Distribution of Juvenile Fish in the Northwestern Parts of Bungo Strait

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From June of 1993 to November of 1995, juvenile fish in the northwestern parts of Bungo Strait were surveyed using a small boat seine. During this period,108 species of fish, 58,765 individuals(inds.), were caught. We identified 20 dominant species in these areas. The catch in the numbers of these species was 56,910 inds.,96.2% of the total fish caught. The species represented 65% of the dominant species, 70.3% in the numbers, were supposed to be sedentary species. Fish fauna were seen as abundant and complex (Morishita's β indices showing from 4.666 to 5.111) on the northward side of these sea areas where *Zostera* and *Sargassum* beds grow well.

About 44,000-97,000 tons of fish per year have been caught by many kinds of fisheries in Bungo Strait during the recent decade,[1] however, there is little available information about some fish species that inhabit shallow waters near the coast of Bungo Strait.[2-4] In this study, we describe characteristic distributions of coastal fish in their early stage using specimens in addition to those which one of authors, Kudo, had obtained at the previous study.[3]

Materials and Methods

As shown in Fig.1 and Table 1, 20 survey stations for specimens are located in Usuki, Tsukumi and Saiki bays in the northwestern parts of Bungo Strait. The specimens used for this study were caught 128 times during the period from June of 1993 to November of 1995. No specimens were available after November of 1994 in Saiki Bay. The specimens were caught with a small boat seine, 2.4 ton and 50 hp., based at the Tojigaura fishing port on the southern part of Tsukumi Bay. Fig.2 shows fishing gear for this study. The specimens were caught in 1 operation at 1 station from approximately 6 a.m.to noon. The operations with the boat were made using the same methods as

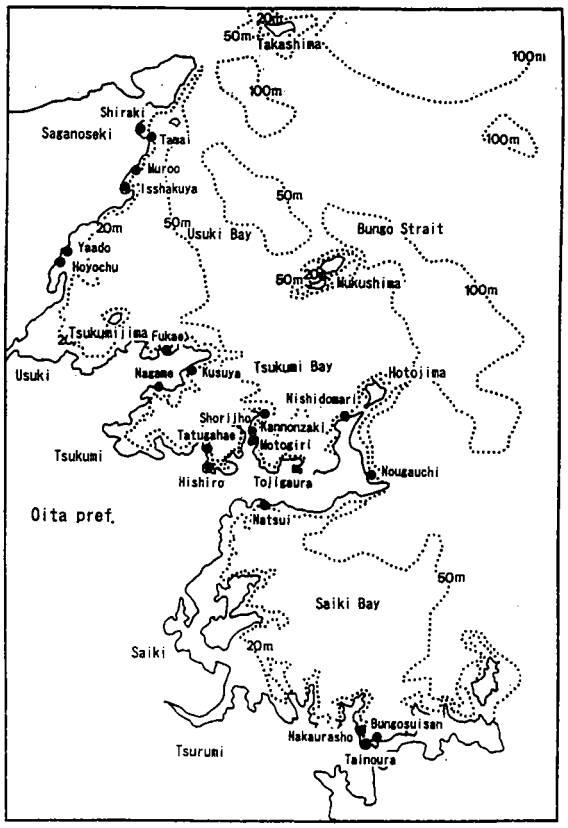

Fig.1. Location of the survey stations for juvenile fish in the northwestern parts of Bungo Strait. Solid cirles: stations, dashed line: isobath.

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Table1.The survey stations of the small boat seine in each bay from 1993 to 1995.

Date	Areas		
	Usuki Bay	Tsukumi Bay	Saiki Bay
1993/6/28·30	5	3	4
7/26	6	2	–
8/13	–	1	4
8/25·26	4	2	4
10/27·28	4	2	2
11/25	3	2	–
12/9	3	2	–
1994/6/28·29	4	2	4
7/28·29	3	2	4
8/23·24	4	2	4
10/3·4	4	2	4
10/20	4	1	–
11/25	2	2	–
1995/3/13	–	2	–
6/15	3	2	–
7/20	3	2	–
8/25	3	2	–
9/27	3	2	–
11/2	2	3	–
Total	60	38	30

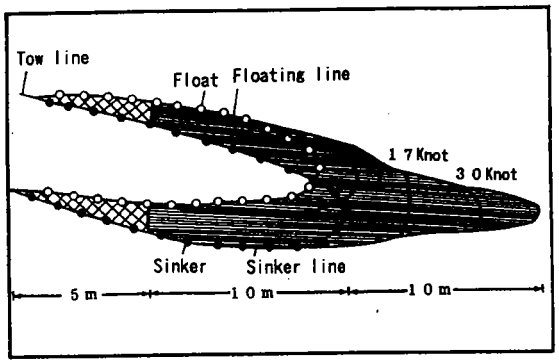

Fig.2. Fishing gear for the boat seine used in this survey.

Sueyoshi *et al.*.[2] That is,first the boat was anchored in the water near the coast. After that, the boat let out the rope until the boat was 100m from the coast. From this new position, the net was let out into the sea moving parallel to the coast. After the net was let out, the boat was roped into the anchor point again and the net was hauled. The specimens were put into boxes with ice and carried out to the facilities of the Oita Institute of Marine and Fisheries Science in fresh condition. The specimens of each species were identified and their body length and body weight, respectively, were measured. This treatment was made within the survey day. We decided to adopt 'total length' as a standard measurement method except for red sea bream *Pargus major* and crimson sea bream *Evynnis japonica* for which we adopted the 'fork length' measurement method. Identification of the fish species was based on Nakabo *et al.*[5] and the English names for the species of fish were based on the Ichthyological Society of Japan.[6]

Results

Specimens and Numbers

The specimens that were caught by the boat seine were 108 species of fish and 6 species of mollusk, so the total species were 114 as shown in Table 2.The species of fish were divided into 13 orders as follows: 1 species of Rajiformes, 1 species of Anguilliformes, 3 species of Clupeiformes, 1 species of Siluriformes, 3 species of Aulopiformes, 1 species of Atheriniformes, 1 species of Zeiformes, 1 species of Gasterosteiformes, 2 species of Syngnathiformes,12 species of Scorpaeniformes, 63 species of Perciformes, 8 species of Pleuronectiformes, and 11 species of Tetraodontiformes. 58.3% of the total fish caught belonged to Perciformes and 11.1% of them belonged to Scorpaeniformes, 10.2% of them belonged to Tetraodontiformes, respectively.

The total number of species was 59,051 individuals. 58,765 of these, 99.5%,were fish and the remainder were mollusk as shown in Table 2. Of the fish, slimy ponyfish *Leiognathus nuchalis* accounted for 26.9% of the fish, 15,784 inds..The next were as follows: hairychin goby *Sagamia genetonema* were 7,307 inds.(12.4%),japanese horse mackerel *Trachurus japonicus* were 6,654 inds.(11.3%), japanese stingfish *Sebastes inermis* were 6,624 inds.(11.3%), crimson sea bream *Evynnis japonica* were 4,253 inds.(7.2%), network file fish *Rudarius ercodes* were 4,035 inds.(6.9%),file fish *Stephanolepis cirrhifer* were 2,983 inds.(5.1%), red sea bream *Pagrus major* were 1,594 inds.(2.7%), sea chub *Ditrema temmincki* were 970 inds.(1.7%), stretched silk *Pterogobius elapoides* were 946 inds.(1.6%), offshore ponyfish *Leiognathus rivulatus* were 898 inds.(1.5%), japanese barracuda *Sphyraena japonica* were 717 inds.(1.2%), three-line grunt *Parapristipoma trilineatum* were 698 inds.(1.2%), goatfish *Upeneus bensasi* were 646 inds.(1.1%), tiny stinger *Hypodytes rubrinpinnis* were 465 inds.(0.8%), motleystripe rainbowfish *Halichoeres tenuispinnis* were 427 inds.(0.7%), black scraper *Thamnaconus modestus* were 373 inds.(0.6%), multicolorfin rainbowfish *Halicheres poecilepterus* were 327 inds.(0.6%), lancer *Lethrinus genivittatus* were 300 inds.(0.5%), and perch sculpin *Pseudoblennius percoides* were 270 inds.(0.5%).

Table2. Catch in numbes of species in each bay.

