# NOTICIAS DE GALAPAGOS

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CONTENTS



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# NEWS FROM ACADEMY BAY

## THE CONTROL OF FERAL INTRODUCED MAMMALS

The disastrous invasion by wild dogs of the land iguana colonies on Santa Cruz and in the Cartago Bay area of Isabela was reported in Noticias 25. An emergency campaign was quickly organised with WWF support, but this is at best only a holding operation. The wild dogs are still there. Their range seems to be expanding and they can always expect new recruits from the villages and farms outside the National Park boundaries. Hunting them in the harsh and rugged terrain of Isabela or Santa Cruz offers no adequate solution.

At its last meeting, the Executive Council of the Charles Darwin Foundation discussed this problem at length and also the related problems of cats, rats, pigs and goats. Although there was deep satisfaction at the way in which goats have been eliminated or brought under control on some of the smaller islands, it was obvious that more drastic, possibly biological, methods would be needed to deal with the menace of introduced species on the biggest islands. However, the Council was fully alive to the dangers of applying new methods without the most careful study of their implications. It was agreed that the first step should be research at the highest possible level. This might well take years and would certainly cost money that the Charles Darwin Foundation could ill afford but it should be given top priority; feral animals were far and away the most serious threat to the Galapagos ecosystems and it was obvious that a hundred thousand resident goats did infinitely more damage than ten thousand very temporary tourists. Sir Peter Scott pointed out that a major effort was justified because this was not just a Galapagos problem but a world problem of deep concern to IUCN and WWF and any solutions would be of universal value.

Such research has already been in progress for some time: on the black rats by David and Deborah Clark and on the vast herds of goats on James Island (alias San Salvador or Santiago) by Dr Tjitte de Vries and Sr Luis Calvopiña. The object is to study these destructive pests – their population dynamics, movements, ranges, reproductivity, feeding habits, etc – with a view to finding weak points through which they could be attacked. Now this programme is to be extended to cover dogs and cats. Discussions were begun in May with the US Fish and Wildlife Predator Control Service regarding the dog problem and with the University of Florida and the National Geographical Society regarding research into the behavioural ecology of the feral cats. These projects are essentially long-term as they involve scientific investigations in depth: but without this, effective conservation methods are unlikely to be developed.

## PRESERVING THE THREATENED LAND IGUANAS

The importance of "pure" scientific investigation to conservation is well illustrated by the current rescue plan for the threatened land iguana populations. Dr Dagmar Werner did not come to the Galapagos to take part in an emergency conservation project: she came as a visiting scientist to do basic research – a three year study of the land iguana's population ecology and social behaviour. Most of her time is spent camping on Fernandina, the largest island that has never been colonized by man, which is happily free from introduced mammals and which has the most numerous populations of land iguanas. It was by mere chance that she was available at the time of the massacres on Santa Cruz and Isabela, but without her detailed studies of the

iguana's peculiar social organisation and behaviour (several aspects of which are new and seem to be unknown in other reptile populations) it would not have been possible to design such an effective rescue and preservation operation as that now being carried out by the National Park Service.

Survivors of the decimated populations from both Isabela and Santa Cruz were taken to the Darwin Research Station where pens were hastily built for their accommodation. Another group was removed to a tiny islet just off the coast of Santa Cruz which, with the addition of some tons of soil from the iguanas' former breeding area, has provided what one hopes will prove a reasonably satisfactory and safe habitat until the dog problem is solved. Meanwhile Mr Howard Snell of San Diego University, a volunteer under the Smithsonian Institution's Peace Corps Environmental Program, has arrived in Academy Bay. He is a herpatologist with experience in captive maintenance and breeding of reptiles and he will work with the Park Service and the Station for the next two to three years to develop a complete conservation scheme for the land iguanas.

## FUR SEALS

Dr Fritz Trillmich has recently reported on the present status of the Galapagos Fur Seal (*Arctocephalus galapagoensis*) for the purpose of bringing the IUCN data sheet up to date. His report includes the following encouraging news:

**Status** – Abundant and widespread. Once common throughout the Galapagos Islands it was reduced to near extinction by sealing expeditions, and was believed to be extinct in the early 1900s. In 1932-33, Captain G Allan Hancock discovered a small group of fur seals on Isla Genovesa. In 1957 another colony was found on Isla Santiago which at that time was estimated at about 100 animals. In the 1960s the much larger colonies on Isla Fernandina and northern Isla Isabela were discovered. Presumably the species has been slowly recovering and extending its range since the 1930s but due to its rather inaccessible habitat has long been overlooked. At present, as a result of its absolute protection, the species seems out of danger if hunting and capture continue to be prohibited.

**Distribution** – Restricted to the Galapagos Islands.

**Population** – Certainly more than 5000, perhaps as many as 10,000 animals. Breeding colonies on at least 11 islands.

## THE PACIFIC GREEN SEA TURTLE

Derek Green is continuing his ecological study of *Chelonia mydas,* the most widespread but also the most over-exploited sea turtle in the world. In the Galapagos, the local sub-species, *C.m. agassizi,* for the time being enjoys government protection but it is important that future policy should be based on a thorough knowledge of its population numbers, reproductive potential, hatching success, survival rates and food supply. To this end it is necessary to count, weigh and measure females on selected nesting beaches and, in addition, males and juveniles as well as females in the feeding areas, where they are captured by skin diving. (This is the only sea turtle study in the world in which extensive capture and tagging of males and juveniles has been successful.)

During 1977-78 Derek Green, who spends 80% of his time in the field, will be assisted by a volunteer biologist and two trained local helpers and also, throughout the nesting season, by Ecuadorean biology students and National Park wardens. This will enable more beaches to be patrolled, day and night. As an illustration of the scale of this operation, in 1975-76, 810 adults were tagged and 6,550 hatchlings were marked and released safely at the water's edge.

An interesting spin-off from the main investigation is the study of a rare type of turtle which exists in the Galapagos. Known to fishermen as the "Yellow Turtle" it has never been described scientifically nor are there specimens in any museum. It may prove to be a sterile mutant of the green turtle but it is obviously desirable to establish its scientific status.

## WHALES

"I have also seen the whales coming, as it were, from the main, and passing along from the dawn of day until night, in one extended line, as if they were in haste to reach the Gallipagoes." Captain James Colnett of the Royal Navy reported in these terms to the British Admiralty on his visit to the Galapagos in HMS Rattler in 1792-3. The voyage was authorised because the whaling catch in the Atlantic was declining owing ot over-killing and there were unconfirmed stories of richer spoils in the Pacific, at that time a region completely unknown to the northern whalers. Colnett stayed a considerable tim e in the Galapagos, improved the pirate Cowley's map of the archipelago, and re-named various islands, including Chatham, Hood, Barrington, Duncan and Jervis. Encouraged by Colnett's report, the British and then the North American whalers reached the Galapagos in the early days of the 19th century. It was whaling that brought Herman Melville to the islands. Great fortunes were made but long before the end of the century the whalers had destroyed their own occupation by unrestricted slaughter. Today nobody sees the great whales "from the dawn of day until night" on the voyage from Guayaquil but there are still plenty of dolphins (small whales) to delight the visitor to the islands, who also has a good chance of glimpsing some of the bigger species. In this issue Jan MacFarland tells of her own sightings in a light-hearted piece with no scientific pretensions. She first came to the islands eight years ago when her husband was doing basic research on the giant tortoises and has now spent a further four years with him in his present capacity as Director of the Charles Darwin Research Station. The Van Straelen Hall and the library owe much to her voluntary services and she will be greatly missed when she leaves with her husband at the end of this year.

