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The Hawksbill Turtle (Eretmochelys imbricata squamata) in Western Samoa

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Introduction

The present status of the hawksbill turtle in the South Pacific Basin is virtually unknown, although some concern has been expressed by various academic institutions. The Fisheries Division of the Government of Western Samoa initiated a sea turtle research program in February 1971, in an effort to gather information on the life history of the hawksbill while attempting to replenish the turtle stocks of Samoa. Although the information is meagre in certain respects perhaps it will help determine the overall status of the hawksbill in the South Pacific and aid in the apparent struggle against extinction.

The hawksbill turtle has always been an important aspect of Samoan culture and until recently, an important protein source for many coastal villages. Samoan legends contain large numbers of turtle stories, indicating a great abundance of turtles early in the history of Samoa. The hawksbill has litrerally been pushed off it's former nesting grounds. The estimated human population of Western Samoa in 1970 is 160,000, while in 1926 it was 23,000. Excellent nesting beaches were quickly settled by villagers and massive slaughtering greatly reduced the turtle population to a point where turtle meat was considered only as a chiefly food.

A year surveillance of the market place in Apia indicates that a local population of 40-60cm. turtles inhabits the reefs around Samoa. Since there is no serious industry in Samoa for catching free swimming turtles, these turtles were accidently caught while the fishermen were spearing small reef fishes. Larger turtles are too big to tackle into the traditional fishing boats thusly explaining the small size range found in the market. Some nesting females are being taken off the few remaining nesting beaches, but fortunately again, no serious attempts

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have been made to camp on the beaches. Samoa's rapidly expanding human population appears to be the largest single facter leading to the total extinction of the remaining hawksbill stocks. The inaccessability of the nesting beaches is becoming a challenge for the hundreds of young fishermen, outboard motors are beginning to appear on the canoes introducing more people to the nesting areas. Rough weather is the only deterrant which keeps the fishermen off 2 of the 4 nesting beaches, thereby temporarily saving the remnants of the nesting population.

The hawksbill turtles throughout the entire South Pacific Basin are facing the similar fate of extinction, the outer islands of Fiji, Tonga and Samoa are the only sites of hawksbill nesting and this is sporadic. Fiji has passed legislation giving almost complete protection to the remaining turtle stocks, but the lack of law enforcement has rendered the legislation useless. Tonga and Samoa are in the process of passing turtle conservation legislation.

Turtle Measurements

All turtle measurements are stright-line distances in centimeters. Carapace, head and eye widths were taken at the widest respective points while carapace and plastral length measurements were always taken along the center axis of the turtle. Weights were measured in grams.

Hatchery Methods

The most impressive aspect of the Western Samoa Turtle Project is its small size. As opposed to other turtle projects, we were dealing with 4 beaches on 3 small islands (Fig.1) which are not only inaccessable but which support small numbers of nesting turtles. The beaches are: Namua, Nu'utele, and Nu'ulua. Another beach, Vini, was closed to us throughout the survey. The operation was built and maintained by 2 Peace Corps volunteers plus 2 local assistants, with the intention of turning the project over to the locals upon termination of the Peace Corps.

Field work was mostly carried out in a 16 foot fibreglass boat powered by a 20 horsepower outboard motor, a 10 foot inflatable boat with a 6 horsepower motor as a reserve.

An attempt was made to check the beaches every morning. Because all our work was on such inaccessable islands we suffered from problems not ordinarily encoutered by other turtle projects. Bad weather and mechanical difficulties were 2 factors which affected our daily patrol. Large squalls frequently errupted making it difficult to stay on a daily schedule. Even more unpredictable than the weather was the mechanical failures our outboards continually underwent. The lack of spare parts as well as a mechanic often meant the engines were inoperable for long periods of time, halting the collection of eggs.

Nu'utele and Nu'ulua presented problems when the nesting season started and we were faced with the problem of removing turtle eggs off the beach intact. Large swells from the open ocean continually converge upon the beach reefs, thereby making each trip through the surf a dangerous one. Initially we used the inflatable boat to land on the beaches. One accident followed another before the practice was dropped for a safer scheme. The plan adopted next was to moor the boat outside the reef and swim to the beach carrying a watertight container for removing the eggs. The plan worked well except on very rough days and was practiced throughout the nesting season. This unstable situation unfortunately prevented the study of many aspects of hawksbill nesting behavior which require continuous beach surveillance. Almost all of our field work and observations were therefore carried out during the daily beach patrols.

Inspection of all turtle tracks on the beach was first carried out and noted in the field notebook before searching for the nest. To locate a clutch sharp sticks were probed into the sand. A sudden soft spot plus the yoke of a broken egg on the stick indicated a nest. The depths to the top and bottom of the nest were recorded in addition to the position of the nest on the beach. Only fresh eggs were taken from the beaches, the oldest being 2 days old. All older nests were marked for future observations. An attempt was made not to rotate or jar the eggs during the entire collecting and replanting process, replanting the eggs in the hatchery as soon as possible to avoid unnecessary embryonic deaths.

