OBSERVATIONS AND NOTES ON THE CAPTIVE BREEDING OF THE GREEN SEA TURTLE *(CHELONIA MYDAS)* ON GRAND CAYMAN, BRITISH WEST INDIES

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INTRODUCTION

The Green Turtle *(Chelonia mydas)* has a worldwide distribution in tropical and sub-tropical seas, and different races have been recognised throughout this large range. Its colouration is variable, although basically greeny-brown with darker markings, with the flippers and head olive green. This species may reach a weight of several hundred pounds, and Carr (1952) mentions old American records of up to 850lbs. They are found most commonly in shallow areas of continental shelf where there is sufficient food in the form of marine grasses. Diet of the adults consists mainly of vegetation, but they will occasionally take animal material such as jellyfish (Bustard 1972). During the first year or so of life they are mainly carnivorous. Tagging experiments have shown that Green Turtles migrate thousands of miles between feeding and nesting grounds; for example, experiments by Carr (1968) have suggested that Brazilian Green Turtles travel to Ascension Island in the mid-Atlantic to nest. Little is known about the behaviour and migrations of juvenile turtles.

The Green Turtle is the best known species since it is widely distributed and its flesh has the best flavour. In American and Caribbean waters it was over exploited at a very early date, when they were collected in vast numbers by seamen and settlers as a source of fresh meat, since captured turtles would live for a considerable period. Often the individuals collected were females on the beach about to lay eggs, which no doubt worsened the situation. Because the Green Turtle is so predictable in its breeding and feeding sites it is an easy target for man, who is increasingly moving into previously undisturbed areas.

In different parts of the world the status of this species varies considerably: for example, there are healthy, large colonies on the coasts of Australia (Bustard 1972), but in some parts of the Caribbean they can no longer be found (Carr 1968), and on a global scale the Green Turtle is greatly depleted and is listed in the IUCN Red Data book as an endangered species. The world's best known "turtle-ologists", Professor Archie Carr and Dr Robert Bustard, have talked at great length about the possibilities of farming this species, and have suggested that such a rational exploitation may be the most effective method of conservation.

During February 1979, while studying herpetology of the Cayman Islands, I was honoured to be a guest of the Cayman Turtle Farm Limited, on Grand Cayman. In this article I will describe the farm and briefly relate some of its history and great success, giving my own impression of this establishment and the importance of the research and achievements carried out there.

Description of the Farm

Green Turtle farming on Grand Cayman was started in 1968 by Mariculture Limited, with a small prototype farm at Salt Creek. In 1970 when the turtle population had reached 30,000 the farm was moved to its present site at Goat Rock (Plate 1) and later after financial difficulties, new owners renamed it the Cayman Turtle Farm Limited. Continued expansion has been necessary to accommodate the current turtle population of around 70,000.

Sea water is continuously pumped through all the tanks on the Farm thus ensuring

maximum cleanliness and minimum risk of infection. The water is pumped in from the sea at one end of the Farm, circulated and discharged at the other end. Each hour the pumping system circulates 2.6 million gallons through tanks varying in size from 12 to over 75,000 gallons. All the turtles are fed on a pelleted feed, similar in appearance to that used in other livestock farming industries, and is sometimes supplemented with locally mown turtle grass *(Thalassia).* The pellets float and vary in size according to the age of the turtle, so that they can pick them from the surface. The pellets are high in protein and give an efficient food conversion ratio and rapid growth rate. The amino acids therein are those found to be essential for hatchling Green Turtles by Wood (1974), and are similar to those generally considered essential for mammals.

The Farm is divided into eight distinct areas, which are briefly described below (Plate 1 and Fig. 1).

Area One
These eight tanks normally hold turtles between the ages of six and eighteen months, and each tank (depending on size) is capable of holding between one thousand and five thousand turtles (mostly commercial growing stock).

Area Two
These small tanks contain the baby or hatchling turtles, which are all between 3 days and 6 months of age. The baby turtles are brought to these tanks from the hatchery, where the eggs have incubated for approximately 8 weeks at a mean daily temperature of 28°C. The eggs are initially removed from all verified nests on the artificial beach (Area 5, see later), placed in batches of up to 100 in three layers in styrofoam boxes and covered with a muslin cloth and a thin layer of sand. The boxes are then placed in an open-sided hatchery with good ventilation, temperature fluctuation in the boxes being reduced by the styrofoam. The survival rate of baby turtles on the farm is obviously much higher than in the wild, where the eggs are subject to human and animal predation before they hatch, and after they hatch crabs, birds, and fish kill the majority of the survivors.

