Pond grow-out trials for sandfish (*Holothuria scabra*) in New Caledonia

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Abstract

Sandfish (*Holothuria scabra*) is a high-value tropical sea cucumber widely distributed in the shallow waters of the Indo-Pacific. In New Caledonia, sandfish are locally called 'gris' and have been harvested since the 1840s. The WorldFish Center in New Caledonia grew cultured juvenile sandfish in earthen ponds to assess the potential for farming the species. In this paper, we report on pond culture grow-out of sandfish from small juveniles to market size in a 21-month trial. Sandfish in two ex-shrimp ponds reached mean weights of 390 and 441 g after 19 and 21 months, respectively. The overall average weight gains were estimated to be 0.60 g and 0.77 g per animal per day, and overall survival to be 69% and 41%, respectively. Some mortality occurred in ponds due to high water temperature and salinity. Beche-de-mer produced from the pond-grown sandfish had a darker skin colour and most was classified as grade-A, although cultured animals lost twice as much weight as the wild sandfish during processing. Positive features were the homogeneous sizes of pond-grown animals and the potential for reduced fluctuations in numbers. Recommendations for improving sandfish farming in ponds centre on the management of animal density and the practice of alternating earthen ponds.

Introduction

Sandfish, *Holothuria scabra*, is a tropical sea cucumber widely distributed in the shallow waters of the Indo-Pacific (Conand 1998). This species has a high commercial value on the international market once processed by boiling and drying into beche-de-mer (also called trepang). In New Caledonia, sandfish are locally called 'gris' and have been harvested since the 1840s (Conand 1990). The current fishery is composed mainly of Indigenous artisanal fishers (Purcell et al. 2002). The price for beche-de-mer exports depends on its quality and size, and in 2007 was in the range US$21–47/kg in New Caledonia. Over the past 10 years, exports of beche-de-mer from New Caledonia have ranged from 40 to 80 tonnes annually according to the Institut de la Statistique et des Etudes Economiques de Nouvelle-Calédonie (ISEE).

Pioneering work on sandfish spawning and rearing was done in India in 1988 at the Central Marine Fisheries Research Institute (James et al. 1994). Rearing methods were then developed further by the WorldFish Center (formerly ICLARM) in Solomon Islands (1996–99), Vietnam (2000–04) and New Caledonia (2000–06). The main focus of the research by the WorldFish Center in New Caledonia was the release of juveniles into enclosures in the wild to determine the optimum size and density for restocking and stock enhancement. Additionally, some of the cultured juvenile sandfish produced in New Caledonia were on-grown in earthen ponds to assess the potential for farming the species. Preliminary results were reported by Bell et al. (2007). In this paper, we report more details on pond-culture grow-out of sandfish from small juveniles to market size (400–600 g).

Methods

The grow-out trials for sandfish were conducted over 21 months between June 2005 and March 2007. Two 0.2-ha earthen ponds (A and B) on a private shrimp

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farm at Tontouta, 50 km north of Noumea, were used (Figure 1). All juveniles used for these trials were reared in the WorldFish Center's sea cucumber hatchery at Saint Vincent (Boulouparis, 73 km north of Noumea) using the methods described by Pitt (2001) and Agudo (2006). Pond A was stocked with juveniles that had a mean weight of 0.9 g at a stocking density of 1.6 individuals/m^2. Pond B received larger juveniles (mean weight of 11.7 g) at a density of 0.8 individuals/m^2. The grow-out trials commenced during winter on 6 June 2005, when the average water temperature was 22 ºC.

Both ponds had a maximum depth of 1 m and a muddy substratum. The ponds had previously been used for maintaining shrimp (*Litopenaeus stylirostris*) broodstock, but had been empty since 2002. They were filled with sea water 2 weeks before transferring the sandfish juveniles. No food or fertiliser was added. Daily water exchange usually varied between 30% and 60%, but fell to less than 10% on one occasion due to a broken water pump. Water temperature (ºC), salinity (ppt), dissolved oxygen (ppm) and secchi disk (cm) measurements were taken twice a day, in the morning and in the afternoon.