Species	Order	Family	1993 Usuki	1993 Tsukumi	1993 Saiki	1994 Usuki	1994 Tsukumi	1994 Saiki	1995 Usuki	1995 Tsukumi	Total	%	Bay total Usuki	Bay total Tsukumi	Bay total Saiki	CPUE Usuki	CPUE Tsukumi	CPUE Saiki
Dasyatis akajei	Rajiformes	Dasyatis akajei	3	0	2	0	0	0	0	0	5	0.0	3	0	2	0.0	0.0	0.1
Gnathophis nystromi nystromi	Anguilliformes	Congridae	1	0	0	0	0	0	1	1	3	0.0	2	1	0	0.0	0.0	0.0
Etrumeus teres	Clupeiformes	Clupeidae	0	1	5	0	1	0	0	18	25	0.0	0	20	5	0.0	0.5	0.2
Spratelloides gracilis	–	–	2	0	9	0	1	0	11	1	24	0.0	13	2	9	0.2	0.0	0.3
Engraulis japonicus	–	Engraulidae	30	20	0	0	0	1	0	2	54	0.1	30	23	1	0.5	0.6	0.0
Plotosus lineatus	Siluriformes	Plotosidae	2	0	0	4	1	0	4	0	11	0.0	10	1	0	0.2	0.0	0.0
Saurida elongata	Aulopiformes	Synodontidae	5	1	2	0	0	0	0	0	8	0.0	5	1	2	0.1	0.0	0.1
Trachinocephalus myops	–	–	0	0	0	4	2	1	0	0	7	0.0	4	2	1	0.1	0.0	0.0
Saurida sp.2	–	–	2	0	1	1	7	0	1	9	21	0.0	4	16	1	0.1	0.4	0.0
Hyporhamphus intermedius	Atheriniformes	Atherinidae	0	0	0	6	0	0	0	0	6	0.0	6	0	0	0.1	0.0	0.0
Zeus faber	Zeiformes	Zeidae	2	1	10	0	2	0	3	4	22	0.0	5	7	10	0.1	0.2	0.3
Aulichthys japonicus	Gasterosteiformes	Aulorhynchidae	109	0	0	37	0	0	5	0	151	0.3	151	0	0	2.5	0.0	0.0
Fistularia commersonii	Syngnathiformes	Fistulariidae	17	0	0	16	1	4	8	4	50	0.1	41	5	4	0.7	0.1	0.1
Syngnathus schlegeli	–	Syngnathidae	69	1	1	14	1	0	2	1	89	0.2	85	3	1	1.4	0.1	0.0
Apistus carinatus	Scorpaeniformes	Scorpaenidae	0	0	0	0	2	0	0	0	2	0.0	0	2	0	0.0	0.0	0.0
Scorpaena onaria	–	–	1	0	0	0	1	0	0	0	2	0.0	1	1	0	0.0	0.0	0.0
Sebastiscus marmoratus	–	–	1	3	1	5	4	0	9	0	23	0.0	15	7	1	0.3	0.2	0.0
Sebastes inermis	–	–	626	2117	1	651	2301	5	801	122	6624	11.3	2078	4540	6	34.6	119.7	0.2
Hypodytes rubripinnis	–	Tetrarogidae	286	34	1	96	44	4	0	0	465	0.8	382	78	5	6.4	2.1	0.2
Chelidonichthys spinosus	–	Triglidae	3	0	12	0	0	0	1	0	16	0.0	4	0	12	0.1	0.0	0.4
Lepidotrigla microptera	–	–	0	3	0	0	1	3	0	0	7	0.0	0	4	3	0.0	0.1	0.1
Platycephalidae	–	Platycephalidae	0	2	0	0	0	0	0	0	2	0.0	0	2	0	0.0	0.0	0.0
Dactyloptena orientalis	–	Dactylopteridae	0	1	0	1	0	0	0	0	2	0.0	1	1	0	0.0	0.0	0.0
Hexagrammos otakii	–	Hexagrammidae	0	0	0	0	0	0	5	0	5	0.0	5	0	0	0.1	0.0	0.0
Pseudoblennius percoides	–	Cottidae	82	30	6	40	5	0	103	4	270	0.5	225	39	6	3.8	1.0	0.2
Pseudoblennius cottoides	–	–	50	16	2	48	17	7	25	1	166	0.3	123	34	9	2.1	0.9	0.3
Lateolabrax japonicus	Perciformes	Percichthyidae	0	1	0	0	0	0	0	0	1	0.0	0	1	0	0.0	0.0	0.0
Epinephelus septemfasciatus	–	Serranidae	0	0	0	0	0	0	0	1	1	0.0	0	1	0	0.0	0.0	0.0
Rhynchopelates oxyrhynchus	–	Terapontidae	0	0	0	57	0	1	0	0	58	0.1	57	0	1	1.0	0.0	0.0
Pricanthus macracanthus	–	Priacanthidae	0	0	0	0	0	1	0	0	1	0.0	0	0	1	0.0	0.0	0.0
Apogon hiranis	–	Apogonidae	0	0	0	0	0	0	0	1	1	0.0	0	1	0	0.0	0.0	0.0
Apogon semilineatus	–	Apogonidae	0	8	0	0	12	0	0	27	47	0.1	0	47	0	0.0	1.2	0.0
Apogon doederleini	–	–	0	0	0	0	0	4	0	0	4	0.0	0	0	4	0.0	0.0	0.1
Apogon endekataenia	–	–	0	3	0	0	0	0	0	1	4	0.0	0	4	0	0.0	0.1	0.0
Apogon lineatus	–	–	9	0	0	1	0	3	7	0	20	0.0	17	0	3	0.3	0.0	0.1
Sillago japonica	–	Sillaginidae	15	2	21	14	1	24	3	1	81	0.1	32	4	45	0.5	0.1	1.5
Scomberoides boops	–	Scombropidae	1	0	0	5	15	0	1	2	24	0.0	7	17	0	0.1	0.4	0.0
Trachurus japonicus	–	Carangidae	1337	1037	1783	472	392	519	1055	59	6654	11.3	2864	1488	2302	47.7	39.1	76.7
Decapterus maruadsi	–	–	0	0	0	6	0	0	0	0	6	0.0	6	0	0	0.1	0.0	0.0
Decapterus muroadsi	–	–	0	0	0	0	0	0	0	6	6	0.0	0	6	0	0.0	0.1	0.0
Kaiwarinus equula	–	–	1	39	1	0	1	0	0	2	44	0.1	1	42	1	0.0	1.1	0.0
Pseudocaranx dentex	–	–	0	0	0	0	0	0	1	0	1	0.0	1	0	0	0.0	0.0	0.0
Leiognathus elongatus	–	Leiognathidae	0	0	0	0	52	10	0	3	65	0.1	0	55	10	0.0	1.4	0.3
Leiognathus nuchalis	–	–	0	371	0	6094	7132	147	133	1907	15784	26.9	6227	9410	147	110.5	247.6	4.9
Leiognathus rivulatus	–	–	1	40	857	0	0	0	0	0	898	1.5	1	40	857	0.0	1.1	28.6
Parapristipoma trilineatum	–	Haemulidae	0	0	0	0	1	0	0	697	698	1.2	0	698	0	0.0	18.4	0.0
Nemipterus virgatus	–	Nemipteridae	0	0	0	0	0	0	1	0	1	0.0	1	0	0	0.0	0.0	0.0
Pagrus major	–	Sparidae	353	90	80	344	39	129	405	154	1594	2.7	1102	283	209	18.4	7.4	7.0
Eoyonis japonica	–	–	1077	218	1255	369	520	266	211	337	4253	7.2	1657	1075	1521	27.6	28.3	50.7
Acanthopagrus schlegeli	–	–	0	0	0	0	0	0	0	1	1	0.0	0	1	0	0.0	0.0	0.0
Gymnocranius griseus	–	Lethrinidae	0	1	0	0	0	0	0	0	1	0.0	0	1	0	0.0	0.0	0.0
Lethrinus genivittatus	–	–	0	0	0	296	0	0	0	4	300	0.5	296	4	0	4.9	0.1	0.0
Sciaenidae	–	Sciaenidae	0	3	0	0	1	0	0	0	4	0.0	0	4	0	0.0	0.1	0.0
Upeneus tragula	–	Mullidae	0	0	0	20	0	0	0	0	20	0.0	20	0	0	0.3	0.0	0.0
Upeneus bensasi	–	–	175	41	66	121	6	136	34	69	648	1.1	330	116	202	5.5	3.0	6.7
Mulloidichthys flavolineatus	–	–	11	0	0	40	0	0	0	0	51	0.1	51	0	0	0.9	0.0	0.0
Henichus acuminatus	–	Chaetodontidae	0	0	0	0	0	0	0	4	4	0.0	0	4	0	0.0	0.1	0.0
Ditrema temminckii	–	Ephiotocidae	431	21	2	319	16	4	177	0	970	1.7	927	37	6	15.5	1.0	0.2
Chromis notata notata	–	Pomacentridae	0	0	0	9	0	0	0	0	9	0.0	9	0	0	0.2	0.0	0.0
Gomistius zonatus	–	Cheilodactylidae	1	0	0	1	0	0	0	0	2	0.0	2	0	0	0.0	0.0	0.0
Mugil cephalus cephalus	–	Mugilidae	0	0	0	0	0	1	0	0	1	0.0	0	0	1	0.0	0.0	0.0
Choerodon azurio	–	Labridae	0	1	0	3	0	0	2	4	10	0.0	5	5	0	0.1	0.1	0.0
Semicossyphus reticulatus	–	–	0	0	0	1	0	0	0	0	1	0.0	1	0	0	0.0	0.0	0.0
Pteragogus flagellifer	–	–	24	46	0	20	44	0	74	27	235	0.4	118	117	0	2.0	3.1	0.0
Pseudolabrus japonicus	–	–	0	11	0	8	25	0	9	14	67	0.1	17	50	0	0.3	1.3	0.0
Suezichthys gracilis	–	–	0	1	0	0	4	0	53	16	74	0.1	53	21	0	0.9	0.6	0.0
Halichoeres poecilopterus	–	–	58	72	12	54	35	12	28	56	327	0.6	140	163	24	2.3	4.3	0.8
Halichoeres tenuispinnis	–	–	142	40	2	84	53	1	78	29	427	0.7	302	122	3	5.0	3.2	0.1
Pholis nebulosa	–	Pholidae	1	3	0	3	8	0	6	3	24	0.0	10	14	0	0.2	0.4	0.0
Kochichthys flavofasciatus	–	Pinguipedidae	0	0	0	0	0	0	0	3	3	0.0	0	3	0	0.0	0.1	0.0
Parapercis cylindrica	–	–	0	0	0	0	0	0	0	4	4	0.0	0	4	0	0.0	0.1	0.0
Parapercis pulchella	–	–	0	11	0	0	2	3	0	14	30	0.1	0	27	3	0.0	0.7	0.1
Parapercis sexfasciata	–	–	1	18	0	6	12	0	0	2	39	0.1	7	32	0	0.1	0.8	0.0
Parablennius yatabei	–	Blenniidae	1	0	0	0	0	0	0	0	1	0.0	1	0	0	0.0	0.0	0.0
Petroscirtes breviceps	–	–	0	0	0	43	0	0	21	4	68	0.1	64	4	0	1.0	0.1	0.0
Callionymichthys japonicus	–	Callionymidae	1	1	0	0	0	0	0	0	2	0.0	1	1	0	0.0	0.0	0.0
Repomucenus huguenini	–	–	0	1	16	0	0	0	0	0	17	0.0	0	1	16	0.0	0.0	0.5
Repomucenus valenciennei	–	–	0	0	0	0	2	6	0	0	8	0.0	0	2	6	0.0	0.0	0.2
Repomucenus beniteguri	–	–	1	1	0	0	0	0	0	0	2	0.0	1	1	0	0.0	0.0	0.0
Callionymidae	–	–	15	3	8	33	5	6	6	17	93	0.2	54	25	14	0.9	0.6	0.5
Sagamia geneionema	–	Gobiidae	915	368	4087	98	142	139	222	1336	7307	12.4	1235	1846	4226	20.6	48.6	140.8
Pterogobius elapoides	–	–	303	387	4	26	2	1	223	0	946	1.6	552	389	5	9.2	10.2	0.2
Pterogobius virgo	–	–	0	3	0	0	1	0	0	0	4	0.0	0	4	0	0.0	0.1	0.0
Gobiidae	–	–	2	0	0	0	0	0	0	216	218	0.4	2	216	0	0.0	5.7	0.0
Siganus fuscescens	–	Siganidae	1	1	0	82	0	1	17	0	102	0.2	100	1	1	1.7	0.0	0.0
Zanclus cornutus	–	Zanclidae	1	0	0	0	0	0	0	1	2	0.0	1	1	0	0.0	0.0	0.0
Sphyraena japonica	–	Sphyraenidae	480	3	7	119	2	10	28	68	717	1.2	627	73	17	10.5	1.9	0.6
Sphyraenidae	–	–	1	0	0	0	0	0	2	1	4	0.0	3	1	0	0.0	0.0	0.0
Pseudanthias anomalus	–	Centrolophidae	0	0	0	0	0	1	0	0	1	0.0	0	0	1	0.0	0.0	0.0
Paralichthys olivaceus	Pleuronectiformes	Paralichthyidae	1	0	0	2	0	10	0	1	14	0.0	3	1	10	0.0	0.0	0.3
Pseudorhombus pentophthalmus	–	–	6	1	40	1	0	12	5	25	90	0.2	12	26	52	0.2	0.7	1.7
Pseudorhombus cinnamoneus	–	–	0	0	1	0	1	9	16	0	27	0.0	16	1	10	0.3	0.0	0.3
Engyprosopon grandisquama	–	–	6	1	18	6	2	4	2	10	49	0.1	14	13	22	0.2	0.3	0.7
Paralichthyidae	–	–	6	0	0	0	0	0	0	0	6	0.0	6	0	0	0.1	0.0	0.0
Pleuronichthys cornutus	–	Pleuronectidae	1	1	0	0	0	0	0	0	2	0.0	1	1	0	0.0	0.0	0.0
Heteromycteris japonica	–	Soleidae	2	0	0	1	0	0	1	0	4	0.0	4	0	0	0.0	0.0	0.0
Cynoglossus joyneri	–	Cynoglossidae	0	0	0	1	0	0	0	0	1	0.0	1	0	0	0.0	0.0	0.0
Rudarius ercodes	Tetraodontiformes	Monacanthidae	582	356	62	2026	29	22	852	106	4035	6.9	3460	491	84	57.6	12.9	2.8
Thamnaconus modestus	–	–	54	57	0	60	20	4	83	95	373	0.6	197	172	4	3.3	4.5	0.1
Stephanolepis cirrhifer	–	–	253	272	88	802	231	247	713	377	2983	5.1	1768	880	335	29.5	23.1	11.1
Lactoria diaphana	–	Ostraciidae	10	0	1	2	0	0	0	1	14	0.0	12	1	1	0.2	0.0	0.0
Ostracion immaculatus	–	–	0	0	0	1	0	0	1	1	3	0.0	2	1	0	0.0	0.0	0.0
Canthigaster rivulata	–	Tetraodontidae	4	23	3	6	12	5	8	19	80	0.1	18	54	8	0.3	1.4	0.3
Takifugu snyderi	–	–	2	1	0	5	1	0	3	0	12	0.0	10	2	0	0.2	0.0	0.0
Takifugu porphyreus	–	–	2	0	0	0	0	0	0	0	2	0.0	2	0	0	0.0	0.0	0.0
Takifugu poecilonotus	–	–	3	1	0	2	1	0	3	3	13	0.0	3	5	0	0.1	0.1	0.0
Takifugu exascurus	–	–	0	0	0	4	0	0	2	0	6	0.0	6	0	0	0.1	0.0	0.0
Tetraodontidae	–	–	0	1	0	0	0	0	0	0	1	0.0	0	1	0	0.0	0.0	0.0
Total			7582	5790	8467	12590	11213	1783	5483	5896	58765	100.0	25835	22990	10230	427.3	602.6	341.0
Sepia esculenta	Decapoda		18	20	0	16	12	0	2	9	77		38	41	0			
Sepia lycidas	–		6	4	0	17	1	0	5	0	33		28	5	0			
Sepioteuthis lessoniana	Teuthoidea		18	31	0	28	0	0	36	3	116		82	34	0			
Photololigo adulis	–		1	0	0	0	1	0	0	24	26		1	25	0			
Loliginidae			3	0	3	1	0	0	1	4	12		5	4	3			
Octopus vulgaris	Octopoda		3	4	4	3	3	3	1	1	22		7	6	7			
Total			7831	5849	8474	12655	11230	1788	5508	5937	59051		25784	23017	10240			

