Studies on the Biology in the Early Stages of Two Types of Chars in Hokkaido

By
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北海道に産する二型のイワナ属魚類の稚魚期の生活史に関する研究

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Abstract

Comparative investigations on the growth and feeding habits of two types of chars in Hokkaido, "amemasu"(white spotted type) and "oshorokoma" (red spotted type), were carried out in the Ichan'ni River, eastern Hokkaido, in which both types co-exist.

The postembryonic developments of the two types of chars resemble in various points each other, but the emergence of the fry of the red spotted type from the redds, which are in the uppermost reaches of the river, occurred later than that of the white spotted type, which emerged from the redds in the middle to upper reaches. The fry of the former species are usually smaller than the latter throughout the first year.

The developmental process of the fry of the two types of chars were divided into six phases by the appearance and disappearance of several morphological characters. Some differences in morphological characters were observed between the two types and these differences of characters were noticeable at the beginning of these phases.

Although the habitats and foods of the fry of the two types of chars were widely overlapped, the morphological and ecological differences observed in this investigation suggested that they belong to two distinct species. Further investigations, especially on the reproductive isolation between them in the river where they co-exist, are considered necessary for complete clarification of their systematic relation.

Key words: Char, White spotted type, Red spotted type, Morphology, Ecology.

Introduction

It has been known that two different types of chars, "oshorokoma" and "amemasu", occur in Hokkaido. They are rather easily distinguished from each other by the colour and size of the spots irregularly distributed on their body sides, i. e., the former

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has smaller red and white spots, while the latter has larger, only white spots. The exact classification of them, however, has been disputed among ichthyologists because they resemble each other in morphology except the differences of colour and size of the spots. For example, TANAKA (1937) asserted that they should be included in a single species, *Salvelinus malma* (WALBUAM), while OSHIMA (1938a-d, 1961) and AOYAGI (1957) regarded them as distinct species, *S. malma* (oshorokoma) and *S. leucomaenis* PALLAS (amemasu), ISHIDA (1942a-b), on the other hand, described them as two subspecies, *S. malma malma* and *S. m. leucomaenis*. These authors based their conclusions on morphological points of view, and not on ecological aspects.

The author has studied the taxonomical and ecological relationships between these two types of chars in Hokkaido. According to the results of his investigation, these two types are distributed in different areas in Hokkaido, geographic ranges showing a wide overlap. Oshorokoma (red spotted type) is restricted to the mountain rivers in the central to northern part of Hokkaido except in some small areas in Oshima Peninsula, while amemasu (white spotted type) occurs in the mountain rivers in central to southwestern Hokkaido, and, in northeastern Hokkaido, they live in lowland rivers.

In the Konsen Moorland, located in northeastern Hokkaido, the white spotted type is a common resident in the southern rivers, which run through open fields or swamps, but the red spotted type has not been found in these rivers. On the contrary, the mountain streams in the northern areas of the same district abound with the red spotted type, and no white spotted type has been observed. As far as the author knows, both types coexist in only two rivers in this district, the Ichan'ni and Shibetsu rivers, which run through the intermediate area between the above-mentioned northern and southern areas. And in these cases, the two types are characterized by clear differences in the colour and size of their spots and no neutral individuals have been observed.

The present paper deals with the results of comparative observations of the early stages of development of these two types in the Ichan'ni River, one of the rivers in which both types coexist, as a first work to clarify the taxonomical and ecological relationships between them.

Topography of the Ichan'ni River

The Ichan'ni River (Fig. 1) is a small, shallow stream of about 8 km long. It rises from a small bog, situated 40 m above sea level, in Nemuroshibetsu Town, and flows west into the Sea of Okhotsk. It has four tributaries, one of which is the Mimi River, as shown in Fig. 1. The greater portion of the drainage area of the Ichan'ni River is covered with deciduous broad leaved trees, and the remaining smaller portion is a grassland, the sewage pollution of the river being completely negligible.

In the three tributary rivers and in the upper and middle reaches of the main river, there are stretches of riffles which alternate with pools. The substrate of the riffles is composed of coarse sand, coarse gravel and stones of various sizes, while that of the pools is composed of sand and pebbles. In the upper reaches, the stream sometimes flows near the small bogs, where their bottoms become muddy. The lower reaches of the main river are deeper and the current speed is not as great as that in the upper or middle reaches, the

riffles appearing only rarely and their beds consisting mostly of sand.

The banks of both the main and tributary rivers are covered with grass and there are no beaches. The sole submerginal plant species occurring abundantly in this river is *Ranunculus aquatilis* which grows in the riffles of the upper and middle reaches of this river, possibly making the composition of their bed stable.

The reaches sampled are the main river and the Mimi River, one of the tributaries. Each river was divided into several sections (Fig. 1), of which the average width, depth, current speed, water temperature and pH value are shown in Table 1.

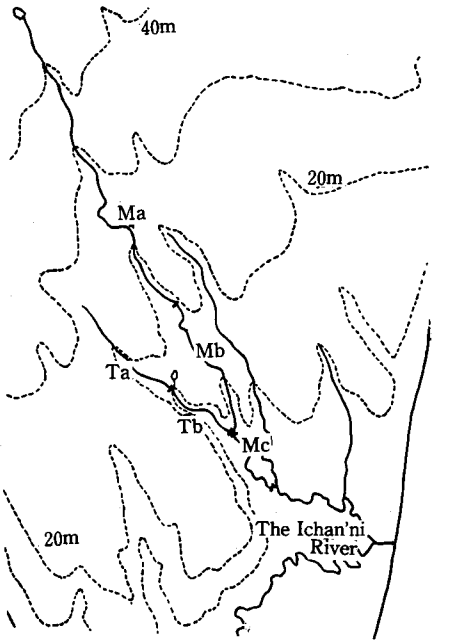

Fig. 1. The course of the Ichan'ni River.

Materials and Methods

The main observations in the field and the samplings were made during the period from 1964 to 1965, once every month from April of

Table 1. Environmental data at five sections of Ichan'ni River and its tributary (Mimi River)

Rivers	Ichan'ni River (main stream)			The Mimi River (tributary)	
Sections	Ma	Mb	Mc	Ta	Tb
pH	7.2	7.0—7.2	6.7—7.3	6.8—7.0	7.0
Current speed in riffles (m/sec)	0.40—0.50	0.40—0.53	0.62—0.86	0.28—0.40	0.38—0.53
Width (m)	2.50	3.00	5.00	1.50	2.50
Depth (m) in riffles	0.20	0.30	0.20	0.05	0.15
Depth (m) in pools	0.40	0.50	0.70	0.30	0.50
Water temperature (℃)					
January	4.0	4.0	3.5	5.0	4.0
February	4.0	3.5	3.5	4.5	4.0
March	—	3.5	3.5	4.5	4.5
April	—	8.0	7.5	6.5	7.5
May	9.0	10.5	8.5	—	8.5
June	8.0	8.5	8.5	7.5	8.0
July	—	10.0	12.0	8.5	8.5
August	11.5	12.5	13.0	10.0	11.0
September	10.0	11.0	10.0	10.0	11.0
October	9.0	9.0	7.0	9.0	9.0
November	6.5	5.5	5.0	7.0	7.0
December	5.0	4.0	3.5	5.0	4.5

1964 to April of 1965, and every second month from June to December of 1965. Some supplemental surveys were continued until 1979.