Figure 1. Earthen pond used for growing out sandfish

To estimate the growth of sandfish, the mean wet weight (g) of 30 individuals from each pond was measured each month. Animals were collected at random, dried in the shade for 5 minutes, then weighed with a digital balance. Survival of sandfish in each pond was determined by counting all animals when the ponds were drained at the conclusion of the trial.

Harvested sandfish were processed by a professional into beche-de-mer by gutting, boiling, soaking in sea water overnight, cleaning, boiling again and drying. A local trader evaluated the beche-de-mer based on skin colour, cleanliness of gut and skin, and resultant product grade.

Results

Water quality parameters

Water temperature was in the range 16.9–33.3 ºC, with mean water temperatures between 27.3 ºC and 27.9 ºC in summer and between 17.5 ºC and 24.1 ºC in winter (Figure 2). Dissolved oxygen variation was 2.9–14.2 ppm, and salinity was mostly between 32 and 36 ppt. Extreme values of salinity such as 25 and 38 ppt were occasionally observed. Secchi measurements averaged 50 cm.

Growth rate

In pond A, sandfish with an initial mean weight of 0.9 g reached a mean weight of 325.4 g after 12 months. Their growth then slowed during the cold season, when mean water temperatures were between 20.4 ºC and 22.7 ºC (Figure 2). Sandfish in pond A reached a final mean weight of 390 g after 21 months (Figure 3). Mean individual growth rate was correlated with water temperature and reached a peak of 1.04 g/day in April 2006, when the mean water temperature was 27.3 ºC (Figure 2).

In pond B, the sandfish with a greater initial weight of 11.7 g reached a mean weight of 395 g after 13 months. Their growth also slowed during the cold season when mean water temperature was in the range 20.7–22.7 ºC. Excessive development of filamentous algae in pond B meant that these animals had to be transferred to another pond in December 2005. At the time of transfer, survival was 73%. The transferred sandfish reached a final mean weight of 441 g after 19 months (Figure 3), and maximum growth rate was 1.3 g/day in March 2006 (Figure 2).