The hatchery is a small section of the beach on the mainland which was fenced off to keep dogs, pigs and people out. The eggs were counted and a sample measured as the eggs were replanted in holes about 50cm. deep and 20cm. wide. A wire mesh enclosure 20cm. high and 50cm. in diameter was then placed over the clutch to catch the emerging hatchlings. This enclosure was marked with the clutch number to avoid possible confusion. To keep down the numbers of ghost crabs (Ocypode sp.), small metal buckets were planted into the sand to act as traps. These traps proved to be effective in thinning the numbers of crabs but never totally eliminating them.

The hatchlings were immediately counted and a sample measured upon emergence, then placed in one of 8, 4x4x1 foot concrete tanks. The time of emergence was recorded. The nest was then excavated the following day to liberate any late arriving hatchlings and record the number of dead embryos plus the number of unfertilized eggs. The turtles were fed after one week in the tanks, the water being changed once during this first week then every day thereafter by a portable Honda gasoline pump. To keep the turtles as 'wild' as possible the time of feeding was always different, and at no time were they watched during feeding. Many different kinds of food were used; chopped fresh fish, fish eggs, fish intestines, razor clams and sea urchins. If many turtles were on hand at any one time they were all fed chopped fresh fish. We did not have the manpower to gather a diversity of food in enough quantity if we had over 1000 turtles on hand. To further fight the conditioning of the turtles to human feeding they were not fed every day, usually 2 days a week were missed. For the first 2 weeks people were allowed to watch the turtles when not feeding, this privilege being removed for the remaining weeks in captivity and the tanks roped off. At irregular intervals the tanks were stirred violently forcing the turtles to swim and dive, and frequently turtle grass (Syringodium isoetilfolium) was added to the tanks.

Since nothing is known of where the turtles spend their first year we notched out the eighth left marginal of 1720 turtles with the hopes that a recaptured turtle would be turned into Fisheries hands. The public relations work being carried out by the Fisheries Division would at least enable a Samoan villager to recognize a marked turtle. The notching seems to be a good short term method for making the turtles. It does not lead to increased predation pressure such as a tag or impair the swimming ability of the turtles. Specimens which were notched as hatchlings still had a perceptable notch at 14 months of age. We notched the turtles one week prior to releasing.

Starting 3 days before releasing the turtles we fed them extra large quantities of food to help them survive until their first pelagic meal. The turtles were counted the day of release and taken out in the boat late in the afternoon. They were taken at least 2 miles outside the reef and released in groups of 3-4 at dusk with 20-30 meters between groups.

The biggest problem in keeping the hatchlings was that of conditioning. These turtles will become conditioned to human feeding in 10 days if extreme precautions are not taken. We discovered that 4 weeks in captivity was the limit even with these precautions, by that time the turtles are strong swimmers and divers and would be able to escape many otherwise potential predators. In the month of captivity the turtles have increased in size 30-40% that of their hatchling size. The gain in weight is 100-120% during this period.

Description of Nesting Beaches

The island of Namu'a is a small chunk of rock 800m. long, 300m. wide and 76m. high. A nesting beach 100m. long is situated on the eastern side of the island. From the low water mark (L.W.M.) to the high water mark (H.W.M.) there is a steep 3m. slope. H.W.M. to the beach vegetation there is an equally steep 4m. slope with another 9m. gently uphill to the jungle. Although the beach face is only a total of 7m., the nesting turtle must exert herself tremendously traversing up the steep slope. The approach to the beach is completely clear of obstacles. A few scattered rocks in the water at the center of the beach should not hinder a nesting turtle or emerging hatchlings. The reef begins immediately in front of the beach and extends sea-ward for 30m. before dropping off into deep water. At low tide a nesting turtle may have trouble crossing the exposed coral heads to the beach. The entire length of the beach has a layer of beach-rock 2m. wide at the L.W.M. This layer of rock is low in profile and is no obstruction for emerging hatchlings, it is often covered with sand and hidden from view. The sand is medium coarse broken shells and coral, extending inland as far as the jungle where it blends into solid dirt and root masses. Most nests were 1-2m. inside the beach vegetation at the north end of the beach.

The largest nesting island is Nu'utele, an oblong island 1450m. long, 850m. wide and 200m. high. There are 2 nesting beaches, Nu'utele and Vini.

Nu'utele beach is located on the eastern side of the island. It is 320m. long and 12m. wide from the L.W.M. to the vegetation. The beach is gently sloping with no obstructions in front except for the exposed reef at low tide. The reef starts directly in front of the beach and extends seaward for 40m. before dropping off into deep water. Where the beach meets the vegetation there is a sharp .5m. incline preventing turtle access to the vegetation. There is no layer of beach rock. The sand is medium coarse broken shells and coral. All nests found on Nu'utele were 1-2m. on the beach side of the vegetation and there was no section of the beach which was preferably nested upon.

