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# Spawning Behavior, Eggs, and Larvae of the Lutjanid Fish, *Lutjanus kasmira*, in an Aquarium

Katsumi Suzuki and Syozo Hioki

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**Abstract** Spawing behavior and early life history of *Lutjanus kasmira* (Forsskål) is described from aquarium observations in 1976. The pesent paper deals with the first record of spawning behavior and early life history among the family Lutjanidae. Spawning of *L. kasmira* took place between plueral males and females in the early hours of the night in mid-August when water temperatures ranged from 22.3°C to 25.0°C. Fertilized eggs are buoyant, spherical, and colorless, measuring 0.78 mm～0.85 mm in diameter, and containing a single oil globule. Hatching takes place 18 hours after fertilization. Newly hatched larvae measure about 1.83 mm in total length and have a large ellipsoid yolk. An oil globule is situated at the front tip of the yolk. Early larval stages of *L. kasmira* are described for the first 3 days after hatching.

The snappers, belonging to the family Lutjanidae, are among the well-known fishes and inhabit tropical and/or subtropical seas all over the world. A few biological studies have been made on this large family. Among them, *Lutjanus kasmira* from the Andaman Sea was studied by Rangarajan (1971) and *L. griseus* from the waters around the Florida Keys was reported by Croaker (1962), by Starck (1971), and by others. But no biological study has been made on Japanese snappers except for a record of the spawning season in *L. flaviflamma* (see Kamohara, 1958; Matsuoka et al., 1975). Little or nothing is known of the spawning behavior and early life history of this family (Breder and Rosen, 1966, and others).

In 1976, the present authors observed the reproduction of *L. kasmira* reared in an aquarium of the Marine Science Museum of Tokai University for 1～5 years. The present paper gives the initial data on the mode of reproduction and the characteristics of developing eggs and early larvae of the family Lutjanidae.

## Materials and methods

**Parental fish and their rearing.** *Lutjanus kasmira* is distributed widely in shallow waters of the Indo-west Pacific Oceans. Twenty adult fish of this species were taken in 20～30 m depth around the Bonin Islands on five occasions during the years 1971～1975, and were reared in an aquarium tank. The tank used for the observations of fish behavior is made of concrete with a glass window for viewing by aquarium visitors. It has a surface area of 3.3 $m^2$, water depth of 1.3 m, and capacity of 4.6 $m^3$. When the spawning of the present species occurred, the fish were being reared with 14 other tropical sea fishes of 7 species: *Cephalopholis aurantius*, *C. argus*, *Variola louti*, *Epinephelus fasciatus*, *Gymnocranius japonicus*, *Lutjanus gibbus*, and *Plectorhynchus chaetodontoides*. The sizes of parental *L. kasmira* were estimated from 13 preserved specimens which had been removed or had died within three months after the spawning period. Six males ranged from 245 mm to 336 mm (299 mm average) in fork length and from 261 g to 924 g (672 g average) in body

Table 1. Water quality of the aquarium from September, 1975 to August, 1976 before the end of the spawning duration of *L. kasmira* within.

| | Min. | Max. | Average |
|---|---|---|---|
| M-Alkalinity (ppm) | 106.0 | 184.0 | 146.8 |
| WT (°C) | 19.8 | 27.6 | 23.3 |
| pH | 7.6 | 7.9 | 7.7 |
| Salinity (‰) | 31.16 | 34.24 | 33.35 |
| $NH_4$—N (ppm) | 0.000 | 0.866 | 0.033 |
| $NO_2$—N (ppm) | 0.000 | 0.089 | 0.027 |

weight, and seven females ranged from 263 mm to 294 mm (278 mm average) in fork length and from 374 g to 595 g (506 g average) in body weight. The rearing water was circulated constantly once an hour by a pump through a sand filter. The water temperature and quality over one year until the end of the spawning period are shown in Table 1.

**Rearing of eggs and larvae.** Just after the reproduction was ascertained, spawned eggs were collected by a small net and transferred into small receptacles of 30 *l* and 500 *l* capacity. The developing eggs and the hatched larvae were reared in still water with weak aeration, though the water was changed occasionally. The water temperature ranged from 24.8°C to 27.9°C.

