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Note

Jaw deformities in the larvae of yellowtail kingfish (*Seriola lalandi* Valenciennes, 1833) from two groups of broodstock

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ABSTRACT

Jaw malformation is a major bottleneck in hatchery development of marine finfish. This study compared the occurrence of jaw deformities in larvae produced from two sets of broodstock of yellowtail kingfish (*Seriola lalandi*, Valenciennes 1833). Fish eggs from two groups of broodstock (B1 and B2) were separately hatched and the fish larvae were reared up to 25 days under similar conditions. No significant differences were found in specific growth rate and overall jaw deformities between these two groups. However, a clear pattern was observed in occurence of jaw deformities at different lengths groups. In population B1, minor deformities occurred in larvae of 9.80-11.60 mm standard length (SL) with maximum in fish of 10.89-11.11 mm SL. In B2, minor jaw deformities occurred in larvae of 8.69-12.21 mm SL with maximum deformities observed in fish of 9.35-9.52 mm SL and 10.18-10.34 mm SL. No severe jaw deformities were found in either of the two groups of larvae in this study. The study clearly showed that the sizes at which jaw deformities occur vary between two groups of larvae of the same species, under the same environmental and nutritional conditions. which indicated the need for selective breeding to reduce occurrence of deformity in the larvae.

Keywords: Broodstock, Fish larvae, Jaw deformities, *Seriola lalandi*, Standard length, Yellowtail kingfish

Inconsistent fingerling quality in marine finfish aquaculture has been considered an important issue in mass production of juvenile fish for grow-out facilities (Izquierdo *et al*., 2001). Jaw deformity is one of the most common issues in marine fish larval rearing. Previous studies indicate that jaw deformity may have lethal or sub-lethal effects on fish larvae (Barahona-Fernandes, 1982) and a deformed fish may have poor market value. The causes of jaw deformities have been attributed to nutrition (Suzuki *et al*., 2000; Cobcroft *et al.,* 2004; Mazurais *et al.,* 2009; Sandel *et al.,* 2010), light intensity, tank colour and temperature (Lein *et al.,* 1997; Pankhurst and Hilder, 1998; Cobcroft *et al.,* 2004; Battaglene and Cobcroft, 2007; Cobcroft and Battaglene, 2009).

The yellowtail kingfish (*Seriola lalandi* Valenciennes, 1833) has been identified as a candidate species for aquaculture due to its fast growth, high flesh quality and suitability for cage culture (Fowler *et al.,* 2003). Jaw deformities have been an issue across fish hatchers in New Zealand and Australia (Tait, 2000; Cobcroft *et al.,* 2004). Deformed fish usually have to be culled before entering the grow-out phase due to their low market value, and the culture of deformed fish is a waste of time and effort. In order to improve fingerling production efficiency, it is necessary to explore the factors that may contribute to jaw deformities. This study compared the occurrence of jaw deformities in the larvae of *S. lalandi* produced from two different sets of broodstock.

The study considered two groups of broodstock from Clean Seas Tuna, Arno Bay, South Australia. The first group (B1) comprised four females and three males caught from the wild in 2006 and the second (B2), consisted of three females and four males caught from wild in 2008. The spawning activities of all broodstocks were synchronised by maintaining the photoperiod (14 h light: 8 h dark). The spawning fish from both groups were artificially induced with hormone to ensure full contribution from all brooders in the breeding tanks. Eggs were collected separately from two spawning events from both groups and about 2,00,000 eggs were randomly sampled out in each spawning group and transported to the South Australian

Research and Development Institute Aquatic Sciences Centre. Upon arrival, eggs from the two groups were hatched in separate 200 l fiberglass incubators at 23°C After hatching, fish larvae were stocked separately in 172 l fiberglass tanks at 2 days post-hatch (DPH) at a density of 100 larvae l^{-1} with four replicates each.

To minimise walling behaviour of fish larvae, the vertical walls of each tank were coated with a marble pattern adhesive film (Cobcroft and Battaglene, 2009). All rearing tanks were supplied with filtered seawater through a 5 µm filter in a flow through system with initial water exchange rate of 600% tank volume; which was increased to 800% towards the end of the rearing period. Aeration was supplied through a single air stone to maintain dissolved oxygen at saturation level and to distribute the larvae as well as the live feed evenly throughout the water column in the tank. A light regime of 13 h light: 11 h dark was provided with a light intensity at 1000 lux, and the salinity was 38%. Throughout the experiment, rearing water temperature was maintained at 23±0.5°C (mean ± SD). The larvae were cultured from 2 to 25 DPH, and fed rotifers (*Brachionus plicatilis*) from 3 to 12 DPH. The rotifers were cultured with *Nannochloropsis oculata* and enriched with *S. presso* (INVE Aquaculture) at 0.175 g l^{-1} for 12 h before being added to the rearing tanks. *Artemia* nauplii enriched with *DHA Selco* (INVE Aquaculture) at 0.6 g l^{-1} for 12 h were introduced to the rearing tanks from 8 to 21 DPH. *Cyclop-EEZE*, a bio-engineered nutritional organism (Argent Chemical Laboratories) was mixed with commercial compounded diet (Otohime B1, Marubeni Nisshin) and supplied to the larvae from 16 to 22 DPH. The larvae were fed with the commercial compounded diet (Otohime B2, Marubeni Nisshin) from 23 to 25 DPH. Fish growth was determined by measuring the specific growth rate (SGR) as % d^{-1} (Hopkins, 1992). Specific growth rate was calculated as: SGR = $100 \times (ln\ L_f - ln\ L_i)/\Delta t$, where L_f is the fish length (mm) at the end of experiment and L_i at the beginning and Δt time interval (d).

