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Transportation methods for restocking of juvenile sea cucumber, *Holothuria scabra*

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Abstract

The sandfish, *Holothuria scabra*, is a heavily exploited sea cucumber species. Minimising stress in the transportation of hatchery-produced sandfish juveniles to release sites is critical for successful restocking. Replicate groups ($n=4$) of 20 hatchery-produced juveniles (1–5 g) were held in plastic bags with oxygen under 6 transport durations (0, 2, 4, 8, 12 and 24 h), two media (water or saturated sponge), and two temperature regimes (ambient and cool). Subsequent deaths and sand burrowing of the groups in release chambers were monitored for 5 days. Juveniles eviscerated or died only in treatments at ambient temperature on sponge for 24 h. Oxygen consumption in bags was reduced at cool temperature. On the first day after release, the normal sand burrowing was suppressed in juveniles held for 12 and 24 h, suggesting that pre-release acclimation for 1 day at field sites would benefit restocking. After the initial 'shock' of transport, handling stress appeared to increase burrowing behaviour for several days. Hatchery-produced sandfish also proved hardy for transport in high densities (100 and 200 juveniles per bag) and transportation stress will be minimised in seawater held at cool, constant temperature.

Keywords: Holothurian; Sandfish; Oxygen; pH; Temperature; Transport

1. Introduction

Sea cucumbers have been overfished in the tropical Pacific and Indian oceans (Conand, 2001). Unfortunately, moratoria on fishing are not always sufficient to enable stocks to recover (Battaglene and Bell, 1999; Hamel et al., 2001). The most valuable tropical species, the 'sandfish', *Holothuria scabra*, is suitable for restocking by the release of hatchery-produced juveniles (Battaglene and Bell, 1999). Although it is well accepted that transportation is a critical stage in restocking of marine animals, little information exists on how best to transport sandfish juveniles from the hatchery to release sites.

Hatchery-produced sandfish juveniles can quickly be eaten upon release, for example by fishes (Dance et al., 2003). Stress from handling and transport can also cause marine invertebrates to behave abnormally at

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the initial time of release, increasing their risk of predation (Van der Meeren, 1991; Shepherd et al., 2000; Heasman et al., 2003). Mercier et al. (1999) showed that small juvenile sandfish (10–40 mm) from Solomon Islands have a daily cycle of burrowing into sediments at sunrise and resurfacing at sunset, which could assist in avoidance of diurnal predators. We found a similar pattern for sandfish juveniles in the hatchery in New Caledonia (S. Purcell and B. Blockmans, unpublished data).

Transport of sandfish would generally be less than 24 h because stocks should not be translocated very far from the native sites where the broodstock were collected, in order to maintain genetic diversity of remnant stocks (Uthicke and Purcell, 2004). It is important to understand the effects of transport duration since changes to water chemistry in transport containers can cause lethal and sub-lethal effects in marine invertebrates (Heasman et al., 2003).

Additionally, the correct choice of medium and temperature regime in which the juveniles are transported can minimise the pre-release stress. For some invertebrates, transportation on a damp surface is less stressful than in water (e.g. trochus, Dobson, 2001; abalone, Heasman et al., 2003). Since sandfish juveniles occupy shallow and subtidal habitats of sandy/muddy coastal areas (reviewed by Hamel et al. (2001)), we considered that damp transport could be better than transport in water.

This study assessed the effects of transport duration, medium and temperature regime on hatchery-produced sandfish juveniles by holding groups of juveniles in bags at the hatchery in combination with these treatments. We examined non-lethal stress by comparing the burrowing behaviour of each group, in the late mornings when most should be burrowed, for one week after release from the bags. In an initial experiment, juveniles were held in bags at low density to allow replication of the three treatments simultaneously, then further experiments examined the survival from transport at high densities relevant to large-scale restocking.

2. Methods

2.1. Culture and preparation of juvenile sandfish

Juvenile sandfish (*Holothuria scabra*) were cultured in December 2002 at the WorldFish Center hatchery, New Caledonia, following methods described by Battaglene (1999) and Pitt (2001). The juveniles were grown to 1–5 g (corresponding to 20–39 mm; S. Purcell and B. Blockmans, unpublished data) on sand substrate in raceway tanks prior to the experiments. An examination of 100 random juveniles under dissecting microscope, checking for fungal or bacterial infection, discolouration, and malformation, indicated that they were healthy and free of noticeable disease.

A total of 3000 1–5 g juvenile sandfish were used in three separate experiments (Table 1). An initial 3-factor experiment ("Experiment 1") was conducted to simultaneously test transport duration, medium and temperature regime on groups of 20 individuals per bag (mean group weight of 30.6 g ± 2.8 g S.D.). Subsequently, juveniles were held at higher density of 100 individuals per bag over several durations using the preferred transportation medium and temperature regime ("Experiment 2"). Since juvenile

Table 1
Summary of conditions used in three experiments to examine transport effects on sandfish juveniles

	Experiment 1	Experiment 2	Experiment 3
Number of juveniles per bag	20	100	200
Replicates (*n*)	4	3	4
Number of handling control groups	4	1	0
Number of non-handling control groups	4	0	0
Duration (h)	0, 2, 4, 8, 12, or 24	0, 4, 12, or 24	26
Total number of groups	100	10	4
Medium	Water or sponge	Water	Water
Temperature	Ambient or cool	Cool	Cool
Number of juveniles per release chamber	20	20	20
Post-release observation (days)	5	2	2