Vini beach is located on the northwestern side of Nu'utele. There is a large plantation behind the beach and poor relations with the owner prevented the collecting of turtle information. The beach is potentially the best nesting site in Samoa, it is 600m. long, has no obstructions, an excellent passage through the reef and no beach rock. Unfortunately someone lives there most of the time to collect nesting turtles and eggs.

The nesting beach on Nu'ulua is on the eastern side of the triangular shaped island. The island is 600m. long on each side and 108m. high. The beach is 300m. long with 50m. sections of rock rubble at the northern and southern ends. There is a uniformly steep 6m. slope from the L.W.M. to the vegetation and a level 20m. from the edge of the vegetation to the jungle. The approach to the beach is blocked in sections by large rocks in addition to the shallow 30m. wide reef. The entire length of the beach has a 2-3m. wide layer of beach rock at the L.W.M. which forms a formidable barrier to the nesting turtles, often completely impassable to emerging hatchlings. The sand is coarse broken shells, coral and rock. The beach vegetation is thick but not impassable. All nesting turtles entered to some degree, usually 2-4m. inside from the beach. Most turtles nested on a 20m. section in the middle of the beach.

Nesting Season

The hawksbill population of Western Samoa has a definite nesting season. Adult turtles congregate near the nesting islands early in October and start nesting by mid-month. They continue to nest, with a January February peak, until June. The turtles in the 1970-71 season nested sporadically in the first 2 weeks of June, but in the 1971-72 season the turtles finished nesting in May. Figure 2 shows the number of turtle tracks found on all 4 beaches during the 1971-72 nesting season plus an additional 50% of that sum. This projected number of tracks is a conserative guess of the actual total number of tracks for the 1971-72 season based on the premise that many tracks were missed during the survey. We did not check all the beaches regularly and for several weeks our outboards motors underwent mechanical difficulties further halting operations.

The data also includes Vini beach on the basis of verbal reports from Samoan fishermen who illegally frequented the area.

Figure 3 is a composite of meterological data extending over a 30 year period from the Apia Weather Observatory. The non-nesting season is accompanied with a mild 2°F drop in temperature and a drastic decrease in rainfall. The significance of these 2 meterological variations in relation to the turtle nesting season is highly questionable. The most important weather factor is that of wind speed and its affects upon the surface of the sea. From June to September the southeasterly trade winds blow continuously, thereby also affecting the temperature and rainfall, causing the sea to become tremendously rough. The large 3m. swell and 1.5m. chop are a strong enough combination to prevent nesting activities. Courtship and copulation would be impossible due to the rough seas as well as the traversing of the shallow beach reefs by the female. We have also found flooding evidence of the nesting areas on all 4 of the beaches by the large swells.

Nu'ulua is the only beach where nesting occurs throughout the entire season. The nesting on Nu'utele beach begins in January and ends in April. Namu'a has the shortest season, January through March. Inconclusive bits of information from Vini beach suggest that nesting in October and extends through April.

These different seasonal lengths are no doubt a result of different amount of human predation pressure. The order of beaches from the smallest nesting turtle population (and therefore the most predation pressure) to the largest turtle population (with the least predation pressure) is; Namu'a, Nu'utele, Vini, Nu'ulua.

Namu'a is the most accessable of the nesting beaches for it can be reached without going outside the mainland reef. Fishermen frequent the site almost every day during the nesting season, often spending the night to fish and wait for turtles. This heavy predation has reduced the turtle population to a point near extinction.

Nu'utele beach is on the ocean of Nu'utele island and not easily accessable. Extensive human predation pressure had existed between 1915 and 1930 when a leper colony was moved to the beach. Since then many fishermen hunt sea birds on the cliffs and work the deserted plantations, often spending the night weather permitting. Although any turtles or eggs found on the beach are eaten, the nesting turtle population not as small as Namu'a.

Vini beach is located just outside the mainland reef on Nu'utele island. There are large deep water channels at the beach and mainland reefs allowing unobstructed, but often rough, passage to the beach. The private plantation behind the beach is maintained throughout the year by 2 or 3 people, usually women. Some turtles and eggs are probably taken yearly by the women but no great influx of outside fishermen disturb the site. The stability of Samoan culture would suggest that this situation on Vini has existed for quite some time and will probably continue indefinately. The nesting turtle population is suspected to be fairly large, although this speculation is based on inaccurate verbal reports.

The beach at Nu'ulua is the opposite extreme of Namu'a. Nu'ulua is the least accessable of the nesting beaches, it being very difficult to land on even on a calm day. There is little human predation pressure on the beach and consequently it supports the largest nesting turtle population accompanied with the longest nesting season. Occasionally fishermen are able to land on the beach and remove eggs, however very rarely spending the night.

