

SOCIAL FACILITATION IN GREEN TURTLE SIBLINGS*

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Introduction

During her biennial or triennial trip to the nesting beach the green turtle (*Chelonia mydas*) lays between 500 and 1,000 eggs, parcelled out at 12-15 day intervals in clutches of about 100. The waters around rookeries are usually deep, rough, and foodless, and one wonders why the turtle should not nest a single time and leave for home pastures. Perhaps the 100-egg complement is the fraction that gives just the right spreading of risk of nest predation. Also, it is unlikely that the capacity to carry 1,000 shelled eggs to the beach at one time could be evolved, while to reduce either the number or the size of the eggs would affect the reproductive potential. Even if the full load could somehow be carried ashore there would be too much volume to be lodged in the zone of stable microclimate: below about a foot, and above the level of waterlogged sand. Moreover, 100 eggs just fill the flask-shaped nest the turtle makes. If the shape is functional, as seems likely, then nest-shape alone would hold down egg number, because the leg and foot of the turtle are extended to the limit in digging the 100-egg nest. Other factors no doubt help regulate the upper limit of complement size. We are here interested in those that keep it from falling below a certain minimum, and social facilitation seems to be involved.

Mechanical and Psychological Co-operation

Carr & Ogren (1959) suggested that a single sea turtle, hatching at the usual nest depth, would be unlikely to survive. Tests made at Tortuguero, Costa Rica, during July, 1959, support this assumption. Results are shown in Table I. Figures in the table refer only to hatchlings reaching the surface of the sand. In a few of the tests observations were continued after emergence, and these tend to strengthen the case for group facilitation. Of the six single hatchlings that got to the surface, none came out, in the opinion of the observer, able (or motivated) to crawl to the sea. Two were even unable to cross the few feet of sand to the wire fence that surrounded the experimental nests. In the larger

Table I. Relation between Brood-size and Emergence success in Green Turtle Nests at Tortuguero, Costa Rica, June-September, 1959. All hatchlings were from divided egg complements re-buried at depths of 30-34 inches. The rank correlation between the number of hatchlings per nest and the percentage survival is 0.092, which is significant at the 0.05 per cent. level.

No. live turtles hatched in the nest	No. of nests	No. of hatchlings emerging	Percentage emergence
1	22	6	27.3
2	22	37	84.1
3	18	49	90.7
4	14	55	98.2
5	13	64	98.5
6	12	71	98.6
7	12	82	97.6
8	13	104	100.0
9	6	54	100.0
10	4	40	100.0

groups kept under observation, however (two sets of five, one of nine, two of ten) all the emerging young actively moved to the seaward side of the enclosure and piled up there. Tests to determine the bearing of this post-emergence behaviour on survival are projected. Meantime, however, it seems clear that some sort of social advantage is involved, and it is of interest to examine the factors that may contribute toward it.

Observations through glass nest-sides (Carr & Ogren, 1959, 1960, and unpublished data) support the implication of the above data that turtles in a nest are not independent individuals but a group that meets the shared predicament of its interment with group action. The first young that hatch do not start digging at once but lie still until some nestmates are free of the egg. Each new hatching adds to the working space because the spherical eggs and the space between them make a volume greater than that of the young and the crumpled shells. The vertical displacement that will carry the turtles to the surface is the upward migration of this chamber, brought about by a witless collaboration that is really a loose sort of division of labour. Although the movements involved are only a generalized thrashing, similar to those

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that free the hatchling from the egg, they accomplish four different (and perhaps indispensable) things, depending on the position of the turtle in the mass. Turtles of the top layer scratch down the ceiling. Those around the sides undercut the walls. Those on the bottom have two roles, one mechanical and the other psychological: they trample and compact the sand that filters down from above, and they serve as a receptor-motor device for the hatchling super-organism, stirring it out of recurrent spells of lassitude. Lying passively for a time under the weight of its fellows one of them will suddenly burst into a spasm of squirming that triggers a new pandemic of work in the mass. Thus, by fits and starts, the ceiling falls, the floor rises, and the roomful of collaborating hatchlings is carried toward the surface.

Once the young turtles are on the beach, whatever integration remains is maintained by the common motivation and taxes that take the hatchlings toward the sea. Although co-operative advantage at this stage remains to be shown experimentally, observations suggest that some interchange continues. The trip to the sea is interrupted repeatedly. This may prolong the period of exposure to desiccation and predation. A broodmate coming up from behind often stimulates a stalled group to move off abruptly, like toy turtles wound up and all let go together. Moreover, when one of a generally well-oriented

group collides with a fellow off its course they both are likely to resume the journey on correct headings after the collision. Once in the water, the sibling group is so spread about by the trip through the surf that facilitation may be of little importance. Watching groups of hatchlings that have crossed the surf line to the calmer water beyond, we have occasionally seen one take a swimming cue from another; but this must be a minor effect with little bearing on survival.

