the food chains obtained in the preceding paper.

Materials and Methods

In an attempt to be well informed about the living condition and distribution of fishes that migrated in the coast of the Sendai Bay, records of daily catch by the set-nets were utilized. The records have been collected from typical five fishery grounds representing the coast of the Bay, namely, south-west area (A), the mouth part of the Matsushima bay (B, C), the inner part of the Sendai Bay (D) and north-east part of the Sendai Bay (E),

as shown in Figure 1. The set-net in the area E is larger than the other in size and has been operated by an association. Each set-net is set up at the coast area shallower than 30 m in depth. In the high zenith of fishing, the nets are hove up twice, but generally once per day.

Fig. 1. Distribution of the set nets in the Sendai Bay, 1968. Signs and the numbers in the frame represent the size and number of fishing units operated (S: small sized set-net, L: large sized set net).

Result and Discussion

Coastal fish fauna in the Sendai Bay Looking over a transition of total amounts of catch of the set-nets in the Sendai Bay, during the period from 1965 to '71, about from 4 to 5 thousands tons of fishes have been caught per year in an average, and kept stability as well as the fishing intensity (Table 1).

Many species of organisms have been caught by the nets at the coastal fishing grounds as shown in Table 2, however, most of those can be included in a category what is called the coastal pelagic fishes, represented by such species as the mackerel (*Pneumatophorus japonicus*), the amberfish (*Seriola quinqueradiata*), the anchovy and so on.

According to the grade of amounts of total catch at five fishery grounds during the period from May to November, some typical species have been taken out and arranged in Table 3. Calculating weight percentage of each species to the total, we can find distinctly that the anchovy get the first (25.7%), the mackerel the second (24.1%) and the amberfish

Table 1. Number of fishing units operated, number of efforts and catches by type of the set nets in the Sendai Bay

Year	Large sized				Small sized			
	Number of set nets	Effort	Catch (ton)	CPUE	Number of set nets	Effort	Catch (ton)	CPUE
1965	7	873	2,229	0.3648	144	19,908	721	0.00025
1966	7	905	3,358	0.5301	134	18,602	2,324	0.00093
1967	7	871	1,968	0.3228	154	19,252	2,277	0.00076
1968	6	900	1,845	0.3417	144	19,119	1,796	0.00065
1969	6	—	2,031	—	162	—	2,895	—
1970	5	891	2,267	0.5089	172	24,023	2,042	0.00049
1971	6	—	2,023	—	185	—	2,958	—

Table 2. List of main fishes caught by the set-nets in the Sendai Bay

Common name	Scientific name
Konoshiro, Gizzard shad	<i>Konoshirus punctatus</i>
Urumeiwashi, Round herring	<i>Etrumeus microps</i>
Nishin, Herring	<i>Clupea pallasii</i>
Maiwashi, Sardine	<i>Sardinops melanosticta</i>
Sappa	<i>Harengula zunasi</i>
Katakuchiiwashi, Anchovy	<i>Engraulis japonica</i>
Sake, Chum salmon	<i>Oncorhynchus keta</i>
Masu, Cherry salmon	<i>O. masou</i>
Ayu, Sweet smelt	<i>Plecoglossus alivelis</i>
Maruta, Dace	<i>Tribolodon taczanowskii</i>
Unagi, Eel	<i>Anguilla japonica</i>
Maanago, Conger	<i>Astroconger myriaster</i>
Sanma, Saury	<i>Cololabis saira</i>
Sayori, Half beak	<i>Hemiramphus sajori</i>
Tobiwo, Flying fish	<i>Prognichthys agoo</i>
Kagamidai	<i>Zenopsis nebulosa</i>
Bora, Gray mullet	<i>Mugil cephalus</i>
Akakamasu, Barracuda	<i>Sphyrna pinguis</i>
Maguro, Bluefin tuna	<i>Thunnus thynnus</i>
Marusoda, Frigate mackerel	<i>Auxis tapeinsoma</i>
Masaba, Mackerel	<i>Pneumatophorus japonicus</i>
Tachiuwo, Hairtail	<i>Trichiurus lepturus</i>
Shiira, Dolphin	<i>Coryphaena hippurus</i>
Maaji, Jack mackerel	<i>Trachurus japonicus</i>