## MARINE BIOLOGY AND OCEANOGRAPHY

All too little is still known about the marine environment of the Galapagos, but is now arguable that, from the scientific point of view, it is *at least* of the same value as the terrestrial eco-system. Moreover, while the latter has suffered serious damage from man and his introduced animals, the pristine condition of the marine environment has been little disturbed. The large number of different habitats, the unusually complex system of annual changes in water conditions, the convergence of many oceanic currents, the high percentage of endemism in almost all groups of near-shore flora and fauna and the high primary productivity, together make the Galapagos a very special place for studies of marine ecology and oceanography. Certainly the underwater world of the archipelago is attracting more and more attention from both scientists and tourists. This may be partly due to fashion and to the improvement of diving equipment, but our increased though still scanty knowledge of the resources is the primary cause.

In the early days of the CDRS relatively little attention was paid to marine biology – if only because there was so much that demanded urgent action on land. Only seventeen of the four hundred-odd visiting scientists who have worked at the Station have been marine biologists, but most of these have come in the last three years. Their numbers are rapidly increasing although the Station lacks the basic facilities it would like to offer them. Collaboration with other national and international bodies provides partial solutions, as Jose Canon (Deputy Director of the CDRS) points out in an article elsewhere in this issue, but a marine laboratory, however modest, is obviously needed. However, this is only the beginning of the problem: a laboratory would mean more marine scientists, who would need more accommodation (the Station is already refusing applicants) and more facilities, while the overheads of the Station would be increased in every department. Yet the CDF seems to be being driven willy-nilly into this expansion. Should the Foundation, as so many times before, simply go ahead and do what it knows ought to be done, in the desperate hope that the funds will somehow be raised before the bills have to be settled ?

## EXTRACTS FROM THE PRESIDENT'S NOTEBOOK

Dr Peter Kramer visited the CDRS again towards the end of 1976 and made the following brief notes on the activities of scientists then working at the Station.

**Leonardo Maridueña** (Universidad de Guayaquil): the ecology of the three booby species; also helped to supervise students and assisted Bob Tindle in his flamingo studies.

**Madre Yolanda Silva, Madre Etelvina Hernandez, Inez Yepez, Yolanda Sandoval** (Universidad Católica de Quito): different aspects of tourist impact on sea bird colonies and the ecology of frigate birds.

**Cecilia Donoso and Yolanda Paez** (Universidad Central): ecology and distribution of red ants.

**Oliva de Blanco** (Universidad Central): the comparative structure and ecology of Miconia communities on Sta. Cruz and San Cristobal and the effects of introduced plants (particularly Cinchona) on these communities.

**Sonia Cueva** (Universidad Central): the invasion of introduced plants along the new road across northern Santa Cruz.

**Jorge Ayala, Patricio Ramón, Bernado Beate, Pete Hall** (Escuela Politécnica Nacional): petrology and mapping of Islas Española and Genovesa.

**Peter Boag and Laureen Ratcliff** (McGill Univ) are back on the Islands for another period to investigate the ecology and adaptive radiation of Darwin's Finches.

**Tom Fritts** (San Diego Natural History Museum): differentiation of tortoise subspecies by external shell characteristics.

**Inka Trillmich** (Max-Planck-Gesellschaft): behaviour and ecology of marine iguanas.

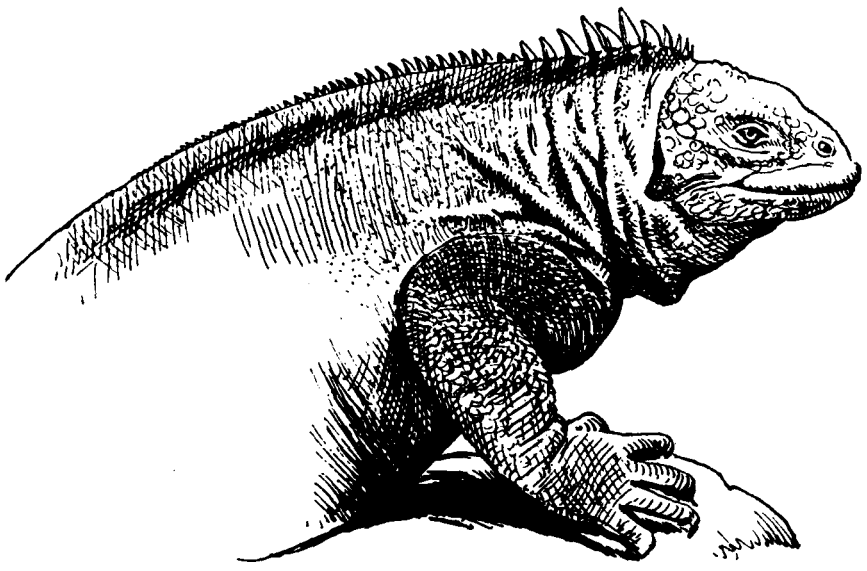
**Fritz Trillmich and Birgit Voigt** (Max-Planck-Gesellschaft): social behaviour and ecology of sea lions and fur seals.

**Gunther Reck and Pedro Ortiz** (Instituto de Pesca, Ecuador): distribution, population dynamics and feeding ecology of the most heavily exploited marine species: Bacalao and other large predatory fish and lobsters.

**Bob Tindle** (resident scientist): tourism impact in visitor areas and the ecology of Galapagos Flamingoes. His wife Liz works part-time as librarian (succeeding Jan MacFarland, who set up the basic library system).

**Stig Jepensen** (Unesco associate) left in October. He continued his predecessors' research on introduced plants and plant distribution surveys (main instrument: monitoring of sample quadrats) and carried part of the administration load.

Twelve Ecuadorean students worked at the Darwin Station during 1976.



Land Iguana *Conolophus subcristatus*

*Drawing by Peter Scott.*

## CHANGES IN THE STRUCTURE OF THE DARWIN FOUNDATION'S EXECUTIVE COUNCIL

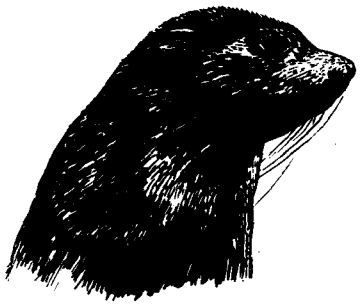
Under the agreement signed in Quito in 1964, immediately after the inauguration of the Research Station, the Charles Darwin Foundation became the consultant of the Government of Ecuador on all matters of scientific investigation and conservation of nature in the Galapagos Archipelago. As there was at that time no national conservation agency in the islands, the Research Station undertook this function and carried it out for some years, always with the unwavering support of the Government. In due course a Galapagos National Park service was created and has gradually taken over all of the conservation work, while mainfaining the closest day to day co-operation with the Station. (The only telephone in the archipelago is the inter-com between National Park headquarters and the Station's laboratory!)

This collaboration has been admirable and has produced results that would have surprised and delighted those who were present at the inauguration. But with the expansion of the National Park Service, the creation of a flourishing tourist industry and the increasing participation of the Universities and Polytechnics in the scientific work of the Darwin Station, the national authorities became more and more involved so that even the most cordial co-operation in the field did not seem to meet all requirements. Under the 1964 agreement, the Government of the Republic had the right to nominate an official representative on the Executive Council of the Foundation but had never taken advantage of this, although various citizens of Ecuador have served in their individual capacity on both the Council and the Scientific Advisory Committee. The Council therefore proposed to the Government that the heads of the six national institutions most concerned should become members *ex officio*. This proposal was accepted and the new composition of the Executive is set out on the last page of this journal.

The achievements in the Galapagos since 1964 both in science and conservation have won world-wide recognition and are a remarkable testimony to the policy of collaboration between national authorities and international scientists. The recent changes in the structure of the Executive Council should strengthen this joint effort still further.