The characteristic distribution of species of fish

Distribution in each bay

The fish caught in each bay showed 81 species in Usuki Bay, 83 species in Tsukumi Bay and 52 species in Saiki Bay as shown in Table 2 and the species showed almost the same numbers in Usuki Bay and Tsukumi Bay, but fewer numbers in Saiki Bay. This difference reflects the sampling ratio between Saiki Bay -(50% of) Usuki Bay, (79% of) Tsukumi Bay, respectively.

CPUE (total individuals/operations=survey times) in each bay showed 427.3 inds. in Usuki Bay, 602.6 inds. in Tsukumi Bay and 341.0 inds. in Saiki Bay. The species of Scorpaeniformes and Tetraodontiformes in Saiki Bay were less than the other two bays. However, there seems to be no difference between the former two bays (Table 2).

The occurrence of species in numbers, and individuals, within each station are shown on Table 3 and species in numbers in more than 2 operations showed that there were 14-20 species at st.Yaado and 12-28 species at st.Hoyochu, however, other stations had less than 10 species. Stations, Muroo, Isshakuya,Kusuya, Nougauchi and Nakaurasho had especially poor fish fauna.

Index of diversity

To examine species diversity, we use the Morishita's β index[7,8] in this study.

$\beta = T(T-1)/\Sigma X(X-1)$

X=number of individuals , T=total of individuals

We calculated this index at 5 stations : st.Tamai, st.Hoyochu in Usuki Bay, st.Kusuya, st.Nishidomari in Tsukumi Bay and st.Bungosuisan in Saiki Bay. As a result of our calculations, β index showed from 1.004 to 11.882, an average being 4.079. The average β index in each of these stations is as follows; st.Tamai=4.666, st.Hoyochu=5.111, st.Kusuya=3.152, st.Nishidomari=3.799, st.Bungosuisan=2.885. The β indices which are more than average are great in number at st.Tamai and st.Hoyochu, as shown Fig.3. On the other hand the index is smaller at st.Bungosuisan. This shows that fish communities at st.Tamai and st.Hoyochu are more complex than at

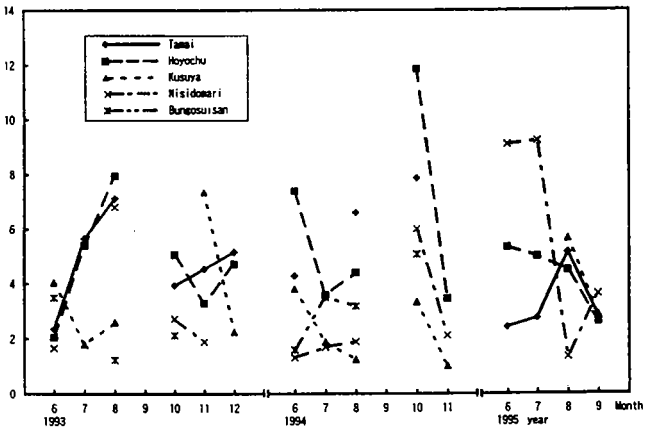

Fig.3. Monthly fluctuations of Morishita's β index at 5 stations.

