Observations on the feeding ecology and behavior of newly-hatched grouper, *Epinephelus coioides*, larvae

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INTRODUCTION

The survival and eventual success in the rearing of marine fish larvae like the grouper, *Epinephelus coioides*, is dependent not only on osteological development but also on the ability to catch, accept and digest prey. This is critical specially during transfer from endogenous to exogenous feeding, referred to as the "mixed-feeding" period¹. The study was undertaken to observe the strategies the grouper larvae used to survive this period. It attempts to show how the larvae utilize its endogenous food, how much it eats as well as its behavior in terms of its prey preference, quantitative feeding ability, actual selection and digestion.

MATERIALS AND METHODS

The larvae were reared under optimum conditions and fed with green algae, *Nannochloropsis* spp. at 300,000 cells/ml immediately after hatching. Prior to mouth opening, rotifer, *Brachionus plicatilis*, was given at 10 ind/ml. From 0-hr after mouth opening, 25 larvae were sampled at 1-2 hr intervals. This was adjusted to 30-min intervals on the 3rd day after mouth opening. All larvae and rotifer samples were preserved in 5% formalin.

About 25 larvae were sampled daily to measure the yolk and oil globule volume following the formula²

$$\text{Yolk volume} = 1/6 \pi L H^2 \quad \begin{array}{l} L = \text{length of yolk, mm} \\ H = \text{height of yolk, mm} \end{array}$$

$$\text{OG volume} = 3/4 \pi r^3 \quad r = \text{oil globule radius, mm}$$

Gut observations were made on 591 larvae and measurements include number and lorica length of rotifer, feeding incidence, rotifer dry weight per larval dry wt. and the index of gut fullness. To assess feeding preference in terms of rotifer size, Ivlev's³ electivity index was used:

$$E = \frac{r_i - p_i}{r_i + p_i} \quad \begin{array}{l} r_i = \text{proportion of } i \text{ food in the diet} \\ p_i = \text{proportion of } i \text{ food in the tank} \end{array}$$

The daily food ration⁴ was estimated using:

$$St = So * \text{EXP}(-R.t)$$

St = food consumed at t

So = food consumed at mouth opening

R = consumption coefficient

t = time after mouth opening

RESULTS

In terms of endogenous materials, the yolk of the grouper measured initially at $1354 \times 10^{-4} \text{ mm}^3$ was exponentially resorbed so that by 35.5 hours after mouth opening (HAMO), only 84% remained. Yolk was 97% exhausted by 26.5-HAMO.

The oil globule volume in the grouper was $33.9 \times 10^{-4} \text{ mm}^3$ at hatching but was exhausted by 39.5-HAMO. The yolk and oil globule resorption coefficient (R) is shown in Table 1:

Table 1 Relationship between the amount of yolk and oil globule (Yvol) and hours after hatching (t). $Yvol = Yo * \exp(-Rt)$; Yo = yolk volume at hatching; r = resorption coefficient

Yolk Vol R	Yolk Vol r	OG R	OG Vol r
0.0781	0.99	0.0506	0.97

Consumption of exogenous materials was also observed in terms of feeding incidence (%) which was first observed at 14.5-HAMO. Food in the gut include both rotifer and algae but the algae remained undigested. The grouper's food size preference using the electivity index indicate that the larvae initially preferred (E value=0.95) small-sized rotifer (80-120 μm) until 63.5-HAMO. Thereafter, the electivity peaked at 120 μm and increased to 180 μm at 109.5-HAMO. By this time, the feeding amount is a maximum number of 5.5 rotifer/larva.

The index of gut fullness (IGF) was also observed and results show low initial values which remained even after mouth opening (19.5-HAMO) which means that food remained insufficient even when larvae are already capable of feeding.

The rotifer dry body weight in the gut in relation to larval dry body weight (%) was also observed. In

grouper, rotifer weight is 0.22% of the larval dry body weight at 14.5-HAMO, increasing gradually and attaining a maximum mean value of 2.55% at 115.5-HAMO.

DISCUSSION

In most species, the development of feeding structures occur even before the yolk is completely resorbed. In the grouper, however, the endogenous food is almost gone by the time the grouper larvae are feeding successfully. Inability of the larvae to acquire the capacity for feeding prior to exhaustion of food is thus one of the factors that make grouper larval rearing difficult.

In a newly-hatched fish, the yolk is the main inherent food source and this is mobilized through a thin tissue that envelopes the whole yolk mass referred to as the vitelline syncytium⁵). The resorption pattern shows that there is preferential consumption of the yolk over the oil globule, as shown by the lower resorption coefficient (R) values. The oil globule serves as floatation material since at this stage, swimming structures are not yet fully developed and fish must rely on neutral buoyancy to maintain itself in the water column. However, it serves as a food source when the yolk is about to be exhausted. The endogenous food in grouper did not last long (26.5-HAMO for the yolk and 39.5-HAMO for OG) perhaps because the larvae are not benefiting nutritionally (algae remained undigested) during the mixed feeding stage. Another proof that the larvae are not feeding well is the fact that even on the third day of feeding, the daily ration is a mere 16.8% of larval DBW. Note further that by the time 50% of the rotifer are feeding, the yolk is down to 5% of the initial volume. This may be due to two reasons: the larvae are not yet morphologically capable of aggressive feeding because of the late development of feeding structures and, the lack of appropriately-sized food considering the small initial mouth size of the larvae (0.140 mm).

In terms of exogenous feeding, the success of the larvae to catch and actually ingest food depends on various factors, foremost of which is the size of the mouth which defines the limits for prey size⁶). Thus the grouper initially fed on smaller-sized (<80 μ m) prey shifting to a wider range of rotifer sizes (100-120 μ m) later corresponding to a parallel increase in mouth size.

Another factor that may ensure feeding success would be larval size because of greater capacity to search for prey. In the small-sized grouper larvae, feeding amount is low (5.5 rotifer/larva, Index of gut

fullness [IGF] value of 2.65, and 1.63% larval dry body weight (DBW).

Another factor worth considering is food density and time of food availability⁷). Initial feeding after mouth opening occurred in the grouper larvae at 14.5-HAMO with a feeding incidence of 75%, with the larvae ingesting only unicellular algae that remained undigested. Considering this observation, there is a need to provide suitable and appropriately-sized food during this period.

In terms of prey size and prey species selection, the newly-hatched larvae were compelled to feed on the algae even if it cannot digest it to compensate for dwindling food reserves (only 0.42% remaining). Considering the above observations, it is recommended that a semi-intensive feeding scheme be adopted⁸) or to look into the possibility of giving alternative food organisms such as copepod nauplii to the grouper larvae specially during the onset of initial feeding.

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