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Stock Identification of Chum Salmon, *Oncorhynchus keta*, based on Scale Character Analysis

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ABSTRACT

We compared scale characters of chum salmon collected in Japanese and Russian local stocks (river and coastal areas) to establish a stock identification technique and baseline data on scale characters. Scale samples were collected at seven sites in Japan in 1994 and 16 sites in Russia in 1993 and 1994. Five items of scale characters were measured using the scale character analysis system. The analysis showed that the widths and cirluli counts in the first year zone of Japanese local stocks were larger than those of Russian local stocks and that them in the second year zone of Japanese local stocks were fewer than those of Russian local stocks. The above observation suggests that there was a considerable difference in scale character between Japanese and Russian local stocks. However, the serious difference in scale characters between age 3 and 4 was also observed. To examine the relation among local stocks by age, we conducted a cluster analysis for the scale characters by age. The cluster analysis for age 3 fish shows no good geographical contiguous among local stocks in each cluster. In contrast, the cluster analysis for the age 4 fish shows good geographical affinity among local stocks in each cluster. These results demonstrated that scale characters used in this study were effective for stock identification of age 4 (mature) fish and not sufficient for of age 3 (mature) fish. This suggests that other new characters suitable to identify origins of age 3 fish is needed.

INTRODUCTION

Chum salmon is most widely distributed among salmonids in the North Pacific Ocean. The population of chum salmon in Japan has been on the increase in recent years, whereas some local stocks of chum salmon in the other countries have been at lowered level. In addition, there have been observed apparent decrease in body size and increase in maturing age. Under these circumstances, it is important to evaluate the status of each local stock migrating in the North Pacific for the rational utilization of the ocean productivity and the better fisheries management. National Research Institute of Far Seas Fisheries (NRIFSF) has been conducting the annual experimental fishing research in the North Pacific and its marginal seas to assess year class abundance of each local stock. In order to identify origins

of the fish collected in the research, an effective stock identification technique is needed. We compared scale characters of chum salmon collected in Japanese and Russian local stocks (river and coastal areas) to establish a stock identification technique and baseline data on scale characters. Each local stock is regarded as a unit of the baseline for the stock identification.

MATERIALS AND METHODS

Scale samples used in this report were taken from adult chum salmon returning to their natal rivers or coastal areas for spawning. Scale samples were collected at seven sites in Japan in 1994 and 16 sites in Russia in 1993 and 1994 (Fig. 1). Scale impressions were taken on the plastic cards from scale samples by electric heating press method, which was developed by Clutter and Whitesel (1956). The following 5 items of scale characters were measured using the scale character analysis system developed by Nitta (1997).

L1: Width of the first year zone (distance along the longest axis of the scale from the focus to the outer edge of the first annulus)

Ca: Number of circuli in the first half of the first year zone

Cb: Number of circuli in the second half of the first year zone

L2: Width of the second year zone (distance along the longest axis of the scale from the outer edge of the first annulus to that of the second annulus)

C2: Number of circuli in the second year zone

RESULTS AND CONSIDERATION

Total number of samples measured were 3308 (1437 samples from Japan and 1871 from Russia, Table 1). The following analysis was made using the measurement data of age 3 and 4 fishes, both of which were majority of total samples. When the number of fish per the age and sampling site is less than 10, we did not use the data on the group.

(1) Comparison on scale characters

Tanaka et al. (1969) investigated numbers of circuli in the first and second year zones and width of each year zone of age 4 chum salmon caught in the mouth of Skeena River, Canada and found that there were not significant difference between male and female. The comparison of scale

characters between both sexes at the same age and local stock in this study also indicated no significant difference. Therefore we combined data of both sexes and compared all local stocks in 5 items of the scale characters by age (Fig. 2). The results obtained are summarized as follows:

L1: L1 values of Japanese stocks tends to be larger than those of Russian stocks. L1 values of Kalininka R. and Khaliyula R. were noticeably larger in Russian stocks.

Ca: Ca counts in Japanese local stocks were more than those in Russian local stocks. In Japanese local stocks, Ca counts of Yuubetsu R. and Nishibetsu R. were comparatively smaller. The Ca count of Avacha R. was greater in Russian stocks. There is a fairly large dispersion of Ca counts as compared with that of L1 value.

Cb: The comparison shows the same tendency as in Ca.

L2: In contrast to the case of L1, L2 values of Japanese local stocks were smaller than those of Russian local stocks. L2 values of Kunashir Islands, Kalininka R. and Khaliyula R. were comparatively smaller in Russian local stocks.

