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NOTES ON THE HAWKSBILL TURTLE POPULATION OF WESTERN SAMOA

by W. Travis

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This report summarises data collected in Samoa during the first three years following the inception of its turtle hatcherx (1969-1972) and concludes with some remarks concerning the apparent present abundance of Hawksbill Turtle in that area since that time.

Background On its formation in 1969, one of the first tasks of Western Samoa's Fisheries Division was a marine turtle population survey. This project was carried out in response to public and governmental concern regarding the rapidly dwindling local turtle population and the near-disappearance of this valuable subsistence protein source.

Surveys by serarches by land, sea and air showed that:

(a) All main-island "historical" turtle nesting sites had been abandoned due to human population pressures.

(b) All off-shore islets supporting a resident human population and possessed of suitable laying-beaches had suffered the same fate.

(c) Three small, & aminly rocky, islets on the southern-eastern extremity of the main island (Upolu) still provided a 'marginal' nesting locality for the Hardier Hawksbill.

(d) No green turtle nesting beaches or localities remained in existence, other than 'stray' or accidental landings by old females probably answering to imprinted, historic, reflexes.

Extensive efforts aimed at capturing, examing, marking (non-permanently) and subsequently releasing sea-turtles to ascertain an approximation of their peak numbers in those waters adjacent to feeding areas and nesting sites, yielded the following figures throughout a 5-month breeding-season November 1969 - April 1970:

Hawksbill		Greens	
M	F	M	F
11	17(6)	0	2

2/.....

When considering these figures, the following should be borne in mind:

(a) Males were more elusive than females and proved harder to capture.

(b) Turtles observed, but not caught, were not tallied due to the likelihood of duplicate counts.

(c) Braketed figures represent turtles captured on land (i.e. females subsequent to their laying, or when returning to the sea from scouting the beaches).

Due to the lack of suitable weigh-scales, none of those captured were weighed. Carapace measurements were taken but, after a lapse of some nine years, these cannot be traced.

From these observations it was deduced that:

(a) The "laying-female" Hawksbill population had reached a dangerously low and possibly unretrieveable position.

(b) No significant numbers of green turtles were present in Samoan waters. *

* (Footnote: subsequent extensive searches showed the only viable Green Turtle nesting area to be at Rose Island, (US Territory) 130 m.m. ESE of Western Samoa's Hawksbill nesting-area. Even here the nesting-site can only be termed a 'last resort' since the turtles have to surmount very difficult terrain on their way from the shore-lines and the nesting site itself is covered in large flat pebbles and fragmented beach rock which often causes considerable damage to the female turtles' flippers, both in transit and whilst digging-out their nests. In the early 1970's, in an effort to prevent total destruction of the islet's resources due to the capacity of distant-water, mainly Asiatic, fisherman, Rose Island was declared a Natural Sanctuary by the U.S. Government).

...../3

Nesting Beaches and Season

The Hawksbill Turtle was the only marine turtle found nesting in Western Samoa. Nesting beaches are located at the eastern end of Upolu on three small off-shore islets, ½ to 4 miles outside the main reef, by name Namu'a, Nu'ulua and Nu'utele.* These three islets possess between them four small, narrow, nesting beches which are covered with thick ground vegetation down to storm-tide level, are barely protected sections of beach-rock. All beaches extend north to south and face east, and one additional beach on Nu'utele faces west - the only landing affording protection from the strong tradewinds and sometimes heavy seas. From the above it can be seen that all four are unsuitable as nesting-beaches for Green Turtle.

The relative inaccessibility of these areas together with local traditional tapu's prohibiting their permanent human occupation are undoubtedly the reasons why these marginal nesting sites have not been wiped-out.

The Hawksbill nesting-season in Samoa extends from September through July, with February as the peak month. Graph 1 shows the total number of turtle-tracks found on the four beaches during each month of the 1971-1972 nesting season. These tracks were obtained by visual inspection of the beaches at first light for two five-day periods each month corresponding to spring-tides. (i.e. over the new and full moon periods). Tracks were obliterated on discovery to avoid recount duplication. From an analysis of meteorological data gathered over a period of thirty years by the Meteorological Office in Apia the "non-nesting" season is marked by a mild drop in temperature and a 10-inch decrease in rainfall (see Graph 2 for a synopsis of these possibly pertinent factors).

Probably the most important weather factor is that of wind-speed and its effects upon the surface of the sea. From mid-June through to the end of September the south-east tradewinds are at their peak, causing considerable surf and back-wash along the reefs fronting the nesting-beaches. Evidence of flooding of the nesting-sites is also apparent during this period. Conversely, during the "hurricane-season" of December to March, long periods of calms are interspersed with shorter spells of disturbed weather characterised by violet

...../4

thunderstorms.

*See map 1.

These, usually localised, situations build-up during the afternoons and result in wave-flattening downpours and extensive post-dusk overcast, ideal conditions for the nesting-turtle.

The Hatchery

Realising the importance (with regard to possible imprinting and subsequent releasings) of having the hatchery close to the actual nesting-beaches and also wishing to generate as few logistic problems as possible, a site was obtained at an old and disused banana-washing station of the south-east tip of Upolu, a mere 4 miles from the furthest outlying turtle-beach. (see Map 2).
This consisted of a long open-sided roofed shed containing wooden benches along one side and having a series of interconnected concrete "tubs" each approximately eight feet wide, six feet long and some two feet high strung-out along the building's centre-line. (see illustration 1).
A dwelling-home was adjacent and the whole complex was situated on the main Apia-Aleipata road, adjacent to a long sandy bay fronted by a shallow (6-8 ft) lagoon. (see map 3).

