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On the Colour Variations of the Mud Loach, *Misgurnus anguillicaudatus* (Cantor)

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(With 2 Text-figures and 1 Plate)

Since S. Tanaka (1930) reported the orange individual of the mud loach, "Akadojo" from Honshu, several investigators have recorded the similar individuals from several localities. The present author collected in Hokkaido a large number of the mud loaches from 1952 to 1955 and found in them several forms of different colours. In the present paper, will be described the colour variations and the results of cross-breeding between these different forms.

Material and method

The material used in this study was collected from rivers, bogs and pond-fields in 6 regions of Hokkaido: Iwamizawa, Tsukigata, Chitose, Oyafuru, Sapporo and Asahigawa. In these regions, the localities having the greatest number of specimens of different colours were Iwamizawa and Tsukigata. The eggs were easily obtained by injection of the hypophyses of a loach, and were inseminated according to Kawamura's method. The embryos were reared in a glass aquarium at room temperature. In each series of experiments, 30-50 embryos were reared each for one kind of hybrid and the controls. Afterwards they were removed into a cement aquarium set in a field.

Body colour

The colour variations of these specimens can be divided into 6 types as follows (Plate II, 2-7):

1. *Yellow form*: The lateral dorsal surface of the body and all the fins are yellow or orange; and the ventral surface of the body is white or light-yellow. In addition to this, there is a yellowish scarlet one showing the colour of the muscle and blood over the entire surface of the body. The integument of head and scales of the mud loach of this type lack melanophores entirely, and possess xanthophores of approximately the same size and quantity as those in the normal individual (Fig. 1). The majority of the specimens showing aberrant body colour belongs to this type, and they were collected approximately 200 individuals per year.

Jour. Fac. Sci. Hokkaido Univ. Ser. VI, Zool. 13, 1957 (Prof. T. Uchida Jubilee Volume).

2. *Yellow body speckled with many black spots*: The body is orange above, light-yellow underneath; many small black spots are scattered between the middle-dorsal and the lateral line, and on the caudal, dorsal and anal fins. There were only 2 individuals of this type in all the specimens.

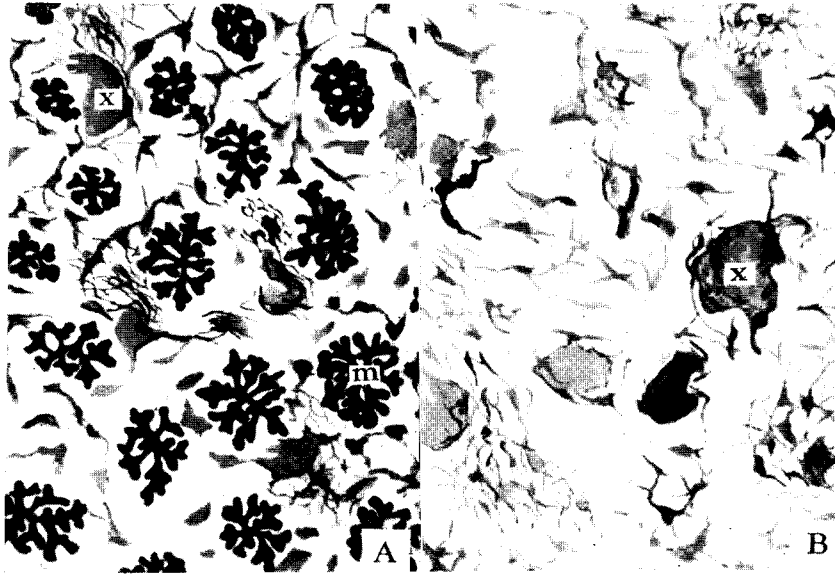


Fig. 1. Chromatophores of the integument of head of the mud loaches.
A, Normal form. B, Yellow form. m, Melanophore. x, Xanthophore.

3. *Yellow body marked with one or two black spots*: The orange or yellow body is marked with one or two black spots on the dorsal surface. These specimens were collected about 4-5 individuals per year.

4. *Intermediate form between the normal and the yellow*: The body is dark green above, yellowish white underneath, and marked with yellow marks of irregular shape on the side or the tail. Seven individuals of this type were found in the whole collection.

