

FEEDING AND SPAWNING BEHAVIOUR OF THE TRUMPET TRITON, *CHARONIA TRITONIS* (L., 1758) IN CAPTIVITY

Jintana Nugranad¹, Supot Chantrapornsilp² & Thanee Varapibal¹

¹Prachuap Khiri Khan Coastal Aquaculture Development Center,
Klong Wan, Prachuap Khiri Khan 77000, Thailand

²Phuket Marine Biological Center, P.O.Box 3, Phuket 83000, Thailand

ABSTRACT

A single female trumpet triton *Charonia tritonis* was collected at Raja Island, Phuket, the Andaman Sea in early April 1997. It was reared in a 14 m³ concrete raceway provided with running filtered seawater in Prachuap Khiri Khan Coastal Aquaculture Development Center. Crown-of-thorns sea stars, cushion stars, and holothurians were provided as feed for the triton. Spawning occurred in November 1998, lasted for 19 days yielding a number of 50 egg capsules, with approximately $2.0-3.4 \times 10^3$ eggs/capsule. The snail did not feed during the month it spawned. As there was no male so the eggs were unfertilized. Spawned egg capsules remained in the raceway for 2 months before they deteriorated. Feeding and spawning behaviour of the triton is discussed.

INTRODUCTION

Trumpet triton *Charonia tritonis* (L., 1758) (Family Ranellidae, syn. Cymatiidae) is one of the most endangered mollusc species in coral reef areas in the tropical Indo-Pacific seas. As its shell is highly valued by shell collectors, exploitation has driven this species near to extinction in most of its area of distribution; it is very rare in Thai waters.

The triton is carnivorous known to feed on echinoderms, especially the crown-of-thorns sea star (*Acanthaster planci*). Its performance as the number one consumer of this species of starfish has raised interest among marine biologists because the snail

may help controlling abundance of the starfish, which prey on coral polyps in coral reef ecosystem.

Despite the importance of the trumpet triton especially from an ecological point of view, information on the snail is very limited. Studies and reports concerning tritons have mainly been published in connection with studies on crown-of-thorns. There has been a research group in Australia working on the tritons. The group published "Charonia Research" providing information via a web site on the Internet. The site contains informative reports and overview on predation by triton on *Acanthaster planci*. (Report to GBRMPA 1986, 1988 & 1990 in Charonia Research, 1996: <http://www.omnicom.com.au/charonia/>). It was believed that the triton played an important role in controlling the population density of the starfish.

The only report available on reproduction of the triton is by Berg (1971), regarding eggs and veligers produced from one female triton, *C. tritonis* from Hawaii laying egg capsules in a culture tank in 1970. The egg laying period lasted for longer than 1.5 months and the snail produced a total number of more than 88 capsules. The capsules were 25 mm long, 9 mm wide at the greatest diameter, and 5 mm wide at the stalk. Veligers hatched out 6-8 weeks after the eggs were deposited. But he could only rear the veligers for 30 days.

The Tropical Marine Mollusc Programme,

an international research collaboration funded by DANIDA, has planned to study every possibility on the trumpet triton since the second phase of the Programme through 1993-1995, but with no progress because it was unsuccessful to find even one live shell. The only existing data from our region is about the shell specimens surveyed from shell shops in Phuket, of which only 4 shells were reported to be collected from Thai waters (Nateewathana & Aungtonya, 1994). Another piece of information was that 8 live specimens were captured in Ujung Pandang around October-November 1996 (Prof. Jorgen Hylleberg, personal communication) but unfortunately attempts failed to maintain them in captivity and all the tritons died within a few following days.

In April 1997, one live trumpet triton was obtained from diving in Phuket, Thailand. It was brought to Phuket Marine Biological Center's Aquarium. Several kinds of liable food such as fish meat, cockles, echinoderms including crown-of-thorns sea star, *Acanthaster planci*, were tried for feeding but the triton refused to eat except for one crown-of-thorns sea star, which was partly consumed. After 1 month, the triton was transported to the mollusc hatchery at Prachuap Khiri Khan Coastal Aquaculture Development Center for further study. Sex was later determined to be female. This is the only live triton available for behavioural observation in Thailand. She has stayed healthful in the tank up till now.

In 1998, 2 live tritons were again caught from Raja Island, Phuket. They were brought also to the PMBC aquarium, but both specimens died soon after arrival. These two snails were suspected to be in a mating stage because they were found together on the reef.