Polarizing glasses or water glasses were used for the observation of the behaviour of the fry under water. The fry were caught by a hand net and classified into two types. Although the red as well as white spots characterizing them were completely absent at the early stages of development, the fry were distinguished by the shapes of their parr marks; the fry of the white spotted type has uniformly elliptic parr marks arranged regularly along the lateral lines, while those of the red spotted type are varied in shape and size, and arranged irregularly on the body sides (Fig. 2). The sample fry were preserved immediately after capture in 10% formaline. The preserved specimens were weighed with balance sensitive to 0.1 g and their fork length, head length, body depth and body width were measured with an accuracy of 1 mm.

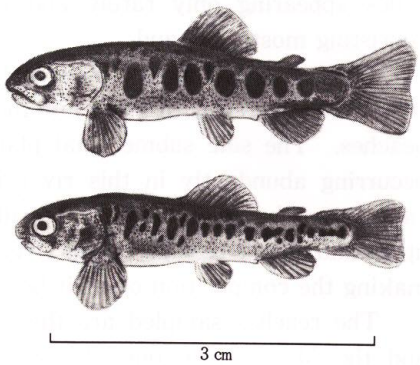

Fig. 2. The char fry of the two types: white spotted type (above) and red spotted type (below).

The stomach contents of the fry were examined under a binocular microscope to identify, as far as possible, the species of the organisms ingested. Analysis of the results was made according to the usual number method and the point method modified by HYNES (1950).

After August, the ranges of fork length of fry and yearlings began to overlap, but fishes were easily classifiable into fry and yearling by observing the circuli of their scales.

The Fauna of the Ichan'ni River

The benthos fauna of the middle and upper reaches of the Ichan'ni River consisted mostly of ephemeropteran nymphs, tricopteran and dipteran larvae, and *Anisogammarus* sp.. Plecopteran nymphs were not so abundantly found as were the above.

The ephemeropteran nymphs included those of *Epeorus latifolium, E. napaeus, E. cinygma, Baetis thermicus, Ameletus montanus, Paraleptophlebia* sp. PA, *Ephemerella trispina,* E. *yoshinoensis, E.* sp. EC, and *E*. sp. nF. Among these, *Baetis thermicus, Epeorus latifoluim* and *Ephemerella yoshinoensis* were prevalent. The nymphs of *Epeorus cinygma* appeared in large numbers only in August and those of *Paraleptophlebia* only in June.

Tricopteran larvae included *Rhyacophila brevicephala, R. stricurata, Stenopsyche griseipennis, Goera* sp. and *Antocha* sp.. The chironomid larvae were very abundant all through the year in this river, but *Simurium* larvae were numerous only in June and August.

Antocha larvae were common to most parts of the Ichan'ni River all the year round.

In addition to these benthos animals, considerable numbers of terrestrial and aerial organisms must have fallen into the water in the summer time, as they were invariably recovered from the stomach contents of the salmonid fishes in this season. The organisms

consisted of adult aquatic insects, terrestrial coleopterans, ants, lumbricid earthworms, spiders, etc.

Besides the chars, 12 species of fishes were collected or observed in this river; their distribution is shown in Fig. 3.

Among these species, the land-locked salmonids, red spotted and white spotted types of chars, and *Oncorhynchus masou* were dominant in most parts of the Ichan'ni River. The northern eightspined stickleback, *Pungitius tymensis,* was also numerous in the middle and upper reaches of the river, especially in the reaches near the bogs. The chinese eightspined stickleback, *P. sinensis,* and the threespined stickleback, *Gasterosteus aculeatus,* were also found but in a very limited area near the estuary.

Every year from May to late June, large numbers of the Japanese brook lamprey, *Entosphenus reissneri,* were observed spawning in the middle reaches of the river, but after spawning they all disappeared. The cloudy-spot loach, *Barbatula toni,* the northern sculpin, *Cottus pollux,* and the floating goby, *Chaenogobius urotaenia,* were also found, but rarely.

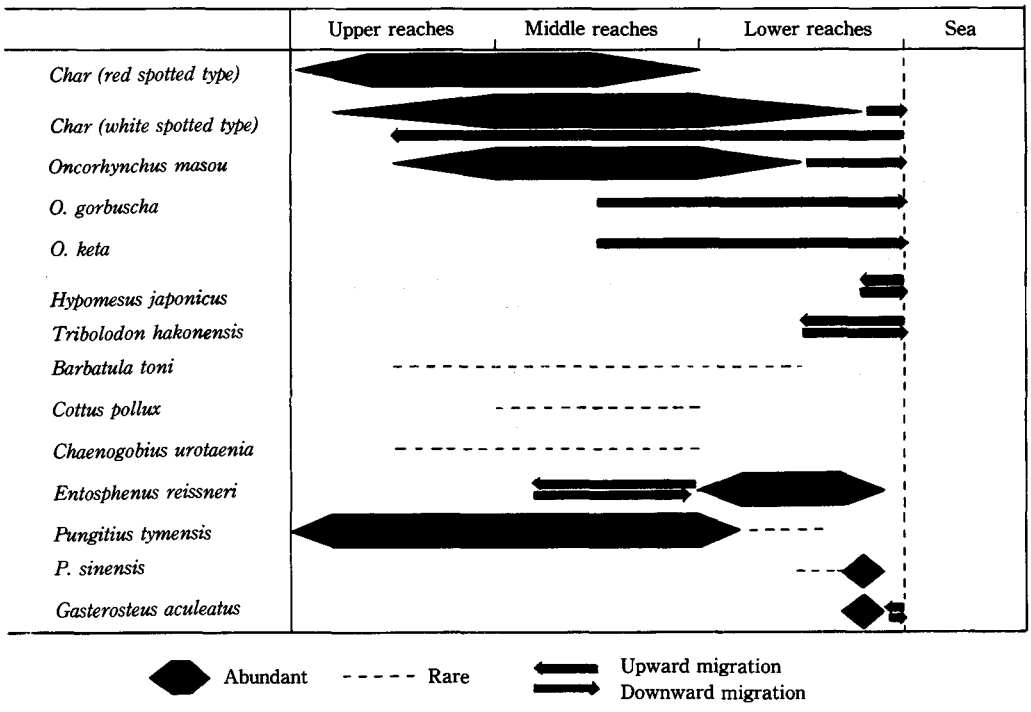

Fig. 3. Distribution of fishes in the Ichan'ni River.

Results of Observations

1. Growth and Postembryonic Development

Growth of the fry under field conditions was estimated by measuring the fork lengths of sample fish caught monthly in the Ichan'ni River during the period from April 1964 to December 1965.

Postembryonic development was observed by examining the changes in their body form (v. i.), the reductions of their yolk sack and fin hold, and the developmen t of their gill rakers, pyloric caeca, scales, fins, parr marks and spots.

a) *Growth in fork length*

The monthly mean fork length and its standard deviation in the fry of the two types of chars are given in Fig. 4.

The alevins of the white spotted type hatched in the redds which are found in the middle to upper reaches of the Ichan'ni River, one after another during January, when their fork length was about 17 mm. They appeared to leave the redds at various times from the middle of February to early March. Under these circumstances, the growth of the fry proceeded gradually during March and April, and accelerated during the period from May to August, and slowed down abruptly thereafter.