At 25 DPH, 50 larvae were randomly sampled from each rearing tank, and were anesthetised with Aquis-S (*Aquis-S*, New Zealand). The standard length and jaw deformities were measured under a dissecting microscope. Totally, 200 larvae from four replicates were examined from each group. Jaw deformity was assessed under a dissecting microscope as per the method by Cobcroft *et al.* (2004) and Cobcroft and Battaglene (2009). The jaw deformities were graded as: normal jaw (JD0); very minor deformities (slight variation from normal) with short lower jaw (JD0.5); minor deformities with short lower or long lower or lower jaw bent or twisted sideways on a slight angle (JD1); and severe deformities with fused maxilla on both sides, or open with broken/bent lower jaw (JD2). The SGR and jaw deformity rate between larvae from the two groups of broodstock were tested by independent t-test, and the cross tables' statistics were conducted by PASW Statistics 18.0.

The SGR and jaw deformity rate were not significantly affected between the two groups (Fig. 1a, b) up to 25 DPH. The standard length (SL) ranged between 6.27 to 14.08 mm in B1 and 7.04 to 14.74 mm in B2. In the present study, no severe deformities (JD2) were observed in both groupe of larvae, and mostly with minor (JD1) or very minor deformities (JD0.5) were observed. Furthermore, both JD0.5 and JD1 were not significantly affected by the two groups.

In B1, most of JD1 occurred when the standard length (SL) of larvae were between 9.80 and 11.60 mm, and the peak of the deformity appeared at SL 10.89 - 11.11 mm (Fig 2a). In B2, most of JD1 was seen in fish of SL between 8.69 and 12.21 mm. In B2,

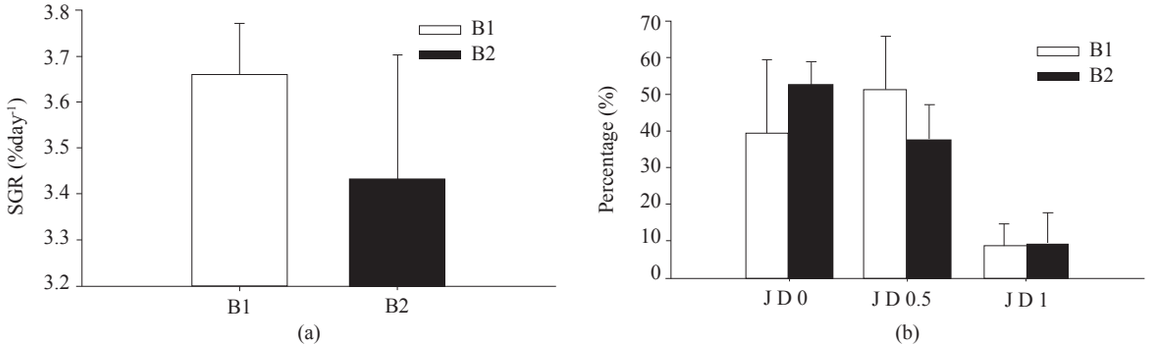

Fig. 1. Specific growth rate (SGR) (a) and jaw deformity (b) in larvae of yellowtail kingfish form two groups (B1 and B2) of broodstock after 25 days of rearing. Normal jaw (JD0); very minor deformities with short lower jaw (JD0.5); minor deformities with short lower or long lower or lower jaw bent or twisted sideways on a slight angle (JD1).

two similar peaks of JD1 were observed: the first peak was observed in the SL range between 9.35 and 9.52 mm and the second peak in the SL range of 10.18 - 10.34 mm (Fig. 2b). In B1, with increase of standard length, the number of larvae with JD0.5 deformity increased and peaked at 9.90 mm and then decreased subsequently. In B2, the number of larvae with JD0.5 deformity was maximum at 8.91mm. The overall trend in jaw deformity grading showed 1 mm difference between B1 and B2. Jaw deformities appeared earlier in B2 and then in B1, suggesting difference in egg quality between the two groups. As the entire rearing conditions such as larval nutrition, temperature and photoperiod were the same for both the larval groups in the present study, these variations may be attributed to factors related to broodstock (egg quality, breeding populations) rather than nutrition and environmental factors.