## Results

**Spawning behavior.** Under aquarium rearing conditions, during the spawning season the parental fish usually aggregate in a small school in a corner near the bottom. At 18:00～19:00, about 2 hours before the spawning occurs, a male starts his courtship behavior towards a selected female. The male attracts the female from the small school, and he pecks and pushes her belly with his snout. Then both fish ascend quickly together in a spiral towards the surface of the water (Fig. 1A). In the early stages, the mutual courtship is interrupted as if by an accident during their ascending movements, and the two fish return to the bottom separately from the middle layer of the water. As the spawning time draws near, their spiral ascending movements become more rapid and reach higher, approaching close to the surface of the water. The mutual courtship activities are repeated twenty or thirty times over about 2 hours. Finally, ten or more fish in the school of the species join in the courtship activity of the couple and ascend spirally all together. Spawnings take place just below the surface of the water from 20:37 to 21:16 or during the night when they are not being observed directly. At such times, all the fish in the spawning group lie one upon another and spawn simultaneously (Fig. 1B).

Sexes of the fish could not be distinguished within the spawning group during the observations except for the two fish mentioned above. The group must at least have contained both pleural males and females. Because, in the spawning period, twenty parental fish, whose sexes were about equal, were reared and ten or more fish of them always joined in each spawning.

Reproduction was observed once a day on August 11, 24, 27, 28, and 29 in 1976. Water temperature ranged from 22.2°C to 25.2°C.

**Early life history.** The fertilized eggs are buoyant, spherical, and colorless. They measure 0.78～0.85 mm in diameter, and contain a single oil globule measuring 0.13～0.14 mm in diameter. The perivitelline cavity is narrow. No special structure is seen either at the surface of the egg membrane or in the yolk. The developmental stages of the eggs and larvae can be described as follows: Fertilized eggs reach the 2-cell stage in 40 min. (Fig. 2A), the 4-cell stage in 1 hr., the 32-cell stage in 2 hrs., the morula stage in 2 hrs. 20 min. (Fig. 2B), the blastula stage in 4 hrs., and the gastrula stage in 6 hrs. 30 min. after fertilization. Eight and a half hours after fertilization, about 3/4 of the yolk is covered by blastoderm and the embryonal body appears (Fig. 2C). At 9 hrs. 40 min. after fertilization, two myotomes and optic vesicles can be seen. At 10 hrs. 10 min. after fertilization, four myotomes and Kupffer's vesicle are seen. At 10 hrs. 50 min. after fertilization, the blastopore is closed, eight myotomes are present, and an oil globule is fixed at the opposite pole from the embryonal body (Fig. 2D).

Thirteen hours after fertilization, 14 myotomes are seen and a few melanophore pigments appear along the dorsal side of the embryonal body. Fifteen hours after fertilization, 20 myotomes are seen, Kupffer's vesicle disappears, and the heart appears. At 16 hrs. 20 min. after fertilization, 24 myotomes and auditory vesicles are seen, and lenses are formed in the eyes. The embryonal body moves intermittently. Eighteen hours after fertilization, 25 myotomes are seen, the embryonal body is elongated and surrounds about 2/3 of the egg circumference, and the caudal part of the embryonal body parts from the yolk. Punctate melanophore pigmentation is