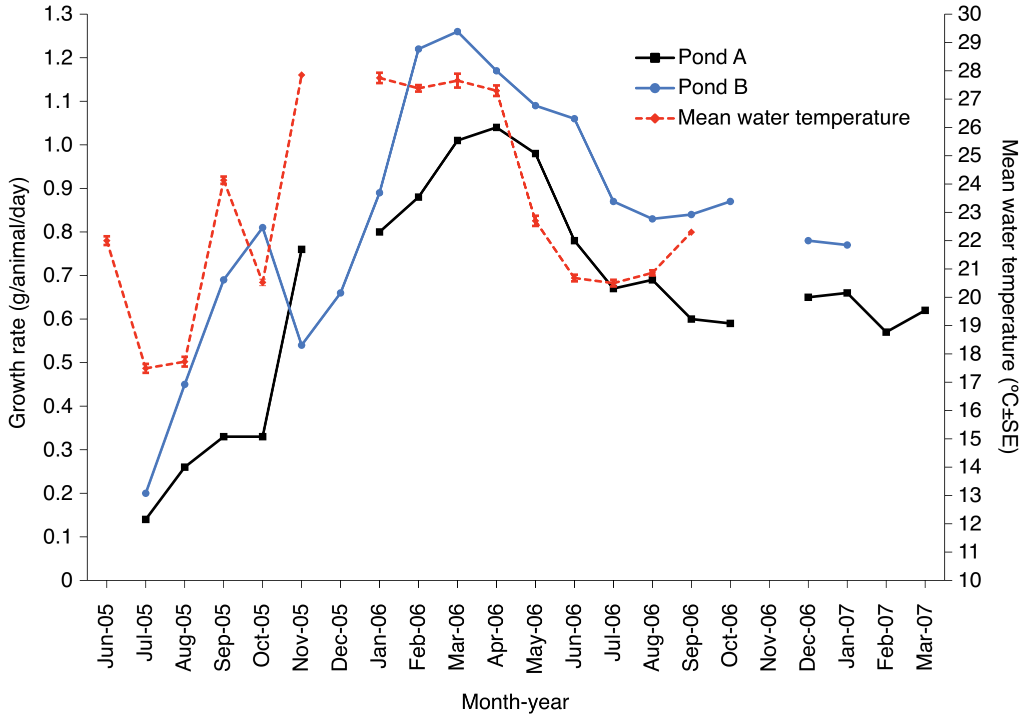

Figure 2. Growth of sandfish and mean water temperature in ponds A and B

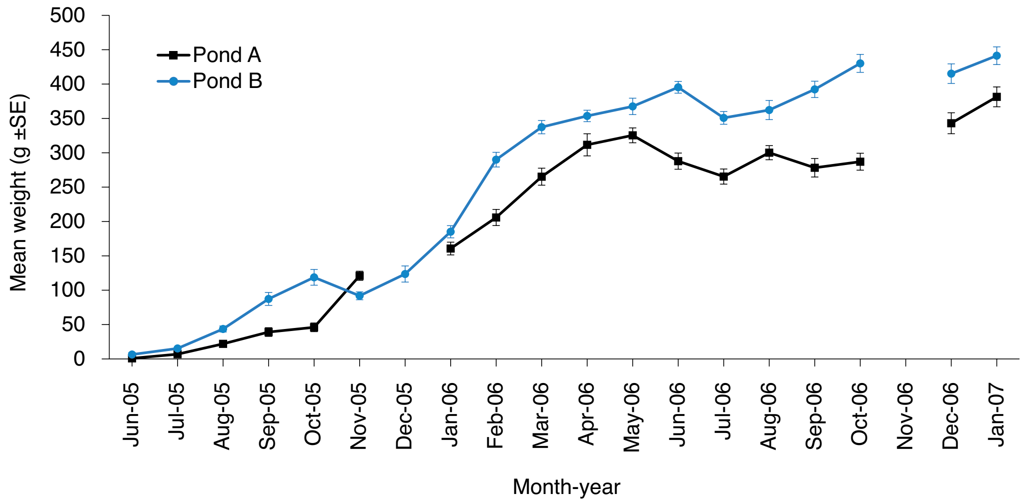

Figure 3. Mean weight of sandfish in ponds A and B

Maximum growth for sandfish in both ponds during these trials was reached after 10–11 months during summer (March–April 2006, Figure 2). Growth then decreased and ranged from 0.6 to 0.8 g/day for pond A, and from 0.7 to 0.9 g/day for pond B (Figure 2). The overall average weight gains were estimated to be 0.60 and 0.77 g/animal/day for ponds A and B, respectively.

The length–weight relationship of the sandfish stocked into ponds A and B (Figure 4) is a power curve, as described by Pitt and Duy (2004a).

Survival and stocking density

In pond A, survival after 21 months was 69%. The final density was 1 animal/m^2 and biomass was 434 g/m^2. This was well above the level of ~225 g/m^2 thought to be the limit of growth rates (Battaglene 1999). Over 3 days in early 2007, 2,222 sandfish were harvested (45, 280 and 1,897 animals harvested on 24 January, 26 January and 15 March, respectively).

In pond B, final survival was 41% after 19 months; high mortalities were observed after the first 6–7 months during the 2005–06 summer due to excessive weed proliferation (Figure 5), which, in turn, induced high water temperature and salinity. At the time of transfer of animals, during that summer, the survival rate reached 73%. The final density was 0.3 animals/m^2 and biomass was 147 g/m^2. Over 3 days in early 2007, 668 sandfish were harvested (376, 68 and 224 animals harvested on 10 January, 13 January and 26 January, respectively).