In order to preserve, as far as possible, conditions similar to those pertaining at the actual nesting-sites, a quantity of sand (coarser-grained than that of the hatchery's beach) was laboriously transported from two of the beaches to provide a 'top-layer' for the hatchery-compound. This compound was established between the dwelling-house and the banana-washing station, some four yards back from the high-tide mark and some six feet above high-tide level. The compound consisted of a fenced rectangle forty with its fencing wire dug some three feet into the ground (to prevent rats or crabs from obtaining easy access) and with its top section curling outwards starting at a point some six feet above the

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ground (to prevent coconut crabs, rats or cats from climbing over). The compound had a latched entrance-gate, secured by a padlock.

Within the compound, circular plots were established, each measuring some four feet in diameter and having intervening spaces of one foot. Thus the compound was capable of accommodating forty-eight clutches (or nearly 7000 eggs) at any one time.

Each 'plot' was provided with a removable open-ended 'tube' of reinforced chicken-wire which was pressed lightly into the ground to serve as its demarcation and which extended about eighteen inches above ground. Thus each clutch was segregated and, through the agency of a wooden peg marking the centre of the mound within, identifiable. These wooden pegs served the same function as seed-bed pegs, having basic information such as clutch number, number of eggs, date and locality of collection written upon them in indelible pencil.

Operation of the Hatchery

Initially, all wild nests discovered were dug-up and their contents transferred to the hatchery. This was done since observation showed that the destruction of existing incubating clutches due to their excavation by other female-turtles in search of optimum nesting sites was a frequent occurrence. In later years and when the hatchery compound was full, peripheral nests or those in difficult, hard-of-access areas were left alone in order to provide comparative hatching and monitor data.

Initially, again, dug-out clutches were transferred to plastic buckets and thence "swum-out" through the surf to a waiting launch. This was obviously bad practice, since the egg-mass was inevitably disturbed, some times spray-soaked and occasionally lost during the process. Later with landing and ferrying techniques perfected, the whole clutch (including the surrounding sand) was excavated as one 'parcel' by means of a "clutch-carrier" having handles like a sedan-chair and equipped with a sliding, steel bottom-plate. (see Figures 2 & 3). This, though very heavy and requiring a minimum of two strong men (and preferably four) to carry it, did result in the whole egg-mass being 'transplanted' with minimal disturbance.

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Once at the hatchery, each clutch was re-buried without delay within one of the prepared compound 'pits' and the appropriate supporting data filled in, both on the 'peg' and in the hatchery-office log.

Observations soon proved that the majority of hatchings took place shortly after drak. In order to minimise delay and prevent the whole emergent clutch from being penned overnight within the confines of their nest-encircling retaining-mesh, those nests due to hatch had these wire retainer-cylinders removed several days prior to the calculated "break-out" date. Additionally, a mesh-covered tunnel was constructed in the corner of the compound leading right in to the dwelling-house/office. Within the house, about a foot from the tunnel entrance, a low stool served as a stand for a kerosene lantern. If the turtles hatched out after dark they scrambled across the compound towards the corner through which the lamp-glow was visible and, finding the tunnel, headed down it into the house. (usually the first inkling its occupant had of the event was a sudden precipitate 'invasion' of turtles into his living-room). The hatchlings were rounded up and dumped into a row of sea-water-filled plastic buckets kept ready along one wall. The turtles were then counted, random measurements taken and all were notched. "Notching" was done with a razor blade, using a binary notation on two of their marginal scutes.

The buckets of turtles were then carried across to the shed where they were poured into any one of the vacant (but sea-water filled) tanks. The following morning the vacated nest was dug-up and any remaining eggs counted and examined for likely causes of arrested incubation.

...../7

Hatchling Rearing

Hatchlings were kept for 29 days (one lunar month) only. This was done to:

(a) Allow a certain growth and survival-adaption to take place thereby lowering the likelihood of their experiencing immediate post-incubation predation.

(b) Ensure that they would not, in that brief time, become "aquarium" animals unfit for a natural existence.

(c) Prevent any form of "aquarium disease" or dietary short-comings from taking their toll.

(d) Keep hatchery expenses minimal.

Turtles were fed a mixed diet gained from reef-gleaning. Handfulls of various forms of seaweeds, crunched-up small molluscs, broken pieces of coral and coraline algae, shredded reef-fish, small crabs, et cetera were unceremoniously scattered into the tanks at random periods. One day out of seven (not necessarily Sunday) was 'diet-day ' when no nutrient was supplied for twenty-four hours.

Early on it was discovered, that the hatchlings would, within their first ten days in the tanks, associate 'humans' with "food-time" and swim rapidly to the side nearest any observer. In order to break this association and due to the ground-level positioning of the tanks, a small boy had to be utilised to crawl along the floor, below tank-wall level, and toss the food in unobserved. Had the hatchery been more sophisticated no doubt we would have possessed an automatic food-despensing system, but the methods we arrived at had certain benefits in that:

(a) it was free

(b) it was a means of educating the children (and their parents) into the purpose of the hatchery.

(c) it was very random (in that half the handfalls tossed-in usually missed).

The Tanks and their Water

At first each tank was filled by hand by bucket at high-tide and on a rotation system. But as this require some two-hundred buckets per day minimum, another system was introduced whereby a small portable water-pump filled simple storage tanks (placed on a platform at roof-level) once per day at high-water, and the contents of these reservoirs could then be gravity-fed by hose to any tank. Tanks were normally flushed out and cleaned once per week (tank-density allowing) and each tank had about 20 gallons drained away and was then topped-up with 20 gallon of fresh sea-water as part of the daily procedure.

...../8

Density and Disease

Tanks were normally kept at a density of one clutch, (average 100 hatchlings per 96 cu feet of water, almost 1 cu. ft per turtle). Occasionally, at peak hatchery periods, two clutches per tank become necessary.