Since the triton is near to extinction, natural breeding may be hampered in nature. Attempts to make artificial propagation, such as breeding in captivity, should be taken in consideration, and it may be a way to help conserve the species.

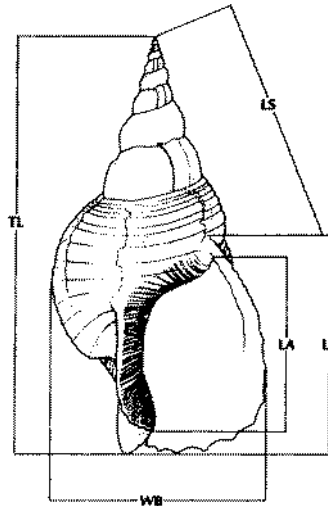


Figure 1. Measurement scheme for *Charonia tritonis* L. (Source: Nateewathana & Aungtonya, 1994)

This report presents biological behaviour of the triton observed in captivity, i.e. food and feeding, spawning, and other information for handling of the species.

MATERIALS & METHODS

The triton

A diver collected one live specimen of trumpet triton on 6 April 1997 at Raja Islands, Phuket. It was brought to Phuket Marine Biological Center (PMBC) and held in fiberglass tank for 1 week, then subsequently moved into the 2 m³ 'echinoderms' aquarium for another 3 weeks, before being transferred to Prachuap Khiri Khan Coastal Aquaculture Development Center (CADC) on 9 May 1997. The triton was transported in a Styrofoam box containing clean sea water provided with aeration. Small ice packs were used to cool down the temperature in the box to be around 24-26 °C. At arrival in CADC, the size of the triton was measured following the scheme given by Nateewathana & Aungtonya (Fig. 1, 1994). The total shell length (TL) was 34.8 cm, width of body whorl (WB) 18.5 cm, length of body whorl (LB) 20.3 cm, length of spire (LS) 15.5 cm, length of aperture (LA) 15.8 cm,

and total weight 2.64 kg. Sex was subsequently determined to be female.

The culture

At Prachuap Khiri Khan CADC, the triton snail was maintained in a 14 m³ outdoors concrete raceway jointly with the giant clam broodstock. The raceway was equipped with motor-driven paddy wheel for thorough water circulation. Sand-filtered seawater was provided by flowing-through system with turnover rate about 1-2 times per day. Black plastic shaded-cloth for 50% light reduction was placed over the raceway to reduce heat from strong sunlight.

Echinoderms, i.e., sea star (*Echinaster* sp.), cushion star (*Culcita novaguineae*), crown-of-thorns sea star (*Acanthaster planci*), sea urchin (*Diadema setosum*), and sea cucumbers (*Holothuria atra* and *Stichopus chloronotus*) were provided in the snail's holding tank in live condition based on availability. Feeding was observed when it occurred in the raceway. Decaying leftover portions of the prey were removed in accordance with the routine of siphoning of faeces and debris from the raceway every morning. But the fresh fractions were left in the tank for further observation. We recorded if the snail would eat it up or not.

Spawning behaviour was observed and recorded. The number of egg capsules was counted and sampled for measurement and determination of fecundity.

Water temperature, salinity, and other conditions in the holding raceway were checked daily. Salinity ranged from 32-34 ‰. Water temperature ranged from 25.5-33 °C.

RESULTS & DISCUSSIONS

The trumpet triton was successfully held in captivity for 2 1/2 years until to date (October 1999). The snail is still healthy and in perfect shape except a long scratch on the body whorl, and the apex that has been torn down by some tiny boring organisms. These damaged portions of the shell were fixed with epoxy glue to cease further breakup.

After 2 years of culture, the triton showed no growth increment in terms of shell size and total weight. The length (TL) decreased from 34.8 to 32.5 cm because of the shell damage by boring organisms. The specimen may have reached its maximum size, or the time in captivity may have suppressed its natural growth. The largest specimen of triton on record from Thai waters was 46.4 cm TL (Nateewathana & Aungtonya, 1994).

FOOD CONSUMPTION

Only one crown-of-thorns sea star was partly eaten by the present specimen while kept at the PMBC. After arrival at CADC, the snail did not eat but kept moving around in the raceway where holothurians were presented. After 1.5 month at CADC, newly collected sea cucumbers; *H. atra* and *S. chloronotus*, were brought into the raceway along with long-spine sea urchins (*D. setosum*). Feeding was initiated 2 days after that. The first prey being attacked was *S. chloronotus*. A specimen of *H. atra* was consumed 2 days later. However, there was no obvious difference regarding preference among these two species of sea cucumbers. A total of 7 holothurians of both species were consumed within a period of the first two weeks. Sea urchins remained untouched even when they were the only available in the raceway.

