FULL OR SPLIT CLUTCHES - WHICH STRATEGY SHOULD BE ADOPTED IN MANAGING MARINE TURTLE HATCHLING PRODUCTION?

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ABSTRACT

A statistical analysis was made on *Chelonia mydas* incubation data for a turtle nesting beach (Mak Kepit, Terengganu) and a hatchery (Chendor, Pahang) in Peninsular Malaysia. Full and undisturbed clutches on the natural beach brought high emergence success of 84.75% (range 79.8-89.0%) for a 4-year period (1997-1998 and 2000-2001). Mean values were c.a. 40% higher than translocated full clutches in the hatchery (1997-1998). There was no significant difference in the emergence success between split and full clutches in both 1997 and 1998 (ANOVA: df = 1, F = 0.188, P<0.05). From this finding and cost of hatchery operations, it is recommended that hatchery should incubate full clutch eggs.

Key words: emergence success, *Chelonia mydas*, natural (in situ) incubation, hatchery, split clutch, full clutch

INTRODUCTION

Hatcheries have been popular tools for marine turtle conservation. The Malaysian Fisheries Department (DoFM) operates hatchling production programme each year to recruit marine turtle populations. Historically, the hatchery operation in Malaysia began in Sarawak in 1950, followed by Terengganu and Sabah in 1961 and 1966, respectively. The DoFM started the natural (in situ) incubation of green turtle eggs in 1992 on the island of Pulau Redang, Terengganu (Kamarruddin and Abdul-Rahman, 1994). The emergence success of 26 clutches was 63.84% but 11 clutches were totally drowned due to inundation from both freshwater and seawater. The term of emergence success has been adopted to assess the performance of hatchling production at different sites since the introduction of hatchery programme.

The success of turtle egg clutches incubated on beaches depends upon a number of factors such as humidity, temperature, salinity, gas flow, rainfall, tidal inundation, predation and beach erosion (Bustard and Greenham, 1968; Fowler, 1979; Mrosovsky and Yntema, 1980; Limpus and Miller, 1980; Witzel, 1981; Mrosovsky, 1983; Eckert, 1992; Kamarruddin and Abdul-Rahman, 1994; Frick, 2003). Many of these factors interact to each other. Improper handling of eggs during movement from natural beaches to hatcheries may increase mortality (Limpus et al., 1979; Blanck and Sawyer, 1981).

One of the major problems of hatchery programmes is the inconsistency of hatch rates. In Peninsular Malaysia, there has been a common practice

to split large-sized clutches (>100 eggs per clutch) into two sub-clutches. This method lacks quantitative information on its effectiveness to improve the emergence success. Unsuitable practice may have detrimental effects and need to be quantified. Moreover, splitting clutches resulted in an increase of space and cost. The aim of the study was to determine the impact of split clutches on nest emergence success.

MATERIALS AND METHODS

We analysed natural (in situ) incubation data from Mak Kepit beach on the island of Pulau Redang, Terengganu, Malaysia during the period 1997, 1998, 2000 and 2001 for their annual emergence success. Second, a comparison analysis was specifically made for full clutches between in situ nests on Pulau Redang and hatchery-incubated nests in Chendor, Pahang for 1997 and 1998. Third, we compared the emergence success in Chendor hatchery between full and split clutches. The emergence success (ES) was defined as percentage of hatchlings, which emerge from the nest in relation to the number of eggs, incubated.

RESULTS

Emergence Success of Natural (Full) Clutches

A total of 165, 114, 224 and 247 clutches of green turtle eggs were examined for the respective year of 1997, 1998, 2000 and 2001 (Fig. 1). Statistical analysis on the data indicated that the emergence success (ES) was significantly different between years (ANOVA: df = 3, F = 13.379, P<0.05). Post Hoc Least Significant Difference revealed that 1998 (81.65% + 1.42) and 2000 (79.81% + 1.71) are significantly lower than 1997 (88.52% + 1.42) and 2001 (89.0% + 1.16) (P<0.05).

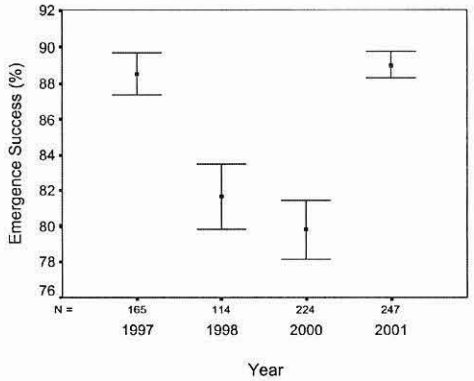

Fig. 1 Mean emergence success (% + SE) of Chelonia mydas nests laid at Mak Kepit, Terengganu, Malaysia, 1997-1998 and 2000-2001. There was a significant difference between years (P<0.05).

Emergence success of full clutches from natural and hatchery incubation

Full clutch data for 1997 and 1998 derived from Mak Kepit beach (165 and 114 clutches) and Chendor hatchery (137 and 17 clutches), respectively, were used to compare their ES. There was a statistically significant interaction between year and site (ANOVA: df = 1, F = 17.355, P<0.05) indicating that there was no patterns due to year or site. ES of full clutches of eggs incubated naturally at Mak Kepit beach was significantly higher than that of Chendor hatchery (Fig. 2).

