Effect of nurseries and size of released *Holothuria scabra* juveniles on their survival and growth

Thierry Lavitra[1,], Gaetan Tsiresy[1,2], Richard Rasolofonirina[1] and Igor Eeckhaut[2]*

Abstract

When 15-g juveniles of *Holothuria scabra* are transferred into sea pens for farming in Madagascar, there is high mortality during the two first months of rearing, which is principally due to predation by the crab *Thalamita crenata*. The use of nurseries (covered pens) is thought to be the best way of protecting those juveniles against predation. An experiment was carried out in Tampolove, a sea cucumber farming site where there is a very low density of predators. The purpose of the experiment was to see how the use of nurseries and the size at which juveniles are released into them affected their survival and growth.

For this experiment, eight nurseries and eight sea pens, all 16 m², were constructed and four size groups of juveniles were tested: 0–5 g, 5–10 g, 10–15 g and 15–20 g. The rearing density was 3 ind. m^{-2}. After three months, the average survival rates were between 78.00 and 83.75%, which suggests that the size of released juveniles did not affect the survival rate. Also, the use of a nursery did not significantly increase the survival rates; they were 87.50% and 78.88% respectively for juveniles reared in nurseries and in sea pens.

This experiment showed that the use of nurseries is not necessary in farming sites with a low density of predators, and that juveniles less than 5 g can be released in these sites.

Introduction

Mesh enclosures in the sea or in earthen ponds are one solution for scaling up production of juvenile sandfish because the cost of mesh and water exchange are relatively low (Juinio-Meñez et al. 2012; Purcell et al. 2012; Purcell and Agudo 2013). Pitt and Duy (2004) conducted the pioneering work of growing sandfish juveniles in mesh enclosures in earthen ponds. This nursery system involved two steps: small juveniles of a few mm body length from hatchery tanks are grown in the fine-mesh enclosures to about 20 mm body length (almost 1 g body weight), then transferred to coarse-mesh enclosures of 1 mm mesh and grown to a competent size for stocking into ponds or into the sea.

Tsiresy et al. (2011) were the first to use sea nurseries (mesh-covered sea pens) ensuring the first months of *Holothuria scabra* juveniles development in SW Madagascar after being transferred from earthen ponds. The *H. scabra* juveniles are transferred into nurseries at a weight of 15 g. The first assays with nurseries were made at Sarodrano and Andrevo, two villages close to Toliara, which suffer the greatest losses of juveniles. The introduction of nurseries made it possible to significantly restrict losses in the first month. The idea behind these nurseries was to physically prevent crabs *Thalamita crenata* (the biggest predator of sandfish juveniles in the region, Lavitra et al. [2009]) from approaching juveniles during the first weeks of growth in the sea. With this new system, 15 days after stocking, the observed survival rates were 79% for Sarodrano and 70% for Andrevo. Unfortunately, these positive results led farmers to neglect crab culling, both in nurseries and in the rest of the pens, so losses after the first few days were huge.

Juinio-Meñez et al. (2012) tested different enclosure systems in the Philippines for rearing sandfish juveniles starting at 4–10 mm over 1–2 months. They found poor survival (18%) of juveniles in enclosures set on the sea bed, better rates in floating enclosures (12–44%) and the best rates in enclosures in earthen ponds (57–73%). Purcell and Agudo (2013) in New Caledonia used coarse-mesh sea enclosures gathered at the top and attached to the benthos but the

1 IHSM (Institut Halieutique et des Sciences Marines), University of Toliara-Madagascar, Route du Port Mahavatsy, PO Box 141 (601), Toliara, Madagascar.
2 Biology of Marine Organisms and Biomimetics, University of Mons-Belgium.
* Corresponding author: lavitra_thierry@ihsm.mg

system did not appear to be a viable nursery system; the slow growth rates of sandfish juveniles that they measured would stifle production of juveniles for stocking programmes.

At present, results of the tests involving nurseries are conflicting. In the present study, we investigate the effects of: (i) the use of sea nurseries; and (ii) the size of released juveniles on the survival and growth of *H. scabra* juvenile in Tampolove, a farming site on the northwest coast of Toliara (Madagascar) where the predator crabs *T. crenata* are rare.

Materials and methods

Construction of pens and nurseries

The construction of pens and nurseries was carried out during low tide in the spring. The pens were constructed with plastic nets fixed to wooden stakes placed at 50 cm intervals and buried to a depth of 25 cm to prevent the escape of juveniles (Fig. 1A). A nursery is a pen covered on top by a local fishing net (Fig. 1B). For this experiment eight pens and eight nurseries were constructed and installed in Tampolove village. Each pen/nursery had a surface area of 16 m^2 (4 x 4 m) and was 50 cm high.

