EFFECTS OF HATCHERY NEST DENSITY ON THE EMERGENCE SUCCESS AND QUALITY OF *CHELONIA MYDAS* HATCHLING

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ABSTRACT

To maximise hatchery efficiency, nests need to be placed as close as possible, while not compromising emergence success or hatchling quality. Hatcheries in Peninsula Malaysia presently place nests at about 0.6m and 0.7m intervals within and between rows, respectively. The aim of this experiment was to determine the effects of increasing the nest density on emergence success and quality of emerging hatchlings. In June 2002, twenty-nine nests were placed in normal density and ten nests were placed in high density in the Ma'Daerah hatchery, Terengganu, Malaysia. A sample of at least 10 hatchlings emerging from these nests were subjected to a running trial over 1.6m and were weighed, measured and scale counted. The emergence success and the proportion of hatchlings with abnormal scale counts did not differ between high and normal density nests. Hatchlings from the higher density nests ran significantly slower than those from normal density nests and had lower mass-length ratios. It is argued that slower running speeds represent a longer exposure to shore predation and decreased vigour for the offshore dispersal. Furthermore, lower mass-length ratio represents reduced residual yolk stores and lower energy reserves available for the swim frenzy period. The development of eggs in high density clutches could be affected by reduced gas exchange between the clutch and surrounding substrate. This could result from adjacent nests competing for oxygen from the same area. From the current results, it is recommended that nests continue to be relocated into hatcheries at normal density to maintain the quality of emerging hatchlings.

Key words: hatchery, nest density, *Chelonia mydas*, emergence success, hatchling quality

INTRODUCTION

As part of a conservation programmes, the Department of Fisheries Malaysia (DoFM) has run a series of marine turtle hatcheries that incubate eggs to produce hatchlings for the purpose of maintaining its turtle populations. Turtle egg exploitation is an issue in the country and this programme is a mean of protection against collection for local egg markets. From management point of view, the choose of hatchery for hatchling production has been closely associated with budget constraints whereby this method is always cheaper and less labour intensive than in situ (natural) incubation.

The incubation success of marine turtle eggs can be influenced by a number of biotic a abiotic factors including nest location, depth, temperature, inundation, beach erosion, predators and microorganisms (Fowler, 1979; Witzell, 1981; Mrosovsky, 1983; Cornelius, 1986; Wyneken et al., 1988; Connant, 1991; Eckert, 1992;

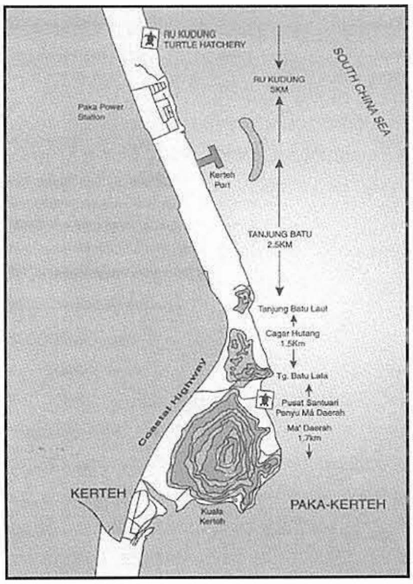
Kamarruddin and Abdul-Rahman, 1994; Sundin, 2001; Blamires and Guinea, 2001; Frick, 2003). In addition, handling can also lead to mortality of turtle eggs (Limpus et al., 1979) and it has been one of the factors that commonly reduce hatch or emergence success of eggs in the hatcheries.

Over 40 years, the performance of hatchery in the Peninsular Malaysia has been merely based on emergence success, that is, the percentage of hatchlings that successfully emerge from a number of eggs incubated. Although incubation success is an important indicator of hatchery performance, resultant hatchling sex ratios and health or in other words, the quality of hatchlings have never been attempted. This study was prompted to fill these gaps and to improve management programme aiming at increasing the production of healthy hatchlings in correct sex ratios. Specifically, the objective of this study was to quantify the effect of nest density in the hatchery on the emergence success and quality of green turtle, *Chelonia mydas* hatchlings.