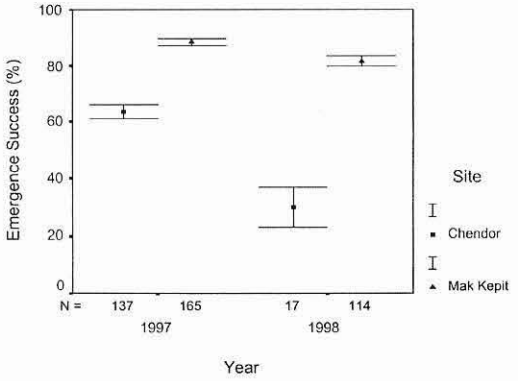

Fig. 2 Emergence success (% + SE) of Chelonia mydas clutches incubated in the Chendor hatchery and in situ at Mak Kepit, Terengganu, 1997-1998. N represents the number of nests.

Emergence success of full and split clutches

We compared the ES in the Chendor hatchery between full and split clutches for 1997 and 1998. A total of 192 split clutch and 137 full clutch for 1997, and 64 split clutch and 17 full clutch clutches for 1998 were statistically tested. Results indicated that there was no significant difference in ES between split and full clutches in both years (ANOVA: df = 1, F = 0.188, P>0.05). There was significantly higher ES in 1997 for both split and full clutches (ANOVA: df = 1, F = 46.143, P<0.05).

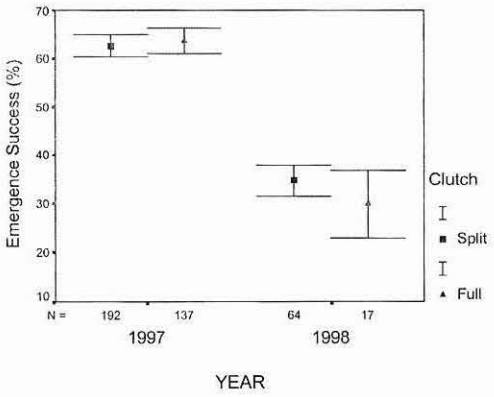

Fig. 3 Emergence success (% +SE) of full and split Chelonia mydas clutches relocated to the Chendor hatchery, Pahang, Malaysia, 1997-1998.

DISCUSSION

Natural versus hatchery clutches

The in situ clutches for a 4-year data resulted in high emergence success (Fig. 1). Mean emergence success of 84.75% (range 79.8-89.0%) in this study is comparable with most in situ clutches of marine turtles in many other parts of the world. Annual values of the emergence success laid on the same nesting beach varied among years. This is presumably due to annual variation in the environmental factors such as rainfall, temperature, predator etc. Female turtles which lay their eggs in each season might come from different feeding populations, different age groups and breeding capability. All these factors can contribute to variations in annual emergence success of in situ clutches. On the other hand, the emergence success of hatchery incubated full clutches was relatively low (Fig. 2). It is commonly accepted fact that human manipulation can influence survival of turtle eggs (Eckert and Eckert, 1990). For safety reason, eggs deposited on Chendor beach were relocated to hatchery at night they were laid or in the next morning. They were obviously subjected to some degree of handling, and if not carefully done it may cause egg mortality (Limpus et al., 1979; Chan et al., 1985). In addition, the congregated eggs in one small area of the hatchery they prone to predators such as ghost crabs and fire ants (Bustard and Greenham, 1968).

Full versus split clutches

Our results indicated that there was no significant difference in ES between the two category of clutch size in either 1997 or 1998. There was also significantly higher ES in 1997 for both split and full clutches. It is obvious that split clutches show no increase in emergence success in comparison with full in situ clutches. That is, there is no reason that managers should split large clutches for hatchling production purposes. However, one has to consider that splitting of clutches requires more space and cost in the construction of the hatchery. It is recommended that hatchery should incubate only full clutch eggs.

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REFERENCES

Blanck, C. E. and R. H. and Sawyer, 1981. Hatchery practices in relation to early embryology of the longgerhead sea turtle, *Caretta caretta* (Linne). *J. Exp.Biol. Ecology,* **49**: 163-177.

Bustard, R. H. and Greenham, P., 1968. Physical and chemical factors affecting hatchling in the green sea turtle, *Chelonia mydas* (L.). *Ecology* **49(1)**: 269-276.

Chan, E. H., Salleh, H. U. and Liew, H.C., 1985. Effects of handling on hatchability of eggs of the leatherback turtle, *Dermochelys coriacea* (L.). *Pertanika* **8(2)**: 265-271.

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

Eckect, K. L. and Eckert, S.A., 1990. Embryo mortality and hatch success in In situ and translocated leatherback sea turtle *Dermochelys coriacea* eggs. *Biological conservation* **53**; 37-46.

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.

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.

Kamarruddin, I. And Abdul-Rahman, K, 1994. A report on the preliminary in situ hatching of green turtle, *Chelonia mydas* (Linnaeus) eggs in Pulau Redang, Terengganu. *Proc. Fish. Res. Conf., DOF Mal.,* **IV**: 379-387.

Limpus, C. J., 1993. Recommendations for conservation of marine turtles in Peninsula Malaysia. Queensland Department of Environment and Heritage, Brisbane, Queensland, Australia.

Limpus, C.J., Baker, V. and Miller, J.D., 1979. Movement induced mortality of loggerhead eggs. *Herpetologica* **35(4)**: 335-338.

Limpus, C. J. and and Miller, J. D., 1980. Potential problems in artificial incubation of turtle eggs. *Herpetofauna* **12(1)**: 2324.

Mrosovsky, N. and C. L. and Yntema, 1980. Temperature dependence of sexual differentiation in sea turtles; implications for conservation practices. *Biological Conservation* **18**: 271-280.

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

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.