Nesting Behavior

The entire nesting process of the Samoan hawksbill has been carefully observed only 6 times during the 1½ year turtle survey. We found that the succession of nesting events were very similar to those described by Carr et al. (1966) and will not be redescribed here. We found the Samoan hawksbills nesting behavior to differ from Carr's in 3 respects.

The Samoan hawksbill is not as wary during emergence as the Costa Rican population. The turtle will not be frightened away if surrounded by people or if lights are played upon her body when she is emerging from the ocean. If the lights are directed into her eyes, however, she will immediately return to the ocean. The further up the beach she travels the less disturbed she comes by the light. When she has reached the nesting area at the top of the beach, an average distance of 8m., lights will not frighten her at all. There were no 'half-moon' tracks found at any time on the beaches.

The process of beach appraisal by the emerging turtle is also slightly different. As the turtles proceed up the beach the 'sand smelling' and 'neck craning' are not as intensive as Carr et al. describe for the Caribbean Sea. Most beach appraisal behavior is performed at the site of initial beach contact, sharply tappering off in frequency as she approaches the nesting area.

We found the Samoan turtles to spend a great deal of time filling in the shallow body pits and concealing the nesting sites. The turtle thrashes considerably with all 4 limbs uprooting vegetation and throwing sand over a large area. The 6 turtles observed thrashed, with many brief rest periods, for an average of 53 minutes (range 42-65mins.), the turtles covering long distances forward due to the thrashing movements. This distance averaged 5m. (range 3-10m.). Other than this forward thrusting motion the turtles did not wander around on the beach to any extent.

The average time for the entire nesting process for the 6 turtles was 1.8 hours (range 1.5-1.9hrs.), of which .88 hrs. was spent concealing the site.

The reasons for these behavioral deviations from those described at Costa Rica may partially be explained zoogeographically. As opposed to the huge mainland nesting beaches in the Caribbean, the Samoan hawksbill population nest on short narrow beaches located on off shore islands. These islands have had no indigeneous animal populations, such as dogs, foxes, monkeys, goats etc. to disturb the nesting process. These factors would tend to develop a nesting population which would be less wary and spend less time appraising the area because no disturbances were ever encountered on the beaches. This would also account for no 'half moon' tracks and less beach wandering. Since the beaches are so small and often contain thick vegetation, the turtle spends much time seemingly concealing the nest site but actually clearing away the vegetation for future nesting. This would help to eliminate the digging up of each others nests due to lack of adequate nesting beach.

The Clutch

The average number of eggs in a sample of 40 nests was 147.2 (range 54-228). A sample (10%) of eggs from the top, middle and bottom of each nest was measured during transplantation. The average diameter of the spherical eggs was 3.5cm. (range 2.30-2.80cm.).

Abnormal eggs were seldomly seen, about 2% of all clutches contained elongated eggs, these few in number. A great number of the nests (37%) contained several yokeless lumps, all spherical and averaging 1.5cm. in diameter. No other abnormalities were seen.

The depths from the surface of the beach to the top and bottom of the egg mass were measured for each clutch. The average depth to the top of the nest was 27.1cm. (range 11-33cm.) and to the bottom 46.0 (range 34-53cm.).

Nest Incubation

The incubation period for 25 nests laid in the 1971-72 season averaged 62.6 days (range 58-69 days).

Attempts to correlate the nest incubation time as a function of rainfall have proved fruitless due to several factors. The amount of rainfall on the eastern coast of Western Samoa varies tremendously, data for the same months in consecutive years may differ by as much as 500%. Also, the rain for an entire week or month may fall from one passing squall, thereby eliminating seasonal rain trends for any annual or biannual period.

To find any possible general trends between rainfall and incubation time we did not have enough data gathered or any equipment in which to perform a meaningful statistical analysis.

Nest temperature studies are being carried out on several nests, but are not finished at this time and will be reported elsewhere when completed.

Clutch Emergence

Each nest which was transplanted into the hatchery was closely watched the last few days of incubation in order to determine the average time of emergence.

Several nests reached the surface before 4PM but did not actually emerge until evening. No nest emerged before 4PM. Most nests (75%) emerged between 5 and 7:30PM, when the sun had passed behind the mountains of Upolu and the temperature had dropped considerably. In order for the turtles to emerge, the sand temperature must fall to around 88°F. In sand warmer than this the turtles are lethargic and will not emerge even if the nest has reached the surface exposing the top layer of hatchlings.

Upon emergence all hatchlings quickly oriented on the sea-ward of the wire enclosures. The presence of a strong light in the vicinity reoriented the hatchlings towards that light after an initial period of unoriented confusion. A nest emerged unexpectedly at 8:15PM and escaped through an improperly set wire enclosure. As far as we know, all the turtles oriented towards the light in the nearby house, seemingly attempting to enter the low windows. Table 1 shows the size range of newly emerged turtles in addition to 4 mature and 2 juvenile turtles.