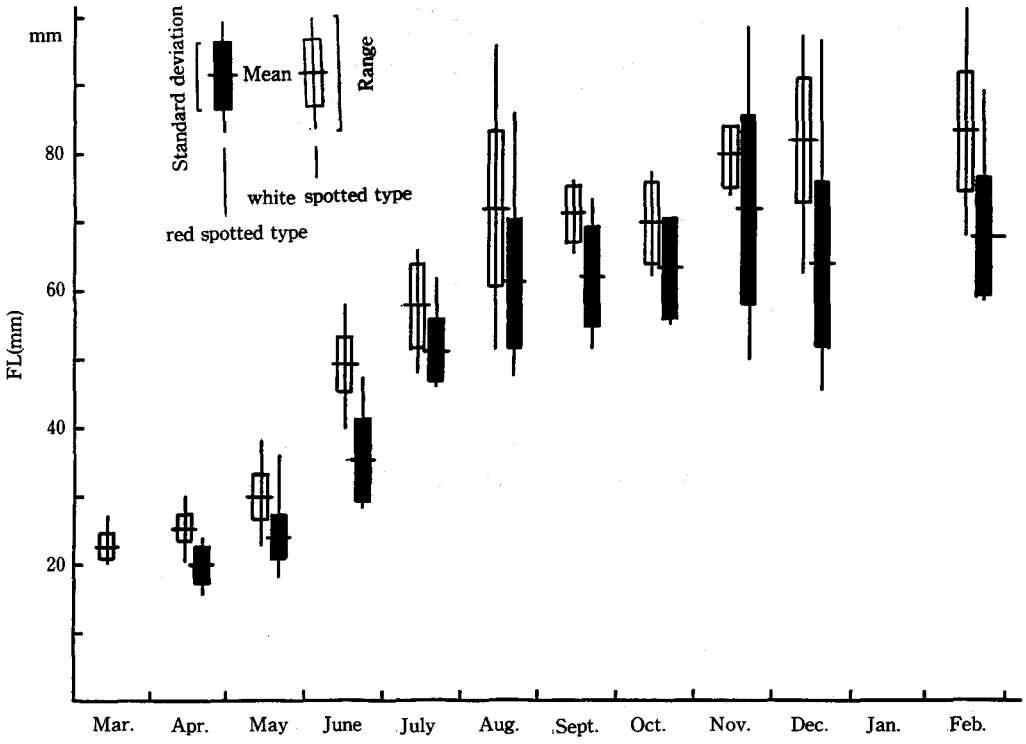

Fig. 4. Fork length (FL) of fry of the two types of chars captured monthly in the Ichan'ni River.

The alevins of the red spotted type of char, on the other hand, hatched in February or March, probably leaving their redds, which are restricted to the small area of the uppermost reaches, in late March or early April. At the time of hatching, they were smaller than those of the white spotted type, being about 14 mm in their fork length. The growth of the fry proceeded rather slowly before May but it accelerated during the period from June to August. As a result, the fry of the red spotted type were always smaller in their mean fork length than those of the white spotted type.

b) *Change in body form*

This change was observed by examining three kinds of ratios between two of the four measurements, i.e., fork length (FL), head length (HL), body depth (BD) and the body width (BW).

The relation between the FL/BD ratio and the actual FL in the fry of the two types is shown in Fig. 5. At the earliest stage of growth, the fry of the white spotted type showed a high FL/BD ratio but it decreased very rapidly while their FL was under 45 mm, after which it hardly decreased. On the other hand, the same of the red spotted type decreased while their FL is under 40 mm, after which it remained almost unchanged. During the time when their FL was over 40 mm, it remained slightly larger than that of the white spotted type.

The relation between the BW/BD ratio and the FL in the fry of the two types is shown in Fig. 6. The BW/BD ratio of the white spotted type appeared to be more or less smaller

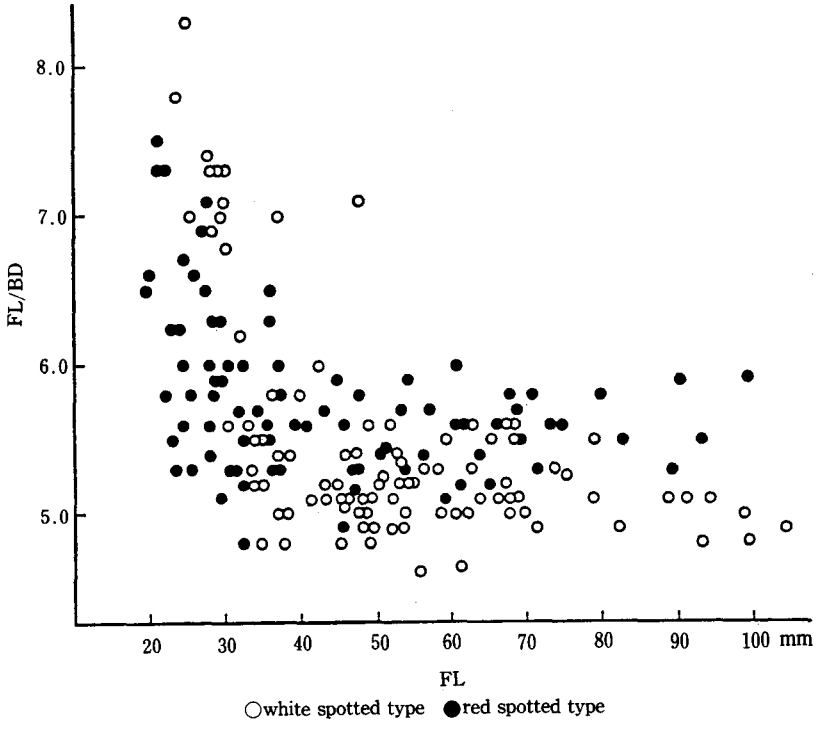

Fig. 5. Relations between FL(fork length)/BD (body depth) ratio and FL of fry of the two types of chars.

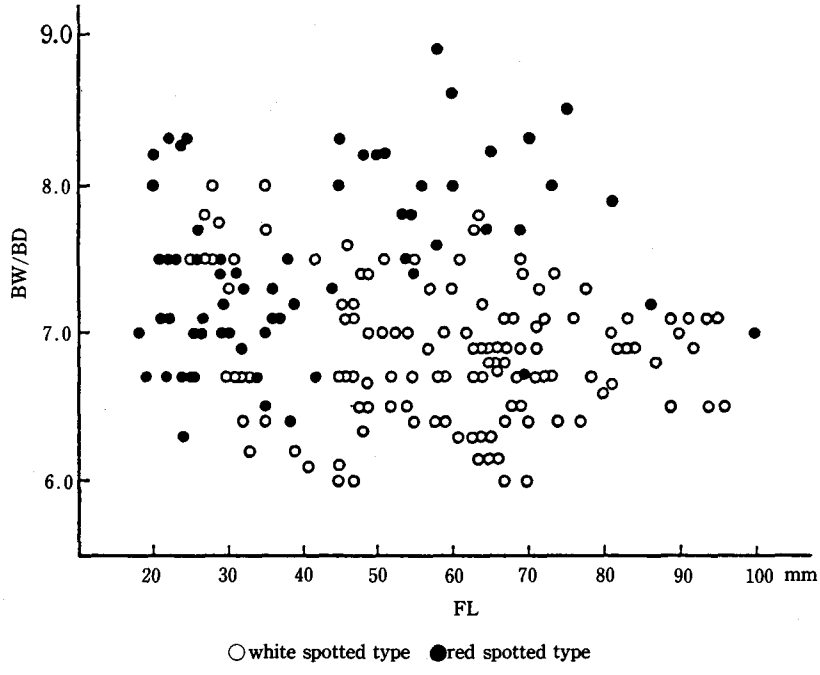

Fig. 6. Relations between BW(body width)/BD ratio and FL of fry of two types of chars.

than that of the red spotted type, especially when their fork lengths were over 45 mm.