The cause of jaw and other deformities are generally considered to arise from improper nutrition (Suzuki *et al.,* 2000; Cobcroft *et al.,* 2004; Mazurais *et al.,* 2009; Sandel *et al.,* 2010) or unfavourable rearing environments (Lein *et al.,* 1997; Pankhurst and Hilder 1998; Cobcroft *et al.,* 2004; Battaglene and Cobcroft, 2007; Cobcroft and Battaglene, 2009). From the environmental perspective, several physical parameters that are associated with jaw deformities have been tested, including incubation temperature (Ottesen and Bolla, 1998; Aritaki and Seikai, 2004; Klein, 2007), tank colour (Cobcroft and Battaglene, 2009); light intensity (Pankhurst and Hilder, 1998) and bacterial invasion (Morrison and MacDonald, 1995). However, the factors causing larval fish deformity are still unclear. The present study emphasises the need to consider genetic factors to study larval fish deformity while selecting brooders. Although statistically there was no significant difference in larval jaw deformity between the two groups of broodstock there are evidences of size dependent deformities in both the groups. Larval deformity can be considered as an important attribute for genetic selection in fish hatcheries, in order to minimise production cost and rejection. Studies involving more spawning pairs need to be undertaken so as to obtain results with greater clarity.

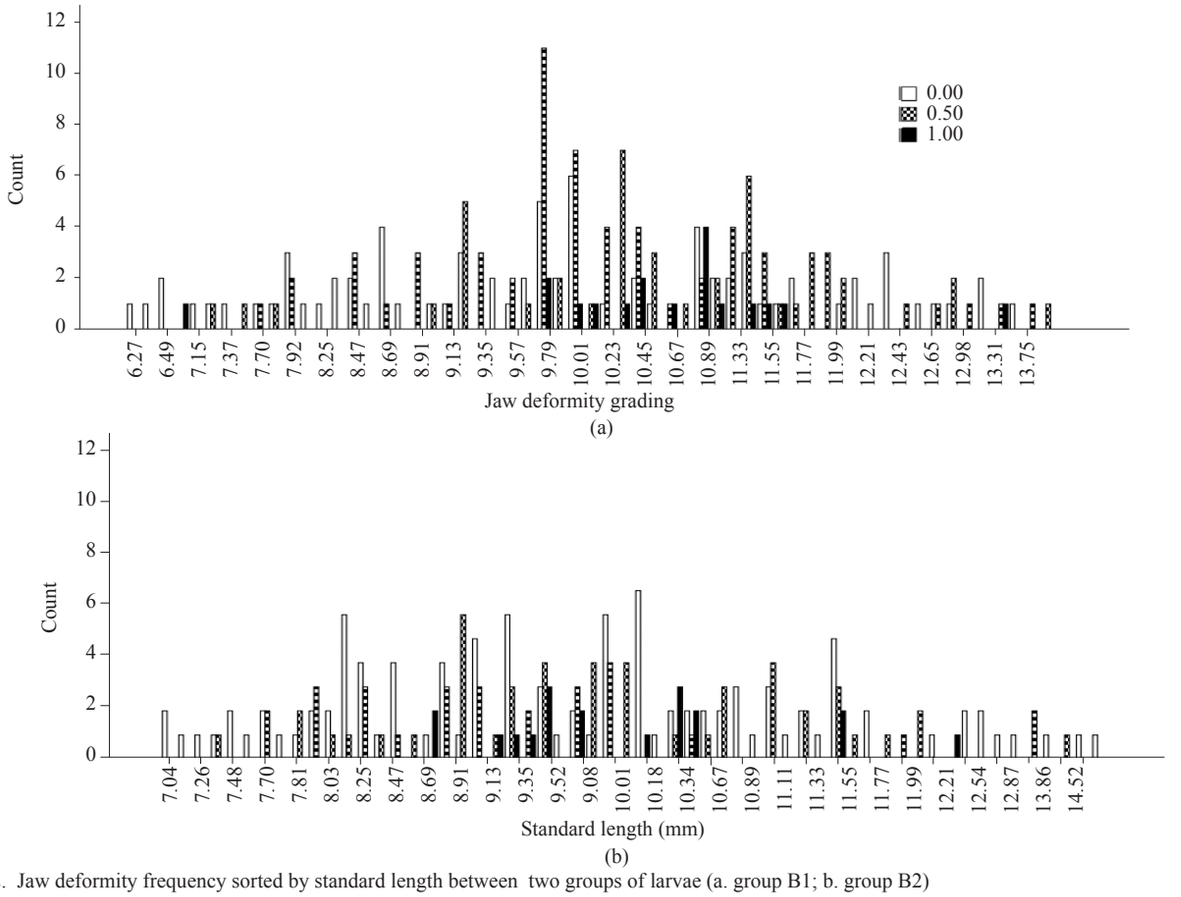

Fig. 2. Jaw deformity frequency sorted by standard length between two groups of larvae (a. group B1; b. group B2)

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