PETER KRAMER

G T CORLEY SMITH



Galapagos Fur Seal *Arctocephalus galapagensis*

*Drawing by Peter Scott.*

# BRYOPHYTES AND LICHENS OF THE GALAPAGOS ISLANDS

*A joint exploration by the University of Colorado Museum (USA) and the University of Utrecht (Netherlands), April-July 1976*

*Supported in part by grants from the National Geographic Society and the Netherlands Foundation for the Advancement of Tropical Research (WOTRO)*

## INTRODUCTION

The main purpose of this study was to complete explorations begun in 1964, of the flora of mosses, liverworts, and lichens of the various islands, as a basis for writing a definitive Flora of the Galapagos Ialands. This project was directed by Dr W A Weber (USA), whose work has been mainly on the lichens and mosses. Participants in the expedition were Dr S Rob Gradstein and Mr J H M Sipman (University of Utrecht), concentrating on liverworts and mosses, and Miss Jeannine Lanier (University of Colorado) assistant to Dr Weber, and concentrating on lichens.

Approximately 1,800 collections of bryophytes and lichens were made on the following islands: Floreana, Isabela (Volcans Alcedo, Cerro Azul, and the coastal areas of Wolf), Pinta, Pinzon, Rabida, Santa Cruz, San Cristobal and Santiago (James Bay). After completion of the identifcation and labelling, sets of these collections will be deposited in the herbaria of the Charles Darwin Research Station and the Catholic University in Quito, as well as the home institutions of the researchers. Copies of the final publication, written in English with Spanish summary, will be made available to the central office of National Park Galapagos and the Darwin Research Station. Interim reports, including an introduction to the lichens of the Galapagos have been prepared, and Spanish versions are being made available through the Darwin Station.

In the present report, some of the major features of bryophyte and lichen distribution, in relation to habitat and altitudinal zonation, are pointed out. These data should be considered preliminary since many species identifications require verification. In fact, identification, especially with the crustose lichens, is a very difficult task because the literature is so scattered and type collections of many species are extremely meagre and scattered in many herbaria over the world. Many of the common large genera have never been monographed or summarised critically. Providing keys, descriptions and illustrations of Galapagos species, in conjunction with distribution and habitat data, will help to fill a gap in the literature and will permit comparisons regarding the cryptogamic flora vis-a-vis the phanerogam flora as to island endemism, the crucial biological problem in the Galapagos Islands.

## NOTES ON DISTRIBUTION IN THE GALAPAGOS

BRYOPHYTES: Previous publications reported about 145 species of bryophytes: 80 liverworts and 65 mosses. This number will rise to c. 200 species of bryophytes (110 liverworts, 90 mosses) as a result of our collections. We were able to rediscover over 95 per cent of the species previously reported, and about 30 liverworts and 25 mosses were found new to Galapagos. Several liverwort species, belonging to the genera *Plagiochila, Frullania* and *Colura,* are new to Science. Of mosses almost 90 per cent of the species are neotropical in distribution, including some rare taxa from Central America or the Caribbean area *(Gymnostomiella orcuttii,*

*Erpodium domingensis, Crossomitrium orbiculatum, Porotrichum insularum).* Of liverworts about 75 per cent of the species are rather common neotropical elements whereas almost 15 per cent are pantropical or even subcosmopolitan. Probably not more than 5 per cent of the bryophytes are endemic to Galapagos. Of liverworts less than 10 species might be true endemics (*Metzgeria grandiflora, Notothylas galapagensis, Plagiochila spinifera, Plagiochila* sp. nov., *Radula galapagona, Riccia howellii, Frullania* and *Colura* spp. nov.) whereas among the mosses there may be one or two. However, the continuing inadequacy of our knowledge of mainland South America's cryptogamic flora leaves most of these somewhat suspect. Like ferns, bryophytes are easily dispersed by means of wind-carried spores over long distances and therefore endemic species are not likely to occur on Galapagos.

Nevertheless, it appears that the bryophyte flora of the various islands of Galapagos is far from uniform. Some islands are very rich in species while on other islands bryophytes are totally lacking. Both qualitatively and quantitatively we found considerable differences in the assemblage of the bryophyte flora of each island. These differences may be due to the age of the island or volcano, climate (especially precipitation), soil or rock composition, vegetation, and the influence of man and his cattle. Most bryophytes favor moist habitats, bryophytes achieving dominance over lichens where moisture dominates as liquid water and lichens dominating in areas bathed by fog. In Galapagos bryophytes therefore are more common in the highlands, and in fact almost two-thirds of the species occur only above 350 metres. South-exposed slopes (with high precipitation) are usually richer in bryophytes than the dryer north-exposed slopes as, for instance, on Santa Cruz, San Cristobal, Pinta and Cerro Azul (Isabela). The total number of the species of liverworts encountered on the principal investigated islands is as follows (data on mosses not yet available):

| | | | |
|---|---|---|---|
| Santa Cruz | 60 spp. | Floreana | 35 spp. |
| San Cristobal | 60 spp. | Alcedo (Isabela) | 35 spp. |
| Cerro Azul | 50 spp. | Pinzon | 25 spp. |
| Pinta | 40 spp. | | |

Since bryophytes are very poorly represented in the arid zone they are rare on dry islands such as Espanola, Genovesa, Marchena (mosses occur here only around fumaroles), Rabida (a few liverworts at the summit), Santa Fe and the volcanos Wolf and Darwin (Isabela). On the smaller islets they are probably totally lacking. Santiago, Sierra Negra (Isabela) and Fernandina have not been investigated. From our preliminary data we might suggest that the bryophyte flora of Santiago is comparable to or slightly richer than that of Pinta, whereas the Sierra Negra flora and that of Fernandina might in richness not exceed those of Floreana viz. Pinzon. The richest bryophyte areas in Galapagos are the southern slopes of Santa Cruz, San Cristobal and Cerro Azul on Isabela. These are probably the areas of Galapagos where the highest rainfalls occur and the most reliable.

VEGETATION OR HABITATS WITH HIGHEST SPECIES DIVERSITY:

1. *Scalesia pedunculata* or *Zanthoxylum* woodlands, as on Santa Cruz (300-700 m) and Pinta (350-600 m). In these moist, dense woodlands growth of epiphytic bryophytes (on trees and shrubs) is luxuriant; festoons hang down from branches and twigs of the mosses *Meteoriopsis patula* (200-600 m), *Squamidium* spp. (3 species, mainly above 500 m) and liverworts belonging to the genus *Frullania* and genera of *Lejeuneaceae.* More than 50 per cent of the liverworts of Galapagos belong to these two groups. The festoon-forming bryophytes

are the principal components of the nests of woodland birds. Many organisms, eg: snails, are found inside the dense bryophyte mats, which contain large quantities of moisture. On Floreana and San Cristobal this type of woodland has been (gradually) changed into monotonous *Psidium guaiava* stands which are poorer in species.

2. *Miconia-Cyathea* shrub of Santa Cruz and San Cristobal. This type of vegetation is probably best developed at present in the "encanadas" of southern San Cristobal (see below). The soil below *Miconia* and *Cyathea* is usually carpeted by a thick mat of liverworts. On Santa Cruz, around Media Luna, *Miconia* stands are lower and disturbed by cattle; there the ground cover is made up of mosses. Twigs of *Miconia* invariably have festoons of the liverwort *Ceratolejeunea cornuta* which occurs exclusively in this vegetation type. The evergreen leaves of *Miconia* are of interest because minute, rare liverworts and lichens grow on them.

3. The permanent streams of San Cristobal, between El Junco and Bahia de Agua Dulce. The alluvial soils along the running water in the "encanadas" of southern San Cristobal are carpeted by bryophytes, especially liverworts. About 10 new species for Galapagos, including 4 new genera, were found here. The flora in general of the permanent streams (including waterfalls!) is unique for Galapagos and it is hoped it can be preserved for the future.

