



Cultured vs wild juvenile trochus: Disparate shell morphologies send caution for seeding

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Summary

Wild juvenile trochus hide from predators and have spiked shell whorls until they reach 25–30 mm, when they begin feeding on the reef surface. In contrast, hatchery-produced juveniles begin producing smooth shell whorls at a much smaller size, 10–15 mm. In wild juveniles, the shift in shell morphology occurs at the same time as the behavioural shift. This suggests that hatchery-reared juveniles seeded onto reefs may be shifting to non-cryptic behaviour when they are not yet large enough to avoid predation.

Introduction

The success of seeding reefs with hatchery-produced juvenile trochus, *Trochus niloticus* L., depends on juvenile survival rates. Mortality of seeded juveniles is usually high due to predation from certain turtles, fish, crabs, octopus, stomatopods and carnivorous gastropods (see Nash 1993). Several studies have shown that trochus survival rates increase with juvenile shell size (Vermeij 1976; Castell 1996; T.P. Crowe, unpubl. data). A corollary of this relationship is that juvenile trochus should be cultured to a larger size for seeding onto reefs for restocking. Effects of rearing on trochus, however, may undermine this corollary because hatchery produced juveniles may have different predator avoidance behaviour to wild juveniles, resulting in higher mortality rates than wild juveniles of the same size.

Clarke et al. (in press) recently showed that the shell wall of juvenile trochus cultured in Solomon Islands was comparable to, or thicker than, the shell wall of wild juveniles. In a laboratory experiment, Castell and Sweatman (1997) found that wild and hatchery-produced juvenile trochus responded similarly to a gastropod predator. However, disparate shell morphology of hatchery-produced trochus may be important and little is known about the effect of hatchery conditions on behaviour or survival of juvenile trochus in field conditions. Studies on juvenile abalone (Schiel and

Welden 1987; Shepherd et al. 2000) and queen conch (Stoner and Davis 1994; Stoner and Glazer 1998) have shown that hatchery-produced juveniles are more naïve in their behaviour (i.e. less cryptic) and suffer higher predation rates than wild juveniles. If these trends are similar for trochus, the release of juveniles that were maintained under hatchery conditions for long periods (i.e. >6 months), may have serious implications.

Findings and discussion

As part of an Australian Centre for International Agricultural Research funded project on methods for restocking trochus on reefs in Australia, Vanuatu and Indonesia, juveniles were produced in a hatchery in Western Australia (WA). There was a striking disparity in shell morphology between hatchery-produced juveniles and the few wild juveniles that were found in WA (Fig. 1). This finding is similar for juvenile trochus elsewhere, such as Vanuatu (M.J. Amos, pers. comm.) and Indonesia (S.A.P. Dwiono, pers. comm.).

In the wild, juvenile trochus shells have distinct spikes on the lateral edge of each whorl. In extensive surveys in WA, wild-caught juveniles of 25–30 mm basal shell width (BSW) consistently had shells that showed a recent shift from spiked whorl to smooth whorl formation. Trochus smaller than this size were rarely found on the reef surface in WA (Colquhoun 2001; Purcell and Lee 2001) and I believe that small juveniles generally dwell in holes and crevices under the reef surface, within the “reef matrix”. When they reach 25 to 40 mm, they appear to shift their behaviour to foraging on the reef surface and hiding less in holes. This behavioural shift is accompanied by a shift in their shell morphology. The spikes on the outer whorl of the shell of small juveniles may increase trochus’ defences against predators (cf. Donovan et al. 1999) and/or enable the animals to lock their shells into cracks for protection. Once large enough to venture onto the reef surface, the spikes are less useful and may hinder movement among macro-algae. The spikes are lost on successive whorls.

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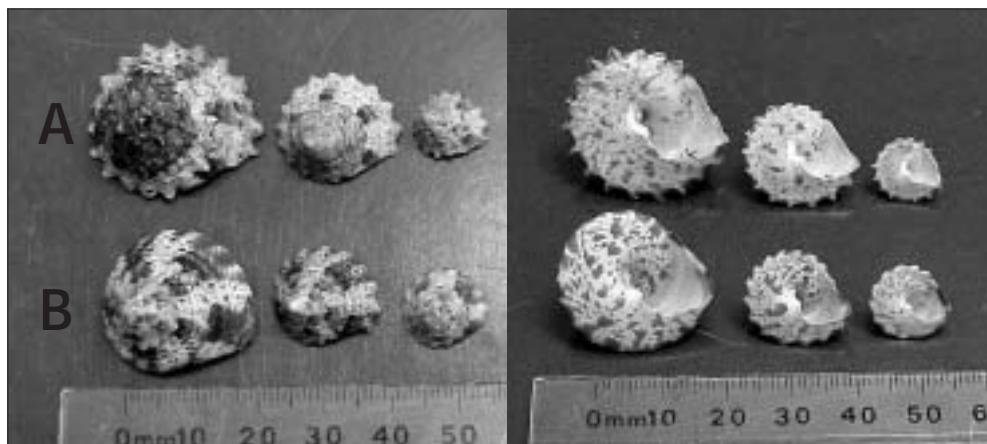


Figure 1.

Size series of wild-caught (A - top three) and hatchery-produced (B - bottom three) juvenile trochus. The largest of the hatchery-produced juveniles has prematurely produced a smooth-edged shell.

Juvenile trochus that were produced in the WA hatchery had shells with spikes, but this only occurred on very small sizes. At about 10–15 mm BSW, they began to produce further whorls with smooth edges. The precocious smooth-shell formation in hatchery-reared juveniles is a warning about seeding with 10–30 mm BSW juveniles. These animals may have shifted prematurely to a non-cryptic behaviour, perhaps due to an absence of predators or predator odours in the hatchery (see Olla et al. 1998), and fail to seek refuge once released onto a reef. It has been suggested that the onset of smooth-shell formation is age- not size-dependent and lower growth rates under hatchery conditions lead to the problem of small, smooth-shelled trochus (T. Komatsu, pers. comm.). Rapid culture of trochus in the hatchery to suitable sizes for seeding or intermediate culture in sea cages, may thus be a key factor for minimising disparities between cultured and wild trochus.

Vermeij (1976) showed that 30–40 mm BSW is a critical size for juvenile trochus; those smaller are prone to predation by crabs. High mortality of seeded juveniles, which do not hide and suffer high rates of predation by crabs and other predators, will result in poor restocking success. Thus, my caution is not related to high mortality due to different shell morphologies, *per se*, but rather that the precocious formation of smooth-shell whorls seems to indicate that hatchery-produced trochus shift to a non-cryptic behaviour at a size when they are quite vulnerable to predators. It is the shift in behaviour that is likely to undermine their survival after release. Until more information is available, releasing small juveniles <5 mm BSW (displaying cryptic behaviour and natural morphology) or sub-adults (40–55 mm BSW), after

intermediate culture in sea cages (Purcell 2001) or raceways, may be more appropriate strategies for restocking with hatchery-produced trochus.

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