Common name	Scientific name
Itohikiai, Threadfish	<i>Alectis ciliaris</i>
Hiramasa, Yellowtail	<i>Seriola aureovittata</i>
Buri, Amberfish	<i>S. quinquerradiata</i>
Kanpachi, Amberjack	<i>S. purpurascens</i>
Sugi, Lemonfish	<i>Rachycentron canadum</i>
Medai	<i>Ocyrius japonicus</i>
Ishidai, Parrot bass	<i>Oplegnathus fasciatus</i>
Ishigakidai	<i>O. punctatus</i>
Matsudai, Triple tail	<i>Lobotes surinamensis</i>
Mutsu, Japanese bluefish	<i>Scombrops boops</i>
Suzuki, Common sea bass	<i>Lateolabrax japonicus</i>
Nibe	<i>Nibea mitsukurii</i>
Ishimochi, White croaker	<i>Argyrosomus argentatus</i>
Kisu, Sillaginoid	<i>Sillago sihama</i>
Mejina, Opaleye	<i>Girella punctata</i>
Chidai, Crimson sea bream	<i>Evynnis japonica</i>
Kurodai, Black sea bream	<i>Mylio macrocephalus</i>
Madai, Red sea bream	<i>Chrysophrys major</i>
Umitanago, Surf fish	<i>Ditrema temmincki</i>
Okitanago, Surf fish	<i>Neoditrema ransonneti</i>
Ikanago, Sand lance	<i>Ammodytes personatus</i>
Mebaru, Black rock fish	<i>Sebastes inermis</i>
Kurosoi	<i>S. schlegeli</i>
Takenokomebaru	<i>S. oblongus</i>
Ainame, Greenlings	<i>Hexagrammos otakii</i>
Umazurahagi, File fish	<i>Navodon modestus</i>
Kawahagi, Trigger fish	<i>Stephanolepis cirrhifer</i>
Kochi, Flathead	<i>Platycephalus indicus</i>
Kemushikajika	<i>Hemitripterus villosus</i>
Saburo	<i>Occa iburia</i>
Hobo, Gurnard	<i>Chelidonichthys kumu</i>
Kusauwo	<i>Liparis tanakai</i>
Hirame, Bastard halibut	<i>Paralichthys olivaceus</i>
Kawagarei, Starry flounder	<i>Platichthys stellatus</i>
Ishigarei, Stone flounder	<i>Kareius bicoloratus</i>
Magarei, Flat fish	<i>Limanda herzensteini</i>
Makogarei, Sole	<i>L. yokohamae</i>
Kuroushinoshita, Tongue sole	<i>Rhinoplagusia japonica</i>
Ezoisoainame	<i>Lotella maximowiczii</i>
Madara, Cod	<i>Gadus macrocephalus</i>
Kianko, Anglerfish	<i>Lophius litulon</i>
	<i>Lamnina</i>
	<i>Rajina</i>
	<i>Exocoetidae</i>
* Invertebrata	
Koika, Cuttlefish	<i>Sepia esculenta</i>
Aoriika	<i>Sepioteuthis lessoniana</i>
Yariika	<i>Doryteuthis bleekeri</i>
Jindoika, Squid	<i>Loligo japonica</i>
Surumeika, Sagittated calamary	<i>Todarodes pacificus</i>
Saruebi	<i>Trochypenaeus curvirostris</i>

the third place (17.9%). In the case of the amberfish, separating the growth stage groups into small sized of 0 year, medium sized of 1–2 years and larger sized of 3 years and upward in age, those compositions are 80%, 12.3% and 7.7% in the order of their sizes. Accordingly, it can be regarded that the young amberfish in age of 0 year is one of the important fishes among the most influential members from the view point of the coastal fisheries in the Sendai Bay.