Behaviour of sandfish in ponds

During the full moon in February 2006, when the average water temperature was 27.4ºC, an aggregation of at least 100 sandfish was observed on the edge of pond A (Figure 6). They formed groups of four or five individuals (mean weight of 206 g), reaching a maximum density of 30 animals/m^2. Pre-spawning behaviour, such as rolling movements, was also observed. In March 2006, in pond B, an adult male (>300 g) spawned in the afternoon. This occurred 1 day after the first quarter of the moon, when the water temperature was 30.7 ºC.

During winter 2006, 70% of the sandfish were buried with a thick layer of mud covering their dorsal surface (Figure 7). The average water temperature in ponds during this period was 20.5 ºC.

Birds and their footprints were often observed around the ponds. Crabs (e.g. *Portunus pelagicus*, *Scylla serrata*), indigenous shrimps (*Penaeus* sp.) and fish (*Apogon* sp., *Siganus* sp.) were also seen in the ponds. During the 21-month grow-out period, 14 sandfish (22–392 g) with skin lesions were observed (Figure 8). The lesions were always on the dorsal surface of the animals, and appeared to have been caused by predators such as large crabs and birds.

Another danger is if the pond water level suddenly drops. Animals buried near the edge of ponds can be trapped, and if they remain out of water for more than a few hours, they will eviscerate and die (Figure 9).

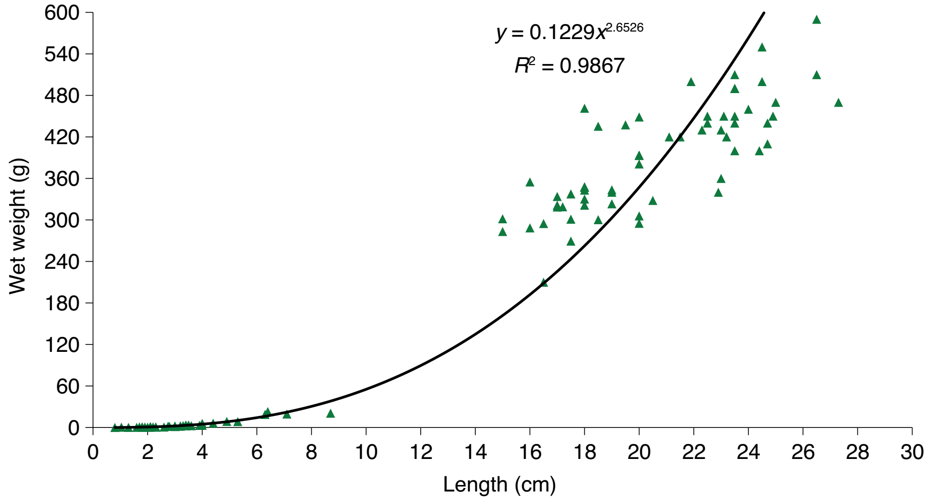

Figure 4. The length–weight relationship for cultured sandfish reared in ponds

Figure 5. Weed proliferation in a grow-out pond

Figure 6. Aggregation of sandfish near pond edge

Figure 7. Buried sandfish

Figure 8. Sandfish with skin lesions

Figure 9. Trapped and eviscerated sandfish

Processing into beche-de-mer

During processing (Figure 10A, B), sandfish were gutted by making a small incision on the ventral surface to remove the viscera. Initial boiling time was about 30 minutes. Drying was done outdoors under the sun for at least 1 week, depending on the weather.