4. The "pampas" of Cerro Azul. These are the wettest and most extensive true pampa (treeless) areas of Galapagos, extending from 300m to the top of the volcano. Their soils provide the best habitats for thallose liverworts such as *Marchantia, Riccia, Fossombronia* and *Anthoceros,* and small mosses, eg: *Bryum* spp. and *Philonotis.* They thrive on open, moist soil trampled by cattle. The moss *Enthostodon bonplandii,* new to Galapagos, grows exclusively here, and in great quantity! Of 23 species of thallose liverworts known to Galapagos, 7 occur exclusively on the pampas of Cerro Azul, among them the Patagonian *Sauteria berteroana* found only at altitudes of 1300-1400m !

On the SE slope of Cerro Azul, at an altitude of c. 800m, an area with two small adjacent craters has the most luxuriant terricolous and saxicolous bryophyte vegetation seen anywhere in Galapagos. Ferns are abundant here, too. Species belonging to the typical High-Andean *paramo* moss genera *Breutelia* and *Thuidium* are abundant as well as species of the liverwort genera *Herbertus* and *Bazzania.* Ca. 5 bryophyte species are exclusively found in the *paramo*-like area, for the "dry" Galapagos Islands an extraordinary kind of landscape. The *Sphagnum-Cyathea* vegetation seen everywhere on the walls of the two craters resembles Color Plate 59 in Wiggins & Porters (1971), "Flora of the Galapagos Islands".

LICHENS: Previous publications (Weber 1966) reported about 76 species. Unfortunately, the taxonomy of the lichens before 1950 was very primitive and a great many of these reports are based on misidentifications. Nevertheless, approximately that number can be accepted under their correct names, although a few reports based on the older expeditions evidently were erroneously attributed to the Galapagos Islands. At the present time we have a total of 226 species fairly well identified and probably over one hundred unidentified, so that the total of lichen species will approach 400. It will probably be a very long time before identifications can be made on some of the larger, common crustose genera where one must really await careful monograph treatment. It is best to refrain from making hasty identifications in these difficult groups.

Phytogeographically, the lichens may be sorted into several groups. Because of the facts stated above, some of our feelings about phytogeography and endemism have to be tentative. However, it is beginning to appear that there is a distinct endemic segment, that of the saxicolous lichens inhabiting the rocks of the immediate coast or, if at higher elevations, still enjoying the ecological conditions of the coastal area. It is obvious that high humidity is necessary for the survival of this element, as can be seen on areas on the low islands where, back from the sea, the horizontal faces of the rocks are too dry and hot to support lichens, while the same rocks may support rich assemblages on their vertical faces where they receive greater protection from the sun, and are occasionally bathed by moist air and fog. The coastal rocks of Galapagos, wherever they have pronounced vertical aspects, are visible from great distances as being lichen-coloured, the predominant colors being white, yellow and orange.

The coastal rock lichens tend to belong to genera and taxonomic groups closely related to the coastal Chilean lichen flora. Several of these have been shown to be endemic to Galapagos *(Buellia galapagona, Roccella galapagosense)* and we found in 1976 one species, *Lecidea chilena,* formerly believed to be endemic to Chile. We suspect that a high proportion of these lichens will prove to be endemic.

The rock lichens of the interior tend to be more widely distributed lichens with geographical affinities more with Central America and the Caribbean than with the South American mainland. The rock lichens of the moist highlands are relatively few in number and tend to be very widely distributed highland species.

The corticolous lichens of the Galapagos appear to be, with very few exceptions, species at least known elsewhere in the neotrophics or actually very common Neotropical species. A few are highly disjunct, suggesting that collecting on the mainland is still too poor to give proper indications of distribution. For example, a common lichen on Santa Cruz, *Schistophoron tenue,* was previously known only from lowland open forests of West Africa! Many of the smaller crustose lichens growing on bark belong to groups which are very poorly understood taxonomically.

The fruticose lichens occurring on the summit highlands in the fern-sedge zone tend to belong to groups characteristic of the Andean and Central American highlands. Those few which have been considered endemic are questionably so. *Cladia aggregata* is a very common highland lichen throughout the southern Hemisphere. The highland lichen flora is not very rich since it cannot easily compete with the rank growth of ferns, sedges, liverworts, and mosses. Crustose species growing on rocks are limited to only a few species: *Trapelia coarctata, Diploschistes scruposus, Leprocaulon microscopicum,* etc.

While lichens are not particularly diversifed on the trunks of trees in the Scalesia forests, some of the more interesting species occur there alone. Some of these species are extremely rare and scattered; it is here that we encounter *Erioderma, Pseudocyphellaria, Sticta, Leptogium* – the larger foliose lichens with the highest moisture requirements. A few of these, such as *Leptogium* ssp. and *Sticta weigelii* find alternative substrates on the ground in the fern-sedge zone, where they form a dense cover on the bare soil between vegetation patches. The complex genus *Parmelia,* recently divided into a number of smaller genera, is ubiquitous on the islands, several species occupying almost every lichen niche, whether rock, bark, or soil. *Cladonia* is well represented and diversified particularly on the rocks and soil of the moister zones. *Roccella babingtonii* is dominant and very conspicuous on the bare branches of trees in the Bursera

forest and in historic times was an important export to the mainland since it was used to produce purple dyes.

CONCLUDING REMARKS:

1. The present investigation has yielded total of c. 200 bryophytes and 400 lichen species for Galapagos. Over 80 per cent of the bryophytes are rather common neotropical taxa, while at most 5 per cent are endemics. The statistics for lichens are not reliable at the present time, but the percentage of endemics will be higher because of a strong endemism of the coastal rock species.

2. The islands with the highest species diversity are Santa Cruz, San Cristobal and Volcano Cerro Azul on Isabela. Apparently bryophytes favor moist sites with high humidity rather than liquid moisture. About two thirds of the bryophytes occur exclusively above 350m, while lichens are more evenly distributed through the dry and moist zones. The richest habitats for bryophytes on Galapagos are:

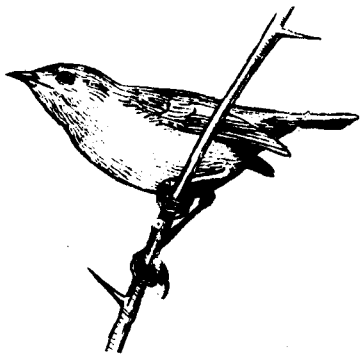
A. Moist *Scalesia pedunculata* or *Zanthoxylum* woodlands, as on Santa Cruz and Pinta.
B. *Miconia-Cyathea* scrub (S. Cruz, S. Cristobal).
C. Permanent streams of San Cristobal.
D. Pampas on southern slopes of Cerro Azul.

3. Considerable differences are seen in the assemblages of bryophyte floras of the different islands. The causes of these differences need further investigation. There is very little difference between islands as to lichen assemblages except that the altitude of the islands determines whether the more mesic element will be present.

4. Future protection of the permanent streams of San Cristobal should be considered, in view of its unique bryophyte flora.

26 September 1976

William A Weber
S R Gradstein
Jeannine Lanier
H J M Sipman



Warbler Finch
*Certhidea olivacea*

*Drawing by Peter Scott.*

## ESTUDIOS OCEANOGRAFICOS EN GALAPAGOS QUE SE REALIZAN CON LA COLABORACION DE LA ESTACION CHARLES DARWIN

Una de las características más sobresalientes en los últimos años de la labor desarrollada por la Estación Científica Charles Darwin ha sido el mayor grado de involucramiento en los estudios marinos. Luego del estudio (Noticias 24 y 25) realizado en 1975 por G M Wellington, un voluntario del Cuerpo de Paz do los Estados Unidos quien trabajó en la Estación por dos anos y cuyo trabajo final permitió sentar las bases para el establecimiento de un parque marino, varios otros trabajos se han iniciado teniendo como base la Estación Darwin, la mayoría en cooperación con instituciones científicas nacionales y extranjeras.