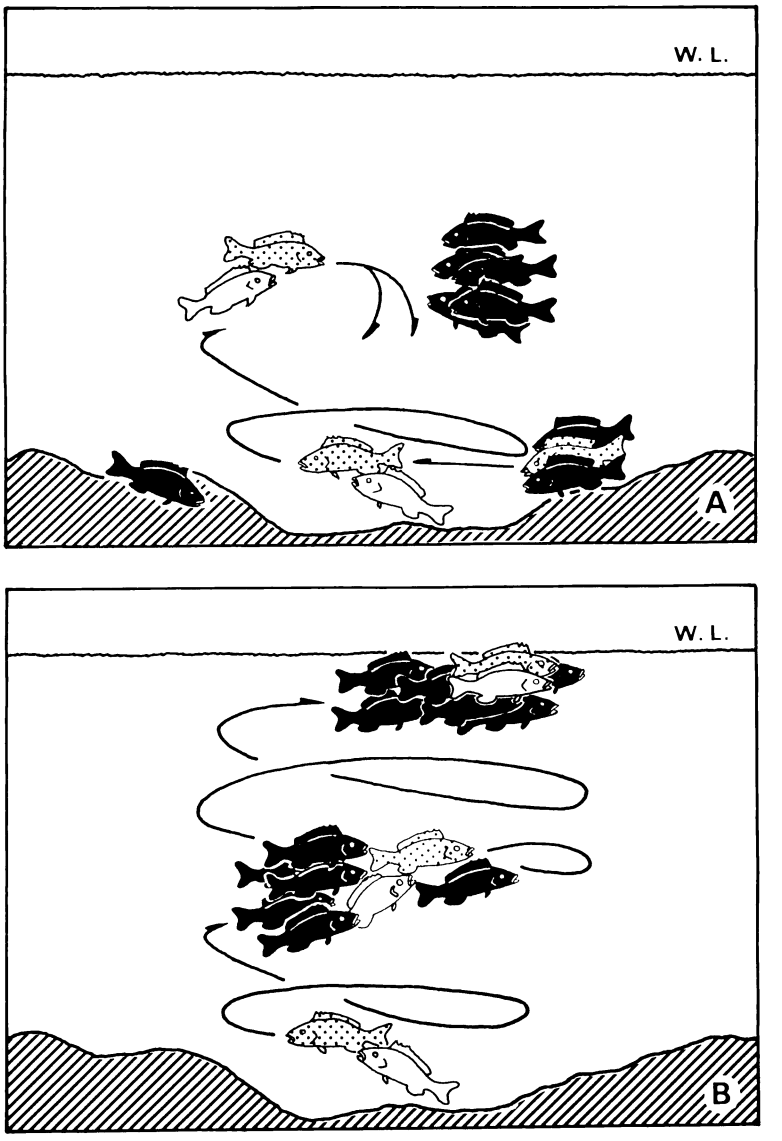


Fig. 1. Diagrammatic view of the courtship and spawning behavior of *L. kasmira* in the aquarium. One male (white) lures one female (dotted) to courtship and both the fish ascend in a spiral (A). During their spiral ascent, ten or more fish (black) join the couple and spawn simultaneously just beneath the surface of the water (B).

seen along the dorsal side and on the postero-ventral part of the embryonal body (Fig. 2E). Eighteen hours after fertilization, the first hatching takes place. Most of the larvae hatch out less than 1 hr. 20 min. after the first hatching, in temperatures of 24.8～26.6°C.

The newly hatched larvae measure about 1.83 mm in total length and contain a large ellipsoid yolk (about 1.28 mm in longest diameter and 0.58 mm in shortest diameter). The front tip of the yolk extends beyond the snout of the larva and an oil globule is situated close to the frontal inner margin of the yolk. The number of the myotomes is 10+15=25. The anus is situated just to the rear of the yolk. Numerous melanophore pigments lie along the body axis from the head to the postero-dorsal part of the body (Fig. 2F).

