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Growth of the Larvae of a Tanganyikan Cichlid, *Lamprologus attenuatus*, under Parental Care

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It is known that *Lamprologus attenuatus* is a substratum spawner and its offsprings are guarded by both parents, or rarely, the female parent on a sandy area in Lake Tanganyika (Kuwamura, 1986). However, details of growth of larvae under parental care are unknown.

Growth of larvae under parental care has been studied on Tanganyikan cichlid fishes (Yanagisawa and Nshombo, 1983; Nagoshi, 1985; Yanagisawa, 1986, 1987). Nagoshi (1985) suggested that in the genus *Lamprologus* the growth of larvae under parental care is related to the mode of parental care and microdistribution of the larvae in the breeding territory.

In the present study, the growth of larvae under parental care in *L. attenuatus* was described on the basis of underwater field observations. The characteristics of the larval growth of this species were discussed in comparison with the growth of other *Lamprologus* species.

Study area and methods

Field work was conducted in the coastal waters of Lake Tanganyika at Mbemba (3°40′S, 29°09′E), from July 1986 to February 1987. Underwater observations and collections of *L. attenuatus* were done by SCUBA diving in a sandy area along the shore. Most of the observations were carried out at depths of 5 to 10 m. Sandy flats and slopes predominated in the sandy area, and separate rocky areas were also found. The breeding sites of the fish were distributed in the sandy area.

Several individuals of free-swimming larvae under parental care were removed from 13 broods with hand net and gill net at 2–19-day intervals to measure their growth. Standard length (SL) was measured as an index of growth.

Results

Five males and 7 females of *L. attenuatus* were found breeding in a comparatively flat sandy area of about 30×10 m along the coast. Independent juveniles were distributed in the midwater. Adults were often found in pairs, but sometimes one male mated with two females at the same time. Their breeding activities were observed throughout the study period. Most of the spawning sites were repeatedly used by the same pairs.

Size and colour differences between the partners were apparent in each brooding pair. Males were found larger than females. Each pair (F1–F7) was distinguished in their colour pattern and size.

Before spawning, a female dug a pit around a boulder or a rock covered with sand. Spawning occurred in the morning. Eggs were laid on the surface of rocks or boulders. Brood size at the egg stage was 229 ± 46 SE ($N = 10$). Of ten broods at this stage, six disappeared within several days. The observed brooding females produced a total of 17 broods during the observation period, but four broods disappeared at the egg or wriggler stage. The disappearances are probably due to predation by fishes.

Eggs hatched on the morning of the 4th day after spawning. The hatched larvae with yolk sac were usually transferred to a new pit by the mouth of the female parent. The new small pit, 2–3 cm in diameter, was dug in a sandy bottom within 1 m from the original one. The male never transferred the larvae and hovered 0.5–1 m above the original pit.

When guarding the larvae, the female usually stayed just above the pit and brood, while the male hovered 0.5–1 m above the school of the larvae. The larvae became free-swimming about one week after hatching and formed a school hovering around the pit. The growing larvae gradually expanded their area, protected by the parents, toward the midwater. The larvae were protected by both parents during 8–12 weeks. The larvae fed on zooplankton under parental care.

Growth of 13 broods produced by six females were examined (Fig. 1). Each female produced a new brood bimonthly but three broods from F1, F5 and F6 females disappeared at the egg or wriggler stage. F5 and F6 females were found in a territory of one male but two broods were not defended by the male at the same time.

The free-swimming larvae were 5.5–6.5 mm SL. When they grew to 18.1–34.1 mm (24.4 ± 4.2 SE on average) SL, they became independent of