En Julio de 1975 se inició un estudio de las fluctuaciones del medio ambiente físico y de algunas características de la variación del zooplancton y del fito-plancton en las aguas circundantes de las Islas Galápagos, por parte del Instituto Oceanográfico de la Armada del Ecuador. La información se recolectó a bordo del M/N Iguana, buque de turismo de la Empresa Metropolitan Touring, la que colabora activamente con los estudios oceanográficos realizados en las islas. La Estación Charles Darwin actuó como el organismo coordinador y supervisor del programa dándole también la necesaria difusión a este. Durante un año se recolectaron en cada viaje del Iguana datos de temperatura, muestras de agua para determinación de salinidad, muestras de fito y zooplancton en 9 sitios diferentes en las islas. Adicionalmente se recolectaron muestras de agua y se registró la temperatura cada cuatro horas en el trayecto entre Guayaquil y Galapagos y vice-versa. Le secuencia de viajes fue de cada 21 días.

Las muestras de zooplancton obtenidas han sido separadas por principales grupos taxonómicos en cada isla y en cada viaje. Una estimación de la abundancia de cada grupo con respecto al total y de sus variaciones anuales ha sido hecha para los grupos principales (copepodos, eufásidos y quetognatos; huevos y larvas de peces han sido también estudiados). El trabajo se encuentra en proceso de revisión antes de su publicacion final. Las muestras de fitoplancton han sido estudiadas para establecer distribución de grupos en las diferentes islas pero no se ha intentado hacer una distribución estacional en parte por problemas derivados del muestreo. El programa fue suspendido al cumplir un año de actividades y evaluados sus resultados. La información recolectada fue inmensa por lo que fue dificil y tediosa la elaboración. Se estimó que una vez concluído este trabajo se hacía necesario suspender por unos meses la toma de muestras y poder así avanzar en la elaboración de los resultados obtenidos.

A fines de 1976 ya se sabía bastante sobre los datos y se decidió reiniciar el programa bajo un nuevo enfoque. Uno de los problemas principales detectados en el muestro anterior fue la falta de información en algunas muestras o la mala fijación de ellas, a pesar de las instrucciones dadas. Para evitar este problema y para obtener información en otros aspectos detectados en el muestro anterior, el nuevo programa iniciado en enero de 1977 contempla cruceros trimestrales a bordo del M/N Iguana pero esta vez un biólogo del INOCAR participará embarcado para realizar el muestreo. La secuencia del muestro se ha disminuído pero en cambio se han agregado observaciones batitermograficas en los lugares en que la embarcación se detiene y se ha intensificado el muestreo en los lugares de desembarque. Ya se ha efectuado el primer viaje trimestral y a fines de mayo de 1977 se llevará a cabo el segundo de ellos.

Complementariamente a este Programa la Estación ha comenzado a recolectar información de temperaturas superficiales en los viajes del Iguana entre Guayaquil y Galápagos y vice-versa

desde enero de 1977. Esta información será enviada a INOCAR para complementar sus estudios trimestrales.

Tambien en el campo de las pesquerías y estudios oceanico-pesqueros la Estación Charles Darwin ha estado activa en estos últimos anos. A comienzos del ano 1976 se formalizó un acuerdo entre el Instituto Nacional de Pesca del Ecuador y la Estación en virtud del cual se iniciaron los estudios sistemáticos de la langosta azul *Panulirus gracilis* y roja *(Panulirus penicillatus)* en Galápagos. En virtud de dicho acuerdo se iniciaban también las investigaciones sobre peces blancos especialmente sobre bacalao *(Myctoperca olfax)*, lisa *(Mugil* sp.*)* y camotillo *(Paralabrax humeralis)*.

El programa fue implementado por dos biólogos, el Sr. Gunter Reck y el Sr. Pedro Ortiz, contratados por la Subsecretaría de Recursos Pesqueros. Desde su llegada, en mayo de 1976, ellos han realizado una activa recolección de datos de capturas y datos sobre la biología de las langostas de Galápagos, utilizando en la mayor parte de los casos, el B/P San Salvador que ha colaborado muy eficazmente en este programa. Recientemente la Estación Charles Darwin ha adquirido equipo de buceo autónomo completo para dos personas, para ser usados en trabajos de marcaje de langostas y observaciones in situ en Bahía Academy, del programa que mantienen con el INP.

El programa del Instituto de Pesca ha funcionado de manera contínua, permaneciendo los biólogos en la Estacion Darwin gran parte del tiempo en que no están embarcados. Una parte del laboratorio ha sido destinada para su uso por este grupo de trabajo. Si bien es cierto que aún no se han publicado resultados debido a que no se completa un año de trabajo, se ha podido por primera vez aconsejar a las autoridades sobre materias tales como la determinación del tamaño mínimo de capturas. La información que se está acumulando servirá entre otras cosas para el manejo del recurso langostero en el archipiélago. El programa será reforzado tanto por parte del Instituto de Pesca como por parte de la Estación en el futuro cercano.

Pero no ha sido solo a nivel de organismos nacionales ecuatorianos que la colaboración para realizar estudios marinos se ha efectuado. También, y de manera más reciente, se han iniciado las gestiones para obtener ayuda y asistencia para iniciar un programa de monitoreo más amplio en las aguas circundantes a las islas Galápagos con varias agencias extranjeras. Los planes a futuro de estos trabajos son:

a) Colaboración con NORPAX – Equatorial Program, para estudiar la estructura térmica de la región oriental del oceano Pacífico ecuatorial. Este Programa está siendo actualmente discutido para implementarlo a fines de 1977.

b) Colaboración con la Universidad de Duke (Duke University Marine Laboratory) y (Cooperative Oceanographic Program). Luego de la visita del R/V Eastward de la Universidad de Duke y de las conversaciones mantenidas por el Dr. Richard T Barber, Director del Programa Oceanográfico Cooperativo en dicha Universidad, con el Director de la Estación, se han iniciado las gestiones para iniciar un programa de colaboración ampliada que abarque estudios oceanográficos, y biológicos en la región costera de Galápagos, usando las facilidades del Laboratorio con que cuenta la Estación, haciéndole las necesarias adecuaciones para este tipo de trabajo.

c) Colaboración con el programa pesquero FAO/BID – Gobierno del Ecuador. La Estación

ha tomado parte en las discusiones que representantes del Gobierno del Ecuador mantienen con el Banco Interamericano de Desarrollo (BID) y la Organización de las Naciones Unidas para la Alimentacion y la Agricultura (FAO) destinadas a la obtencion de un préstamo para el desarrollo, la investigación y el fomento de la pesca artesanal en el Ecuador. La Estación está siendo considerada como uno de los centros científicos en los cuales se efectuará inversion para el desarrollo de la investigación oceanográfica pesquera. El proyecto considera la implementación o el fortalecimiento de un laboratorio marino ha ser operado conjuntamente con el Instituto Nacional de Pesca y el Instituto Oceanográfico de la Armada.

d) Colaboración con la Universidad de Hawaii en Manoa (Departamento de Oceanografía). Se han iniciado las gestiones para instalar por parte de dicha universidad un mariografo en los terrenos de la Estación intengrando este al sistema de la red de mariografos en el Oceano Pacífico Oriental.

Finalmente se puede decir que en los últimos meses se han iniciado una serie de contactos que permitirán en muy corto plazo hacer posible la creación de una infraestructura adecuado para llevar a cabo estudios biológicos-marinos. La cooperación internacional para llevar adelante estas ideas parece garantizada y, por tanto, la Estación y por ende, Galápagos, comenzarán a recibir un contingente cada vez mayor de estudiosos del mar. Paralelamente a estos esfuerzos el Gobierno ecuatoriano termina las consultas para promulgar un Decreto creando un Parque Marino en Galapagos. Con ello y con los esfuerzos que realiza la Estación Darwin el futuro de la vida marina en Galápagos parece asegurado.

