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From the office of the Managing Director MICHAEL R. GOODIER
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21st March 1975

Mr Norbert Dlugoss
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U S A

Dear Sir

In reply to your letter dated 10th March 1975 we enclose herewith further descriptive literature relating to Mariculture, together with copies of papers given at the World Mariculture Society Meeting held at Charleston. These papers have not as yet been printed in any scientific journals but we trust you will find them informative. If you have any further queries or questions please let me know.

Yours faithfully
MARICULTURE LIMITED

M R GOODIER
Managing Director

PRELIMINARY NOTE ON THE REPRODUCTION OF *CHELONIA MYDAS* UNDER FARM CONDITIONS

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INTRODUCTION

Little is known about the feasibility of breeding the green sea turtle *Chelonia mydas* (Linn.) in captivity. There are reports of captive mating with eggs produced (Whitham, 1970; Mowbray, 1965) and Hendrickson (pers. comm.) has observed nesting in an open aquarium with a beach in Hawaii. However, in each of the above reports, less than the minimum required facilities were available and no hatchlings were produced.

In 1969 at the Mariculture Limited turtle farm, females that had been captured at Tortuguero, Costa Rica laid 6 clutches of eggs soon after being placed in a large pool with a beach. Three clutches were laid the following year by newly captured females from Guyana. These clutches hatched normally (Simon, pers. comm.)

BREEDING POOL

The breeding pool is located in the centre of Mariculture's Goat Rock Farm on Grand Cayman Island, British West Indies. It is rectangular in shape with a surface area of 0.167 hectares. The sea water exchange rate for the 2.25 million litre pool is estimated at once every two hours. The pool, excavated from the calcareous substrata, has a maximum depth on the west side of 1.98m with the bottom contour sloping gently up to the 0.072 hectare nesting beach on the east side. Sand on the artificial beach varies in depth from 0.5 to 2.0m and is planted with common beach vegetation. At the eastern-most extremity of the beach a dark-coloured, plywood fence prevents the escape of nesting turtles and shields them from the lights of passing automobiles. At present there are a total of 75 wild caught and 176 captive reared animals in the breeding pool.

Wild caught turtles are from the nesting beaches of Costa Rica, Surinam, Guyana, Ascension Island and the turtle fishing grounds off the eastern coast of Nicaragua.

The first introduction of breeding stock was in September of 1969 when 17 females from Costa Rica were placed in the pond. Twenty-one females from Surinam and Guyana were added in May 1970 and an additional three females from Surinam were introduced in May 1971.

The difficulty of catching male turtles in the vicinity of the nesting beaches necessitated the purchase of turtles from

Caymanian boats fishing the Mosquito Keys of Nicaragua. Twenty-four females and seven males from this source were added to the breeding stock between September 1970 and May 1971.

Two adult males, captured off the breeding beaches of Ascension Island were introduced in March of 1972; however one of the males died the following November. Two large males from Surinam were placed in the pool in April 1973.

Farm reared stock has been selected periodically from three age groups and placed in the breeding pond. Information on the sex ratio of these farm reared turtles is not available because of their immature state of development. The groups selected for breeding stock have been designated 001 (Costa Rican stock), 002 (Ascension stock), and 004 (Ascension stock) and are 5, 4½ and 3½ years of age respectively. The oldest farm reared stock in the pond are nine turtles from a Mariculture Limited pilot study which are now 6 and 7 years old.

The animals are fed daily on either a high protein commercial pellet or turtle grass (Thalassia) which is cut with an underwater mower.

The central location of the breeding pool places it under the constant watch of many of the farm employees and tour guides who assisted the research staff by reporting any unusual occurences. In addition, observations on mating activities were made on a daily basis at irregular times. Observations were conducted from the side of the pool since entering the water caused a great disturbance among the animals and left the water too murky for further observation. Beginning 19 June, a night watch was initiated to tag and measure each nesting animal, collect the eggs and observe non-nesting emergences.

RESULTS

Breeding

On 12 April 1973, two males which had been collected at the nesting beach in Surinam were introduced into the pool. These males had been captured 15 days prior to introduction and held in a crawl or concrete pool before being flown to Grand Cayman. Within 30 minutes of being placed in the breeding pool one of the males had mounted a female. The same day the second Surinam male also mounted a female. Within two days at least two of the pre-existing wild caught males were mounting or attempting to mount females. We are not able to say when mounting resulted in intromission; however, unreceptive females clasp their back flippers in a ventrally opposed manner (also noted by Booth and Peters, 1972) causing a mounted male to loose interest in from a few seconds to thirty minutes. For this reason as well as the many observations of apparent prolonged mating (1 to 15 hours) in which the female did not exhibit the unreceptive flipper position and did not struggle we feel that effective matings may last several hours. One pair was noted in copula on four consecutive days. Night observations were not undertaken at this time but it is possible they remained in copula for the entire period. Booth and Peters (1972) have noted C.mydas copulating for 6 hours.

Mating pairs were observed almost daily from 12 April to 5 June. On 4 June, four mated pairs were observed. On 14, 17 and 21 June single pairs were observed mating, while on the 22nd (last observation of mating) two pairs were observed. During June the wild males made constant attempts (usually unsuccessful) to mount females, i.e. 6 attempts in 30 minutes at 0730 hours on 10 June. During July mating attempts were only occasionally observed.

Females that had begun to nest (identifiable by new tags) were not observed mating and were on two occasions seen to bite viciously in avoiding males attempting to mount. Mating or mating attempts were occasionally seen at night, thus the possibility that these females were mated nocturnally cannot be ruled out.

Farm reared animals have been observed in the mounted position, although in all but the first instance we do not know for how long. 1) in June 1973 a 57Kg female introduced to the breeding pool was mounted by a wild male for 30 minutes. 2) two farm reared animals from group 001 were seen mounted on 11 June. 3) several of the females from groups 001, 002 and 004 were observed being mounted by wild males.

Dissections of one female from group B-1 indicate an immature gonadal state with very rudimentary oviducts (Parkes, pers. comm.) Males from group 001 and 002 have started to develop elongated tails and may be approaching sexual maturity. A wild caught male that had been in the pond at least two years, when sacrificed in June 1973, was found to have highly active testis and epididymis (Amoroso, pers. comm).

Courtship

Courtship appeared to be an attenuated form of what has been described by Bustard (1972) and resembled closely the excellent observations of Booth and Peters (1972). Males in the pool would first try nuzzling and/or biting the neck region followed by an attempt at swimming behind the female to mount. Unreceptive females occasionally bit viciously at the male and either swam away from the male during the first phase or swam around face to face when the male attempted to mount. Unreceptive females, mounted more or less by surprise, clasped their rear flippers as previously described. Males biting the rear flippers as noted by Bustard (1972) and the female vertical refusal position (Booth and Peters, 1972) were not observed. A male which had just mounted a female would gently bite the back of her neck.

"Escort" males (Booth and Peters, 1972) nearly always accompanied a mated pair. Often they attempted to dislodge the male by ramming and biting the pair. In addition, we have noted females in this "escort" group, their behaviour being similar to the males. On one occasion a mounted female was seen feeding on floating *Thalassia* for a period of 30 Minutes.

Nesting

Most of the original tags placed on the turtles at the time of capture had been lost, making it very difficult to positively identify the country of origin for all but two of the nesting animals. The first animal (tag No. 6993), identifiable by a notched carapace, was captured while nesting in Guyana in May of 1970 (three year cycle) and the other (tag No. 989) was captured while nesting in Surinam in May of 1971 (two year cycle).

Table 1 and Fig. 1 summarize the nesting activity. Over the 120 day nesting season, 19 females laid 92 nests for a total production of 11,26[illegible]. The peak of nesting activity by 7 day periods occurred from 21 to 27 July when 12 nests were made. Nesting females were occasionally missed as evidenced by hatchling emergences on 29 July, 26 September, and 25, 26 and 29 October. Total eggs produced from these nests was 552.

We have used characteristic data on mean egg size, carapace length, and clutch size (Carr and Hirth, 1962 for Costa Rica and Pritchard 1969 for Surinam) to tentatively assign animals to populations (Table 1). On this basis, 42% are Costa Rica-Nicaraguan and 58% Surinam-Guyana. It is interesting to note that the span of nesting is the same as that reported for Grand Cayman's nesting beach prior to its demise (Fig. 1).

Nesting behaviour followed very closely the stages outlined by Carr and Ogren (1960) for Costa Rica and by Schulz (1968) for Surinam.

Three observations, possible only in this closed system, indicate that there may be a distinct period between the female's first mating and first nesting. There was a 37 day interval between the onset of mating activity and the first nest and a 42 day interval between the last observed copulation and the first emergence of the latest nesting turtle. The eggs from the last two turtles to nest (No. 6970 and E6164) were all infertile. Turtle 989, identifiable by distinctive carapace markings, was observed mating on 21 June and made its first nesting emergence on 20 July, an interval of 30 days.

Hatchlings

The 11,268 eggs laid during the nesting season produced 4770 normal turtles, a percentage hatch of 42.4%. Non-viable eggs were examined and assigned to one of the following categories: infertile, 51.6%; dead embryo, 2.3%; died after hatch 0.8%; and malformed hatchlings 2.9%. The possibility that some of the eggs designated as infertile were actually very early embryonic deaths has not been ruled out. Hatching success was extremely variable, both between clutches from the same animal and from turtle to turtle. The source of this variation has not been identified at this time.

DISCUSSION

Despite the artificial environment of the breeding pond, both the behaviour of the captive breeding colony between April and September of 1973 as well as the temporal relationship between mating and nesting, approximate very closely what has been described for an Australian breeding colony of C.mydas (Booth and Peters, 1972). We therefore feel justified in making limited comparisons between what has been reported for wild populations and what we have observed in the breeding pool at Mariculture.

It appears as if the introduction of the two wild Surinam males in April of 1973 provided the stimulus for the observed mating activity and subsequent nesting. The competitiveness of a group of males in pursuit of a female has been described by Hendrickson (1958). This appears to have been the primary factor in causing the pre-existing males in the pond to begin mating just after the two Surinam males were introduced.

A similar experiment in March of 1972 involving the introduction of two adult males from Ascension Island resulted in no observed mating and no nesting despite having 17 wild Costa Rican females that had nested three years previously and therefore could possibly have been ready to nest. Carr and Carr (1970) have found that 43.8% nest on a three year cycle and 26.1% nest on a two-year cycle. The one month difference in the timing of the introduction experiments would seem to point to a Caymanian Zeitgeber as the important factor in preparing the females for the breeding season (Fig. 1). Controls were not possible on the male introduction experiments and thus one cannot rule out the possibility that nesting might have eventually commenced among the pre-existing breeding stock, or for that matter that nesting might conceivably have occurred without mating (assuming sperm storage). These possibilities seem unlikely, however, in light of the nearly four years during which no mating and nesting occurred. The lack of mating in 1972 as well as the waiting period noted between the prolonged mating and subsequent nesting leads us to propose that mating may not only be necessary for fertilization of ova but may also function in some manner to stimulate ovulation.

Carr and Hirth (1962) and Carr (1965) have proposed delayed fertilization in C.mydas as is known to occur in terrestrial turtles. On the other hand Booth and Peters (1972) feel that fertilization probably occurs just before egg laying. An adaptation for prolonged sperm storage might be most useful in animals that by chance often remain isolated for two or more breeding seasons. The aggregate mating and nesting behaviour of C.mydas, the possibility of prolonged obligate mating prior to nesting and the observed delay between mating and nesting, indicate that a mechanism for sperm storage (more than 3 or 4 months) is probably not necessary.

Carr and Hirth (1962) also suggest that copulation could take place both before and after a female nests. We made no observations of a nesting female being mated, thought attempts by males were common. Booth and Peters (1972) also did not observe nesting females to be mated. Amoroso (pers. comm.) flushed the oviduct of one adult known to have nested three years earlier and found no sperm. More thorough anatomical studies will be needed to clarify the question of sperm storage.

The important questions concerning sexual development in farm reared animals cannot at this time be answered. A male secondary sexual characteristic (tail lengthening) and limited testicular development have been noted in 4½ year old animals. The present size of the captive reared animals in the breeding pond is smaller than wild breeders despite an apparent rapid rate of growth. Original Mariculture reared stock, now 6 and 7 years of age and of comparable size to Costa Rican nesters did not take part in this year's mating or nesting. These observations indicate that sexual maturity in farm reared animals is in excess of six years.

This preliminary study indicates that the answers to essential questions concerning the reproductive behaviour of C.mydas although difficult to study in the wild, may be particularly amenable to study under farmed conditions.

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This paper was presented at the World Mariculture Society Meeting January 1974, and will be incorporated in the proceedings of that meeting when published.

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TABLE 1

Characteristics of the Nineteen Verified Nesters and Probable Country of Origin

Female & Tag	Carapace Length cm	Verified nests	Probable nests	Apparent Nesting Intervals - Days	x̄ Clutch size	Range Clutch size	Probable origin
6979	83.5cm	2	4	10,10,10,9,19	78.2	68- 93	Costa Rica
6993	120.6cm	7	1	13,12,10,11,10,10,9	177.0	158-188	Guyana (verified)
E1653		1	3	11,9,9	.81.5	62-126	Costa Rica
R1188	103.2cm	6	1	10,10,10,9,9,10	150.3	132-165	Surinam/Guyana
6977	103.8cm	5	1	10,10,9,9,10	109.3	97-131	Surinam/Guyana
E6159	100.3cm	6		11,10,10,9,10	116.1	109-124	Costa Rica
6989	89.2cm	4		10,9,9	88.7	84- 95	Costa Rica
6981	103.2cm	4		12,11,10	126	120-129	Surinam/Guyana
6990	114.3cm	6		10,10,10,11,11	117.3	118-150	Surinam/Guyana
6976	102.2cm	7		10,10,11,11,11,10	136.9	119-151	Surinam/Guyana
6992	91.8cm	4		11,10,11	80.7	75- 92	Costa Rica
6985	94.3cm	4		12,19,12	58.7	24- 90	Costa Rica
6958	106.7cm	1			138		Surinam/Guyana
6960		4	1	11,10,10,12	128.2	107-143	Costa Rica
6961	114.0cm	6		11,10,11,11,11	136.5	69-166	Surinam/Guyana
6959	91.4cm	4		11,13,12	99.7	90-106	Costa Rica
989	107.0cm	4		11,10,10	134.2	129-137	Surinam (Verified)
6970	121.9cm	4		9,9,11	132.7	111-152	Surinam/Guyana
E6164	116.2cm	2		10	185	179-191	Surinam/Guyana

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Characteristics of the Nineteen Verified Nesters and Probable Country of Origin

Female & Tag	Carapace Length cm	Verified nests	Probable nests	Apparent Nesting Intervals - Days	x̄ Clutch size	Range Clutch size	Probable
6979	83.5cm	2	4	10,10,10,9,19	78.2	68- 93	Costa Ric
6993	120.6cm	7	1	13,12,10,11,10,10,9	177.0	158-188	Guyana (v
E1653		1	3	11,9,9	81.5	62-126	Costa Ric
R1188	103.2cm	6	1	10,10,10,9,9,10	150.3	132-165	Surinam/C
6977	103.8cm	5	1	10,10,9,9,10	109.3	97-131	Surinam/C
E6159	100.3cm	6		11,10,10,9,10	116.1	109-124	Costa Ric
6989	89.2cm	4		10,9,9	88.7	84- 95	Costa Ric
6981	103.2cm	4		12,11,10	126	120-129	Surinam/C
6990	114.3cm	6		10,10,10,11,11	117.3	118-150	Surinam/C
6976	102.2cm	7		10,10,11,11,11,10	136.9	119-151	Surinam/C
6992	91.8cm	4		11,10,11	80.7	75- 92	Costa Ric
6985	94.3cm	4		12,19,12	58.7	24- 90	Costa Ric
6958	106.7cm	1			138		Surinam/C
6960		4	1	11,10,10,12	128.2	107-143	Costa Ric
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E6164	116.2cn	2		10	185	179-191	Surinam/C

MARINE TURTLE CULTURE - AN OVERVIEW

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ABSTRACT

The general background and present status of this new branch of maricultural science are briefly surveyed, with a description of the only large industrial complex now in existence. Progress in turtle mariculture up to the present is summarized, and some outstanding scientific problems which require solution are delineated. The new industry's interface with problems of conservation of wild stocks is discussed.

INTRODUCTION

The present section of the World Mariculture Society's meeting devoted to marine turtle culture is the first serious treatment of this subject at a major scientific meeting, for publication. The entire field is likely to be a new one to many members, and therefore deserves some background explanation. The papers which follow this one will deal with various technical phases of the subject; I wish to deal briefly with the principal culture species, the single major turtle farm now in existence, the state of the art at present, and the special relationship of this new culture field to wild stocks and conservation problems.

THE GREEN SEA TURTLE, CHELONIA MYDAS

Of the seven described marine turtle species belonging to five genera, the Green sea turtle is the only one which is primarily herbivorous as an adult (all juvenile sea turtles are considered to be carnivores). This is the only species which will be considered here. The herbivorous habit of the adult Green sea turtle presumably accounts for the fact that it is considered by far the most flavorsome of the marine turtles. It certainly accounts for its being the most promising candidate, in energy terms, for large scale commercial culture. It may be thought of as a sort of reptilian "steer of the sea", a red meat animal grazing in the wild on submarine pastures of turtle grass and algae, and reaching weights above 70 kg. As in all reptiles, growth continues at decreasing rates throughout life, and weights of 350 kg have been recorded (Ingle and Smith, 1949); however, the lower weight ranges are likely to be important ones in commercial farming.

The Green sea turtle is distributed around the globe in equatorial seas. It reaches sexual maturity in something over six years in the wild, probably dependent upon the nutritional state of the individual. Maximum, or even average life span in the wild is unknown; individuals have lived 20 years in captivity (Ernst and Barbour, 1972). Except for occasional basking above water line on a few remote beaches, and for the females' ascent of sea beaches to nest, the animals are totally aquatic. The females reproduce on a multi-annual cycle in the wild, making multiple nests of 100+ eggs each at intervals of from 10 to 15 days. Bi-annual, tri-annual and longer periodicities for nesting have been recorded; the period probably varies according to nutritional state and the length of migration route between feeding and nesting areas. The most remarkable migration known at present is that between the Brazilian coast and Ascension Island -- some 2,000 km across the Atlantic Ocean (Carr, 1964, 1965). Each population tends to have a breeding season with a demonstrable peak in the mid-summer months of the appropriate hemisphere, although nesting may occur virtually the year around in some equatorial localities. The eggs develop untended in the sand of the nesting beach and the young make their way to the sea upon emergence from the nest. For the first few days in the water, the young turtles apparently swim almost continually, thereby achieving wide dispersal at sea. So little is known of their life from this point on until they reappear on the feeding grounds as "yearlings" from 20-25 cm in carapace length, that the term "lost year" is common currency among students of sea turtles. All available evidence points to their being obligate carnivores during this first year at sea, dependent upon the larger elements of the plankton and nekton for food. When they reappear in shallow waters, however, they apparently convert rapidly to an herbivorous diet of aquatic grasses and algae. Carr (1967), Hirth (1971), Bustard (1972) and Ernst and Barbour (1972) review the state of present knowledge of sea turtle biology, the latter three references providing good bibliographies of recent literature.

THE MARICULTURE, LTD. TURTLE FARM

Although captive rearing of stock obtained from the wild has been practiced for centuries, and in a few cases (Le Poulain, 1941) this has developed into a traditional local industry, true culture over generations of animals reproducing in captivity has not yet been developed. Full culture is now being attempted in a number of places, the best known of which are the Torres Straits, Australia program (Anon., 1970; Bustard, 1972), a pilot farm operated by the Caribbean Conservation Corporation on Great Inagua Island in the Bahamas (Carr, 1967), and the major capital-intensive operation established by Mariculture, Ltd. on Grand Cayman Island in the British West Indies. The latter establishment is by far the largest and the most advanced in its operations; so far as the author knows, it is the only one presently engaged in commercial marketing of its product. All the sea turtle research reported on at this meeting is based on the livestock and the resources of the Mariculture, Ltd. turtle farm.

Incorporated in 1968, Mariculture, Ltd. began limited sales operations in 1972 and a regular slaughtering program for three-and four-year-old, farm-reared stock (30-35 kg) was begun this year. The farm (Figure 1) now occupies about 4 hectares with a coastal exposure; 158 tanks ranging from 546 liters to 409,500 liters capacity house upward of 100,000 animals of all ages. There is a large breeding pond of approximately 4.5 million liters capacity excavated out of the coral rock and provided with a sand nesting beach. Total water circulation rates range above 5 million liters of natural sea water per hour.

All phases of the operation, from hatching of eggs to processing of market-sized stock, are systematized and automated as far as possible. Eggs are incubated and hatched artificially in styrofoam containers (Figure 2). Young hatchlings are converted as rapidly as possible from multiple daily feedings of minced natural food (squid, fish, etc.) to twice-daily feedings of prepared, high-protein pellets. Thereafter for the rest of their lives, ordinary farm stock is fed mainly prepared pelleted food, with only occasional offerings of turtle grass to provide variety and bulk to the diet. Water circulation systems in the pools are devised to make them self-cleaning; handling for purposes of medication and obtaining growth records is kept to a minimum to reduce stress on the animals. The turtles are kept under remarkably crowded conditions throughout their lives, as compared with normal densities in nature (Figures 3 and 4). The animals presumably accommodate to the stresses produced by crowding through the simple circumstance of never experiencing anything else - indeed, one gets the impression that they show less agonistic behavior in the crowded farm stock tanks than in experimental tanks where each animal has more individual space. In the stock tanks it is too crowded for coherent one-to-one encounters and there is no real opportunity for meaningful dominance hierarchies to develop; as a result, food is probably more equally distributed and less total energy is expended in non-growth activity.

Slaughtering is handled on a rigidly-controlled basis, with humane killing and scrupulous hygiene (Figure 5). Flesh is cut and packaged for freezing in several styles; fat is separated for extraction of turtle oil; livers are being experimentally used for pâté; whole shells are cleaned and polished for sale as curios, and plates from imperfect carapaces support a small tortoiseshell jewelry industry on the premises. It is noteworthy that, while the scutes from wild Green sea turtles are ordinarily too thin for use in jewelry-making, the scutes from these farm-reared animals fed high protein diets are abnormally thick and provide good quality material for jewelry.

TURTLE CULTURE PROBLEMS AND THE PRESENT STATE OF THE ART

Various public aquaria and research establishments have for years maintained small numbers of Green sea turtles successfully in captivity, and a considerable literature on this exists (see especially the references cited in Hirth, 1971 and Ernst and Barbour, 1972). The problems of commercial sea turtle culture at present revolve largely around two central themes: economics of mass culture, and controlled breeding in captivity. The papers presented here by Wood, Rebell et al. and Haines et al. relate to the first theme and the papers by Owens and Ulrich and Owens relate to the second.

Throughout the discussion which follows, certain essential differences from most other maricultural activities, and similarities to terrestrial meat-producing industries such as hog farming, will be noted. The individual animal unit in turtle culture is reared to large size over a relatively long time, and therefore has a high unit value. It is not marketed entire, but in parts. The pre-reproductive life history and the breeding cyclicity after maturation involve extended periods of time in nature; whether these time elements can be shortened in culture is yet to be determined. Fecundity, however, is very much higher than for hogs and might be expected to rise as culture techniques reduce reproductive time parameters, further increasing the similarity to most maricultural activities.

ECONOMICS OF MASS CULTURE

The present systems in force at the Mariculture, Ltd. farm demonstrate success in developing techniques for mass rearing of Green sea turtles on a paying, commercial level. The problems in this area, therefore, are less in the realm of qualitative "break-throughs" and more in the realm of quantitative refinements resulting in increased efficiency, improved quality, and risk reduction. Non-biological problems of distribution, marketing, plant size, etc. will not be discussed here.

The methods developed at Mariculture, Ltd. for hatching sea turtle eggs include incubation in styrofoam containers and mechanical opening of all eggs, once normal hatching has begun. These methods have produced hatchlings from as high as 95% of the eggs. This contrasts with around 60% commonly emerging to the beach surface from wild nests. It must be noted that the Mariculture figure includes all those reaching full development in the eggs, whereas the figure for wild nests eliminates those baby turtles not escaping from the shell and those not successfully making their way to the surface of the beach from the subterranean nest. The culture farm figure, therefore, includes an unknown proportion of weak, non-viable individuals (see next paragraph). However, the 95% figure is significantly higher than a comparable figure determined from a random sample of totally-censused wild nests which was conducted in Malaya and Sarawak, and it does appear to be at least the operational equivalent of the wild production rate.

Mortality of the young hatchlings during the first few months of life is high on the turtle farm and the reduction of this rate, which has exceeded 50% on occasion, is presently one of the priority concerns of the industry. This rate of loss is, however, miniscule when compared with that in wild populations subject to predation. I once (Hendrickson, 1958) attempted an armchair estimate of wild hatchling losses based on several years of field observation and estimated that, for a completely undisturbed beach under natural conditions, 40% of the hatchlings emerging from nests might be killed before reaching the sea and 50% of the remainder might be eaten during their first hour in the water. It would not surprise me to learn that the normal wastage rate in the wild comes close to 50% per day for the first week of life out of the nest. Considerable work needs to be done on devising optimal feeds and feeding procedures for young hatchlings, on means of detecting and eliminating non-viable culls, and particularly on diseases in culture. Disease is probably a significant negative element in culture as compared with wild conditions.

During the entirety of the main flesh production period (three to four years), culture problems with marine turtles seem to me to be remarkably similar to those of other modern, meat-growing industries on land. Continual effort must be expended to develop, from cheap and dependable sources, diets which will produce the greatest amount of marketable flesh and fat of desired qualities from the smallest amount of food consumed in the least amount of time. Studies on essential ingredients, palatability, digestive efficiency, and feeding behavior are called for. At the present time, costs of the pelleted food used are undesirably high and this expense factor can be marginally tolerated only because the sale price of the turtle products is so high. Unit sales prices must be lowered as the market expands and volume is increased, and it would appear that a large segment of the reduced production costs must come from the food bill. An efficient, mechanized harvester of turtle grass has been developed by Mariculture, Ltd., and abundant "hay" is available from nearby submarine pastures, but the pelleted food is preferred for the main feeding pens at present because it produces better growth rates and because constancy of supply is not subject to the same vicissitudes of weather and labor force changes as is the supply of turtle grass delivered to the feeding tanks. The farm turtles tend to become strongly habituated to the form of their food, adapting to new foods only with some resistance. This indicates against frequent, arbitrary changes in diet.

As for almost all new culture animals, one of the most serious problems in the mass culture of sea turtles is disease, its prevention, diagnosis, and treatment. A whole, confusing host of pathological conditions have been identified, and new ones continue to appear. Some can be related to conditions found in wild sea turtles, but are exacerbated under the crowded conditions and special stresses of culture; most are new to our experience and coping with them is a pioneering task of first magnitude. It is presently believed that lifting the larger, heavier animals by their front flippers (a most convenient technique) may produce internal strains with resultant bad effects. Even repeated strandings of the larger stock for weighing, disease treatment, etc. may be injurious. Inspiration of excessive amounts of water during frenzied action (feeding time in a crowded tank, release to the water after treatment under restraint, etc.) may produce serious pneumonic problems. There is a generally-observed fatty liver condition which will continue to cause concern until its cause and, if necessary, its cure has been determined. This may well be a simple nutritional disease linked with the high-energy diet fed to produce the desired rapid growth rates in culture, and it has merit for the production of liver pate, but its total etiology and relation to other aspects of culture must be known as thoroughly as possible.

Parasitism has, thus far, not been identified as a major problem in sea turtle culture. A whole host of available agents exists, however, and it would seem likely that problems of massive parasite infestation will occur sooner or later.

It is in the area of infectious microbial diseases, bacterial and viral, that the greatest problems have been encountered. Many and varied conditions appear, some relatively constant, others sporadic and epidemic in proportions. Two papers in this section report on vitally important research in this field. It is of the greatest urgency that progress be made in identifying causal microbial agents of serious disease, and in distinguishing these from a host of other forms which may be more or less normal symbionts or secondary agents infecting bite lesions produced by other turtles, etc. Development of efficient, specific treatments can then be attempted. In time, when true, full culture has been developed (see below), planned breeding programs can include selection for disease resistance.

Without waiting for the specific and serial developments mentioned above, attention must be given to study of the entire physical plant of the farm from an epidemiological point of view. All elements of siting, process, and general functional communication must be studied with a view to providing minimal disease transmission risk and optimal quarantine capability for containment of contagious infections.

CAPTIVE BREEDING PROGRAM

It is in this area that there is the most serious lack of basic information and experience, and where the most crucial problems for the survival and development of the industry lie. Not only is full control of breeding in captivity the <u>sine qua non</u> for true culture of marine turtles, and essential to development of improved strains to meet industrial requirements but, as is discussed in the last section of this review, it is related to unusually pressing circumstances from a conservation point of view. A "break-through" in this area is not only highly desirable, but is virtually mandatory within the very near future if the industry is to survive (see next section).

During past years a great deal of speculation has occurred regarding possible barriers to the systematic reproduction of sea turtles in captivity, largely based on what is known about wild turtles. Physiological necessity of a long migration prior to breeding, relative isolation of sexes (and individuals) for long periods followed by aggregation off nesting sites as a requisite behavioral substrate, and comparable phenomena have been identified as potentially important for normal reproduction. The events of this past year, as reported here by Ulrich and Owens, largely remove these doubts and provide grounds for cautious optimism. It is very difficult to resist detailed commentary on their landmark paper before they have even had an opportunity to present it!

One thing has become very clear to Mariculture, Ltd. as they have obtained grounds for believing that the goal of total independence from wild stocks for annual collections of hatching eggs is an attainable one in the near future: The simple arithmetic of the farm's producing its own hatching eggs sufficient for its annual needs at present wastage rates during the three year pre-slaughter period, and with planned increasing production levels, will require a massive investment in breeding facilities. A major problem will be the construction of these, necessarily far in advance, before all requisite knowledge on their optimal design can be available.

INTERFACE WITH CONSERVATION PROBLEMS

So far as I know, the Green sea turtle is the only existing maricultural subject of clear commerical promise which is simultaneously classified as potentially threatened with extinction. In the Red Data Book of the International Union for the Conservation of Nature and Natural Resources (Honegger, 1970), Chelonia mydas is placed in category 3: "Continuing to decline at a rate which gives cause for serious concern." In the Convention on International Trade in Endangered Species signed by representatives at a plenipotentiary conference this year, the Green sea turtle is placed in Category 2: "..species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival.."

The late development of culture methods for the Green sea turtle, then, combined with its continually depleting stocks in the wild state, provide a two-fold problem for Mariculture, Ltd. and any other sea turtle farm proposing to develop this species as a new domestic animal. They must inevitably depend upon wild-laid eggs as seed stock for the farms during initial developmental years, with increasing pressure to develop total independence from such wild resources at the earliest possible opportunity (and it takes from 6 to 8 years to mature a farm-reared turtle to the point where serious breeding attempts may be made!). Simultaneously with a crash program to develop total self-sufficiency in producing fresh stock, the farm acknowledges a special obligation to support active turtle conservation work in every way possible. The latter is being done through financing of conservation censuses and studies in selected areas (for instance, Aves Island in the Caribbean), through provision of facilities at the Grand Cayman farm for pure scientific studies as well as goal-directed, applied studies, and through a variety of self-imposed controls on their own collections of hatching eggs from the wild. The latter include attempts to define and restrict activities to a category of wild nests termed "doomed" (with no significant promise of contributing to the wild populations, even if left undisturbed).

In some localities, the intense site-fixation of experienced nesting females produces heavy concentrations of nests on small areas of beach; on such beaches, later-nesting females destroy incubating nests of earlier females in the process of excavating their own nest cavities (Hendrickson, 1958; Bustard and Tognetti, 1969). This is a density-dependent phenomenon which can, in some instances, permit collection of early nests for farm hatching without effect on the natural recruitment rate. It could, in fact, have a positive effect in reducing predation rates on adjacent, more thinly-used grounds by virtue of the farm team's presence. The difficulty is in accurate prediction of nesting densities over future time, and statistical justification for the exact harvest taken.

In other areas, regular destruction of incubating nests may occur due to changing marine current systems and cyclical storms, eroding out incubating nests before development can be completed (Schulz, 1968, 1969; Pritchard, 1971). Study is proceeding to enable increasingly accurate prediction and delineation of such "doomed" portions of nesting beaches. In Ascension Island, there are reported to be certain sea beaches of volcanic origin where nests have exceedingly low rates of success, presumably due to sulfur content of the sand or other adverse chemical or physical factors. In a number of tropical countries where sea turtles nest in numbers on very remote beaches, patrol and enforcement of protective laws is virtually impossible; recruitment from such beaches is alleged to be near zero. It has been suggested that farm personnel stationed on such beaches by agreement with the parent Government could "earn" a complement of eggs for farm use by providing free patrol and simultaneously operating "transplant-hatcheries" on the beach to guarantee a sizable number of young returning to the sea annually under natural conditions. These and other measures will continue to receive strong attention and hopefully may provide the necessary temporary sources of seed stock for farming without added damage, and with positive benefit, to the wild stocks.