C2: Ca counts in Japanese local stocks were fewer than those in Russian local stocks.

The above observation shows that there was a considerable difference in scale character between Japanese and Russian local stocks. Moreover, the difference in scale character between age 3 and 4 fishes was observed within the local stock. This differences were very clear in many of Japanese local stocks. Especially, average values of L2 of age 3 fish were wider than those of age 4 fish. Such difference was also reported for returning chum salmon in the northeastern Pacific (Tanaka et al., 1968; Ishida et al., 1989).

To examine the relation among local stocks by age, we conducted a cluster analysis (standardized Euclidean distance, group average method) for the scale characters by age (Fig. 3). The analysis for age 3 fish indicates that local stocks were grouped in 4 clusters as following:

Cluster3-1: Gakko R., Tsugaruishi R. and Tokachi R.

Cluster3-2: Yurappu R., Nishibetsu R., Langry R., Yuubetsu R., Chitose R., Avacha, Kunashir, Khayryuzovo R., Bolshaya R. and Kamchatsk R.

Cluster3-3: Kalininka R.

Cluster3-4: Nyyskii R., Anadyr R., Nayahan R., Khaliyula R., Amur R.,

Taui R. and Kukhtuy R.

Cluster3-1 was composed exclusively of Japanese stocks. Cluster 3-2 being mixed with Japanese and Russian stocks, and Cluster 3-3 and 3-4 being made up with Russian stocks. Cluster 3-4 included many Russian local stocks which were located in wide area of Russia. This analysis shows that locations of local stocks in these cluster are not geographically contiguous.

The cluster analysis for age 4 fish indicates that local stocks were separated firstly into 2 large clusters. The first cluster (Cluster 4-1) was composed of all Japanese local stocks and Kuhashir Island stock, and the second one (Cluster 4-2) was exclusively of Russian local stocks. Secondly, Cluster 4-1 was divided into two sub-clusters. The first sub-cluster including local stocks of Gakko and Tsugaruishi rivers (Honshu local stocks) and the stock of Chitose R (Hookaido loal stock). The second sub-cluster includes the other Japanese local stocks and Kunahir Islands stock. Cluster4-2 was also broken down into two sub-cluster. The first sub-cluster mainly composed of the stocks in the Okhotsk Sea coasts and the second cluster includes the stocks in the Bering Sea coasts. Thus, in contrast to the case of 3 age fish, the analysis on the age 4 fish shows good geographical affinity among local stocks in the cluster and sub-cluster.

(2) Consideration on a baseline for stock identification

The main purpose of this study is to establish a baseline to identify origins of chum salmon caught in offshore waters. The results of this study demonstrated that scale characters used in this study were effective for age 4 fish and not sufficient for age 3 fish. This suggests that other new characters to identify origins of age 3 fish is needed.

In the future study, it is scheduled to obtain baselines including local stocks of North American origins for scale character stock identification of chum salmon in overall areas of the North Pacific.