MATERIALS AND METHODS

Study site - We conducted the study at a turtle hatchery on the east-faced nesting beach of Ma' Daerah, Terengganu, Malaysia (Figure 1). The rectangular hatchery, measured 20m long x 8m wide x 1.6m high was fenced with 2.5cm mesh of plastic material (locally known as netlon) and shaded with nursery-typed black cloth of 75% light retention. This production hatchery accommodated 251 clutches of green turtle eggs in 2002.

Density experiment - Three middle rows of nests in the hatchery were used in this experiment (Fig. 2). A set of normal density nests (a) and high density nest (b) was separated by a distance of about 2m to avoid sharing effect on parameters studied. Ten clutches were relocated at a higher density in the first week of team 1 of the EARTHWATCH volunteer programme (1-8 July, 2002). Normal density nests have approximately 0.6m between their centres within rows and 0.7m between rows (Fig. 2a.). The high density nests have 0.46m between their centres (Fig. 2b.). When hatchlings emerged, a sample of at least 10 hatchlings from these nests were subjected to a running trial over 1.6m trough and were weighed, measured and scale counted. Abnormality was determined as any hatchling with a scale count differs from adult's scale count. The percentage of abnormal hatchlings from each nest (from the sample, N=10-20) was then calculated and the mean percent of abnormal hatchlings was compared for high and normal density nests. The nests were excavated and its contents were examined to quantify the emergence success. A comparison of all parameters was made between hatchlings from high density nests and those from normal density nests. The ANOVA was used for a statistical analysis of the factor affecting nest density. Normality was tested by visual interpretation of Q-Q plots. Homogeneity was tested by Levene's test.



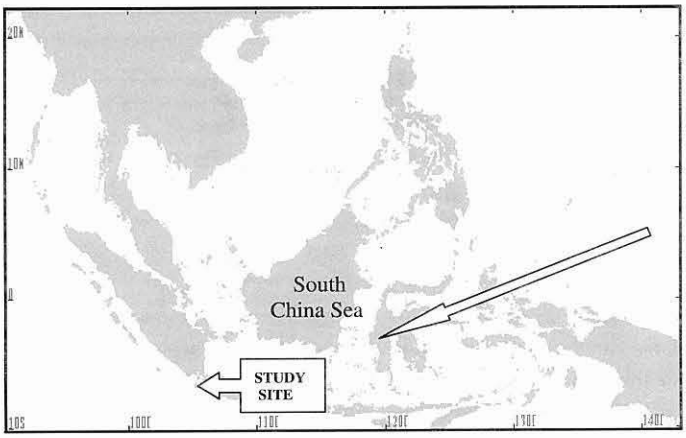


Fig. 1 Map showing study site of the nest density experiment at Ma' Daerah turtle hatchery, Terengganu, Malaysia

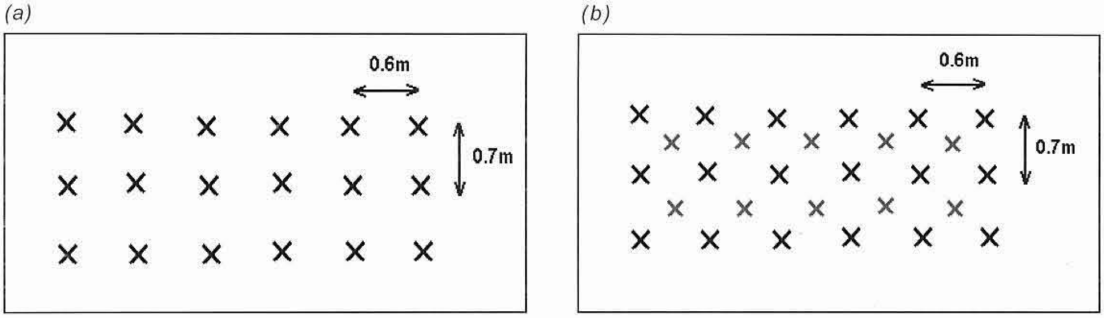


Figure 2. The density of nests positioned in the hatchery. (a) normal density Nests: (b) high density nests (in red).