Area Three
These two large tanks contain commercial growing stock of a medium size. The length of the carapace can be a rough guide to their age. For example, a 10" carapace indicates a one year old turtle, 15" would indicate 18 months, and 20" about three years. When turtles begin to get sizeable they look incapable of moving anything but slowly; however, they can move surprisingly quickly in bursts of up to 20 miles an hour.

Area Four
These six small round fibreglass tanks came from the first turtle farm site at Salt Creek, where they were floated in the sea attached to cat-walks and contained all the original Green Turtle Stock. Now they contain various species of turtle, including Loggerheads *(Caretta caretta),* Hawksbills *(Eretmochelys imbricata)* and Ridleys *(Lepidochelys olivacea).* These are kept purely for observation and research and the Cayman Turtle Farm has no intention of farming these other species on a commercial scale. It is worth mentioning that most other species of sea turtle are carnivorous, which causes their meat to have a strong and less appealing flavour.

Area Five
This large pond (Plate 3) and artificial beach contain the breeding herd. Basically in this area the turtles mate, the females crawl up on the beach to deposit their eggs and return to the water. The pond measures approximately 200 ft (60.5m) by 86 ft (26.5m) giving an area of about 0.4 acres (0.2 ha). It is about 10 ft (3.1m) deep on the north-west side and shelves up to an artificial beach about 35 ft (10m) wide on the south-east side. The capacity of the pool is about 0.75 million gallons, and sea water is pumped through at a rate calculated to give 18 changes daily.

In order to accelerate the Farm breeding programme it was necessary to bring to Cayman mature wild male and female turtles. As the Cayman Turtle farm was not started until 1968 the oldest farm reared turtles are only just reaching maturity. The farm reared

turtles can be easily recognised by their far superior shell colours and patterns. In 1973 the first known nestings in captivity occurred in this breeding pond, subsequently eggs were laid on the artificial beach and healthy turtles hatched. This was a major breakthrough and in 1975 the farm achieved its second major step forward when a farm reared female laid 601 eggs and healthy hatchlings emerged.

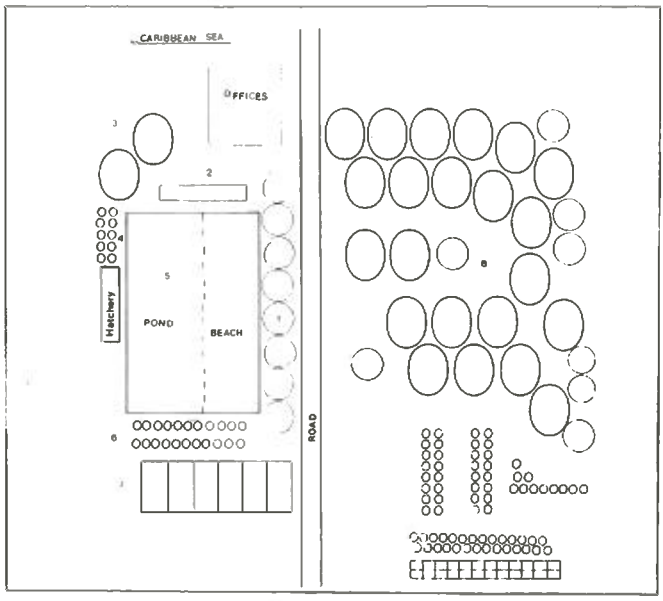
During the mating and laying seasons farm personnel maintain a 24-hour watch on the pond and artificial beach: all the breeding turtles are tagged so it is therefore easy to keep records of such facts as when and how long each turtle mates, and how many eggs each female lays per nest and per season. In Cayman, mating occurs between April and July each year. Following a complex courting procedure, male and female will mate sometimes for periods of up to 52 hours. The laying season in Cayman is from May until September. During this period and only at night the females crawl up the artificial beach, scoop out a 2 to 3 ft hole with their rear flippers and then deposit their eggs, cover their nest and return to the water. This, of course, is an exact replica of their behaviour out in the wild. Females have laid up to 230 eggs per nest and the Farm has recorded one female which nested 10 times in one season laying over 1,700 eggs in the artificial beach.

Area Six
This double row of tanks holds commercial growing stock from 6 to 18 months. There are also small tanks used for research experiments in feed, stocking density and medication.

Area Seven
These oblong tanks were the last to be constructed at Goat Rock, and water circulation within this particular shape and size tank has proved to be very efficient. Three of these tanks normally hold larger commercial growing stock, whilst three tanks nearest the road are reserved for future breeding stock. As the turtles become older, they spend less time floating on the surface and during non feeding periods can be seen resting on the bottom, occasionally coming up to the surface to breathe.