When a tank become temporarily vacant on the liberation of its occupants, it was emptied, flushed-out, scrubbed with a weak solution of sea-water and permanaganate of potash and left to dry (preferably for 24 hours) before refilling with fresh sea-water.

The only time any disease or infection become apparent was in the early setting-up days when sickness of our Volunteer hatchery-assistant and no funds to secure outside labour resulted in one tank, containing 108 turtles, not experiencing any change of water for the entire 29-day period.
Two days before their due 'liberation' date, the author who had travelled to the hatchery from Apia to arrange this - found many of the hatchlings afflicted with an (apparently) fungoid-infection which was attacking the turtles eyes and flipper edges. Transference to clean water treated with permanganate (no anti-biotics or anti-fungoids being available) and isolation of some 27 badly-infected individuals resulted in 76 being eventually set-free in an undamaged condition and 14 with some scarring.
18 died-or were destroyed due to incapacitating damage such as total loss of sight.

No other instances of disease or infection were noted and no other mortalities recorded. A few turtles suffered minor damage due to their flippers having been nipped by their companions -such bites being usually restricted to the rear edges and tips of fore-flippers.

Liberation

Hatchlings were set-free on, if possible, the exact lunar date of their emergence, during the late afternoons and, weather permitting, close to the reefs fronting the beach of the original nest-site. Thus every effort was made to duplicate the conditions that would have pertained

had they been undisturbed - save that they were a month older, (by which time they could dive to a depth of several feet and had total control of their buoyancy - abilities they do not master for the first three weeks of their life and the lack of which may seriously affect their survival on first entering their natural surroundings).

Scientific Data and Observations*

1. Hatchery Data

24 transplanted nests, averaging 147.2 eggs each (range 54-228), had hatch-rates averaging 68.4% (19-93.66%).
Following emergence of young each clutch was excavated and all unhatched eggs were opened to determine how many eggs had been fertilised.
The average fertilisation rate was 74.5% (21-95.7%).
These figures correspond closely to comparable figures on 12 nests left undisturbed.
10% of the eggs from each transplanted clutch were measured at the time of transplanatation.
The overall average diameter of the spherical eggs was 3.5 cms (3.3-5.8 cm). About 2% of all clutches observed contained, besides normal eggs, a few yokeless spherical lumps averaging 1.5 cm in diameter. Nest measurements were taken for each transplanted clutch. The average depth to the top of the egg-mass was 27.1 cm (range 11-34 cm) and to the bottom, 46.0cm. (34.53cm). The incubation time for the above nests laid in the 1971/72 season averaged 62.6 days (range 58-69). (See Fig 4)

Nest temperatures were studied on six transplanted nests using Van Waters Number 407 indoor/outdoor thermometers.

...../10

Nest temperatures were monitored daily during incubation, with simultaneous readings of undisturbed sand at equal depths and air temperature at surface level. The weather conditions were also noted.

Whilst the sand at equal depth showed only a $2^{o}F$ fluctuation (traceable to local weather conditions), the nests gave an average temperature-increase of $6.6^{o}F$ (range 4.9 - $9.0^{o}F$). Nest temperatures were affected both by clutch-size and prevailing weather. The larger the clutch the higher the rise in comparative temperature and the less fluctuation related to adverse weather. Long periods of rain when experienced during the first 30 days of incubation, lowered the nest-temperature $1-4^{o}F$ and lengthened the incubation period 4-6 days compared with clutches laid in rain-free periods.

Hatchling Growth:

Growth rates were studied on six hatchlings raised in captivity. Three to four times a week these turtles were fed 1-5% of their body-weight of a combination of fresh fish and molluscs. Graph 3 is a growth rate curve based on a cubic regression of data from the average growth rate of the six turtles, from hatching to 128 weeks of age.* They remained in good health during the study and were 'exercised' in the lagoon (but prevented from feeding). No doubt they would have eaten larger quantities of food had it been provided.

*The author is indebted to Wayne N. Witzell, one-time Peace Corps biologist Hatchery Manager, presently a staff-member of the United States National Marine Fisheries Service Southeast Fisheries Centre in Miami, Florica for this section.

...../11

*Authors note: A sibling of one of these six, (from the same clutch) was captured, aged 92 weeks. Its carapace measured 40 cms, some 7 cms greater than its captive nest-mate.

Post-release Recaptures

The first positive group-recapture took place in mid-1971. A fisherman brought into the Fisheries Office a juvenile Hawksbill which he has speared and on which he had noticed two, obviously man-made, notches.

He volunteered the information that the specimen was part of a large group of similarly - sized turtles which had appeared in his village's lagoon during the past few days. A "fish-drive" of this area mounted the next day produced a further 56 individuals, all belonging to the same original clutch release.

Details as follows:

Date of 1st release	Place	No.in group	Av. size	Age
March 3 1970	100 yds. offshore Namua Is.	81	3.9 cms	4 wks.
Date of Recapture	Lagoon area			
June 8 1971	17 miles WNW of release point.	57	30.8 cms	66 wks.

Points of note:

(a) The re-capture zone was down-wind and down-current of the release point.

(b) The group had stayed reasonably compact. (the 57 recaptured were taken within a 4-mile stretch of coast).

(c) Even if the 57 represented the total numbers still extant of the original release, this still represents 70% survival during the supposedly critical juvenile period.

...../12

Further Data: It must be stressed that the sole purpose of the hatchery was an attempt to increase the numbers of turtles in the coastal waters around Samoa. There was no provision - in terms of finance, expertise or equipment - for any scientific studies to be undertaken on the rearing, survival, migration, feeding patterns et cetera, or the collection of any form of quantative data concerning turtles. That any data was collected at all was due to the efforts of two Peace Corps Volunteers (both graduate students in Marine biology) who tried their best under difficult conditions to produce some sort of order and systemisation into what was a grass-roots "village" undertaking.