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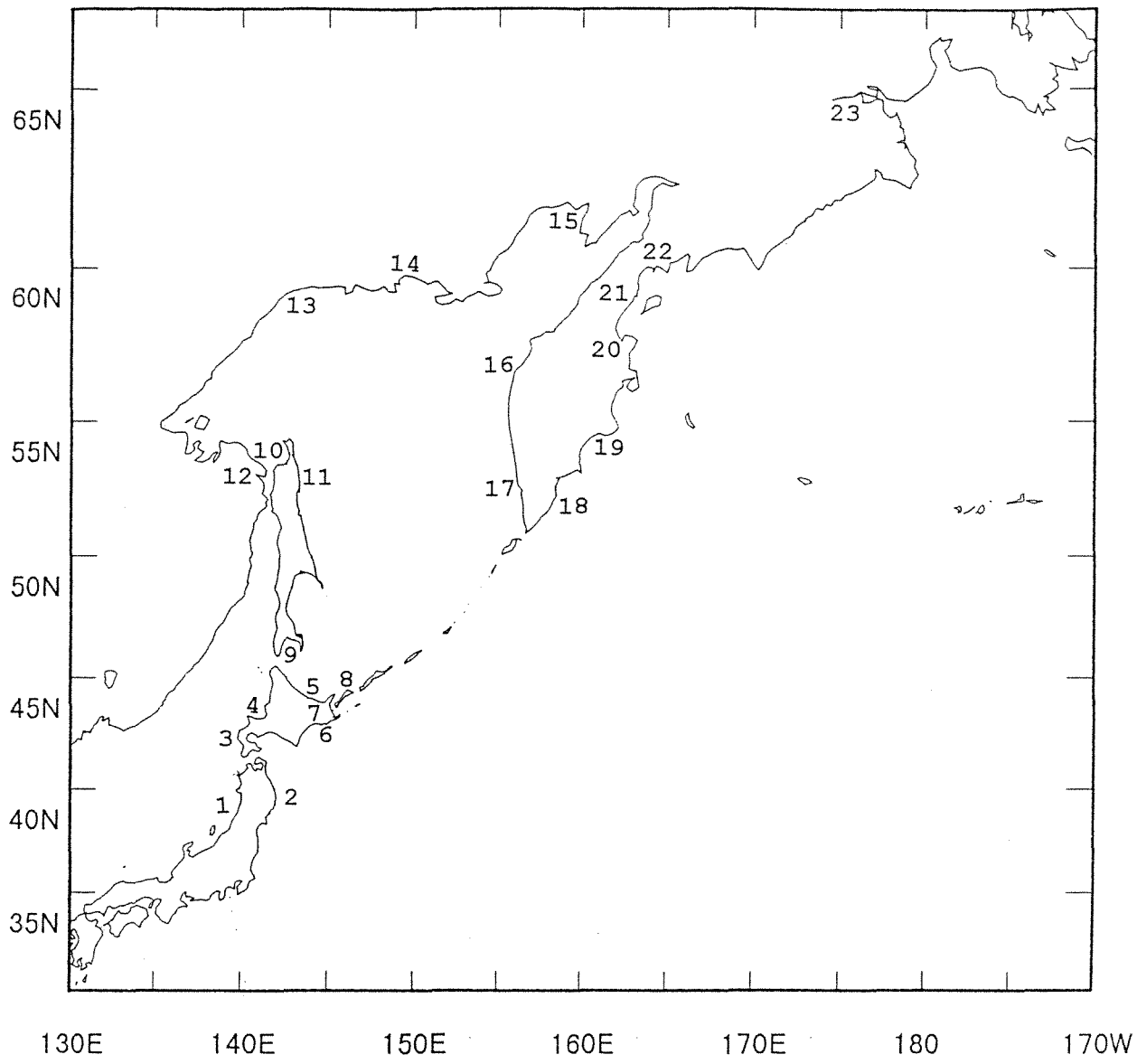
Table 1. List of local stocks and sample size by age and sex.

Local stocks	Sampling year	Sex	Age					
			2	3	4	5	6	Total
Gakko River	1994	♀	3	109	32	2	0	146
		♂	8	79	26	8	0	121
Tsugaruishi River	1994	♀	0	51	45	4	0	100
		♂	2	63	32	2	0	100
Yurappu River	1994	♀	0	60	77	0	0	137
		♂	0	51	37	1	0	89
Chitose River	1994	♀	4	37	44	1	0	86
		♂	1	32	59	1	0	93
Yuubetsu River	1994	♀	3	66	25	0	0	94
		♂	6	75	9	2	0	92
Tokachi River	1994	♀	0	25	57	2	0	84
		♂	0	39	44	4	0	87
Nishibetsu River	1994	♀	0	61	53	1	0	115
		♂	2	63	28	1	0	94
Kunashir	1994	♀	0	11	3	0	0	14
		♂	1	39	14	0	0	54
Kalininka River	1994	♀	1	23	14	28	0	66
		♂	0	21	16	4	1	42
Langry River	1994	♀	0	2	3	0	0	5
		♂	0	18	7	0	0	25
Nyyskii River	1994	♀	1	31	24	6	0	62
		♂	0	40	22	8	0	70
Amur River	1993	♀	0	46	41	0	0	87
		♂	0	48	38	1	0	87
Kukhtuy River	1994	♀	0	33	15	0	0	48
		♂	0	33	16	1	0	50
Taui River	1993	♀	1	30	87	4	0	122
		♂	4	25	114	4	0	147
Nayahan River	1993	♀	1	65	74	2	0	142
		♂	11	53	61	4	0	129
Khayryuzovo River	1994	♀	0	32	53	0	0	85
		♂	0	9	33	2	0	44
Bolshaya River	1993	♀	1	12	11	0	0	24
		♂	0	18	11	0	0	29
Avacha	1994	♀	0	12	20	4	0	36
		♂	0	7	32	12	0	51
Kamchatsk River	1994	♀	0	7	23	0	0	30
		♂	0	25	81	7	0	113
Khaliyula River	1993	♀	0	42	1	0	0	43
		♂	0	6	0	0	0	6
Karaga	1994	♀	0	2	30	0	0	32
		♂	0	1	54	2	0	57
Kichiga	1994	♀	0	3	20	1	0	24
		♂	0	3	46	0	0	49
Anadyr River	1994	♀	0	26	31	3	0	60
		♂	0	19	19	0	0	38