Area Eight
This large area contains the majority of the commercial growing stock over 18 months of age.

Fig. 1. Plan of the Cayman Turtle Farm. See text for explanation of area numbers.



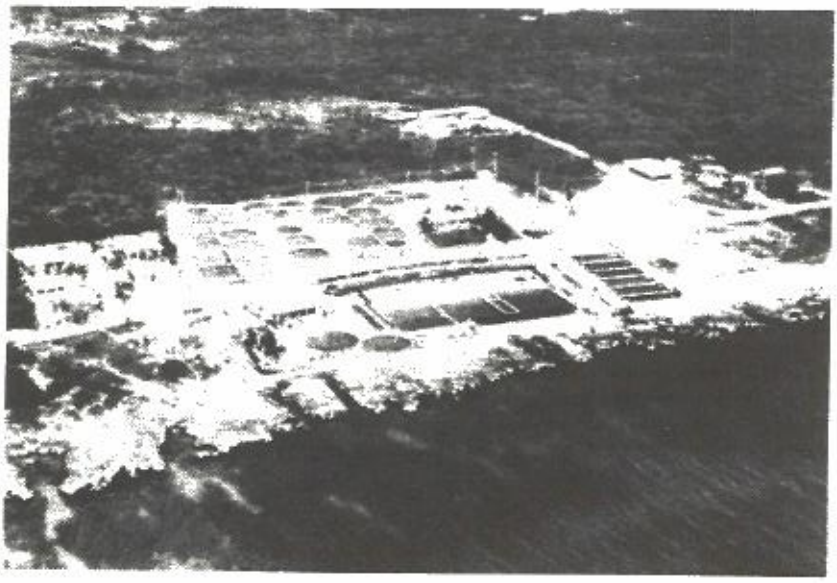


Plate 1. The Cayman Turtle Farm At Goat Rock, Grand Canyon.

Plate 2. Captive bred *Chelonia mydas.* Commercial growing stock over three years old.

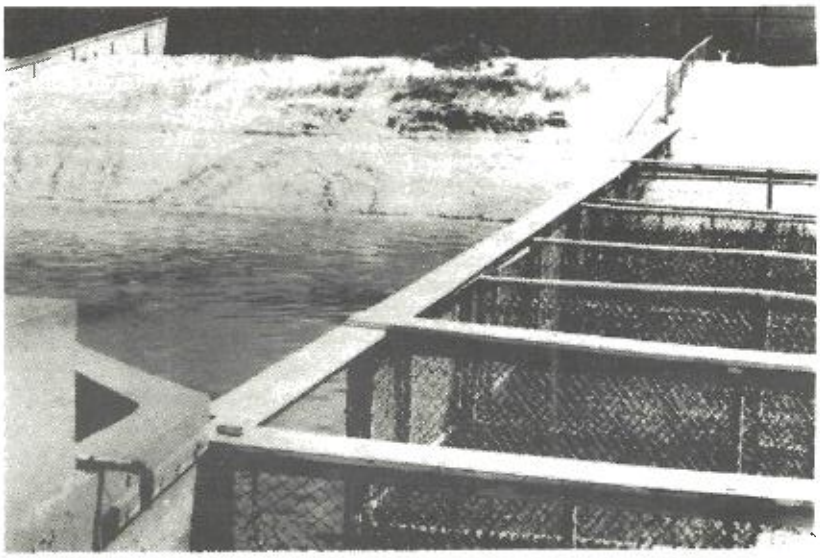


Plate 3. The large breeding pond and artificial beach. Turtle tracks can be seen in the sand. Mating pairs of turtles are coaxed into the meshed pens on the right of the picture to prevent displacement of the copulating male by others.

Plate 4. Small tanks used for research and medication purposes in Area 8.

DISCUSSION

I realise that many turtle lovers may not be sympathetic towards the idea of farming turtles for commercial purposes, but I believe that a rational exploitation in this way may be the best approach from the turtle's point of view.

Firstly I would like to make a few points about the way the Cayman Turtle Farm was set up, it's aims and achievements, and the attitudes its owners and employees have towards conservation.

The Farm is a new and unique operation, and in the absence of existing farm stocks to draw on, this pioneer farm had to obtain its foundation material from the wild, but did so with as little disturbance to wild populations as possible (Simon 1975). Up to 1973 the stocking of the rearing tanks at the farm depended entirely on the artificial incubation and hatching of eggs collected from natural beaches, with the permission of the appropriate authorities. During the period 1971-3 almost all of the eggs collected came from nests doomed by tidal washout or volcanic sand, so that loss of hatchlings to the wild was small in comparison with the number of eggs collected, which was 188,568 (Simon 1975).