A second major concern expressed regarding Green sea turtle farming is that the development of new markets with high prices before the volume production necessary to satisfy demands is achieved might increase poaching pressure on wild populations (Carr, 1969). The attendant recommendation is that the necessary maricultural work go ahead in small, pilot programs without a commercial interface until required techniques are available for efficient, high volume production at low prices. A number of experienced businessmen express doubts as to the logicality of expecting any technique with profit potential being allowed to develop to full flower without commercial interfaces, willy-nilly. They also question the probability of any business enterprise being able to leap more or less instantaneously into high volume, low-priced production of the sort envisioned in this plan. The realities of modern economics demand, they feel, that any such new industry can develop to high volume, low-priced production only through a process of evolutionary growth in close association with the dynamics of country and world commerce. The above counter-arguments do seem persuasive to me, but I am emphatically no expert in such matters.

Of greater import, to my mind, is the promise of the International Convention mentioned above and of local laws at country and state level which are rapidly appearing in response to this conservation stimulus. These laws (I am personally familiar with several in draft stage) support the full conservation impact by prohibiting trade in turtles and turtle products from wild sources, while allowing openings for farm-reared products under carefully-designed rules for certification, inspection, and control of temporary wild egg collection from "doomed" nests along the lines outlined above.

I am motivated primarily by desires to conserve and build back the wild stocks of these magnificent creatures, and secondarily by interest in developing sources of self-renewing protein in a crowding world. The greatest existing barrier to satisfying my primary desire is lack of knowledge of sea turtle biology; I would hope to add significantly to this through the aid of commercial turtle farms and their incomparable facilities for many types of study. Less immediate, but more pervasive, is my desire to make it cheaper to farm turtles than to poach them. I can foresee this day, when sea turtles are protected more by offering an attractive substitute in consonance with man's baser instincts than by prohibitions which automatically run counter to his essentially adventurous, acquisitive nature.

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A PRELIMINARY EXPERIMENT ON THE REPRODUCTIVE ENDOCRINOLOGY OF THE GREEN SEA TURTLE (*Chelonia mydas*)

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ABSTRACT

Knowledge is completely lacking concerning the endocrine physiology of reproduction in marine turtles. A preliminary hormone forcing experiment utilizing immature *Chelonia mydas* at Mariculture Ltd., Grand Cayman Island, B.W.I., is described.

Gonadotropin from pregnant mare's serum induced marked hypertrophy of testicular and epididymal tissue while sheep luteinizing hormone had no apparent effect on those organs. A crude homogenate prepared from sea turtle pituitaries may have caused limited testicular activity.

Testosterone-propionate and Estradiol-dipropionate treatment groups indicate that steroid feedback mechanisms may be similar to those of mammals. Histological results are also discussed.

INTRODUCTION

One of the most interesting questions pervading comparative endocrinology today is whether the reptilian reproductive cycle is controlled by a single pituitary gonadotropin or by two gonadotropins (follicle-stimulating hormone, FSH and luteinizing hormone, LH) as in birds and mammals (Callard et al., 1972a; Burzawa-Gerard and Fontaine, 1972).

The studies of Licht and his colleagues (1972a) indicate that an FSH-like molecule alone is responsible for both gametogenesis and steroidogenesis in reptiles. More recently, however, two separate gonadotropins with the same apparent biological activities have been isolated from snapping turtle (*Chelydra serpentina*) pituitaries. The second gonadotropin exhibits LH-like activity in anuran bioassay, exists in very small quantities and is much less potent (1:1000) than the FSH-like molecule (Licht and Papkoff, in press). This dichotomy of gonadotropins has not been thoroughly tested in squamates, thus it is not known if the phenomena is uniquely chelonian. The primary FSH-like gonadotropin of turtles is biochemically unique in comparison to most other vertebrate gonadotropins in its apparent lack of dependence on sialic acid for biological activity (Papkoff and Licht, 1972).

Androgens and estrogens (steroids) have also been shown to be important in chelonian reproductive physiology (Lofts, 1968; Evans, 1952; and Callard et al., 1972b). However, as with the protein hormones, little actual characterization of biological activity has been attempted so far in turtles. This consideration provides part of the reasoning behind the initiation of our study on the Green sea turtle, Chelonia mydas.

Of more immediate importance to the conservation and potential culture of this valuable species, is the acquisition of a thorough understanding of its reproductive physiology. This knowledge will be essential in determining whether or not the Green sea turtle can be domesticated without excessive stress on existing wild populations (Hendrickson, 1972, 1974).

The preliminary experiment reported here was designed to begin looking for answers to the above questions. The primary objective was to test the effects of a variety of exogenous reproductive hormones on the sexual development of immature, farm-reared C. mydas.

MATERIALS AND METHODS

The experiment was conducted at the Goat Rock facility of Mariculture, Ltd. on Grand Cayman Island, British West Indies.

Turtles used were selected from a population that had been removed from Ascension Island as eggs. At the time of the experiment (23 July - 1 Sept.) the animals were 42 months old. The males used in the experiment had a mean weight of 33.06 Kg. and a mean curved carapace length of 64.4 cm. Females, from the same population, had a mean weight of 35.97 Kg. and a mean curved carapace length of 66.27 cm. Criteria used in selecting experimental animals from the farm stock were a weight of at least 18.14 Kg., absence of conspicuous structural abnormalities and minimal observable disease. At the time of the experiment several hundred animals from the same population were being slaughtered. Judging by secondary sexual characteristics and gonadal development, these animals were at least two years from sexual maturity.

External sexing of immature C. mydas is extremely difficult. We were, however, able to choose a population that had had a high male-to-female sex ratio in earlier slaughter records. Another, predominantly female, population was available, but males were judged more suitable for the present work for two reasons. Firstly, males of certain chelonian species have been shown to develop secondary sexual characteristics (e.g. penis and claw lengthening) under the influence of androgens (Evans, 1952a, 1952b), while females do not undergo obvious external changes. Secondly, spermatogenesis in certain turtle species has proven to be relatively more sensitive to hormone stimulation than has ovarian development (Licht, 1972a).

Over a four day period 160 animals were selected from the farm stock, tagged, weighed and randomly assigned to 16 treatment groups of 10 animals each; each group of 10 was placed in a separate round fiberglass tank of 3,200 liters capacity. The tanks were in a linear series and determination of which treatment was given to which tank was also randomized. The experimental tanks, located outdoors, were supplied with running sea water at a rate of approximately one volume per hour. Water temperatures varied from 28°C to 31°C during the diurnal cycle, but were constant between all tanks at any one time. The animals were fed commercially prepared pellets containing 37% to 45% protein and a vitamin supplement. Food and feeding schedule (8:00 A.M. and 5:00 P.M.) were identical with the normal farm procedure to which the animals were accustomed, but the experimental animals were fed to satiation in the afternoon instead of the normal heavy meal. The morning feeding for all animals was a light meal.

A summary of the treatment groups and dosages used during the five week experiment is presented in Table 1.

Both untouched stress controls and placebo controls were used. The stress control consisted of two treatment groups (e.g. total of 20 animals) while one placebo control received sterile demineralized water (protein injection medium) and a second received sterile sesame oil (steroid injection medium).

All injections were adjusted to 2 ml. volume and were given I.M. in the area between the neck and foreflipper of the turtles, on alternate sides. Injections were given on Monday, Wednesday and Friday afternoons (15 incremental injections in all, except for the immune reaction controls described below). In planning for the dissection of such a large number of animals at the termination of the experiment, it was necessary to randomly stagger the treatment schedules. First injections were given on July 23, 25 and 27; final injections therefore occurred on August 24, 27 and 29. Dissections followed two to three clear days after final injections, on August 28, 30 and September 1.

The turtle anterior pituitary homogenate was prepared from glands obtained from farm stock of the same age as the experimental subjects. It is important to note, therefore, that these glands were from animals which had not yet reached sexual maturity (see paragraph 2 of Materials and Methods). The complete pituitary glands were removed within one hour of death (during normal slaughter operations on the farm) and were immediately placed in pure, chilled acetone. They were then kept at room temperature and put through five daily changes of acetone, after which they were stored in a deep freeze until needed. Batches of glands were later air-dried, the neurohypophyseal portions removed, and the material was divided into daily dose batches according to a mean dry weight which had been determined from a group of 33 glands ($\bar{x}$ = 7.4 mg.). The daily dose batches were then stored, dry, in a standard deep freeze until they were used for injections. On the day of injection, each batch was prepared

Table 1

Treatment Groups

Group No.	Treatment	Total Dose per Animal
1	Stress control "A"	(animals not touched during course of experiment)
2	Stress control "B"	(animals not touched during course of experiment)
3	Protein injection medium control (placebo)	30 ml. of water
4	Steroid injection medium control (placebo)	30 ml. sesame oil
5	Pregnant mare serum gonadotropin (PMSG)*	750 I.U. (International Units)
6	Pregnant mare serum gonadotropin (PMSG)*	7,500 I.U.
7	Sheep luteinizing hormone (LH)**	1.5 mg. equivalent
8	Sheep luteinizing hormone (LH)**	15.0 mg. equivalent
9	Estradiol-dipropionate (E-D)***	0.1 gm.
10	Estradiol-dipropionate (E-D)***	1.0 gm.
11	Testosterone-propionate (T-P)****	0.1 gm.
12	Testosterone-propionate (T-P)****	1.0 gm.
13	Turtle anterior pituitary homogenate	3 turtle glands (equivalent vol. of homogenate)
14	Turtle anterior pituitary homogenate	30 turtle glands (equivalent vol. of homogenate)
15	Immune reaction control (PMSG)	3,000 I.U.
16	Immune reaction control (LH)	6.0 mg. equivalent

* Nutritional Biochemical Co. (control no. 3366); this was the material expected to have FSH-like activity with minimal LH-like activity (Zarrow, et al., 1964).

** Sigma Biochemical Co. no. G-4877.

*** Sigma Biochemical Co. no. E-9125.

**** Sigma Biochemical Co. no. T-1875.

with a manual tissue grinder and sterile, demineralized water. After grinding for 15 minutes, the homogenate was centrifuged and the supernatant diluted to appropriate volumes for individual injections.

It has been suggested that antibody formation may inhibit activity in lizards when mammalian hormones are used (Licht and Donaldson, 1969). C. mydas is known to have an efficient antibody system (Benedict and Pollard, 1972). Based on the assumption that an early sensitivity of gonadal tissue might be negated over the period of the five week experiment, immune controls were conducted in which treatment groups received the standard high doses of PMSG and sheep LH per animal for two weeks only (total of 3,000 I.U. PMSG; total of 6 mg. equivalent LH), after which they were slaughtered and examined.

Data were accumulated on individual weights and curved carapace lengths before and after the experiment to determine general metabolic effects. Increase in tail length was measured as an index of androgen effect. The measurement was done by first inserting a rule firmly in the groove above the tail and below the carapace. Then by pulling the tail straight (and standing on one's head!) the distance to mid-cloaca (nearest .5 cm.) was measured.

The testis and epididymis from one side of each individual were weighed fresh, then preserved entire in Bouin's solution, while those from the opposite side were cut into 2 cm. pieces to assure proper fixation, then placed in Bouin's solution for histological analysis. This material was prepared in paraffin sections and stained with Ehrlich's hematoxylin and eosin. In 5 of 131 males receiving primary treatments, and in 5 of 16 males among the immune controls, the testis or epididymis could not be macroscopically distinguished (satisfactorily dissected free) from the surrounding connective tissue. In these instances, a minimum wet weight of 0.75 gm. for testis or epididymis was estimated and recorded for the animal.

The percent of body weight gain during the experiment, increase in tail length, log testis weight and log epididymis weight were analyzed using Student-Newman-Keuls (S.N.K.) multiple range test for mean discrimination in one way analysis of variance (Sokal and Rohlf, 1969). This a posteriori test was programmed using the Statistical Package for the Social Sciences (S.P.S.S.) and a CDC 6400 computer (Nie et al., 1970). The 5% level of significance is applied in all cases. Logarithms of testis and epididymis weights were used because it was found that variance increased considerably with increased treatment means. Although it was originally planned to express testis and epididymis weights as percentages of total weight, regression analysis indicated no significant correlation between these measurements.

The small number of females (N=27) in the treatment groups did not permit statistical analysis of changes in oviducal or ovarian tissue. However, these organs were dissected out, weighed, and preserved in Bouin's fixative.

On August 22 an error was made in the hormone administration, the net result of which was that the high-dose pituitary homogenate group received 500 I.U. each of PMSG. The result of this treatment is presented nevertheless, as it does appear to provide an indication of the activity of the pituitary homogenate (see Discussion).

RESULTS *

Males

The results for four quantitative parameters used to assess the effects of the treatments are found in Table 2. Additional qualitative data are summarized in Table 3. Figure 1 is a composite of preserved gonadal tissue from selected treatment groups.

Gonadotropins. The high dosage level of pregnant mare serum gonadotropin (PMSG) caused a significant increase in testicular and epididymal weight as compared to controls (Table 2 and Fig. 1). The low dose PMSG caused a significant increase in epididymal weight while the slight increase in testis weight was not significant. Sheep luteinizing hormone (LH), on the other hand, had no significant effects on either gonadal tissue at the two dosage levels used. (Table 2, Fig. 1).

Histologically, the PMSG high dosage caused a marked proliferation of spermatogonia and spermatocytes as compared with the controls (Fig. 2, A and C). Spermiogenesis, however, is not apparent although the lumina of the tubules have started to clear. Interstitial cells are also much larger than in the corresponding control (Fig. 2, C). No testicular changes were noted in the histology of the high dose LH group (Fig. 2, B).

The high dose of PMSG also had a significant stimulatory effect on the secondary sexual characteristic of tail elongation (Table 2).

C. mydas Anterior Pituitary Homogenate. As stated earlier, a mistake in administering the high dose of the crude homogenate resulted in a net PMSG contamination of 500 I.U. per animal for this group. Despite this, the significantly greater mean testis weight compared to the low dose PMSG (each received 750 I.U.) would indicate possible intrinsic activity of the homogenate (Table 2). Histologically, interstitial cell hypertrophy, spermatogonial proliferation and increased clearing of the seminiferous tubules is also apparent. The low dose homogenate group,

* Because of repeated cross-reference in the text which follows, all Figures and the remaining Tables are placed at the end of the text.

though not significant, does indicate slight stimulation of testicular androgenesis; e.g. interstitial cell stimulation causing epididymal hypertrophy (Table 2, Fig. 2, D).

Immune Controls. The two week PMSG treatment of 3,000 I.U. per animal indicates epididymal hypertrophy when analyzed with all data in a separate S.N.K. procedure as discussed in the section on Methods. The LH immune control group at 6 mg. equivalent did not exhibit discernable activity based on gonadal size (Table 2).

Steroid Hormones. Both testosterone-propionate (T-P) and estradiol-dipropionate (E-D), at each dosage level, stimulated significant epididymal hypertrophy. In addition, the T-P stimulation was significantly greater than that produced by E-D. The two E-D doses produced significantly larger testis weights than in the oil controls, while the T-P doses did not. T-P also induced tail elongation (significant only at high dose) in the males. The most striking effect of E-D was the greater-than-5% decrease in body weight for both doses compared to 4.84 - 11.25% gains in all other groups.

Histologically, both steroids affected the testis in that the interstitial cells appear small in comparison to controls (Fig. 3, A and B). In the E-D group alteration of spermatogonia is also apparent but it is difficult to evaluate what these changes are. In addition to tail elongation with T-P, a very striking hypertrophy of the glans penis was noted in the high dose group. As the animals were removed from their tanks, it was noticed that the glans was extended 7-8 cm. beyond the cloacal opening. This was not observed with any other treatment. The organs were virtually the size of an adult's (Ulrich, pers. comm.). In controls the glans was rudimentary.

Females

As explained in the section on Methods, the experimental population had few females (4.9:1 sex ratio). Consequently these observations must be qualified by the very low N numbers for treatments.

The high and low doses of PMSG (N=2 and 1 respectively) and the low doses of LH and homogenate (N=3 and 2) affected no changes in ovarian weight compared to the combined female controls (N=9). Unfortunately no females were found in the high dose LH or the pituitary homogenate groups. In addition, a lack of ovarian response was noted with the steroids (N=3 for E-D and N=5 for T-P).

Marked oviducal development did occur with the steroid hormones. One female on the E-D low dose had near-adult-sized oviducts (Fig. 1). In other individuals from both the T-P and E-D groups enlargement was localized at the base of the oviduct.

Elongated tails did not develop in the females for high dose PMSG or T-P treatments. One female in the high T-P group did develop an enlarged glans penis.

DISCUSSION

When evaluating the effects of exogenous hormones in an intact animal, one must be particularly aware of the continued and possibly altered role of the animals endogenous hormone systems. The use of reproductively immature animals should, however, reduce this problem.

The obvious PMSG stimulation of testicular tissue at both the steroidogenic (interstitial cell) and spermatogenic loci would appear to strongly support Licht's hypothesis of a single functional gonadotropic hormone (GTH). Based on this theory, cyclical regulation could be controlled by temperature and/or concentration-sensitive target tissues (Licht, 1972a). The present lack of response at either dose of sheep LH also supports this view, although the possibilities of insufficient dosages or a very precise molecular specificity for C. mydas cannot be ruled out. A possible role, however, for the second gonadotropin, which has been recently demonstrated in a chelonian (Licht and Papkoff, in press), might be to promote the completion of spermiogenesis; recall for example, the high dose PMSG treatment, where there appears to have been a build up of spermatocytes in the lumina of the seminiferous tubules with only minimal evidence of spermiogenesis (Fig. 2, C). The effects of combined FSH (or PMSG) and LH have apparently not been tested in a chelonian. Licht's results (1972b) using ovine NIH-(National Institute of Health)FSH on adult hypophysectomized male sliders (Pseudemys scripta) appear very similar to our high dose PMSG results,e.g., a large number of spermatocytes with no spermiogenesis. The lack of completed spermiogenesis in both experiments,however, could also be explained by insufficient dosages and/or insufficient time for expression. Our results for PMSG do appear to approximate a dose response relationship when all treatment groups are compared. This may indicate that higher or more prolonged doses could cause more complete testis development.

Immune Response. It would appear unlikely that the animals developed an effective protein hormone antibody system during the 5 weeks of the experiment. This conclusion is based on the apparent dose response when the three PMSG groups are compared, as well as the non-significant differences in testis weight for combined LH groups. Benedict and Pollard reported antibody activity in 4 to 8 weeks for C. mydas (1972).

Pituitary Homogenate. The high dose pituitary homogenate treatment may have had some intrinsic gonadotropic activity; however, because of the PMSG contamination it is difficult to evaluate these effects. Enlargement of the testis and epididymis in the low dose homogenate group (although not significant) and the histology for the high dose may also support this possibility.

Female. The work of Callard and his associates indicates that somatotropic hormones (STH) may have essential synergistic effects with gonadotropin in promoting ovarian growth in certain lizards (1972c). Licht tested this possibility in female painted turtles (Chrysemys picta) without success, but felt that the lack of response may have been due, once again, to insufficient dosage (1972b). The lack of ovarian response in our 5 females with PMSG thus, could be due to either of the above conditions. The animals' immaturity would not seem, however, to be an important factor, as striking hypertrophy of ovarian tissue has been demonstrated in very immature alligators (Forbes, 1937). Forbes used a whole extract of sheep pituitary, which may also indicate the importance of a second hormone principle in the female reptilian system. The effects of steroids on female C. mydas would appear to conform with earlier work on reptiles (Lofts, 1968; Callard et al., 1972a). Generally, the female oviduct responded more completely to E-D than to T-P. The striking weight loss with E-D affected both sexes and the reason for this is difficult to evaluate. The interstitial spaces of the testes in the E-D groups appear to have lost lipid (Fig. 3, B). T-P, on the other hand, caused a significantly greater increase in epididymal weight compared to E-D. These data would seem to reinforce the general sexual specificity of androgens for males and estrogens for females.

A comparison of the two control types indicated that the experimental procedures did not have a deleterious effect on the animals in general. This conclusion argues strongly for the continued use, by the industry, of the assay system reported here. The rather obvious gaps in our understanding, particularly in reference to the female system, emphasizes the need for further experimentation with Chelonia mydas.

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The mean and standard error of variables used to evaluate the effects of a variety of hormone treatments. The Student-Newman-Keuls procedure (SNK column) is used to indicate significant differences between means at the 5% level. Significance is indicated when means do not have at least one letter in common. Log values were used for data analysis of testis and epididymis weights; however, the raw data are presented here as more meaningful.

Group #	Treatment	N	% Body Wt. Gain	SNK	Increase in Tail Length cm.	SNK	Testis Wt. (g)	SNK	Epidddymis Wt. (g)	SNK
1,2	Stress	17	5.78 ± .92	B	.35 ± .23	A	1.49 ± .15	AB	1.74 ± .24	A
3	H_2O	8	5.71 ± .87	B	.81 ± .16	AB	1.74 ± .07	ABC	1.78 ± .18	AB
4	Oil	6	10.21 ± 1.10	B	.95 ± .53	ABC	1.22 ± .20	A	1.75 ± .29	AB
5	PMSG, low	9	6.06 ± 1.74	B	1.25 ± .28	ABC	1.92 ± .22	ABC	3.33 ± .28	CD
6	PMSG, high	8	7.56 ± 1.45	B	2.13 ± .39	CD	8.58 ± 1.20	E	11.09 ± 1.76	E
7	LH, low	7	4.84 ± 1.78	B	.64 ± .36	AB	1.57 ± .08	ABC	1.66 ± .25	AB
8	LH, high	10	5.52 ± 1.69	B	.80 ± .20	AB	1.76 ± .15	ABC	2.00 ± .25	AB
9	E-D, low	8	-5.36 ± 1.58	A	.03 ± .33	A	2.76 ± .36	BC	5.41 ± .53	D
10	E-D, high	9	-5.18 ± .83	A	1.06 ± .30	BC	2.18 ± .25	C	5.49 ± .66	D
11	T-P, low	7	10.57 ± .97	B	1.71 ± .32	BCD	1.61 ± .27	ABC	9.70 ± 1.86	E
12	T-P, high	8	6.87 ± 1.51	B	2.75 ± .21	D	1.60 ± .18	ABC	13.60 ± 2.00	E
13	Pit. low	6	8.50 ± 1.50	B	1.13 ± .26	ABC	2.19 ± .22	BC	2.94 ± .28	BC
14	Pit. high	10	11.25 ± .91	B	.80 ± .21	AB	3.66 ± .52	D	4.67 ± .49	CD
15	ImmunePMSG	8	2.97 ± .65	-	.44 ± .33	-	3.00 ± .29	-	4.73 ± .73	-
16	ImmuneLH	8	1.76 ± .41	-	.56 ± .15	-	2.16 ± .3'	-	1.47 ± .41	-

Table 3

Qualitative Effects of Hormone Treatments on

Immature Green Sea Turtles *

	Spermatogenesis	Interstitial Cells	Glans Penis	Oviduct	Ovary
1. PMSG	+ +	+ +	0	0	0
2. LH	0	0	0	0	0
Homogenate	+	+	0	0	0
4. Est-diprop.	0?	-	0	+ +	0
5. Test-prop.	0?	-	+ +	+	0

*(Strongly effected organs indicated by + +, mildly effected +, no effect 0, negative effect -).

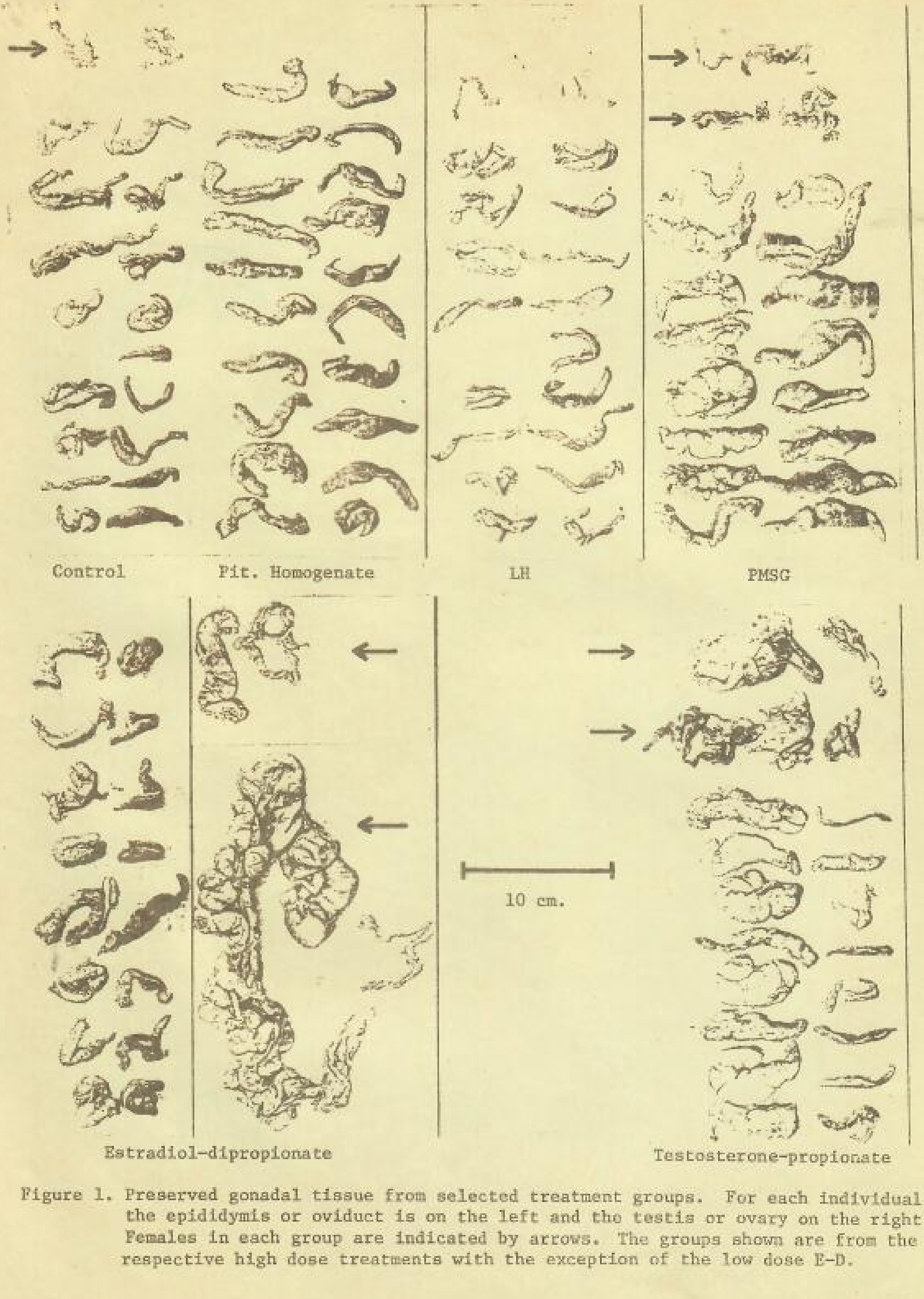
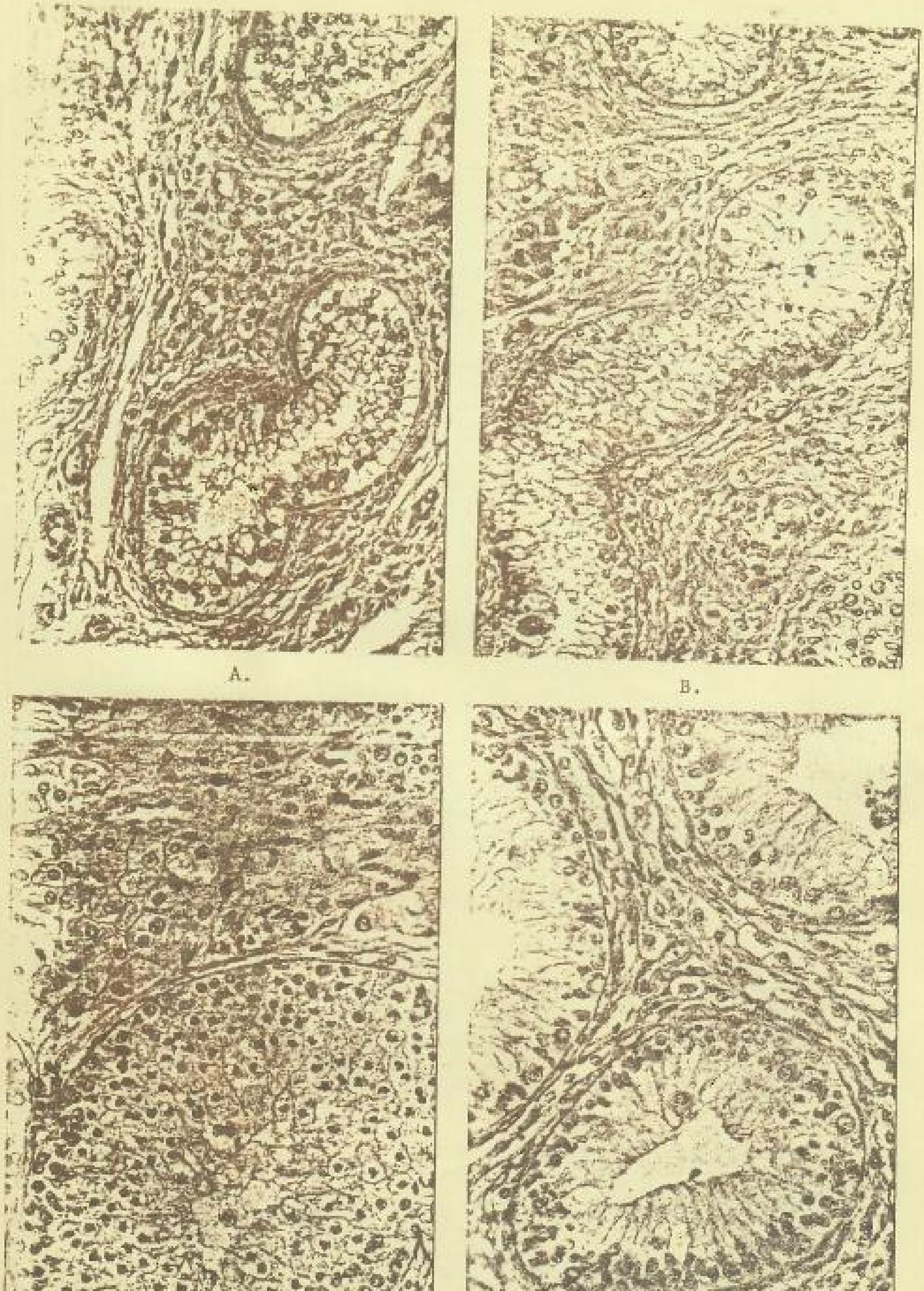


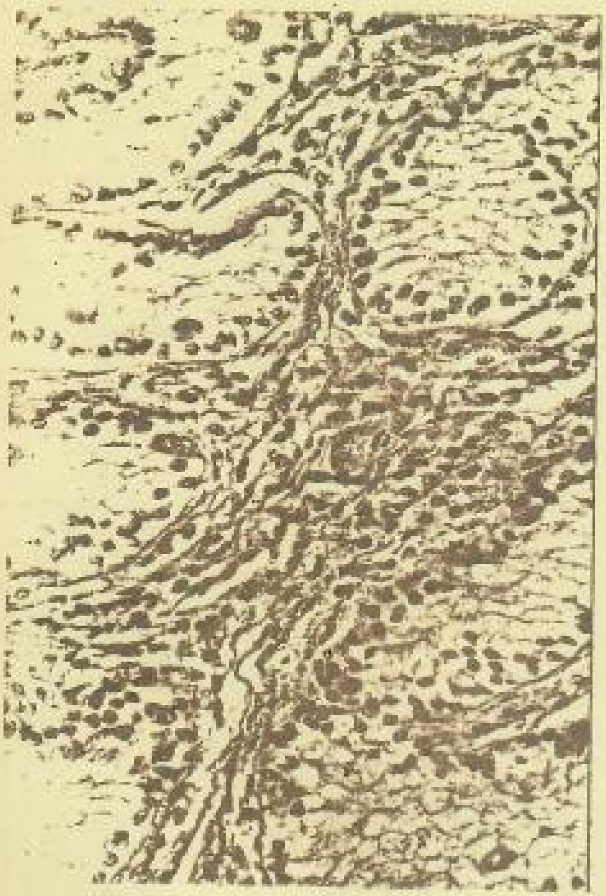
Figure 1. Preserved gonadal tissue from selected treatment groups. For each individual the epididymis or oviduct is on the left and the testis or ovary on the right. Females in each group are indicated by arrows. The groups shown are from the respective high dose treatments with the exception of the low dose E-D.