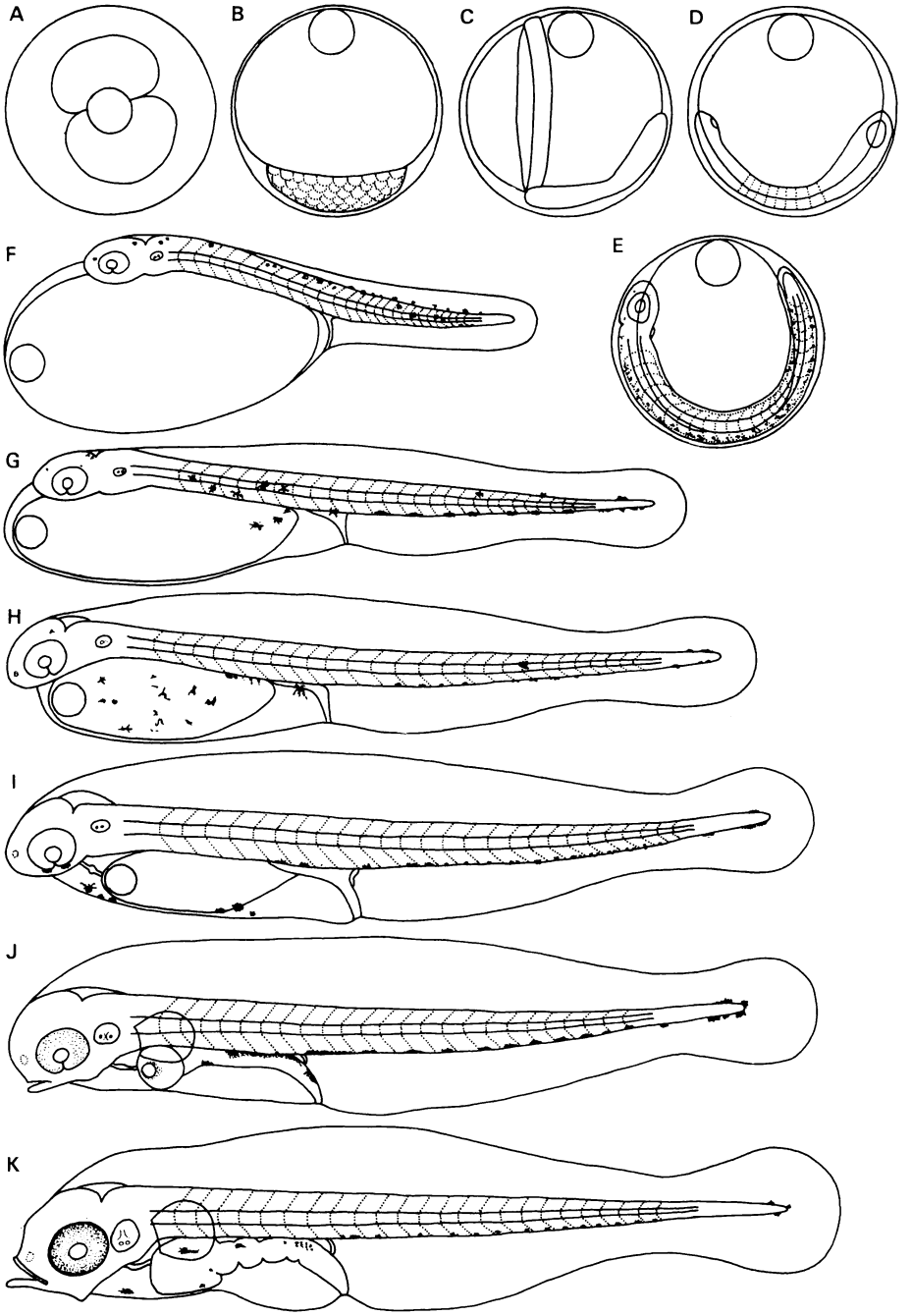


Fig. 2. Developing eggs and early larvae of *L. kasmira*. A: 2-cell stage, 40 min. after fertilization. B: Morula stage, 2 hrs. 20 min. C: Embryonal body appears, 8 hrs. 30 min. D: 8-myotome stage, 10 hrs. 50 min. E: 25-myotome stage, 18 hrs. F: Newly hatched larva, 1.83 mm in total length, 18 hrs. after fertilization. G: Larva, 2.52 mm in total length, 6 hrs. after hatching. H: Larva, 3.00 mm in total length, 12 hrs. I: Larva, 3.20 mm in total length, 24 hrs. J: Larva, 3.20 mm in total length, 48 hrs. K: Larva, 3.20 mm in total length, 72 hrs.

Larvae 6 hours after hatching, measuring 2.52~2.64 mm in total length, have 9+16=25 myotomes. The yolk measures about 1.0 mm in longest diameter. The anus is situated at about the midpoint of the total length of the larva. The melanophore pigmentation on the dorsal surface moves mostly towards the lateral and ventral surface of the body, and some of these pigments become enlarged and branch-like in shape. A few melanophore pigments appear at the end of the yolk (Fig. 2G).

Larvae 12 hours after hatching, measuring about 3.0 mm in total length, have 9+16=25 myotomes. There is a small retained yolk measuring about 0.92 mm in longest diameter. The melanophore pigments on the yolk increase in number and size (Fig. 2H).