Table3. Occurrence of Fish in numbers (top) and individuals (bottom) in each station.

	St. \ Date	1993/6 28-30	7 26	8 13	8 25-26	10 27-28	11 25	12 9	1994/6 28-29	7 28-29	8 23-24	10 3-4	10 20	11 25	1995/3 13	6 15	7 20	8 25	9 27	11 2
Usuki Bay	Shiraki		10																	
			60																	
	Tamai	19	20		19	9	14	11	22		22	18	14			20	16	25	8	9
		1,719	555		307	51	133	42	619		395	239	163			572	1,225	944	366	88
	Muroo	12	7		5	1														
		604	23		11	8														
	Isshakuya	5	3		13	10	7	4	10	7		3								
		23	71		120	123	25	37	25	43		156								
	Yaado	19	14							20				16						
		437	121							743				882						
	Hoyochu	12	19		25	17	21	12	21	19	18	28	19	18		16	19	19	15	18
		394	593		548	385	766	429	773	526	309	555	488	346		197	257	224	309	1,032
	Fukae								17	6	14	15	8			12	8	5	15	
									290	494	5,459	69	17			117	41	14	94	
Tsukumi Bay	Kusuya	19	7		16		11	4	20	11	8	3	8	5	4			15	15	4
		205	196		692		56	19	1,098	263	753	5	773	5,040	4			222	75	1,604
	Tatugahae	3	14					9							15					
		73	71					384							373					
	Kannonzaki														14					
															92					
	Nishidomari	26		16	23	15	17		22	21	19	6		4		27	19	18	10	
		1,043		2,226	259	146	420		1,658	674	462	13		90		312	436	805	63	
	Hishiro													10						
														384						
	Nagame															14				
																1,447				
	Shorijho																			7
																				140
	Motogiri																			11
																				342
Saiki Bay	Nougauchi	11		4	8				10	9	5	4								
		1,288		13	22				82	47	8	10								
	Natsui	11		3	6				15	11	8	10								
		38		37	71				184	298	71	29								
	Nakaurasho	11		8	8					10	8	6								
		227		63	39					102	58	21								
	Bungosuisan	13		13	18	8			16	10	11	9								
		5,699		507	380	27			659	54	66	49								
	Tainoura								9											
									25											

st.Bungosuisan. The index showed a large monthly fluctuations in each stations, and also at st.Nishidomari, yearly fluctuations of the β index are large and the index in 1995 year is larger than in other years. But these fluctuations don't show seasonal variation. The results show that fish communities are complex, having a greater number of species, in the north part of Usuki Bay than in two other bays.

The catch of major species of fish

Of the 20 kinds of major species of fish mentioned above (catch in numbers accounted for more than 0.5% of the total fish), survey station, period, fish size and so on were investigated as shown in Table 2, Fig.4 and 5.

Japanese stingfish: the catch of this species accounted for 11.3% of the total fish and the fourth largest catch of all. Catch per unit effort (catch in number/1 operation), CPUE, for the fish in each bay showed 34.6 inds. in Usuki Bay, 119.5 inds. in Tsukumi Bay and 0.2 ind. in Saiki Bay, respectively. There was a significant catch at st.Nishidomari in Tsukumi Bay. The fish were caught during the period from June to October, especially between June to August. Total length ranged 4-20cm, the highest mode of them showed a range 5-6cm and 11cm during the period from June to August.

Tiny stinger: the catch of this species accounted for 0.8% of total fish. CPUE showed 0.2-6.4 inds., especially large in Usuki Bay. The fish were caught during the period from June to November, especially between August to November.Total length of the fish ranged 3-9cm, and the highest mode was of 5-6cm length.

Perch sculpin: the catch of this fish accounted for 0.5% of the total fish.CPUE showed 0.2-3.8 inds., especially large on the northern coast of Usuki Bay.The fish were caught during the period from June to December. Total length ranged 5-18cm, and the highest mode was of 8cm length.

Japanese horse mackerel: the catch of this species accounted for 11.3% of the total fish. The fish was caught in each bay and CPUE showed from 39.2 inds. to 76.7 inds.. Total length ranged 2-20cm, and the highest mode was of 5-8cm length in June, after that it grew and became 13cm length by October. This suggests that the fish had already appeared in the coastal area before June, and the 18cm highest mode group recruited in the previous year in these sea areas was caught in June.

Slimy ponyfish: the catch of this species were 15,784 inds. and it accounted for 26.9% of the total fish, the largest catch of all. Most of the fish were caught in Usuki Bay and Tsukumi Bay. CPUE was 110.5-247.6 inds. in each bay. The fish were caught mostly off the southern coast of Usuki Bay and next to that, in the northern coast of Tsukumi Bay. There was a small catch in Saiki Bay, CPUE was only 4.9 inds.. The fish were caught each month during the period from June to December, and more than 1,000 inds. of CPUE appeared in August,October and November, respectively. Total length ranged 2-7cm, the highest mode caught on June and July were 6cm length. This changed to 3-5cm length after August.

Offshore ponyfish: the catch of this species accounted for 1.5% of the total fish and it was only 5.7% of the slimy ponyfish. The catch in Saiki Bay in 1993 accounted for most of the catch and CPUE showed 28.6 inds.. No catch was available in Usuki and Tsukumi Bay. The fish seemed to belong to a different habitat than the slimy ponyfish.

Three-line grunt: this species'catch were 697 inds. in Tsukumi Bay in 1995 and only 1 ind. was caught in the previous year. No catch was available in Usuki Bay and Saiki Bay. The catch of the fish accounted for 1.2% of the total fish.

Red sea bream: the catch of this species accounted for 2.7% of the total fish and was caught in each bay. CPUE showed 7.0-18.4 inds. and the majority, 18.4 inds., appeared in Usuki Bay. The catch at st.Hoyochu in the northern coast of Usuki Bay was the largest. The fish were caught in each month of the survey period. Fork length of the fish ranged 2-28cm and the highest mode was 3-6cm length in June. After that, it grew to 11cm length by December and also 12-16cm mode group, bred previous year, was caught during the period from June to August.

Crimson sea bream: this species accounted for 7.2% of the total fish, more than red sea bream. The fish were caught in each bay and CPUE showed 27.6-50.7inds.. The stations where more than 100 inds. were caught were also more than red sea bream. Fork length ranged 3-18cm and the highest mode was 7-8cm in June which grew to 11cm by December.

Lancer: the catch of this species accounted for 0.5% of the total fish. 99% of these were caught in Usuki Bay from October to November of 1994. Most of these were caught at st.Hoyochu and st.Yaado on the northern coast of Usuki Bay. CPUE showed 4.9 inds. in Usuki Bay. Total length