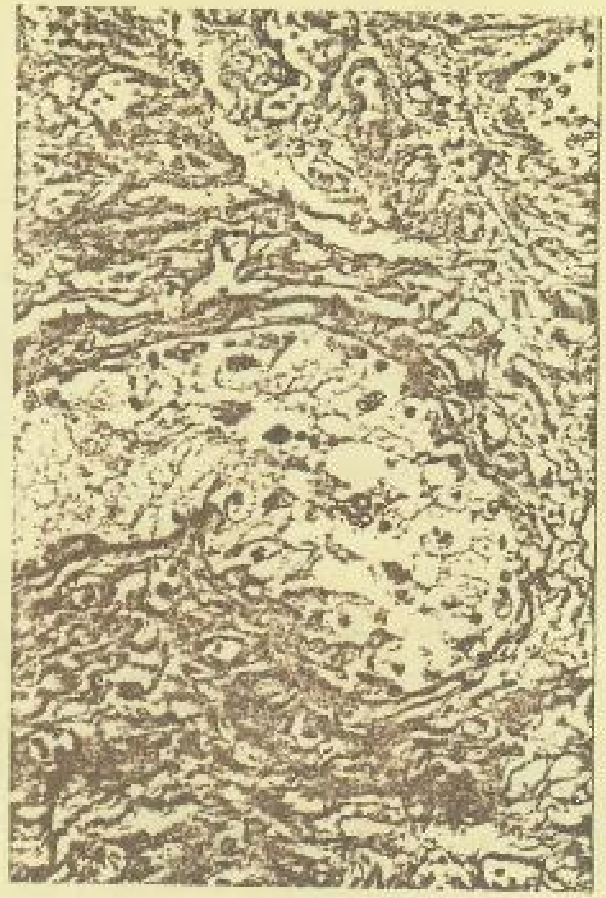
A. B.

C. D.

Figure 2. (see legend following Fig. 3)



A.



B.

C.

Figure 3. (see legend on following page)

Figure 2. (All photomicrographs at 200X.)

A. Control- A few spermatogonia line the seminiferous tubules and, the interstitial cells appear small. A typical immature condition.

B. LH high dose- No discernable differences from control except that the spermatogonia are more closely appressed to the tubule wall.

C. PMSG high dose- A marked enlargement of the seminiferous tubule with proliferation of spermatogonia, spermatocytes and possibly spermatids. The lumen has also started to clear. Hypertrophy of both the interstitial cells and the interstitial cell nuclei is obvious.

D. Pituitary homogenate high dose- Interstitial cells much larger than controls. Seminiferous tubule slightly enlarged with some spermatogonial proliferation and a few spermatocytes forming.

Figure 3.

A. Testosterone-Propionate high dose- Interstitial cells appear smaller than controls. Spermatogonia are appressed to the tubule wall.

B. Estradiol-Dipropionate low dose- Interstitial cells are very small. Spermatogonia appear altered but it is difficult to say if they are dividing or disintegrating.

C. Injection method- Two assistants restrain turtle, by holding fore-flippers over edge of tank, while the injection is administered.

AMINO-ACIDS ESSENTIAL FOR THE GROWTH OF YOUNG GREEN SEA TURTLES

(*Chelonia mydas*)

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ABSTRACT

The development of a completely defined amino acid test diet suitable for hatchling sea turtles is briefly discussed. The results of a series of experiments designed to determine the nutritionally essential amino acids required by the hatchling Green sea turtle, *Chelonia mydas*, are presented. Of the eighteen amino acids of nutritional significance, nine are shown to be clearly essential, eight are shown to be clearly non-essential, and one amino acid is shown to be possibly semi-essential. Possible relationships of the reported results to the protein and amino acid requirements of turtle age classes other than hatchlings are mentioned. Directions of future research and implications for the development of commercial turtle feeds are suggested.

INTRODUCTION

Of the many amino acids which are constituents of animal protein and which must be available to the animal's cells if protein is to be produced, 18 occur most commonly and are considered to be nutritionally significant. Amino acids which the animal can synthesize are deemed nutritionally non-essential while those which must be provided by the diet are designated as nutritionally essential.

The qualitative and quantitative amino acid requirements of various mammals, birds, fish, and invertebrates have been determined during the last 25 years. It is interesting to note that in almost every case the species for which these requirements have been determined have been species of economic importance. Information concerning the nutritional requirements of amphibians and reptiles is almost non-existent except for general information on natural foods on which these animlas can be maintained in captivity.

The first dietary study on turtles was conducted by Pearse, *et al.* (1925). Three species, a painted turtle, a gopher tortoise, and a terrapin were fed different rations of "pure" foods such as sand, casein, eggs, lettuce, meal worms, dextrin, wheat, and cod-liver oil. The authors concluded that the food requirements of chelonians as poikilothermal animals are similar to those of homoiothermal animals.

Coulson and Hernandez (1964), in discussing results of blood amino acid studies on the alligator, suggest that the essential amino acids required by the alligator are the same as those required by mammals with the exception of lysine, for which they cite evidence of synthesis of this normally essential amino acid from arginine and citrulline in the alligator. Coulson and Hernandez (1965) state that the turtle, Pseudomys (sic!) scripta elegans, is very similar to the alligator in amino acid metabolism and they tentatively identify a conversion product of arginine and citrulline as lysine, indicating the ability of this turtle to synthesize this amino acid.

Work on determination of the nutritionally essential amino acids required by the hatchling Green sea turtle, Chelonia mydas, was initiated for two reasons: 1. On a pure science level, it would be the first time that the qualitative amino acid requirements of a reptile had been determined, and 2. On an applied level, information concerning the nutritional requirements of the species in its infancy as a "domestic" and cultured animal could be very important in the development of economical rations.

DETERMINATION OF AMINO ACID REQUIREMENTS

Approaches to the Problem

There are two common approaches to the problem of determining the nutritionally essential amino acids required by an animal. Borman et al. (1946) and Womack and Rose (1947) introduced the use of a synthetic diet made up of purified substances to determine amino acid requirements in their studies on the rat. This method involves the planned deletion of selected test amino acids from the prepared diet. If growth is halted or severely depressed, the deleted amino acid is considered to be essential. The second approach utilizes the injection of a radioactive carbon source, usually labeled glucose. After a period of time, tissue samples are removed and the constituent amino acids are analyzed for radioactive carbon. Heavily-labeled amino acids will have been synthesized by the animal from the carbon source and are considered non-essential, while non-labeled amino acids are considered to be nutritional essentials.

The purified synthetic diet method was chosen for the present study on sea turtles, since once the purified diet was developed it could be used to determine quantitative as well as qualitative amino acid requirements.

Development of a Purified Diet

A purified diet for the determination of nutritionally essential amino acid requirements must be completely defined chemically; it must allow the manipulation of any one or more amino acids and, if growth is to be the test criterion, it must maintain the physical condition and promote growth of the test animal. The development of an amino acid test diet for young Green sea turtles has been complicated by two factors: 1. hatchlings can be obtained on the average of only twice a year (Northern hemisphere and Southern hemisphere breeding seasons), and 2. the cost of purified amino acids is high. For these reasons, it was often impossible in the work reported here to repeat preliminary experiments and it was sometimes necessary to accept and act upon results not substantiated as fully as would have been desired under other circumstances.

Preliminary experiments during the development of the purified diet were conducted in a wide variety of water systems, always utilizing either artificial or natural sea water at a water temperature between 24 and 29°C. Hatchlings were fed all they would eat 3 to 4 times a day, 6 days a week. Individual weights were determined each week following the day of fasting.

The initial purified diet was based on the composition of shrimp as given by the United States Department of Agriculture (1963) since both Harrison (1955) and Caldwell (1962) had reported raising hatchlings for up to 3 years on a diet of shrimp. The diet contained (wet weight) 18.5% amino acid mixture, 1.5% dextrose, 2.5% vitamin mixture, 1.4% salt mixture, 2.0% corn oil, 3.0% agar as a binder, and 71.1% distilled water. The amino acid mixture contained the 18 common amino acids in the proportion they occur in shrimp as reported by Borgstrom (1962).

The original test diet evolved by trial and error experimentation into the test diet which is currently used. Some steps in this process were as follows: 1. The amount of carbohydrate (dextrose) was increased from 1.5% to 20.0% to provide energy; 2. potato starch was substituted for dextrose as the carbohydrate material when it appeared that a larger molecular size was desirable (less active leaching before ingestion, apparent improved growth rates); 3. the salt mixture was supplemented with additional sodium and potassium to more closely approximate the mineral composition of shrimp; 4. substitution of carboxymethyl cellulose for agar as the binder when it was discovered that this reduced obstructions in the large intestine; 5. use of diammonium citrate to replace the nitrogen of deleted amino acids; 6. change from the amino acid pattern of shrimp to that of casein when it was found that this produced better growth rates; 7. doubling of protein (amino acid) complement from 18% to 36% wet weight of the diet and halving of starch complement from 20% to 10% wet weight, since this resulted in improved rates of growth; 8. deletion of L-alanine from all diets after tests indicated that this amino acid was non-essential and consistently satisfactory results were obtained without it; 9. substitution of "Alphacel" (ground cellulose) for deleted amino acids rather than using diammonium citrate after learning that diammonium citrate had been shown to have a negative effect on chinook salmon (DeLong et al, 1959).

The composition of the amino acid test diet as it is currently used is given in Table 1.

Preparation and Storage of the Diet

The amino acid mixture, potato starch, vitamin mix, salt mix, and corn oil were thoroughly mixed. Distilled water heated to 85-90°C. was added to the above ingredients and stirred until soluble components were dissolved. The carboxymethyl cellulose was then blended into the diet until a homogeneous mixture of dough-like consistency was produced. The diets were then stored in wide-mouthed jars at a temperature of approximately 10°C., until used.

Determination of 6 Non-essential Amino Acids

In an experiment conducted during the latter stages of the development of the purified diet, 19 groups of 6 hatchlings each were fed synthetic diets. The control group received a diet containing all 18 amino acids, while each of the remaining 18 groups received variations of the diet, each missing a different amino acid. In each case the amount of nitrogen removed from the diet by deleting an amino acid was replaced by adding the appropriate amount of diammonium citrate. The composition of this diet is given by Table 2.

During the fourth week of this experiment a severe disease problem developed which resulted in a 68% mortality and the virtual elimination of several of the groups, including the control. Since disease was so obviously a major factor in this experiment, no firm conclusions could be reached concerning the essential nature of the deleted amino acids. Six test groups did, however, gain relatively high percentages of their initial weights and generally had a lower mortality than did the other 13 groups. Fig.1 shows the rate of growth and number of surviving turtles in each group. The above 6 groups were on diets lacking either alanine, proline, serine, cystine, tyrosine, or glycine, suggesting that these amino acids might be nutritionally non-essential.

To further test if the indicated 6 amino acids were non-essential, selected survivors of the above experiment were used in a second experiment. All were fed shrimp for 11 days and were then weighed. By the end of this period, losses due to disease had tapered off. The 16 hatchlings which showed the greatest percent gain during the 11 days on the shrimp diet were divided into 4 groups. During the second test, the turtles were fed during the day in fresh water and were placed in artificial sea water each evening.

Group 1 received the standard control diet as shown in Table 2, with 36% protein complement using diammonium citrate to replace alanine. The other three groups received diets with further deficiencies and with variations in make-up of the total protein complement. The diet for Group 2 contained 18% protein, made up of the 12 amino acids other than those 6 presumed above to be non-essential; the diet for Group 3 contained the same 12 amino acids, but at double quantities to produce a 36% protein level. The diet for Group 4 contained the 12 amino acids at the same level as for Group 2, but had the presumed non-essential amino acid glycine added to make the total protein up to 36%. The exact make-up of diets 2, 3 and 4 is presented in Table 3.

As shown in Fig. 2, group 1 gained the most. Group 2 (low protein level) lost weight, and groups 3 and 4 gained approximately equal amounts. The excellent growth obtained by the control confirmed alanine as being a non-essential amino acid. The 22.6% weight increase for group 3 corresponds to an average gain of 16 grams per turtle, which supports the conclusion that the deleted 6 amino acids are non-essential. Growth response of group 4 indicates that glycine is efficient as a replacement source of nitrogen.

Determination of Essential Amino Acids

Thirteen groups of 8 hatchlings each were fed test diets based on the formula givem in Table 1. The control group received the complete test diet, the other 12 groups each received the diet with a single amino acid deleted (either lysine, histidine, arginine, aspartic acid, threonine, glutamic acid, valine, methionine, isoleucine, leucine, phenylalanine, or tryptophan). The hatchlings were fed during the day in plastic dishpans containing fresh water, then transferred in the evening to similar dishpans containing filtered artificial sea water. Turtles were fed as much as they would eat each day for 6 days a week. Individual weights were determined on the day after fasting. The regime was continued for 3 weeks, then all were fed the control diet during the fourth and final week of the experiment.

Figure 3 shows the percentage of initial weight gained for each group receiving a deleted diet, compared to percentage of initial weight gained in the control group. It can be seen that only the groups fed the aspartic acid-free or the glutamic acid-free diets had rates of gain equal to the control. The groups receiving diets lacking either lysine, histidine, threonine, valine, methionine, isoleucine, leucine, phenylalanine, or tryptophan had rates of growth less than the control but, with the exceptions of the leucine-free and the valine-free diet groups, they responded with an increased rate of growth upon receiving the control diet in the fourth week. The group receiving the arginine-free diet did not gain as well as the control, but it gained better than the other low-growth groups.

During the last 2 weeks of the experiment, a number of turtles died, apparently from disease. Total mortality was 32%. The group fed the valine-free diet had only one turtle remaining at the end of the experiment, while the other groups lost an average of 2 turtles each.

Duncan's multiple-range test on percent of initial weight gain values of each group at the end of the third week indicated no statistically significant difference (P=.05) between the control and the glutamic acid-free or aspartic acid-free diet groups. A significant difference did exist between the control and all other groups. The arginine-free diet group was significantly different for all other groups, having gained more than the groups lacking either lysine, threonine, histidine, methionine, valine, isoleucine, leucine, tyrosine, tryptophan, or phenylalanine, and having gained less than either the control, glutamic acid-free, or aspartic acid free diet groups.

Since disease became a problem during the last two weeks of the above experiment, it was felt that it would be necessary to retest those amino acids which appeared to be essential. Upon arrival of additional hatchlings the above experiment was repeated with a few changes: The turtles were maintained constantly in artificial sea water made up daily. The amino acids lysine, histidine, threonine, valine, methionine, isoleucine, leucine, phenylalanine, and tryptophan were tested as before, and glycine was retested. Basic diet composition and preparation was the same as in the previous experiment, as was the experimental proceedure.

Figure 4 compares the percentage of initial weight gained by the control to the percentage of initial weight gained by each of the deleted diet groups. This figure shows that only the glycine-free group had a rate of growth approaching that of the control group. All other deleted groups had depressed rates of growth. As before, growth of the arginine-free group, while less than that of the control or glycine-free groups, was greater than amounts of growth obtained on the other deleted diets. All deleted groups except the glycine-free group showed increased rates of growth after being placed on the control diet. Only 4 of the initial 96 hatchlings died during the 4-week experimental period, indicating almost no disease.

Duncan's multiple-range test, when applied to the percentage weight gain values of each group at the end of the third week shows there to be no statistically significant difference between the control and glycine-free diet group. All other groups grew at a significantly slower rate than did the control or glycine-free groups. Arginine again occupied a more or less intermediate position, gaining less than the control or glycine-free group, but gaining more than the other deleted groups and being significantly different from all slower-growing groups except threonine.

These two experiments demonstrate that glutamic acid, aspartic acid, and glycine are nutritionally non-essential while lysine, histidine, threonine, valine, methionine, isoleucine, leucine, phenylalanine, and tryptophan are nutritionally essential amino acids. The status of arginine is less clear. Its removal from the diet depressed growth in both experiments but not to the extent that deletions of other essential amino acids did. It appears that hatchling Green sea turtles may be able to synthesize arginine, but not in sufficient quantities to support maximum growth. Arginine should probably be considered as a semi-essential amino acid.

DISCUSSION OF RESULTS

It cannot be assumed that the qualitative dietary amino acid requirements of the adult Green turtle are the same as those of the hatchling. In nature the hatchling is presumed carnivorous during the first year and later becomes mainly herbivorous (Hirth, 1971). If herbivorous turtles utilize microbial action to digest cellulose, then their dietary requirements will depend upon the extent to which the intestinal flora modifies the dietary intake. Normally essential dietary components may be synthesized from non-essential elements by the intestinal micro-organisms. In such a case, the animal's cells have not changed in their ability to synthesize amino acids, but the dietary requirement is met by microbial synthesis. Such a system would also have a profound effect on quantitative amino acid requirements as well. Currently in large-scale turtle culture, rations fed are high in protein and relatively low in carbohydrate. On such diets the effect of microbial action in older turtles, if it does in fact exist, would probably be minimal.

One other factor should be discussed in a consideration of the relationship between hatchling and adult turtle amino acid requirements. The hatchling represents the most rapidly growing size class with rate of growth decreasing over time, until at maturity growth virtually ceases. With a decreasing rate of growth comes a corresponding decrease in demand for amino acids. The qualitative requirement in the absence of microbial action should remain the same, but the quantitative requirements could be radically different between the hatchling and the adult due to the difference in rate of growth. The amino acid arginine, if truly semi-essential, could become non-essential if the adult turtle could produce adequate quantities to meet its limited protein synthesis requirements.

Knowledge of the qualitative amino acid requirements of the Green sea turtle in itself has little practical value, since virtually every natural protein food source contains all 18 amino acids of nutritional significance, as well as many others. The next step in the study of the protein requirement of the Green sea turtle should be to determine the quantitative requirement for each of the essential amino acids. Research is also needed on required levels of protein, efficiency of utilization of various carbohydrates, studies on lipid requirements, and vitamin requirements. As this information becomes known, rations can be formulated on a more factual basis using the least expensive ingredients to fulfill the requirements. The objective would be to utilize the protein fed for protein synthesis and to obtain energy for metabolic functions from the cheaper fat and carbohydrate sources. The possibility of microbial action in the digestive tract of herbivorous turtles should be investigated and, if found to exist (as expected), then studied to determine ways of utilizing this mechanism to lower feed costs. In much of the foregoing I have considered only manipulations of what goes in a turtle's mouth. This ignores the large factor of digestive tract efficiency and urinary excretion. Many standard nutritional techniques and tests which would provide much useful information on turtle nutrition must await the development of a method for collecting total excreta during feeding trials.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of Dr. Robert Bustard, Australian National University, Mr. G. S. de Silva, Forest Department, Sabah, Malaysia; Dr. J. Schulz, Forest Service, Surinam; and Mariculture, Ltd., Grand Cayman Island, British West Indies in obtaining hatchling turtles. This work was supported in part by an NSF institutional grant to the University of Arizona and by funds supplied by Mariculture, Ltd. Thanks are given to Dr. Henry Schafer, Director of Escuela de Ciencias Maritimas y Technologia de Alimentos Guaymas, for generously providing laboratory space during the summer, 1973. This paper is a contribution of the Marine Biology Program of the University of Arizona.

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Table 1.- Composition of amino acid test diet

Ingredient		gm/100 gm of diet [1]
L Lysine · HCl		1.44
L Histidine · HCl · H_2O		1.04
L Arginine · HCl		1.34
L Aspartic Acid		2.64
L Threonine		1.46
L Serine		1.98
L Glutamic Acid		8.28
L Proline		3.70
Glycine		1.28
L Cystine		.28
L Valine		2.02
L Methionine		.70
L Isoleucine		1.52
L Leucine		3.26
L Tyrosine		1.96
L Phenylalanine		1.70
L Tryptophan		.36
	Total	34.96
Potato Starch		10.00
Vitamin Diet Fortification Mixture		2.50
Hawk Oser Salt Mixture No. 3		1.40
Potassium Phosphate Monobasic		.40
Sodium Chloride		.20
Corn Oil		2.00
Carboxymethyl Cellulose Sodium		5.00
Distilled Water		43.54

[1] in deleted diets the deleted amino acid was replaced by an equal weight of "ALPHACEL", a ground cellulose obtained from Nutritional Biochemical Co.

Table 2.- Composition of experimental diet including L Alanine and diammonium citrate.

Ingredient	gm/100 gm of diet [1]	
L Lysine · HCl	1.44	(1.78)
L Histidine · HCl · H_2O	1.04	(1.68)
L Arginine · HCl	1.34	(2.88)
L Aspartic Acid	2.64	(2.24)
L Threonine	1.46	(1.38)
L Serine	1.98	(2.12)
L Glutamic Acid	8.28	(6.34)
L Proline	3.70	(3.64)
Glycine	1.28	(1.94)
L Cystine	.28	(0.26)
L Valine	2.02	(1.96)
L Methionine	.70	(0.52)
L Alanine	1.04	(1.32)
L Isoleucine	1.52	(1.30)
L Leucine	3.26	(2.82)
L Tyrosine	1.96	(1.22)
L Phenylalanine	1.70	(1.16)
L Tryptophan	.36	(0.36)
Total	36.00	
Potato Starch	10.00	
Vitamin Diet Fortification Mixture	2.50	
Hawk Oser Salt Mixture No. 3	1.40	
Potassium Phosphate Monobasic	.40	
Sodium Chloride	.20	
Corn Oil	2.00	
Carboxymethyl Cellulose Sodium	5.00	
Distilled Water [1]	42.50	

[1] () indicates the amount of diammonium citrate used to replace nitrogen of deleted amino acid. The amount of water varied depending upon the amount of diammonium citrate used.

Table 3.--Composition of experimental diets

Ingredient	gm/100 gm of diet		
	Group 2 diet	Group 3 diet	Group 4 diet
L Lysine HCl	1.01	2.02	1.01
L Histidine HCl H_2O	.72	1.44	.72
L Arginine HCl	.94	1.88	.94
L Aspartic Acid	1.84	3.68	1.84
L Threonine	1.03	2.06	1.03
L Glutamic Acid	5.78	11.56	5.78
L Valine	1.40	2.80	1.40
L Methionine	.49	.98	.49
L Isoleucine	1.06	2.12	1.06
L Leucine	2.27	4.54	2.27
L Phenylalanine	1.19	2.38	1.19
L Tryptophan	.25	.50	.25
Glycine	-	-	11.40
Total	17.98	35.96	29.38*
Potato Starch	28.00	10.00	16.60
Vitamin Diet Fortification Mixture	2.50	2.50	2.50
Hawk Oser Salt Mixture No. 3	1.40	1.40	1.40
Potassium Phosphate Monobasic	.40	.40	.40
Sodium Chloride	.20	.20	.20
Corn Oil	2.00	2.00	2.00
Carboxymethyl Cellulose Sodium	5.00	5.00	5.00
Distilled Water	42.52	42.54	42.52

* This total is equivalent to 36 gm. of protein due to the relatively high level of nitrogen contained in glycine.

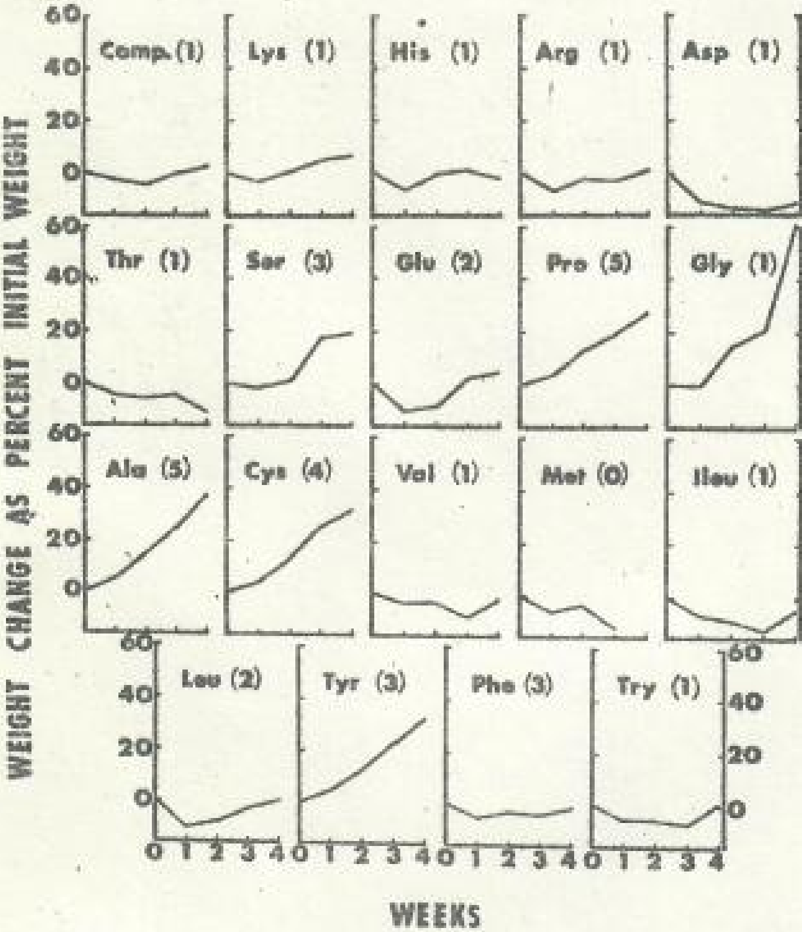

Figure 1. Rates of growth of hatchling Green sea turtles (C. mydas) fed synthetic diets. () indicates number of hatchlings surviving experimental period.

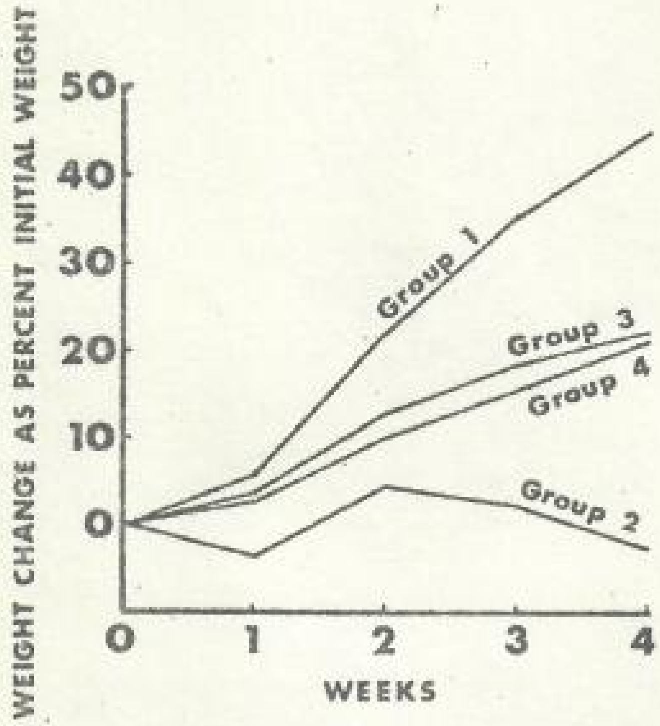

Figure 2. Rates of growth of hatchling Green sea turtles fed 4 different synthetic diets.

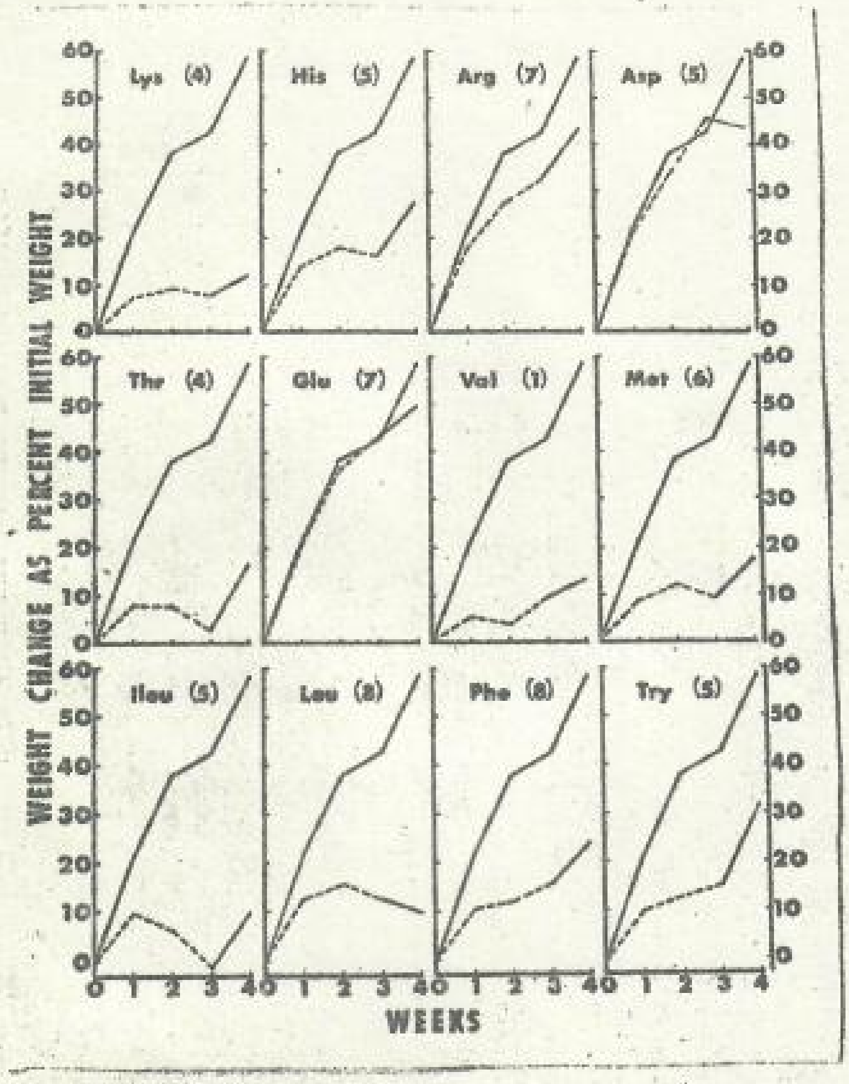

Figure 3. Rates of growth of hatchling Green sea turtles, fed for 3 weeks on synthetic diets each lacking a different amino aci((– – – – – –) compared to rate of growth of hatchlings fed the control diet (————). Number in () indicates the number of hatchlings surviving experimental period.

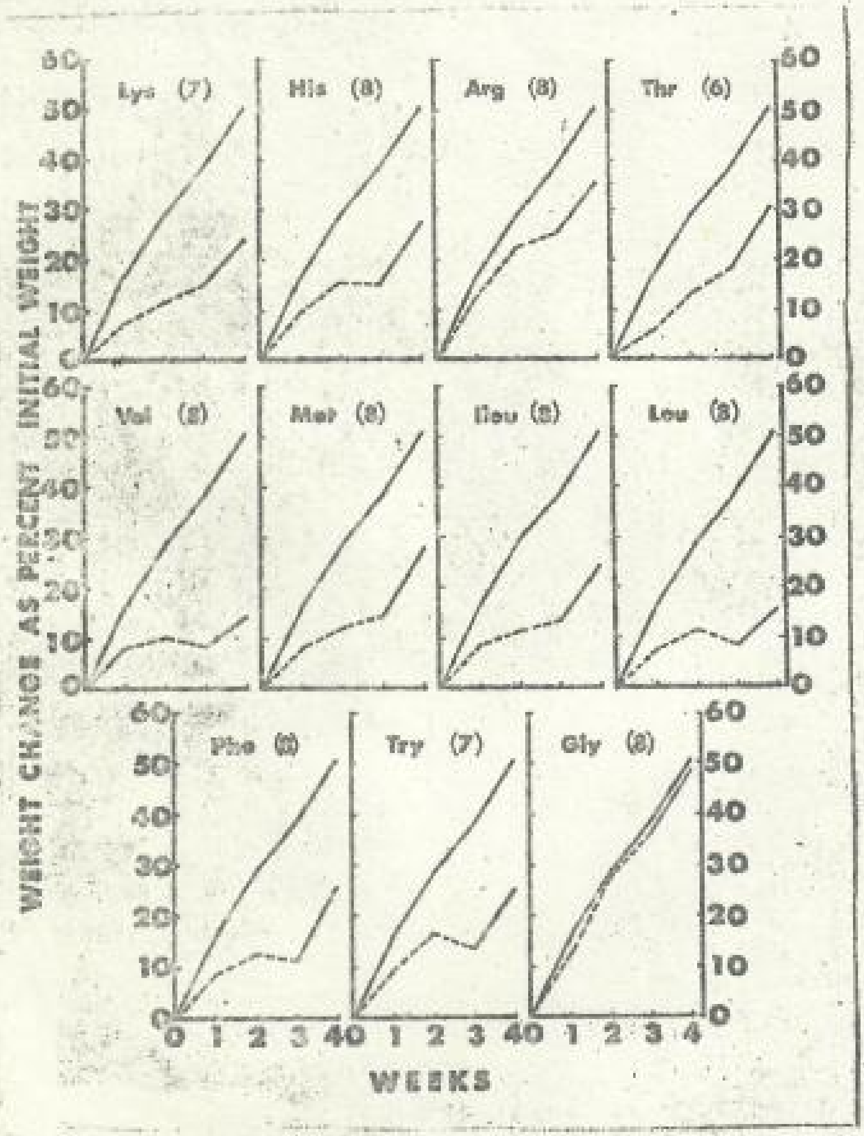

Figure 4. Rates of growth of hatchling Green sea turtles, fed for 3 weeks on synthetic diets each lacking a different amino acid (- - - - - -) compared to rate of growth of hatchlings fed the control diet (————). Number in () indicates the number of hatchlings surviving experimental period.

MARICULTURE, Ltd.
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SCHILDKRÖTEN
SUPPE
LEGIERT
»Zum Schutz der wildlebenden Schildkröten werden für Lacroix-Erzeugnisse gezüchtete Farm-Schildkröten verwendet.«
CONSERVENFABRIK EUGEN LACROIX GMBH · FRANKFURT AM MAIN · BUNDESREPUBLIK DEUTSCHLAND

CALIFORNIA LEGISLATURE—1973-74 REGULAR SESSION

ASSEMBLY BILL No. 3536

Introduced by Assemblyman Keysor

March 27, 1974

REFERRED TO COMMITTEE ON NATURAL RESOURCES AND CONSERVATION

An act to add and repeal Article 4 (commencing with Section 2450) to Chapter 4 of Division 3 of the Fish and Game Code, relating to turtles.