With the departure of the last of these helpers in 1972 the scheme devolved into what ha' been its intended function and scale; namely, an operational unit capable of being run single-handed by a part-time labourer equipped only with a small punt and who could call on villagers or friends during the nesting season to assist in the work of digging-up and transporting eggs from nesting-sites to the hatchery.

Consequently such refinements as record-keeping, notching,* measuring and general basic data-collection were beyond the scope of the scheme.

The reason the hatchery has continued in existence is due solely to two reasons:

(a) It costs almost nothing to run.

(b) It is successful - i.e. after nine years of operation there are significantly more turtles available in Western Samoa despite significant increases in both human population and fishing activities.

...../13

Note: In May of last year (1978), the author saw 17 adult turtles for sale in the Apia Market over a 2-days period. All were mature and 11 bore vestigal notches. During the 1970/72 period the presence of any turtle in the market was unusual.

*(Unsystematic notching of hatchlings is still sometimes carried out at random, haphazard invervals).

Interviews with fishermen confirm that hatchery-raised (i.e. notched) turtles have been taken by hand whilst mating at sea and on laying-forays whilst on the beaches.

Conclusion

The hatchery would appear to be successful in a modest way in that:

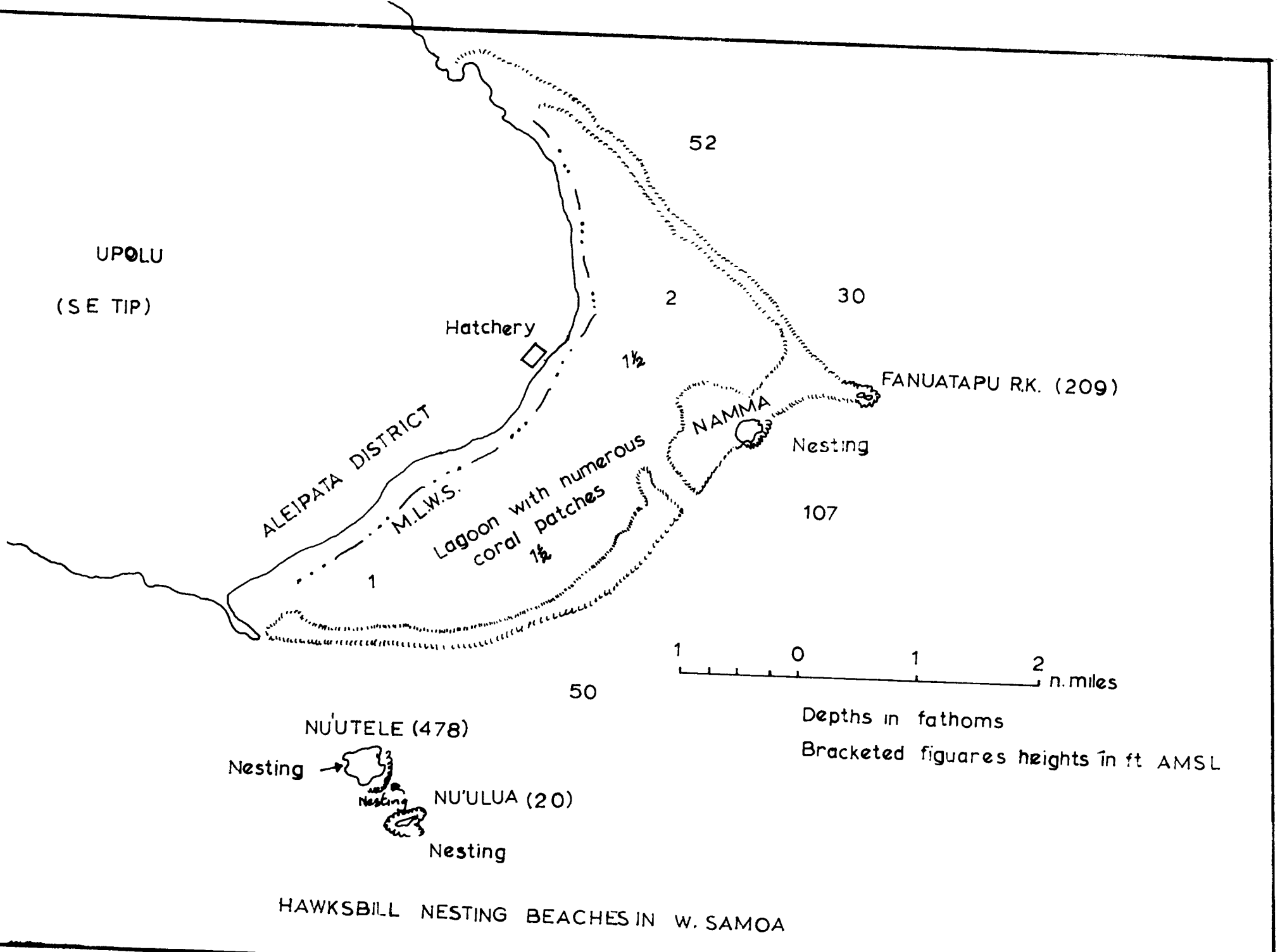
(a) The evident returns far exceed its original and on-going cost.

(b) By demonstrating its practicality, coastal villagers have become aware of its benefits and human predation on eggs and juveniles has been largely arrested.

Operation of the hatchery since the author's departure:

"During 1976 a total of 5254 Hawksbill turtle eggs were collected from the Islands of Aleipata and taken to the hatchery. The hatch returned 1856 turtles. Three months after hatching they were released about one mile offshore. These turtles are marked. Many two to three year old marked turtles are being caught in Samoa which indicates these turtles are surviving and growing to adult size. In their normal form of hatching and immediately entering the sea it has been estimated that the survival rate is about 5 per cent. Since the project started over 13,000 turtles have been released in the sea. As the project is a long-term one tangible results cannot be expected until after 10 years or more."