The relation between the FL/HL ratio and the actual FL in the fry of the two types is shown in Fig. 7. At the earliest stage, while FL was less than 35 mm, growth of HL surpassed that of FL in the white spotted type and their FL/HL ratio decreased very rapidly. On the other hand, the FL/HL ratio of the red spotted type decreased while their FL was less than 25 mm. After which, however, the FL/HL ratio of both types increased slightly.

c) *Gill rakers and pyloric caeca*

At the time of hatching each alevin of the two types has no gill rakers on his gill arches. The first gill raker formed on the lower part of the gill arch in the time just after his emergence from the redd and then increased in number and spread on the upper part of gill arch with the growth of the body. The relations between the numbers of gill rakers and FL of the two types are shown in Fig. 8. The number of gill rakers increases rapidly when the FL is under 80 mm in white spotted type and 50 mm in the red spotted type, and it remains unchanged thereafter and the mean value of the red spotted type (20.2) is slightly larger than that of the white spotted type (19.2), and this difference is significant (t-test, $P<0.05$).

Fig. 9 shows the relations between the numbers of pyloric caeca and the FL of the two types. Pyloric caeca of both types also formed after emergence from the redd and increased in number with the growth of the body, but reached the bounds earlier than those of the gill rakers. There is no significant difference between the numbers of pyloric caeca

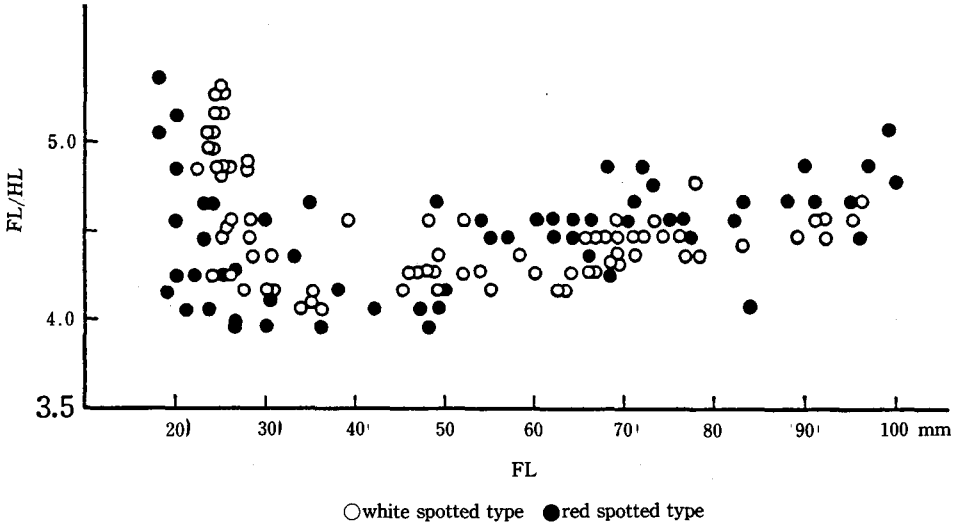

Fig. 7. Relations between FL/HL(head length) ratio and FL of fry of two types of chars.

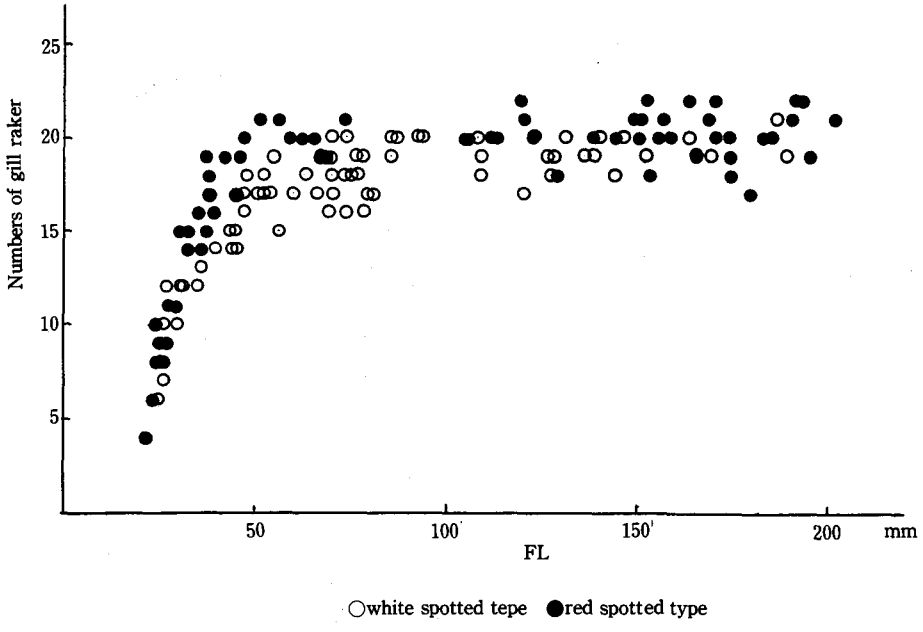

Fig. 8. Relations between the numbers of gill raker and FL of fry of two types of chars.

of the two types.

d) *Scales and fins*

At the time of hatching each alevin of the white spotted type or of the red spotted type had a heavy yolk sack but no scales. Their fins were not yet formed and only their rudiments were observed in the fin hold. The content of the yolk sack appeared to be

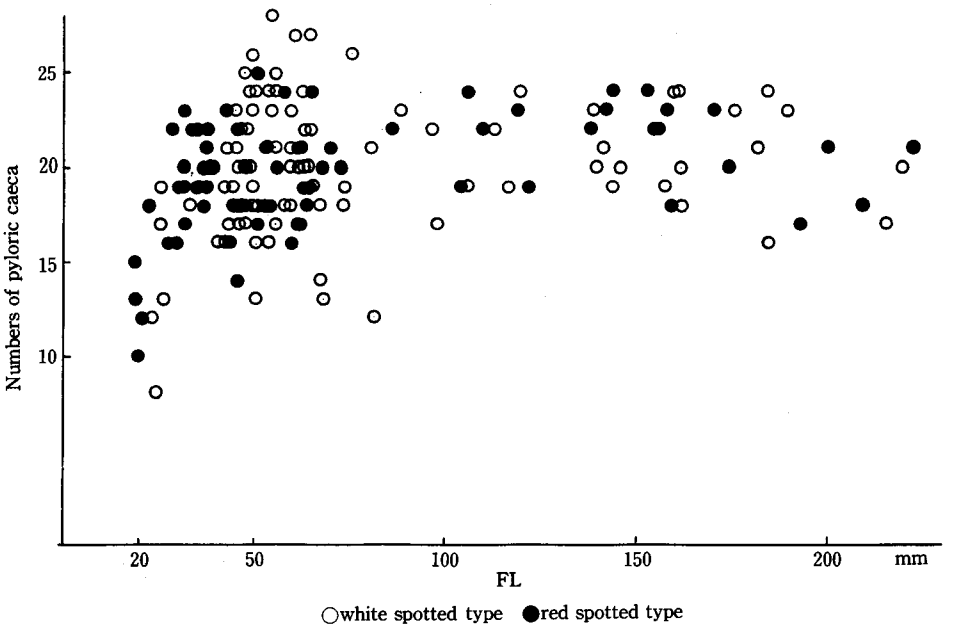

Fig. 9. Relations between the numbers of pyloric caeca and FL of fry of two types of chars.

completely absorbed in about 60 days after hatching and the larvae of the white spotted type were found early March and those of the red spotted type in early April in the Ichan' ni River. By this time, their fins were clearly formed, each has a definite number of rays, the fin hold having disappeared, except between the caudal and the adipose fins. The posterior edge of the caudal fin was round at first, but it became truncated by April (in the white spotted type) or in May (in the red spotted type), and little by little emarginated in June, after which it was observed in both types.