Japan

1. Gakko River
2. Tsugaruishi River
3. Yurappu River
4. Chitose River
5. Yuubetsu River
6. Tokachi River
7. Nishibetsu River

Russia

8. Kunashir
9. Kalininka River
10. Langry River
11. Nyyskii River
12. Amur River
13. Kukhtuy River
14. Taui River
15. Nayahan River
16. Khayryuzovo River
17. Bolshaya River
18. Avacha
19. Kamchatsk River
20. Khaliyula River
21. Karaga
22. Kichiga
23. Anadyr River

Fig. 1. Locations of sampling sites of local stocks for scale charcter pattern analysis.

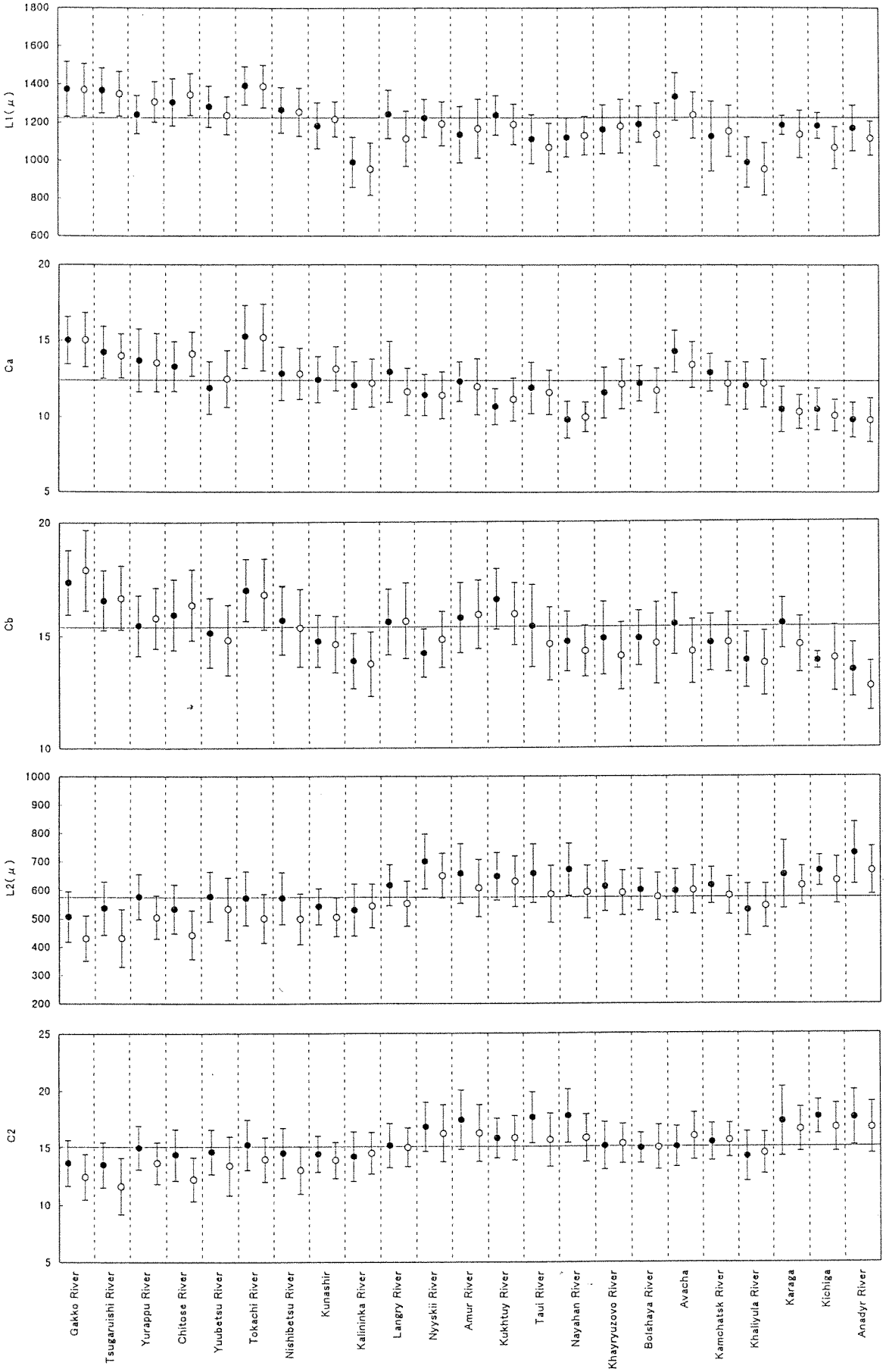


Fig. 2. Mean values and standard deviations of scale characters of local stocks. Solid circles indicate the average of age 3 fish and open circles indicate the average of age 4 fish.