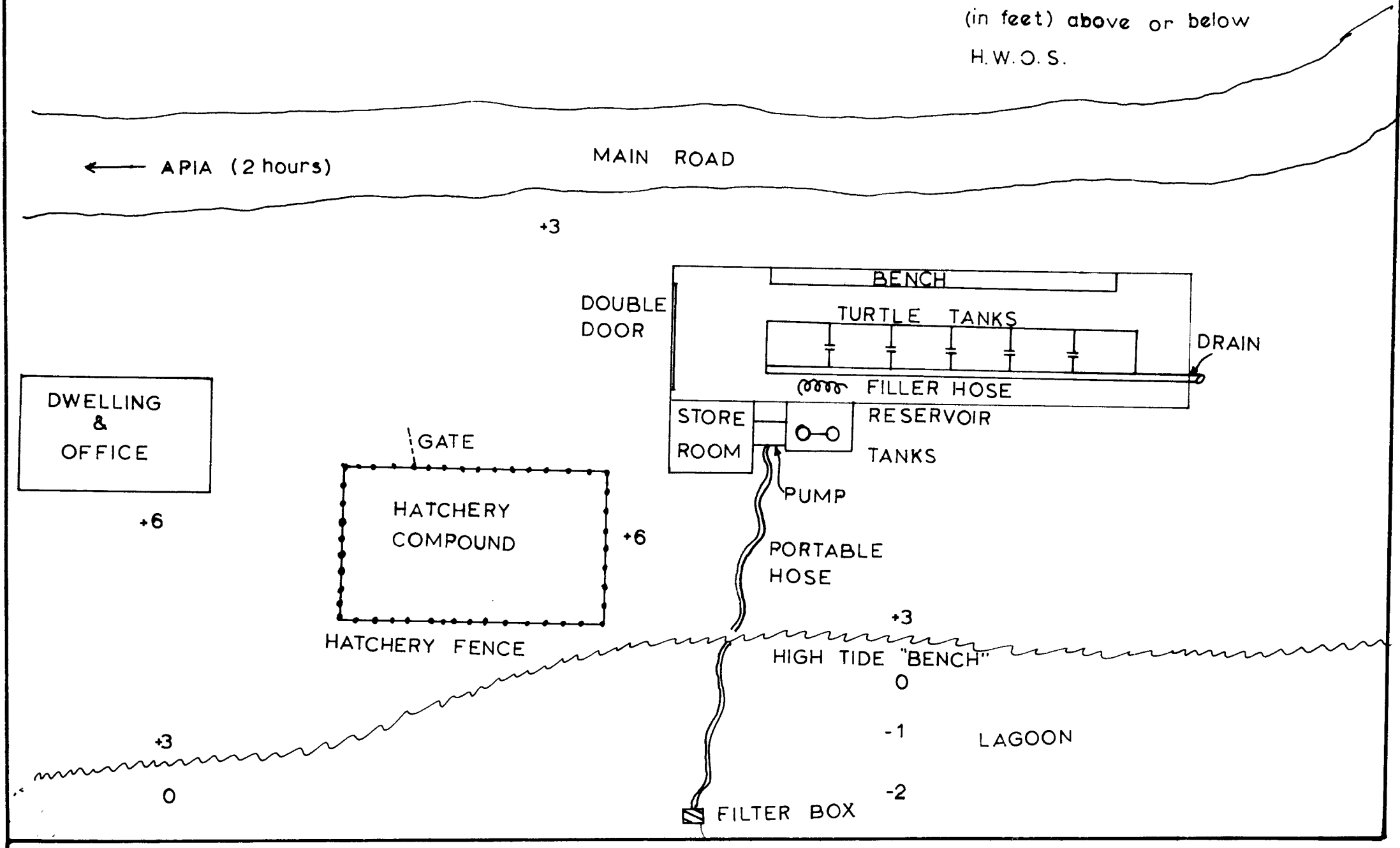
(From SPC/Fisheries 9/WP.38 24 January 1977
by A.L. Philipp)



