CRAB PREDATION ON GREEN TURTLE (*CHELONIA MYDAS*) EGGS INCUBATED ON A NATURAL BEACH AND IN TURTLE HATCHERIES

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ABSTRACT

A study of crab predation on green turtle (*Chelonia mydas*) eggs was conducted on a natural beach of Mak Kepit, Pulau Redang and at turtle hatcheries in Geliga and Chendor during March - September 2002. The objectives were to quantify crab predation on turtle eggs on natural beach and hatcheries and to determine the effectiveness of plastic mesh fencing for preventing crab predation. A total of 658 nests comprise of those on natural beach (214), hatcheries (429) and experimental plot (15) were investigated. Result showed that mortality of green turtle eggs in the study area due to ghost crab predation is not an important threat as the magnitude of depredation was only 1.3% (range 0.4% - 2.7%). Two species of crabs, i.e., *Ocypode ceratophthalmus* and *Ocypode kuhlii* were recorded. The use of 0.5 cm meshed plastic netlon to fence surrounding nests down to 1m deep under sand surface was proven effective in preventing crabs from entering the nests in turtle hatcheries. This preventive method was recommended for adoption in the operation of turtle hatcheries, as it was effective and eco-friendly sound.

Key words: ghost crab predation, *Chelonia mydas*, *Ocypode spp*, natural beach, turtle hatchery

INTRODUCTION

The green turtle, *Chelonia mydas* is known to nest extensively on selected sandy beaches on the mainland and offshore islands of Peninsular Malaysia. Highest concentrations of nesting green turtles occur on the island of Pulau Redang, followed by Geliga and Paka, all is located in the state of Terengganu. In the state of Pahang, the only good green turtle rookery is located at Chendor, whereas Pantai Segari of Perak is a main rookery for this species on the west coast of Peninsular Malaysia. There are also nesting of green turtles reported in the other areas but their nesting numbers are considered small (Kamarruddin, 1994). This report also concluded that the nesting season of green turtles in Peninsular Malaysia occurs throughout the year with peaks in June-July period.

Eggs and hatchlings of sea turtles are subject to a number of non-human predators. There are many species of predators that prey upon the loggerhead turtle *Caretta caretta*. Their eggs and hatchlings were reported to be predated by the nine-banded armadillo, *Dasypus novemcintus* (Drennen et al., 1989). They were also preyed upon by a number of the other predators such as the Atlantic ghost crabs, *Ocypode quadrata* (Sundin, 2001), the surf crabs, *Arenaeus cribrarius* (Frick, 2003), varanid lizards, raccoons, coatis, feral dogs, coyotes, shorebirds, vultures, wild boars, and ghost crabs (Fowler, 1979; Mrosovsky, 1983; Cornelius, 1986; Connant, 1991; Eckert, 1992; Blamires and Guinea, 2001). Hatchlings of green turtles when entering sea from rookery beaches and during the swim-frenzy period en route

to nursery habitats were easily eaten by the grouper, *Promicrops lancelotus* (Witzell, 1981).

The ghost crabs (*Ocypode* spp) are fast running crustaceans with a speed of up to 3.4 m/sec, capable of covering long distance during foray. This species spends the greater parts of its life in, or associated with a burrow. Hughes (1966) reported that burrows have depth that range from 30 cm to 1.3 m depending on how long they had been occupied and their position on the wave beach. The burrows were most often located in positions between high water spring tide to just below high water neap tide. Ghost crab collectively exhibits many feeding tactics and activity cycles (Hermkind, 1983). They leave their burrows mostly at night and scurry along the beach in search of food. Although ghost crabs spend most of their lives on land, they still have gills that they must keep wet in order to breathe. They periodically shed an exoskeleton when they outgrow it. Ghost crab depredation on sea turtle eggs and hatchlings is frequently observed, although the extent of loss has not been quantified.

