Wolfgang von Hagen Ph. d.

(Contribution to Los Anales de Universidad Central de Quito, Ecuador)

Contributions to the Biology ot the Galapago of the Archipelago de Colon (Testudo sps)

Contributions to the Biology ot the Galapago of the Archipelago de Colon

At present the giant Galapago is known to and confined only to the islands of the Archipelago de Colon. Formerly they were also abundant on several islands within the Indian Ocean. North-west of Madagascar are the Islands of the Aldabra group, the Mascerne group —Reunion, Mauritius, Rodriguez, the Arminates and the Scychelles— these once supported an enormous indigenous Testudo fauna, similar to those that are now found on the Galapagos Islands. The French traveller Lehaut wrote that on his first visit to these Indian Islands that the tortoises covered the ground in such numbers that one might walk for a hundred paces using the backs of the tortoises as stepping stones. And this same prolificacy of distribution also, once existed on the Archipelago de Cólon.

Why, precisely, one finds giant tortoises living only upon these remote volcanic islands of the Pacific is not altogether clear. Fossils of ancient tortoises, ressembling the Galapagos species have been found in Cuba. Other fossilized tortoise, four feet in length, (Testudo peripiniana) has been unearthed in Patagonia. Why the Galapagos Islands, inter alia, should have received an original paucity of the now-extinct Mesozoic reptiles, which henceforth were confined only to these volcanic islands, is a zooligical puzzle that only thorough geological and oceoanographical research will solve.

The distribution of the Testudo fauna on the Archipelago points definitely to the fact that the Islands were once an indefinite land mass. Whether or no they were connected

with the American mainland is at present non-deductable because of the dubious value of present oceanographic knowledge. The Galapago is, or rather was, found on Nine of the archipelago's thirty-three islands. It is singularly absent on some of the islands; principally, Barrington, Bindloe, Tower, Seymour, Crossman and Brattle. Each island possessing a Testudo fauna harbors a unique species, so unique in point of fact that with experience one can distinguish the species immediately, and name the islands from which they came. Precisely what island has the more'pure' type of fauna, that is, the species most akin to the first migratory species, is an academic question, that none may answer. It is however certain to one who has had a vast experience in the islands, and with the handling of the many species, that the fauna is one, and that the varieties that exist between the species has been the result of long isolation.

Apparently neither the altitude of the island, nor its size, nor the amount of Optunian vegetation has anything to do with the distribution of the Testudo within the archipelago. Hood (Española) is only 640 feet, at its highest point above sea level. It is one of the most barren of all the islands, has little or no water, and I myself have found Galapagos dead within their shell, obviously from thirst, and yet and in spite of these hazards the fauna has existed until recent times in teeming hundreds. Bindloe (Marchena) a few miles South of Abingdon (Pinta) is 840 feet in height, has a fair amount of vegetation, but has never had a Testudo fauna, although its nearest neighbour, Abingdon has had a singular and prolific fauna. The same applies to Barrington (Santa Fe) which Island lies in the center of the islands, Indefatigable (Santa Cruz) Chatham; (San Cristóbal) Charles (Floreana) and Hood (Española) all having a unique testudo fauna, of which Barrington possesses none. Nor does the difficulty of terrain or of the distribution of cactus (the principle food of the Galapago) seem to inhibit the species growth. The Islands of Jervis (Ravida) and Duncan (Pinzon) are respectively three and five miles in diameter and encompass within so a short a space a most unusally percipitous and tortuous terrain. One need only climb about Duncan, crawl over its tumbled lava, thorns and percipitous slopes to appreciate fully what such labyrinthian horrors must be to the clumsy Galapago. Yet the tortoise thrives in this environment. And yet Bar-

rington esconsed between four tortoise bearing island, having the easiest terrain of all the islands; possessed of a remarkable and ubiquitous Optunia flora, has supported no tortoise fauna. What then is the natural prerequisites of tortoise distribution. Vegetation? Geology? Water? Natures caprice?