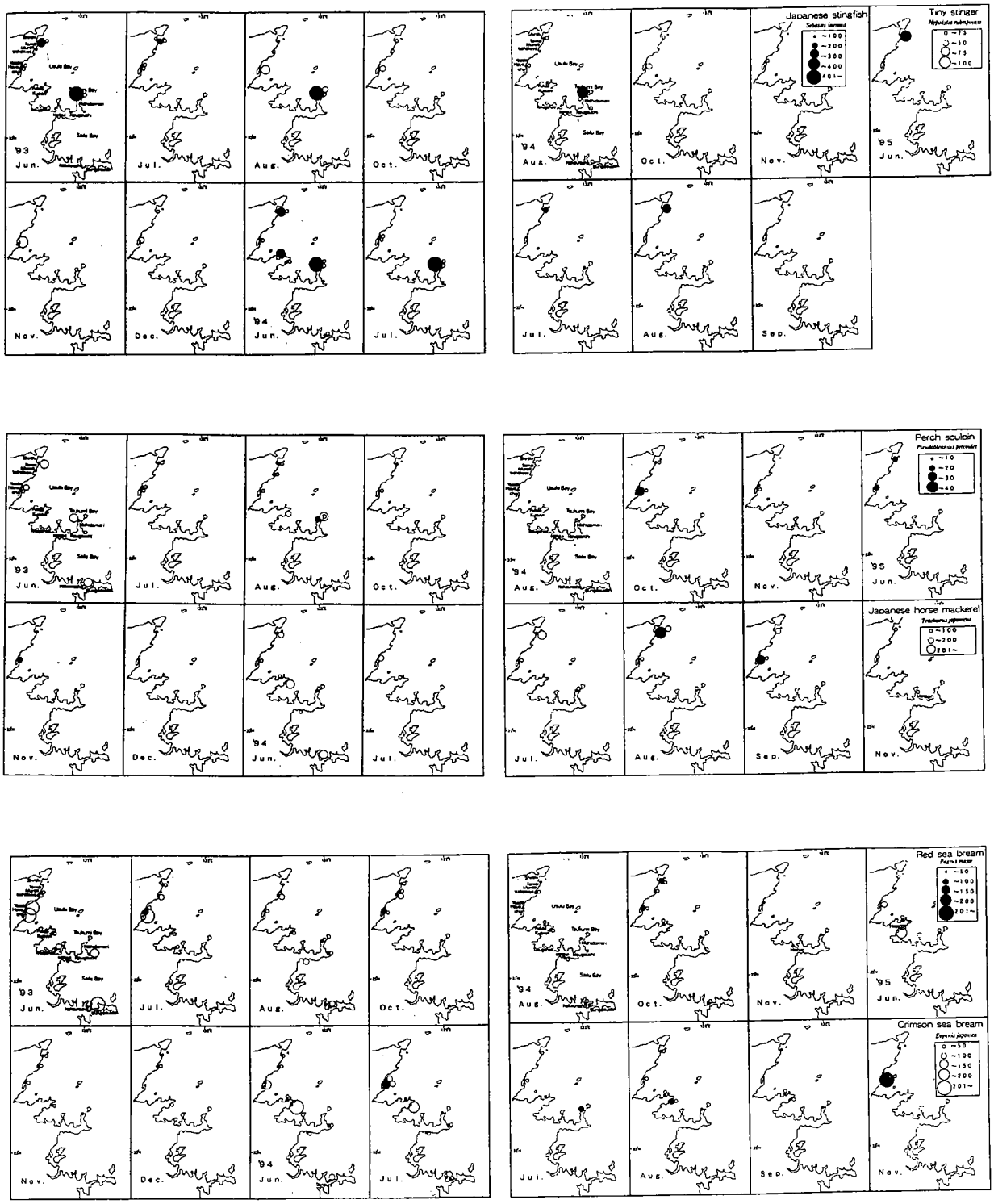

Fig.4-1. Distribution of catch in numbers in each station from 1993/6 to 1995/11.
Top,solid circles: japanese stingfish, circles: tiny stinger.
Middle,solid circles: perch sculpin, circles: japanese horse mackerel.
Bottom,solid circle: red sea bream, circles: crimson sea bream.

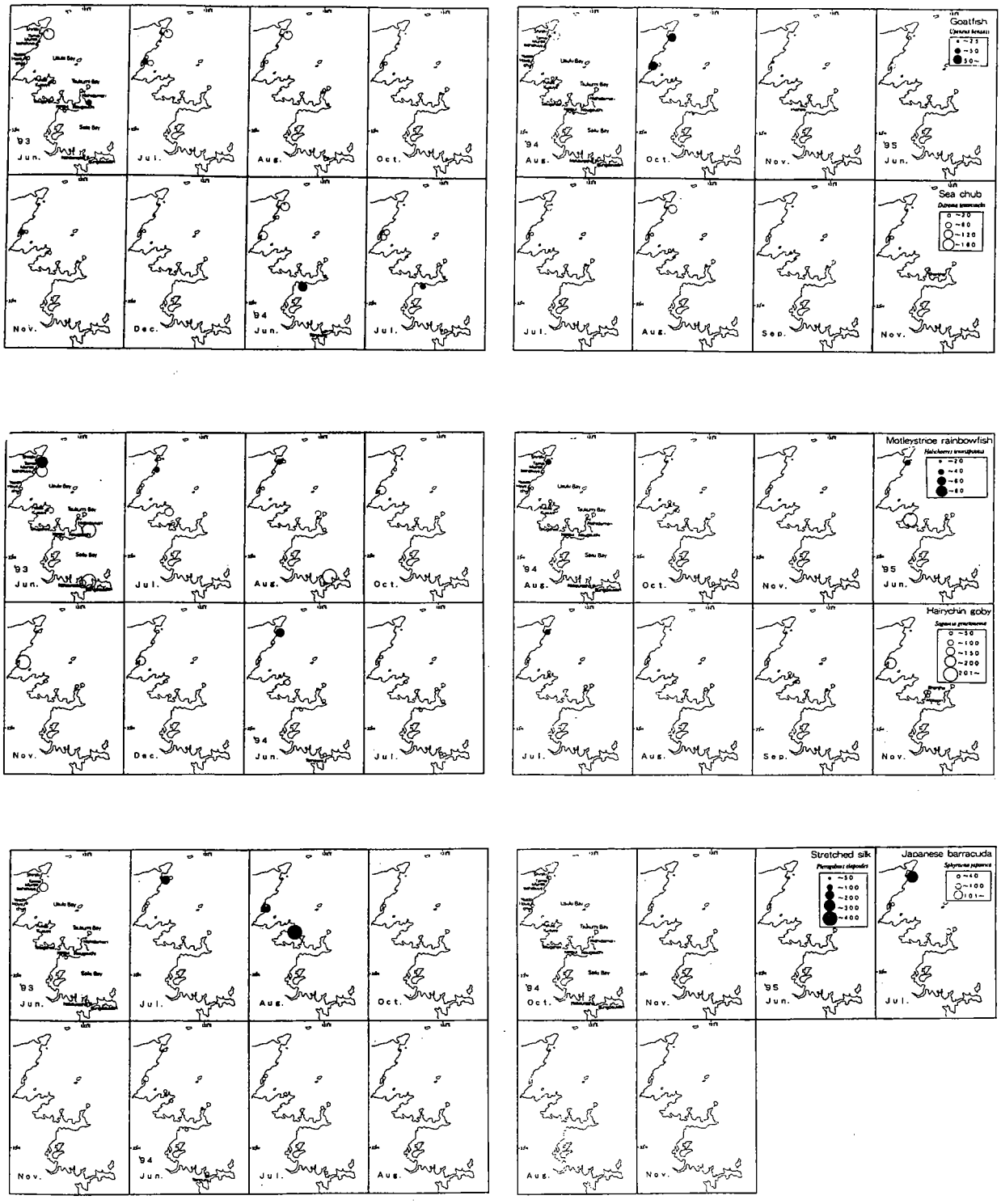

Fig.4-2. Distribution of catch in numbers in each station from 1993/6 to 1995/11.
Top,solid circles: goatfish, circles: sea chub.
Middle,solid circles: motleystripe rainbowfish, circles: hairychin goby.
Bottom,solid circles: stretched silk, circles: japanese barracuda.