The development of the scales began first along the lateral lines of the caudal peduncle and spread gradually toward the head. In May of 1964, none of the fry of each type had scales, whereas in June of the same year, 67% of fry of the white spotted type (with FL from 45 to 58 mm) and 34% of the red spotted type (with FL from 30 to 48 mm) had scales at least on their peduncles. In August all the sample fry of the two types had scales covering their body sides. The monthly mean of circuli of the scales in both types of fry in 1964 and its standard deviation are given in Fig. 10. The number of circuli increased with the growth of the body before October, but this increase slowed down thereafter. No appreciable increase in the number of circuli was observed from December to February but the first winter band was supposed to have been formed during this period. The scales of the white spotted type were apparently larger than those of the red spotted type in size as well as in the number of circuli.

e) *Parr marks and spots*

The alevins of each type at the time of their hatching possessed numerous melanophores on the surface of their body. By the time their yolk sack was completely absorbed, the well-known oval parr marks had appeared on their body sides. The parr marks of the red spotted type were varied in size and scattered more or less irregularly above and below the

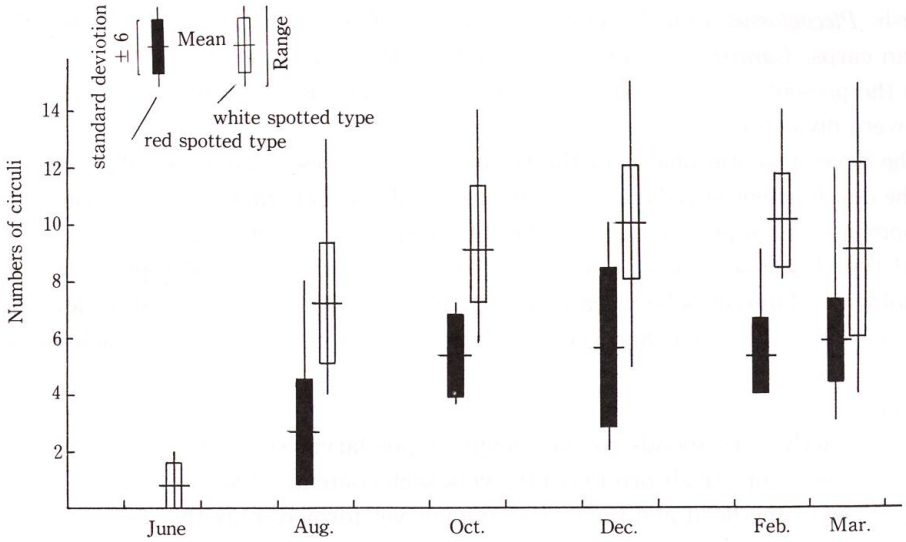

Fig. 10. Development of scales.

lateral lines, while those of the white spotted type were fairly uniform in size and rather regularly arranged along lateral lines as shown in Fig. 2. These differences in the size and arrangement of parr marks are clear identification marks to distinguish the fry of the two types.

In both types, a whitish oval ring appeared first in June or July around each parr mark of the fry. As the fry grew, this ring gradually divided into several whitish, more or less scalene or trapezoidal pieces of the spots (Fig. 11). The spots gradually became rounded in shape as the fry continued to grow into yearlings and at the same time, they scattered over both sides of the body. Some of the spots of the red spotted type showed colouration in autumn, i. e., they changed from yellow and finally to red. But the spots of the white spotted type did not show this colour change.

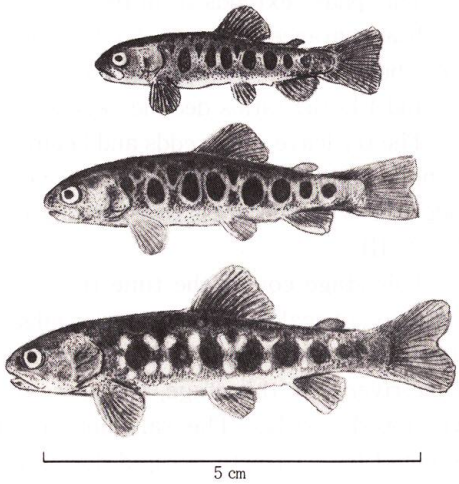

Fig. 11. Development of the spots (white spotted type).

f) *Postembryonic developmental phase*

It has been proposed to divide the period of postembryonic development of fish into several phases by VASNETZOV (1946), UCHIDA *et al.* (1958), etc. VASNETZOV (1946) stated that in each phase growth and development take place but no new qualitative changes appear, the synchronic qualitative changes occurring usually at the end of each phase.

AZUMA (1964) divided the postembryonic developmental process of the land-locked

Ayu-fish, *Plecoglossus altivelis,* into five phases, while TOMODA (1965) divided that of crussian carps, *Carassius burgeri* and *S. cuvieri,* into eleven phases.

In the present investigation the developmental periods of the fry of the two types of chars were divided into six phases as shown in Fig. 12.

The developmental phases of the fry of the two types of chars are illustrated along with the development or reduction of some morphological characters. The postembryonic development was approximately similar between the two types, the phases of the red spotted type being seasonally later than those of the white spotted type. Some of the morphological differences between them, as described above, were noted as development proceeded. Morphological and ecological characteristics of the fry in each phase are summarized as follows:

Phase I

This exactly corresponds to the alevin or pre-larval stage, i. e., from the time of hatching to the complete absorption of the yolk sack content. The eye balls are prominent on both sides of the head and their fins have not yet formed, only the rudiments of them being perceptible in the fin hold.

Phose II

This phase extends from the time of complete absorption of the yolk sack to that of the disappearance of the fin hold. The fin rays and parr marks are already fully developed, but the posterior edge of the caudal fin is still rounded. During this stage, the FL/HL and FL/BD ratios decline very drastically.

The fry leave their redds and begin to eat small aquatic animals. They generally stay in shallow places (5 to 10 cm deep), not very far from the redds, often hiding themselves under the withered grass overhanging the banks of the river.

Phase III

This stage covers the time from the disappearance of the fin hold to the complete formation of scales. The posterior edge of the caudal fin has become truncated. The fry can swim rather freely and their dispersion takes place, especially in a downward direction in the river. At this stage, the areas of distribution of the fry of the two types become overlapped widely. The salveline fry are markedly benthic as compared with other salmonid fry. Growth is rapid during this stage.