The Farm is now entirely self-sufficient, since it has taken no eggs from the wild since 1978, and does not intend to do so again (Johnson, personal communication, Cherfas 1979). Representatives of the Department of the Environment and British management authority for CITES (Convention of International Trade in Endangered Species) recently stated that the Cayman Turtle Farm meets the criteria for a farm as outlined in CITES, since its products are now derived from a closed operation.

The success of the Farm is heavily dependent on research, and a competent team of zoologists are continually working on more efficient means of turtle husbandry and equally important, a fuller understanding of the Green Turtle's life cycle and biology (Simon 1975; Simon, Ulrich & Parkes 1975; Wood & Wood 1978; Wood 1974; Ulrich & Owens 1974; Ulrich & Parkes 1978). Of particular importance is a complete understanding of its reproductive habits, and considerable progress has also already been made in areas such as nutrition and disease control.

As mentioned previously, the first breakthrough came in 1973 when the first farm laid eggs hatched successfully. Up to this time there had been no reproductive activity in the large breeding pool which contained about 70 ex-wild turtles. However, on April 12th 1973 a burst of mating activity occurred after the introduction of two Surinam males (Ulrich & Owens 1974) at the beginning of the mating season. Not only did the two new males mount females almost immediately after 15 days in transit, but within a few days mating activity was shown by at least two of the previously inactive males. It would appear that turtles kept continuously together all year round do not become sexually active in the mating season, and require some kind of trigger, such as the introduction of the wild Surinam males. Therefore in 1974 the males were segregated from the females except during the mating season, which proved successful: this technique was effective in breeding the Giant tortoises of the Galapagos, and is probably a familiar manipulation to most reptile breeders. The 1974 season provided an interesting example of the importance of the social environment in sexual behaviour (Ulrich & Parks 1978). A pair of ex-wild turtles, both of which had been sexually active in 1973, were isolated in a large tank from February to June 1974 where in this situation they showed no sexual activity. They were then transferred to the breeding pool, where the male, apparently stimulated by competition, quickly mounted the female, as afterwards did two pool mates.

The table below shows the breeding results for 1973 and 1974 (from Ulrich & Parkes 1978).

	1973	1974
No. of females laying	19	14
No. of clutches	92	80
Average no. of clutches per female	4.8	5.7
No. eggs	11268	9752
Average no. eggs per female	593	697
Average no. eggs per clutch	122	122
Hatch rate %	42.3	44.8

Although the hatch rates are relatively low when compared to eggs collected from wild rookeries (80%) and hatched under the same conditions, these results clearly show that the Green Turtle can be captive bred on a large scale, and with further research and experience these figures should improve dramatically. Whether or not the reproductive cycle from farm bred turtle to farm bred turtle can be completed, is not likely to be answered before the early 1980s, when stock hatched from eggs laid on the farm in 1973 should become sexually mature.

Unlike illegally poached turtles, every part of a farm reared turtle is utilized to make a variety of products, including steak, soup products, shell products (whole shells and jewellery), leather, and oil. Although this exploitation of the Green Turtle may not appeal to many BCG members, I do believe it to be a realistic approach to the problems of conserving the species and satisfying the demand for turtle products. Man has been killing turtles and their eggs in vast numbers for centuries, and passing legislation to protect them has not stopped poaching on a large scale, since many poor people rely on this animal to make a living. However, if there is an alternative to poached material, in the form of superior high quality farm products at acceptable prices, then this can only be a good thing: wild populations will not be threatened by this kind of venture and the control of the distribution and export of farm products should be relatively easy. Strict control by governments should ensure that such products operate within the law, and that pseudo-farms, as with some crocodile farms, do not emerge. Arguments suggesting that selling farm products may stimulate the market and increase demand for wild turtles are not convincing, as there is little evidence for this being true.

The big "spin-off" from this commercial venture is the great deal of knowledge gained, at private expense, about the biology and large scale captive breeding of the Green Turtle. The uses this information could be put to for conservation projects are numerous. For example, Robert Bustard (1972) has shown that releasing pen-reared yearlings to the wild increases overall survival something like 50 to 100 times over the natural situation. Further research has to be completed to determine whether or not pen-reared turtles behave normally when released to the sea, although results so far are encouraging. Alternatively, captive bred hatchlings could be released directly to the sea: survival up to the hatchling stage would be much higher than in the natural situation, where a large percentage of eggs and hatchlings are killed on the beaches. Because the employees and owners of the Farm have been so open and published their methods and techniques developed over many years, we now have the technology and understanding to breed marine turtles on a large scale, which, I am convinced, may prove invaluable to their future conservation.

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