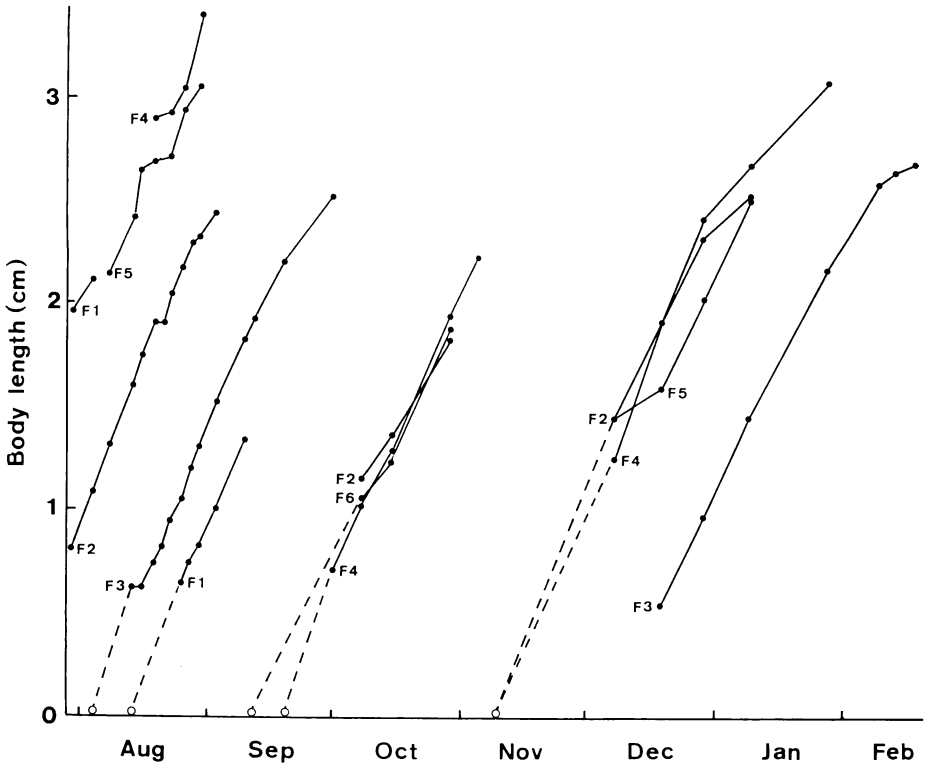

Fig. 1. Growth curve of larvae in each brood of *Lamprologus attenuatus* under parental care. F1–F6 indicate female parent. Broken line represents guarding period growth expected.

parental care and gradually dispersed toward the midwater, 1–3 m above the bottom. The larvae of each brood under parental care represented nearly linear growth.

Growth curve in body length of *L. attenuatus* is represented in Fig. 2. Mean growth rate within the duration of parental care was 0.38 mm/day. The growth rate was 0.44 mm/day until they attained 20 mm SL during the initial 30 days. But the growth was slightly retarded during the latter half of parental care and the rate decreased to 0.33 mm/day. These growth rates were the greatest among the species of the genus *Lamprologus* reported so far.

The larvae of *L. attenuatus* are able to expand their area protected by the parents toward the midwater like those of *L. elongatus*, so their growth will not be retarded even in the latter half of parental care as compared with other *Lamprologus* species.

Discussion

In the Tanganyikan cichlid fishes, two types are discriminated in the microdistribution of larvae under parental care: the hovering type and the benthic type. In the former, the school of larvae expands its area into the water as they develop, and in the latter, it spreads horizontally on the substrate (Nagoshi, 1985; Kuwamura, 1986; Yanagisawa, 1987). According to this classification, *L. attenuatus*, *L. elongatus*, *L. toae*, *Perissodus microlepis* and *Haplotaxodon microlepis* belong to the hovering type, and *L. furcifer* and *L. modestus* to the benthic type. As seen below, the growth rate of the former except *L. toae*, is larger than that of the latter.

The mean growth rates of larvae in the duration of parental care are 0.29 mm/day in *L. elongatus*, 0.31 in *L. modestus*, 0.25 in *L. toae*, 0.25 in *L. tretocephalus* (Nagoshi, 1985) and 0.26–0.34 in *L. furcifer* (Yanagisawa, 1987). In the present study, the growth rate of larval *L. attenuatus* was