The Galápago is a vegetarian. It eats cactus (Optunia sp.) some grass, and is unusually fond of the pale green filamentous lichen (Usnera plicata) that hangs in tresses from the boughs of the trees. Its eats only during the morning and in the late afternoon. When the sun is in the meridian it retires to the shade, and this factor has something to do with its distribution. In the later afternoon it will again browse over its cactus pad and at dusk retire. The pads of the Optunia, however form its main diet. From this it derives starch, sugar and a good deal of water, as the cactus is made up of 86% water. Its bites are deliberate; stretching out its long neck, it takes goodly portions of cactus, then it raises its head and gazes stupidly about as the throat muscles and tongue crush the substance and propel in down the long throat into the intestines. The tongue, a thick, soft whitish organ seems to press the cactus to the roof of the mouth, and the water from the cactus pours down from the mouth and flows, we may well assume, in considerable quantites into its reserve sack. Thus water is not absolutely essential to the Galapago, but he will drink copious draughts whensoever the opportunity arises. By instinct they move to the Southern side of the Island where there is gathered in certain times of the year, pools of water in the natural crevices of the earth. It plunges its head into the water, at times entirely immersing its head until it appears to have drowned. Occasionally it raises its heads and gives several gulps and plunges it in once again. That water which is not absorbed at once by the system passes into a large sack on the ventral side of the shell near the end of the large intestine. The other organs move over to accomodate this plutonian reserve. As the dry season approaches this water reserve is absorbed by the organism, thus permitting, if conditions so demand, a tortoise going as long as two years without again taking water! I have estimated a water-reserve in a tortoise about 150 pounds of weight as much as 4-5 gallons. Many of these I had occasion to inspect during their slaughter by the natives living on

the Galapagos. It is said (1), indeed, that when inhabitants of the islands would be overcome by thirst, they would often take advantage of the circumstance of this reserve of water within the Galapagó and cut open the shell and drink the contents of the bladder, which they would find to be quite limpid, but slightly bitter in flavor.

When dusk falls the Galapago will find a place to sleep, usually on an even space of ground, devoid of rocks, and prepare to spend the night there. There is apparently no definite resting place, the tortoise merely spending his nights in whatsoever part his wanderings may take him. They do not sleep withdrawn into their shell, as is the general impression. On the contrary, the four feet and the head are stret ched out in full length, the shell resting full upon the ground. Coming across the Galapagos in this attitude one might take it for dead, They sleep from dusk to dawn. When out looking for tortoises the inhabitants of the islands, should they come across a Galapago late in the afternoon will not disturb it, they know that provided they arrive before seven o' clock on the following day it will still be there. That this is true, I myself have seen on numerous occasions.

In moving about in its pursuit of water or food, the Galapago makes a direct line path. In Abingdon I have seen them follow a path to the upper regions, which is true of the other islands also. But in moving forward it veers neither left not right but continues in a straight line. Small trees and boulders are either cut down or pushed out of the way, the tree snapping at its base in exact position of the shell from the distance it is from the earth. In this manner when following the trail of a Galapago, one might tell something of its size.

Between the months of October-November one senses a great movement among the tortoises. This is the inception of the mating-season. The tortoises now move rapidly and seem on a definite search of some complementary mate. In a part known as La Fé on the extreme central Southern shore of Indefatigable I found an area where the Galapago distribution is now, as it perhaps, once was, on many is-

---

(1) Darwin, Charles «Naturalist Voyage around the World». Page 383.

lands. Quite close to the sea where is a flat plain filled with shade-trees and cactus, we counted fifty tortoises within eight hours. Here we observed the first reaction to the sexual stimulus. One could hear distant bellowings, that sounded much like cattle. These were the males, who only use their volce during the mating season. In order to observe them the more closely, five specimens of the genus *Testudo porteri,* were brought with us to our encapment at Academy Bay, Indefatigable, where with unusual good fortune I had the opportunity of watching the Galapagos mating and was able to take the ilustrations that accompany the text. There is, as one will see, ample evidence to deduce that like many of the larger herbivorous mammals, the Males undoubtedly copulate with many females, and bear toward the assembly the same relation as the Male Goat or Bull.

I placed in a large bomboo cage four females and one male and began to watch them daily for the first signs of the sexual instinct. Toward the beginning of November I heard the Male bellowing the first part of the morning and observed the female in rapid retreat from the bellowing and now belligerant male (see Ilustration Nº. 1) She retreated from the male, who bit at her shell and particulary desired to bite her in the neck. The female withdrew into her shell. The male made a steady round of the other females with the same result. By the third day, the actions of the Male becoming more and more animated, one of the females at last yielded. She no longer ran but stood her ground and allowed herself to be buffeted about and nipped. Later the Male mounted the female. The penis of the Male Galapagos is long, rather bell shaped at the terminus with an apparent long groove, from which I gather comes the flow of spermatozoa. Some little difficulty is experienced in the first approaches. The male however mounts, inserts the penis, and copulation proceeds for about ten minutes. Once contact is established, the necessary friction to produce ejaculation of the spermatozoa is accomplished by a most singular method. The female remains passive. The Male lowers and raises its body, the legs (front) being all the time on the top of the shell of the female. The legs in front flex and reflex, and the lower extremities are lowered and raised causing the necessary irritation for the ejaculation of the sperm.