The beche-de-mer from the cultured animals had a darker skin colour than the product processed from wild sandfish. Most of the cultured beche-de-mer was classified as grade A (with some grade Extra-A and grade B) with a free-on-board export value of €75–77/kg (2007 prices). A negative aspect was that cultured animals lost twice as much weight during processing compared with wild sandfish. Hence, for the grade A beche-de-mer, there were 25 pieces/kg instead of 13–15 pieces as found in wild sandfish harvests. In spite of this disadvantage, the consistently large specimens and high final grade were encouraging features for the trader, who normally has to deal with variable sizes and fluctuations in numbers from local wild sandfish fisheries.

Discussion

Although the sandfish in our trials required minimal husbandry, some mortality did occur in pond B due to high water temperature and salinity. Thus, a combination of extreme conditions, such as sudden variation of temperature and salinity, handling and transport may generate harmful stress leading to loss of stock. A key requirement of management is to observe some relatively simple measures to minimise the risks of stress, such as avoiding extreme variations in water temperature, always keeping the animals in water in the shade, and not overcrowding the animals in containers. Nevertheless, the costs of husbandry should be modest because sandfish do not need feeding in ponds at medium densities (1.5–3.0 t/ha) (Pitt and Duy 2003).

Stratification of water in ponds due to heavy rainfall is to be avoided (Pitt et al. 2001) because it can lead to extremely high temperature, low salinity and low dissolved oxygen. Sandfish can survive salinities as low as 20 ppt, but they are vulnerable to anoxic conditions in ponds (Pitt and Duy 2004b). Proliferation of filamentous algae can also cause similar problems.

Figure 10. Sandfish processing showing: freshly harvested sandfish (A) and initial boiling (B)

Provided that suitable water conditions can be maintained in ponds, the growth rates of sandfish are encouraging for farming. Indeed, from grow-out trials in shrimp ponds in Vietnam, individual growth rates of 2 g/day appear to be possible throughout much of the year on a range of substrates (Pitt et al. 2001; Pitt and Duy 2003, 2004b). Growth rates in New Caledonia were also favourable—at 0.6–1.3 g/day—and higher than those in the wild (Hamel et al. 2001). They were lower than those in Vietnam, presumably due to cooler water temperature and lower levels of nutrients in the ponds. It appears that lack of nutrients in the sediment, high biomass and low water exchange resulted in environmental conditions that did not favour growth. Management of density was not attempted during the grow-out trials because of the distance to the site and the fact that a technician was not on site at all times. These results suggest that survival and growth could be improved substantially by regular removal of sandfish to another pond.

The duration of grow-out to 400 or 600 g can possibly be reduced in New Caledonia if juveniles are released in summer into ponds with enriched substrates. Another potentially promising way to reduce the cost of farming sandfish is to find ways to bypass the second nursery phase in hatcheries by releasing newly settled juveniles directly into ponds. For this to succeed, the pond will need to have sediment that allows the growing juveniles to bury, and predators will need to be controlled.

This trial showed that sandfish, *Holothuria scabra*, could be reared in earthen ponds. In nature, these sea cucumbers live mainly on sandy–muddy subtrata. However, the sediment found in shrimp ponds in New Caledonia appears to fit the habitat requirements of sandfish.

In New Caledonia the hot season lasts from November to mid April, and the coldest season from mid May to mid September. In summer, tropical depressions and cyclones can also bring heavy rains that pose a risk to the farming of sandfish. Without any management or intervention, long periods of rain can lead to partial or total loss of animals in earthen ponds. Future studies should focus on the monitoring and management of freshwater influx into ponds during these high-risk periods.

During the hatchery–nursery phase, juveniles of 1 g may be obtained after 2–3 months of culture. But we must consider that 19–20 months of rearing in ponds is necessary for a minimum of 500 g weight, on average, for sea cucumbers. Further research should focus on improving farming conditions for better growth performance and reduced rearing periods.

Finally, the practice and advantages of alternating pond-culture species could also be considered. This practice could actually improve sediment quality and thus the pond environment. Research on the effects of livestock sandfish quality and the structure of the sediment basins would be useful.

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