A sample of 21 nests contained a total of 3,223 eggs, of which 68.4% resulted in emerged young (range 19-93.9%). The day after emergence each clutch was dug up and all unhatched eggs opened to determine how many of the eggs were actually fertilized. The same sample of nests above had a total average of 74.5% fertilization (range 21.9-95.7%). The average percentage hatch and fertilization figures for these transplanted nests correspond closely with 12 nests which were left undisturbed on the beach. This indicates no excessive mortality due to the transplantation of the nests into the hatchery.

We did not encounter many abnormal hatchlings, most died during the latter stages of embryonic development. Those which did emerge died within a week, along with those turtles which were too small and too weak to survive.

The color of the newly emerged turtles was fairly uniform (figs. 4-6), diverse color differentiation was noticed in our specimens which were at least 6 months old.

The carapace and the top of the head and neck were a uniform tan, the sides and bottom of the neck and head, including the beak, were grey/black. The top and bottom of the fore flippers were grey with a light fringe around the edge. The top and bottom of the hind flippers were a uniform grey/black. The entire plastron was grey/black with light cream ridges posteriorly.

In 4 of our transplanted nests 50% of the hatchlings had grey/black centrals, the remainder of the carapace being tan. The rest of the clutch was normal. In 2 other nests all of the hatchlings had the centrals outlined in grey/black. These were the only major hatchling color deviations encountered.

Predation on Eggs and Young

Predation upon hawksbill nests is not an important factor contributing to the decline of the turtle population. Polynesian rats (Rattus exulans) are the only mammals found on the beaches, and at no time during the survey were any nests visibly disturbed by these animals. The ghost crab (Ocypode sp.) abounds in great numbers on all the nesting beaches, the characteristic holes in which these animals live can be seen scattered along the face of the beach near the H.W.M. The Ocypode holes do not extend inland as far as the turtle nesting area, thereby also eliminating them from nest predation.

Nest destruction only resulted from human intervention or accidental excavation by another nesting turtle, the former occuring frequently and the latter rarely.

The hatchlings which traverse the beach upon emergence are surrounded with potential predators. The belt of Ocypode holes must first be passed, then a section of beach rock. The beach rock itself is a formidable barrier but upon this rock lives a large population of rock crabs, Grapsidae, averaging 6-10cm. carapace width.

The nesting islands support nesting sea birds throughout the year. They consist of different species of: Noddy (Anous), Boody, (Sula), and Tern (Sterna). Tropicbirds, Frigatebirds, Petrels and Shearwaters are constant visitors, also in large numbers. These birds are all oceanic feeders and their hunting territories extend for miles around the nesting islands. The hatchlings are constantly in danger from these birds from the time they emerge on the beach to the time they are miles away. The newly hatched turtles are not able to escape the birds due to their inability to swim and dive properly during the initial few weeks.

The oceanic predators are numerous in both species and numbers of individuals, Garfish, barracude, snapper, travally, grouper, wrasse and sharks are among the list of potential reef predators. Deep water predator species include bonito and skip-jack tuna, both often in huge schools within a mile of the nesting beaches.

All of the aforementioned species of crabs, birds and fishes have been called potential predators of the hatchling hawksbill. We have seen no predation during our brief visits to the nesting islands. Our overwhelming presence near the turtles, both in and out of the water, during observations had probably frightened off any predators.

Transplanted nests did suffer from Ocypode predation, the tunnels often extending into the incubating nests through which the occupants nibble holes into the egg shells before devouring the yoke or embryo. Several of our nests were thusly badly damaged, one completely. The degree of damage done by exposing the nests to extreme temperature variations by the Ocypode tunnels can not be guessed. Rats never disturbed the transplanted nests, though a large population lived nearby.

The reared turtles were released 2-3 miles outside the reef at dusk in an effort to reduce predation. Boobies sometimes followed the boat, but none were ever seen to dive on the turtles. Large schools of bonito and tuna were also often in the vicinity, we released the turtles as far from the schools as practicable. On one occasion the author stopped the boat and saw a 5-6 foot black-tipped reef shark

(Carcharinus spallanzani) attack and eat the last group of released turtles.

Growth Rates

Weekly measurements are being taken of a sample of hatchlings through the first 6 months of age, monthly measurements are simultaneously being taken on several of the older turtles. The data will hopefully provide some insight into the age determination of hawksbill through various statistical proportions. The data is not complete at this time and the results will be reported elsewhere.

Mariculture

The raising of hawksbill turtles for export to overseas souvenir markets is a definite possibility in the near future. Some preliminary observations were carried out in an effort to learn how to raise healthy turtles both quickly and cheaply.

The tanks should not be so big that improper water flushing occurs or too small so that overcrowding results. We found that 4x4x1 foot concrete tanks were adequate and they were cheap and easy to build. The tanks had a slanted floor with a small trough at the low end with a plastic drain to collect and drain out collected felecal matter. An average of not more than 200 hatchlings were placed in each tank, although the figure could be doubled without overcrowding for the first 2 months.