Juveniles

Holothuria scabra juveniles were offered by the MHSA Company (Madagascar Holothurie Société Anonyme) and four different sizes were tested: 0–5 g; 5–10 g; 10–15 g and 15–20 g. The rearing density was 3 ind. m^{-2}, which was equivalent to 48 juveniles per pen/nursery.

Measurements

This experiment was conducted over a three-month period (June to September 2012). To get the growth rate, the juveniles were weighed monthly at night, since they burrow under the sediment during the day. The survival rate was recorded at the end of each month by counting the number of live specimens.

Data analysis

All samples presented a normal distribution of the data and homogeneity of variances after running the Kolmogorov-Smirnov and Levene tests. Therefore, a two-way ANOVA was used to analyse the data. The statistical analysis was performed using SYSTAT v12 Software.

Results

Survival

After three months of rearing, the average survival rates were 83.75% ±6.18, 88.00% ±13.88, 78.00% ±17.49 and 83.00% ±13.63 for the four size classes respectively (juveniles released in nurseries and pens combined; Fig. 2). The statistical analysis showed that the release size of the *H. scabra* juveniles did not affect their survival ($P = 0.7640$). Also, the use of a nursery did not increase the survival rates ($P = 0.226$). They were 87.50% ±11.42 and 78.88% ±12.87 respectively for juveniles reared in a nursery and in a pen (all sizes combined; Fig. 2).

Growth

A slightly exponential growth was observed during the three months of the experiment for the four size classes of *H. scabra* juveniles: 0–5 g, 5–10 g, 10–15 g, and 15–20 g (Fig. 3). Because the juveniles released at the beginning of the experiment were of different sizes, their average weights were also different after three months (P = 0.0001). They were 35.25 g ±4.14, 48.80 g ±3.80, 58.32 g ±5.72 and 62.99 g ±4.02 for the four size classes respectively (Fig. 4).

Figure 1. Experimental enclosures constructed on a seagrass bed.
A: Uncovered pen; B: nursery (pen covered by fishing net).

No significant difference was observed for *H. scabra* juveniles reared in nurseries (51.66 g ±13.39) compared to those reared in pens (51.01 g ±10.59) ($P = 0.794$).

Discussion

In sea cucumber aquaculture developed in Madagascar, *H. scabra* juveniles of 2 cm are reared on sandy-muddy substrates in earthen ponds until they reach a length of 6–8 cm (about 15 g) (Eeckhaut et al. 2008; Lavitra 2008). Once the individuals reach this size, they are placed in sea pens. Below this size, predators such as crabs and fish could attack them (Battaglene 1999; Lavitra 2008; Eeckhaut et al. 2008). Thus, the use of covered pens (nurseries) was suggested for the first months of the transfer (Tsiresy et al. 2011) in order to protect the newly delivered

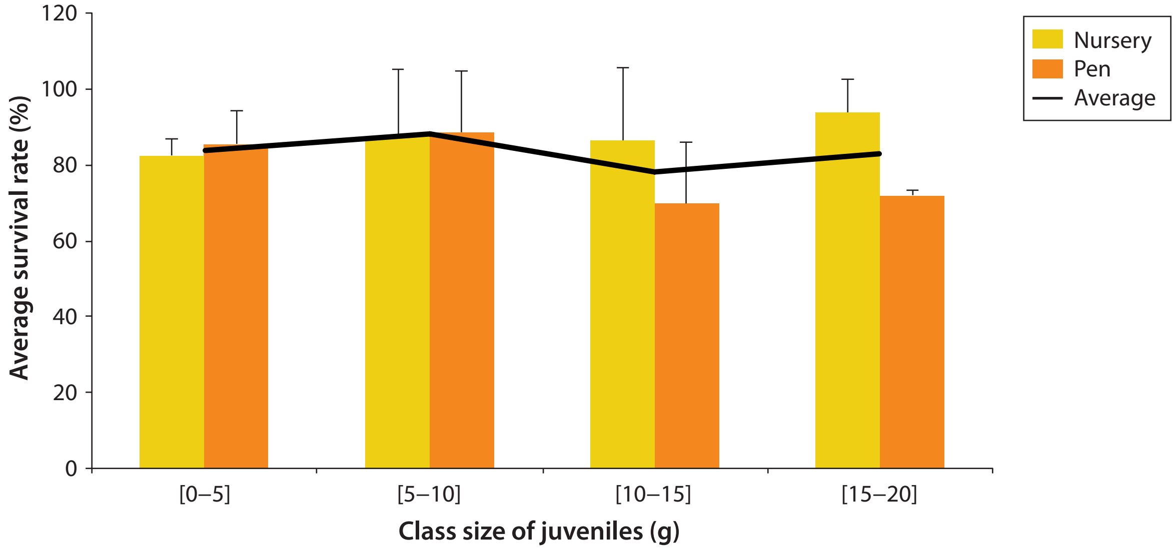

Figure 2. Average survival rates of *Holothuria scabra* juveniles of different sizes in pen and nursery after three months of rearing.

