

## External Characteristics of the Eggs of Japanese Catfishes (*Silurus*)

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Three species of the catfish genus *Silurus* (family Siluridae) are found in Japan: *S. asotus* Linnaeus, 1758, *S. biwaensis* (Tomoda, 1961), and *S. lithophilus* (Tomoda, 1961). *S. asotus* is widely distributed throughout Japan and East Asia (Haig, 1950; Nikol'skii, 1961), whereas *S. biwaensis* is restricted to Lake Biwa, and *S. lithophilus* to Lakes Yogo and Biwa (Tomoda, 1961). The external characteristics of Japanese catfish were first described by Atoda (1935), who regarded all Japanese silurids as the single species *S. asotus*. The species which Atoda (1935) studied was almost certainly *S. asotus* judging from the color of the yolk and the locality of sample collections. Tomoda (1962) briefly described the eggs of the three Japanese silurids. His description, however, was inadequate and too simple for precise comparison of the characteristics among the three species. The present study describes features of the eggs of Japanese silurids obtained by artificial spawnings and gives the basic data for their classification. It will supplement Tomoda's inadequate description on egg morphology as a basis of their classification.

### Materials and methods

Adults of *S. asotus*, including females just before spawning, were captured in May, at Shina on the southeastern shores of Lake Biwa; prespawning adults of *S. biwaensis* and *S. lithophilus* were collected in June at Oura on the northern shores of the same Lake. One male and three females each of *S. asotus* and *S. lithophilus*, and one male and female each of *S. biwaensis* were artificially inseminated. The *S. asotus* females weighed about 220 g, 300 g, and 810 g; the *S. lithophilus* females 200 g, 250 g, and 420 g, and the *S. biwaensis* female weighed 4,300 g. Each female received 10 I.U./g body weight gonadotropin injected into the dorsal muscle. Eggs were stripped 18 hours after injections, and inseminated with conspecific sperm suspension made from homogenized testes.

For measurements 60 eggs of *S. biwaensis*, and 20 eggs each of *S. asotus* and *S. lithophilus* were selected at random from each batch.

The eggs were compared between the three species for five characteristics: diameter excluding the jelly layer and perivitelline space (in this study, this dimension indicates the egg diameter), jelly thickness, condition of the jelly surface, yolk color, and adhesiveness of the jelly surface. Diameter and jelly thickness were measured before the blastula stage, since the swelling of the jelly layer was still minimal during this period. Observations were made under a dissecting microscope.

### Results and discussion

All the *S. asotus* eggs were fertilized, though five were not measured before the blastula stage, 59 *S. biwaensis* eggs were successfully fertilized and all *S. lithophilus* eggs were fertilized. All species had a very translucent jelly layer facilitating the observations on yolk condition. The yolk color of *S. biwaensis* and *S. lithophilus* was a similar brownish yellow, while that of *S. asotus* was vivid yellowish green as described by Atoda (1935) and Tomoda (1962).

Several minutes after the insemination the eggs of *S. asotus* and *S. biwaensis* became adherent to the bottom of shallow dishes, and they did not drop even if the dishes were turned upside down; the eggs of *S. lithophilus* did not adhere to any object through all stages of development. The egg surface of the former two species was relatively smooth, while that of *S. lithophilus* was very rugged (Fig. 1). Both egg diameter and jelly thickness of *S. lithophilus* were the largest, and the egg diameter of *S. asotus* and the jelly thickness of *S. biwaensis* being the smallest of the three (Table 1).

The eggs of these Japanese silurids are similar in having a relatively thick jelly layer and wide perivitelline space compared with other siluroid fishes (Armstrong, 1962; Nikol'skii, 1964; Uchida, 1933), the jelly layer of *S. lithophilus* eggs being especially thick. The observations revealed major differences among the eggs of the three Japanese silurids in the five characteristics mentioned above. Differences in egg diameter, jelly thickness and yolk color were reported by Tomoda (1962) who assumed *S.*

Table 1. External characteristics of the Japanese silurids.