LEGISLATIVE COUNSEL'S DIGEST

AB 3536, as introduced, Keysor (N.R. & Con.). Importation of turtle products.

Permits products derived from green sea turtles, notwithstanding Penal Code provisions prohibiting importation for commercial purposes, to be imported into the state under a permit issued by the Department of Fish and Game. Specifies terms and conditions of such permits, and requires payment of $50 filing fee. Requires the department to inspect the operations of the permittee, as specified, and requires permittee to pay the costs of such inspections, as specified. Requires the department to report to the Legislature on the operation of the permit program by January 1, 1979.

Effective only until January 1, 1980.

Vote: majority. Appropriation: yes. Fiscal committee: yes. State-mandated local program: no.

The people of the State of California do enact as follows:

SECTION 1. Article 4 (commencing with Section 2450) is added to Chapter 4 of Division 3 of the Fish and

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Game Code, to read:

Article 4. Turtles

2450. Products derived from green sea turtles, including meats, oils, hides, calipees, shells, and other derivatives, may be imported into this state under a permit issued by the department, notwithstanding the provisions of Section 6530 of the Penal Code.

2451. No permit shall be issued to any person pursuant to this article unless such person has obtained written permission for the exportation of turtle products from any state or foreign country in which such person conducts business, including all states and foreign countries where he obtains any turtle eggs in the wild.

2452. An application for a permit under this article to import products derived from green sea turtles shall be accompanied by a filing fee in the sum of fifty dollars ($50), which fee shall not be refundable.

2453. The department shall issue permits pursuant to this article for products derived from green sea turtles which are one or both of the following:

(a) Raised domestically from eggs laid on the property of the permittee

(b) Raised domestically from all or part of eggs obtained from the wild if the eggs are, or are reasonably expected to be, ruined by the chemical or physical composition of the sands where they are laid, or if the eggs are, or are reasonably expected to be, ruined by being washed over by high seas or are from nests laid below the high tide line or are original eggs laid on beaches so heavily nested upon that the greatest part of the original nests are dug up or disturbed by other eggs laid in the same nesting season.

The permit shall specify whether or not any eggs are to be taken from the wild.

2454. A person holding a permit under this article may take a specified percentage of eggs saved as the result of such person having placed on the beaches sufficient patrols with the approval of the proper governmental officials to protect against the poaching of turtles. Such percentage of eggs to be taken shall relate directly to the amount of eggs saved by the stopping of such poaching and the allowing of a normal laying of eggs. Such percentage shall be negotiated with the proper local governmental authority. Such percentage shall be reasonable and shall be negotiated in good faith by the person or firm holding the permit. Such percentage shall be approved by the department.

2455. A person taking eggs pursuant to Section 2454 shall be required by the department to hatch out and release locally in the area where the eggs are taken a proportion which shall be agreed upon with the proper local government authority of the number of eggs so taken, for the purpose of increasing the total turtle population in the area. Such proportion shall be reasonable, and the person shall act in good faith in negotiating the proportion with the proper local governmental authority. The department shall approve such proportion.

2456. A person holding a permit under this article shall annually submit to the department a report on the conservation efforts of the permittee in regard to green sea turtles.

2457. The department shall inspect the operations of the permittee from time to time each year to determine if the permittee is in compliance with the provisions of this article. Such inspection may be unannounced and permittee shall cooperate with any reasonable or lawful request of the department for an opportunity to inspect and for the permittee to provide any written material requested, including proof of permits from other jurisdictions, and actions in conformity with the requirements contained in this article.

2458. Costs incurred for any inspection pursuant to Section 2457 shall be borne by the permittee, and a note issued by an international banking firm shall guarantee the deposit of sufficient funds by the permittee to cover costs incurred by the department to inspect the complete operations, up to four times a year. The funds deposited

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shall cover transportation costs, salaries, and living expenses for the trip. An amount equal to 15 percent of such funds shall be paid to the Fish and Game Preservation Fund to reimburse the department for administrative costs.

2459. Upon a finding by the department that the permittee has violated any of the provisions of this article or has not acted in good faith in the taking of turtle eggs from the wild, the department shall revoke the permit.

2460. The department shall review the operation of the permit program authorized under this article and shall report thereon to the Legislature by January 1, 1979.

2461. This article shall remain in effect only until January 1, 1980, and as of such date is repealed, unless a later enacted statute, which is chaptered before January 1, 1980, deletes or extends such date.

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AIR MAIL

RICHARDSON SECURITIES OF CANADA

SERVING INVESTORS ACROSS CANADA
AU SERVICE DES INVESTISSEURS À TRAVERS LE CANADA

Mrs. Linda R. Evans,
P.O. Box 8195,
Honolulu,
Hawaii 96815.

Director's Report

RICHARDSON SECURITIES OF CANADA

SENIOR PARTNER: GEORGE T. RICHARDSON

WEST WIND BUILDING, N. CHURCH & FORT ST., GRAND CAYMAN, B.W.I. TEL: 9-4066 TELEX CP241

P.O. BOX ~~XX~~ 1095

28th August, 1974

Mrs. Linda R. Evans,
P.O. Box 8195,
Honolulu,
Hawaii 96815.

Dear Mrs. Evans,

Thank you for your letter of 20th August, 1974, enquiring about Mariculture Limited.

The most recent report we have from the Company is dated 15th March 1974, and we are enclosing same as the last annual report is out of print, at the present time, and the 1974 annual report will not be out until 31st December, 1974.

Mariculture Limited expects to be in a break-even position around the end of the current year and hope to be in black in early 1975. Present prices of the shares are US$5.95 - 6.25. If you wish to purchase shares in the Company there are offerings at the present time at US$6.25. If you will kindly mail us a Bank Draft for the number of shares you wish to purchase we will look after the details and will airmail you a certificate, registered in your name, approximately one month after receiving your order.

Sincerely yours,

A Geo Colwill

A.GEORGE COLWILL
Resident Manager

RICHARDSON SECURITIES OF CANADA
SENIOR PARTNER: GEORGE T. RICHARDSON
WEST WIND BUILDING, N. CHURCH & FORT ST., GRAND CAYMAN, B.W.I. TEL: 9-4066 TELEX CP241

P.O. BOX 1095

22nd February, 1974 EAW/DMH

Mrs. L.R. Evans,
P.O. Box 8195,
Honolulu,
Hawaii, 96815,

Dear Mrs. Evans,

Thank you for your enquiry re Mariculture Limited. We are enclosing some current literature on the company which we trust you will find of interest.

The shares are presently selling at US$6.25 net per share (or CI$5.15 net). Th Annual meeting will be held on 15th March at which time the new annual statement will be available.

If we can be of further service please contact us again.

Sincerely yours,

Elizabeth Wiechers

ELIZABETH WIECHERS (Mrs.)
Registered Representative

Encs.

DIRECTOR'S REPORT

Presented At the Annual General Meeting
March 15th. 1974

MARICULTURE, Ltd.
P. O. BOX 645, GRAND CAYMAN ISLAND, BRITISH WEST INDIES

(INCORPORATED UNDER THE COMPANIES LAW 1960)

MARICULTURE LIMITED

THE REPORT OF THE DIRECTORS

ANNUAL GENERAL MEETING OF SHAREHOLDERS
15 MARCH 1974

During the past year our Company has achieved vital progress in many areas including captive breeding, expansion financing, marketing, and the continued development of technology and management. The Company has also been faced with a very serious short-term cash problem caused mainly by the unprecedented international rise in the prices for protein feed and the set back in our marketing programme.

The permanent increase in the cost of feed, which increased our expenditure in 1973 by almost CI$0.5 million, has delayed the achievement of profits. However, there are other positive factors, such as improved feeding techniques and higher marketing returns, which indicate that future profitability could be as attractive as originally predicted.

Breeding:

During the period April to July 1973, 12,500 eggs were laid in the man-made beach of the Company's breeding pond at Goat Rock. Approximately ten percent of the breeding stock was involved in this activity.

The achievement of captive breeding is indeed a milestone in the domestication of the green sea turtle: in addition to being of major significance to the science of marine biology and the conservation of the turtle, it has also provided the basis for our programme for the Company to become independent eventually of stocks of wild turtle eggs.

Other technical developments:

Less spectacular but significant developments have also taken place in the area of turtle husbandry: the successful development of alternative feed formulations has realized cost savings and provided a more competitive situation for feed supplies; and improved farming techniques and further advances in medical care have reduced mortality at each stage of turtle growth, from hatchling to mature stock. During the year work has also continued in the development of a vaccine to combat the incidence of the herpes virus infection that is apparently endemic to Chelonia mydas, both in captivity and in the wild.

The contract with the Upjohn Company for the collection of gorgonian coral was terminated at the end of the fiscal year, due to a phase-out by Upjohn Company of the associated research program

Expansion Programme:

Encouraged by rising market prices for many turtle products, and the break-through on the domestic breeding of the turtle, in mid year the directors decided to launch a long-term programme for the expansion of our production facilities. The first phase of this expansion is the doubling of the capacity of the Goat Rock farm in Grand Cayman. Preliminary steps had already been taken by management, such as the acquisition of adjacent land.

The installation on the Goat Rock farm of larger and more efficient livestock tanks, water pumps, freezer capacity and warehousing space will take place over the next eighteen months (involving an investment of over CI$0.5 million). This capital expansion programme, which is being undertaken with engineering advice from Sir Robert McAlpine Limited, will provide sufficient production capacity to increase the gross sales revenue for the Goat Rock farm to $2.5 million in 1975 to $5.0 million in 1978.

The second phase of the expansion is the construction of a second farm with a design capacity (at full production) to process a minimum of 60,000 turtles per year. The target dates for this facility are for commercial operation to commence during 1976, and full production to be achieved two and a half years later.

Over the past eight months intensive work has been undertaken on the possible financing, technical design and location of the new farm. As a result, the Directors have asked the management to prepare for consideration later this year a detailed financial and technical feasibility study for a major new facility, to be constructed probably in Puerto Rico. It is the intention of the Directors that such an expansion would be undertaken through a totally owned subsidiary company of Mariculture Limited.

Marketing:

During fiscal 1973 the Company processed and marketed the products of over 10,000 farm-raised turtles, having an average weight of approximately 90lb per turtle and realizing a gross revenue of CI$657,745. This gross revenue was substantially less than forecast, due to the much larger efforts required to establish steady market demand for a quality source of reliable, farmed turtle products.

During the first half of 1973 most of the marketing effort of the

Company was in the form of trial shipments of the various products of the turtle to potential markets around the world. Through such trial shipments the Company established distribution outlets and firm market prices for most major turtle products: portion control steak; chunk steak; steak pieces; leather; shell; soup products; and turtleshell jewellery.

During the second half of 1973 the demand and market prices for most of our products has hardened, as customers around the world have learned that they can obtain from Mariculture Limited turtle products of reliable quality, packaging and delivery. As a result the prices for many products have risen substantially.

The main exception to this trend of price increase is turtle oil, which was expected to contribute a significant proportion of the total sales revenue obtained from a turtle. Intially it appeared that this product would be totally sold out to a single customer, a US corporation that specializes in cosmetics using turtle oil as a base. Unfortunately this corporation ran into serious conservation legislation problems in California, its major market, and as a result has had to cut back production in 1973 very considerably. We now believe that the California legislation problem can be resolved, which would then allow sales of our farmed products in that State.

During a twelve-week period from October to December 1973, the abattoir at Goat Rock was closed for major modifications and improvement. This was necessary because Salmonella (a bacteria found on the surface of most raw meat and meat by-products) had been found on some Mariculture products. The cause of this contamination has been identified and eliminated, and deliveries of meat products have been resumed.

More than 90 per cent of our current production is exported, and during the past year the Company has shipped turtle products to more than twenty countries, including regular consignments to Japan and Australia. The shipment of products from Cayman involves severe logistical problems, and the development of efficient export shipment procedures has been an essential part of our initial marketing programme.

With this essential (and costly) ground-work now accomplished, our marketing efforts will now concentrate on securing the maximum financial return from each of the products of the turtle.

Finance:

The disappointing trading results for fiscal 1973 arise almost entirely from the unprecedented rise in the prices for animal feed, and the fact that the initial market development programme was considerably longer and more expensive than we had anticipated. The shutdown of the abattoir in October has affected production, and thus sales, but the effects will mainly fall into the trading results of the current fiscal year.

Both of these factors also affected the liquidity of the Company very seriously, and in April 1973 the Company negotiated a further CI$500,000 loan (in addition to the existing loan of CI$1.01 million) from FNCB. This loan is secured $200,000 on a guarantee by Commonwealth Development Finance Company Limited (in addition to the CI$400,000 already guaranteed by that shareholder), CI$100,000 guaranteed by five directors (in addition to the CI$300,000 already guaranteed by those directors), and CI$200,000 secured on the assets of the Company (in addition to the CI$310,000 already secured by a first mortgage debenture on those assets). The various guarantors were granted specific options, as shown in the accounts, as consideration for their financial support of the Company.

In April 1973 the Company served notice on all holders of the 10% Convertible Unsecured Loan Stock, 1977, indicating its intention to redeem the issue unless converted by 31 July 1974. As a result there was 100% conversion of the stock into ordinary shares at CI$5.00 per share, giving an indication of the strong support for the Company by the stockholders.

In July the directors approved a major financing plan for the company, involving the raising of CI$4.0 million in additional equity, to be issued at CI$8 per share (this issue was subsequently reduced to CI$2.5 million at CI$5 per share). These funds were to be applied to reduce debt, to pay for the capital expansion programme of Goat Rock farm, and to provide the initial funds for the expansion programme into a second farm.

As a result of a Rights Offering to all shareholders made at the end of September 1973 the Company received subscriptions or commitments to subscribe for approximately CI$650,000 of which approximately CI$100,000 was from US shareholders. In addition to the direct offer to shareholders, the company also entered negotiations with several institutions and companies who had expressed interest in the possibility of investing in Mariculture Limited. To date those negotiations have led to further subscriptions of CI$350,000 and commitments to subscribe CI$100,000. The Directors are confident that from the several negotiations still continuing that substantial additional subscriptions at CI$5 per share will be received over the course of the next few months.

A major benefit of these intensive fund-raising efforts has been the negotiation of a financing scheme for the entire investment funds required for the second farm in Puerto Rico. This involves the issue of Industrial Revenue Bonds in the United States to raise the approximate US$10 million total funds required for this expansion (covering both construction costs and the substantial working capital requirements). It was the development of this facility that enabled the Directors to reduce the total equity issue from CI$4.0 million to CI$2.5 million.

A further exciting development is that one major investor, Brazilian Equity Holdings SA, has negotiated with Mariculture Limited an option for the franchise rights to build and operate turtle farms in Brazil, using Mariculture knowhow, technology and assistance. Under the terms of the otpion agreement, Mariculture will also be entitled to a significant shareholding in the Brazilian franchise enterprise.

At an early stage of the fund raising campaign, the Company learned that the Rights Offer to our US shareholders was possibly in technical breach of the US SEC regulations. After taking advice from an experienced US securities attorney, the Directors reluctantly decided to return the subscription of US shareholders. This was done to avoid any possible further compromise of the ability of the Company to seek and obtain an SEC registration in due course.

Conservation Legislation:

During 1973 major steps have been taken to establish international standards and agreement for the preservation of endangered and threatened species, including the green sea turtle (Chelonia mydas). The most significant step towards the protection of endangered and threatened species is The Convention of International Trade in Endangered Species of Wild Flora and Fauna signed in Washington DC in March 1973 by the representatives of some eighty countries. Chelonia mydas is included in the list of "threatened" species set out in Appendix II of the Convention, and the Convention will form the basis for legislation in each of the signatory States. This Convention permits the import and export of green turtles on conditions which the Company will be able to meet. International trade in wild turtle products between parties to the Convention will be barred, and it is expected therefore that the Company will have a unique advantage in the international supply of turtle products.

On 28 December 1973 the United States Department of the Interior inserted into the federal register an announcement developed by the US Fish and Wildlife Service, proposing to include Chelonia mydas on the "endangered species" list. The effect of this would be the establishment of a dangerous precedent which other countries may follow and could eliminate the US as a market for Mariculture Limited's turtle products. At present, about 40 per cent of our revenues come from the US and almost all of our exported products travel through US ports. Our Company is endeavouring to have the US Department of Interior withdraw their recommendation, thus returning Chelonia mydas to the "threatened" category - a classification in which the Company feels confident that it will be able to meet the meaningful management and scientific authority requirements as set forward in the International Convention on Endangered Species of Wild Fauna and Flora. The Company is currently setting forward its case in Washington DC to the proper US authorities.

The Company will continue to present its special case for farmed turtle products whenever it is aware of impending conservation legislation. The Company actively supports conservation of the green turtle. Its activities are consistent with good conservation practices, and are welcomed by qualified conservationists, many of whom actively support and endorse the efforts of the Company.

In June 1973 the Company formed the Division of Conservation and Research (DCR) an organization to consolidate, preserve and control all conservation and research work carried out on sea turtles, with the initial emphasis on the green sea turtle. This organization is currently being funded by the Company and has its headquarters at Goat Rock farm. The Company will be providing laboratory, photographic, statistical and reference library facilities. The work of DCR, in which several eminent international scientists are participating, is expected to make a major contribution to the scientific understanding and conservation of turtles.

Management and Staff:

Under the guidance of our Managing Director, Michael Goodier, the senior executive staff of the Company has been considerably strengthened over the past few months. Roy Major joined the Company as Farm Manager in October 1973 (replacing John Drinkwater, who has returned to the UK), and Jeffrey Parker (an experienced and qualified accountant) joined the Company in the same month as Financial Controller. Jeffrey Parker has recently been appointed as Secretary to the Board of Directors. A Marketing Director, Roger Cooley, has also been recruited and it is expected that this strengthening of the marketing function will have a substantial positive effect upon Company revenue later this year.

We are very gratified to report that the level of competence and morale of the management and staff of the Company is extremely high; the progress of the past year could only have been achieved by a completely dedicated and well managed staff.

During the year the Company has continued to enjoy the valuable assistance of several consultants, many of international eminence. The Directors are pleased to extend their sincere gratitude to Professor Sir Alan Parkes, Professor E.C.Amoroso, Mr Gerbert Rebell, Dr H. Haines and Dr M. Rydberg for their valuable guidance and counsel through the past year.

Messrs Vickers, da Costa and Co. Limited, the international investment and stockbroking company with headquarters in London have recently accepted the appointment of financial advisers to the Company.

<u>Directors</u>:

At the beginning of the year the Company were pleased to learn that Keith Norman (previously the CDFC nominee director to our Board) was willing to remain as a Director of the Company, and available to provide the Company with consultancy services as Finance Director.

In October 1973 the Company has accepted with regret the resignation as a director of Edgar Fain. His wise counsel in the Boardroom will be missed.

During 1973 our Company has almost fully completed the first phase of its commercial development: the initial domestication, captive breeding, and marketing of the products of the green sea turtle. We are now standing on the threshold of a second phase, that of the large-scale commercial exploitation of the knowhow and technology developed by our Company over the past five years. The Directors are determined that this phase will be thoroughly planned, carefully executed and that adequate finance will be assured before any firm commitments are made.

The forthcoming year will be another vital year for our Company, in which we must consolidate the progress made during 1973, particularly in the marketing area. Only when we have achieved a well-established profitable base can we go forward in confidence with the major expansion we are now planning. We are confident that with the high calibre of dedicated staff in our Company that these objectives will be achieved.

The Directors

28 February 1974

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P.O. BOX 1095

15th November, 1974

Emily B. Bauser,
P.O. Box 403,
Yucca Valley,
California,
U.S.A. 92284.

Dear Madam,

Your enquiry regarding Mariculture Limited has been turned over to us as Hoblyn (Cayman) Ltd. are closing their office in the next few days.

Unfortunately, the last Annual Report of Mariculture Ltd. is out of print, but we take pleasure in enclosing information on this Company, which we trust you will find of interest.

At the present time Mariculture shares are trading at US$6.25 per share. If you decide to place an order please send a cheque, or bank draft, for the number of shares you wish to buy and advise registration and delivery instructions and we will forward a certificate to you in about three week's time. For example, if you wish to buy 100 shares kindly forward a cheque or bank draft in the amount of US$625.00.

Sincerely yours,

A Geo Colwill

A.GEORGE COLWILL
Resident Manager

Encs.

AGC/dmh

GERMAN FIRM BOOSTS MARICULTURE

A large commitment by a German firm has bolstered the financial outlook at Mariculture, it was learned yesterday.

After several inquiries, Mariculture's Managing Director Mike Goodier finally confirmed that the firm, Lacroix, owned by IT&T, has committed itself to buy all of Mariculture's edible products through 1975. "This could mean over a million dollars to us," said Mr. Goodier. "It is our largest single forward-buying ever and is a tremendous help to the farm. Mariculture is the World's only live green sea turtle farm.

"TREMENDOUS BOOST"

As a result of the failure of Interbank, Mariculture was strained financially. "But this will give us a tremendous boost," said Mr. Goodier in a telephone conversation yesterday, "and with it comes other benefits."

Lacroix is one of Europe's largest canning factories which mainly cans turtle soup. Negotiations are also underway about the future of the non-edible products which will still probably be shipped to New York, Japan, and other places besides Germany.

FINALISED IN TWO WEEKS

The complete deal has not been finalised as yet but "things should be completed in about two weeks," Mr. Goodier noted.

Lacroix has also indicated their desire to purchase stocks available after the end of 1975.

DIRECTOR'S REPORT

Presented At the Annual General Meeting

March 15th. 1974

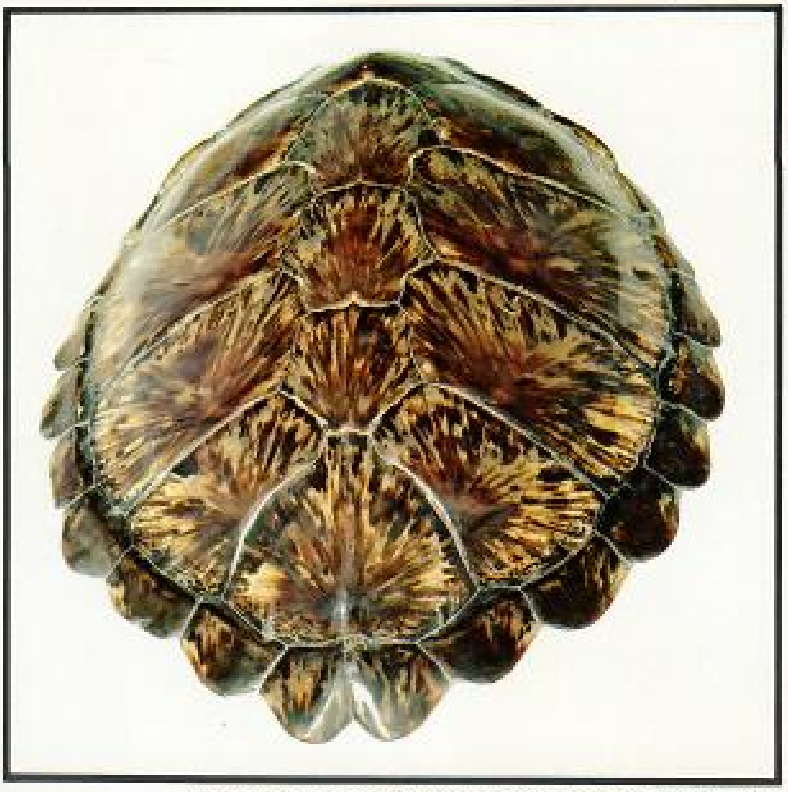
MARICULTURE, Ltd.

P. O. BOX 645, GRAND CAYMAN ISLAND, BRITISH WEST INDIES

(INCORPORATED UNDER THE COMPANIES LAW 1960)

EXCEPTIONAL VIVID COLOURS AND PATTERN RANGE •
ALL SHELLS CLEANED CURED AND HAND POLISHED •
NATURAL FINISH •
NO LACQUER USED •
NO 'AFTER SALE' MAINTENANCE •
COMPLETE WITH HANGING FIXTURE •

IDEAL FOR:
WALL DECOR •
INCORPORATING IN WALL LIGHTS •
FURNITURE SUPPORTS •
USE IN FOOD CONTAINERS •



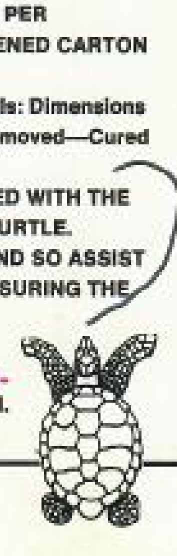
AVERAGE DIMENSIONS: LENGTH 26"; WIDTH 20"; AVERAGE WEIGHT 8½ LBS.

FARMED PRODUCTS FROM

MARICULTURE, LTD.

GREEN SEA TURTLE POLISHED SHELLS

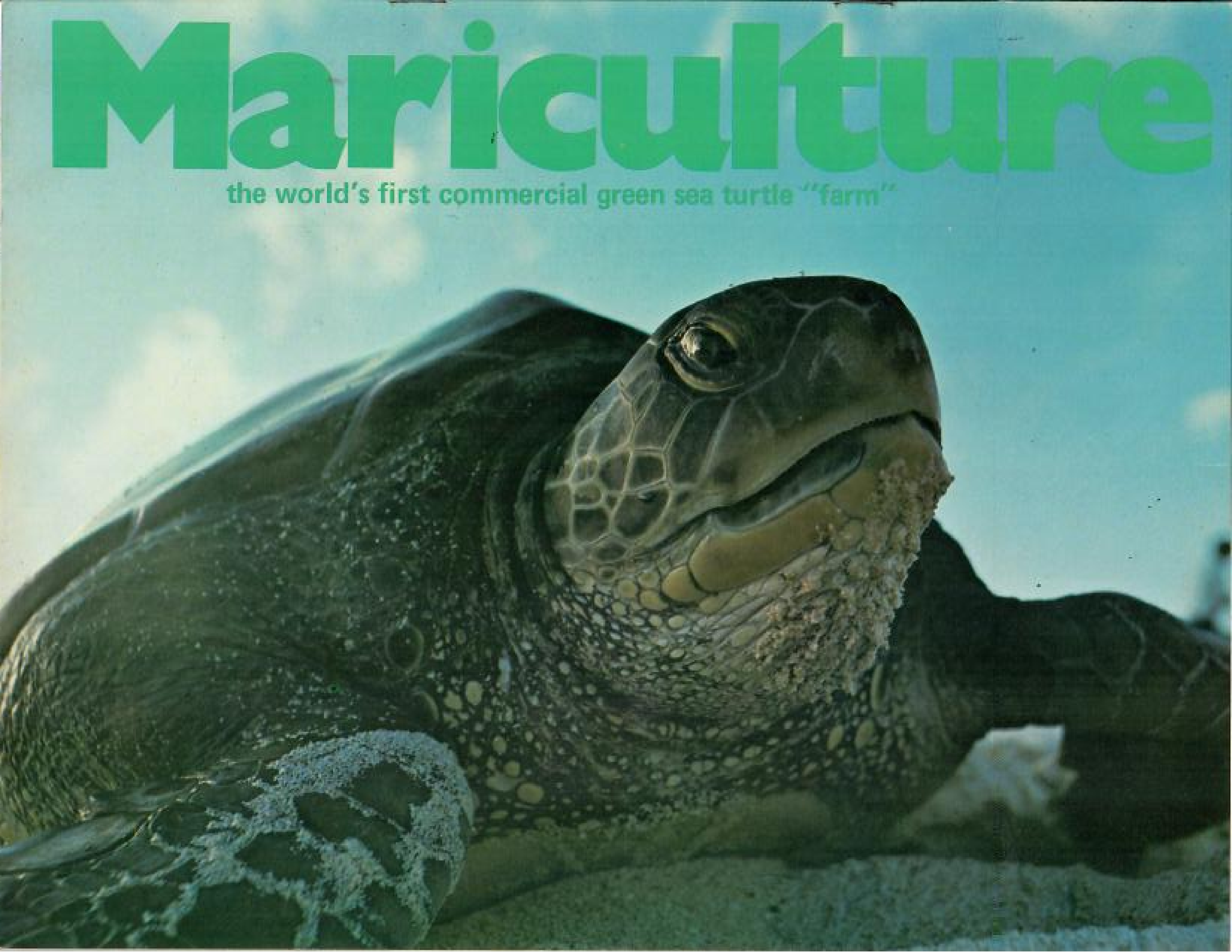
- ALL SHELLS ARE FROM OUR FARMED THREE YEAR OLD GREEN SEA TURTLES (CHELONIA MYDAS)
- FOR EXPORT ALL SHELLS ARE INDIVIDUALLY WRAPPED, PADDED AND PACKED, FIVE PER SPECIALLY DESIGNED AND STRENGTHENED CARTON 30"x23"x12".
- ALSO AVAILABLE: Smaller Polished Shells: Dimensions from 12"x18" and White Shells, Scutes Removed—Cured and Polished — Standard Size.
- MARICULTURE IS ACTIVELY CONCERNED WITH THE CONSERVATION OF THE WILD GREEN TURTLE. PURCHASE OUR FARMED PRODUCTS AND SO ASSIST MARICULTURE'S CONTRIBUTION TO ENSURING THE SURVIVAL OF THE WILD SPECIES.



MARICULTURE, Ltd.
BOX 645, GRAND CAYMAN ISLAND, B.W.I.
TEL: 9-3313

Mariculture

the world's first commercial green sea turtle "farm"



Walk through Mariculture's Turtleland

When you enter the ten-acre headquarters of Mariculture, Ltd., you enter the home of more than 100,000 green sea turtles. Tbis pioneering venture encompasses a complex of huge concrete pens, a man-made breeding pond and nesting beach, nursery pens for hatchlings, processing facilities, laboratories and offices.

To begin your tour of Turtleland, leave the Visitors Reception Center and step across the road to the entrance to the farm proper. Turning to your right just inside the entrance, you walk past a row of huge rows of tanks in which very young hatchlings are cared for. These delightful little creatures range in age from one day to six months. Seeing them, apparently so frail and vulnerable, one wonders that any at all survive in the wild. And, in truth, as we shall learn on later pages, very few do.

At the sea-shore end of these tanks, another left turn brings you alongside the man-made breeding tank and its adjacent nesting beach. Adult green sea turtles swim and mate in this million-gallon pond and the females crawl up onto the beach to dig nests and lay their eggs. In addition to these "home-grown" eggs, each year some 60,000

are subjects of continuing research. Some are helping us determine the best foods and feeding methods, some are helping us learn how to keep turtles in glowing health, and some are simply adding to man's inadequate knowledge of one of nature's most fascinating creatures.

It is worth noting, at this point, that there are some 158 pens and tanks of varying capacities at Turtleland, ranging from 120 gallons to 90,000, not to mention the million-gallon breeding tank. Six new pens of 80,000 gallons' capacity each are under construction. It takes a powerful pumping system and an intricate network of piping to circulate more than 2.6 million gallons of sea water through the pens and tanks every hour.

Finally you come to a showcase of artifacts and handicrafts created from the green sea turtle, and find yourself back at the entrance to Turtleland. You should make your tour of Turtleland as leisurely as you please, because there is endless fascination in watching these creatures. For all their size when grown, they have a certain undeniable beauty (note the shell markings, in particular). And the antics of turtle young are a delight to visitors of all ages.

concrete turtle pens. Each of the eight pens in this sector of Turtleland is capable of housing as many as 2,000 green sea turtles. The turtles you see here range in age from six months to 18 months. Informative signs provide interesting details about the tanks and the turtles in them.

After walking north along this line of pens, you turn left and walk directly west toward the sea. First on your right, you pass the offices—a reminder that Mariculture, Ltd. is a burgeoning commercial enterprise, with careful records maintained on all operations. Statistics on breeding, egg-laying, hatching, survival, growth, production and the value of the products of turtle farming are fed into a computer in London for analysis that will guide ongoing international operations. On your left, at this point, are several long

to 100,000 eggs are collected from various wild nesting beaches and hatched at Turtleland. Mariculture has achieved a hatching rate of over 95% of all the fertile eggs.

Coming to the mid-point of this side of the breeding pond, on your left is an enclosed display. Here you will see fascinating exhibits illustrating the life-cycle and traits of the green sea turtle.

At the south end of the breeding tank, another left turn brings you to two rows of tanks containing a variety of turtle species. The turtles housed in these tanks

Before you leave Turtleland, cross the road again to the Visitors Reception Center where, in the Souvenir Shop, you may choose from an assortment of unique and beautiful artifacts created right here at Turtleland from the highly prized shell of the green sea turtle. Here, too, your questions about the green sea turtle, his care and conservation, and Mariculture's progress in building a sound and useful business on conservation-minded farming of this intriguing creature, will be answered.

We are confident that your visit to Mariculture's Turtleland will long be remembered, and we hope you will keep this souvenir booklet both as a memento and a source of interesting information. Read on and learn more about the green sea turtle, his place in history, his life, his usefulness to man. And read how the green sea turtle's best chance for survival as a wild creature lies in the success of intelligent commercial farming, as practiced by Mariculture.