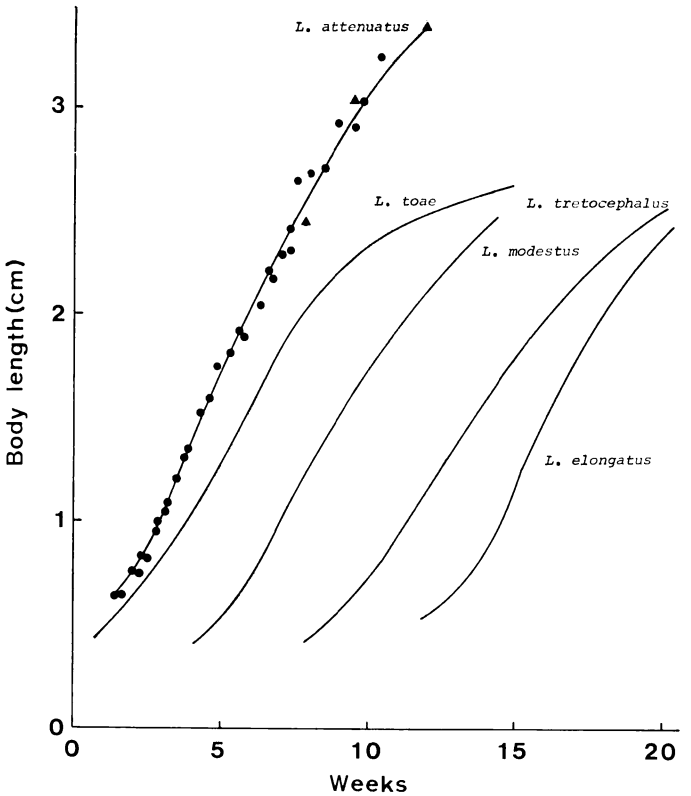

Fig. 2. Growth curves of larvae under parental care in genus *Lamprologus* from free-swimming stage to independence. Triangles indicate just before independence of fry.

0.38 mm/day which was the greatest among the six species of the genus *Lamprologus*.

In other cichlid species of Lake Tanganyika, the growth rate of *P. microlepis* was 0.55–0.66 mm/day (Yanagisawa, 1983), *Xenotilapia fluvipinnis* 0.20–0.40 (Yanagisawa, 1987), *H. microlepis* 0.51, and *Tanganicodus irsacae* 0.50 (Kuwamura et al., in preparation). The growth rate of *L. attenuatus* is smaller than those of *P. microlepis*, *H. microlepis* and *T. irsacae*.

It has been suggested that the growth rate of larvae under parental care is related to the mode of parental care. Parental care pattern is different among these species: *P. microlepis* and *H. microlepis* exhibit prolonged biparental guarding after mouthbrooding (Yanagisawa and Nshombo, 1983; Kuwamura, in preparation) while *T. irsacae* is a mouthbrooder (Kuwamura et al., in preparation). In the former two species, breeding sites are moved with the development of larvae. However, the breeding site of *L. attenuatus* is fixed at the same place during the parental care. It seems that the movement is related to the acceleration of the growth of the larvae. Microdistribution of larvae under parental care of *L. attenuatus* and *L. elongatus* resembles each other. However, the former breeds in sandy areas and the latter in rocky areas. The number of fish species inhabiting sandy areas is smaller than that of rocky areas (Kuwamura, 1987). The larvae of both species feed on zooplankton, *Diaptomus simplex*, *Mesocyclops leuckarti* etc., in the midwater (Gashagaza and Nagoshi, 1986). Therefore, if the zooplankton is randomly distributed in the midwater on sandy and rocky bottom, *L. attenuatus* will be able to take much zooplankton and get a greater growth rate than *L. elongatus*.

Thus, the high growth rate of offspring at the early stage in *L. attenuatus* is probably related to their distribution pattern and the breeding site protected by the parent.

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タンガニイカ湖産カワスズメ科魚類 *Lamprologus attenuatus* の親の保護下における稚魚の成長

名越　誠・Masta Mukwaya Gashagaza

Lamprologus attenuatus はタンガニイカ湖の沿岸域の砂場の石または岩に産卵し，両親が稚魚の保護を行った．親の保護下の稚魚は成長に伴って湖底より水面に向って分布を拡げた．それらの稚魚の成長を調べるためスキューバ潜水により定期的に一部の稚魚を採集した．ふ化後 30 日間の平均成長率は 0.44 mm/day であり，全保護期間中の平均成長率は 0.38 mm/day であった．これらの成長率は *Lamprologus* 属の他の 5 種の値に比べ，最も大きい値であった．この種の成長率が高いのは，生息魚類が少なく，餌条件に恵まれた砂場で成育し，成長に伴って分布空間を拡げるためであると推察した．

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