Table 3. Annual catch by species and fishing grounds in the Sendai Bay during the period from May to November in 1967

Species name	(Unit, kg)				
	A	B & C	D	E	Total
<i>Engraulis japonica</i>	9,585		295	300,338	310,218
<i>Pneumatophorus japonicus</i>	48,543	30	1,627	239,902	290,102
<i>Seriola quinqueradiata</i> (L)	172	12	15	16,478	16,677
" (M)	17,077	470	1,596	7,447	26,590
" (S)	39,937	1,724	7,257	123,536	172,454
<i>Sardinops melanosticta</i>	157,410	3	515	5,540	163,468
<i>Trachurus japonicus</i>	88,747	405	2,641	269	92,062
<i>Auxis tapeinosoma</i>	9,678		94	24,979	34,751
<i>Coryphaena hippurus</i>	110		23	33,009	33,142
<i>Todarodes pacificus</i>	2,198		170	12,086	14,454
<i>Nibea mitsukurii</i>	12,731	716	315	146	13,908
<i>Sphyræna pinguis</i>	12,543		32	370	12,945
<i>Lateolabrax japonicus</i>	497	3,090	505	4,530	8,622
<i>Thunnus thynnus</i>	776			6,169	6,945
<i>Prognichthys agoo</i>	965	13	114	4,089	5,181
<i>Paralichthys olivaceus</i>	194	466	12	814	1,486
<i>Mylio macrocephalus</i>	451	413	5	590	1,459
<i>Seriola aureovittata</i>	670	49	8	320	1,047

In the next place, on the distinctive features of fish faunas in typical areas in the Bay, some descriptions are given from the data of species composition, in the case of 1967.

At the north-east area (E), a distinguishing trait is found in a tendency that gravitation of amounts of catch concentrate towards both the anchovy (38.5%) and the mackerel (30.7%) in high level, and that the dolphin (*Coryphaena hippurus*), the frigate mackerel (*Auxis tapeinosoma*) and the amberfish show higher rate of appearance as compared with the other areas.

On the other hand, at the south-west area (A), amount of catch of both the sardine (*Sardinops melanosticta*) and the Jack mackerel (*Trachurus japonicus*) show high level (39.1% and 22.1%), especially in reference to the abundance of the sardine, it can be seen that this area shows diametrically opposite to the character of the north-east area.

At the area of the mouth part of the Matsushima bay (B–C), it is a prominent characteristics that the common sea bass (*Lateolabrax japonicus*) show a high amount of catch by far and away.

Lastly, at the inner part area (D), with the exception of a prominent amount of catch of the young amberfish, there are any distinctive features concerning to the species composition. Looking over the composition of each growth stage of the amberfish, the larger size one appears for the most part in the north-east area, and very rare in the other less than 30 m in depth.

Researching on the case of warm season in 1969 (Fig. 2), basic property in fish fauna is similar to the case in 1967, though ranking of amount of catch change places to some degrees. Obvious discrepancy in species compositions among the areas in the Bay, suggests the existence of space-time segregation of niche as the result of selection for conditions of life in a field, caused by interspecies correlation connected with adaptational behaviors, such as searching for food and escaping or defending from enemies.

Considering the background for pelagic fish fauna, it will be reasonable to divide the area of the Bay, basing on species compositions that communicates with partitioning the space for grasp the production structure in the community. From a point of view mentioned above, the coastal area of the Sendai Bay can be divided into four areas; namely, entrance part of the Matsushima bay, the Ishinomaki Bay, south-west area and

Fig. 2. Species compositions of the fish caught by set nets in the Sendai Bay, from June to August, 1969.

north-east area of the Sendai Bay.

YAMAMOTO *et al.*³⁾ have tried to partition the Sendai Bay into three or four biological areas, concerning to the distribution of benthic polychaetous annelids, and also, HATANAKA³⁾ has divided water masses of the Bay into four portions, basing on distribution pattern of chlorinity and surface water temperature as shown in Figures 3-a and b. The water mass (area III), raiding into the central part of the Bay from the direction of south-east, divide a coastal area into two parts, north (area I) and west (area II). And he called the rest area of east part of the Bay as the open sea area (area IV). These results may be taken to indicate that there is an apparent parallelism of a basic pattern concerning to a distribution of water mass, of benthic fauna and of pelagic fish fauna. This distributive phenomena suggests that there is close interspecies relationship in each of the growth stages of the fishes adaptationally connected to conditions nonorganic environments. Accordingly, it may be suggested that species composition is not a representation of the result of a random distribution owing to the physical force, but a phenotype of some systematic production structure in ecosystem, in the case arranging by the limitation in space time by means of some suitable methods.