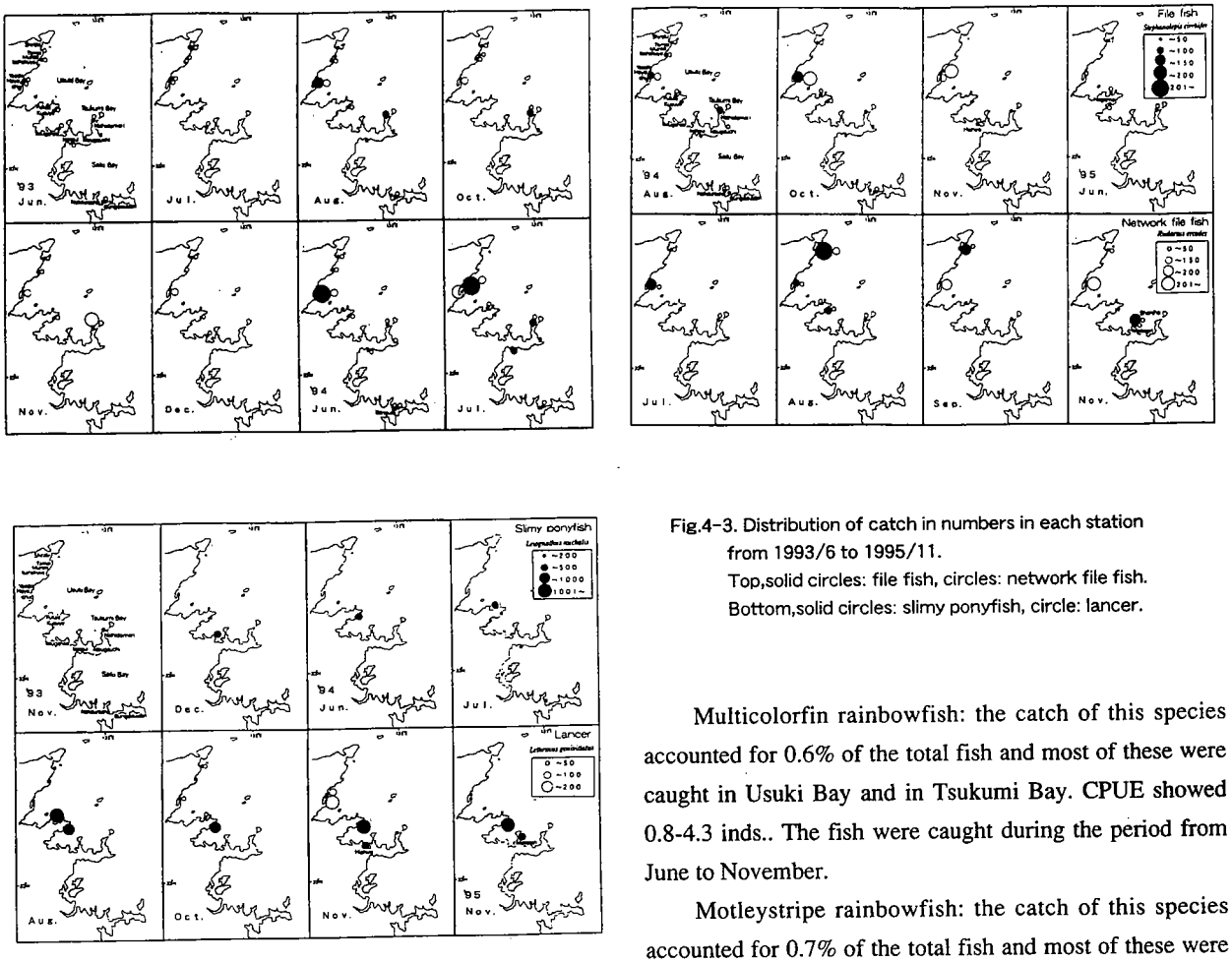

Fig.4-3. Distribution of catch in numbers in each station from 1993/6 to 1995/11.
Top,solid circles: file fish, circles: network file fish.
Bottom,solid circles: slimy ponyfish, circle: lancer.

ranged 4-9cm, indicating 5-7cm as the highest mode.

Goatfish: the catch of this species accounted for 1.5% of the total fish and were caught in each bay, CPUE showed 3.0-6.7 inds.. The stations where there were more than 25 inds. of CPUE appeared along the northern coast of Usuki Bay,out side of Tsukumi Bay and the northern coast of Saiki Bay. The fish were caught in each month during the period from June to December. Total length ranged 3-14cm and the mode grew from 4cm in June to 7cm in November. It suggests that the fish appeared in these areas before June.

Sea chub: the catch of this species accounted for 1.7% of the total fish. 95% of these were caught in Usuki Bay, especially on the northern coast and a few were caught in Tsukimi Bay. CPUE showed 15.5 inds. in Usuki Bay. The fish were caught during the period from June to December, most were caught from June to August. Total length ranged 5-17cm and the highest mode was 7-9cm during the period from June to August.

Multicolorfin rainbowfish: the catch of this species accounted for 0.6% of the total fish and most of these were caught in Usuki Bay and in Tsukumi Bay. CPUE showed 0.8-4.3 inds.. The fish were caught during the period from June to November.

Motleystripe rainbowfish: the catch of this species accounted for 0.7% of the total fish and most of these were caught in Usuki Bay and in Tsukumi Bay. CPUE showed 3.2-5.0 inds. there, but 0.1 ind. in Saiki Bay. The fish were caught during the period from June to November, mostly at st.Tamai in the Saganoseki area on the northern coast of Usuki Bay.

Hairychin goby: the catch of this species accounted for 12.4% of the total fish, indicating the second turn next to slimy ponyfish. The fish were caught in each bay, 58% of these in Saiki Bay. CPUE showed 20.6 inds. in Usuki Bay,48.6 inds. in Tsukumi Bay and 140.8 inds. in Saiki Bay, respectively. The fish were caught during the period from June to December. Total length of the fish ranged 3-9cm and the highest mode grew from 4-5cm length in June to 6-8cm in November.

Stretched silk: the catch of this species accounted for 1.6% of the total fish. 99% of these were caught in Usuki Bay and Tsukumi Bay during the period from June to August, mostly from July to August. Total length of the fish ranged 3-10cm.

Japanese barracuda: the catch of this species

accounted for 1.2% of the total fish. The fish were caught in Usuki Bay, Tsukumi Bay and Saiki Bay, respectively, mostly on the northern coast of Usuki Bay. CPUE in Usuki Bay showed 10.5 inds. and 5.5 times of Tsukumi Bay. The fish were caught mostly in June and more than 100 inds. were caught at st.Muroo in June of 1993. Total length of the fish ranged 6-21cm, indicating the highest mode at length 7-10cm.

Network file fish: the catch of this species accounted for 6.9% of the total fish. CPUE showed 57.7 inds. in Usuki Bay and the other two bays showed 2.8-12.9 inds., respectively. The fish were caught during the period from June to December.

Black scraper: the catch of this species accounted for 0.6% of the total fish. CPUE showed 3.3 inds. in Usuki Bay, 4.5 inds. in Tsukumi Bay and 0.1 ind.in Saiki Bay, respectively.

File fish: the catch of this species accounted for 5.1 % of the total fish and were caught in each bay. CPUE showed 29.5 inds. in Usuki Bay, 23.1 inds. in Tsukumi Bay and 11.2 inds. in Saiki Bay, respectively. Most of the catch was off of the northern coast of Usuki Bay. The fish were caught during the period from June to December. Total length of the fish ranged 2-22cm, and the highest mode changed in each year, showing the highest mode at 4cm in June growing to 10cm by October. 11-17cm ranged schools in June seems to represent fish from the previous year.

Characteristic distribution

The main habitats of the 20 major species are classified as follows(Table 2,Fig.4 · 5.):

Usuki Bay: tiny stinger, perch sculpin, lancer, sea chub, japanese barracuda and network file fish.

Usuki and Tsukumi Bay: japanese stingfish, slimy ponyfish, motleystripe rainbowfish, muticolorfin rainbowfish, stretched silk and black scraper.

Tsukumi Bay: three-line grunt.

Saiki Bay: offshore ponyfish.

All bays: japanese horse mackerel, red sea bream, crimson sea bream, goatfish, hairychin goby and file fish.

The fish found mainly in Usuki Bay accounted for 30% of all 20 species, 30% of the habitats in Usuki and in Tsukumi Bay and 30% of the habitats all bays. This suggests that the major species in these areas seems to inhabit the northward sea areas mainly.

Table 4 shows the relationship between main species and binding species at the largest CPUE. The species accounted for more than 70% of the catch in numbers at the largest CPUE were japanese stingfish, slimy ponyfish, three-line grunt, japanese barracuda and network file fish. These 5 species were dominant there. However, the species that were less than 20% were: tiny stinger, perch sculpin, offshore ponyfish, red sea bream, crimson sea bream, sea chub, multicolorfin rainbowfish, motleystripe rainbowfish, stretched silk and black scraper. These 10 species did not appear to be dominant, inhabiting a co-existence in these areas. Japanese horse mackerel, offshore ponyfish, crimson sea bream and hairychin goby appeared in the same station at each largest CPUE and these 4 species accounted for 98.5% of all catch in numbers there. This station is Bungosuisan on the southren part of Saiki Bay. However, it is not clear that this closely shows a relationship between species or not. And, sea chub and motleystripe rainbowfish appeared at the same station in the largest CPUE too, indicating only 12.7% of all catch in numbers there.

On the assumption of the same family fish having a high degree of relatedness, we examined interspecific relation as follows: in the Leiognathidae, slimy ponyfish and offshore ponyfish are dominant and the former is 17.6 times than the latter on catch in numbers. These two species co-exist only 2 of 21 stations. Sparidae has red sea bream, crimson sea bream and black porgy *Acanthopagrus schlegeli* and the third is less. The second of these is 2.6 times that of the first in catch in numbers and these two species co-exist in 28 of 32 stations. The stations where red sea bream is larger than crimson sea bream in number are almost all on the northern part of Usuki Bay, this suggests that a border line of two species habitat areas seems to be there. Labridae has 7 species and multicolorfin rainbowfish and motleystripe rainbowfish, in number, accounted for 65% of all. CPUE of the two species are almost the same and they inhabit co-existence in 16 of 27 stations. Gobiidae has 5 species and hairychin goby and stretched silk are dominant, they accounted for 99.9% of the total gobies. The former being 7.7 times in number of the latter in catch, the former inhabits as individuals in 21 of 32 stations, but the latter inhabits only 2 stations as individuals. The latter population was samll in Saiki Bay. Monacanthidae has 3

