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Effects of photoperiod and feeding frequency on performance of newly weaned Australian snapper *Pagrus auratus*

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Abstract

An experiment was done to investigate the interactive effects of photoperiod (12L:12D or 18L:6D) and feeding frequency on the growth of newly weaned Australian snapper (mean weight = 0.14 g fish^{-1}). Feeding frequency was investigated over 4 levels with 2 feeds delivered during the first half of the daylight period (2FE), 2 feeds during the latter half of the daylight period (2FL), 4 (4F) or 8 (8F) evenly spaced feeds per daylight period. Each treatment combination was replicated in 6 tanks and each tank was stocked with a biomass of 15 g tank^{-1} (i.e. approximately 108 fish tank^{-1}). Snapper were fed a constant ration of 10% BW day^{-1} for 32 days, which was adjusted during the experiment according to frequent weight check procedures. Fish that died were counted but not replaced.

Photoperiod, feeding frequency and the interaction of these factors significantly affected the individual harvest weight and thermal growth coefficient (TGC) of snapper. Interactions were driven by an increase in the magnitude of individual weight and TGC in snapper fed the 4F and 8F treatments and reared under the 18L:6D photoperiod, compared to snapper fed at the same frequencies but reared under the 12L:12D regime. Weight gain and TGC were best in snapper reared under a 18L:6D photoperiod regime and fed 8 feeds day^{-1}, however, weight gain did not plateau, suggesting further increases in weight gain may be possible if feeding frequencies greater then 8F are employed. Survival and apparent feed conversion ratio (AFCR) were significantly affected by feeding frequency alone, with significant improvements in snapper fed more frequently and in snapper fed twice daily but later in the same photoperiod (2FE < 2FL < 4F < 8F). Size heterogeneity (measured by the coefficient of variation for individual harvest weight, CV_{hw}) was affected by photoperiod, and decreased significantly in snapper reared under the 18L:6D regime. Size heterogeneity was also affected by feeding frequency, however, only the CV_{hw} for snapper reared under the 8F feeding frequency was significantly lower than snapper fed at other rates (i.e. 2FE = 2FL = 4F < 8F).

Snapper fed later in a photoperiod regime generally performed better than snapper fed earlier. Results from this study indicate that in order to maximize weight gain, survival and AFCR and to reduce size heterogeneity, newly weaned snapper should be reared under a 18L:6D photoperiod and, for fish fed 10% BW day^{-1}, fed 8 times day^{-1}.

Keywords: Weight gain; Survival; Feeding frequency; Photoperiod; Size heterogeneity

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1. Introduction

The Australian snapper (*Pagrus auratus* = red sea bream *P. major*; Paulin, 1990) is one of several marine species being grown in small sea-cage operations in New South Wales (NSW) and South Australia (SA). The growth of the snapper industry has been constrained by several factors including the poor performance of snapper reared in the cooler waters of SA (Hutchinson, 2003), the high cost of imported and locally manufactured feeds and the low availability of high quality, competitively priced hatchery reared fingerlings. Fingerling supply and price is a particular problem for the snapper industry in NSW, where prices can range from AUS$0.90–1.20 per 35 mm fingerling. These costs are between two and five times higher than prices paid for similar sized freshwater or diadromous fingerlings including silver perch and barramundi. The cost of snapper fingerlings in NSW is high because most marine fish hatcheries operate labour intensive rearing technologies and at the same time produce relatively small numbers of fish (Fielder et al., 2003).

The prospect of a major expansion in the snapper industry providing the economies of scale that might ultimately reduce the price of hatchery reared fingerlings is unlikely in the near future. However, improvements in rearing technology can dramatically increase production efficiency by improving the quality and quantity of hatchery reared juveniles. For example, Fielder et al. (1999) improved the efficiency and quality of egg production in domesticated brood-stock snapper by applying truncated phototherms; effectively allowing year round production of eggs. In addition, Fielder et al. (2005), demonstrated that identification of optimal salinity and temperature regimes dramatically improved the growth of snapper larvae. Identification of improved weaning strategies for snapper has also dramatically improved weight gain and survival (Fielder et al., 2002). Although many of the optimal rearing regimes for larval snapper (15–20 mg fish^{-1}) have been elucidated, there is little information on optimizing the performance of snapper during the nursery or intermediate phase of growth (Partridge et al., 2003).

Two parameters under the immediate control of hatchery personnel that may affect the performance of nursery fish are photoperiod and feeding frequency (Boeuf and Le Bail, 1999; Dwyer et al., 2002). Extended photoperiod regimes have induced faster growth rates in gilthead sea bream (Tandler and Helps, 1985), Atlantic halibut (Simensen et al., 2000), greenback flounder (Hart et al., 1996), sea bass (Barahona-Fernandes, 1979) and snapper larvae (Fielder et al., 2002). However, increased photoperiod does not always result in increased survival and increased photoperiod can sometimes have a deleterious effect (Barahona-Fernandes, 1979; Hart et al., 1996). Optimal feeding strategies can also enhance growth, survival and feed conversion efficiency by minimizing feed wastage, improving water quality and reducing size variation within different cohorts (Dwyer et al., 2002). Poorly timed or sporadic feeding regimes may lead to increased hunger, intra-specific aggression and increased rates of cannibalism (Folkvord and Ottera, 1993); all problems that decrease the efficiency of production and ultimately increase labour input costs.

There is a paucity of scientifically evaluated technologies designed to increase the performance and efficiency of snapper reared during the nursery or intermediate phase of growth. Therefore, the aim of this experiment was to compare the weight gain and performance of newly weaned snapper reared under different photoperiods and subjected to different feeding frequencies.

2. Materials and methods

2.1. Experimental design

A factorial experiment was designed to investigate the interactive effects of photoperiod (12 light:12 dark or 18 light:6 dark; hereafter 12L:12D or 18L:6D, respectively) and feeding frequency (2 feeds early, 2 feeds late, 4 feeds or 8 feeds per day; hereafter 2FE, 2FL, 4F or 8F, respectively), on the weight gain and performance of newly weaned Australian snapper *P. auratus*. These photoperiods were selected based on photoperiod recommendations for larval snapper made by Fielder et al. (2005). Feed was distributed at evenly spaced intervals within the daylight hours of each photoperiod regime (Table 1). Each of the experimental treatments was randomly assigned to 6 replicate experiment tanks and the experiment was run for 32 consecutive days.

2.2. Stocking, weight check and harvest procedures

Approximately 7000 newly weaned snapper (46 days after hatching; dah) were removed from weaning tanks at the Port Stephens Fisheries Centre (PSFC) and carefully transported to the rearing laboratory. Snapper were acclimated to general laboratory conditions for 3 days. Prior to stocking procedures, snapper were visually graded in order to reduce the initial size variation within replicate tanks and decrease the possibility of cannibalism. After grading, fish were stocked into each experiment tank in two rounds of 10 and 5 g per tank, respectively, resulting