History: a turtle's eye view

When the earliest ancestors of man—just recently separated off from the evolutionary branch that led to the apes—emerged from their caves to search for food, they met a family of animals which had already been flourishing on the earth for some 30 million years: the turtles.

Students of pre-history tell us that a large number of turtle and tortoise species thrived in the Eocene epoch, about 60 million years ago. And what they call the *Hominidae*, the branch of the animal kingdom which eventually led to johnny-come-lately Homo Sapiens, didn't appear on the scene until the Miocene epoch, a mere 20 to 30 million years ago. Like many reptiles familiar to us, turtles are so well adapted for survival that many species exist in relatively unchanged form after all these millions of years. (It is ironic that man, in the space of a few profligate centuries, almost

While some nations which revered the turtle considered the eating of its flesh taboo, the Roman historian Pliny wrote of a cave-dwelling tribe near the mouth of the Red Sea who were pragmatic enough to relish a dinner of turtle even though they worshipped the turtle as sacred.

Moving closer to the locale of Mariculture's Turtleland, in the 10th Century A.D. we find the Mayas building the "House of Turtles" in their great city Uxmal, in Yucatan. Deftly carved stone turtles decorated the structure's upper cornices. Among these Mayans, the turtle was associated with water, wind and rain, and thus with grain and fertility.

And moving into the almost immediate past (by comparison with the millenia we have just leapfrogged in a few paragraphs), we find early natives of the Caribbean enjoying turtle meat with no religious compunctions at all. The Caribbean certainly provided an abundance of turtle for their feasting. When Christopher Columbus came upon some islands south of today's Cuba, he saw so many turtles on the shore and swimming in the nearby waters that both land and sea appeared to be studded with little rocks. This led him to call the islands Las Tortugas. Today we know them as the Caymans.

turtle's survival as a species could be assured only if the animal were raised commercially for its meat and other valuable by-products.

While this may seem a paradox, the logic—as demonstrated by Mariculture—is convincing. The threat to the green sea turtle lies in uncontrolled hunting of the animal in its wild state. Uncontrolled hunting interferes sharply with the breeding cycle by which the species renews itself. The turtle is hunted, primarily, for food and for its handsome shell. If green sea turtles were "farmed," reasoned the scientists, far more young would survive than do in the natural state where they are subject to predatory animals as well as man the hunter. There would be enough survivors to allow release one to two per cent of the hatchlings—well above the survival rate in nature. The remaining 98% could satisfy the demand for turtle meat, shells and other by-products. And the ready availability of this commercial supply would eliminate the need for (by reducing the profitability of) uncontrolled hunting. This would be especially true since the "farmed" turtle is superior to the wild specimen for both food and shell quality.

The story of how Mariculture, Ltd., came to be formed and how the firm has weathered the first difficult years to develop into a successful enterprise belongs on another page of this booklet. But one last note about history is appropriate here: when you traveled the uncrowded road through a quiet countryside to this relatively remote and placid spot at Goat Rock on unhurried Grand Cayman, you came to a spot where, in all probability, a history lesson that will be studied in the 21st Century is being written today.

Just reflect on a few facts and you'll see achieved what the ravages and extremes of millenia could not achieve—the near-extinction of the green sea turtle!)

Skipping on through the ages, historical research shows turtles coming to occupy an important place in man's world. We find the turtle prized as food and honored in art, mythology and religious ritual from early times. Aborigines of northern Australia honored the turtle as one of their principle totems. Early Hindus pictured the universe resting in a vast milky sea, with an enormous turtle swimming in the sea; standing on the turtle's shell were four giant elephants facing north, east, south and west; and on the elephants' strong backs rested the flattened disc of the earth.

In his book, "The Green Turtle and Man," James J. Parsons noted that some Burmese tribes considered turtles divine and housed them on the sacred grounds of pagodas, feeding specially prepared delicacies to their captive deities.

As the explorers and conquistadores from Europe crowded into the Caribbean, they all came to relish turtle steaks as a welcome variation from the miserable (and scurvy-causing) shipboard diet of those years. "Two of these (turtles), with the eggs, feed ten men for a day," wrote Captain William King of the merchantman Salomon.

And the pirates who swarmed in to prey on the merchantmen and bullion ships sailing the old Spanish Main didn't lag behind in their appreciation of the merits of fresh turtle. "Because of turtles," noted British historian Neville Williams, "pirates dined like lords." Explained an 18th Century gourmet, "The meat was sweet and tender, some part of it eating like chicken, some like veal."

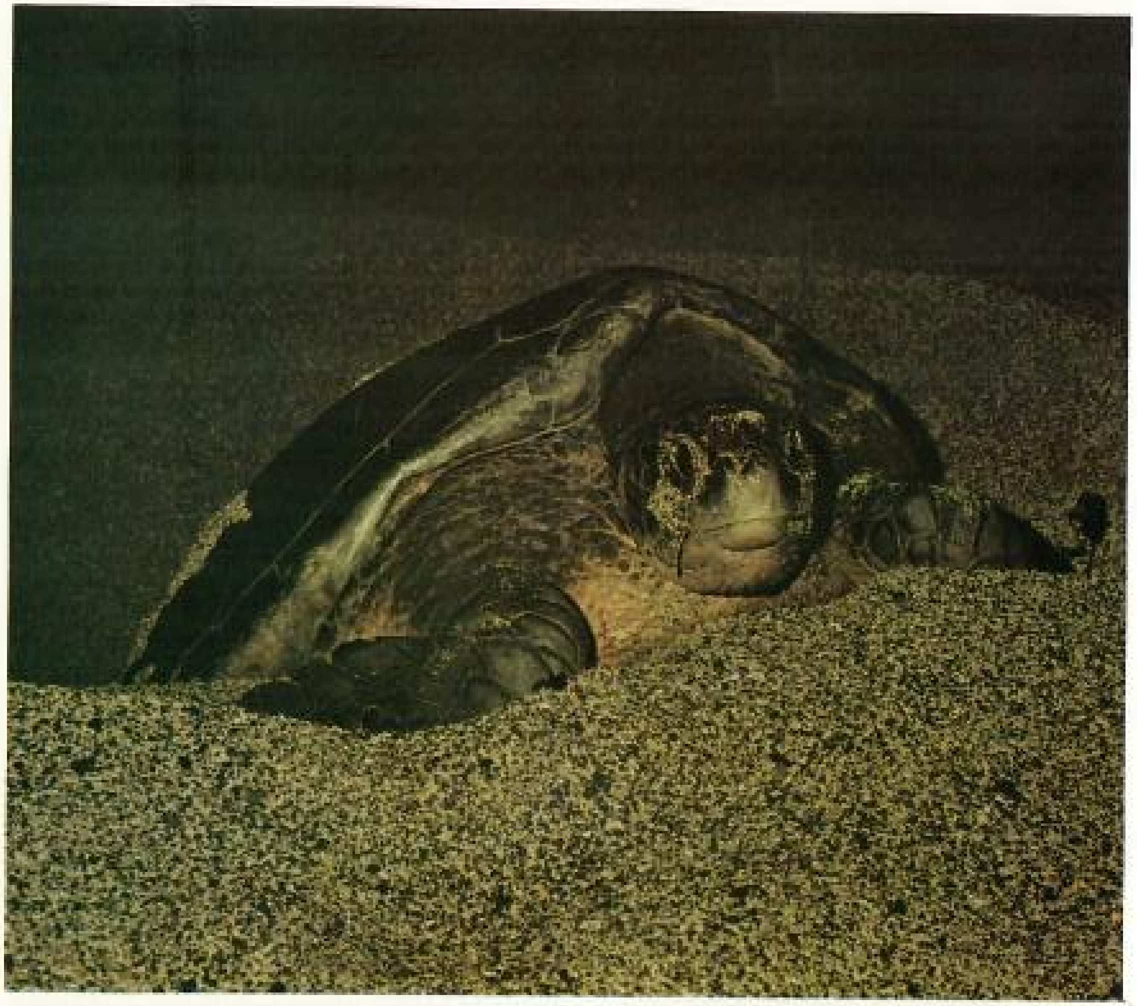
While all this lip-smacking appreciation was highly flattering to the green sea turtle, it was also nearly the cause of the species' becoming extinct. With the buildup of settlement and commerce and a spurt in population on all shores of the Caribbean, the turtle was well on its way to disappearing by the middle of the 20th Century. Turtle colonies vanished from the Caymans, and from parts of the Pacific, too. University of Florida marine biologist Dr. Archie Carr stated that ". . . now many of the beaches which used to swarm with nesting turtles never see one, and the toll of over-exploitation . . . has been reflected in declining harvests of eggs."

As the world moved into the 1960's, a seemingly minor event happened which has since led to a dramatic change for the better in the outlook for the green sea turtle as a species. Two U.S. scientists became interested in the green sea turtle and conducted research studies off the lower Florida Keys. They came to the rather startling conclusion that the green sea

why this is so. The world's population is still increasing at a rate alarmingly faster than the increase in food supplies. One-third of the world's population suffers from malnutrition right now. There is a limit to the land suitable for farming and stock-raising, and a limit to how much the productivity of that land can be increased. Scientists tell us that the world's food supply *must triple by the year 2000!*

More facts: the sea covers 71% of our earth, yet today only two or three per cent of the calories consumed by mankind come from the sea. The best hope for feeding man lies in the sea. But if this hope is to be realized, we must take the same step that early man took when he gave up picking wild berries and relying on hunted game and began farming crops and keeping herds . . . we must take the step that separates haphazard hunting from rational farming. Mariculture is the world's first large-scale commercial enterprise based on farming a migratory sea animal.

In short, you are looking at history in the making. You are looking at the future of man's food supply.



The fascinating life story of Chelonia Mydas

It is night. An expectant hush has settled over the deserted sandy beach. With a gentle whisper, wavelets wash the foreshore. Then a dark hump appears in the shallows. And another, and another, and then scores of them. The humps are the shells of green sea turtles, the species known to science as Chelonia Mydas.

It is a weird scene that every mature female green sea turtle enacts from three to ten times during the breeding season every second or third year. It takes place, today, on the lonely beaches of places like Costa Rica, Surinam, the mid-Atlantic island called Ascension, and other warm-water shores. With each female laying from three hundred to a thousand eggs every two or three years, it would seem that the world should

It is a hazardous journey. Along the way he must run a gauntlet of sea and shore birds and hungry crabs. Once in the sea, he is still not safe. Just off the shallows predatory fish lie in wait. Sharks, in particular, relish the taste of young turtle.

The one hatchling in perhaps several hundred who makes it beyond the ring of predators now embarks upon an adventure which may well be called "the year of mystery," because he quickly disappears completely from the ken of man. In today's world of jet planes, oceanographic research ships and almost-ubiquitous curious scientists, it seems that no species could escape the studious eye, but these tiny hatchlings manage to do just that. Hatchlings in captivity at this stage of life swim steadily for several days and nights, not even stopping to eat. This seems to indicate that the wild hatchlings immediately swim many miles from land. But where? And why? What do they do out there? It is believed that they act like pelagic creatures, seeking the very deep parts of the sea. Yet these are air-breathing reptiles, not fish, and must come to the surface regularly to breathe. Somehow, they do it unseen. And the mystery remains.

It is known, however, that after about a year's growth has brought him to a weight of some five pounds, the turtle begins to change his diet, becoming more of a vegetarian and feeding on marine vegetation variously called "eel grass" and "turtle grass." To get this food, the growing turtle moves back into the shallows, once again becoming visible to man. And it was the presence of huge banks of turtle grass that made the Caymans such a popular gathering place for the green sea turtle set in pre-Columbian times. From a turtle point of view, there must be a lot of

With dogged determination the turtles make their way up the beach. They begin scooping shallow holes in the sand, and when satisfied with the depth of their nests these female turtles lay some 120 eggs each. After covering the eggs with sand, the females drag themselves ponderously back into the sea and swim offshore. There they rejoin the males, who never accompany them onto the nesting beach. And they swim off together, following the mysterious migration patterns that green sea turtles have established through countless aeons, leaving the buried eggs to the vagaries of nature.

soon suffer from a turtle explosion. But nature can be a harsh mother. Actually probably fewer than two hatchlings in a thousand survive the hazards of birth and growing up to return and nest years later on the same rookery beaches where they were born.

About two months after the eggs (looking for all the world like little ping-pong balls) are laid, a crack appears in each shell. This is the infant turtle using his sharp, beak-like "egg tooth" to cut through the leathery-textured shell and win his way to freedom. Even when he has worked himself out of the shell, the young hatchling is not yet ready for the sea. His body must first absorb the large ball of egg yolk that protrudes from his underside, while his soft shell takes its proper shape and hardens. Then, together with his scores of brothers and sisters, he digs his way up through the soft sand to the surface and begins to scuttle across the beach, a marvelous instinct leading him toward the sea which he has never seen before.

nutrition in this sea grass, for the green sea turtle thrives on it and grows to become the largest of the sea turtles, in some cases exceeding a weight of 800 pounds.

It is thought that mature male and female green sea turtles travel the migratory routes of their species together. It is known that they mate in the sea, and then follow the nesting scene which began our brief recounting of the Chelonia Mydas life cycle.

During the less romantic periods of their lives, these turtles may wander across thousands of miles of sea to favored feeding grounds. But somehow they always return to their own original nesting beaches so that the female can fulfill the instinctive compulsion of crawling out of the sea to dig her nest close to where she herself first pecked her way out of an egg years before.

"The most valuable reptile in the world . . ."

The above words were part of a tribute paid to the green sea turtle by Dr. Archie Carr, Technical Director of the Caribbean Conservation Corporation and one of the leading authorities on creatures of the sea. Dr. Carr went on to say that the turtle, ". . . with wise management, could be extremely beneficial to man." This is precisely the premise upon which Mariculture is based.

Not long ago, concepts of "farming the produce of the seas" on a controlled, commercial basis were the stuff of science-fiction. In 1972, Mariculture began very limited sales operations after four years of difficult development and exploratory work. During just a few months of sales in that year, gross receipts totaled CI$48,000. With a full year of more intensive and constantly expanding operation and sales effort, the company is projecting export sales in millions of dollars. This makes turtle products the Cayman Islands' chief export commodity. And proves that sea-farming has enhancement of health and processing for food after the age of three (by which time the turtles weigh approximately 100 to 125 pounds), Mariculture's "farmed" turtles produce meat which is superior to that of "wild" turtles in every respect—flavor, tenderness, texture and color. This in itself indicates one way in which Mariculture's success will help preserve the wild green sea turtle, since the ready availability of the superior "farmed" product will remove the economic incentive for hunting the wild turtle.

Gourmet flavor is not, however, the only advantage that Mariculture's farmed turtle meat offers the diner. By a happy circumstance, turtle steak rates impressively higher with nutritionists and dieticians than beef sirloin or chicken does. Look at this comparison:

	PROTEIN	FAT	CALORIES PER 100 GRAMS
beef sirloin	19.0%	19.0%	247
chicken	21.0%	2.0%	109
MARICULTURE TURTLE STEAK	23.0%	0.2%	102

More protein . . . less fat . . . fewer calories . . . and delicious! No wonder those familiar with turtle steak sometimes sound almost fanatic in their enthusiasm!

While a fair number of people have tried simple fried or grilled turtle steak—with great satisfaction, there are in fact a sumptuous variety of ways in which this taste treat may be prepared. Mariculture has compiled a book of recipes ranging from simple "Turtle Steak Florida Keys" to the more elaborate "Turtle Steak St. Thomas" and "Turtle Roulade." Ask for a copy while you're visiting Mariculture's Turtleland, or send your request to: Mariculture, Ltd., Box 645, Grand Cayman Island, British West Indies.

Another valuable by-product of green sea turtle farming is the leather made from the animal's skin. This is a supple, handsome leather with a small-grained pattern ideal for attractive finishes in such articles as high-quality shoes and handbags. Once again, the "farmed" product from Mariculture is superior to the wild product. The farmed green sea turtle leather has a smaller pattern, is more pliant, and is undamaged by barnacles and sea life. This is another way in which Mariculture's success will eliminate the economic incentive for uncontrolled hunting of the wild turtle, and can help preserve the species.

There are other turtle by-products of great value, too. Each turtle yields about seven pounds of a gelatinous flesh called calipee, which gourmets prize as the base for clear turtle soup. And each turtle yields fat which is rendered to produce a light, golden oil much in demand among cosmetic manufacturers for its ability, properly compounded with other ingredients, to smooth out skin wrinkles and soothe sunburn. Experiments indicate that this oil has many desirable properties, one of which is that it is completely absorbed into the user's skin and leaves no greasy coating or residue.

ceased to be science fiction material and is on its way to becoming a scientific business.

What are these turtle products that the world deems so valuable? In short, what is the green sea turtle good for commercially?

First—as any gourmet will tell you—comes food. The delicious flavor and satisfying heartiness of turtle meat is exactly what made the green sea turtle such a favorite in earlier times—and also exactly what almost led to the extinction of the species before conservation programs like that of Mariculture began to reverse the downtrend.

By a strictly controlled rearing program which includes scientific feeding, maximum

Now that we've whetted your appetite for a turtle dinner, let us move on to consider the green sea turtle shell, which will appeal to your esthetic appetite. Its beautiful colors and exotic patterns delight the eye. Imaginative people have used these shells for wall decor and as part of lighting fixtures, or have devised ingenious ways to blend them in with home furnishings. Mariculture has developed its own tested methods for cleaning, curing and polishing the shells, using no lacquers or other treatment that will require bothersome care later. Segments of polished turtle shell are also used in making unique artifacts, and you can see (and purchase) some splendid examples of this handicraft at Mariculture's Souvenir Shop in the Visitors Reception Center.

This brief summary of the value derived from the green sea turtle and its by-products helps explain the confident outlook prevalent among the directors, management and workers of Mariculture these days. There are some pleased shareholders, too. Mariculture was incorporated and its first stock issued in 1968. By the beginning of 1972, the market price of these shares had risen by 125%, and by mid-March of 1973 shares were being traded at a price 650% above the original issue value. Not only does Mariculture now represent the Caymans' major export business, but the company is already providing jobs for over 100 Islanders.

There is something especially satisfying about it when one can contribute to scientific knowledge of an important species, help preserve that species from extinction, add to the world's food supply, help strengthen the Caymans' economy. . . and at the same time engage in a successful commercial enterprise.

One last glimpse into the future prospects of Mariculture as a business: it has been estimated that an acre of salt water five feet deep can produce 1,688,000 pounds of green turtle per year. The same volume of water would produce only 4,000 pounds of catfish or 600 pounds of milkfish, two other species under serious consideration for sea farming. And for an even more impressive contrast: one acre of *land* produces a mere 800 pounds of beef per year. Little wonder that food scientists, pondering man's future on this crowded globe that is almost three-quarters water, spend a lot of their time looking to the sea.

Studying—and saving—Chelonia Mydas

Mariculture was established to become, and is now operating as, a commercial enterprise, in business to bring its shareholders a reasonable return on their investment. However, the requirements for success in such a pioneering venture include

For many other researchers, the company provides support in the form of supplying fertile eggs, hatchlings and full-grown turtles, and making available the use of its experimental pens and tanks at Turtleland on Grand Cayman. Among the scientists and researchers who have availed themselves of Mariculture's assistance are noted

Another Mariculture research activity is a series of "tagging" expeditions. Turtles in the wild are measured and described, then tagged and released. Scientists will observe the migratory movements of the tagged turtles and tabulate changes in their weight and condition in order to learn more about Chelonia Mydas.

acquiring a great deal of knowledge about the green sea turtle. This quite naturally led Mariculture to make major efforts in research and experimental study, efforts which continue as the company grows.

This, in turn, has led Mariculture into a pattern of close cooperation with and support of scientists and marine biologists pursuing turtle and oceanographic research. The company has retained a number of eminent scientists as full-time and part-time consultants. Mariculture has also engaged a leading virologist from the University of Miami School of Medicine and a distinguished microbiologist from Mt. Sinai Medical Center and Florida International University as consultants in research directed at maintaining and enhancing turtle health.

authorities from many institutions and universities, as well as from such leading firms as Doane's, Ralston Purina and Central Soya Corporation.

One of Mariculture's significant projects looking to the future is sponsorship of a non-profit World Turtle Research & Conservation Foundation, headquartered on Grand Cayman. The company aids the Foundation with funds and practical assistance, as growing commercial success permits. The company also helps the Foundation solicit support from major charities, research foundations and governmental research grant programs.

A by-product of Mariculture's turtle research and rearing programs has been controlled cropping of gorgonian coral from Cayman waters. This sea product is used in production of the recently developed family of "wonder drugs" known as the prostoglandins. The company has achieved some success in the controlled growing of this coral, which should lead to both the further benefit of mankind and another area of profitable sea-farming.

One of the great mysteries of the sea that fascinate scientists is the unerring manner in which, after ranging thousands of miles of ocean to feed, the female green sea turtle invariably returns to the same nesting beach on which she was born before she will lay her own eggs. Zoologist Dr. Carr believes the secret of this fabulous navigational ability may be related to the creature's sense of smell. But it remains a puzzle that men of science ponder.

Since the period from hatching to the first birthday is the most vulnerable time in a turtle's life, which only some .002% are estimated to survive in the wild, Mariculture's contribution to the survival and reestablishment of the species is significant. While Mariculture has developed its own nesting beach to create its own supply of eggs, the company still follows its initial practice of harvesting eggs from the turtle's favorite nesting beaches. And to these beaches the company returns five times the number of turtles which could be expected to survive if left to the hazards of nature. These turtles are returned when a year or more old and better fitted for survival, and they are tagged for scientific research purposes. The company also aids the devèlopment of conservation projects within these nesting areas.


TURTLELAND
MARICULTURE, LTD.
Box 645
Grand Cayman Island
British West Indies
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Telex: CP 257
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Beautiful Jewelry and Objects

This visit to Cayman Turtle Farm
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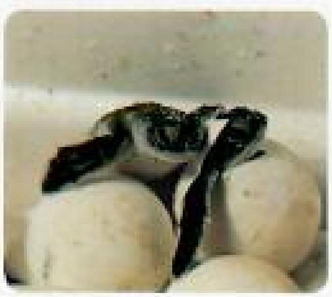
which you may find in many countries round the world.
Our gift shops offer a wide range – come and see.

On Cayman Turtle Farm, thousands of turtles are on view. Tiny hatchlings, weighing a few ounces only, swim briskly around in their baby basins. The growing turtles show the exotic beauty of their shell colours and patterns. The big breeders move slowly and elegantly in the clear waters of their lagoon, where they mate in the season and lay their eggs on the man made beach.
You will be fascinated to see the first successful attempt to farm the green sea turtle and to learn more about this 100 million year old species.


Come to
TURTLELAND:

Over 50,000 Sea Turtles

There's nothing like Turtleland anywhere. And there's no animal like this wonderful and oddly beautiful creature of the sea. Learn about some of the mysteries that still surround the green sea turtle.

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Turtleland

the world's first commercial green sea turtle "farm"

See where the green sea turtle swims, mates and nests —at Turtleland

Come and see these marvellous creatures of the sea.

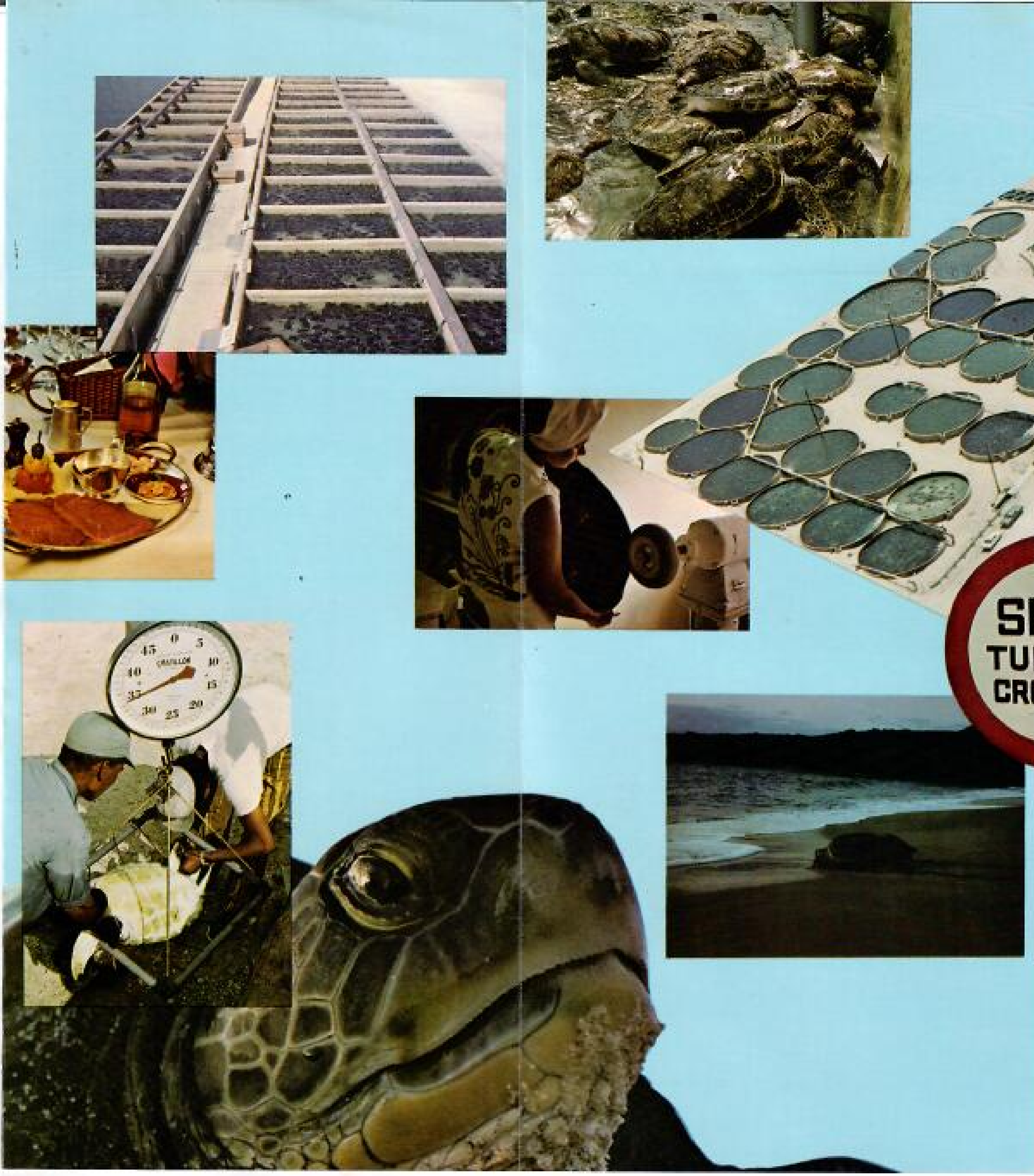
You'll see thousands of turtles weighing from a few ounces to over 600 lbs. in Turtleland's specially designed tanks. During the Breeding Season, you can see mature green turtles swimming and mating in the huge man-made breeding pond.

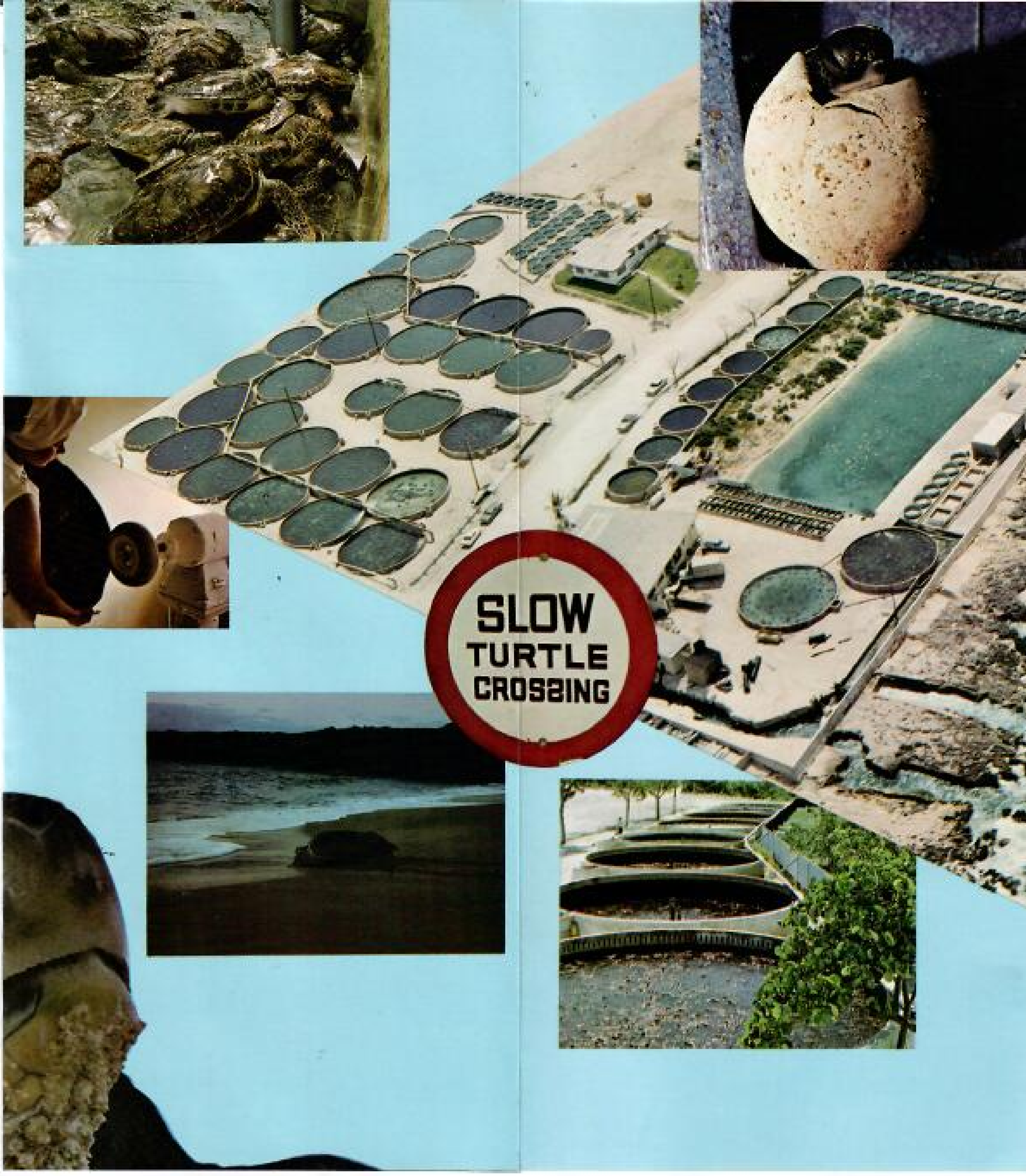
Learn how the workers collect the turtle eggs from the artificial beach and incubate them under controlled conditions.

Learn why delicious turtle steak is nutritionally superior to beef or chicken.

See hundreds of hatchlings, reared in a protected environment, where a significantly higher percentage survive than in the "wild".

A visit to Turtleland is a truly unique experience and you will be fascinated just by watching these magnificent creatures swimming majestically in their seawater tanks.




SLOW
TURTLE
CROSSING

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Turtleland

the world's first commercial green sea turtle "farm"

Beautiful jewelry and artifacts

While man has long prized the natural turtle shell for its beauty, the shells of "farmed" turtles at Turtleland are far superior. We'll show you why. And you'll see how imaginative people use these exotic shells to achieve stunning home decor effects. And you'll covet the enchanting jewelry and artifacts made from turtle shell right here at Turtleland, as well as some of the finest leather goods made with the supple leather from "farmed" green sea turtles.

Cayman Turtle

The 6 well-proven recipes in this folder were selected from the cuisines of those high class hotels and restaurants to which Cayman Turtle Farm have supplied their choice Farmed-Turtle Steak.

CAYMAN TURTLE FARM LTD.
Box 645
British West Indies
Tel: 95133 Telex: CP 257 - Cable: TURTLE

Cayman Turtle

6 Recipes for Farmed Turtle Steak Delicacies

FARMED TURTLE STEAK DE

Turtle Steak Cayman Style

2 lbs. turtle steak
salt and pepper
cooking oil or butter

SAUCE

1 onion, sliced
2 green peppers, diced
4 ozs. mushroom, sliced
flour
1 tbsp. dark rum or sherry
½ pint light chicken stock

Cut the steak across the grain into aprox. ½" thick pieces. Pound softly but firmly until thin, but not too hard to break them. Pan-fry the steaks very slowly in lots of oil under very slow heat. Turtle meat has no fat and will dry out and toughen under extreme heat. Cook until light brown, similar to a Veal Escalop.

To make the sauce, saute the onions, green peppers and mushrooms, stir in flour and mix in the chicken stock. Add a spicy seasoning and then the rum or sherry. Boil for five minutes to thicken. Keep your choice of vegetables crisp and serve on top of the turtle steaks or separate.
Serves four

Turtle Steak Florida Style

2 lbs. turtle steak
salt
black pepper
cooking oil
butter
parsley
lemon

Slice the meat across the grain into approx. ½" thick steaks. Then pound lightly but firmly. Salt and pepper to taste. Flour well on both sides. Pan-fry with a little cooking oil and a touch of butter until brown on both sides. (Do not over fry). Garnish with parsley and wedge of lemon. Serve with choice of potatoes. Serves four.