Phase IV

This covers the time from the full development of scales to the disappearance of the parr marks. The posterior edge of the caudal fin has been emarginated. Some morphological differences between the fry of the two types of chars are found, i. e., the FL/BD as well as BW/BD ratios of the white spotted type are smaller than those of the red spotted type. Both types inhabit the shallows (10 to 20 cm deep) of the upper and middle reaches of the river (their adults also live together in the midstream, except during their breeding seasons, but habitat segregation according to the depth of water is found between the fry and the adults). Territorial behaviour of fry is often observed at this stage.

Phase V

This phase covers the time from the formation of white spots to their dispersion on the body sides. The fry of both types migrate gradually to the upper reaches, and all fry

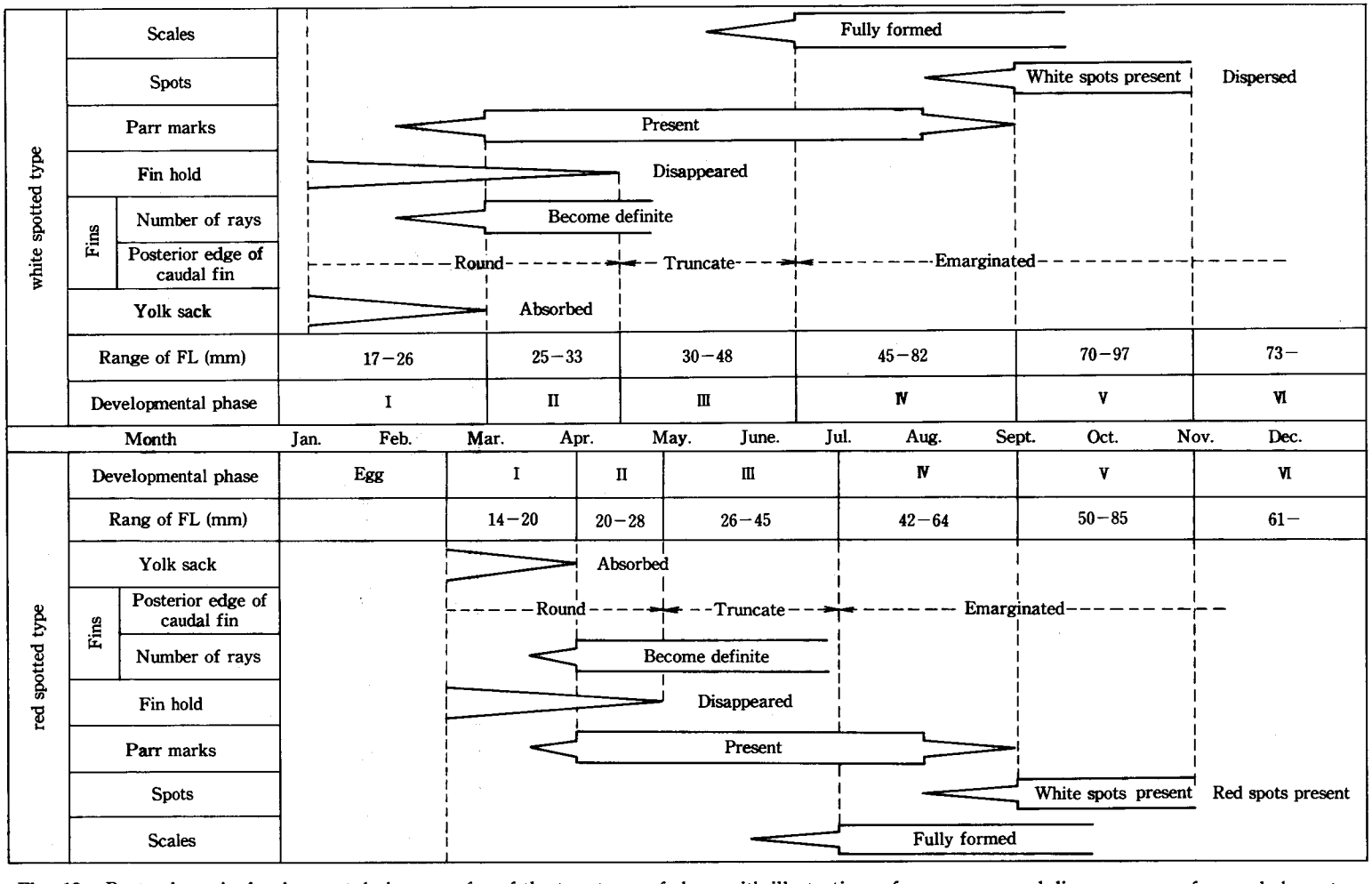

Fig. 12. Postembryonic developmental phases or fry of the two types of chars with illustrations of appearance and disappearance of several characters in the Ichan'ni River.

disappear from the midstreams by the end of October.

Phase VI

The white spots of the fry in this stage are completely scattered over the body sides, while the parr marks have almost completely disappeared. In the red spotted type, some of the spots change their colour, primarily becoming yellow and then red at this stage. The body form of the fry of each type is already similar to that of the adults. The fry aggregate to the uppermost reaches of the river for hibernation.

2. Feeding habits

In the present investigation the stomach contents of the fry were analysed according to the usual number method and the modified point method recommended by Hynes (1950). The former was employed to clarify the relations between food and growth and the latter to compare the diets of the fry collected in different months or places.

a) *Seasonal changes of food*

The stomach contents of the fry of the two types of chars were examined every other month during 1964 to 1965. The percentage compositions of the diets of the fry are given in Fig. 13. As the months of examination nearly coincided with the developmental phases of the fry as described above (Fig. 12), Fig. 13 shows approximately the food composition of the fry in every developmental phase. Details of food composition will be explained below.

February (Phase I)

In this month, the alevins of the white spotted type possessed a yolk sack and they remained in the redd, while most of the alevins of the red spotted type were not hatched yet.

April (Phase II)

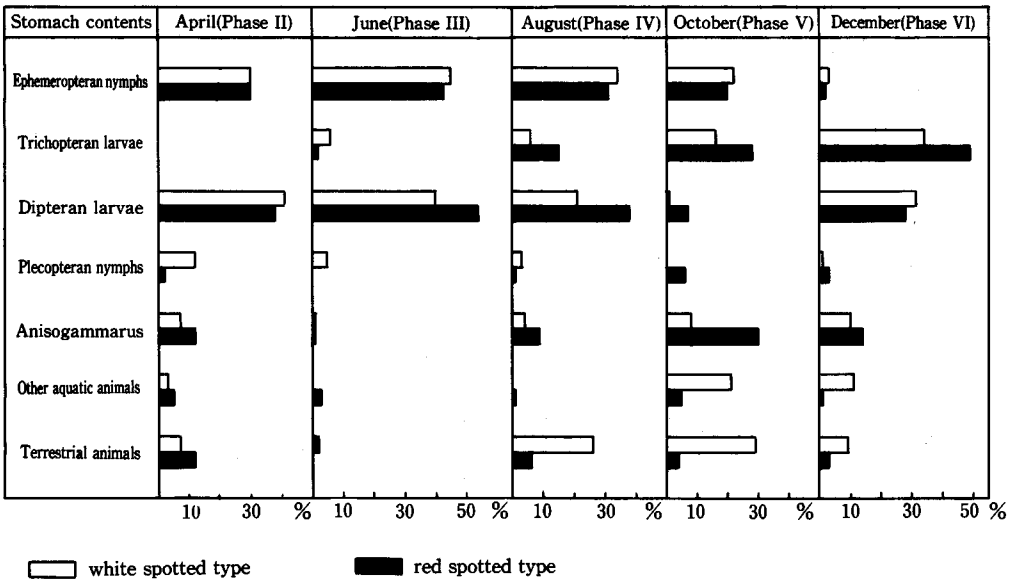

Fig. 13. The food composition of fry of two types of chars in the Ichan'ni River (point method).