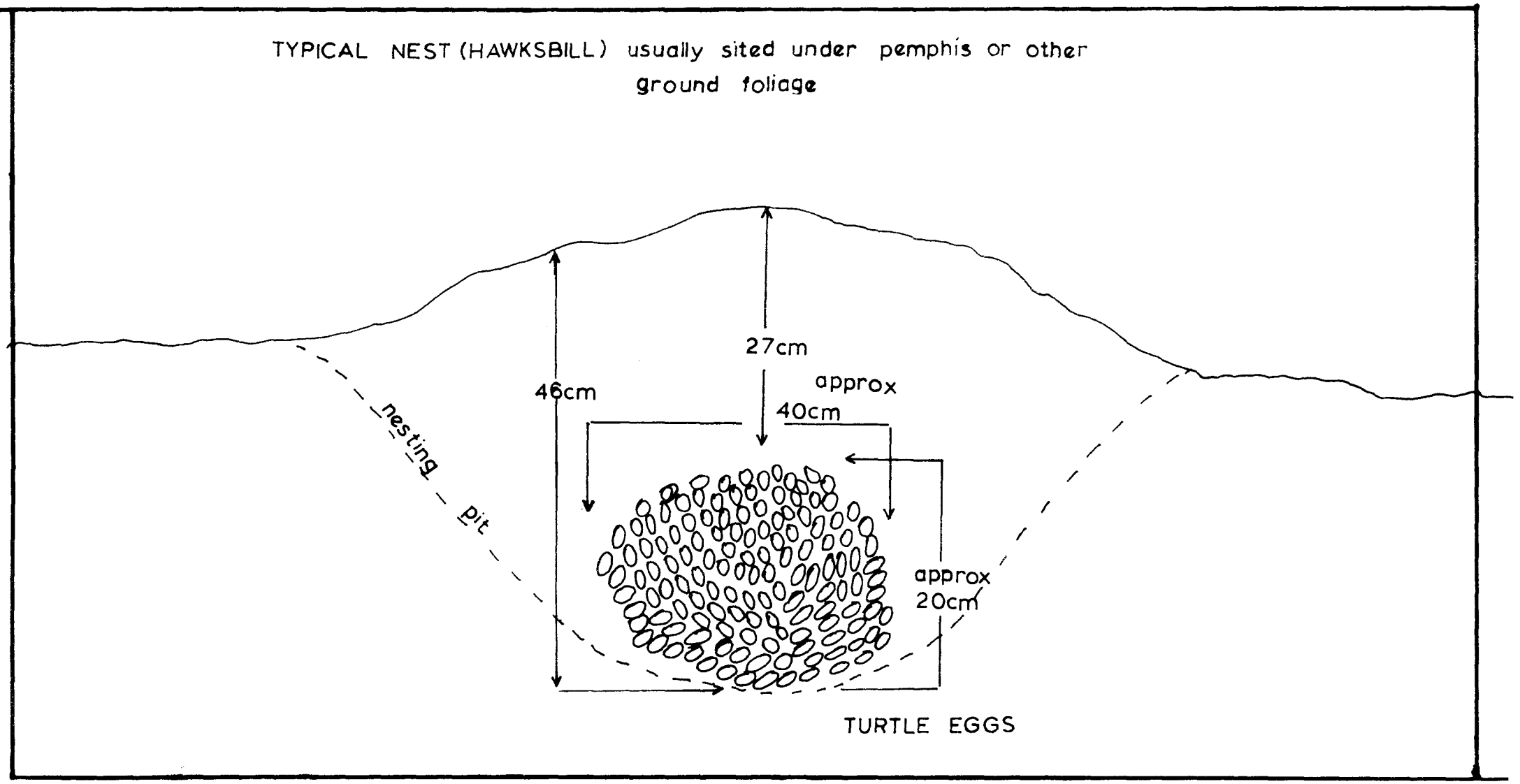
HAWKSBILL NESTING BEACHES IN W. SAMOA

ALEIPATA TURTLE HATCHERY COMPLEX

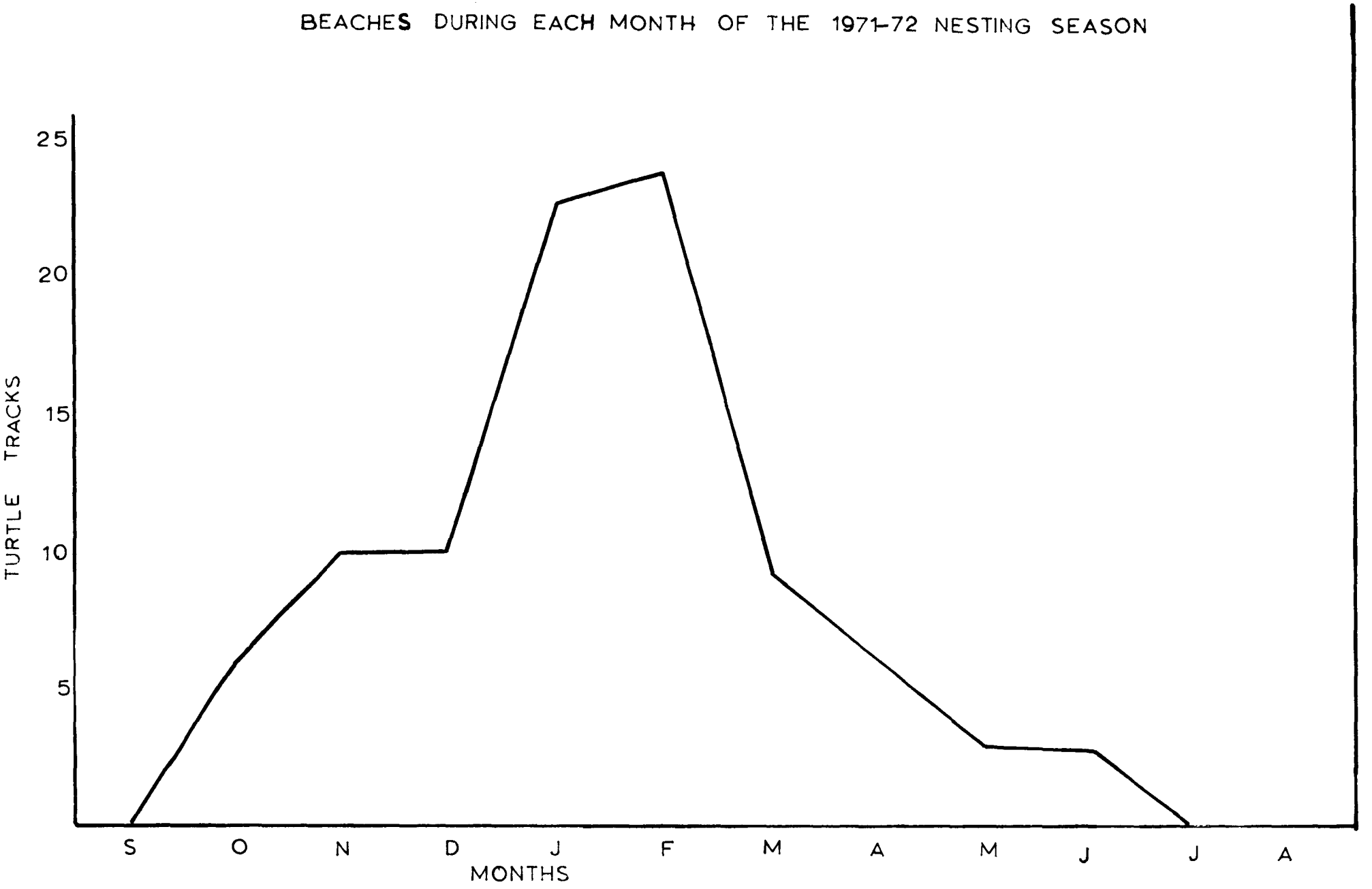
Note:
Figuares refer to hights (in feet) above or below H.W.O.S.