Turtle Cordon Bleu

1 turtle steak (pound out steak thin with meat tenderizer)
1 slice of smoked ham (average size)
1 slice of Swiss Cheese (average size)
eggs
flour, seasoned
cracker meal (corn meal or Shake & Bake)
margarine
turtle meat gravy

Fold over turtle meat with ham and cheese enclosed. Pound edges of meat together.
Roll Cordon Bleu in seasoned flour, shake off extra flour.
Dip Cordon Bleu in whipped whole eggs. Drain. Then roll Cordon Blue in cracker meal (corn meal or Shake & Bake). Shake off the extra meal.

Cut off uneven edges of breaded Cordon Blue.

Heat skillet, add marganne. Add Cordon Bleu. Brown until well done. Serve with turtle meat gravy which can be made from the scraps of turtle meat cut from the edges of the rolled Turtle Cordon Bleu.

Turtle Schnitzel Viennese Style

4 turtle steaks
1 egg
bread crumbs
salt and pepper
flour
butter
milk
garnish

Pound the steaks softly but firmly until very thin, but not so hard as to beak the steak. Season to taste, flour each piece, dip in egg and milk mixture, then into bread crumbs. Pre-heat frypan, melt butter, add the breaded turtle steaks. Brown on both sides at medium heat. Cook 10-15 minutes. Garnish with lemon and parsley. Add your favourite vegetables. Serves four.

Cayman turtle meat is very lean,
lower in fat and calories
than either chicken or beefsteak,
and higher in protein.

The point to remember with turtle meat
is its very leanness, which means
the tissue should be
broken down or tenderised.

Cayman turtle meat
is put through a
machine tenderising process that
breaks down most of the fibers.

The recipes we suggest
call for thin slices,
cut against the grain and sometimes
a little pounding.

HAPPY COOKING!

Cayman Turtle

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Farmed Turtle Steak.

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Cayman Turtle

Recipes
Recommended for
Farmed Turtle Steak

CAYMAN TURTLE FARM LTD.

TURTLE PARMESAN

4 large turtle steaks cut ½ inch thick and pounded
2 eggs
1/4 teaspoon salt
1/8 teaspoon pepper
1 cup bread crumbs
4 tablespoons grated Parmesan cheese
1/4 teaspoon oregano
1/4 cup olive oil
2 cups tomato sauce
4 slices mozzarella cheese

Beat eggs well. Add salt and pepper to taste. Mix bread crumbs with the grated parmesan cheese and oregano. Dip turtle steaks into the beaten eggs. Then roll in bread crumbs mixture. Fry the dipped and crumbed steaks in olive oil until golden brown on both sides. Remove browned cutlets from pan and place them into a greased baking dish. Pour the tomato sauce over the steaks. Place a thin slice of mozzarella cheese on top of each steak. Bake meat in a 375° oven for 30 minutes. Serves 4.

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TURTLE STEAK ST. THOMAS

2 sticks celery, chopped
1 onion minced
1 tomato minced
3 large mushrooms, chopped
1 clove garlic minced
1 small can tomato puree
2 sprigs parsley
1/2 pint dry white wine
dash brandy
1 tablespoon flour
1 teaspoon salt
pinch sweet basil
pinch thyme
pinch marjoram
2 pounds turtle steak, cut into 1½ in. by ½ in. strips

Put first eight ingredients into a pan and blend well. Mix flour, salt, and herbs; stir into mixture and bring to a boil stirring from time to time. Add turtle strips, blend and transfer all to a casserole. Bake for 1¾ hours in a 350° oven. Before removing from oven, stir in Brandy. Serves 4 – 6.

TURTLE BIRDS

2 pounds turtle steak
salt
pepper
1/2 package stuffing mix made up according to directions on package.
3 tablespoons minced onion
2 tablespoons minced parsley
4 tablespoons butter
1 cup chicken broth
1 cup dry white wine
1/2 pound mushrooms

Pound the turtle steak thinly as possible. Then cut into six pieces. Salt and pepper each piece lightly. Spread the stuffing mixture on the turtle pieces and roll them up. Tie securely with thread or fasten with toothpicks. Melt the butter in a deep skillet; brown the turtle rolls in it. Add the wine, onion, parsley, broth, and mushrooms. Cover and bake at 375° for 45 minutes or until tender. Serves 6.

****

TURTLE RAGOUT "PRINTAINERE"

2 lbs. turtle meat
1 turtle flipper
1 onion
1/2 lb. carrots
1/2 lb. potatoes
1/4 lb. celery
2 tomatoes
salt, pepper, paprika
2 bay leaves
2 ham cloves
thyme
garlic

Dice the turtle meat, onions, carrots, celery and potatoes; season the meat and brown in a skillet with hot butter. (In the meantime you set up your turtle flipper with some hot water and let it boil for stock.) When the meat is properly browned, add the diced onions, carrots, potatoes and tomatoes and brown with the meat. Then add the turtle stock and simmer for 1½ hours. Serve on a bed of noodles.

TURTLE STEAK HOLSTEIN
(Turtle Steak with Fried Eggs)

Combine 1 lb. of freshly ground prime turtle steak with two eggs, salt and pepper. Form into four balls, flatten slightly. Fry in hot butter until lightly browned on the outside, serve with a fried egg on the top and garnish with lettuce and tomato.

****

SAVOURY TURTLE AND ONION STEW

2 large, sliced onions
1 oz. flour
1/2 lb. prime chopped steak
Pickerpepper sauce
1 pint of meat stock
3 bay leaves
5 cloves
1 tbsp. vinegar
salt and pepper
1½ oz. shortening

Brown the onions and flour in the shortening and gradually blend in the stock. Add the bay leaves and cloves and simmer for 7 min. with saucepan lid on. Take the diced turtle steak and vinegar and simmer for a further 30 min. Thicken if desired and garnish with sweet green and red peppers.

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TURTLE STEAK a la LOBSTER POT

1/2 pint Rich brown gravy
3 oz. chopped mushrooms
2 oz. chopped onions
4 prime turtle steaks (6oz.)
1 tsp. pickerpepper
sauce
2 oz. butter
1 sliced sweet pepper
1 tbsp. brandy

Heat the butter in a frying pan and seal the steaks, both sides, for one minute, remove from pan and place to one side. Brown the onions in the pan and add the gravy and other ingredients excepting the brandy. Gently heat for five minutes, return the steaks to the pan, simmer gently for a further five minutes, pour over the brandy and flambe. Serve at once on hot plates wich choice of vegetables.

TURTLE SCALLOPINI (for 2 persons)

1/2 lb. turtle meat
onions
white wine
red and green peppers
garlic
flour

Slice turtle meat very thin. Salt and pepper each slice. Flour, then saute meat in butter with diced red and green peppers, onions and garlic. When ready to serve, add white wine.

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TURTLE SCHNITZEL

1 lb turtle meat
egg
bread crumbs
salt and pepper
flour
garnish

Cut turtle meat against the grain, salt and pepper, beat two eggs; flour each piece of meat, dip in eggs and then bread crumbs. Fry slowly in butter until cooked. Garnish with lemon and anchovies.

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TURTLE STEAK FLORIDA KEYS

Turtle steak
lime juice
garlic powder
beaten egg
seasoned bread crumbs
cooking oil

Slice the turtle into thin slices. Put a layer in a flat pan and pour lime over and sprinkle a little garlic powder on top of the lime juice. Keep adding layers until all turtle is used up. Let marinate 4 to 6 hours. Drain and dip in beaten egg and then into seasoned bread crumbs. Fry in hot cooking oil until just light brown.

BARBEQUED TURTLE STEAK

Pound the desired amount of turtle steak until fairly thin to break the muscle tissue. Sprinkle garlic salt on both sides. Cook over a barbeque grill basting with your favorite sauce until done. (About ½ hour.)

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TURTLE STEAK GRAND CAYMAN

Rub six individual steaks with a damp cloth dipped in vinegar. Dip each steak into seasoned bread crumbs, in beaten egg, and finally in sieved bread crumbs. Heat ¼ cup butter,and stir in one tablespoon finely chopped shallots. Cook the steaks in this to a delicate brown on both sides. Pour over the browned steaks one cup Bordeaux and season with salt, pepper and a dash of nutmeg. Cover the pan and simmer gently for 15 to 20 minutes. Dress steaks and keep in hot platter. Reduce sauce in pan over a hot flame to almost nothing. Stir in ½ cup rich beef stock, ½ cup sherry and one cup thinly sliced mushrooms, which have been cooked in a little butter. Taste for seasoning. Pour a little sauce over each steak and serve the rest in a sauceboat. Garnish with watercress.

TURTLE STEAK WITH SOUR CREAM

2 pounds turtle steak
1 clove garlic
3 anchovies, mashed
1/2 teaspoon thyme
3 tablespoons butter
1 cup dry white wine
1/2 teaspoon pepper
1 tablespoon flour
1/3 cup sherry
1/2 cup sour cream
1 tablespoon capers
1 teaspoon salt

Slice the turtle steaks thin and pound with a meat hammer. Cream together the garlic, anchovies, thyme and one half the butter. Spread over the meat, roll and tie in several places. Place the turtle in a glass or pottery bowl, pour the wine over it, and marinate for 3 hours or more, turning and basting occasionally. Drain and dry the meat, reserving the marinade. Rub the meat with salt and pepper. Heat the remaining butter in a dutch oven; brown the meat in it on all sides. Slip a rack under the meat and add the marinade. Cover and cook over low heat two hours. Transfer the meat to a hot serving platter. Blend the flour with the sherry, and stir into gravy until thickened. Then cook two minutes longer. Blend the sour cream and capers in, taste for seasoning, and heat, but do not boil. Slice the meat, pour some of the gravy over it, and serve the rest separately. Serves 6.

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PAPRICA TURTLE GOULASH

1 lb. turtle meat
garlic
paprika
onions
salt and pepper
flour

Cut the turtle meat, add chopped onions, salt, a little garlic, and pepper. Place everything in a roast pen with butter and roast it for several hours. Add water to keep meat moist; later add white wine to taste.

TURTLE RAGOUTFAIM

1 lb cubed turtle meat
salt and pepper
onions
garlic
dill pickles
flour
vinegar or lime
white wine

Boil cubed turtle in salt and pepper, onions, garlic until tender. Saute in butter with diced onions; thicken with flour and use turtle stock for the sauce. Add dill pickles, vinegar or lime-white wine to sauce. Simmer cubed turtle meat and sauce for about 15 minutes. Serve on a bed of noodles.

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TURTLE ROULADE (Serves 4)

1 lb. turtle meat
4 slices bacon
1 onion
1 spiced pickle
salt, pepper, paprika
butter
1 cup wine
2 cups water

Cut the turtle against the grain in 8 equal slices; pound the meat slightly, then cut the sliced bacon in half and lay ½ slice on each piece of turtle meat. Split the pickle in 8 wedges and put on the upper end of each slice of meat; cut the onion in half and slice, then lay one slice by each piece of pickle. Then roll everything into one tight roll and fasten with a toothpick.

Now you season the roulade with salt, pepper, paprika. Then roll in flour and brown in a skillet with hot butter. In the meantime, chop the remaining half onion and add to the meat. If you wish, you can now add 2 ham cloves and one bay leaf and some thyme. After the meat and the onions are well browned add one cup red wine and 2 cups water. Then cover the skillet and simmer everything for one hour and let the sauce reduce to a thick gravy, Serve hot.

CAYMAN TURTLE STEAK MIRZA

2 lbs. prime turtle meat
1/2 lb. fresh cleaned white grapes
1/2 lb. fresh cleaned red grapes
2 peeled bananas
Butter – 1/2 lb.
Flour – 1/2 cup
Salt
4 halves peaches
4 halves pears

Cut turtle meat into thin escalopes. Season with salt and flour lightly. Melt part of butter in frying pan and saute steaks. In another frying pan melt remaining butter. Add white grapes and red grapes, with bananas cut in half, and saute in frying pan. In a small saucepan warm peaches and pears. When steaks are cooked add bananas and grapes over, and garnish with parsley. Serve on a hot plate. From Holiday Inn of Grand Cayman. Serves 4.

****

TURTLE WITH CREAM SAUCE

4 turtle escalopes
flour
salt pepper
2 oz. butter
4 tbsps water
1 tbsp. capers
1/2 tsp. paprika
1 tsp. made mustard
1/4 pint cream
juice of one lime.

Beat the escalopes of turtle, season and dip each one in the flour, fry the turtle in a pan in the butter until lightly brown, place to the side and keep hot. Chop the capers then pour the water into the pan together with the paprika capers and other seasoning and simmer. When hot remove from the fire and add the cream. Stir in gradually return to the fire and lastly add the lime juice. When hot pour over the turtle, garnish and serve immediately.

TURTLE MARENGO

two pounds of cubed turtle steak
1/4 lb. of button mushrooms
1/4 pint dry white wine
flour, salt and pepper
4 tbsp. of butter
2 sliced onions
1 chopped garlic clove
1/4 pint water
4 oz. tomato paste
Parsley, bouquet garni and fried croutons.

Toss the meat in the seasoned flour, heat the butter in a pan add the turtle and cook to seal the meat. Add the garlic and onions and cook until tender, add one tbsp of flour cook until it browns. Gradually stir in the liquid and bring to the boil. Add the tomato paste seasoning and herbs cover the pan and simmer gently for one hour add the mushrooms and cook for a further ten minutes. Serve in a deep dish cover with the sauce and garnish with chopped parsley and fried croutons.

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TURTLE KEBAB

Marinade small pieces of turtle steak in well seasoned red wine, olive oil and a few sherry peppers, one clove of garlic. Place the turtle on a skewer alternately with slices of blanched onion, green peppers and tomato. Grill for about ten minutes turning to cook all sides, serve flambed with rum on a bed of rice.

SAVOURY TURTLE STUFFED BREADFRUIT

Two cups of ground turtle steak
one firm whole breadfruit
one onion
one tomato
gravy to moisten
seasoning

Peel the breadfruit remove the stalk and core, par-boil in salted water, remove a little more of the fruit from the cavity. Mix together the remaining ingredients to a firm mixture and fill the fruit, brush with a little oil and bake in a preheated oven for about 45 minutes, garnish and serve hot.

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STUFFED SWEET PEPPERS

6-8 large firm green peppers
2 cups of cooked ground turtle steak
1 1/2 cups of fresh bread crumbs
1 small chopped onion
seasoning

Remove the stalk and seeds from each pepper and parboil for two minutes, combine the remaining ingredients and fill the pepper shells. Shake a few breadcrumbs that have been soakedin a little butter on the top of each and bake in a moderate oven for ten to fifteen minutes. Before serving brown tops under the grill. Goes well with rice and a hot tomato gravy.

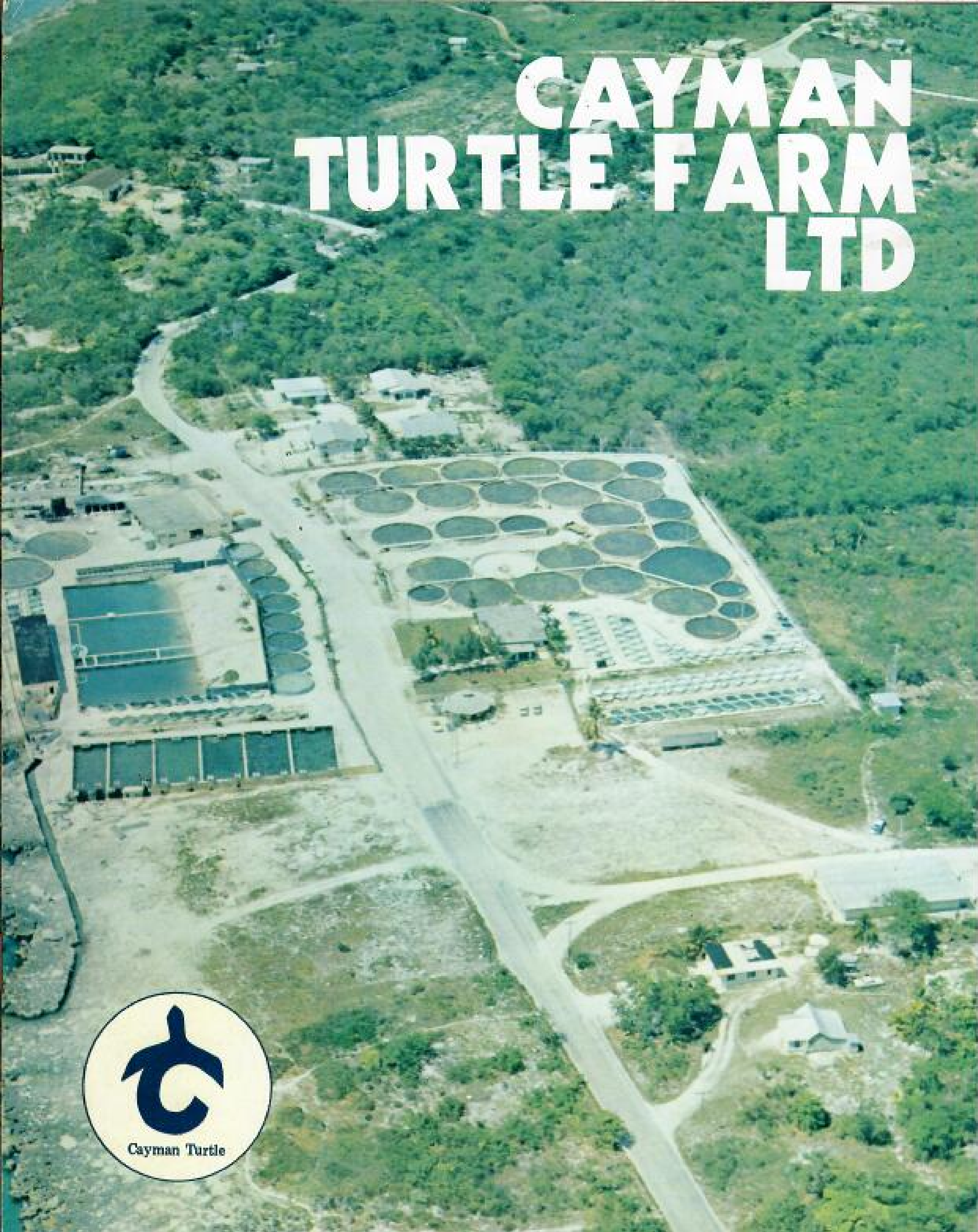
****

TURTLE SOUP WITH MEAT BALLS

two cans of turtle soup
1/4 lb. ground turtle steak
salt, pepper, grated nutmeg
flour
2 oz. fine vermicelli

Season the meat well with salt pepper and nutmeg, shape into balls about the size of marbles and roll them in flour adding them to the previously heated soup, break in the vermicelli cover the pan and simmer for twenty minutes, serve at once.

CAYMAN TURTLE FARM LTD



Cayman Turtle Farm Ltd.

Cayman Turtle Farm Ltd is located on the North West Point of Grand Cayman; the largest of the group of three islands that form the Cayman Islands. This British Crown Colony is situated 500 miles south of Miami and 200 miles northwest of Jamaica.

The Cayman Islands with their crystal clear water and all year round temperature of 75/80 degrees F were an ideal choice for the turtle farming operation. In fact ever since Columbus sighted the islands in the 14th century, their name has been synonymous with that of the sea turtle. Early visitors to these islands found no people but an abundance of green sea turtles to supply them with fresh meat and eggs. The Cayman turtles became a regular source of fresh meat for the Caribbean seamen and in the later years for the early settlers and soup manufacturers of Europe. Of course, inevitably the wild Cayman population of breeding green turtles, once one of the largest in the world, dwindled to almost nothing.

Other advantages of this location include political and economic stability, absence of company taxes and ever improving freight and communication facilities.

Commercial green turtle farming was started in 1968 and within a few months a small prototype farm was established at Salt Creek, Grand Cayman. In 1970 when the turtle population had reached 30,000, it was decided to move the farm to the present site at Goat Rock. Continued expansion has been necessary to accommodate the current farm population of over 70,000 turtles

This main shareholder of Cayman Turtle Farm Ltd is a West German business group. The rest of the shares are held principally by the Commonwealth Development Finance Company of London with a small holding by the Cayman Government.

Cayman Turtle Farm Ltd. is still heavily dependent on research. It is a new and unique operation. There is no text book on turtle farming, so the farm is trying to find all the answers. It is now involved in continued research, which is leading to a more efficient means of turtle husbandry and equally important a fuller understanding of the green turtles' life cycle. Of particular importance is a complete understanding of its reproductive habits. Considerable progress has also already been made in other areas such as nutrition and disease control.

The aim is to become entirely self-sufficient in terms of replacement turtles and, of course, to become an efficient commercial operation. Considerable progress has been made towards establishing self-sufficiency in eggs and further knowledge is now being gathered to achieve this. In conjunction with this the company works closely along the lines set down by the International Union for the Conservation of Nature as applied to turtle farming — our way of fighting illegal slaughter and poaching of wild turtles is to provide an alternative legal source of consistently high quality products.

The owners of Cayman Turtle Farm Ltd., intend to develop green turtle farming based on the concept that the world's food supplies would ultimately have to be supplemented from the sources of the sea. Considering that 70 p.c. of the earth's surface is covered by water, the interest now being shown in aquaculture is surely long overdue.

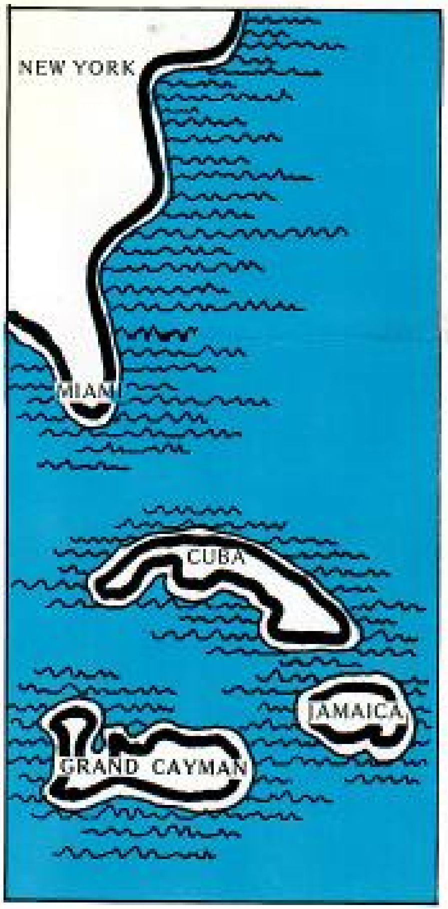
Before the company's marketing policies are discussed, it would be as well to summarise the main aspects of turtle farming management.

As can be seen from the illustrations, the turtles are reared in tanks of varying dimensions. Fresh salt water is continually circulated through all the tanks. The farm now provides a total volume of approximately 2.1 million gallons for the commercial growing stock and 800,000 gallons for the captive breeding area. This necessitates an overall pumping capacity of 3 million gallons per hour.

The policy is to raise the commercial growing stock to an average live wet weight of 100 lb. at which age they are humanely slaughtered in the modern processing plant, the products are then packaged and distributed to markets throughout the world.

Captive Breeding Research

The company is conducting intensive and detailed research into the reproductive physiology and behaviour of the green turtle, and the techniques necessary to manipulate reproduction. Successful control of the reproductive cycle would make



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1. View of breeding stock.
2. Baby turtles.

possible a regular and adequate supply of eggs, thus releasing the company from future dependency on wild nesting stocks. The recent success of the company in captive breeding (over 39,000 eggs were produced in the 1973, 1974 and 1975 breeding seasons by captive adult breeding turtles in the breeding pond) has proved that it is feasible to produce substantial numbers of turtles in captivity. In fact in the 1975 farm breeding season, there was a second major breakthrough when two farm reared turtles mated, the female nested on the beach and subsequently healthy baby turtles were hatched from these eggs. In other words, it has now been clearly shown that turtles reared from birth to maturity in captivity can produce healthy off-spring. The number of farm reared turtles capable of reproduction is now expected to increase rapidly over the next three years.

Reproduction in sea turtles is a fascinating subject.

At Cayman Turtle Farm Ltd. the mating season occurs between April and July and the nesting season between May and September. As in the wild, the females only leave the water at night to lay their eggs. The large females slowly and laboriously make their way up the beach and then begin to scoop a hole with their rear flippers. The soft shelled eggs, up to 230 per nest and up to 1,000 per season, are then deposited in the hole and the nest covered with sand. The exhausted female then slowly returns to the water taking no further interest in the fate of her eggs.

At Cayman Turtle Farm the eggs are immediately removed to the safety of the hatchery where, after 60 days approx, healthy young turtles emerge.

Of course, in the wild the story is even more dramatic and certainly does not have such a happy ending. The eggs deposited on the beach by the wild female are subject to human and animal predators. After hatching, the baby turtles struggle to the beach surface and all together make a frenzied dash for the sea; it is a hazardous journey. Crabs and birds take a heavy toll and once they reach the surf, fishes including sharks, kill the majority of survivors.

Obviously the survival rate is substantially better at Cayman Turtle Farm and, through the ever improving farm management, is increasing every year.

Nutrition

The company, in conjunction with its United States feed suppliers, has developed satisfactory feeds using fish meal and soya bean as a protein base. Nutritional research is now concentrated on the development of the most economic feed formulations. Numerous feeding trials have been and are presently being conducted to test various feed formulations for their potential to produce rapid growth and efficient food conversion ratios. Studies have determined the essential amino acids required by the sea turtle, and are now being continued to determine the optimum level of each in the diet.

Research is in progress for determining the energy available in current rations and for testing the suitability of low protein foods. Reformulations of present feed, using lower cost ingredients, are continually being tested to determine their acceptability, and the physical characteristics of the rations are also being studied to improve retention and prevent wastage. This research provides the company with a better understanding of the basic nutritional requirements of green turtles with a view to more efficient and less costly feed formulations.

Health Research

Health control research for green turtles was, until recently, an unchartered area. Almost nothing was known of the parasitic, bacterial and viral diseases of turtles until the company's research department began their work.

In-depth research continues in the fields of medical treatment, environmental conditions, drugs, the inclusion of preventive medications in feed formulations, etc., and the results of this research are applied in improving the health of the herd.

Conservation

Worldwide conservation legislation is gradually restricting the sale of wild green turtle products, thus saving the wild population from serious and indiscriminate slaughter. In the past the availability of low quality 'wild' products has been erratic, and Cayman Turtle Farm is now regularly supplying these markets with high quality products, thus easing the pressure on the wild green turtle. The company works in close collaboration with the International Union for the Conservation of Nature and adheres as closely as possible to the principles laid down by that organisation as they apply to turtle farming.

Marketing

In many respects the marketing of the products of farmed green turtles is a unique operation. Prior to October 1972 there had been no reliable source of quality turtle products available in the world. The challenge currently facing the company is therefore to provide high quality turtle products based on a reliable source, with the emphasis on continuity of supply. Experience has also shown that the nature of several of the products obtained from farmed turtles is significantly improved from those obtained from wild turtles, so that many of the company's products are effectively new.

Cayman Turtle Farm's concept of commercial turtle farming was mainly based on the view that almost every part of the green turtle's anatomy has commercial value. Also current chronic food shortages would indicate that the world's food supply would ultimately have to be supplemented by resources from the sea.

It has been stated that it is the company's policy to raise the turtles to a weight of 100 lb. approx; this weight is considered the optimum for obtaining highest quality products and a viable feed conversion rate.

Complete specifications of all the farmed green turtle products are included in this brochure as separate sales sheets. The following is a brief description of the items currently being marketed.

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1. Individual mating pens.
2. Turtles mating on farm.
3. Female digging nest on artificial beach
4. Female laying eggs on artificial beach
5. Eggs being collected from female for transfer to hatchery.
6. Female leaving beach after laying her eggs.
7. Baby turtles emerging from eggs in hatchery.
8. Baby turtles being placed in hatchling tanks.
9. Feeding growing stock.
10. Farmed turtle soup, served at the Lobster Pot, Cayman Islands
11. Farmed turtle steak, served at the Lobster Pot, Cayman Islands
12. Finished products manufactured from farmed turtle skins.
13. Farmed turtle soup products.

Food Products

STEAK

This light coloured meat, with complete absence of fat, is similar to veal in texture and flavour. The protein content is higher than that of beef or chicken and the calorie count and fat percentage is significantly lower. The meat can be considered 'versatile' and can be prepared, as with veal, in countless different ways.

Steak is currently being exported to the U.S.A., including Hawaii and Puerto Rico, Japan, the Caribbean, South America and Europe. Of course, the majority of Cayman hotels and restaurants also feature farmed turtle steak on their menu.

SOUP PRODUCTS

These include Calipee/Calipash, Skinned Flipper and Steak Pieces. Calipee/Calipash is the local name given to the gelatinous material found in the back and belly plates of the green turtles. This product is an essential ingredient of traditional clear turtle soup and the majority of manufacturers are located in Europe.

Skinned Flipper is again mainly sold to the soup manufacturers of Europe but also included in traditional turtle stews and chowder which are prepared in most Caribbean countries. Steak Pieces — the offcuts from steak fillets are distributed in the Caribbean, U.S.A. and Europe and used mainly in the manufacture of canned turtle stew, chowder products and in recipes, such as kebabs, fondues, burgers and stroganoff.

BY-PRODUCTS

The company is currently establishing markets for all the by-products, thus reducing the waste to a minimum. A percentage of the by-products such as liver, neckmeat, heart and kidney is supplied for human consumption; whilst other offal products are valuable sources of protein for recycling as animal feeds or petfoods. The possibilities of utilising the bones for a fertiliser additive are also being investigated.

Non-Food Products

LEATHER

This hardwearing product from the green turtle with its varying grain pattern is particularly attractive and is normally sold to reptile tanneries in the U.S.A., Japan or Europe. After processing, it is manufactured into a complete range of leather ware, such as belts, handbags, wallets/billfolds, watch straps, etc.

SHELL

The Shell of the farmed green turtle is truly a beautiful product and far superior in colour and pattern range to that of the wild species. The company's policy is to remove the back/belly shell sections (scutes) from the whole shell and then process them into finished or semi-finished items. Shell beads are now being mass produced and will be exported to many countries; these strings of beads are unique and particularly attractive when other items such as turquoise and silver are added. Polished shell shapes are also being mass produced and will be exported to jewellery manufacturing companies throughout the world. The company now has facilities for mechanically cutting and polishing shapes to any required dimensions. These shapes are eventually included in an attractive range of finished jewellery such as bracelets, earrings, pendants, rings and necklaces. A range of finished jewellery is also manufactured on the farm, mainly for sale in our farm gift shop.

Whole polished shells are also available and are a unique and beautiful item. Each shell is carefully cleaned and polished to a high quality natural finish and of course every one is different.

Raw shell sections, unpolished are also exported to many countries for eventual inclusion in jewellery, laminations, picture frames, etc.

OIL

Green turtles carry a layer of fat under their back shells and when rendered, the oil is used in many cosmetic/pharmaceutical preparations. Turtle oil has unique moisturing qualities and is exported to many countries and utilised in cosmetic products such as sun/ski tan oils, bath oils and gels, shampoos, soaps, conditioning creams, etc.

FREEZE DRIED & TAXIDERMY TURTLES

These are produced strictly only from the farm's natural mortality and are sold mainly through the farm's gift shop.

Finally, whether you are interested in purchasing farmed green turtle products for overseas' markets or just learning more about this fascinating creature of the sea, you will always be welcome at Cayman Turtle Farm Ltd., and a tour of the farm is a unique and worthwhile experience.

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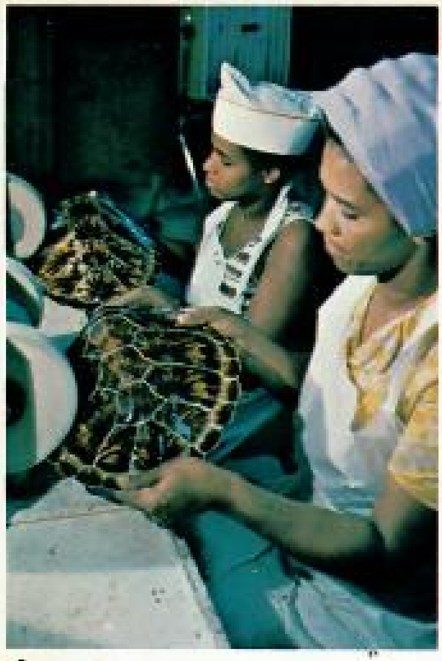

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1. Preparing shell jewellery products.
2. Final polishing of turtle shell shapes.
3. Polishing back shells.
4. Necklace manufactured from turtle shell
5. Finished turtle back shell
6. A selection of farmed shell jewellery
7. Finished products manufactured from farmed turtle oil
8. A selection of Freeze Dried and Taxidermy turtles
9. Farm staff preparing taxidermy turtles
10. Interior of Turtle Farm gift shop.