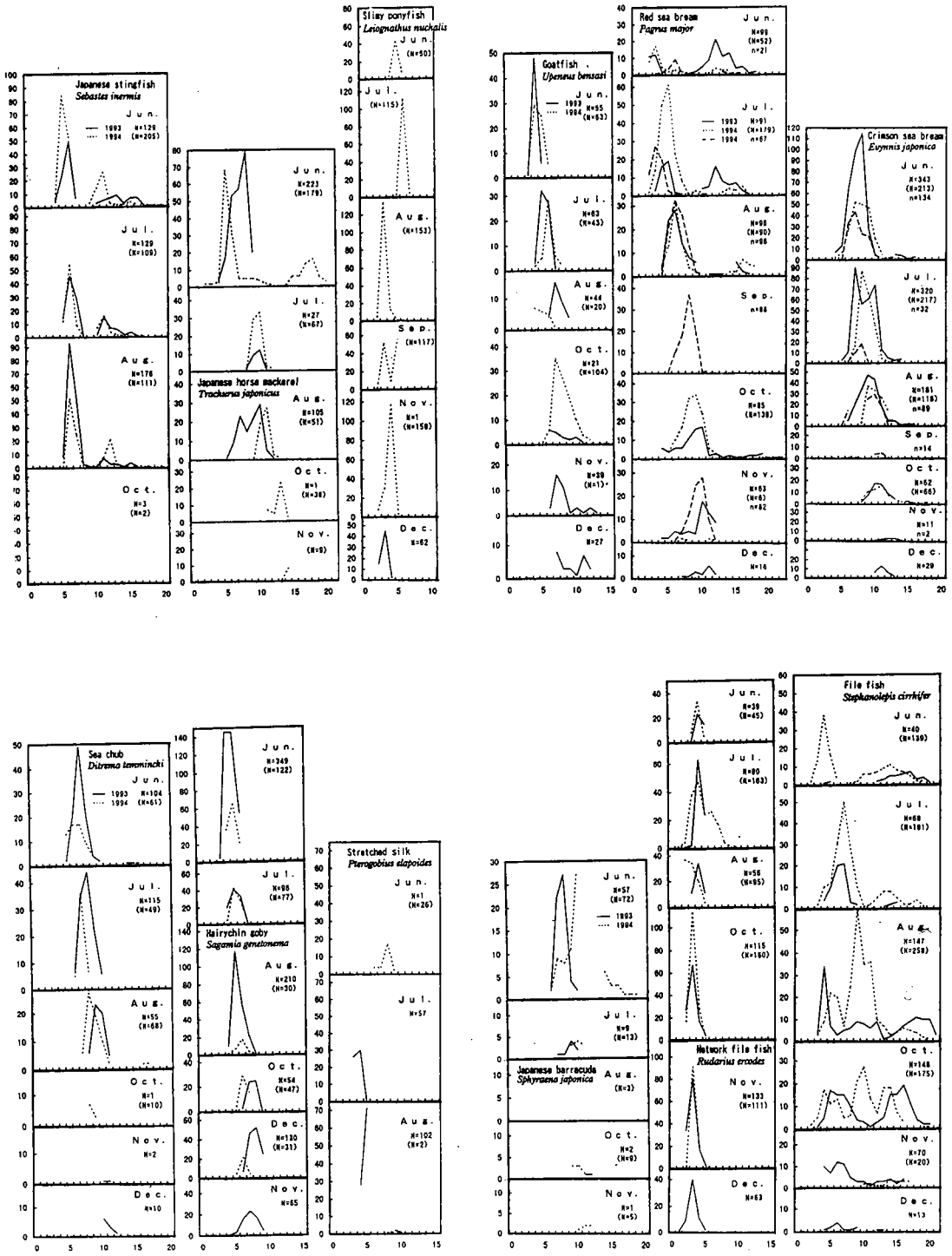

Fig.5. Monthly change in total length distribution in each species . Length: cm, frequency: individuals.
Top: from the left, japanese stingfish, japanese horse mackerel, slimy ponyfish, goatfish, rea sea bream(fork length) and crimson sea bream (fork length).
Bottom:from the left, sea chub, hairychin goby, stretched silk, japanese barracuda, network file fish and file fish.

Table4. Interspecific relation when the species on the left margin showed the largest CPUE.

Species	S.inermis	H.rubripinnis	P.percoides	T.japonicus	L.nuchalis	L.rivulatus	P.trilineatum	P.major	E.japonica	L.genivittatus	U.bensasi	D.temminckii	H.poecilopterus	H.tenuispinnis	S.genetonema	P.elapoides	S.japonica	R.ercodes	T.modestus	S.cirrhifer	
S.inermis	1,455	17	2	2	-	-	-	-	-	-	-	13	12	15	-	2	-	3	11	38	1,658
H.rubripinnis	-	94	20	-	-	-	-	13	1	-	30	2	-	-	389	-	-	117	-	2	766
P.percoides	2	35	30	17	4	-	-	57	18	22	51	10	6	-	43	-	6	425	-	118	1,043
T.japonicus	-	-	-	1,760	-	780	-	11	884	-	4	-	-	-	2,192	4	-	32	-	4	5,699
L.nuchalis	3	-	-	-	5,370	-	-	19	37	-	-	1	-	6	1	-	-	1	-	13	5,459
L.rivulatus	-	-	-	1,760	-	780	-	11	884	-	4	-	-	-	2,192	4	-	32	-	4	5,699
P.trilineatum	1	-	-	14	-	-	695	11	-	-	4	-	5	-	2	-	-	6	4	46	805
P.major	-	-	-	20	75	-	-	183	2	-	2	9	-	-	199	-	23	470	-	4	1,032
E.japonica	-	-	-	1,760	-	780	-	11	884	-	4	-	-	-	2,192	4	-	32	-	4	5,699
L.genivittatus	-	16	1	9	13	-	-	4	-	160	-	-	-	-	26	-	5	89	-	2	346
U.bensasi	-	-	-	2	-	-	-	5	47	-	67	-	-	-	24	-	4	6	-	13	184
D.temminckii	234	10	8	1,173	-	-	-	17	-	-	1	152	14	68	-	-	-	8	2	-	1,719
H.poecilopterus	78	-	-	-	5	-	-	7	1	4	-	-	38	6	4	-	-	34	19	12	314
H.tenuispinnis	234	10	8	1,173	-	-	-	17	-	-	1	152	14	68	-	-	-	8	2	-	1,719
S.genetonema	-	-	-	1,760	-	780	-	11	884	-	4	-	-	-	2,192	4	-	32	-	4	5,695
P.elapoides	161	-	5	712	-	-	-	-	6	-	-	39	5	25	-	204	-	2	36	16	1,225
S.japonica	1	-	2	-	-	-	-	1	1	-	-	-	-	1	119	-	469	2	1	2	604
R.ercodes	-	20	1	-	11	-	-	1	-	76	1	2	-	-	5	-	-	755	-	1	882
T.modestus	43	-	4	14	-	-	-	58	-	-	49	-	7	4	49	-	68	22	67	29	436
S.cirrhifer	216	-	-	106	-	-	-	10	28	-	3	79	2	-	-	1	-	69	-	318	944

species such as network file fish, black scraper and file fish and the catching ratio showed 10.8:1.0:8.0. Black scraper was fewer than the other two species, however, 3 species inhabit as co-existence in 21 of 34 stations. These results suggest that the dominant species, 20 species, in these sea areas are mostly solitary species except for red sea bream and crimson seabream, inhabiting a high degree of relatedness.

The characteristic distribution in numbers are seen in the CPUE. The largest CPUE in japanese stingfish, japanese horse mackerel, slimy ponyfish, crimson sea bream, hairychin goby, japanese barracuda and network file fish show more than 100 inds., so they seem to be inhabiting as schools in these sea areas. On the other hand, 78 species, 70.9% of the total species, show less than 10 inds. at the largest CPUE. These species are estimated to be few in abundance or inhabiting the areas as individuals.

The year class of species is estimated by monthly changes of body length,although the survey period is from June to December.

1 mode group: goatfish, crimson sea bream, sea chub, hairychin goby.

2 modes group: japanese stingfish, japanese horse mackerel, slimy ponyfish,red sea bream, stretched silk, network file fish, file fish.

Unkown group: japanese barracuda.

The 2 modes group seem to be constructed of more than 2 years classes. Of these, the large size group in japanese horse mackerel, red sea bream and filefish have disappeared by the middle of their growth stage. This shows that they have moved out of these sea areas, into deeper sea areas.

The species inhabiting the coastal zone are classified into 3 types such as species inhabiting all year as sedentary species, species inhabiting only certain stage of growth as seasonal species and others. The major 20 species above mentioned are classified as follow:

Species inhabiting all year:

japanese stingfish, tiny stinger, perch sculpin,slimy ponyfish, offshore ponyfish, goatfish, multicolorfin rainbowfish, motleystripe rainbowfish, hairychin goby, stretched silk, network file fish, black scraper,file fish.

Species inhabiting certain stage of growth:

japanese horse mackerel, three-line grunt, red sea bream, crimson sea bream, sea chub.

Other species: lancer, japanese barracuda.

Discussion

Sueyoshi *et al.*[2] surveyed juvenile fish in Tsukumi Bay during the period from May to December of 1988/89 years using the same fishing gear as us. They reported main 20 species of fish in each year, 14 of which are the same species in this study as follows: japanese stingfish, tiny

stinger, japanese horse mackerel, offshore ponyfish, three-line grunt, red sea bream, crimson sea bream, goatfish, multicolorfin rainbowfish, motleystripe rainbowfish, hairychin goby,network file fish, black scraper and file fish. Oita Prefectural Fisheries Experimental Station[4] surveyed juvenile fish inhabiting the seaweed beds(near st.Hoyochu in this study) of Shitanoe port on the northern part of Usuki Bay, during the period from June to January of 1962/63 years, and collected 49 species of fish. Of which, more than 1% in numbers of them accounted for 14 species including tiny stinger, file fish, network file fish, japanese stingfish, hairychin goby, red sea bream and stretched silk. These species are the same of the major 20 species of this study. The result showed that the collected species, in numbers, were smaller than in this study. It depended on smaller survey areas. We suppose that the result of this survey shows the coastal fish fauna on the northwestern parts of Bungo Strait during the period from Summer to Winter.