TYPICAL NEST (HAWKSBILL) usually sited under pemphis or other ground foliage



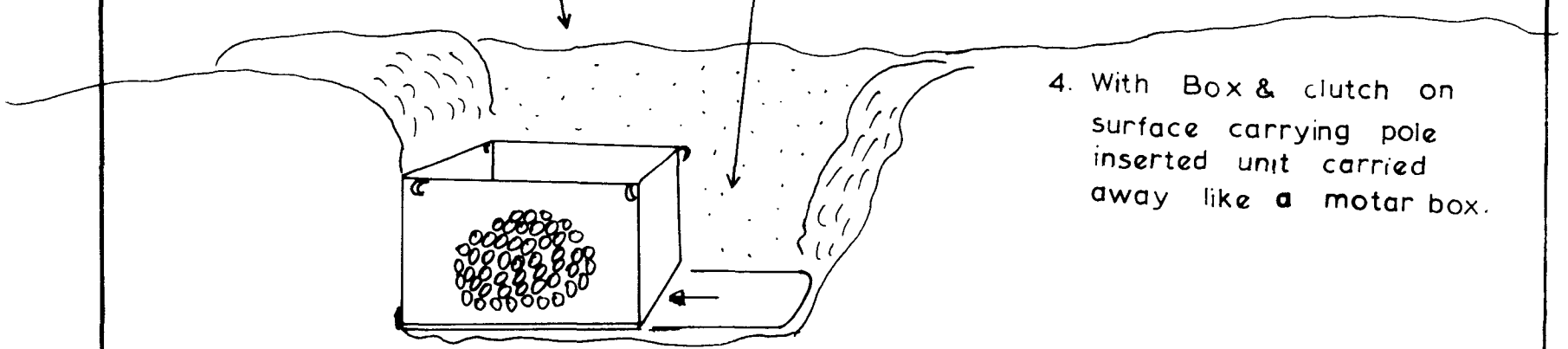
THE TOTAL NUMBER OF TURTLE TRACKS FOUND ON FOUR W. SAMOAN BEACHES DURING EACH MONTH OF THE 1971-72 NESTING SEASON



1. Collector box pressed or hammered into sand around clutch

2. Trench dug to allow insertion of iron sliding bottom-tray

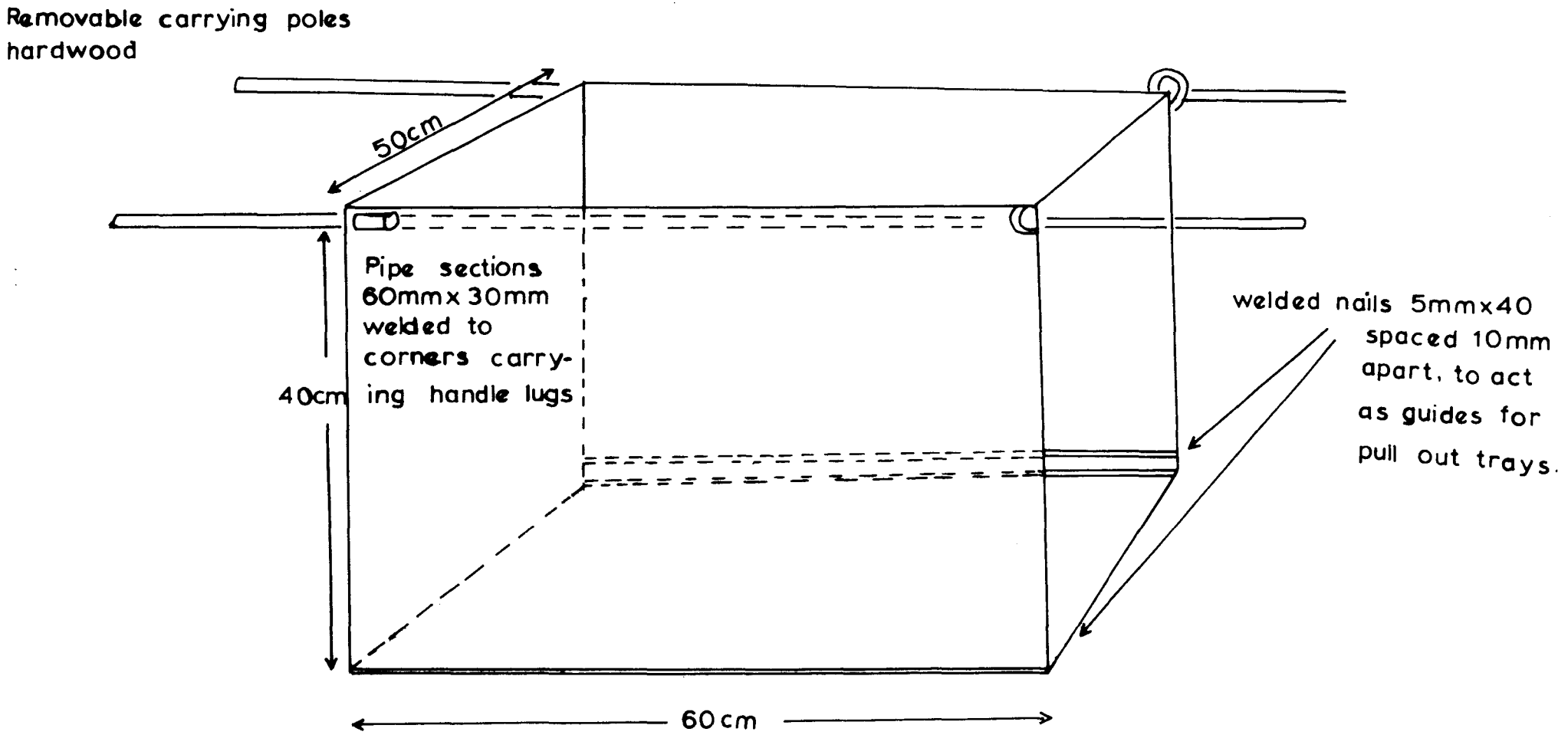
3. When bottom tray securely home whole box lifted out by carrying pole lugs.