Seasonal transition in fish fauna Since the set-net have generally been set up at near coast, it may be considered that changes of the daily amount of catch reflect the state of movement of fish schools migrate in and out of the Bay, in spite of insufficiency in re-

Fig. 3-a

Fig. 3-b

Fig. 3-a. Distribution of surface temperature in July 23-27, 1969, in the Sendai Bay (after Hatanaka, 1971).

Fig. 3-b. Distribution of surface chlorinity in Oct. 28-Nov. 1, 1969, in the Sendai Bay (after Hatanaka, 1971).

searching for the actual state of the distribution and life of fishes.

In this part, the author has taken a general view of a seasonal transition of amount of catch in each species, based on records of catch in the fishery grounds A, D and E. Figure 4-a, b, c show typical states of the change of amount of catch concerning to the main species during the fishing season of set-nets in the Sendai Bay. The amount of catch has been represented by the rate in per cent of catch in a period of ten days to the total catch.

At the fishery ground of north-east part of the Bay, regions of Tashiro island near the Oshika peninsula, as shown in Figure 4-a, the file fish (*Navodon modestus*), the angler fish (*Lophius litulon*), young cherry salmon (*Oncorhynchus masou*), juvenile of the cod fish (*Gadus macrocephalus*), the common sea bass and the gurnard (*Lepidotrigla microptera*) appear simultaneously in late April, when the surface water temperature⁴⁾ is approximately 10°C (Fig. 5). They have been composed a main part in amount of catch up to the ten days of May; showing one peak or two of the amount of catch during the time from May

Fig. 4-a. The sequent fluctuations of amount of catch of the coastal fishes caught by the set-net in the fishing area E (Tashiro isl.), 1968. Curves showing the ratio of catch in every 10 days to the total amount of catch of each species.

Fig. 4-b. The sequent fluctuations of amount of catch of the coastal fishes caught by the set-net in the fishing area A (Yuriage), 1968. Curves showing the ratio of catch in every 10 days to the total amount of catch of each species.

to June, and the fishes excepting the common sea bass get out of sight at about the beginning of July.

After a while, in the first ten days of May, the large and medium sized amberfish are coming into the area, when the surface water temperature shows approximately 12°C as in other years. The large sized has peaks of catch in the second third of June and of August, and the medium sized appear almost continuously up to the middle ten days of October, showing the peak of catch at the beginning of August.

In the second third of May, the sagittated calamary (*Todarodes pacificus*) and the anchovy are coming in. The former is continuously appearing up to the beginning of August, and the latter continues to the second third of October.

In the last ten days of May, the large and small sized blue fin tuna (*Thunnus thynnus*) and the large and medium sized mackerel are coming in at the same time, and after that

Fig. 4-c. The sequent fluctuations of amount of catch of the coastal fishes caught by the set-net in the fishing area D (Orinohama), 1968. Curves showing the ratio of catch in every 10 days to the total amount of catch of each species.

the small sized mackerel and the small sized amberfish are coming in at the beginning of June. The small sized mackerel has its peaks of catch in the beginning of June and the middle ten days of July, and the small sized amberfish in the middle of June and that of September.

Most of species, as mentioned above, have been appeared up to the middle ten days of August, when the surface water temperature in the Bay has attained to the maximum (25–26°C) and is going to decline (Fig. 5).

At the fishery ground of south-west part of the Bay, along the coast of Yuriage, as shown in Fig. 4-b, the file fish, the squid, the sagittated calamary, black sea bream (*Mylio macrocephalus*), the large sized amberfish, the *nibe* (*Nibea mitsukurii*) and the anchovy are coming in. The large sized amberfish, showing peaks of catch in June and late in August, has no continuity of appearance such as the case of the north-east area, and the amount of catch is rather small. The *nibe* and the anchovy are appearing continuously up to the middle ten days of October.

Fig. 5. Seasonal fluctuations of surface water temperature, during the period from April of 1968 to March of 1969, at a coast and the neighbourhood area of the Sendai Bay.
 ○, Tashiro island; ●, Inner part of the Bay; —, Enoshima.