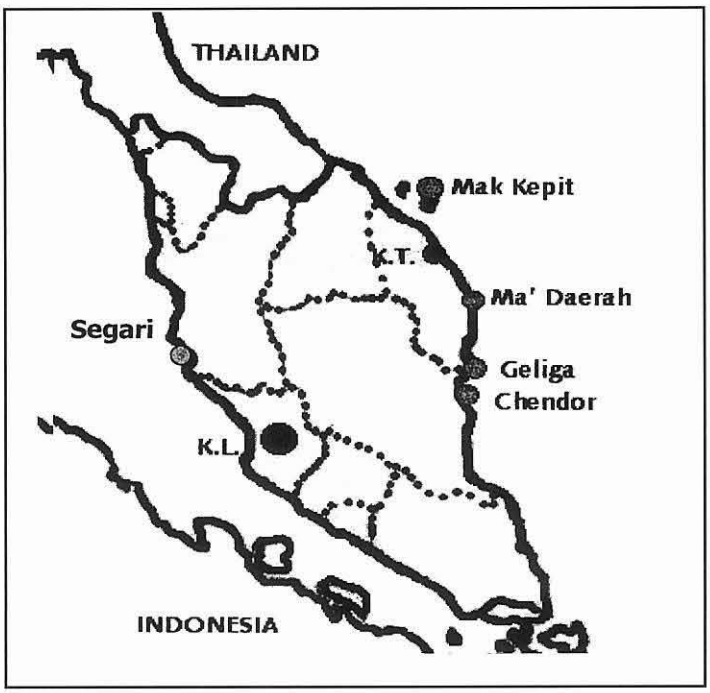

Fig. 1 Map showing the locations of three study sites on the east coast of Peninsular Malaysia - Mak Kepit, Geliga and Chendor

The information about depredation of sea turtle eggs and hatchlings by ghost crabs in Malaysia is very scanty. John (1998) during his study at Chagar Hutang on the island of Pulau Redang documented two species of ghost crabs: *Ocypode ceratophthalmus* and *Ocypode kuhlii* and reported that ghost crabs were the most prominent nest predators (56.67%). He also introduced a control method by trapping and removing as a mean of protecting turtle eggs from being predated by ghost crabs. In Peninsular Malaysia, the ghost crabs (*Ocypode* spp) live in deep burrows on sandy beaches of both mainland and offshore islands.

The objective of this study was to quantify ghost crab predation on green turtle eggs at a nesting beach (Mak Kepit) and in hatcheries (Geliga and Chendor). In addition, an experiment was conducted by fencing a plot of hatchery area where eggs were incubated with the aim to understand its effect on reducing crabs predation. Information derived from it would be used for hatchery management purposes.

MATERIALS AND METHODS

Study sites

Three study sites on the east coast of Peninsular Malaysia were chosen (Figure 1). Mak Kepit, a natural white sand beach is located on the island of Pulau Redang in the South China Sea. Two other sites are turtle hatcheries at Geliga and Chendor on the mainland where the beaches are of brown-type sand.

Quantification of crab predation - Quantification of crab predation on green turtle eggs was made at all three sites. Identification of crab species was based on the field keys (Lovett, 1981) and the characteristics of burrows (John, 1998). The species Ocypode ceratophthalmus is characterised by having a pyramid-like sand mound adjacent or close to the burrow, whereas Ocypode kuhlii covers its burrow hole with a mound of sand. O. ceratophthalmus is usually found in the intertidal zone and has prominent eyestalks with a long stem. The stem is shorter in O. kuhlii, which generally has round eyes. Stridulation is apparent in O. kuhlii where during observation, rasping sounds could be heard from the burrows. O kuhlii also prefers to construct burrows on the isolated area, in contrast with O. ceratophthalmus that present everywhere on the beach.

Nests were excavated and their contents examined within a week after the emergence of hatchlings. The presence of characteristic snip marks on egg shells were attributed to attack by ghost crabs and were easily distinguishable with marks left by the other predator such as fire ants. The sum of the numbers of unhatched eggs and empty shells removed from a nest used as an approximation of total clutch size (Fowler, 1979). The incubation of C. mydas eggs for 214 clutches took place at Mak Kepit beach from 25 March until 12 September 2002, whereas a total of 357 clutches (at Geliga) and 72 clutches (at Chendor) were incubated during the period of 1 April to 13 September, and 1 April to 6 September, 2002, respectively. The emergence success was calculated as percentage of eggs that result in hatchlings that emerge from the nest.