Species	No.	Egg diameter (mm $\pm$ S.D.)	Jelly thickness (mm $\pm$ S.D.)	Adhesiveness	Color of yolk	Jelly surface
<i>Silurus asotus</i>	55	1.54 $\pm$ 0.11	0.53 $\pm$ 0.03	+	yellowish green	smooth
<i>S. biwaensis</i>	59	1.64 $\pm$ 0.07	0.51 $\pm$ 0.02	+	brownish yellow	smooth
<i>S. lithophilus</i>	60	1.73 $\pm$ 0.12	0.82 $\pm$ 0.03	—	brownish yellow	rugged

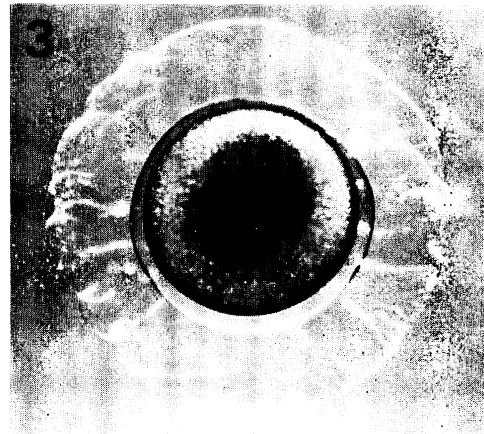
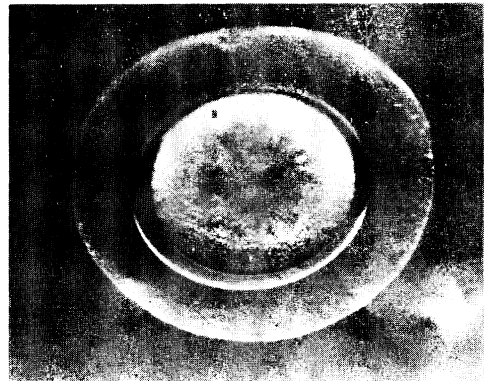
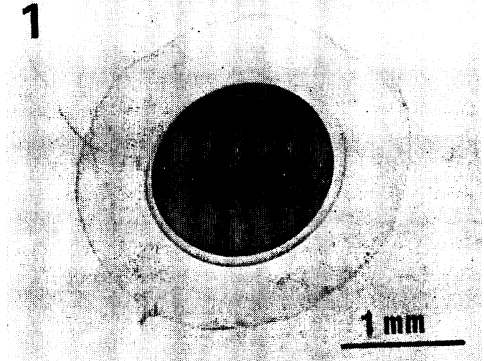
Table 2. Size of females and eggs of the Japanese silurids.

Species	BW (g)	SL (mm)	No. of eggs	Egg diameter (mm $\pm$ S.D.)
<i>Silurus</i>				
<i>asotus</i>	220	254	20	1.47 $\pm$ 0.10
	300	295	20	1.61 $\pm$ 0.09
	810	441	15	1.56 $\pm$ 0.09
<i>S. biwaensis</i>	4,300	738	59	1.64 $\pm$ 0.07
<i>S. lithophilus</i>	200	234	20	1.68 $\pm$ 0.15
	250	285	20	1.72 $\pm$ 0.09
	420	353	20	1.78 $\pm$ 0.12

*lithophilus* eggs to be slightly sticky and to weakly adhere to the rock surface. However, the present observations have made it clear that the egg surface of this species is not adhesive. It is probable that *S. lithophilus* eggs lie in the space among stones and are protected from abrasions by their thick, rugged jelly layer.

The egg diameter differed significantly among the batches in the same species, and the difference among the three species was also found to be significant. Consequently the egg diameter is one specific characteristic, but it is not very useful for identification of species because the actual differences are very small and egg size varies with maternal size (Table 2). A combination of yolk color and at least one of the other two characteristics i.e., adhesiveness and condition of the jelly surface, is much more useful for identification of eggs of Japanese silurids in their natural habitats.

As shown in Table 1, none of the five characteristics was common for the eggs of all three species. Comparing any two of the three species, *S. asotus* and *S. biwaensis* were similar in adhesiveness and condition of the jelly surface; *S. biwaensis* and *S. lithophilus* had the same yolk color and *S. asotus* and *S. lithophilus* had no common characteristics. As far as the egg morphology is concerned, therefore, *S. litho-*

Fig. 1. Eggs of the three Japanese silurids. 1, *Silurus asotus*; 2, *S. biwaensis*; 3, *S. lithophilus*.

*philus* is much more similar to *S. biwaensis* than to *S. asotus*.

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#### 日本産ナマズ属の卵の特徴

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日本産ナマズ属魚類, *Silurus asotus*, *S. biwaensis*, *S. lithophilus* の卵を人工受精によって得、卵径、卵黄の色、ゼリー層の厚さ、粘着性の有無、卵表面の状態の5つの形質について観察した。その結果、*S. lithophilus* に友田 (1962) の報告には記されていない特徴がみられた。即ち、*S. lithophilus* の卵は他2種と異なり、粘着性がなく、卵表面の凹凸が著しいことである。一方、*S. asotus* と *S. biwaensis* の卵は、卵黄の色が異なることを除けば、類似していることがわかった。

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