Available online at www.sciencedirect.com

SCIENCE DIRECT®

Aquaculture 252 (2006) 361–371

Aquaculture

www.elsevier.com/locate/aqua-online

The effects of wave and feeding disturbance on roe enhancement of the sea urchin *Evechinus chloroticus* held in sea-cages

Philip J. James

National Institute of Water and Atmospheric Research, Wellington, New Zealand

Received 14 April 2005; received in revised form 22 July 2005; accepted 29 July 2005

Abstract

An experiment was conducted over a 10-week period to test the effects of wave and feeding disturbance on the gonad index (GI) and gonad color of sea urchins fed an artificial diet. The sea urchins were held in sea-cages at a depth of 6 m. Eight cages were suspended from a surface line (wave disturbed) and eight were subsurface buoyed from a bottom line (not wave disturbed). These two treatments were further divided into four replicates that were fed and cleaned in situ underwater (no feed disturbance) and four replicates that were removed from the water three times per week for feeding and cleaning (feed disturbance). Increased water movement, probably caused by the vertical motion in the wave disturbed cages resulted in a higher GI in these urchins compared to urchins in cages that were subsurface buoyed and did not experience any vertical movement. Feeding disturbance had no effect on the GI values or color quality of the urchin gonads, regardless of whether the urchins were held in sea-cages that were wave disturbed or not wave disturbed.

Keywords: Urchins; *Evechinus chloroticus*; Sea cages; Wave disturbed; Feeding

1. Introduction

There has been extensive international research into the factors that effect sea urchin roe enhancement (Pearse and Cameron, 1991; Klinger et al., 1997; Robinson and Colborne, 1997; Walker and Lesser, 1997; Lesser and Walker, 1998; Lawrence et al., 2001). The key factors that have been identified are the availability of an effective artificial diet, the reproductive condition of the animals and the availability of suitable holding systems (Pearse and Cameron, 1991; Lesser and Walker, 1998; Lawrence et al., 2001). There has been increasing worldwide interest in sea-based urchin roe enhancement with promising results (Robinson and Colborne, 1997; Bridger et al., 1998; Kelly et al., 1998; Vadas et al., 1999; Mendes and Becarra, 2004; Aas, 2004).

In New Zealand the sea urchin (kina) *Evechinus chloroticus* (Val.) has been commercially fished since 1986 and the urchin roe has almost entirely been sold on the domestic market. There have been a number of attempts to export urchin roe to overseas markets such

E-mail address: p.james@niwa.co.nz.

0044-8486/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.aquaculture.2005.07.023

as the Japan, but only a small amount has been exported due to the roe having a bitter taste (McShane et al., 1994), poor color, and inconsistent or low yields (Herbert, pers comm.). Consequently, the fishery has not expanded in New Zealand to the same degree that has occurred in other countries (Andrew et al., 2002). Currently, fishing urchins in New Zealand is marginally economic and requires significant local knowledge and resources because of the variable quality and wide distribution of animals that do have good quality roe (James, 2004). Growing worldwide interest in the enhancement of sea urchin roe from wild caught animals has created intense interest in New Zealand. If it is possible to consistently improve the quality and quantity of roe from wild urchins this would present the opportunity to export enhanced roe into lucrative international markets. There have been a number of studies on the sea urchin (kina) *E. chloroticus* in New Zealand testing the efficacy of natural diets and artificial diets on roe enhancement in land-based holding systems (Barker et al., 1998; Buisson, 2001; James et al., 2004). A study by Fell (2002) investigated the effects of holding kina in sea-cages and feeding a combination of artificial and natural diets with promising results and a recent study comparing the efficacy of land- versus sea-based holding systems showed little difference in the GI or the color of sea urchin roe held in either system (James, in press).

There are a number of other factors that effect urchin roe enhancement such as temperature and photoperiod (Spirlet et al., 2000; Buisson, 2001; Shpigel et al., 2004; Siikavuopio and Christiansen, 2004; Hofer and Watts, 2004). Factors that have been less studied are disturbance effects such as wave disturbance, and feeding and cleaning disturbance. Urchins held in sea-cages may need to be removed from the water on a regular basis to replenish feed supplies, remove uneaten feed and clean the cage but there have been no studies to determine the effects of removing urchins from the water for feeding. Similarly, there have been no studies on the effects that environmental conditions such as vertical wave movement may have on animals held in a sea-cage system (Fig. 1).

The aim of this study was to test the effects of both feeding and wave disturbance on the roe enhancement of sea urchins held in sea-cages by measuring roe production, survival and roe color quality.

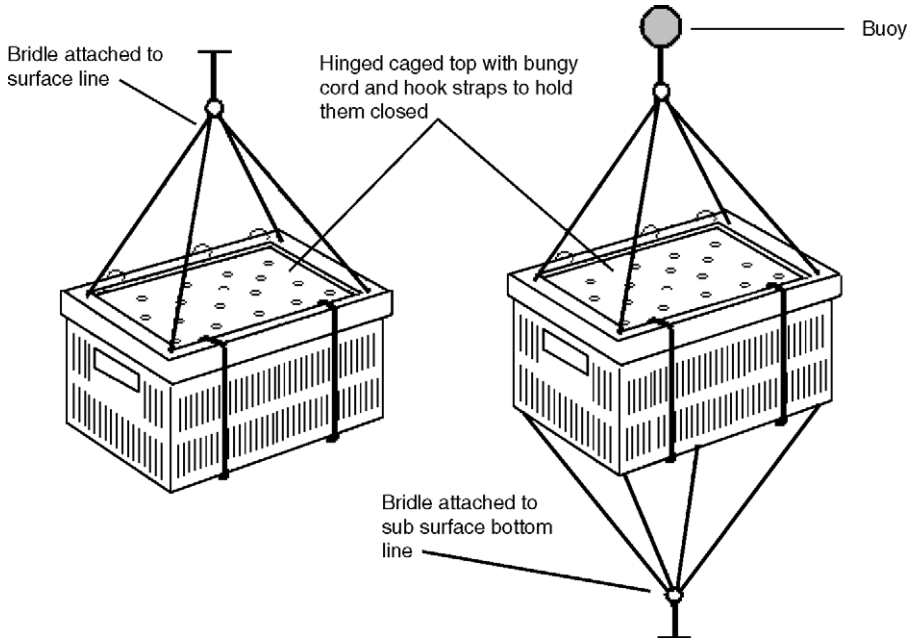

Fig. 1. The sea-cage system used to hold sea urchins in during the experiment. The cages suspended from the surface line were 6 m below the surface and those attached to the subsurface bottom line and suspended 2 m above the seafloor were also 6 m below the water surface at mid tide.