The medium sized amberfish is coming in at the middle ten days of June, and the small sized late in the month. In the wake of the amberfish, the shrimps (*Trochypenaeus curvirostris*), the gizzard shad (*Konosirus punctatus*), the small sized jack-mackerel, the common sea bass and the barracuda (*Sphyraena pinguis*) are successively coming in.

Peaks of catch of the small sized amberfish can be seen respectively, during the period from the mid-July to the beginning of August, in mid-October and at the beginning of November. And then, during the period from early in July to mid-August, the small sized mackerel, the blue fin tuna, the frigate mackerel and the *kanpachi* are successively migrating in; and lastly, in mid-September, the sardine comes in sight, which constitute a characteristic feature of this fishing area in the Bay.

At the fishing ground of the inner part of the Bay (D), first of all, at the beginning of May, the Kawagarei (*Platichthys stellatus*), the file fish, the gizzard shad, the squid, the *nibe*, the common sea bass and the half beak (*Hemiramphus sajori*) are coming in. Among these species, preceding three fishes are out of sight for a time during the period from mid-June to October and are coming again in mid-October and last to November.

Through mid-May into June, the large sized *nibe*, the sagittated calamary, the small sized mackerel and the squid are coming in the area at intervals of a period of ten days; and in mid-June, the small sized jack mackerel, young amberfish and the flying fish (*Cypselurus sp.*) are migrating in simultaneously. The amberfish show the maximum values of catch twice during the periods, through mid-July into August and in mid-September, and the staying period continues into late in October.

The large sized amberfish appear during the period from late in June into July, uncommonly in this fishery ground.

Looking through the state of appearance in each species quantitatively concerning to the three fishing grounds in the Bay, as mentioned above, it can be observed that there present some marked differences in the main species composition between three areas each other, and present a time lag pertaining to the first period of appearance and the period of the formation of the maximum catch in each species according to the fishing area. Nevertheless, in a period of temperature rise, many species of fish appear in each area following one another, and most of the main species are already in the areas by middle or late August, when the water temperature begins to show a descending tendency.

As a whole, it can be found that the period of appearance is rather short, in the case such as the file fish migrating in at an earlier period of time, and as the blue fin tuna and the frigate mackerel appearing comparatively behind time. On the other hand, some species such as young amberfish, the anchovy, the mackerel and the jack mackerel, appearing for the middle of the two periods above mentioned, show rather long sojourning period of time. Namely, during the period from late in June to the beginning of July, numbers of species caught by the set-nets show the maximum, and that this is a charac-

teristic common to the three fishery grounds, each of which has different species composition.

Each species shows peaks of amount of catch one or more times during their staying period surely. From the view of the tendency for peaks, at an interval of a period of ten days, it can be recognized that the peaks in catch at any one time is composed of not more than five species at the maximum, and generally two or more species populations, linked either with predator-prey relationships, and scarcely overlap with each other in a restricted space.

Assuming the peaks of amount of catch for an index of size of schools migrating in the fishery ground of the Bay, that is a part of whole distributional areas for species populations, it may be suggested that species populations migrate and distribute in their living zone not to overlap preferably with another species populations, and that there are some stratified constructions in interspecies and distributional relationships in the coastal fish fauna. The phenomena, mentioned above, can be considered fundamentally as a result of interspecies coadaptation, in order to avoid an inordinate competition on getting foods and attacking by enemies, for the sake of preservation and development of the production of the species population.

Interspecies relationships concerning common food items in communities As well as in the amberfish community, we can find many species of fish which prefer the anchovy for food in the coast, as mentioned in the previous paper.¹⁾

In the area A, during the period July 5 to August 20, by way of example, the predators of anchovy are the *kanpachi* of 14–24 cm in fork length, the barracuda of 17–25 cm, the Japanese bluefish (*Scombrops boops*), the *nibe* of 10–20 cm, the black rockfish of 9–16 cm and the jack mackerel of 13 cm and over: and, during the period from August 28 to October 29, the *kanpachi* of 20–21 cm, the common sea bass of 16–20 cm, the frigate mackerel of 29–31 cm, the *nibe* of 10–30 cm, the white croaker (*Argyrosomus argentatus*) of 10–20 cm and the mackerel of 8–20 cm.