Hatchery Experiment

An experimental plot was constructed within Chendor's production hatchery. The total area of the plot was 15 m2 (5 m x 3 m). It was fenced right under the sand surface with one-meter depth of 0.5 cm (internal diameter) mesh size of netlon plastic to protect crab encroachment (Figure 2). Fifteen full clutches of green turtle eggs taken from Chendor beach during a period of 26 June - 29 July, 2002 were transplanted into the experimental hatchery. The quantification of crab predation in the experimental hatchery followed similar manners as described for clutches on the natural beaches and production hatcheries.

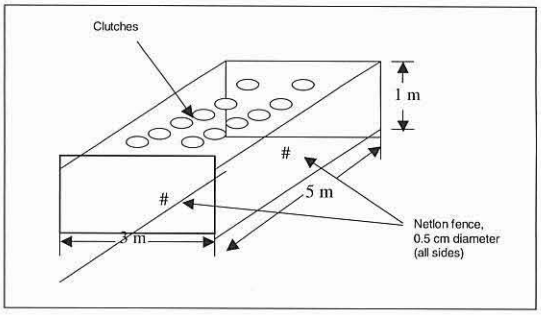

Figure 2. An experimental plot at Chendor hatchery

RESULTS

Incubation parameters - High emergence success was recorded for green turtle eggs incubated at a natural beach and two hatcheries (Table 1). The values range from 81.38% (+ 22.30) for in situ incubation at Mak Kepit beach, 81.87% + 26.35 for artificial incubation at Chendor, and 82.47% + 18.28 for artificial incubation at Geliga were relatively high and there was only slight difference among them. The emergence success of eggs in the experimental hatchery was 73.52% + 27.52, a reduction of about 10% from the natural and hatchery figures and is obviously depicted by a significant small numbers of the incubated eggs. The mean depth of nests in both hatcheries was in a range of 13-16 cm shallower than that of nests on natural beach.

Table 1: A summary of the incubation parameters and crab predation on green turtle (Chelonia mydas) eggs incubated on natural beach and turtle hatcheries

Parameter	Mak Kepit Beach	Geliga Hatchery	Chendor Hatchery	Experimental Hatchery
Total no. of clutches	214	357	72	15
Total no. of eggs	20,294	33,409	6,549	1,374
Mean clutch size	96.6	93.6	91.0	91.6
Mean nest depth (cm)	76.7	60.2	63.1	61.0
Mean Emergence success	81.38%	82.47%	81.87%	73.52%
S.D. (Standard deviation)	! 22.30	! 18.28	! 26.35	! 27.32
No. of nests predated by crabs	78 (36.0%)	81 (22.7%)	36 (50.0%)	0
No. of eggs predated by crabs	244 (1.0%)	145 (0.4%)	180 (2.7%)	0
Range (crab-predated eggs/clutch)	0 - 6	0 - 7	0 - 23	0
Mean no. of eggs/clutch predated by crabs	1.14	0.41	2.50	0
S.D. (Standard deviation)	! 1.80	! 0.93	! 4.19	-

Crab predation

Crab predation on green turtle eggs incubated at all sites is summarised in Table 1. Nest examinations made on 643 clutches of turtle eggs from a natural beach and two production hatcheries revealed that the mortality of eggs due to ghost crab predation was very small. This is reflected by the mean values of the predation rate that ranges from 0.4% - 2.7% only or 1.3% combined. These figures were derived from individual site that recorded egg depredation at Chendor hatchery as 2.7% followed by Mak Kepit and Geliga as 1.0% and 0.4%, respectively. The values of the percentage of eggs predated by crabs seemed in agreement with the mean numbers of predated eggs per clutch, i.e, 2.5 + 4.19 eggs/clutch (n= 72), 1.14 + 1.8 eggs/clutch (n=214) and 0.41 + 0.93 eggs/clutch (n=357).

The percentage of nests being predated by crabs seemed highest for those in the hatchery at Chendor (50.0%), followed by the natural nests at Mak Kepit (36.0%) and in the hatchery at Geliga (22.7%). Similarly, the range for crab-predated eggs/clutch was recorded highest at Chendor hatchery (0-23 eggs/clutch). On the other hand, such a value was slightly higher at Geliga hatchery (0-7 eggs/clutch), followed by Mak Kepit beach (0-6 eggs/clutch). Two species of ghost crabs, i.e., *O. ceratophthalmus* and *O kuhlii* were recorded during this study but effort to understand the magnitude of egg depredation by each species was not attempted at this stage.