Larvae 24 hours after hatching, measuring about 3.2 mm in total length, have 9+16=25 myotomes. The small retained yolk measures 0.56 mm in longest diameter. The anus is situated at a point 2/5 of the total length from the head. Eighteen or nineteen melanophore pigments are seen along the ventral and caudal edges of the body, with a further two or three beneath the eyes and seven or eight on the anterior part of the ventral membranous fin (Fig. 2I).

Larvae 48 hours after hatching, measuring 3.08~3.20 mm in total length, have 7+16=23 myotomes. The yolk sac is barely retained. The mouth and anus are open. Melanophore pigments are seen along the ventral ridge of the body, those of the caudal part increase in number and become larger than in the previous stage. Numerous spotted melanophore pigments appear on the posterior part of the digestive organ and in the eyes (Fig. 2J).

Larvae 72 hours after hatching, measuring about 3.20 mm in total length, have 7+16=23 myotomes. The yolk sac is completely absorbed. The eyes become blackish in color with the development of the malanophore pigments within (Fig. 2K).

Larvae 3 days after hatching fed on the larvae of the oyster, *Crassostrea gigas*, but they gradually decreased in number and the last individual died 7 days after hatching. No remarkable growth in size nor change in shape was observed during this period.

## Discussion

The early life history of lutjanid fishes is described here for the first time. Starck (1971) noted the characteristics of eggs of a Caribbean lutjanid *L. griseus* as "demersal", but he did not succeed in obtaining fertilized eggs. At least, the fertilized eggs of the present species, *L. kasmira*, have been reliably established to be non-demersal. Shinohara (1966) proposed that the lutjanid fishes have some phylogenic relationships to the epinephelid fishes belonging to the family Serranidae and to the fishes belonging to the families Nemipteridae and Pomadasyidae. However, in *L. kasmira*, the only lutjanid whose larval characteristics have been studied, the finding are clearly dissimilar to those for the three epinephelids studied, *Epinephelus akaara* (see Ukawa et al., 1966), *E. striatus* (see Manday and Fernandez, 1966), and *E. tauvina* (see Chen et al., 1977), the two nemipterids studied, *Nemipterus virgatus* (see Aoyama and Sotogaki, 1955) and *Pentapodus nagasakiensis* (see Mito, 1963), and the only pomadasyid studied, *Parapristipoma trilineatum* (see Mito, 1963). They differ in such points as the location of the oil globule in the yolk sac, distribution of melanophore pigments, number of myotomes, site of the anus, etc. The present author could not find a larval form which bears any resemblance to *Lutjanus kasmira* among fishes belonging to the suborder Percoidei studied up to the present time.

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Contribution No. 52, Marine Science Museum, Tokai University.

(Marine Science Museum, Tokai University, Miho, Shimizu-shi, 424 Japan).

### 水槽内で観察されたヨスジフエダイ *Lutjanus kasmira* の産卵習性と卵および仔魚

鈴木克美・日置勝三


小笠原群島近海で採集されたヨスジフエダイが1976年8月に水槽内で合計5回産卵した．本種の産卵行動は1尾の雄の求愛で始まり，やがて雌雄1対となって螺旋状に水面に向かって上昇する．産卵の直前には雌雄の上昇途中で，水槽中層付近に集合している本種の他の10数尾の雌雄がこれに参加し，水面直下で1団となって産卵する．フエダイ科魚類の受精卵及び初期仔状は本種で初めて記載された．本種の受精卵は油球1個を有する卵径 0.78～0.85 mm の球形分離浮性卵である．水温 24.8～26.6°C で受精18時間後に孵化が始まり，その1時間20分後にすべての卵が孵化する．孵化直後の仔魚は全長 1.83 mm，卵黄は長卵形で大きく，その先端は吻端より前方に突出する．油球は卵黄先端近くにあり，卵黄表面より突出しない．

孵化3日後の仔魚は全長 3.20 mm，卵黄を吸収し口と肛門が開く．本種の孵化直後の仔魚の形質は本科と比較的近縁とされるハタ類（スズキ科），イトヨリダイ科，イサキ科の既知種のそれとは著しく相違し，かつ，本種のそれと同様な形質の仔魚をスズキ亜目の既知種からは見出すことができなかった．


(424 静岡県清水市三保 2389 東海大学海洋科学博物館)