On the basis of the frequency occurrence of food items found in stomachs, food niche of each species relatively to the amberfish has been decided, as shown in Fig. 6.

Then, taking the case of area A, possibilities for the interspecies competition for food, have been investigated, comparing the seasonal variations of the standing crop in each species.

First, as shown in Fig. 5-b, vast number of small sized amberfish are migrating in and out of the Bay, covering over a period of a month, showing the peak of amount of catch in mid-July. The anchovy appear about 20 days preceding the appearance of the amberfish, and show the peak of catch in the first ten days of July. The *kanpachi* appear on and after mid-August, having a peak of catch in the last ten days, and the centroid of the population shifts apparently to that of the amberfish and of the main group

Fig. 6. Relationships on food niche between the young amber-fish and the other fishes feed on the anchovy in the Senday Bay.

(1): Jul. 5-Aug. 20, 1968 (2): Aug. 28-Oct. 29, 1968 (3): Nov. 2-26, 1968

of the anchovy.

The *nibe* appear during the period from late in May to the first ten days of November continuously, and the heights of migration are mid-June and the beginning of August, that corresponding to the period just before coming of young amberfish. An appearing period of the mackerel keep up from the beginning of July to mid-November, and the peak of catch gets out of the place for the height of the amberfish, notwithstanding the population exceed to that of the amberfish.

On the other hand, making a conjecture from the amounts of catch, populations of the barracuda and the Japanese bluefish are approximately 3.4% and 1% of the amberfish. Namely, the level of the competition concerning to the food item may be considered in a low grade, in relationships between any and every species to the young amberfish.

During the period from August 8 to October 29, the small sized amberfish show a peak of catch at mid-October, just when a large school of the anchovy are migrating in the area at least 1.8 times of the amberfish in amount of catch, and overlap the peak of catch each other. During the same period, the mackerel show a peak, but the level of the population is rather low, grading about 1/2 of the amberfish. On the other hand, some fishes such as the *kanpachi*, the frigate mackerel, the barracuda, the *nibe* and the like are in low level.

On the first ten days of November, the small sized amberfish show a peak, and a large school of the sardine are migrating in. The amberfish eat on the anchovy principally, and show a low degree of dependence on the sardine. Accordingly, amounts of catch of the most species that eat on the anchovy for food are generally rather small, in the case of migrating into the area in company with the amberfish. Even if several species show the appearance of living in the same area seemingly, it is general inclination in fish communities that species taking a common food items distribute evidently, lest they should overlap the center of population each other.

As we have seen, numerous fishes live on the anchovy and the *shirasu* for food in the coast of the Sendai Bay, for that reason, we can not afford to overlook the fact that the anchovy playing an important role in food sources for carnivorous fishes. Namely, it is reasonable to consider the existence of several communities, the construction fairly independent to the other, like the amberfish community including the anchovy as a key species and maintain a stable organization. However, the formation mechanism of the community is not always identical to that of the amberfish community.

Picking up typical terminal species from fish fauna in the Sendai Bay, the types of community formation can be classified into the following three classes.

The first, waiting type, represented by the common seabass, which appear all the year round, taking the anchovy for food during the period appearing in the Bay and getting away from the living area of the young amberfish.

The second, sojourning type, represented by young mackerel and young jack mackerel,

having an intense migratory character but sojourning in the Bay for a good while. The fishes are relying intensely on the anchovy or the *shirasu* for food, and under certain circumstances pertaining to the growth stage, they are often included in the member of the amberfish community and transfer to the another communities.

The third, passing type, represented by the frigate mackerel, the barracuda, the *kanpachi*, the blue fin tuna and the dolphin, migrating in temporarily during some short period in warm season and feeding intensely on the anchovy, and the peak of migration accord with that of the anchovy.

These three types of communities have the common feature in a point that they include the anchovy as a principal member in a community. However, it is reasonable to consider the main part of the community as separate from other communities in time and space, and that two or more communities rarely hold a common school of the same anchovy population, but connect some definite school of the fish. This is closely related to the unequal quality in career of the anchovy population⁵⁾ and differences in life habit of the anchovy eaters.

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