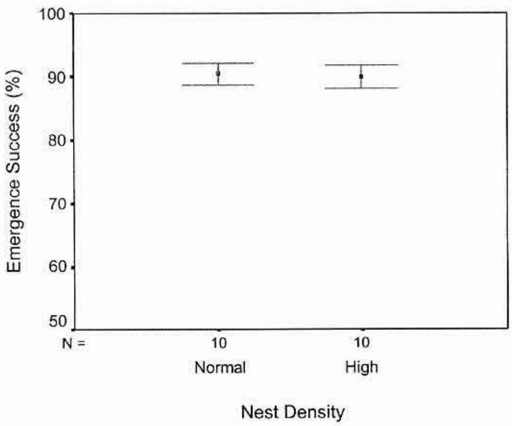


Fig. 3 Emergence success (% +SE) of Chelonia mydas clutches incubated at high density (0.46m between nests) and normal density (0.6-0.7m between nests) in the Ma' Daerah hatchery, Terengganu, Malaysia, 2002. N represents the number of nests.

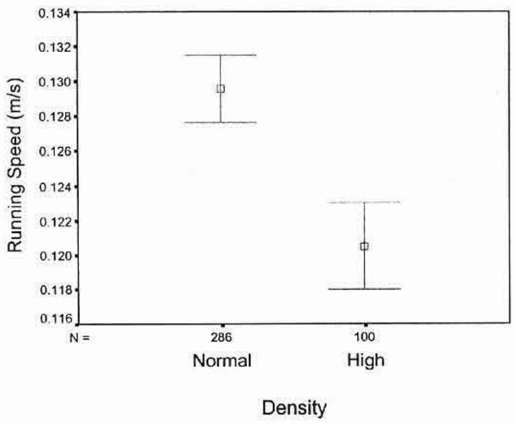


Fig. 4 Mean running speed (+SE) for Chelonia mydas hatchlings emerging from high density nests and normal density nests at Ma'Daerah hatchery, Terengganu, Malaysia 2002. N represents the number of hatchlings.

RESULTS

Comparison of nest emergence success

Data on the emergence success of 10 clutches of respective high density and normal density nests were compared. There was no difference in the emergence success between high density nests (89.94% + 1.78) and normal density nests (90.49% + 1.78) (ANOVA: df = 1, F = 0.048, $P>0.05$). Homogeneity was satisfied (Levene: P = 0.564). The results are summarised in Fig. 3.

Comparison of hatchling running speeds

Figure 4 indicated that hatchlings from normal density nests (0.130m/s + 0.002) ran significantly faster than hatchlings from high density nests (0.120m/s + 0.003) (ANOVA: df = 1, F = 6.511, $P<0.05$). Homogeneity satisfied (Levenes: $P>0.05$).

Comparison of hatchling mass-length ratios

The mass-SCL (straight carapace length) ratio of hatchlings emerging from normal density nests (0.463+0.001) was significantly larger than hatchlings from high density nests (0.457+0.003) (ANOVA: df = 1, F = 4.375, $P<0.05$, Figure 5). Homogeneity satisfied (Levenes: $P>0.05$).

Determination of abnormal hatchlings

The percent of abnormal hatchlings from high density nests (42.0 + 6.5) was not significantly different from the percent of abnormal hatchlings from normal density nests (51.8 + 2.9) (ANOVA: df = 1, F = 1.888, $P>0.05$) (Figure 6). Homogeneity satisfied (Levene: $P>0.05$).

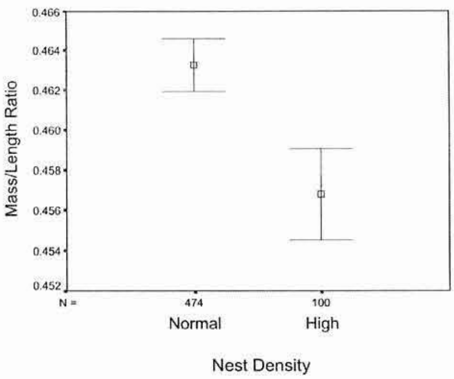


Fig. 5 Mean hatchling mass-SCL ratio (+SE) for Chelonia mydas hatchlings incubated at normal densities and hatchlings incubated at high densities at Ma'Daerah hatchery, Malaysia 2002. N represents the number of hatchlings.