Copulation lasts about ten minutes, the male withdraws and rests after the exertion. When in heat a curious phemenoa arises. Toward the inner corner or canthus of the eye near the lacrimal caruncle a formation of a form of white cataract forms over this part, and is most conspicuous, as will be noticed in the accompanyng illustrations. The eyes too, in the Male, take on a vacant look and seem greatly dilated. This phenomena only appears in the Male. I do not know the physiological significance of this. Nor am I aware that this appears in other reptiles.

Every morning for twenty consecutive mornings this amorous espisode is repeated by the Male. The frequent bellows, the chase and nipping of the females. There is, or at least was, not in these peculiar instances, no definite form of selection. One female received the Male numbers of times, even though she was, perhaps already fecund. In short this female received the Male eight times. The others were taken at the caprice of the Male, the only selection that I noticed was that female which showed less hesitancy was most readily accepted.

After the terminus of the sexual phase, a period of quietude settled amongst my colony. About December one of the females, became exceedingly restless and began scraping at the earth and the stones. I decided to allow her liberty to see her place her eggs in freedom. Unfortunately I did not take the necessary precaution and she escaped my obersation entirely. I had, however, opportunity of observing others in the moment of egg laying.

In buryng the eggs the Female selects a spot somewhat opened to the sun. I have found egg caches at 600 feet elevation and at sea-level, obviously altitude is not too important a factor, save at the higher element it is apt to be damp and cause the eggs to mildew. The female selects a spot where differential erosion has caused quite a deep sediment of eroded earth and she scrapes this away with stones, abandoning the spot should she be unable to get the depth that is required for the egg cache. Eight to twelve inches are hollowed out, the female weilds about and the eggs are dropped into the hole. The legs are spread and held awwardly, as if the female were passing a large feces. The eggs, the exact size of a billiard ball, tumble into the hole made for them. The egg is white, sometimes being spot-

ted with feces from the anus and intestines. They are somewhat soft when laid, but harden rapidly. The female then covers the hole with the earth and stamps it down with the weight of the body. Inhabitants of the islands have told me that in addition to the stamping of the earth the female also urinates on the spot and places in addition a bit excrement which hardens and makes a cement-like surface. I have not seen this myself and thus cannot vouchsafe for the accuracy of the observation. From 8 to 17 egss are layed at one time, and, from the number layed, and the fact that the Female lays perhaps every year, I deduce from what I have found, that all the eggs do not hatch. I found innumerable instances where the egg-cache, has still a number of spoiled eggs and cases where the little Galapago has failed to make its egress. The small Galapagos must, with their fragile claws, scrape away all this hard earth to gain their freedom. Those at the bottom, are sometimes placed so that their efforts to escape avail them nothing and they become exhausted and die. Apparently like all the rest of the reptiles many eggs are laid, in view of the fact that only a percentage will hatch. It is one of Nature's universal compensatory rules of procreation.

I myself, do not know the actual period of incubation of the eggs, I am however inclined to think that the eggs, hatch between 6-8 weeks, the rapidity of the hatching process depending on the locality of the eggs. If placed where the sun reaches them more easily, and the heat be constant, the period of incubation might be hastened. The contrary developing when the eggs are placed in the shade. I recovered eggs from a Female before they were laid, I placed half of them in the ground in a habitat similar to one chosen by the Female Galapagos, the others I placed in an improvised incubator. Those eggs in the ground spoiled and moulded. Those in the box hatched. Again I was enabled, fortunately to observe and photograph the hatching process of the small Galapago.

The brittle covering of of the egg begins to crack as the small head of the Galapagos cracks against it from the inside. To hasten the process I broke off bits until I had broken away a whole side of the egg. Inside rolled up with the shell on the exterior side, was the little Testudo. Rolled in such fashion so that whilst the shell was on the outside,

the small head and the tail met in juxtaposition. The Galapago had small difficulty in freeing itself and then immediately moving about. Save that the shell was flat, it was the exact counterpart of what it would be later on in life. Its methods of movement and the flexing of the limbs being the same.

Attached to the ventral plates near the junction of the hind-legs is a cream-like placenta about the size of a Sucre piece. This the Galapago drags about with it when it walks. It takes no nourishment for the first two weeks, gradually absorbing this placenta until it has finally disappeared. A small hole from whence was attached this placenta is visible for a few days; then it seals itself. There after the Galapago begins to feed. It drank, when offered, considerable quantities of water, and I fed it papaya. In free nature I assume it eats tufts of grass and cactus pads.