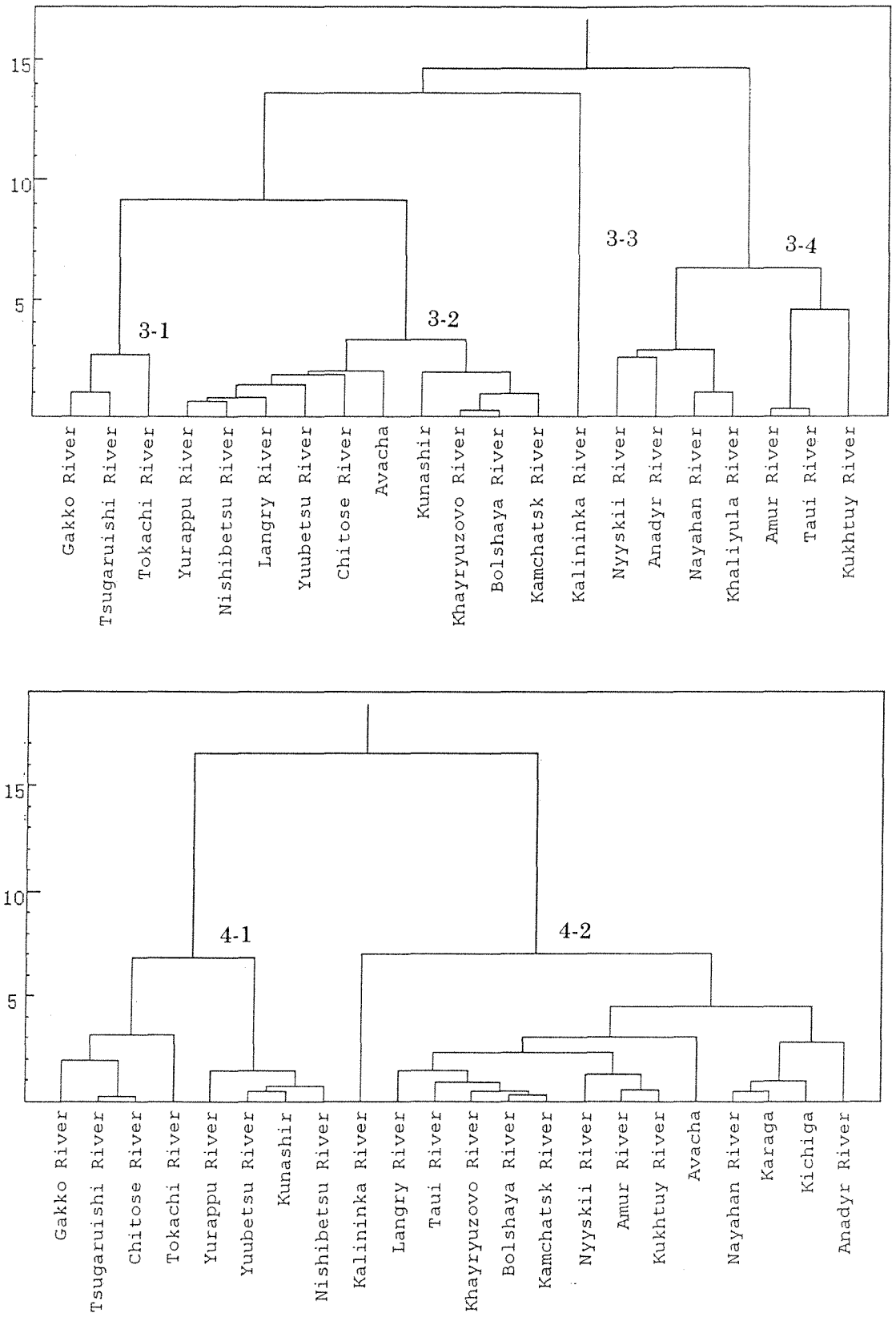


Fig. 3 Dendrogram drawn from the cluster analysis for scale characters of age 3 fish (top) and age 4 fish (bottom).