CAYMAN TURTLE FARM LTD.
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BRITISH WEST INDIES.
TELEPHONE: 93324/93313/93250
CABLES: TURTLE, TELEX: CP 257

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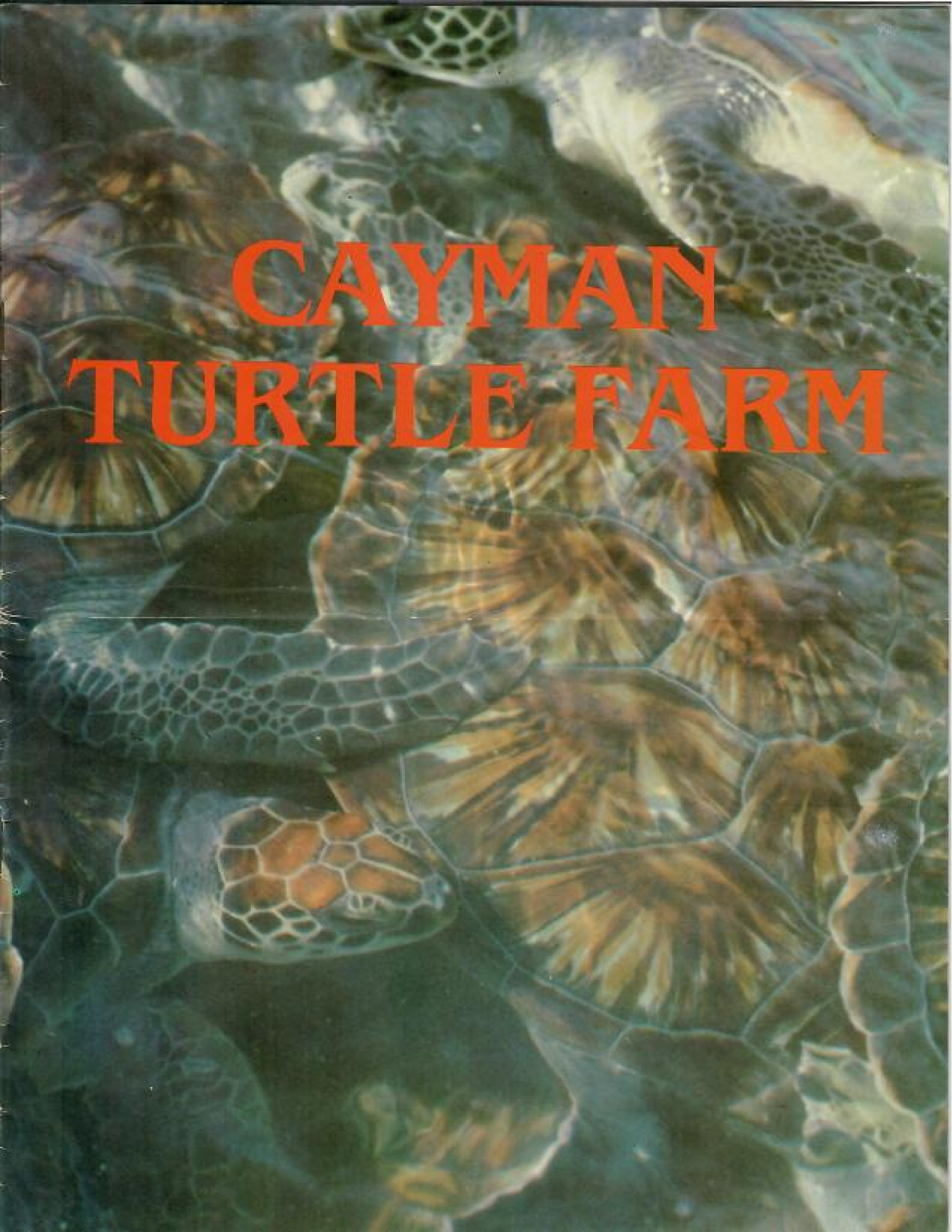
CAYMAN TURTLE FARM



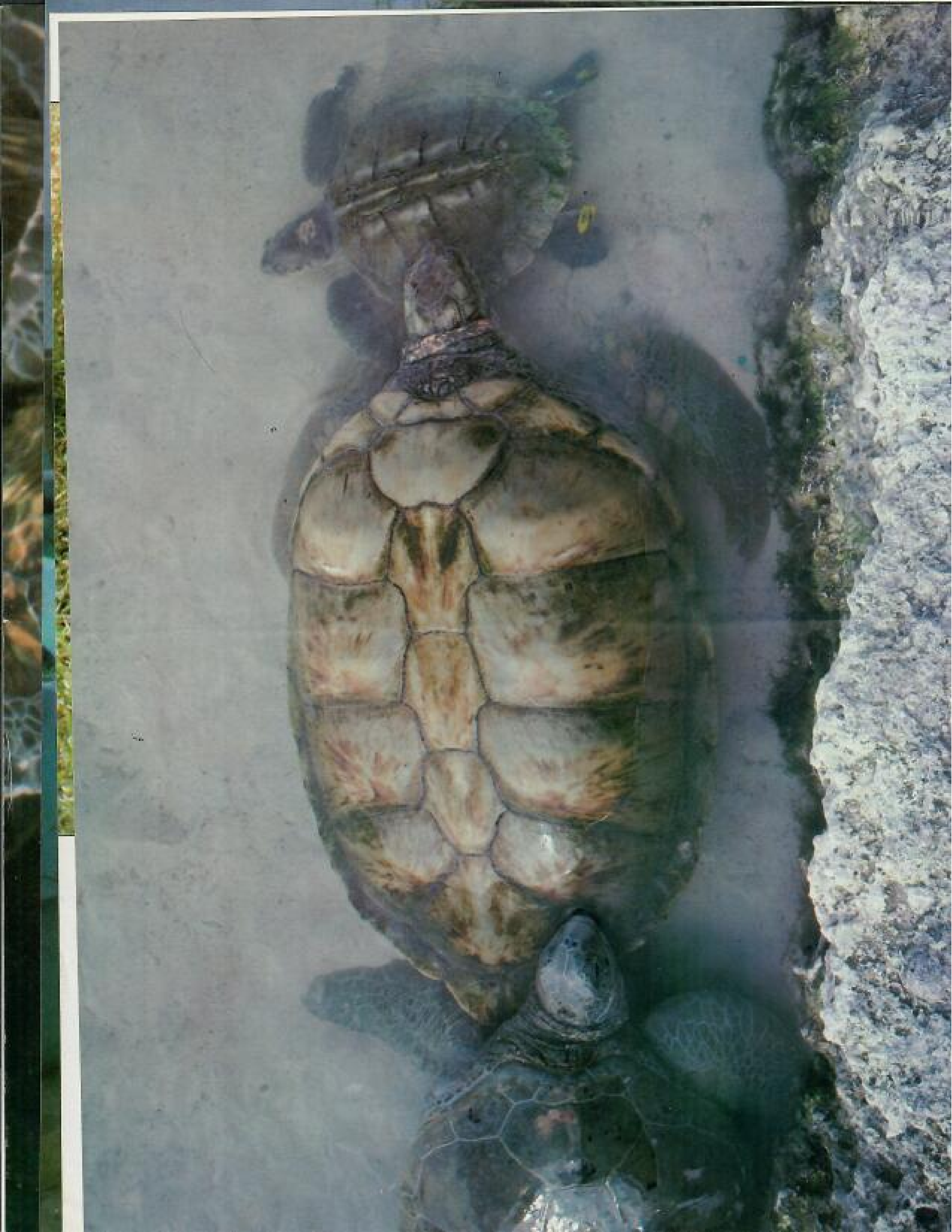
A Visit to Cayman Turtle Farm

As one of Grand Cayman's main tourist attractions, the Farm is visited by over 50,000 people annually. A visit to the Turtle Farm is unique and educational. A display of Caymanian turtling tools of the trade as well as a colorful pictorial review of the sea turtle's natural history and cultural links to man greets the visitor at the beginning of the tour.

Visitors may move leisurely around the tanks observing the turtles from the tiniest hatchlings in shaded tanks to the massive adults swimming in the breeding pond. A selected group of young turtles are set aside so that one can snap a picture of a friend holding one of these animals. An array of signs throughout the Farm provides interesting information about turtle farming. During June through December, eggs and hatchlings, awaiting transfer to the tanks, are on view through the large windows enclosing the hatchery.

The visitor to the Farm may also see loggerheads, hawksbills, and ridleys on exhibit. The Farm's breeding colony of Kemp's ridley are seen in the breeding pond where their smaller size and color distinguishes them from the green sea turtles. The Cayman green parrot *Amazona leukocephala* and ground iguana *Cyclura nubila*, two of the Islands more interesting indigenous species, complete the tour.

The Farm's gift shop carries an assortment of Island and turtle souvenirs. Turtle shell jewelry, leather articles and fine turtle oil cosmetics from the farmed green sea turtle are featured in the gift shop. Polished back shells are displayed along the walls and highlight the remarkable beauty and diversity of the shell patterns.



Farming the Green Sea Turtle

The Cayman Islands, a British Crown Colony, are a group of three small islands located in the Caribbean Sea approximately 480 miles south of Miami, Florida. The Islands are internationally recognized for excellent skindiving and SCUBA diving and as a financial center. The warm water temperatures, and politic and economic stability attracted investors to the Islands in 1968 when Mariculture Ltd. was established. Now operating as Cayman Turtle Farm (1983) Ltd., CTF, commercially raises the green sea turtle *Chelonia mydas*. CTF is unique in its scope, researching and developing commercial captive culture of a historically and biologically intriguing species.

Other than for a few individual turtles raised for private or public display, virtually nothing was known about raising the green sea turtle, especially in intensive culture, when the Farm was started. The green sea turtle adapted well to culture conditions and the technology developed at the Farm is constantly being improved and modified as more is learned about the species through the Farm's research program. The Farm was first situated in Salt Creek, a narrow tidal estuary in the north sound of Grand Cayman. The original concept of the Farm was to release young green sea turtles into the enclosed tidal creek containing beds of turtle grass, *Thallasia sp.* However such a system quickly proved unworkable due to difficulties with herd management and animal loss in storms. Therefore, a floating tank and pier system was constructed within the creek which housed the first substantial stock of turtles. Tidal fluctuations proved insufficient to flush the tanks of waste materials and an extensive pipeline was laid transversing the width of the island, about three fourths of a mile, to provide improved waterflow for the system. During the first couple of years the turtles were maintained on a diet of turtle grass, harvested from North Sound and an assortment of dog food, cat fish food and frozen fish. In 1971 the Farm moved its operation to its present land based tank system on the northwest point of Grand Cayman, which allowed increased herd production, improved water quality, and proper herd management.

From its inception, the Farm has sought to be self-sustaining, independent of wild stocks of eggs or wild breeding turtles. Until 1978, when stock production could be met by the captive breeding herd, the Farm collected eggs from the wild in Surinam, Costa Rica and Ascension Island. All egg collections were made with the co-operation and permission of the appropriate governmental authorities. In Surinam, where the majority of the eggs were collected, eggs purchased were from beaches which would normally be eroded by tidal action, or from nests laid below high tide which would not survive under natural conditions. Adult wild turtles were collected from Surinam, Costa Rica, Ascension Island, Nicaragua, Guyana, and Mexico to form the nucleus of a breeding colony at CTF.

The present breeding herd consists of approximately 180 wild caught turtles, obtained prior to 1977, and 58 farm reared turtles, turtles hatched from eggs incubated on the Farm and raised to maturity on the Farm. In addition an increasing number of potential breeders are selected from turtles hatched from eggs conceived and laid in captivity. These farm bred turtles are technically the first generation farmed animals and their offspring would be second generation farmed animals. The distinction of the Farm's breeding herd into captive wild, farm reared, and farm bred turtles is necessary to evaluate the biological success of the Farm's breeding program. The implications are more fully realised when trade and conservation issues are discussed.

The breeding herd is kept in a million gallon, excavated pond approximately nine feet deep sloping up to a sandy beach, where the females can lay their eggs. Constant flowing sea water results in water turnover approximately every hour. Stocking density varies between 4 - 6.5 yd^2 surface area per turtle. Adult green sea turtles vary in size from 200

to 600 lbs. with an average weight of 300 pounds. The breeding herd is fed twice daily a high protein, pelleted feed obtained from Ralston Purina and aptly named Purina Turtle Chow.

Because of the need to define the green sea turtle's reproductive potential, careful records are maintained on each turtle in the breeding herd. During the winter, each breeder is removed from the pond and tagged on each rear flipper and along the top edges of the back shell with yellow, plastic tags which can be seen by observers during the reproductive season. The breeders are also carefully weighed and measured. The different groups of breeders -- captive wild, farm reared, and farm bred turtles -- are generally kept separated within the pond to facilitate evaluation of the herd's development. During the reproductive season the turtles are observed twenty-four hours a day and data is recorded concerning courtship, mating, and nesting behaviour. All this data is then computerized for analysis.

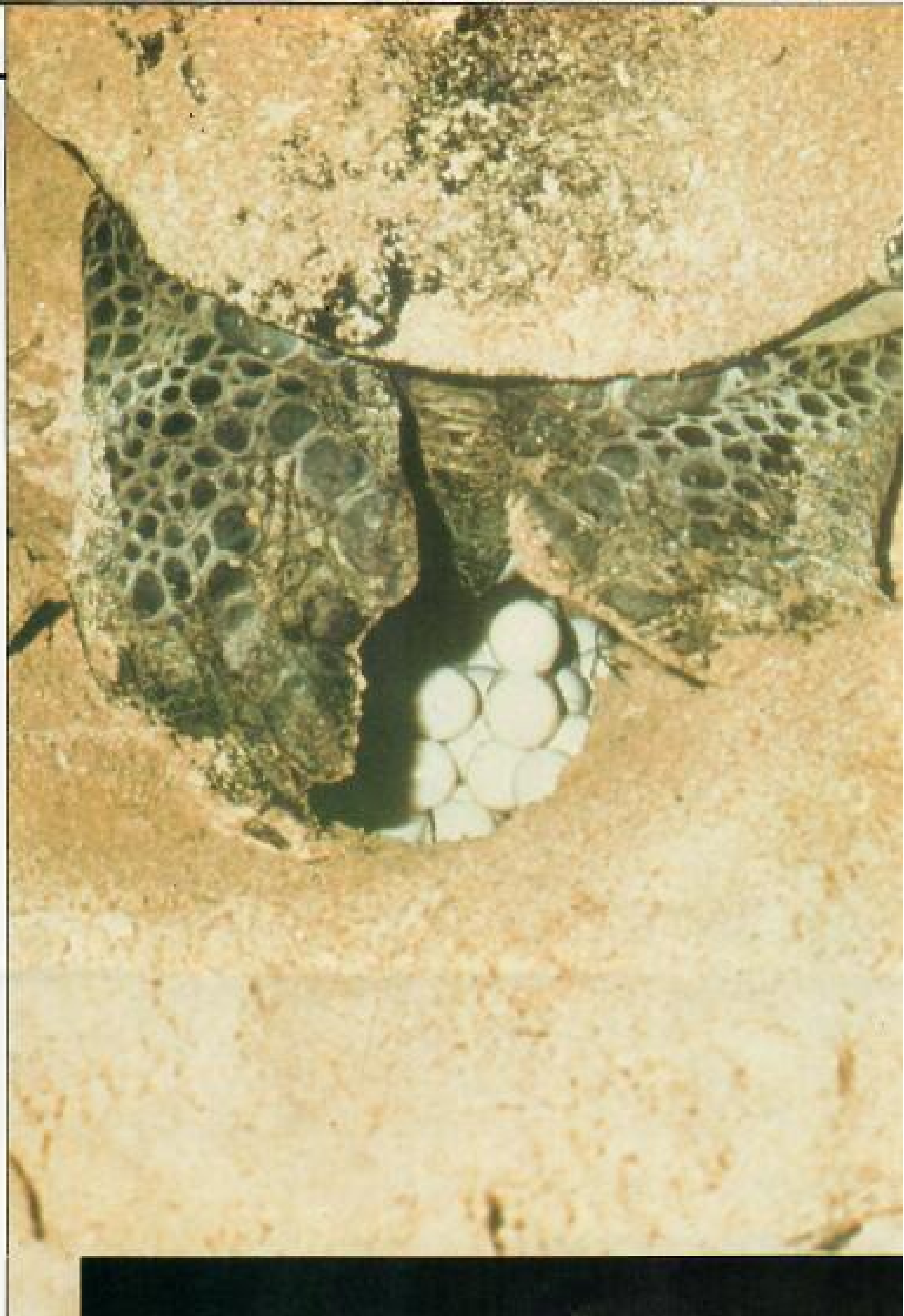
The reproductive season for the Farm's breeding colony begins in April when the males, separated from the females at end of the previous season, are introduced into the female sections of the pond. Mating continues through July and nesting is observed from May through October, with a few nests being laid in subsequent months. The female green sea turtle will accept mating from one or more males, generally during a specific period of four to five days, during the reproductive season. Mating is preceeded by an elaborate courtship period in which the males will follow female, nudging and biting her until sh accepts a male. A female may prev the male from mating her by assumi a vertical position in the water, consta facing the male, floating high in the water, or in desparate situations, seeking refuge in shallow water or on beach.

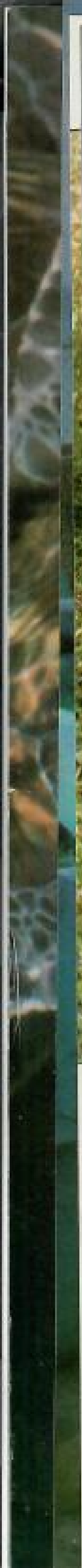
Following mating, the female will generally begin nesting 30 days late The female green sea turtle nests a night and the nesting process, from emergence from the water to her retu may take several hours. The female v laboriously crawl up the beach, snif the sand until she finds a suitable site begin digging. She then excavates a body pit with her fore flippers, throwing sand several yards around her. When her body rests below the level of the beach she then begins to dig an egg chamber by scooping the sand with her rear flippers. The action is synchronized so that one flipper holds and packs the sand of the chamber while the other lifts sand out of the cylindrical hole. The female may abandon one or more nest holes during her time on the beach, partially covering the false nesting site to seemingly confuse any would be predators.

Eventually satisfied with her egg chamber, the female then begins depositing her eggs -- one, two or three at a time -- dropping the mucous-coated soft-shelled eggs into the egg chamber. The number of eggs laid by the green sea turtle is about 100 per nest. Females on the Farm have laid from 1 to 236 in one clutch. The eggs are about the size of a table tennis ball and weigh two ounces each. After ten to twenty minutes the female has generally finished laying her eggs and will then begin to cover her nest, first packing sand over the egg chamber and then filling the body pit, throwing sand over the nesting area as she edges away. She then returns to the water with no longer any concern for her eggs or the resulting hatchlings.

During one reproductive season a female usually lays five to seven clutches, repeating the nesting process at ten day intervals. Farm females have laid from one to ten clutches during a season. The maximum number of eggs laid by any one female during a single season was 1700 eggs. Each female does not necessarily lay every year. Interseasonal nesting intervals of one to six years have been observed at the Farm. The average interseasonal nesting interval is 1.6 years. The estimated average annual egg production per female among the Farm's breeding colony is 400 eggs. Among wild green sea turtle populations egg production is estimated between 100 - 180 eggs per female per year. Wild green sea turtle populations appear to nest less frequently, every 3 to 4 years, and to lay fewer eggs during a reproductive season. Dietary and migratory constraints appear to be the limiting factors between captive and wild breeding capabilities.

Although a nesting female can easily be frightened when she first begins crawling and digging her nest, once she begins to actually lay her eggs, she is single-minded and not easily shaken from her task. This allows observers on the Farm to collect her eggs as she drops





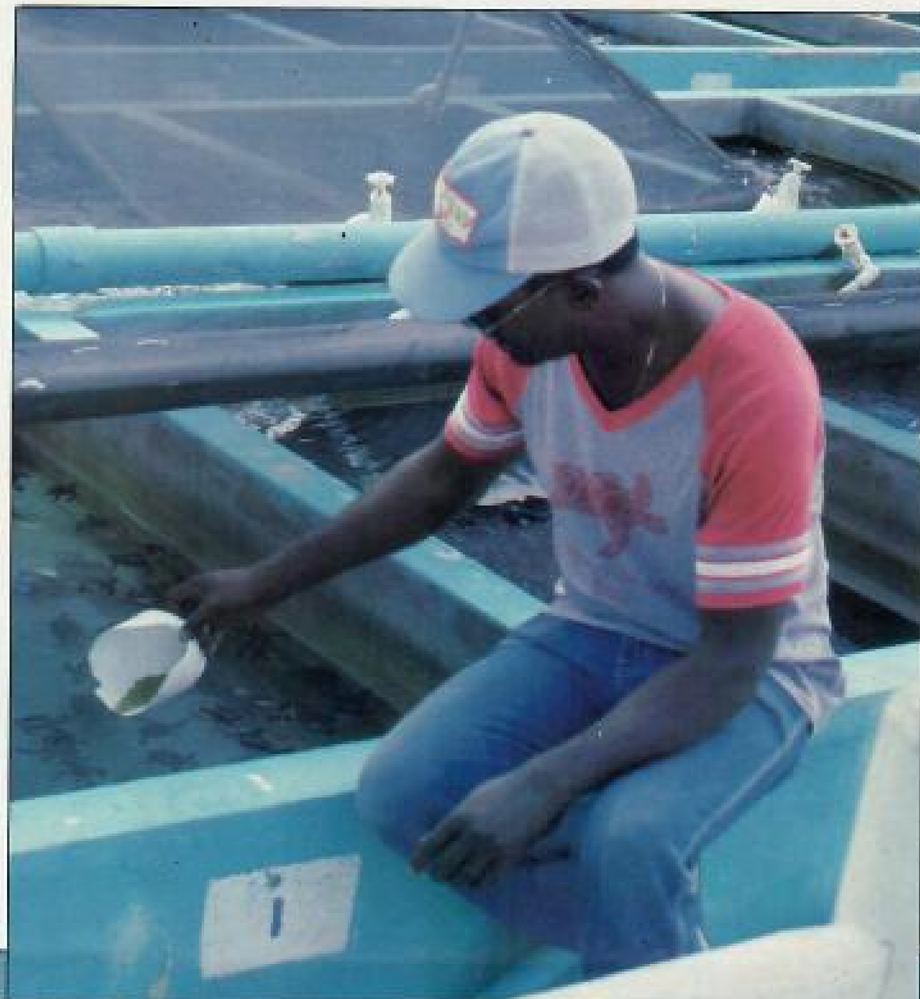
them and then pack the eggs for incubation in a temperature controlled hatchery. The eggs are carefully placed on a layer of sand in a styrofoam box. A rayon cloth then separates the eggs from another layer of sand over the eggs. Sea turtle eggs can be handled and moved without damage until two to three days following nesting at which time movement may damage or kill the developing embryo.

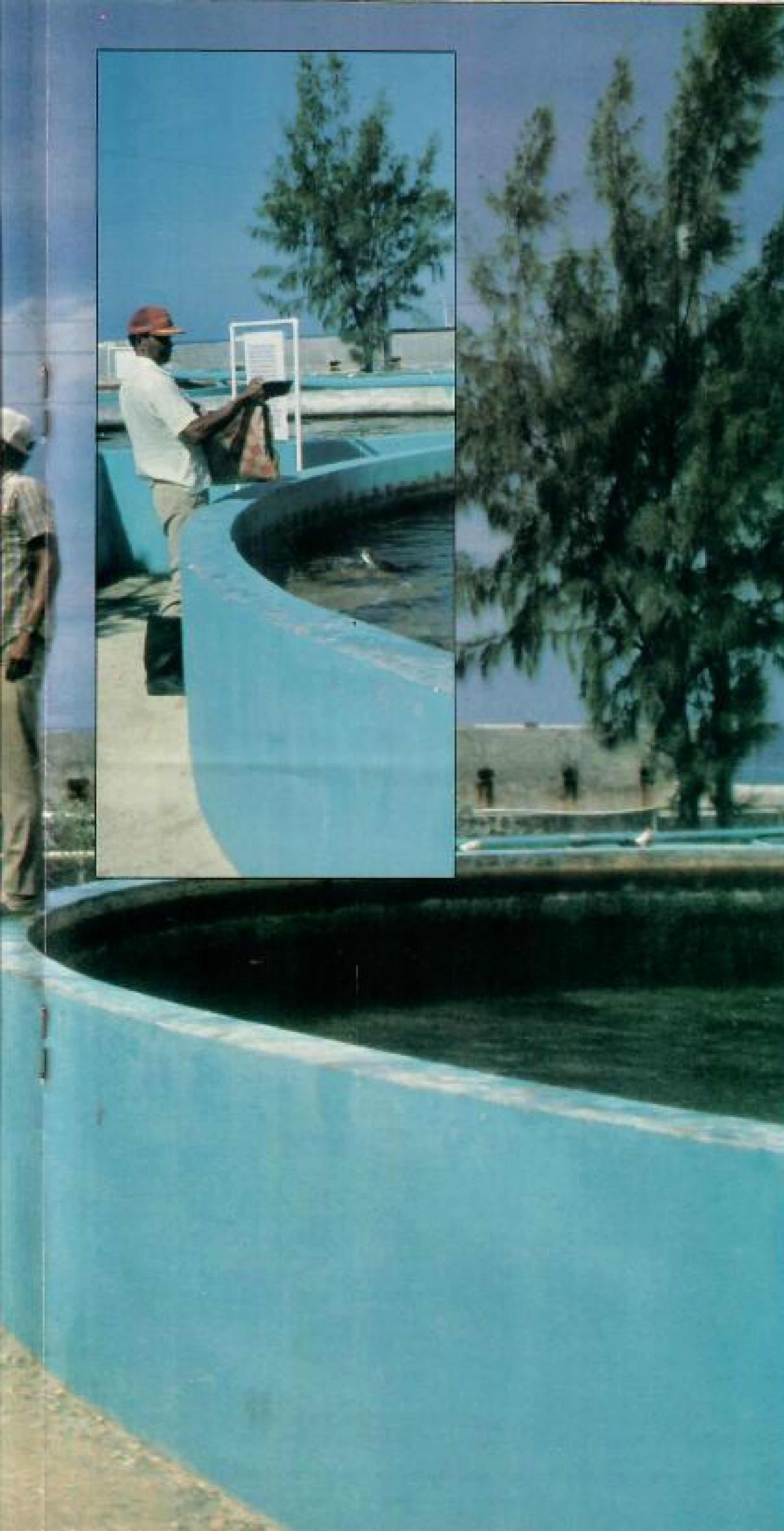
Once the eggs are packed they are placed on racks to remain undistrubed until hatching. Incubation temperatures below 75°F or above 90°F generally result in no hatch success. As the sex of the green sea turtle is dependent upon the incubation temperature, the eggs are incubated at 82°F to produce an equal number of males and females. At cooler temperatures all males are produced and at warmer temperature all females are produced. Hatching occurs after 60 days.

After 55 days of incubation the top layer of sand and rayon cloth is removed from the styrofoam box. As the hatchlings emerge from their eggs they are placed in a tray on a layer of sand for two to thre days before being transferred to water. Under natural conditions hatchlings would emerge from their shells in the nest chamber which is two to three feet below the level of the beach. Upon hatching, the tiny turtles have a reserve food supply, the yolk sac, attached to their bellies which furnishes nournishment until they reach the surface of the beach in two to three days. In the Farm's hatchery, the yolk sac is absorbed during the time they remain in the sand filled trays. When the hatchlings, weighing less than two ounces, are transferred to the hatchling tanks they exhibit the swimming frenzy, which, in the wild, would carry them rapidly down the beach and out to sea. This swimming frenzy continues for a day or two. Seasonal hatching success at the Farm has ranged from 15 to 60%.

Hatchlings are kept in rectangular, concrete tanks containing 150 gallons of sea water chlorinated at 1 to 2 ppm. During their first year of growth they are fed a modified Purina Trout Chow containing 40% crude protein, 8.0% crude fat and less than 5.0% crude fiber. Stocking density varies from 300 to 30 turtles per tank as the turtles grow. A year old turtle weighs about six pounds and has a carapace length of eight to ten inches.

After the turtles reach a year old they are transferred through a series of fiberglass or concrete circular tanks of 775 gallons to 32,000 gallons water capacity. Complete water turnover occurs in most tanks every 20 to 30 minutes. Tank size and stocking density increases as the turtles grow. The turtles are ready for processing at four years of age and weigh about 45 - 70 pounds. The growing stock is fed Purina Turtle Chow containing 35% crude protein, 3.5% crude fat and less than 5.0% crude fiber. The daily ration varies from 2.0% to 0.4% body weight per day depending upon the size of the turtle. Food conversion ranges from 1.2 to 6.5 units of diet fed to unit of weight gain. The turtles are fed by pouring the feed along the edges of the tanks.

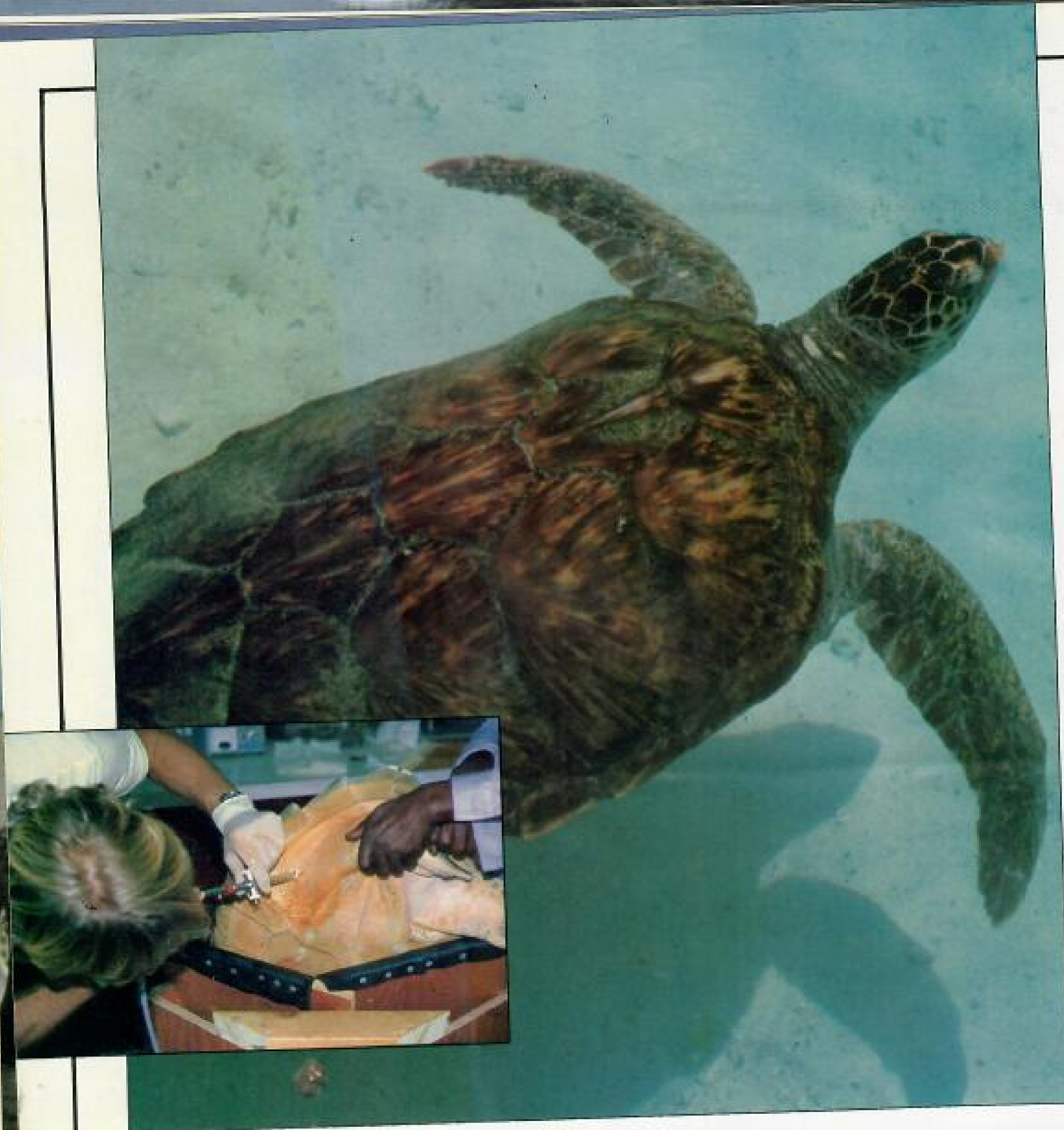




The Farm's stock is periodically weighed to accurately assess its growth and development. The health of the herd is monitoried by carefully checking tanks and removing any ill animals. Mortality is highest among the hatchlings with survivability of 60% of the hatchlings expected at one year. Less than 3% mortality per year is observed among turtles over a year of age. All tanks are routinely drained and cleaned. As in any intensive culture system, disease problems do occasionally occur. Maintenance of adequate food supplies, proper stocking densitites and clean, fresh water serves to effectively control most disease problems. Water temperature also appears to determine the morbidity of some diseases and temperatures greater than 77°F would appear to be the minimum desired for maintaining the health of the herd.

A few turtles from each year's production are selected for potential breeders. The remaining animals are processed in the Farm's abattoir.