4. With Box & clutch on surface carrying pole inserted unit carried away like a motar box.

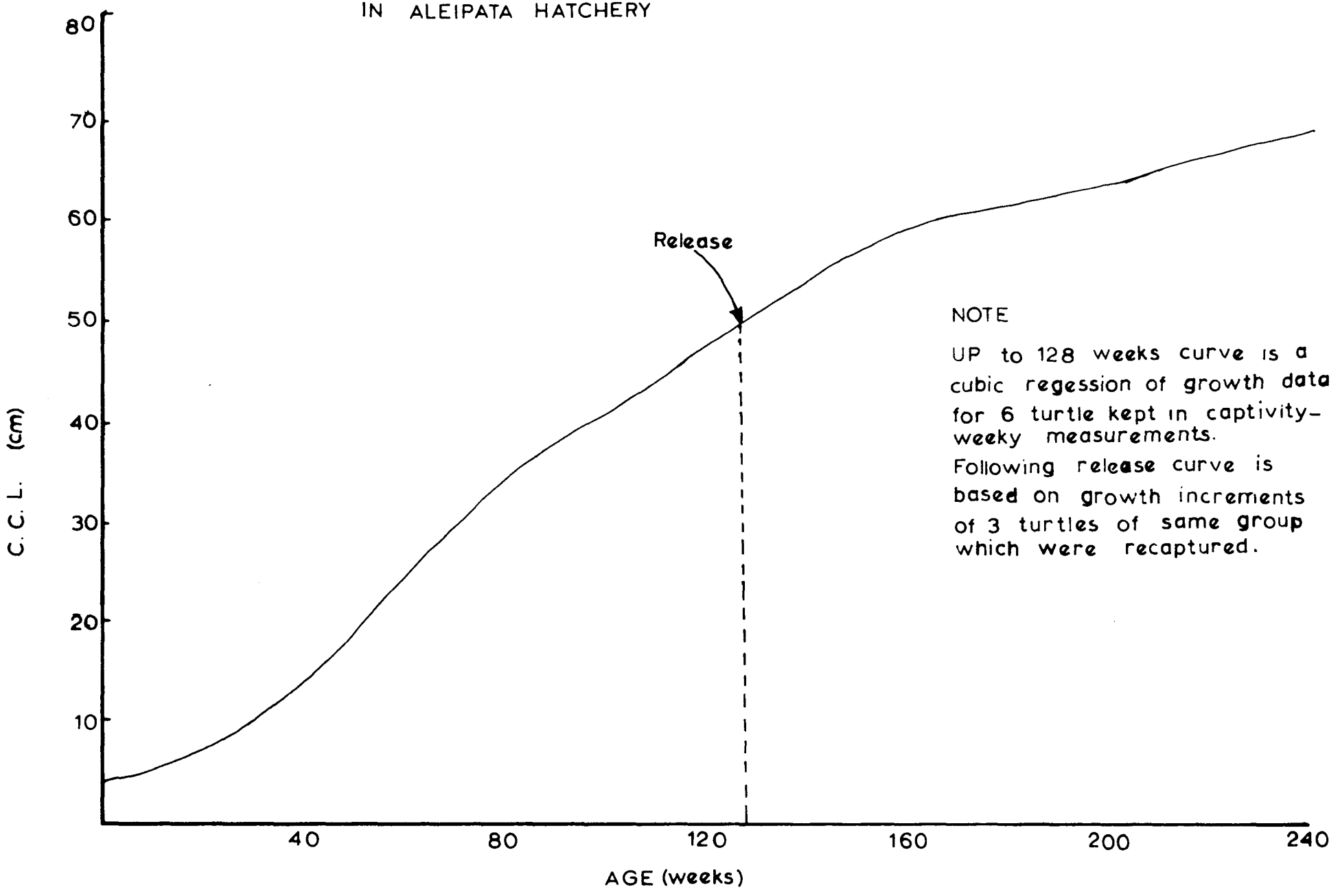
THE "CLUTCH CARRIER" IN OPERATION

TURTLE EGG CLUTCH CARRIER
(constructing details)



Container consists of 4 sided steel box, welded out of 4mm sheet, with open top & separate sliding bottom tray running on guide nails welded longitudinally along inside bottom lip. Tray was 5mm sheet with rouded off corners usually had to hammered home in order to cut through sand blocking the guide nails.

GROWTH CURVE FOR HAWKSBILL TURTLES REARED IN ALEIPATA HATCHERY



NOTE

UP to 128 weeks curve is a cubic regession of growth data for 6 turtle kept in captivity- weeky measurements.

Following release curve is based on growth increments of 3 turtles of same group which were recaptured.