Mayo 5, 1977 Jose R Canon

SUMMARY

The rapidly growing interest in Galapagos marine studies has led to increased CDRS collaboration with other bodies. The Station and Metropolitan Touring are both assisting the Naval Oceanographic Institute in its researches into zooplankton variability and the distribution of phytoplankton and in the measurement of water temperatures. The Station is also collaborating with the National Fisheries Institute in a long term programme of investigation of the fish and lobster resources with a view to establishing rational exploitation.

Regarding the future, discussions are in progress with Duke University for an important joint programme of oceanographic and biological research and the CDRS hopes to be able to provide scientific information for the Government of Ecuador, FAO and Interamerican Development Bank programme of stimulation for the small-scale fishing industry. Joint projects with the Norpax-Equatorial Programme and the Oceanogrphic Department of the University of Hawaii are also under consideration.

# THE STATUS OF THE GREATER FLAMINGO IN GALAPAGOS

*R. W. Tindle, PhD, Research Scientist, Charles Darwin Research Station.*
*Assisted by L. E. Tindle, BA, Dip.Psych.*

## INTRODUCTION

The Flamingo in Galapagos is thought to be an insular race of the Greater or Caribbean Flamingo (*Phoenicopterus ruber ruber*). It is separated from the Caribbean flock by some 3000 Km of land and sea. Although Flamingos are capable of long-range migration (1) it is unlikely that interchange of birds takes place between the two places.

In Galapagos, Flamingos are to be found at high- and low-salinity lagoons and saline crater lakes, on Southern Isabela, Santiago, Floreana, Santa Cruz, Bainbridge and Jervis Islands. They have been rarely recorded on San Cristobal. Breeding occurs currently at Poza Noreste and Mina de Sal (Santiago), Poza del Cementerio and Quinta Playa (Isabela) and Bainbridge lagoon. It has formerly occurred at Espumilla lagoon (Santiago) and Punta Cormorante (Floreana).

The status of the Flamingo in the Islands has been hitherto unknown and various anecdotal reports have presumed the population to be both increasing and decreasing.

In 1959, 22 individuals were found (5); in 1964, Leveque (8) estimated the population at 100-150 individuals, and supposed that the Flamingo was the Galapagos bird most in danger of extinction. In a 1967 census for the Charles Darwin Research Station, Gordillo (6) recorded 317 adults + juveniles at 17 sites, and in 1968, 512 adults and juveniles at 22 sites (7).

The increase in numbers over the years is certainly more apparent than real, due to the discovery of new feeding and breeding grounds. For example at Poza del Cementerio (Isabela), an important colony of 158 adults, 39 juveniles and 57 occupied nests was found in October 1968.

By contrast, there have been fears that airmen in World War II had decimated the population, that fishermen salting their catches consistently disturbed the breeding grounds, and that feral pigs and donkeys were trampling the nest-sites. More recently, there has been concern that increasing tourist pressure might be detrimental to this, one of the shyest of Galapagos birds. However, none of these factors has been operative at the two largest breeding sites, namely Poza del Cementerio and Poza Noreste.

## CENSUS

On December 22 1976, a whole-archipelago census of the Flamingo was undertaken. The census consisted of having observers at all of the major lagoons, lakes and *pozas* that Flamingos are known to frequent, these observers making counts of the birds at a pre-set time (10:00) on the pre-set day.

A concomitant census of the Black-necked Stilt or Tero Real (*Himantopus himantopus*) was also made.

The results were as follows:

442 Adult + Juvenile Flamingos
21 Chicks
32 Nests with or without eggs

(124 Stilts)

For complete details, see Table I.

The principal omissions from the Census were the lagoons at Punta Moreno (S. Isabela) where up to 20 Flamingos are to be expected. Flamingos are also known to occur from time to time at other small lagoons around Santa Cruz, not included in the census, eg: LAS BACHAS, and could conceivably occur at the numerous small lagoons on the east coast of Santiago.

The only other reliable census, an almost identical one of 1968, revealed 512 adults + juveniles. Since many smaller, less frequented lagoons, where flamingos may occur in the archipelago, have been omitted from both the censuses, it is judged that no diminution of the population has occurred between 1968 and 1976 and the population is more-or-less stable.

## POPULATION DYNAMICS

The stability of the population is supported by analysis of the fragmentary breeding data available since 1968. Allowing the currently-accepted view that Flamingos first breed at five years of age (2), it can be calculated that each breeding pair in Galapagos is producing 0.26-0.33 chicks per year. Allowing a 30% first-year mortality of chicks, and 10% mortality thereafter (2), each pair will require 11.8-15.4 years to replace itself with new 5-year old breeding birds.

This correlates reasonably with the theoretical mean life expectancy, calculated by assuming the usually accepted 10% annual adult mortality (2). See Fig. I. It may also seem from Fig. I, that a few birds may be expected to live in the wild for as much as 35 years or more.

The breeding of Flamingos is an uncertain business. Experience with the large flocks in the Camargue, France (1), Africa (3) and the Caribbean (4), has shown that, in some years, thousands of young may fledge, in others, virtually none. Partial or mass failure can usually be associated with droughts, floods or disturbance (sometimes human). Thus, Rooth (4) estimates that success and failure average out to give a juvenile recruitment matching adult mortality over 'units' of about 6 years duration.

Similar fluctuations in breeding success have occured in the Galapagos flock since 1968. It is thus to be recommended that regular monitoring of the Flamingos in the Archipelago be undertaken at 5-7 year intervals.

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FLAMINGO CENSUS (INCLUDING BLACK-NECKED STILTS)

December 21, 1976

A: adults
J: juveniles
C: chicks
N/E: nests/eggs
B/S: black necked stilts

| ISLAND | SITE | A | J | C | N/E | B/S | CENSUS TAKER |
|---|---|---|---|---|---|---|---|
| ISABELA | LAS NINFAS | 2 | 0 | 0 | 0 | 2 | Luis Segura |
| | LAS SALINAS | 2 | 2 | 0 | 0 | 2 | Jenny Gil |
| | BALTAZAR | 0 | 0 | 0 | 0 | 5 | Julio Segura |
| | JELI | 3 | 0 | 0 | 0 | 0 | Julio Segura |
| | COCAL | 1 | 0 | 0 | 0 | 10 | Nelson Gil |
| | GUAMAN | 2 | 0 | 1 | 0 | 11 | Nelson Gil |
| | CEMENTERIO | 0 | 0 | 5 | 7 | 10 | R. & E. Tindle |
| | ORIENTAL BARAHONA | 13 | 0 | 0 | 0 | 0 | William Jaime |
| | OCCIDENTAL BARAHONA | 3 | 0 | 0 | 0 | 0 | William Jaime |
| | TERCERA PLAYA | 21 | 3 | 0 | 0 | 3 | Pedro Cartagena |
| | CUARTA PLAYA | 0 | 0 | 0 | 0 | 2 | Ulises Guerrero |
| | QUINTA PLAYA | 162 | 0 | 0 | 0 | 18 | Arnaldo Tupiza |
| JERVIS | | 0 | 0 | 0 | 0 | 0 | Rafael Gil |
| SANTIAGO | MINA DE SAL | 29 | 8 | 3 | 10 | 10 | A. Sánchez |
| | NORESTE (EL SARTEN) | 37 | 17 | 12 | 10 | -- | G. Ramón |
| | ESPUMILLA | 28 | 11 | 0 | 0 | 5 | A. Pachay |
| RÒCAS BAINBRIDGE | | 1 | 2 | 0 | 5 | -- | A. Villa |
| SANTA CRUZ | LAS PALMAS (2 ponds) | 0 | 0 | 0 | 0 | 2 | A. Calapucha |
| | BAHIA CONWAY | 0 | 0 | 0 | 0 | 0 | Juan Jaya |
| | BAHIA BORRERO (2 ponds) | 21 | 0 | 0 | 0 | 0 | D.Green & J.Snyde |
| | PUNTA ROCAFUERTE (2 ponds) | 0 | 0 | 0 | 0 | 6 | Gil De Roy |
| | BAHIA TORTUGA | 0 | 0 | 0 | 0 | 2 | Jorge Larrea |
| FLOREANA | PUNTA CORMORANTE | 63 | 6 | 0 | 0 | 17 | E. Cruz & Son |
| | PUNTA SADDLE | 3 | 2 | 0 | 0 | 8 | E. Cruz & Son |
| | | 391 | 51 | 21 | 32 | 124 | |

TOTAL: 442 Flamingos (adults and juveniles), 21 chicks, 32 eggs
124 Black-necked stilts

Principal omision: Punta Moreno (Isabela)

Other sites where flamingos are found: Las Bachas and other small ponds on Santa Cruz.
Small ponds on the east coast of Santiago (James).