From observations over a period of 2 years, other consumed species were cushion star (*C. novaguineae*) and crown-of-thorns sea star (*A. planci*). Small sea stars (*Echinaster* sp.) were never touched, even when placed close to the triton. Attack was initiated both in day and nighttime. Hunting was observed sequentially for 1-year in 1997-1998. A total of 56 attacks were recorded: 20 in the morning (35.7%), 4 in the afternoon (7.1%), and 32 in the evening (57.1%).

Feeding duration ranged for few hours to longer than 24 hours, depending on prey size, species, and attack position. The total number of prey hunted by the triton is shown in Table 1.

Table 1. Triton in captivity. Feeding on specified species of prey.

Period	Prey species	Number presented	Number hunted	Average consumption
24-30 June 97	<i>H. atra</i> & <i>S. chloronotus</i>	5	3	1 per 2.3 days
1-31 July 97	<i>H. atra</i> & <i>S. chloronotus</i>	17	14	1 per 2.2 days
1-31 August 97	<i>H. atra</i> & <i>S. chloronotus</i>	20	10	1 per 3.1 days
1-16 September 97	<i>H. atra</i> & <i>S. chloronotus</i>	10	-	No feeding
17 Sept. - 9 Oct. 97	<i>A. planci</i>	2	1	1 per 23 days
10-31 October 97	<i>C. novaguineae</i>	2	2	1 per 10.5 days
1 Nov. - 31 Dec. 97	<i>A. planci</i>	4	4	1 per 15.3 days
1 Nov. - 31 Dec. 97	<i>C. novaguineae</i>	1	1	1 per 61 days
1 Nov. - 31 Dec. 97	<i>H. atra</i> & <i>S. chloronotus</i>	10	2	1 per 30.5 days
1-8 January 98	<i>H. atra</i> & <i>S. chloronotus</i>	8	-	No feeding
9 Jan. - 9 March 98	<i>A. planci</i>	8	8	1 per 7.4 days
9 Jan. - 9 March 98	<i>H. atra</i> & <i>S. chloronotus</i>	8	1	1 per 59 days
10 March - 26 May 98	<i>H. atra</i> & <i>S. chloronotus</i>	7	-	No feeding
27 May - 26 July 98	<i>A. planci</i>	12	8	1 per 7.5 days
27 July - 15 August 98	<i>A. planci</i>	3	3	1 per 6.7 days
16 August - 3 Nov. 98	<i>H. atra</i> & <i>S. chloronotus</i>	6	4	1 per 19.8 days
4 Nov. - 19 Dec. 98	<i>H. atra</i> & <i>S. chloronotus</i>	26	*	No feeding
20 Dec. 98 - 20 Jan. 99	<i>A. planci</i>	3	3	1 per 10 days
21 Jan. - 11 March 99	<i>H. atra</i> & <i>S. chloronotus</i>	15	4	1 per 12.3 days
11 March - 7 June 99	<i>A. planci</i>	5	5	1 per 17.6 days
11 March - 7 June 99	<i>C. novaguineae</i>	4	4	1 per 22 days
8 June - 14 July 99	<i>H. atra</i> & <i>S. chloronotus</i>	11	-	No feeding
15-31 July 99	<i>A. planci</i>	3	1	1 per 17 days
15-31 July 99	<i>C. novaguineae</i>	7	**	only attack

* Spawning took place on 8-26 November 1998. The triton did not feed during the period of egg laying. ** 2 cushion stars were attacked, but not eaten

CONSUMPTION OF SPECIFIC PREY SPECIES

Sea cucumber

Feeding on sea cucumbers mostly finished within few hours after beginning of the attack, but could be extended up to 30 hours. This was found in one case with *H. atra* where the triton attacked in the morning around 8 a.m., and continued eating until 4 p.m. of the following day. Most of the sea cucumbers were consumed entirely by the triton. Predation on sea cucumber in the raceway is shown in Table 2. No other food organisms were presented during those tri-

als.

Sea cucumber, although readily eaten, was found somewhat unfavorable for the triton. The sea cucumbers spurted sticky, thread-like, white substance when being attacked. The triton was found seemingly anaesthetized after preying on sea cucumber.