5. *Entirely black form*: The entire body-surface of this type is dark green, and speckled with many small black spots. Only a male specimen of this type was captured in 1954.

6. *White form*: The body is reddish white, showing the colour of the muscle and blood, and the integument of head and scales have neither melanophores nor xanthophores. But some individuals of this type are marked with yellow spots on the head or median part, and all specimens of this type have black pigments in the eyes; then these white loaches can not be regarded as of an albino type. Four to five individuals of this type were collected each year.

Recently, I received the information that a true albino mud loach was captured in the vicinity of Osaka City.

Results of cross-breeding experiments

Cross-breeding experiments with 8 kinds of combinations of loaches of different body-colours were carried out as follows: normal form \times yellow form, yellow form \times yellow form, yellow form \times yellow form marked with one black spot, normal form \times yellow form marked with one black spot, white form \times yellow form, white form \times normal form, white form \times white form and entirely black form \times normal form. The results are shown in Table 1.

Table 1. Results of cross-breeding experiments between loaches of different body-colours.

Years of crossing	Parents		Number of crossing	Average hatching ratio(%)	Body-colour of F ₁
	Female	Male			
1953	Yellow form	\times Yellow form	17	43	Yellow form
1953	Normal form	\times Yellow form	16	46	Normal form
1953	Yellow form	\times Normal form	13	38	Normal form
1954	Yellow form	\times Yellow form marked one black spot	1	1.5	Yellow form
1954	Yellow form	\times Yellow form marked one black spot	2	17	Yellow form
1955	Normal form	\times Yellow form marked one black spot	2	26	Normal form
1954	White form	\times Yellow form	2	18	Yellow form
1954	White form	\times White form	1	20	Yellow form
1954	White form	\times Normal form	2	17	Normal form
1954	Normal form	\times Entirely black form	1	80	Normal form

In the crossings of yellow form with normal form their F₁ showed all normal forms, and just after hatching these larvae became to possess normal melanophores. On the other hand, the F₁ crossing between the yellow forms which lack melanophores, just after hatching, developed all yellow form. Therefore, the yellow character seems to be inherited recessively against the normal colour character, and appears as the homozygote of the yellow colour genes.

The crossing of the normal colour female with the entirely black male was observed only once. In this case the F₁ was all of normal colour. Therefore, the entirely black character is possibly a recessive mutant from the normal colour character.

Both the crossing of the yellow form marked with one black spot and the yellow form and normal colour type did not bring satisfactory results in the hatching ratio; however their F₁ which hatched from the crossing of the yellow

form marked with one black spot and the yellow form were all yellow in colour; and their F_1 from the crossing of the yellow form marked with one black spot and the normal form were all normal in colour; therefore, the yellow character marked with one black spot is probably regarded as an independent character inherited recessively against the normal colour character and also the yellow character.

As to the white form, the author is of opinion that it has no connection with the inheritance from their parents, because, not only the F_1 crossing of the white form with yellow form were all yellow in colour, but also the F_1 crossing between the white forms were all yellow in body colour and among the adult loaches cultured in our laboratory, were discovered several individuals which changed from yellow into white.

In concluding, it is the author's great honor to dedicate this piece of work to his teacher Professor Dr. Tohru Uchida of Hokkaido University under whose guidance this work was carried out, in commemoration of his 60th birthday. The author is also indebted to Professor Sajiro Makino for invaluable advices in the course of the experiments.