## WHALES IN GALAPAGOS – A Personal Viewpoint

by

Jan MacFarland

*A whale told me, with some reservation*
*He was writing a long dissertation*
*He said, with a smirk,*
*"I am doing some work*
*"On a scientist's life at the Station".*

Though surrounded by marine iguanas, flightless cormorants, giant tortoises and the innumerable other endemic and indigenous animals that make these islands so unique, I have never known anyone who did not get a special thrill when, from the watch, the cry goes up: "Ballena!" The most seasick or cynical of passengers can be seen, lugging his camera, climbing the companionway and staggering to the rail in hopes of glimpsing (and perhaps photographing) a cloud of vapor or a disappearing tail fin that would put him in the growing but still elite group of those who have seen a whale.

Whale sightings in Galapagos are poorly recorded and come primarily from fishing boats, charter yachts, or sightings from Station and Park Service personnel aboard BEAGLE III. Certainly during the nineteenth century, whaling was a prosperous endeavour along the western coast of South America where the Sperm, Fin, and Humpback whale were commonly taken. Indeed, before Charles Darwin's historic work, the Islands were known primarily for being a source of tortoise meat and fresh water for the American and European whaling fleets.

This will be an amateur's report supplemented with second-hand information gleaned from others residing in the Islands. I have been fortunate to have observed numerous groups of whales in virtually all parts of the Islands' interior waters, and have personally seen Killer whales (actually a species of porpoise), Humpbacks, Fins, and Seis. Others have been reported.

My first whale was a momentary glimpse of a broad back and cycle-shaped dorsal fin, as a small animal (probably a Sei) dove for safety from the direct approach of the yacht from which I watched, enchanted. That day, eight years ago, off the northern end of Isabela, marked the beginning of my life as a cetacean "freak". A scientist can give you migration ranges, speak about the weight of the brain, and discourse on the numbers now extant of the various species – but scientists are as much in awe of a whale sighting as any illiterate crewman on a fishing boat, perhaps more so. In the field of cetology, many amateurs have much to teach the biologists.

Probably the most spectacular sighting of my experience occurred aboard BEAGLE III on the southern coast of Isabela, as we idled in the water for perhaps 40 minutes. Two animals surfaced 30 meters from the yacht and blew, then dove directly under the ship giving a fine profile in the azure water against the blackness of the depths below. Five of us on deck, turned, watched and yelled in unison, "Humpbacks", for there could be no doubt. The knotted heads and incredibly long flippers could have belonged to no other species. We were treated, for the duration of our short stay, to the marvelous activities of these two beasts who dove again and again only to surface each time near the ship. When the Captain put the engines into "Speed Ahead", we countered our dismay at leaving that place with the exhilaration of having witnessed a unique display. We felt we had been paid a special compliment.

A year ago, aboard a luxury tourist ship, we passed through a large school of whales which I felt were Fins. There were approximately 30 to 40 whales in the pod and they moved without concern as the large ship moved through them. Another passenger with much experience in both Galapagos and the oceans of the world agreed with me about the species. We were contradicted by someone who should know, but I will never be convinced that those enormous backs breaking the surface so close to us were the same species as a mature Sei (with unborn calf) I had seen washed up on the shores east of Academy Bay in 1971. Fin whales and Seis resemble each other when seen from the deck of a ship, but the Sei is a smaller species and therefore, not as valualbe on the commercial whale market.

Sperm whales have been sighted frequently along the equatorial line between Galapagos and the South American continent, and, of course, it was 30 degrees west of Galapagos that the American whaleship ESSEX was rammed and sunk by a "cachalote" in the early 19th century. It was this incident which formed the genesis for Melville's *Moby Dick.*

The Killer whale, my favourite because of his great beauty and evil reputation (most certainly undeserved), has been observed throughout the Islands. My first Killer whale literally came to my doorstep one morning as I arose and gazed at the sea. There, beyond the lava reef that separates the Darwin Station from the waters of Academy Bay, moved two large fins, so unlike anything I had before witnessed that I knew immediately what they must be. I watched them enter the Bay, circle through the 5 or 6 yachts then anchored before departing along the opposite cliff in apparent pursuit of a small fishing boat going out for an early catch. The size of the two fins certified to me that two great males had paid me an early morning visit. Later that same year, a European colonist on Santa Cruz was circled several times by a Killer in the same bay before rowing his small dinghy to the cliff. Several Killers, among them at least one mature male, were observed off the fur seal colony on northeastern Santa Cruz in 1976, apparently feeding as they roiled in the water close to the lava shoreline.

The crew of one tourist boat in the Islands reported in 1974 that they had been accompanied by a lone male Killer whale for approximately an hour. The animal would dive under the vessel to reappear off the opposite beam and frequently rolled on his side as though to get a better look at the activity on deck.

In 1975, several marine biologists and the crew of the BEAGLE III passed close to a pod of four large Goose-Beaked or Cuvier's whales. At least one was a large male with the characteristic and distinctive white head. This is the first reported sighting of this species in Galapagos waters.

To see a whale break through phosphorescence on a moonless night must rate as one of the biological marvels of the world. This was our good fortune on an otherwise dismal night on the eastern shores of Santiago as we struggled to make headway, without engine or wind, against the current. A cloud of light below the surface grew slowly brighter and larger until suddenly, the surface was broken by a pyrotecnic display of micro organisms that certainly could not be equaled by even a massive fireworks explosion. The animal blew several times and disappeared downward into the cloud from which he had come.

I have seen whales breach, and blow, and dive. I have thrilled to their apparent curiosity from the railing of a yacht, and I have unsuccessfully tried to photograph them. Never am I bored with even a glimpse of dorsal fin or dissipating mist cloud. It is a thrill that I believe

the world shares. Of all living creatures on the earth, they are, for me, the greatest miracle of an infinity of evolutionary design. Fortunately, for those of us who live or visit in Galapagos, the whale seems to share our curiosity for an alien species.

# ESTRUCTURA Y DINAMICA DE LA POBLACION DE CHIVOS SALVAJES *Capra hircus* L. Y LOS EFECTOS EN LA VEGETACION DE LA ISLA SAN SALVADOR GALAPAGOS

*por*

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El presente artículo es un resumen de los trabajos realizados por el autor en colaboración con el Dr. Tj. de Vries por un lapso de más de 18 meses. Este estudio ha sido presentado como tesis de Licenciatura en Ciencias de la Educación de la Pontificia Universidad Católica del Ecuador por el señor Calvopiña quien se incorporara al personal de la Estación Charles Darwin como asistente científico del Director. En esta nueve calidad, el señor Calvopiña espera continuar con sus esfuerzos de investigación para la con servación del Archipiélago de Galápagos.

Este estudio pudo realizarse gracias a la beca de investigación otorgada por el WWF (Fondo Mundial para la defensa de la Naturaleza) y el programa de becas para estudiantes ecuatorianos de la Estación Charles Darwin y Metropolitan Touring.