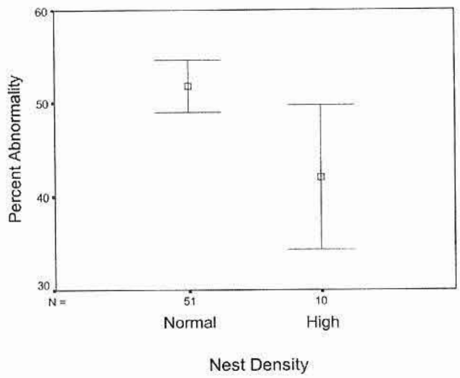


Fig. 6 The mean percent (%+SE) of abnormal Chelonia mydas hatchlings from high density and normal density nests incubated at Ma' Daerah hatchery, Terengganu, Malaysia, 2002. N represents the number of nests.

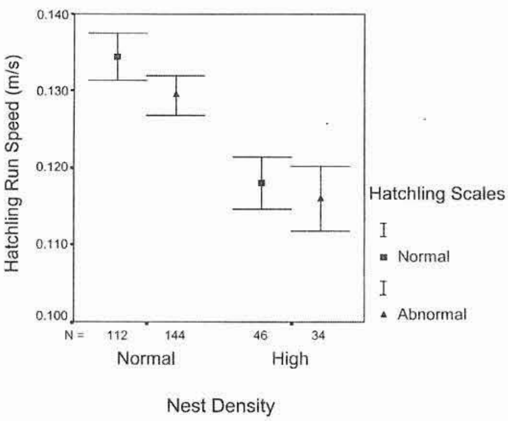


Fig. 7 Mean running speed (+SE) of Chelonia mydas hatchlings with normal and abnormal scale counts found in normal density and high density nests at Ma'Daerah hatchery, Malaysia 2002.

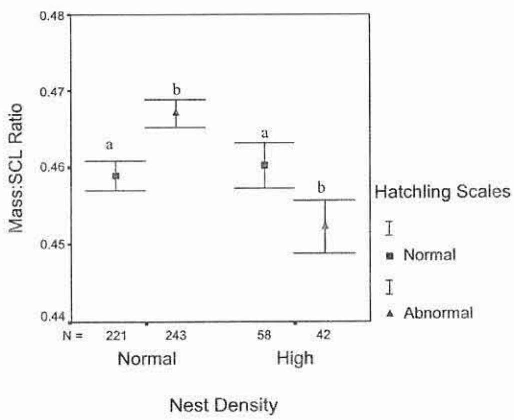


Fig. 8 Mean mass-SCL ratio (+SE) of Chelonia mydas hatchlings with normal and abnormal scale counts found in normal density and high density nests at Ma' Daerah hatchery, Malaysia 2002. a and b were significantly different (LSD: P<0.1).

Comparison of running speeds between hatchlings with abnormal scale counts and hatchlings with normal scale counts in normal density nests and high density nests

There was no significant difference (ANOVA: df = 1, F = 0.154, P>0.05) in running performance between hatchlings with abnormal and normal scale counts in either normal density or high density nests (Fig. 7).

Comparison of mass-SCL ratios between hatchlings with abnormal scale counts and hatchlings with normal scale counts in normal density nests and high density nests

The interaction between scale counts (abnormal/ normal) and nest density (high/normal) was significant (ANOVA: df = 1, F = 6.778, P<0.05) (Fig. 8). Post Hoc Least Significant Difference found normal hatchlings from normal density nests had a higher mass-SCL than all other groups (P<0.1).

DISCUSSION

The emergence success and the proportion of hatchlings with abnormal scale counts did not differ between high and normal density nests. Hatchlings from the higher density nests ran significantly slower than hatchlings from normal density nests and had lower mass-length ratios. It is argued that slower running speeds represent a longer exposure to shore predation and decreased vigour for the offshore dispersal. Smaller hatchlings face increased risk of predation and furthermore, lower mass-length ratio represents reduced residual yolk stores and lower energy reserves available for the swim frenzy period. The development of eggs in high density clutches could be affected by reduced gas exchange between the clutch and surrounding substrate. This could result from adjacent nests competing for oxygen from the same area and warrants further investigation. The findings revealed an advantage of having clutches incubated in normal density over high density in terms of running performance. From the current results, it is recommended that nests continue to be relocated into hatcheries at normal density to maintain the quality of emerging hatchlings.

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