Kudo *et al.*[9] surveyed fish inhabiting tidelands and shallow sea waters on the southern parts of Beppu Bay from January to December using small beach seine and small scale trawl nettings and caught 106 species of fish. The collecting species, in numbers, were almost the same as in this study, however, the main 20 species of fish were not the same as in this study. There were only 4 of the same species such as slimy ponyfish, red sea bream, goatfish and network file fish. The survey of Beppu Bay collected mostly species of Callionymidae and Pleuronectiformes, the result suggests that the difference of the two surveys depends on characteristic sea areas and fishing gears.

The fish caught in Bungo Strait were 108 species, almost the same as the 106 species caught in Beppu Bay,[9] however, it was less than: the nearly 200 species caught in Shijiki Bay at Hirado Island,[10] the nearly 250 species of Yuya Bay faced Japan Sea [11] and the nearly 400 species of Seto Inland Sea.[12] This might depend on short survey periods.

Sea surface temperature and salinity showed 13-26℃, 31-34 psu in these sea areas, respectively, and these are almost the same in each bay.[3] It is well known that seaweed beds hold important positions as the nursery grounds of fish.[13] Koike and Nishiwaki[14] indicated that fish inhabiting *Zostera* beds are more abundant than those in sandy areas. Nakabo [10] used *Zostera* beds and *Sargassum* beds for the division of fish communities. In this study, *Zostera* grew well at st.Tamai and st.Hoyochu, *Sargassum*, *Eiseina* and *Ecklonia* grew well at st.Nishidomari and also *Eisenia* and *Ecklonia* grew well at st.Bungosuisan. And the fish in these stations were more abundant than at other stations. The seaweed beds of these sea areas were investigated 1979 [15] and it was reported that sea weed beds such as *Eiseina* and *Sargassum* grew well along the coast of Usuki, Tsukumi and Saiki bays, however, *Zostera* beds only appeared on the northern parts of Usuki Bay. Oita Pre.Fish.Exep.Stn.[4] surveyed fish fauna at *Zostera* beds in Shitanoe port (above mentioned) and reported that there are *Zostera* beds on the Ohama coast next to Shitanoe port. The result of this is shown by the major fish in Usuki Bay being more abundant than in the other two bays.

This is also shown by the index of diversity, that is, by Morishita's β index which is the reciprocal of Simpson's index of diversity, and Morishita's β index approaches one when the community is simple and parts from one in proportion to the complexity of communities.[7,16] In this study, the values of 4.666 to 5.111 that we obtained from st.Tamai and st.Hoyochu seem to be parting from one, and almost similar with 4.8 ± 1.4 to 5.4 ± 2.2, as surveyed by Kamijyo and Onoue[17] on discarded fish caught by small trawl nets in Suo-nada. This suggests that fish species in the northern part of Usuki Bay are abundant, because small trawl nets always catch many kinds of fish.

The fish in these sea areas are 52～83 species in each bay, however, the species found in 1 operation at each station were almost less than 1/4-1/5 of that. This suggests that the distribution of each species doesn't inhabit an average frequency, inhabiting different kinds of life patterns. Catch in numbers of the major 20 species was 56,910 inds., 96.2% of the total fish, they are dominant in this sea areas, although the species numbers only accounted for 18.1%, and rest of that, the other species, are few in numbers.

Species inhabiting Yuya Bay were divided into 3 types of fish by Mori,[11] such as: species inhabiting areas all year as sedentary species, species inhabiting only certain stages of growth as seasonal species, and others. Nakabo[18] divided species into inhabiting all year, and seasonal species. Moreover, the former was divided into seasonal patterns and the latter was divided into 5 types such as: feeding migration groups and growing groups and so on. Koike and Nishiwaki [14] divided into 4 types of fish groups in *Zostera* beds. Oita Pref.Fish.Exp.Stn.[4] surveyed fish fauna in *Zostera* beds and divided sedentary species and

migration species. It reported that tiny stinger, japanese stingfish, one of Fistulariidas, network file fish, pipe fish *Syngnathus schlegalei*, striped catfish *Plotosus lineatus* and gobies belonged to the former group while rabbit fish *Siganus fuscescens*, file fish, red sea bream and gizzard shad *Clupanodon punctatus* belonged to the latter. These divisions are almost same as the first and second types of this study. 13 of the 20 major species belonged to the inhabiting all year group, 70.3% in numbers. This means species inhabiting all year are dominant in these coastal areas.

On the interspecific relation, japanese horse mackerel, offshore ponyfish,crimson sea bream, hairychin goby inhabit a co-existence at the same station.However, we suppose that interspecific relations are only deep between red sea bream and crimson sea bream.

About 400 thousand artificially-raised juvenile fish of red sea bream are released into the northern parts of these sea areas, Usuki Bay and Tsukumi Bay,every year.[19] In this study, 103 released fish were recaptured with natural ones in 6.5% of the mixing ratio. Kamijyo *at el.*[20] reported that many released red sea bream resulted in a change of fish construction, producing dominant species. However,the present status of these sea areas seems not to reflect that phenomenon.

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References

1) Statistics & Information Oita Office: Statistical year book of Oita prefecture in 1996.1-117(1997).

2) Takashi Sueyoshi,Takashi Oobayashi and Hiroshige Anami: Distribution and growth of 0-age red sea bream,*Pargus major*,in Tsukumi Bay.Bull.Oita Pref. Fish.Exp.Stn.,(14),1-12(1990).

3) Katsuhiro Kudo: The distribution of juvenile and young red sea bream and crimson sea bream in the north parts of Bungo Strait.Bull.Oita.Pref.Fish.Exp.Stn.,(16),58-76(1996).

4) Oita Pref.Fish.Exp.Stn.: The report for seeding production of 1962/63. 1-53(1964).

5) Nakabo *et al.*: Fishes of Japan with pictorial keys to the species.1st ed.,Tokai University Press,Tokyo,1993,pp. 1 -1,474.

6) Ichthyological Society of Japan: Dictionary of Japanese fish names and their foreign equivalents.1st ed.,Sanseido,Tokyo,1981,pp.1-834.

7) Masaaki Morishita: The seasonal distribution of a butterfly in Kyoto and its environs,edited by Morishita and Kira,nature-ecological study.Chuoukouronsha,95-132(1967).

8) Shuichi Mori: The ecology of animal,1st ed.,Kyoto Universiy Press,Kyoto,1997,pp.245-297.

9) Katsuhiro Kudo,Kazumitsu Fukuoka and Yukihiko Mori: Ecology and community of demersal fish - Ⅰ, Reclamation sea and its adjacent waters. The survey report of the affect of the reclamation act,174-199(1981).

10) Tetsuji Nakabo: Demersal fish community in Shijiki Bay- Ⅰ, Distribution of some species and distribution of the community.Bull.Seikai Reg.Fish.Res.Lab.,(54),209-229(1980).

11) Keiichiro Mori: Seasonal fluctuation in the abundance of pelagic stage larvae of gobiid fishes in Yuya Bay, Yamaguchi prefecture, An approach to the study of fish production in semi-closed area. Rep.Fish.Res.Iinv.Sci.,(20),65-76(1977).

12) Reiichiro Hirota: Marine organisms of the Setonaikai.Mar.Sci., 4 (4),29-35(1972).

13) Gontaro Yamamoto and Takeo Ito: Ecology for hydrospheric animal Ⅰ. 3 rd ed.,Kyoritu Press,Tokyo,1977.pp.1-95.

14) Keiichi Koike and Saburo Nishiwaki: Seasonal change of fish fauna in the Zostera zone in Shimoda Bay and Nabeta Cove,the Izu Peninsula.Japan.J.Ichthyol,24(3),182-192(1977).

15) Oita prefecture: The survey report for seaweed beds along the coast of Oita pref..1-31(1979).

16) Shinsaku Kimoto and Hiroshi Takeda: A guide to Community Ecology.1st ed., Kyoritsushuppan,Tokyo,1992,pp.123-151.

17) Yoshinobu Kamijyo and Shizumasa Onoue: Change in Biological Diversity of discarded catch.Bull.Oita Pref.Shallow Sea Fish.Exp.Stn.,(10),12-19(1996).

18) Tetsuji Nakabo: Demersal fish community in Shijiki Bay- Ⅱ,Seasonal change in occurrence of major species and seasonal division of the community.Bull.Seikai Reg.Fish.Lab.,(59),47-70(1983).

19) Oita Pref.Fish.Exp.Stn.: Progress report of marine ranch program in 1993.pp.1-16(1994).

20) Yoshinobu Kamijyo,Hisafumi Kotobuki and Katsuhiro Kudo: Effects of stocking experiment of hachery-reared juvenile red sea bream(*Pagrus major*)on the fish community.Bull.Oita Pref.Fish.Exp.Stn.,(13),63-74(1988).