The fry that emerged from the redds began to eat small organisms of less than 2 mm in length.

Dipteran larvae, ephemeropteran nymphs, and sometimes *Anisogammarus* were important foods for both types. Dipteran larvae, mostly of *Chironomus*, were found to constitute about 40% of the food of both the white spotted and the red spotted type. Ephemeropteran nymphs, mainly of either *Paraleptophlebia* sp. or *Baetris thermicus,* constituted about 30% of the food consumed by the fry of both types. Besides these, *Anisogammarus* was found abundantly in the stomachs of the fry collected from certain places, but they were not always important.

It is noteworthy that a considerable number of copepods, though small in total volume, were eaten by the newly emerged fry.

June (Phase III)

The fry of both types began to feed actively in this month. For both types, dipteran larvae were the most important food, followed by ephermeropteran nymphs, as in April. The percentage of dipteran larvae eaten increased considerably, constituting more than 60% of the total number of foods. Some trichopteran larvae began to appear in the stomachs of some fry of the two types, but the total number and volume were very small.

No important differences in the kinds of food stuffs were found between the two types up to this stage.

August (Phase IV)

The fry of both types ate voraciously in this month, and examination of the stomach contents revealed the consumption of a large amount of food, consisting of various organisms. For the fry of both types, the nymphs of ephemeropterans included *Epeorus, Ephemerella* and *Baetis,* the larvae of trichopterans, *Deplocerus* and *Rhiacophila,* and some terrestrial animals are important food items, the dipteran larva being still the most important food item for the red spotted type.

Some noticeable differences in feeding habits began to appear between two types of fry. The fry of white spotted type consumed more ephemeropteran nymphs and terrestrial animals than the red spotted type. On the other hand, the fry of the red spotted type ate more trichopteran larvae and anisogammarus than the white spotted type.

October (Phase V)

In this month wide differences in diet were noted between the fry of the two types accompanied with a remarkable decrease in the percentage of dipteran larvae in the stomach contents of both types. In the white spotted type, drift animals, as well as ephemeropteran nymphs, and dropping terrestrial animals come to be important in this month. In the red spotted type, on the other hand, trichopteran larvae and *Anisogammarus* constituted about 60% of food items.

December (Phase VI)

Few differences were found between the kinds and percentage compositions of the food stuffs consumed by the two types in this month. Both types confined their diet to dipteran larvae (mostly chironomids) and trichopteran larvae. The limitations in food organisms might be due to the decrease of other available organisms in winter. The fry of both types did not eat so voraciously in this month, and the differences in their diets noted in October

had, for the most part, disappeared.

b) *Difference in the stomach contents between fry collected in the upper and middle reachs*

It has been found that the foods of salmonid fishes differed considerably between the rivers or habitats in a river (McCormack, 1962; Thomas, 1963 etc.). While comparison of the foods eaten by fry collected from various places in the Ichan'ni River has revealed that the main foods of the fry of the two types were dipteran larvae and ephemeropteran nymphs but that the comparative importance of these differed considerably from place to place. Generally speaking, the fry of both types collected in the upper reaches ate more dipteran larvae than those collected in the middle reaches, the latter eating more ephemeropteran nymphs than the former.

Fig. 14 shows the foods of the fry of the two types collected in section Ma (upper reaches of the main river) and in section Mc (midstream of the main river). In section Ma, 51% (by the number method) of the food of fry of white spotted type consisted of chironomid larvae and 21% of ephemeropteran nymphs, while in section Mc, 41% consisted of chironomid larvae and 42% of ephemeropteran nymphs. Similar results were obtained by the analyses of the contents of red spotted type, as shown in the right column of Fig. 14.

c) *Relation between food and growth*

The results of analyses of the stomach contents of the fry of both types indicated that dipteran larvae are the most important food resources, both in number and quantity

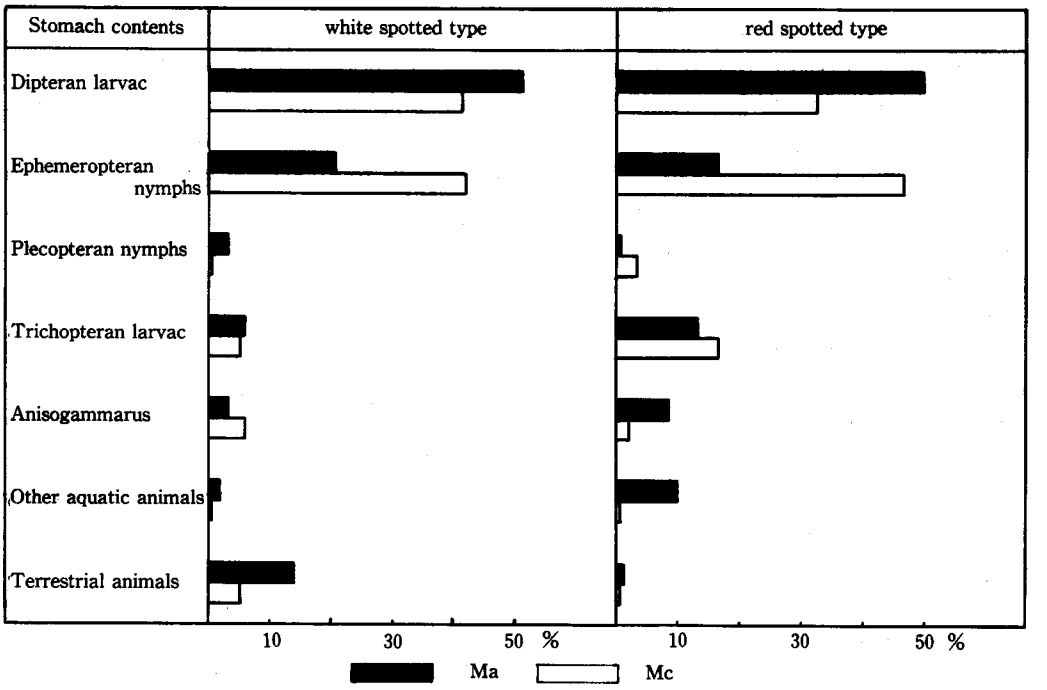

Fig. 14. The percentage composition of food (number method) of fry collected in section Ma (upper reaches) and Mc (middle reaches) in August.

throughout their growing season, from April to August. But the importance of dipteran larvae relative to other food animals differs considerably among the seasons and habitats, and between the two types.

In Fig. 15, the mean fork length of the fry of the two types and the quantities of dipteran larvae found in their stomachs in April, June and August are plotted against various sections of the Ichan'ni River. Results showed that in April and June, the mean fork length of each type of fry was larger in the fry collected from the sections where they ate more dipteran larvae than in those from the section where they ate less dipteran larvae. In August, however, the amount of dipteran larvae eaten by the fry decreased considerably (except in Ma), as compared with those in April and June, and the above-stated relation between the ingestion of dipteran larvae and the mean fork length disappeared in both types of chars.