Heat Gain in Green Turtle Nests

The figures in Table I represent survival of hatched-out turtles—not survivors from egg clutches. Moorhouse (1933) found reduced viability in fractional complements of eggs placed in artificial nests, and attributed this to injury in transportation. Hendrickson (1958) thought it more likely caused by lowered metabolic heating in the small egg masses, having found that, during a two-week period at the China Sea rookeries, nest temperatures gained an average of 5.9 degrees Centigrade over the outside average at the same depths. Our data comparing temperatures inside and outside the nests at Ascension Island (Fig. 1) show an average gain of 2.3 degrees Centigrade in nests.

While it is possible that some of the rise in temperature is the result of decomposition of infertile or defective eggs, the character of the degeneration that these undergo—gradual shriv-

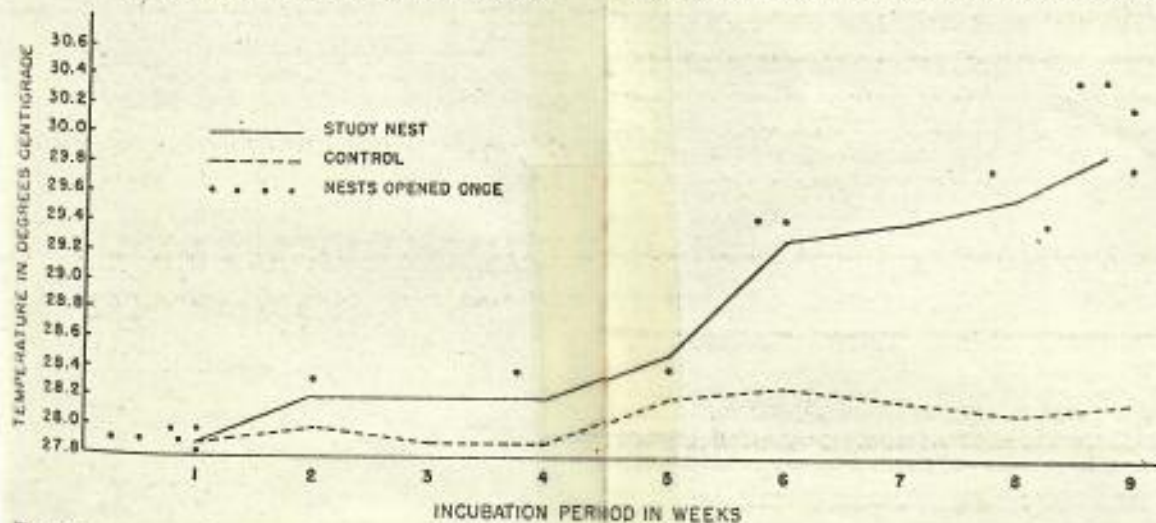


Fig. 1. Temperatures in turtle nests and outside at the same depth (about 31 inches); Ascension Island, 23rd Feb.—24th April 1960. Temperatures for the study nest and control were taken four times daily at the bottom of a tube inserted into the nest, and are given as weekly averages. Diel ranges were 1 degree Centigrade or less. From the 105 eggs in the study nest, laid by a turtle with carapace length of 43 inches, 63 young emerged after 61 days' incubation. The rest were infertile or produced dead or deformed embryos.

elling and solidification—make this factor seem less probably significant than the mass metabolizing of the live eggs. If the self-heating actually influences viability and hatching time, which remains to be shown, it might explain some of the incongruence between our small high survival groups (Table I) and the oddly large safety factor the female seems to be allowing when she stocks a nest with 100 eggs.

Summary

1. Tests made at the green turtle nesting ground at Tortuguero, Costa Rica, show that turtles hatching singly have reduced prospects of emerging from the nest, and even less chance of reaching the sea.

2. Observations through glass nest sides, and of young going from the nest to the sea, show that group facilitation, probably involving both mechanical and psychological factors, occurs.

3. Data from tests at Aomori, Japan, and extending Hendrickson's results in the China Sea, indicate that group facilitation raises the temperature in the nest, and that green turtle eggs and suggest that group facilitation constitute thermal co-operation which increases the fitness of the sets of eggs and young as primary units.

REFERENCES

- Carr, Archie & Larry, Ogren (1956). The migrations of sea turtles. *J. Herpetol.* 1, 1-10.
 Carr, Archie & Larry, Ogren (1957). The migrations of sea turtles. *J. Herpetol.* 2, 1-10.
 Carr, Archie & Larry, Ogren (1958). The migrations of sea turtles. *J. Herpetol.* 3, 1-10.
 Hendrickson, John R. (1958). The green turtle, *Chelonia mydas* (Linn.), in Massachusetts. *Proc. zool. Soc., Lond.* 130, 4-10.
 Moorhouse, F. W. (1937). Notes on the green turtle (*Chelonia mydas*). *Rept. Geol. Surv. India* 4, 1-22.

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