The most important factor to overcome is finding a proper method for exchanging fresh sea water. Without fresh changes of water daily the tanks quickly become fouled, this situation would then greatly increase the chances of bacterial and fungal disease epidemics. As a suitable method for continually running sea water has not, at this time, been built at the Western Samoa Turtle Hatchery, we had to drain, clean and refill each tank daily with a portable Honda water pump and a series of plastic hoses. The tanks were scrubbed with antiseptic once a week in order to reduce any bacteria which may have accumulated.

We experimented with most of the local food sources but found nothing suitable which was cheap, easy to obtain and good for the turtles. Copra was readily eaten when properly shredded but fouled the water and led to a fungal infection of the eyes. Quartered ripe bananas were also tried. They were eaten readily and they didn't foul the water. A diet consisting only of ripe bananas, however, produced large quantities of gas in the intestine and eventually resulted in constipation and death in turtles under 6 months of age.

A supply of ground fish meal was easily obtainable from Pago Pago at WS $4.60/110lbs. We mixed squashed ripe bananas and fish meal together in a ratio of 2:1 respectively by weight and made small cakes .5cm. thick on pieces of wood. The cakes were baked in the sun 5-8 hours until dry, then the cakes were cut into long strips and stored for future use. When fed to the turtles the strips were cut into chunks and thrown into the tanks in small quantities at any one time in order for the turtles to quickly consume the pieces. The cakes would start to disintigrate after about 5 minutes and discolor the water making further feeding impossible.

The various different addatives that can be put into the cake is endless. Vitamins, antibiotics, preservatives and even algae and grasses can easily be mixed together. We added turtle grass, Syringodium isoetifolium, frequently to help balance the diet.

Hawksbill turtles have to be kept well fed when placed together in high concentrations. If the turtles are not kept well fed they tend to nip each other, a wounded turtle will be nipped at until he is taken out of the tank. The older the turtles the more extensive damage they can inflict, so that older turtles should not be kept in the high concentrations and they should be kept well fed at all times.

The raising of hawksbill turtles for souvenir export (30-40cm. C.L.) is possible provided care is taken in maintaining an adequate water system and proper diet. If either of these 2 factors is neglected the entire group of turtles can become diseased within a week. Consideration must be taken to ensure the turtles safety before any rearing program begins.

Disease in Captivity

The pump which supplies fresh sea water for the rearing tanks experienced mechanical difficulties for a period of 3 months. At this time we were rearing 1 clutch of 95 turtles for food and growth studies. The food source consisted of a ripe banana fish meal cake through most of this period but shifted to a fresh fish diet 1 month before the pump was fixed. The tanks were filled by hand, so to ease the work load we filled the tanks to an average of 15cm.

The water was not changed for 3 days and the fish diet turned the shallow tanks putrid, giving the water a soapy appearance. The turtles immediately broke out with an infection which attacked the eyes first. The fore flippers and top of the head became infected 3-4 days later. The disease spread rapidly among the turtles, eating the tissue away so badly that the turtles were blind within a week and dead the next.

A superficial microscopic inspection of some diseased turtles revealed a bacillus bacterium. However, it is impossible to say whether the bacterium was the cause or result of the disease, no animal pathological equipment was available.

The Ph of the putrid water was 6.75.

Several diseased turtles were set aside and injected with 300,000 units of procain penicillin. This exposure to the antibiotic stopped the spread of the infection, but the tissue damage was so great no marked improvement was noticed.

The pugnacious nature of hungry hawksbills prevented any improvement in the tissue damage to occur. The constant nibbling of infected areas often resulted in death.

Project Goals

The present Western Samoan Turtle Program evolved from a very ambigous beginning. Without any initial survey of the nesting turtle stocks a green turtle, Chelonia mydas, rearing program was initiated. When the program started the only hawksbills were nesting we hastily contacted overseas taxidermists to start a new program of exporting 30-40cm. C.L. turtles to be sold as curios. It did not take long to realize, however, that such an endeavor was unfeasible at the time. The many problems concerned with reliable water and food supplies had not been satisfactorily solved.

The ultimate goal of the present turtle program is the restocking of Samoan waters with the hawksbill turtle. At the end of our first complete (1971-72) nesting season 2,446 strong, well fed month old turtles have been released. The precautions that are being taken with these turtles are decreasing the mortality rate of the hatchlings by a tremendous amount. Although the actual affects of the stocking program will not be felt at all for 5-7 years we are confident that we are at least doubling the size of the present nesting population. We are simultaneously studying the possibilities of re-attempting the export program feasibly.