An interesting result was recorded at the experimental hatchery. The data (Table 1) clearly showed that there was no ghost crab predation at all at this site as reflected by all 15 clutches were safely incubated. The use plastic mesh netting proved to be effective in deterring ghost crabs from entering the fenced hatchery.

DISCUSSION

A number of biotic and abiotic factors are known to affect nest and egg mortality in marine turtles. The hate rate of the Atlantic loggerhead (*C. caretta*) in South Carolina was only 6.1% (Hopkins et. al., 1979). This was mainly due to intense predation by animal predators. He reported that raccoons (Procyon lotor) and ghost crabs (*Ocypode quadrata*) destroyed 56.1% and 2.4% of the overall 458 nests, respectively. Poachers took the rest. In this study, we found that ghost crabs (*Ocypode* spp) were not important predators to green turtle eggs as the mortality rate of 0.4% - 2.7% or 1.3% overall was very little. Such a low mortality could probably be associated with the presence of human being (the workers) that looked after all three-hatchling production sites. Result of this study is in contrast to John (1966) who reported that ghost crabs, *Ocypode* were the most prominent nest predators, contributing 56.67% of nest mortality at Chagar Hutang, a turtle beach located next to Mak Kepit beach, both are on the island of Pulau Redang. The probable answer to the ghost crab - human interaction is also found in a report of Cornelius (1986) who stated that ghost crabs have been reported to be prominent predators of turtle eggs in areas where bigger predators are absent or sparse. Ghost crab burrows occurring near turtle nests throughout the incubation period provide an entrance for other predators to infest or prey on the nest. John (1966) reported that ghost crab density at Chagar Hutang beach on the island of Pulau Redang was highest at the beginning of the nesting season (in May) with a count of 177.88 crabs/100 m. The density decreased throughout the following months with 43.44 crabs/100 m in October. The drop may be largely due to the increase in human activities on the beach during the nesting season. Hughes (1966) also reported that ghost crab activity is correlated with human or predator activity. The breeding cycle of the species itself could have caused a decline in abundance. It is noted that *Ocypodidae* has distinct breeding seasons that are regulated by exogenous factors (Simons and Jones, 1981). The predation of eggs by ghost crabs in this study is considered small if compared with other predators such as varanid lizards that caused 51.9% mortality of flatback turtle, Natator depressus eggs in Australia (Blamires and Guinea, 2001).

Taking into consideration that the mean emergence success of eggs at three studied sites was 81.9%, the different of 18.1% was derived from the unhatched eggs that included 1.3% crab predation. For management purposes, a major proportion of the unhatched eggs recorded from this study requires further investigation in order to understand what factors affecting their hatching. Opportunistic observations made during the study period recorded some predators such as fire ants and varanid lizards, besides roots and fungi, may also contribute to mortality of turtle eggs.

In the experimental hatchery, the use of small mesh plastic netlon (0.5 cm diameter) to fence 15 clutches (1,374 eggs) of green turtles resulted in zero numbers of

eggs being predated by ghost crabs. The method has proven effective in preventing crabs from entering the nests. It is believed that minimising egg mortality through preventive method is more appropriate than trapping or removal of predators as the former is eco-friendly in nature.

Many agree that there is a link between ghost crabs and the other predators. The initial harm occurs when ghost crabs make tunnel into the nest chamber and break open several eggs. This begins a sequence of events, which normally results in entire clutch being destroyed although the crab may actually eat only a few eggs. This direct access into the nest provided by the ghost crabs act as a pathway for secondary predators such as red ants and fungi. Fungi and harmful microorganisms find a suitable medium on the broken eggs and spread slowly, encompassing eggs at different stages of embryonic development. It seems that addressing ghost crab issue would at the same time address the problems associated with other predation.

CONCLUSIONS

Mortality of green turtle eggs in the study area due to ghost crab predation is not an important threat because the magnitude of depredation is only 1.3% (range 0.4% - 2.7%). Two species of crabs, i.e., *Ocypode ceratophthalmus* and *Ocypode kuhlii* present. The use of small meshed plastic netlon fencing is proven effective in preventing crabs from entering the nests in turtle hatcheries. It is suggested that minimising egg mortality through preventive method is more appropriate than trapping or removal of predators as the fencing is more eco-friendly sound. Further studies are required to quantify magnitude of egg mortality due to other factors that contributed a major portion of the unhatched eggs as revealed from this study. The next step is introducing remedial measures aiming at producing hatchlings with zero egg mortality.