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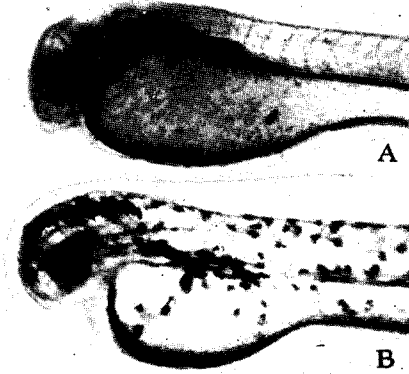
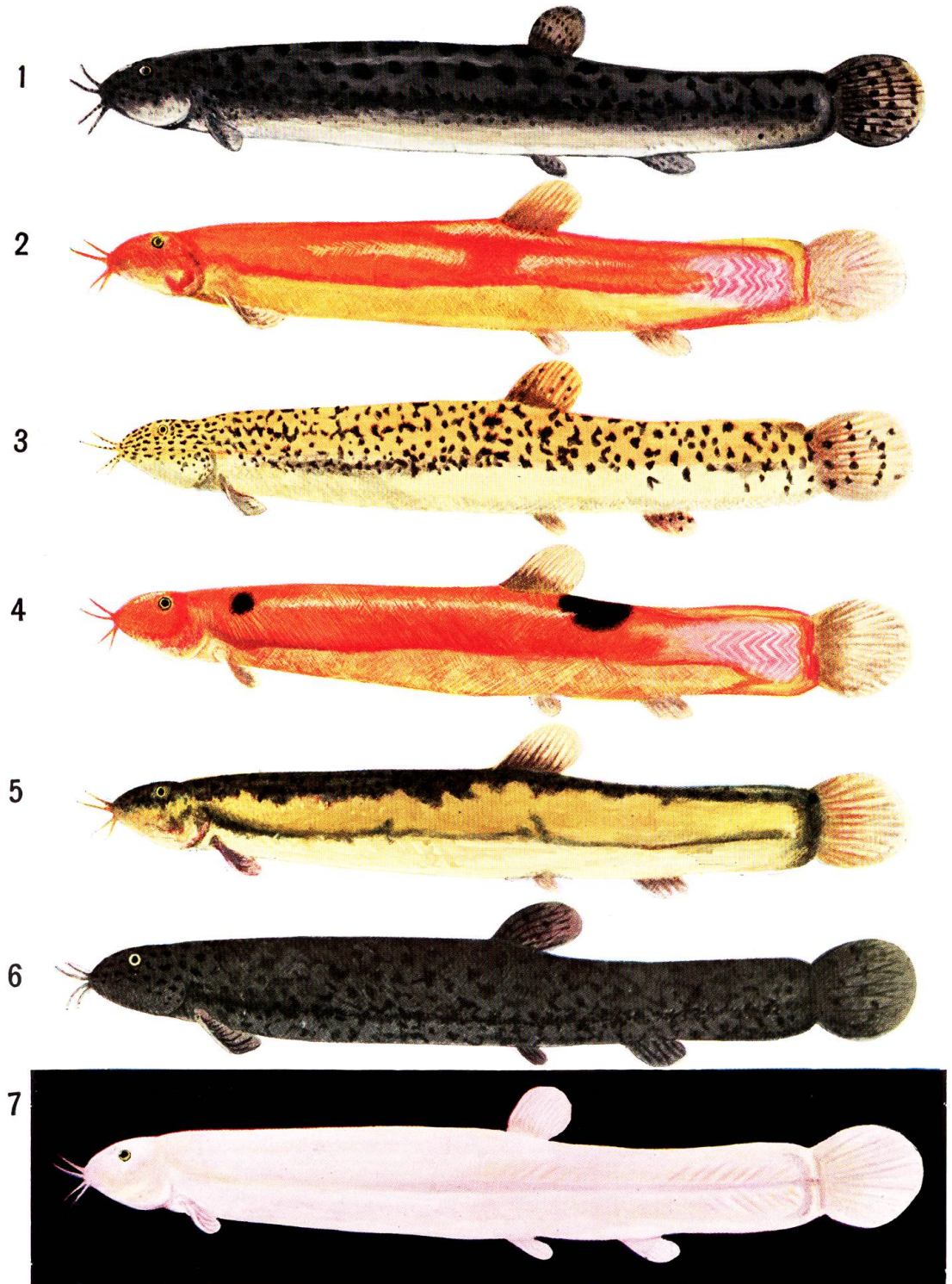


Fig. 2. Larvae, one day after hatching.
 A, Yellow form. B, Normal form.

Explanation of Plate II

Body colour variations in the mud loach.

- 1) Normal form. 2) Yellow form. 3) Yellow form, speckled with many black spots.
 4) Yellow form marked with two black spots. 5) Intermediate-coloured form between the normal and the yellow. 6) Entirely black form. 7) White form.



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