These results suggest that dipteran larvae are the most important food organisms for the fry of two types during the months before June, and that the quantity eaten has a greater effect on their growth than any other food organisms. A change in feeding habits,

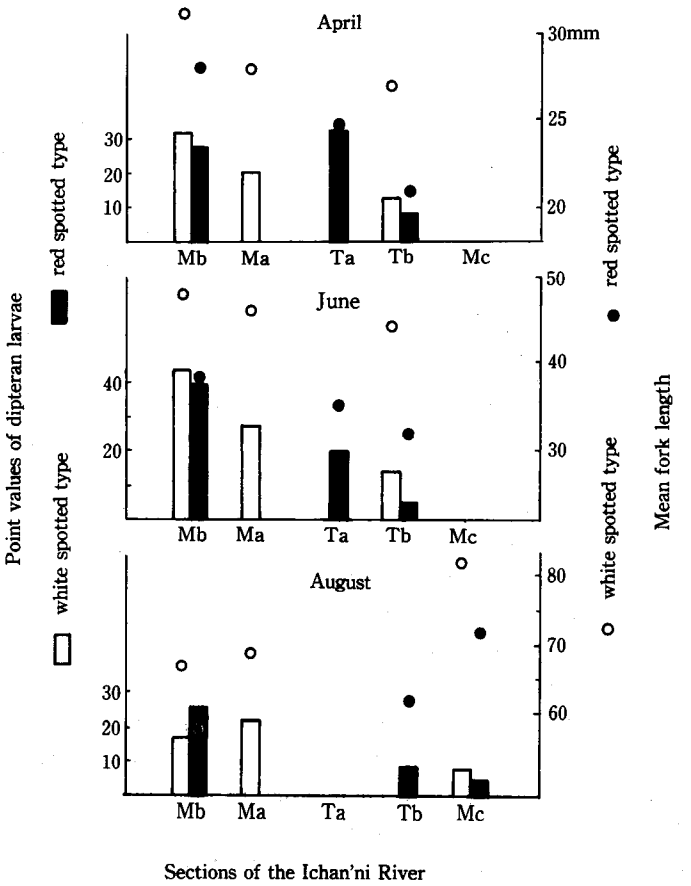

Fig. 15. Relation between the mean fork length and ingestion of dipteran larvae in the Ichan'ni River.

however, occurred in both the types during the period from June to August and larger organisms such as ephemeropteran nymphs and trichopteran larvae became the most important food items, replacing dipteran larvae.

Discussion

It is well known that chars (*Salvelinus*) are very plastic morpholcgically, and the presence of many types of variants has caused much of the dispute concerning their taxonomy. Since old times, numerous species of *Salvelinus* have been described in the world, many of which are probably synonymous.

The two types of chars in Hokkaido have also been the subject of dispute among ichthyologists since the first description of the white spotted type as *Salmo leucomaenis* by BREVOORT (1856) and the red spotted type as *Salvelinus malma* by JORDAN and SNYDER (1902). But the discussions have been made only from the morphological points of view, as mentioned in the introduction.

The result of this investigation established that, in the Ichan'ni River, the fry of these two types of chars emerged from different areas of the river and in different seasons from each other, and the fry of the red spotted type, which hatched later, were smaller in body size than the white spotted type, which hatched earlier, throughout the first year of their life histories. Furthermore, some differences in morphological characteristics were observed between them, ranges of variation of these characteristics being overlapped. These differences appearing in the early stages of their life histories provide strong evidence that these types belong to two distinct species.

It is known that two or more species of salmonids, having many common habits, sometimes coexist in the same river. This pattern is found in many of the mountain streams in Japan, among land-locked *Oncorhynchus* and *Salvelinus,* and IMANISHI (1951) advanced the theory that, in such cases, habitat segregation always occurs between them in the upper (*Salvelinus*) and the lower reaches (*Oncorhynchus*) of a stream due to differences of habitat preference and interference between the species.

Similar segregations have also been found among the salmonid fishes of other countries: *Salmo clarki* and *Salvelinus malma* (ADRUSACK and NORTHCOTE, 1971), *Oncorhynchus tschwytscha* and *O. kisuch* (LISTER and GENOE, 1970) in Canada, *Oncorhynchus tshawytscha* and *Salmo gairdnerii* (EVEREST and CHAPMAN, 1972), *Salvelinus fontimals* and *Salmo trutta* (FAUSCH and WHITE, 1981), *Salvelinus fontinalis* and *Salmo clarki* (GRIFFITH, 1972), and *Salmo trutta* and *S. gairdnerii* (JENKINS, 1969) in North America.

On the other hand, NILSSON (1955) clarified that a food segregation occur between two species of slamonid, *Salvelinus alpinus* and *Salmo trutta,* in cohabiting lakes.

However, it has been repeatedly reported in Europe that two nearly related salmonids, *Salmo trutta* and *S. salar* live together in many becks and their habitats and foods are widely overlapped, being isolated from each other in reproduction (FROST, 1950; KALLEBERG, 1958, THOMAS, 1963; MAITLAND, 1965; PEDLEY and JONES 1978 etc.).

It was appeared in the present paper that in the Ichan'ni River, the fry of the red spotted type and white spotted type of chars were sharing the same ecological niche in the animal community. Although minor differences in their habits have been observed during

the course of this investigation, most fry of the two species live together during the greater part of their growing period and their chief food items, the dipteran larvae, are moreover in common. These facts suggest that these two types of chars are closely related in systematics.

Therefore, further investigation about reproductive isolation between them in such co-existed rivers is thought necessary for the complete clarification of their systematic relation.

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要　　約

北海道に生息する二型のイワナ属魚類，アメマス（白色斑点型）とオショロコマ（赤色斑点型）の稚魚期の生態の比較調査を，両者の混生河川である道東の伊茶仁川で行なった。

両者のふ化後の成長，発育の過程には類似点が多かったが，赤色斑点型の稚魚の産卵床からの浮出は白色斑点型のものより約1ヶ月おそく，またふ出場所も，白色斑点型の場合は中流－上流域にわたっていたが赤色斑点型では最上流域に限られていることがわかった。

赤色斑点型の稚魚はふ出時から白色斑点型のものより小型で，その後の1年間の成長過程を通じて叉長の平均値は白色型のそれを下まわっていた。また両者の体形を比較した結果は，頭長比，体高比には差が認められなかったが，体幅比では赤色斑点型の稚魚の方が白色斑点型のものより高かった。一方各形質について見ると，幽門垂数には差は認められなかったが，鰓耙数では赤色斑点型が，側線有孔鱗数では白色斑点型が，少差ながら有意に多かった。いくつかの形質の発達過程を綜合し，両者の稚魚期の成育過程を六つの発育段階に分けたが，各形質の差異は，いずれかの新しい発育段階への移行の初期に表われる。

両者の食物は，ふ出後間もない時期にはいずれもユスリカの幼虫が主体で差はないが，摂食活動が盛んな夏期になると白色斑点型は流下性の水性動物を，赤色斑点型は底生動物をより多く食べるようになり，食性に差異が表われることがわかった。

北海道に生息するこの二型のイワナ属魚類が，同一河川内に混生する場合においても，ふ化・ふ出の場所と時期を異にし，微妙ではあるがいくつかの点で形態的にも異なる特徴を持ち，また食性等の習性面でも差異が認められたことから，両者は別種である可能性が高いとみなされた。

両者が互いに独立した種であることを検証するために，混生河川内での両者の繁殖生態を調べ，生殖隔離の有無を確認することが必要と考えられた。