Crown-of-thorns sea star

A total of 33 *A. planci* were totally consumed by the triton. Feeding on this sea star species mostly resulted in partial success in

Table 2. Predation on sea cucumbers observed during 60 days.

Feeding details	Feeding duration	Number of prey	Percentage
Totally consumed	2.5 hrs - 1 day	14	60.9
Only some parts leftover	few - over 30 hrs	4	17.4
Partly consumed	less than 1 day	4	17.4
Only attacked, not eaten	-	1	4.3

each hunting case, because the crown-of-thorns performed autotomy to escape from its predator. Feeding mostly lasted for 1 - 2 days in each attack. Several crown-of-thorns started regeneration after having escaped attack by the triton, and they were hunted again by the snail. Leftover portions of this prey species, even small pieces of arm, were later consumed by the triton. Only the spine tips were discarded.

Cushion star

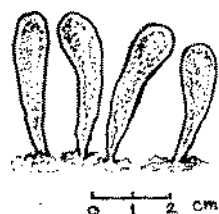
Cushion stars *Culcita novaguineae* were only partly consumed, and the remaining portions discarded, in most cases (Table 3). Only one specimen was found to be a totally consumed. The triton ate the whole sea star within 2 days. Two cushion stars were attacked but not eaten. The size of each prey

Table 3. Predation on cushion star, *Culcita novaguineae*, observed during 9 attack cases.

Prey No.	Feeding details	Feeding duration	Note
1	1/2 consumed	5 days	Prey escaped on day 3, hunting resumed on day 5
2	1/2 consumed	2 days	-
3	2/3 consumed	3 days	-
4	1/2 consumed	3 days	-
5	1/3 consumed	4 days	Prey escaped on day 3, feeding resume on day 4
6	1/3 consumed	1 day	-
7	1/1 consumed	2 days	-
8	Only attacked	2 days	Drilled hole on body surface
9	Only attacked	2 days	Small wound on body surface

item did not correlate with the amount of prey consumed.

Among the three groups of prey; sea cucumber, cushion star, and crown-of-thorns sea star provided for the triton in this study, feeding on cushion star took longest time. The cushion star has a round body form and a low degree of autotomy, so it could not easily escape when being caught by the triton while the crown-of-thorns sea star utilized autotomy of arms to escape.

Figure 2. Egg capsules of *Charonia tritonis* (L.)

SPAWNING

The female triton began spawning after 1.5 year in the raceway, although there was no male. Egg laying began on 8 November 1998 and lasted for 19 days until 26 November 1998 resulting in a total number of 50 egg capsules.

Occasionally, egg capsules were deposited individually attached onto the raceway wall, but mostly attached closely together forming a bright egg mass. The capsules had a long sac-like shape and measured from 17-39 mm in height, and 9-10 mm in width (Fig. 2). The capsules were made of a transparent gelatinous-like material containing

bright orange coloured eggs inside. Eggs measured from 0.4–0.43 mm in diameter. The number of eggs in each capsule varied from 2,000–3,400 eggs, with an average number of 2,933 eggs per capsule. The estimated fecundity of this triton was 150,000 eggs in one sequence of spawning.

After egg laying was terminated, the triton was found dwelling at the egg mass and it did not feed for an additional 24 days. On day 16 after having finished spawning, the triton moved about 50 cm away from the egg mass, but it returned again on the following day. This might be a sign of brooding behaviour as found in other species such as cowries.

The egg capsules remained in good appearance for about 2 months. As the eggs were unfertilized, they became rotten after that period.

CONCLUSIONS

The triton can be maintained healthfully in captivity for a period longer than 2 years. It developed mature gametes and could lay normal egg capsules. Feeding with various food items should be applied to provide the best conditions for the triton.

Feeding time mostly began at night, but the triton also showed active hunting during daytime, indicating that the triton is not a real nocturnal species as was formerly believed. Hunting might not depend on hunger of the predator. It looked as if presence of prey in the proximity could stimulate attack. Feeding of the triton varied much, both in terms of amount consumed and frequency of hunting.

Information gained in this study might be too limited, and might not be applicable to explain the actual biology and behaviour of

the triton in nature. However, it could serve as a guide for further handling of the species in captivity. We hope to get some more live specimens, not only to obtain more information on the biology, but also to access hatchery breeding to produce some offspring hoped for restocking the depleted population.

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