An important facet of the Western Samoan Turtle Project was that of informing the Samoan people about turtle conservation. This is a very difficult problem because the villages nearest the nesting beaches are far from Apia, and the conveniences of local newspaper and radio broadcasts have no impact. Nevertheless, radio programs did eminate from Apia in an attempt to educate the more urban population and egg clutches were taken to some of the Apia colleges to hatch. The instructors were very helpful and completely capable of informing the students on turtle conservation.

The hatchery was always open for local tourism, and many schools visited the site. Pamphlets printed in Samoan were given out explaining some of the hawksbills life history and why we are attempting to conserve them.

A short 8mm. color movie is, at this date, almost completed. The movie depicts my Samoan counterpart as he goes through an entire clutch cycle, from gathering the eggs to releasing the young turtles. The sound track is in Samoan and the general theme is turtle conservation. This movie will be shown in all the schools near the nesting islands in addition to regular showings at the hatchery itself.

The largest goal of the turtle project is for Samoan turtle conservation legislation to be passed. Earlier attempts to pass such legislation have ended in failure on the grounds that the gathering of nesting females and eggs is a traditional Samoan custom. We will continue to attempt to pass the Bill every year, before the extinction of the hawksbill turtle is complete.

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1972

FIGURE 2 TURTLE TRACKS/ MONTH

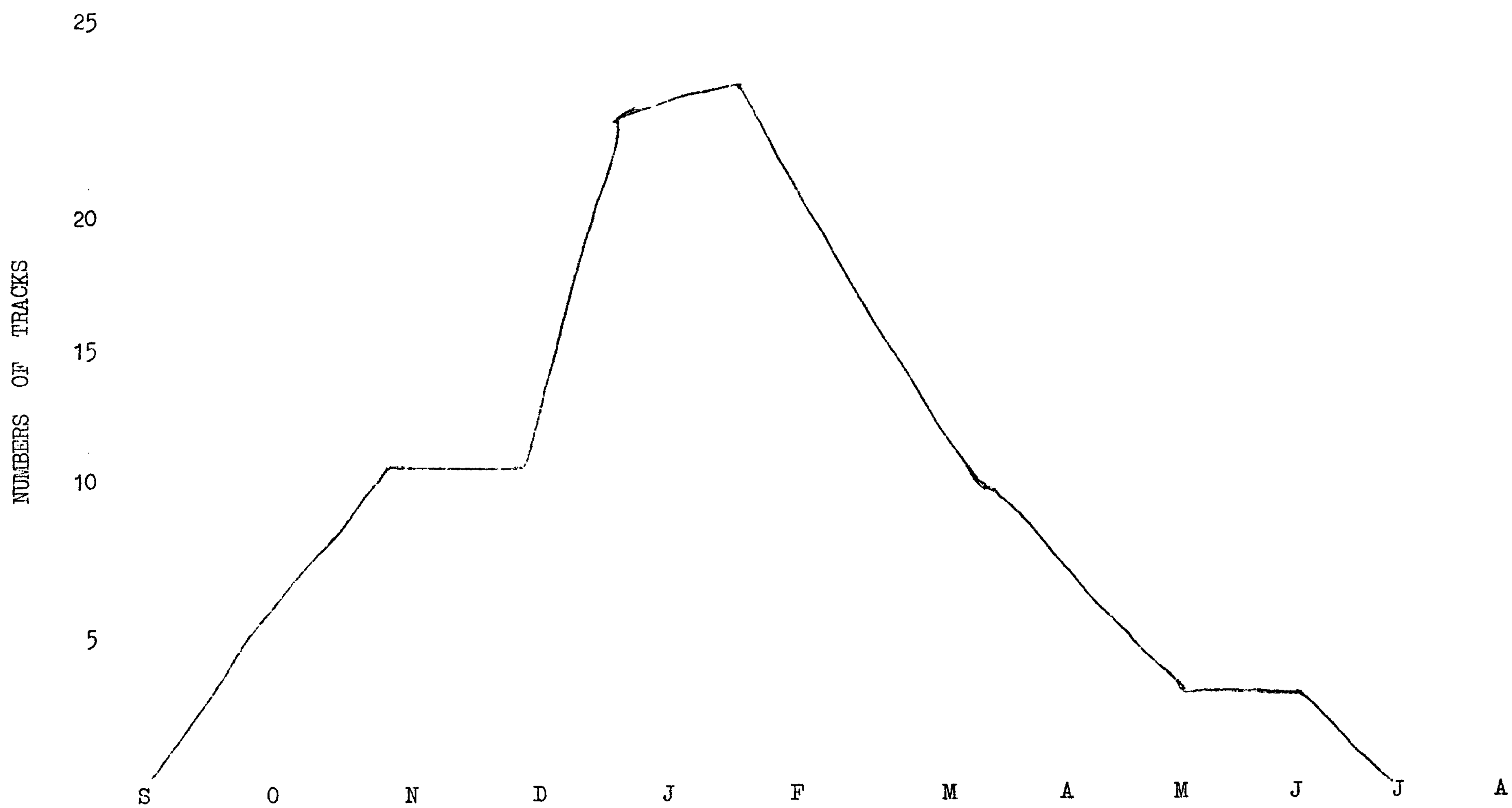

FIGURE 3

NORMAL VALUES OF METEROLOGICAL ELEMENTS FOR APIA (30 YEARS)