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REFERENCES

Blamires, S.J. and Guinea, M.L., 2001. The influence of temperature on egg mortality, emergence success and hatchling sex ratio for flatback sea (Natator depressus) at Fo Bay, Northern Territory, Australia. http://www.arbec.com.my/seaturtles/art21julysept01.htm

Bustard, R., 1972. Sea turtle: Natural history and conservation. Taplinger Publication, New York , 31 pp.

Connant, T.A., 1991. Ghost crab predation on emergent sea turtle from relocated nests on a Barrier Island, North Carolina. M.Sc. thesis, Western Washington University, Washington D.C., 50 pp. Cornelius, S.E., 1986. The sea turtle of Santa Rosa National Park. Fundacion de Parques Nacionales, Costa Rica. 64 p.

Drennen, D, Dwignt Cooley and John, E. D., 1989. Armadillo predation on Loggerhead Turtle Eggs at Two National Wildlife Refuges in Florida, USA. *Marine Turtle Newsletter* **45**:7-8.

Eckert, S.A., 1992. Bound for deep waters. Natural History, 46 (11);15-19.

Frick, M.G., 2003. The surf crab (Arenaeus cribrarius): A predator and prey item of sea turtles. *Marine Turtle Newsletter* **No.99**, 2003. 16-18.

Fowler, L.E., 1979. Hatchling success and nest predation in the green sea turtle, Chelonia mydas, at Tortuguero , Costa Rica, *Ecology.* **60** (5):946-955.

Herrnkind, W.F.,1983. Movement patterns and orientation. In: The biology of crustacean. F.J.Vernberg and W.B.Wernberg (eds):41-101.

Hopkins, S.R., Murphy, M.Stansell, K.B. and Wilkinson, P.M., 1979. Biotic and abiotic factors affecting nest mortality in the Atlantic loggerhead turtle. *Proc. Ann. Conf. S.E. Assoc. Fish & Wild. Agencies* **32**: 213-223.

Hughes, D.A., 1966. Behavioral and ecological investigations of the crab Ocypode ceratophthalmus (Crustacea:*Ocypodidae*). *J. Zool., Lond.***150**:129-143.

John, A.H.F., 1998. Ghost crab (*Ocypode* spp) predation on green turtle (*Chelonia mydas*) nests and hatchlings in Chagar Hutang, Pulau Redang. Final year project report, Bachelor of Marine Science, Faculty of Applied Science and Technology, Universiti Putra Malaysia. 92 p.

Kamarruddin, I., 1994. The Status of marine turtle conservation in Peninsular Malaysia. In. Nacu et al. (eds). *Proc. First ASEAN symposium-workshop on marine turtle conservation*, Manila, Philippines.

Lovett, D.L., 1981. A guide to the shrimp, prawns, lobsters, and crabs of Malaysia and Singapore. Universiti Pertanian Malaysia.

Mrosovsky, N., 1983. Conserving sea turtle. The British Herpetological Society, London.

Simons, M.J. and Jones M.B., 1981. Population and reproduction biology of the mud crab, Macrophthalmus hirtipes (Jacquinot, 1853) (Ocypodidae), from marine and estuarine habitats. *J.Nat.Hist*. **15**:981-994.

Stancky, S.E., 1982. Non-human predators of Sea Turtle and their control. In. K.A.Bjorndal (ed). Biology and conservation of sea turtle. *Proc. World Conf. On Sea Turtle Conservation*, Washington, D.C. Smithsonian Institution Press. 139-142.

Sundin G., 2001. A Test of Three Simple Trap Designs for Suitability in Controlling Drepredation on Sea Turtle Nesting Beaches. University of South Carolina Beufort Pritchards Island Research & Education. (http://www.sc.edu/beaufort/pritchar/res00.htm)

Witzell, W.N., 1981. Predation on juvenile green sea turtles, Chelonia mydas, by grouper, *Promicrops lancelotus* (Pisces: Serranidae) in the Kingdom of Tonga, South Pacific. *Bulletin of Marine Science* **31**(4): 935-936.