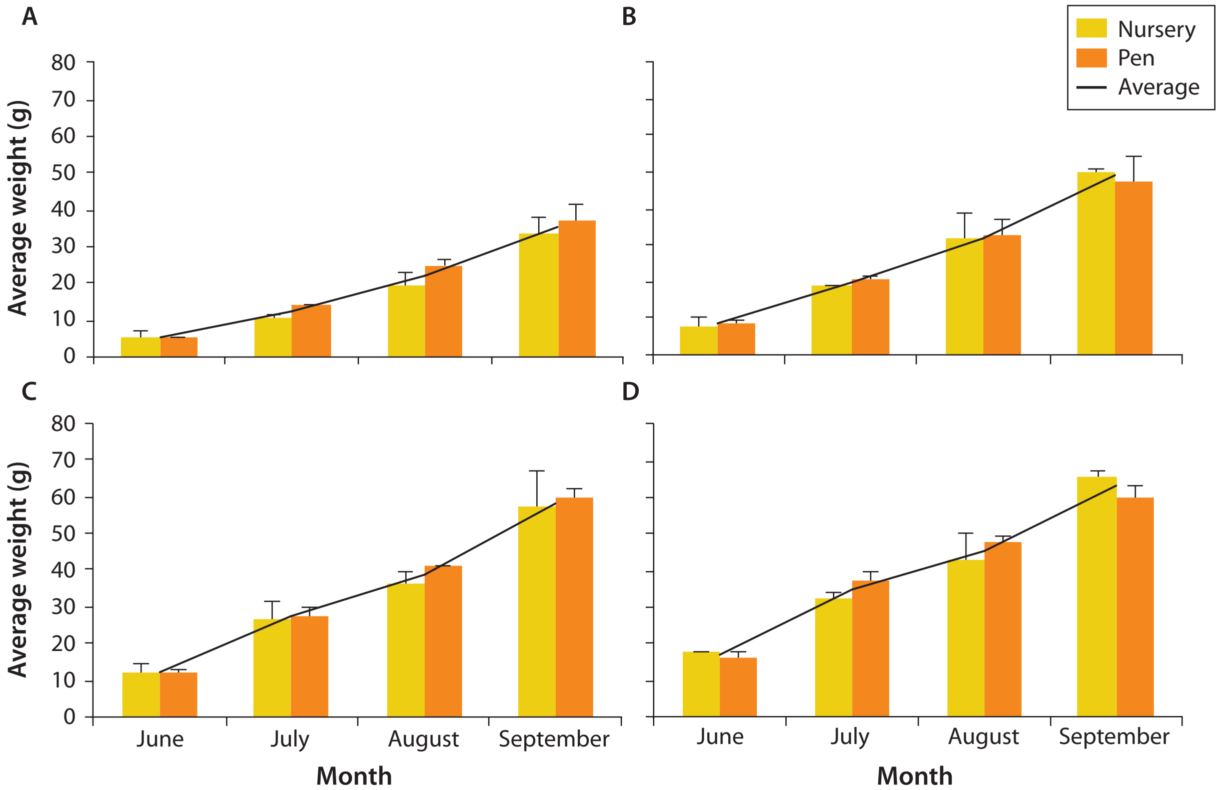

Figure 3. Average growth of *Holothuria scabra* juveniles during three months of rearing in pens and nurseries. The initial measure was taken in June. A: Size release 0–5 g; B: 5–10 g; C: 10–15 g; and D: 15–20 g.

juveniles. Our experiment showed that the use of nurseries was not necessary in Tampolove, as the survival of *H. scabra* juveniles reared in normal sea pens and in nurseries did not differ significantly, nor did their growth. Also, this experiment showed that the size of released juveniles did not affect their survival, which suggests that *H. scabra* juveniles of less than 5 g could be released directly into sea pens in some regions where the density of predators, like the crabs *T. crenata* in SW of Madagascar, is low. This new data mean that the time necessary for *H. scabra* juveniles to grow to the appropriate size of 15 g in external tanks — two to three months — can be reduced to only one month if juveniles are reared in appropriate sea sites without predators. From this experiment, we would suggest that the presence of predators is one of the most important factors that should be considered before choosing: (i) a sea cucumber farming site; (ii) the type of enclosure; and (iii) the size of released juveniles.

Acknowledgments

The authors thank the Malagasy Government through AMPA agency (Agence Malgache pour la Pêche et l'Aquaculture) for financial assistance and MHSA Company for technical assistance and for offering *H. scabra* juveniles.

References

Battaglene S.C. 1999. Culture of the tropical sea cucumbers for the purpose of stock restoration and enhancement. Naga, the ICLARM Quarterly 22(4):4–11.