It weighs at birth an average of $2^1/_4$ ounzes. The growth in the first years is comparatively rapid. The Galapagos doubling its weight and length in the first year. The shell almost flat at birth, has by the third year become greatly convex so that its «curved» length is almost as great as its «curved» width. After the Galapagos has attained 15-25 years the growth is less rapid. We understand it grows about $^1/_2$ inch a year. Growth is strangely accelerated by the falling of the sections forming the shell. About the Galapago, it will be noticed, is a series of sections; these become loosened from the nerve fibres and fall out, and under these is a new section of shell. I believe these «moults» are replaced every year. Thus in brief is a resumé of the biology of the Galapago.

Concluding remarks

The lack of further details of the biology of the Galapagos, our lack of knowledge if this biology, as related to the *Testudo porteri,* is true about all the other Testudo species of the Galapagos Islands, makes a closer and more detailed study of the Testudo species imperative. It will, too, give us some idea of the processes that have brought this transformation of a species of Testudo about, it may help us determine in what manner the Galapago came to these volcanic islands separated ted from the continent by 560 miles of water.

How did the Galapagos tortoises come to the Islands? Why did the last remaining giant Meszoic reptiles determine upon these islands as the last stand against those factors that annihilated their contemporaries? Frankly no one knows. Hypotheses advanced by students of Hereptology are so overdrawn as to border on the ridiculous. Dr. Townsend (2) says «It would not be a *wild guess* that tortoises were taken to the Galapagos Islands by primitive man. Speculation regarding such matters is interesting however inconclusive». Such a statement disregards the time-space elements. Are we to suppose that these «primitive men» brought *Ten distinct species to* the Galapagos Islands, placing a distinct species on as many islands? That would be a primitive zoological feat indeed. Or perhaps we understand that 'primitive men' merely brought one species to the Galapagos Islands when these islands were all part of the land mass and the subsequent submersion of part allowed the respectively isolated tortoises to develop their own chacacteristics. The genes of evolution are indeed plastic, but certainly they cannot disregard the gracious patina of time. Such transformations that took place in the tortoises that caused them to be separated into distinct, indeed very distinct species, was not less than 50-75,000 years. And where, and who, were our «primit ve man» then?

The land bridge theory, the theory that connects the Islands with the continent is attractive, put we only have vagiue and generalized Oceanographic figures to prove it. In fact most of the depth in the waters from the Galapagos to Panama is on an average of 2.000 fathoms. If this land bridge existed in the Age of Reptiles it would be understandable why only Reptiles crossed it, and not mammals; as is known, outside of a small rat that is endemic, that, with a small bat, are the only mammals that the Galapagos possesses.

From the Termites, to the plants, to the unqiue reptilian species, the zoological finger points to an isolated land mass, lying in the Pacific, entirely volcanic, the result of subterranen volcanic activity, that built the islands up, layer upon layer, until they rose above the sea, helped no doubt by a certain volcanic 'pushing' heavenward. Such was Darwin's conception (3); Such is Teodore Wolff's conclusions (4); such, finally, is the re-confirmation of Agassis (5).

Why is it incumbent to posit an unproven land bridge theory, of distribution by primitive human mythical agencies when the Galapagos tortoise can swim? That it can swim, the author has proven often pragmatically, and I myself have seen a large 450 pound Galapago having escaped from its Galapagero near the sea swimming off across Academy bay with the natives in pursuit in a boat. The reader's attention is called to the peculiar development of the fore legs. The jointing of the leg, its comparative flatness when juxtaposed with that of the hind legs, reveals ambulatory digits that were formed, phylogenetically, for something else than for walking. Why is it not zoologically possible for the Galapago in former centuries to have had a swimming ability, which it subsequently lost or abandoned when the Testudo became a'pure' land species? If we term the Whales return to a maritime element from that of a terrestrial habitat, *involution.* If the Dolphin sought for the same reason a return to the sea; if the Seal-Lion felt it expedient to imitate fish-form and changed physiologically to meet its new maritime element, why might not the Galapago have evovled from a quasi sea-species to a 'pure' land species. It is a peculair faculty of man, in his romantic meanderings after fact to circumvent what is most obvious. Man seems to unravel everything in theory, and tangle up everthing in fact.

LITERATURE

1) Darwin, Charles «Naturalists Voyage around the World». London 1870.

2) Townsend, Chas. H. «The Galapagos Islands Revisted». *Bulletin New York Zoological Society.* September-October 1928.

3) Darwin, Charles: Op. cit.

4) Wolff, Teodor «Ein Besuch der Galapagos Inseln». Heidelberg 1870.

5) Aggazis, Alexander «Report on the Albatross». Cambridge U. S. A. Feburaray 1892.