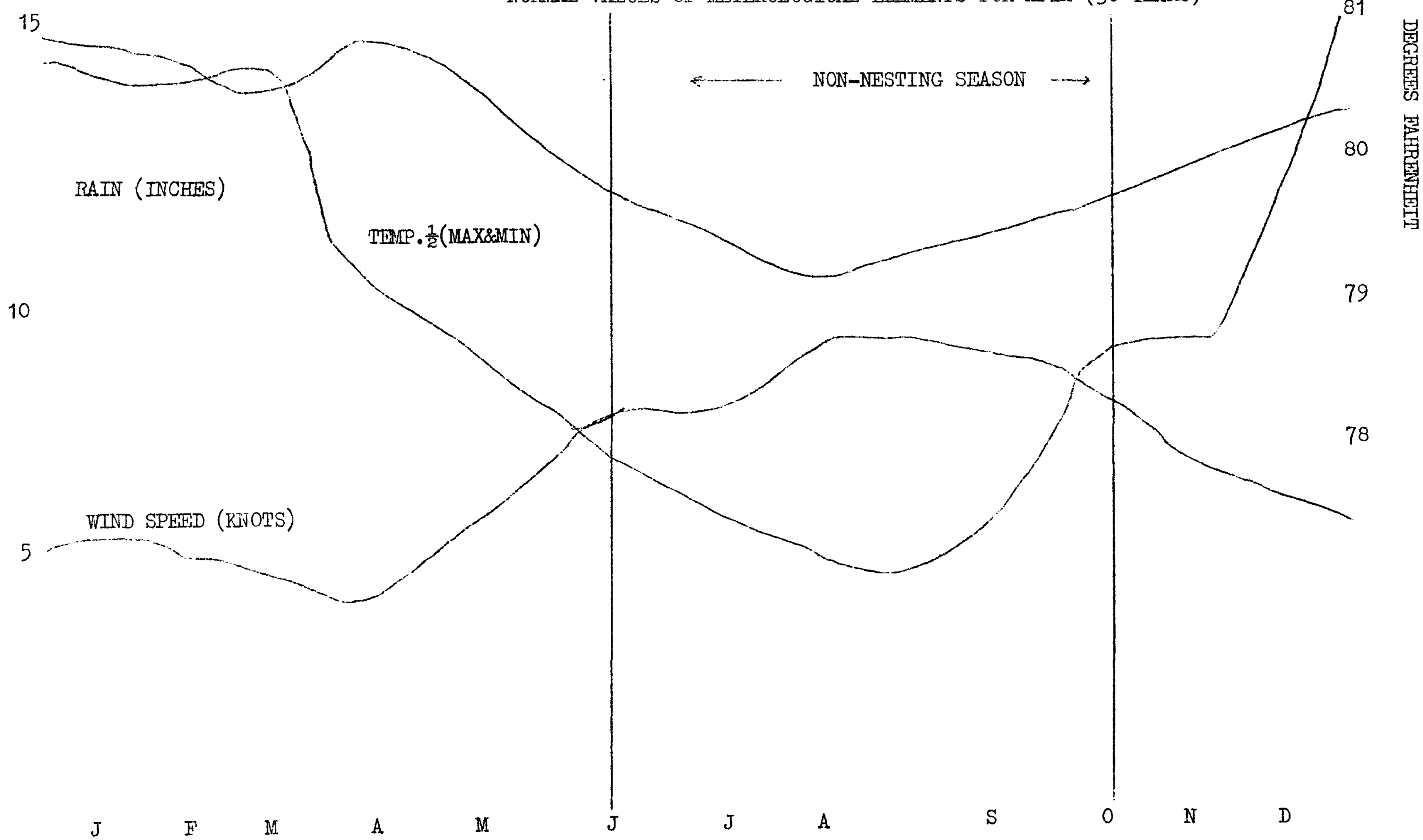

Table 1

Measurements of Hawksbill Turtles

Newly emerged hatchlings	Carapace length	Carapace width	Plastron length	Head width	Eye width
Range	3.8-4.1	2.9-3.3	2.9-3.4	1.4-1.5	.4-.5
Mean	3.98	3.16	3.26	1.42	.46
Sample size	20	20	20	10	10
Mature Female	74.5	60.0	59.5	11.1	3.2
Mature Female	57.0	44.7	41.5	8.5	2.1
Mature Male	72.5	53.5	52.0	10.9	3.2
Mature Male	78.0	55.5	53.5	11.0	3.2
Juvenile	48.5	32.0	36.8	6.7	2.3
Juvenile	27.6	20.1	21.3	4.5	1.4