Eeckhaut I., Lavitra T., Rasolofonirina R., Rabenevanana M.W., Gestin P.G. and Jangoux M. 2008. Madagascar Holothurie SA: The first trade company based on sea cucumber aquaculture in Madagascar. SPC Beche-de-mer Information Bulletin 28:22–23.

Juinio-Meñez M.A., de Peralta G.M., Dumalan R.J.P., Edullantes C.M. and Catbagan T.O. 2012. Ocean nursery systems for scaling up juvenile sandfish (*Holothuria scabra*) production: Ensuring opportunities for small fishers. p. 57–62. In: Hair C., Pickering T. and Mills D. (eds). Asia-Pacific Tropical Sea Cucumber Aquaculture. ACIAR Proceedings No. 136. Canberra, Australia: Australian Center for International Agricultural Research. 210 p.

Lavitra T. 2008. Caractérisation, contrôle et optimisation des processus impliqués dans le développement postmétamorphique de l'holothurie comestible *Holothuria scabra* (Jaeger, 1833) (Holothuroïdea: Echinodermata). Thèse de Doctorat, Université de Mons-Hainaut, Belgique. 166 p.

Lavitra T., Rasolofonirina R., Jangoux M. and Eeckhaut I. 2009. Problems related to the farming of *Holothuria scabra* (Jaeger, 1833). SPC Beche-de-mer Information Bulletin 29:20–30.

Pitt R. and Duy N.D.Q. 2004. Breeding and rearing of the sea cucumber *Holothuria scabra* in Viet Nam. p. 333–346. In: Lovatelli A., Conand C., Purcell S., Uthicke S., Hamel J.-F. and Mercier A. (eds). Advances in Sea Cucumber Aquaculture and Management. FAO Fisheries Technical Paper No. 463. Rome, Italy: Food and Agriculture Organization of the United Nations. 425 p.

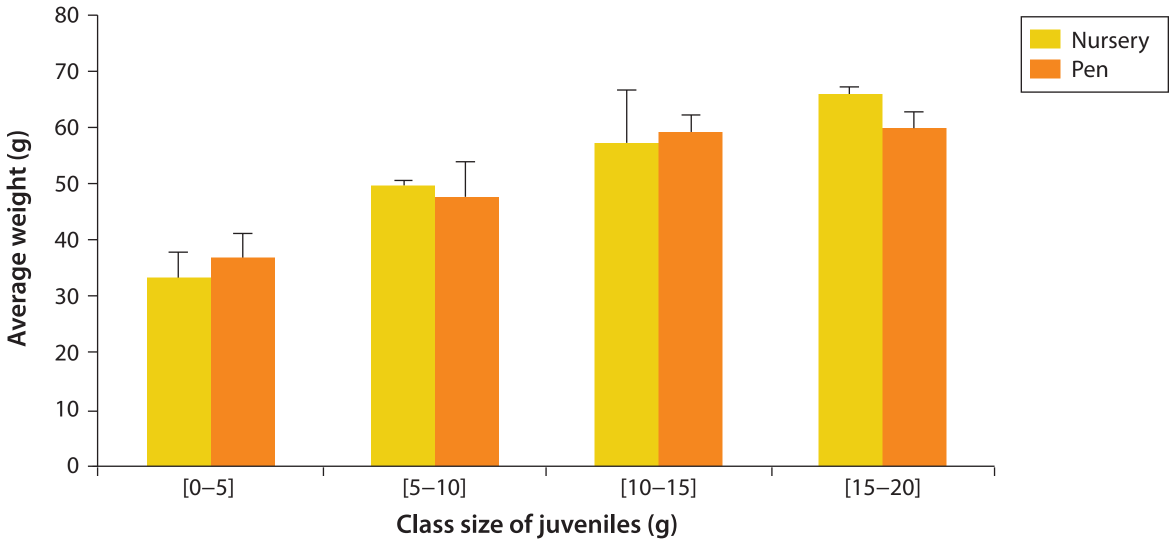

Figure 4. Average weight of *Holothuria scabra* juveniles of different sizes in pens and nurseries after three months of rearing.

Purcell S.W., Hair C. and Mills D. 2012. Sea cucumber culture, farming and sea ranching in the tropics: Progress, problems and opportunities. Aquaculture 368:68–81.

Purcell S.W. and Agudo N.S. 2013. Optimisation of mesh enclosures for nursery rearing of juvenile sea cucumbers. PLoS ONE 8(5): e64103. doi:10.1371/journal.pone.0064103.

Tsiresy G., Pascal B. and Plotieau T. 2011. An assessment of *Holothuria scabra* growth in marine micro-farms in Southwestern Madagascar. SPC Beche-de-mer Information Bulletin 31:17–22.