The turtles are killed with a captive bolt pistol and then processed. The primary products are meat products, skins, fat (rendered into oil), shell and soup products. Meat products include stew, a mixture of steak pieces, liver and fat which is consumed locally, and turtle steak, a highly valued culinary delight which is distributed both locally, primarily to the restaurant trade, and abroad, depending upon production levels. The shell products are sold as either polished whole backs or as scutes which are converted into jewelry and other decorative items. Secondary processing of the oil and skins into finished consumer products is done abroad in Japan, Mexico and Europe. The soup products include calipee and calipash, a gelatious material obtained from boiling of the plastron and carapace of the turtle. The marketing and distribution of sea turtle products is determined by changing laws and economic conditions affecting utilization of products from endangered or threatened species and is discussed more fully elsewhere.



Research at CTF

The owners and management of CTF have continually supported research at the Farm, on both the development of successful husbandry practices as well as research on the biological processes of the green sea turtle. Every aspect in the care and handling of the turtle had to be developed, or modified from husbandry techniques for other animals.

Reproduction has necessarily been a primary research area. Through successful management of the captive breeding herd, mating and subsequent nesting and hatching of green sea turtles in captivity was first achieved by the Farm in 1973. In 1975, a turtle, reared from egg to sexual maturity, mated and nested on the Farm with a resultant hatch rate of 33%. In addition to the reproductive capabilities discussed previously, research at CTF has defined many reproductive paramaters for turtles in captivity which may be correlated with wild populations. The minimum age of sexual maturity of th captive green sea turtle is 8 years w the average being 12-15 years. Turt continue to grow rapidly until they reac sexual maturity, generally weighing 20 to 400 pounds. Mating preceeds nesti during a reproductive season, fertiliz the eggs laid for that season. The fema normally begins nesting 30 days following mating. A minimum amount mating, more than 100 minutes, is required to insure a hatch success, although hatchability is not linearly correlated to mating time.

Research is being continued into artificial insemination of the sea turtle. Techniques for successful electrojaculation have been developed by researchers at the Farm. Insemination techniques are being developed for more selective breeding studies. In conjunction with these studies gonadal development of the turtles is being safely and continually followed by laparoscopy. The endocrine physiology is being studied with researchers at the University of California at Berkeley and Texas A & M. CTF, in cooperation with the Mexican government, maintains a group of Kemp's ridley, *Lepidochelys kempi*, the most endangered of all sea turtle species. In 1984, the first observed nesting in captivity of this species occurred at CTF. The turtles nested at only five years of age and the production of hatchlings from this captive colony promises continued success for research programs on this species in the United States and Mexico as well as at the Farm.

The Farm also maintains a group of natural hybrids between the green and hawksbill sea turtles. They are characterized by the imbricated carapace, double clawed fore flippers, and elongated snout of the hawksbill turtle. Their size and lower jaw dentation are indicative of the green turtle. Their head scalation and serum protein electrophoretic patterns reflect both hawksbill and green characteristics. Hybridization of sea turtle species offers a unique field of research in sea turtle culture.

Research supported by, and conducted by CTF, has defined the quantitative amino acid requirements of the hatchling green sea turtle. This has aided in formulating a diet that is economical and nutritious for the species. Continued research is being done on the vitamin and energy requirements of the species. Feeding regimes and rations are constantly being checked and modified to achieve maximum productivity and health of the herd.

Control of disease occurring among the Farm's herd is essential. During the Farm's development, several causative agents have been isolated and identified allowing for preventive treatment. Disease research has been done in association with the University of Florida at Gainesville and the University of Miami in Florida, as well as with the cooperation of other leading diagnostic and control institutes in the United States.

CTF continues to encourage scientists from abroad by providing materials and facilities to those working with sea turtles. The Farm has assisted recent studies on turtle egg shell structure, thermoregulation, swimming dynamics and energy demands, social behaviour, genetic diversity among sea turtle populations, biochemical comparison of turtle tissues, population dynamics, and aging studies.

The Release Program and Turtles in the Cayman Islands

Prior to the Farm becoming self-sufficient (totally independent of eggs or breeding adults from natural populations) in 1978, the Farm collected approximately 460,000 eggs. From these eggs, 2,300 year old turtles were returned to the area of their collection for release to the wild. This represented about one half of a percent of the total collections. Estimates for the chance of survival of a turtle in the wild to maturity ranges from one in 100 to one in 1,000 eggs. The early releases made by the Farm of a percentage of eggs collected from the wild were to help negate any possible depletion of wild stocks, although collections were made of eggs from beaches normally eroded before incubation completed or of eggs generally sold locally to generate revenues for a country's conservation program.

As CTF began to produce its stock from its own captive breeding population, releases of Cayman bred stock were made into the waters surrounding the Cayman Islands. This continuing release program is extremely popular among residents and visitors alike.

The people of the Cayman Islands have a history tied to the turtle. In the

1600 and 1700's the Cayman Islands became a provisioning stop for vessels sailing the the Caribbean because of a abundance of green sea turtles which could be caught and kept alive on board as a source of fresh meat. Permanent settlements developed on the Cayman Islands in the seventeenth century and turtling became a means of income as well as providing a local source of food. However, the turtles around the Islands were depleted by the mid nineteenth century and the turtling industry focused around the Misquito Cays off the coast of Nicaragua. The Cayman turtling fleet continued operating at a sustained level until the early 1900s. By this time turtle populations were dwindling and, in subsequent years, national and international regulations and available alternative sources of income reduced the turtling industry to a negligible level. The appearance of the turtle on the Islands' flag, seal, and currency reflects the close association the people have to the turtle.

Since CTF has begun local turtle releases, the sightings of green sea turtles by divers and residents living along the coast have been common. To fully assess the re-establishment of a Cayman turtle population, CTF, with the cooperation of the Cayman Islands government, has initiated both aerial and ground level surveys of the beaches and waters surrounding the Islands. The public has cooperated by providing information on turtle sightings and nestings. Because of observed dog and crab predation and increased public use of all beaches, reported nests are relocated to CTF's hatchery for incubation. All hatchlings are then returned to the collection beach for release.

The Farm's captive breeding colony now produces an average of 45,000 eggs per year. Ten thousand hatchlings are needed each year to satisfy current production goals. Excess hatchlings are designated for tagging and release. Local releases of farm-bred turtles averages about 5.0% of all hatchlings produced by the Farm since 1973, when nesting first occurred. To reap the maximum benefits from these large numbers of released turtles, CTF now tags the turtles with a "living tag". The "living tag" was developed by Professor John Hendrickson and Lupe Hendrickson of the University of Arizona. This tagging method involves the autografting of a small, white dot of belly shell on the turtle's dark colored back. This is done when the turtle is only a few days old. As the animal grows, the dot grows with it. The location of the tag on the turtle's back can specify its age and place of its release. This tagging method is tremendously significant in that it is the only method whereby a tiny sea turtle hatchling may be identified as a 300

pound adult more than 15 years later on a nesting beach. This tagging method may allow scientists to discover whether or not sea turtles actually return to the beach from which they hatch to nest, a hypothesis which has never been proven. CTF has released several thousand hatchlings both a few days old and one year old. Information from these tagged turtles will help to determine the benefits of head-starting, a widely used conservation technique of releasing older turtles in the hopes of better insuring their survival in the wild. Visitors to CTF help in the repopulation of Cayman waters by sponsoring the release of these tagged turtles.

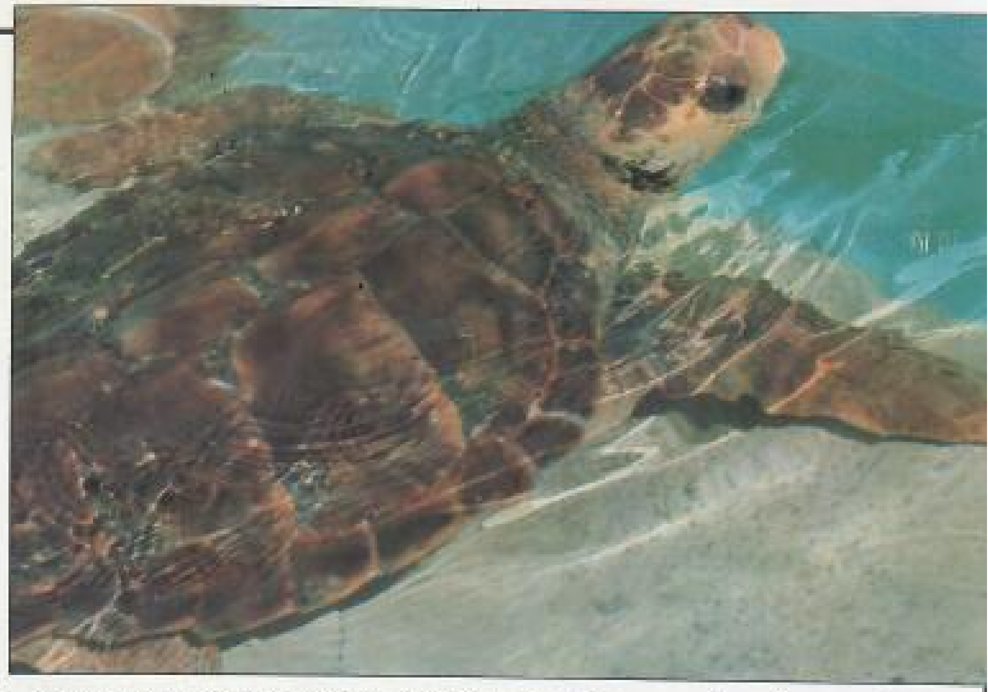
Commerce and Conservation

Sea turtles are characterized by their large size, adults ranging from 40 to 1000 pounds, their largely aquatic existence, except for nesting females, and their specialized limbs designed for swimming. Unlike other turtles, sea turtles are not able to retract their heads and flippers into their protective shell covering. There are seven species of sea turtles. Five of the seven species occur circumglobally in tropical and sub-tropical seas and show little morphological diversity over this extensive distributional range.

The Atlantic or Kemp's ridley, *Lepidochelys kempi* is the smallest of sea turtle species with the adult weighing between 40 - 80 pounds. Its restricted nesting range, along the east coast of Mexico, has contributed to its extreme vulnerably and it is considered the most endangered of all sea turtles species. The Pacific ridley, *Lepidochelys olivacae* weighs between 100 - 120 pounds as an adult. Both *Lepidochelys* species often nest in aggregations known as "arribadas" where large numbers of females, sometimes several thousand, will nest both day and night over a period of two to three days on a single nesting beach.

The two *Chelonia* species, *Chelonia mydas* and *Chelonia depressa* are the only sea turtles which are primarily herbivorous. *Chelonia mydas*, the green sea turtle, weighs between 200 - 600 pounds as an adult and ranges throughout the Atlantic, Pacific and Indian Oceans as well as the Mediterranean Sea and Gulf of Mexico. The smaller flatback turtle, *Chelonia depressa* occurs mainly off the N Coast of Australia.

The hawksbill turtle, *Eretmoc imbricata*, is relatively small, usua weighing around 150 pounds. It i characterized by a narrow, sharp serrated carapace with overlappi scutes and an extended snout. T thick, colorful scutes of the hawk turtle, the traditional "tortoise-she long been prized for decorative purposes.



The loggerhead sea turtle, *Caretta caretta*, is characterized by a relatively large head, from which it gets its common name. The adults weigh between 200 - 350 pounds.

The leatherback sea turtle, *Dermochelys coriacea*, is the largest of all the sea turtles weighing an average of 600 - 800 pounds, but with individuals weighing up to 2000 pounds reported. Unlike the other sea turtles, the leather-like shell of the leatherback is not a solid bony shield. The leatherback lives an open ocean existence, feeds largely on jellyfish, and is often found in cooler waters than other sea turtle species. The leatherback is the sole species in the family Dermochelyidae, while the other sea turtles belong to the family Cheloniidae.

Sea turtles have been harvested in past centuries both for subsistence and to satisfy a large international market. The green sea turtle supplied soup products for the "clear" turtle soup in the European market and meat products for the southeastern U.S.A. The hawksbill turtle supplied the tortoise shell market of Japan. The ridley turtle supplied leather products. Many coastal populations harvested both the turtles and their eggs as a primary source of red meat and protein.

Man's uncontrolled utilization of the sea turtles has attributed to the decline in sea turtle populations over the past two hundred years. In addition, large numbers of sea turtles are killed each year by becoming trapped in shrimp trawls and fish nets and drowning, because they are unable to come to the surface to breathe. For such species as the loggerhead and Kemp's ridley, which are not traditionally commercially utilized, this probably represents the major source of danger to the species. Coastal developments along previously isolated nesting beaches has substantially altered the nesting areas of all sea turtle species. Although the females may still nest along relatively populated beaches, the hatchlings confused by bright lights, are often unable to orient themselves upon hatching and never find their way to the sea. Pollution has taken its toll among sea turtles. The turtles swallow plastic bags and oil soaked food supplies resulting in death. Nesting beaches are also threatened by oil spills.

Although sea turtle populations are still estimated by the tens of thousands, the declining numbers in recent decades has resulted in international awareness of the possible extinction of these species. The International Union for Conservation of Nature and Natural Resources, IUCN, has listed species of sea turtles as endangered, vulnerable, or rare for several years based upon population estimates and casual factors affecting their decline. At present all sea turtles, except *Chelonia depressa*, are listed as endangered, in danger of extinction. Founded in 1948, IUCN represents international conservational interests for both flora and fauna and has focused private and governmental attention on the need to monitor and conserve living resources.

In 1968, when the Farm began operating, the green sea turtle was not protected internationally nor was it listed as endangered by IUCN. The large existing markets for sea turtle products and the apparent logical alternative of supplying these markets with a cultured supply rather than a wild supply of turtle prompted the Farm's formation. Since the Farm was incorporated, U.S. domestic legislation and international regulation has come into affect which has restricted and denied access to large markets, and which has, to an increasingly larger extent, determined the production level of the Farm even as culture techniques were developed and refined.

The United States offered the largest market to the Farm. In 1975 the United States proposed domestic regulations listing the green sea turtle as a threatened species and provided an exemption for the importation of sea turtle products derived from mariculture operations. Stiff opposition to the mariculture exemption came from environmental organizations who generally opposed utilization of wildlife. When the final rules were published in July 1978, all importation of green sea turtles was prohibited with no exception for commercial mariculture operations. A request for reconsideration was made by the Farm, but was denied in December 1978. The Farm then filed suit against the U.S. Department of Interior and Commerce, but lost the case in May 1979 on the basis that while the decision by the U.S. was a subjective one, it was not arbitrary and capricious. From that date the U.S. market was closed to the Farm, and no turtle products could enter the U.S. or pass through any U.S. port or possession enroute to another destination. The U.S. market represented approximately two thirds of the total sales market available and the transshipment restriction through the U.S. (Miami being the major commercial route from the Cayman Islands) greatly impeded the possibility of providing products to other overseas markets such as Europe and Japan.

In January 1982 the Pacific Legal Foundation and the Association for National Environmental Alternatives requested the U.S. to review the ban of commercial trade in green sea turtle products. In October 1982 the Subcommittee on Fisheries and Wildlife Conservation and the Environment of the Committee on Merchant Marine and Fisheries, United States House of Representatives held a hearing on sea turtle farming. This hearing resulted in the Committee recommending that importation of products from Cayman Turtle Farm be allowed.

In 1973 the Convention on International Trade in Endangered Species (CITES) was formed and, in 1975, had been ratified by sufficient countries to go into effect as an international treaty. Animals or plants which it felt needed protection were included on either Appendix I or Appendix II. Appendix I (Endangered) species could not be traded for commercial purposes and shipments from one country to another required an export permit and an import permit. Appendix II (Threatened) species required only an export permit stating that the export was not detrimental to the wild population and such traffic could be for commercial purposes. The Convention specifically stated that Appendix I species bred in captivity would be downlisted to Appendix II and be subject to international trade.

The green sea turtle, *Chelonia mydas,* was not placed on Appendix I until February 1977. Between 1975 and February 1977 products from CTF were accompanied by an export permit. Following listing of *Chelonia mydas* Appendix I, products were certified as being farm bred. This produced some confusion in that while some products were derived from animals conceived at CTF the majority were derived from animals hatched and reared in captivity, but conceived in the wild. While the English version of CITES read bred in captivity, the other languages clearly read raised in captivity. This problem was addressed at the March 1979 meeting of CITES held in Costa Rica. A resolution was passed stating, not only that the animals must be conceived in captivity, but that the breeding herd must be managed in a manner shown capable of reliably producing second generation offspring. Since CTF had hatched eggs obtained from the wild, raised the hatchlings to sexual maturity and had these animals successfully reproduce, the Scientific Authority of the United Kingdom certified that CTF was a farm. However some other countries, including the United States, held that since the animals had been conceived in the wild the offspring were first, not second generation. Therefore, even though all products currently being produced are from animals conceived, hatched and reared in captivity, and no wild eggs have been collected since 1978, several countries will not accept products from CTF.

Universal acceptance of CTF as a farm depends upon proving the ability to achieve the production of a second, complete generation conceived and raised in captivity. Since the first animals conceived in captivity were hatched in 1973 and since 12 - 15 years is the average age of sexual maturity for turtle in captivity, production of second generation offspring is not expected until 1985, although first generation females laid non-hatching eggs in 1983. Second generation offspring will be produced in the next few years, but a further difficulty lies in what is meant by "reliable production" of second generation hatchlings. CITES has not defined "reliable production" and the application of the term may be left to the arbitration of individual countries. A definition requiring second generation offspring to be produced by several different females for a number of years, would be considered by CTF an attempt to unreasonably delay proposed trade in farmed sea turtle products.

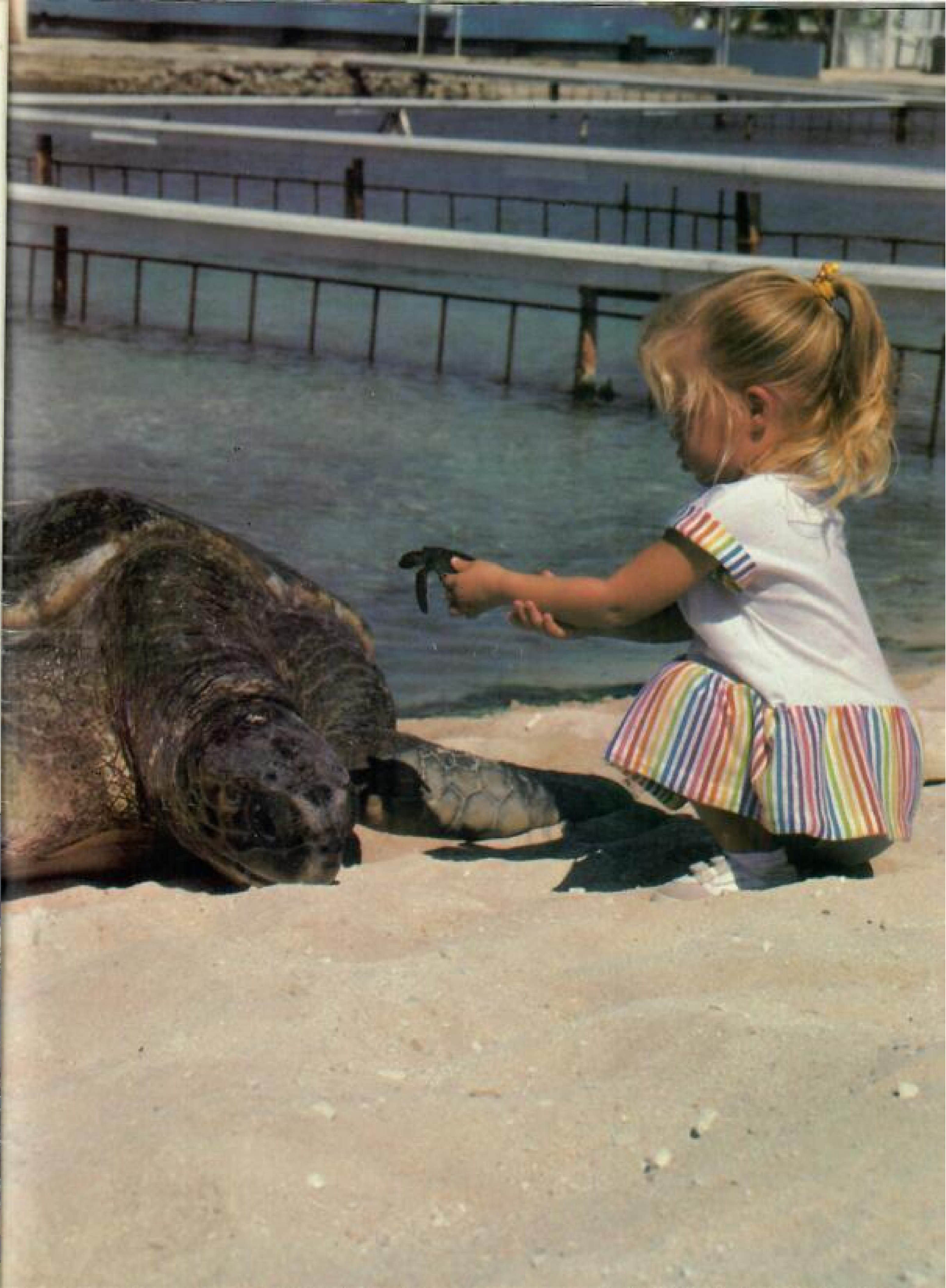
At the 1981 CITES meeting, ranching was accepted as another means whereby an Appendix I species could be downlisted to Appendix II. Ranching required that the local population be sufficiently numerous to sustain the take of eggs or young which would be reared in captive conditions. Some of the reared animals must be released to repopulate the local populations. The remainder would be for trade, once it could be shown that the ranched products could be marked in such a way to allow differentiation between those from the wild population. The main difference between a farm and a ranch is that a farm breeds its own stock and is independent of wild populations, while ranches depend upon the wild population for stock.

In April 1984, the United Kingdom, on behalf of the Cayman islands, submitted a ranching proposal for approval by the CITES countries at the April 1985 meeting. The ranching proposal presents some technical difficulties because no turtles or eggs are being taken from the wild. Surely the Convention must allow for the progressive evolution of a ranch to a farm. To reject CTF's ranching proposal because no animals and egg[s] are being taken from the wild would b[e] illogical when one of the original objec[tions] to the Farm was its dependence on wild stocks.

Sea turtles evoke a considerable emotional response against utilization yet sea turtles, especially the green sea turtle, are very valuable and relatively huge markets continue to exist. The position of CTF is that these markets ar[e] not going to disappear and that the conservation of the sea turtle is best served if market demand is met, even if only partially, by a reliable source of farmed or ranched products. Many modern day conservationists believe th[e] survival prospects of a species are enhanced if the species has commercia[l] value, thereby providing incentive for sustained yield utilization.

A Corporate Synopsis

Cayman Turtle Farm (1983) Ltd. [is] a private, incorporated company of th[e] Cayman Islands and the company's shares are held by the Cayman Islan[ds] Government. The company was incorporated in April 1983 when the Cayman Islands government purchas[ed] the Farm, from its previous owners. T[he] Farm began operation in 1968 as Mariculture, Ltd., and operated as Cayman Turtle Farm., Ltd., between 1976 and 1983.



CAYMAN TURTLE FARM (1983) LTD.

P.O. Box 645, George Town
Grand Cayman, British West Indies

Designed and produced by Graffix Ltd

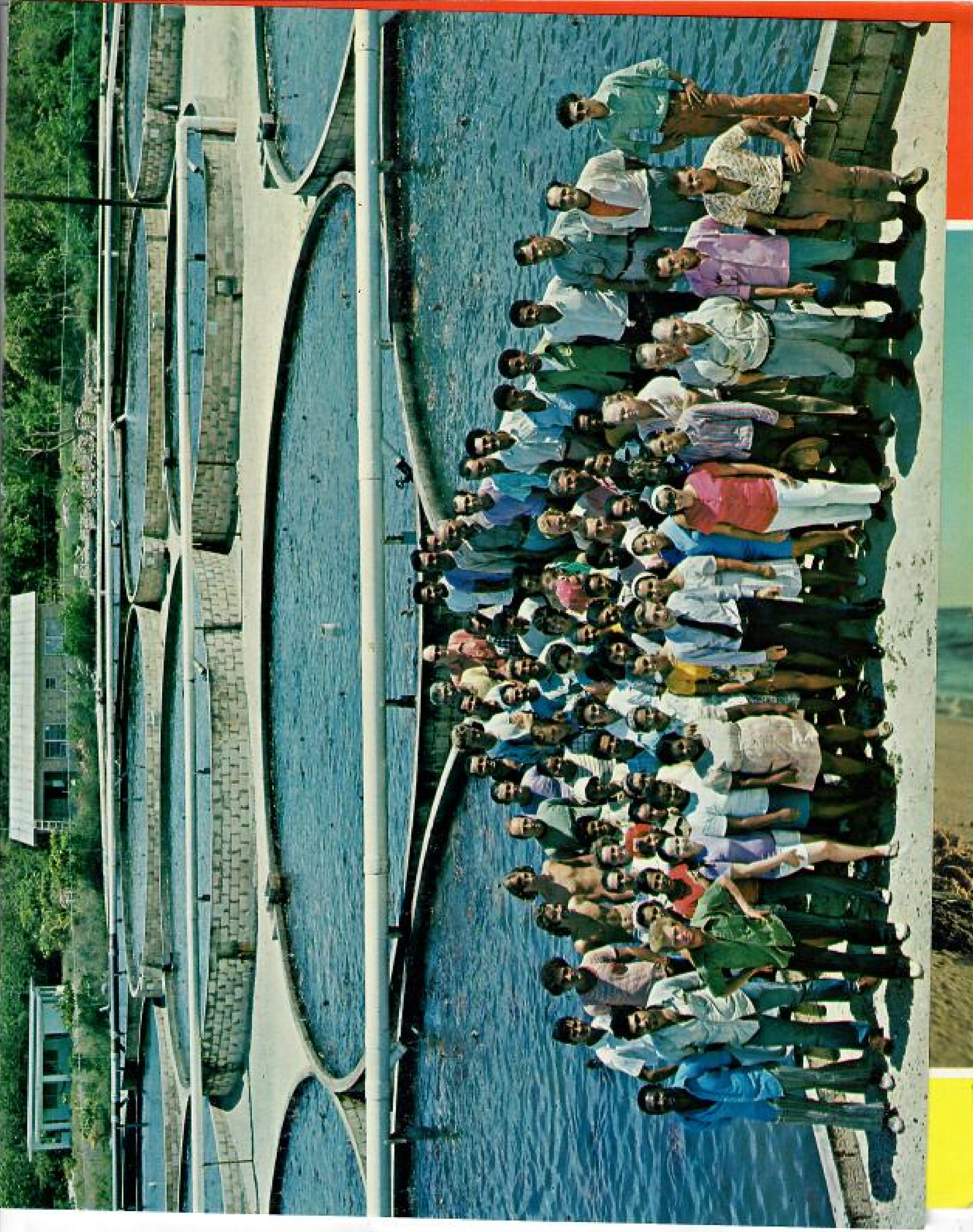
a MARICULTURE, Ltd.
supplement to —

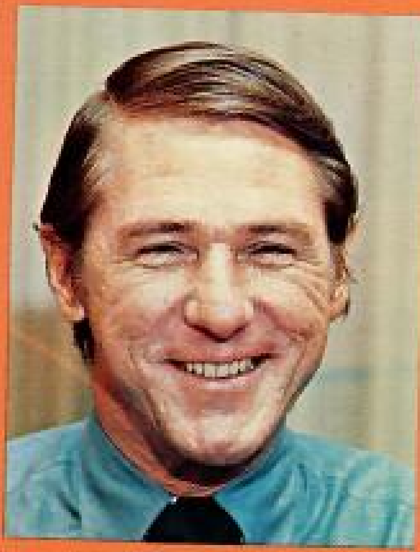
The Cayman Islands

Northwester

OCTOBER, 1973

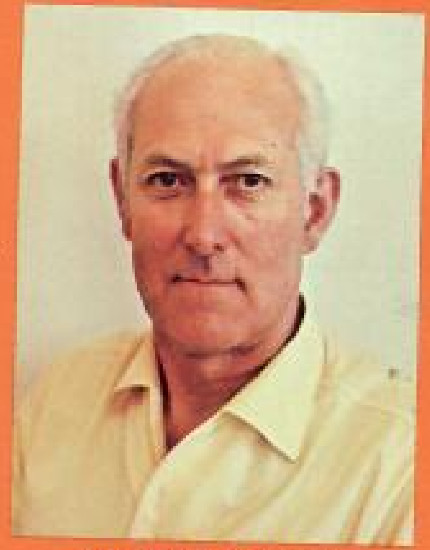

MARICULTURE, Ltd.
P. O. Box 645, GRAND CAYMAN ISLAND, BRITISH WEST INDIES
...saving the Green Turtle





IRVIN S. NAYLOR

HENRY M. HAMLIN



ANTONY G. A. FISHER

MICHAEL R. GOODIER

MARK FISHER

KEITH J. NORMAN

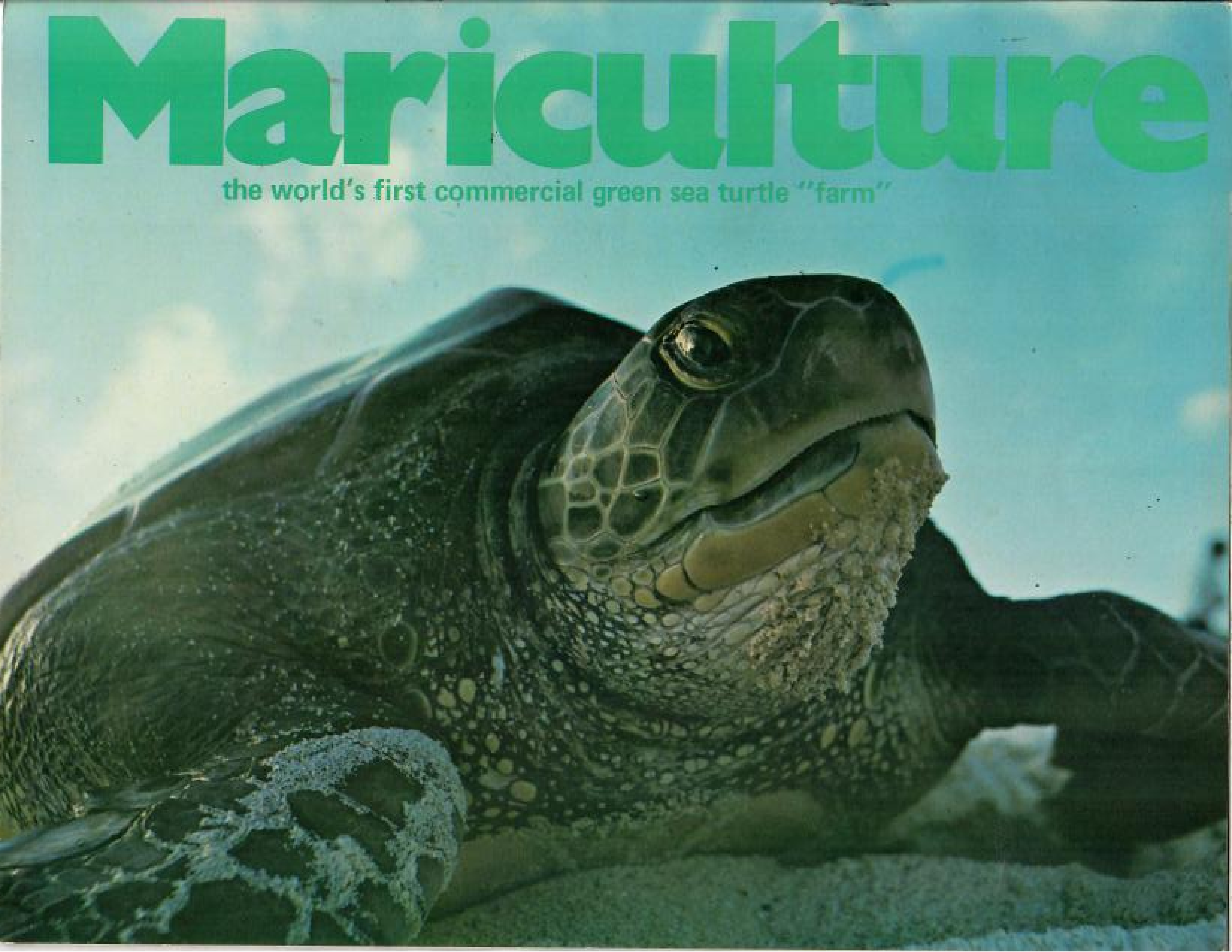
32-year-old businessman also has a growing earth-moving company.

Keith J. Norman, the 46-year-old financial director of Mariculture, has a background in business administration and economics, having taught the subjects at Cornell, Harvard and the Massachusetts Institute of Technology. Educated at Quinton School in England, he served with the Indian Army in the Far East, and later took an engineering degree at King's College, London.

Mr. Norman spent 13 years with the U.K. Atomic Energy Authority, the last five as its commercial director. He went on to serve as regional director for the Commonwealth Development Finance Company, responsible for investments in the Caribbean and Latin America.

Michael R. Goodier, the 35-year-old managing director of Mariculture, joined the company in 1971 after a successful career in engineering and commerce in his native England. Educated at Harris College and Wellington House, he studied mechanical engineering with Leyland Motors, won an award for student apprentices and was connected with original test work on the Lightning fighter and the Canberra bomber. After

ROGER J. WEBSTER


Mariculture
the world's first commercial green sea turtle "farm"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