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San Salvador es una isla grande (586.6 $Km^2$) y está localizada en la parte central del Archipiélago de Galápagos. Esta es una de las 9 islas que tienen chivos en estado cimarrón, con una población que se ha estimado en aproximadamente 100.000 animales para esta isla. Los chivos fueron introducidos por primera vez a San Salvador en 1813 y desde entonces la población se ha incrementado extraordinariamente. Los chivos están organizados en pequenos grupos o rebaños (2 – 10 individuos), pero ocasionalmente forman grupos de centenares de individuos. Las hembras paran de una a dos crías en cada parto. Los chivos se alimentan de hojas, ramas y corteza de los árboles y arbustos; hierbas anuales, semillas y plantas jóvenes de casi todas las especies vegetales de la isla.

Se ha estudiado los movimientos de la población de chivos en el costado noroccidental de la isla (incluyendo zonas que van desde el nivel del mar hasta la cumbre). Los chivos de esta area pueden dividirse en dos grupos, chivos residentes y chivos visitantes. Son residentes aquellos chivos que han sido encontrados por períodos de dos a doce meses y visitantes son aquellos que han sido vistos solamente una vez en Bahía Bucanero. Se encontró que los chivos residentes se desplazan diarimente un máximo de 1100 metros. Los movimientos de los chivos visitantes, en cambio, son desconocidos; estos chivos sin embargo representan el 90% de la población de Bahía Bucanero. Los chivos visitantes probablemente tienen un movimiento diario mayor y/o no se encuentran asentados en ninguna parte sino que diariamente se desplazan hacia las areas mas propicias para su alimentación.

Los cambios en la vegetación de Bahía Bucanero a lo largo del año estan correlacionados con los cambios en densidad de chivos. En invierno cuando hay abundancia de vegetación anual, hay muchos chivos, pero en verano, cuando la vegetación es escasa, el número de chivos disminuye notablemente. En otras areas se ha observado tambien que hay cambios en la densidad de chivos de acuerdc a la abundancia de la vegetación. En la parte alta de la isla, la humedad parece ser un factor importante en la densidad de chivos. En Cerro Pelado, por

ejemplo, aumenta la población de chivos en verano. En invierno, en cambio, cuando es muy humedo, h ay pocos chivos en esta localidad.

Los chivos, sobretodo en los últimos diez años, han destruido la vegetación de casi toda la parte alta de la isla. Para estudiar los efectos de los chivos en la vegetación y la regeneración de la vegetación en ausencia de chivos se han construido cuadrantes abiertos y cercados (a prueba de chivos) desde la costa hasta la cumbre y se ha observado los cambios que han ocurrido en los mismos. En los pocos meses de observación se han encontrado diferencias notables entre los cuadrantes cercados y abiertos en cuanto a la composición vegetal y al número de especies presentes. Adentro de los cuadrantes cercados se desarrollaron nuevas plantas de *Scalesia pedunculata, Zanthoxylum fagara* y *Croton scouleri;* además arbustos como *Tourneforlia rufo-sericea* se cubrieron de hojas. Afuera de los cuadrantes, las nuevas plantitas al igual que los retoños en la base de los árboles grandes son completamente comidos por los chivos.

Los cuadrantes cercados son relativamente pequeños (un máximo de 750 $m^2$) y la sequedad exterior influye por lo menos un metro adentro de la cerca, con lo cual el area realmente protegida, en algunos casos, es inferior a los 100 $m^2$. Para salvaguardar verdaderos núcleos de vegetación nativa con una composición floral representativa, los cuadrantes cercados deberían ser de por lo menos 100 x 100 m. Es deseable que se establezcan cinco cuadrantes de este tipo: uno en la zona seca, en Caleta (Bahía) Bucanero, uno en el bosque de *Psidium* (en la zona B de Calvopina y de Vries, 1975, Revista de la Universidad Católica III, 8: 219-241) y tres en la zona alta (zona C de Calvopiña y de Vries, 1975). Uno en el bosque de *Zanthoxylum,* otro en el bosque mixto de *Zanthoxylum Psidium* y *Croton* y un tercero en la parte suroccidental de la cumbre, donde todavia se encuentran extensas áreas del helecho arbóreo (*Cyathea weatherbyana*). Finalmente sería de sumo interés, hacer visible el problema de la protección y conservación de la vegetación de la isla, construyendo un cuadrante cercado en una zona frecuentada por visitantes como es el caso de Bahía James. De esta manera, los turistas podrían apreciar mejor el daño que causan los chivos en la vegetación nativa.

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## SUMMARY

The author has written this outline of the thesis he presented for his degree (Licenciatura). His 18 month study of the goat problem on San Salvador (also known as Santiago and James) was made possible by the programme of research scholarships granted by the WWF, Metropolitan Touring and the Charles Darwin Foundation.

San Salvador is a large island of some 587 square kilometres and is afflicted with an estimated 100,000 feral goats. In collaboration with Dr. Tjitte de Vries, the author worked on two main subjects: the seasonal movements and feeding habits of the goats and their effects on the vegetation. The damage done by the goats was catastrophic, particularly in the higher parts of the island. In contrast, where goat-proof quadrats had been fenced in, notable improvement in both the quantity and the variety of plants was visible even in the few months he was there. However, he considers that much larger quadrats are needed to secure regeneration of the native flora and to preserve the species until such time as effective action can be taken against the goats.

Destruction of the San Salvador (James Island) Vegetation by Goats. *Photo: Tjitte de Vries.*

## ANOTHER ERUPTION OF THE FERNANDINA VOLCANO

*The Galapagos are one of the most volcanically active regions in the world and Fernandina (Narborough) is currently the most active volcano in the archipelago. It is the most westerly of the large islands and the rim of its crater rises nearly 1,500 metres (5,000 feet) above sea level. Its caldera collapse in 1968 is rated the largest since that of Katmai (Alaska) in 1912. Fernandina has been in eruption again in 1977. The Charles Darwin Research Station (which operates a meterological and a seismograph station) reports such occurences to the Smithsonian Institution's Scientific Event Alert Network. Tom Simkin, the Darwin Foundation's Secretary for the Americas (Science), has communicated the following preliminary bulletin which was immediately circulated by the Scientific Event Alert Network.*

**Fernandina Caldera,** Isla Fernandina, Galapagos Islands (0.37°S, 91.55°W). All times are local (= GMT-6 hours).

A 4 day eruption began 23 March from fissures at the SE end of Fernandina caldera. As in the similar eruptions of 1972 and 1973, lava flowed down the inner caldera wall into the large (2 km diameter) caldera lake. The following report is compiled largely from information provided by Dr Dagmar Werner (Basel University) and the Charles Darwin Research Station.

A red glow over Fernandina's summit was first noticed at 2140 on 23 March by Dr Werner who was camped at the coast, 16 km WSW of the eruption site. Later inspection of seismograms at the Darwin Station, 140 km ESE of Fernandina, showed 3 small events (M – 3) between 1831 and 1852 that same evening, but no tremors were felt by Dr Werner. A light ashfall dusted her camp that night and heavier ashfall was experienced twice while climbing to the caldera rim the next morning. Reaching the rim at 1 pm, she observed low fountaining from fissures along the western half of the prominent bench 300 m below the caldera's SE rim. Lava cascaded over 500 m to the lake (formed by the 1968 caldera collapse) and steaming was localized around a growing lava delta, forming there. This activity continued through the night and little change was observed before Dr Werner departed the rim at 7 am 25 March. Glow was again observed that night and a vapor cloud was visible as she sailed away on the morning of 26 March.

A separate group including David Doubilet (National Geographic) and Jerry Wellington (University of California, Santa Barbara) was working near Fernandina and on the evening of 26 March observed a bright red glow that increased in intensity until midnight. By dawn, however, the intensity had decreased greatly and the eruption was essentially over by the time they reached the caldera rim at 8 pm, 27 March. At the time of this writing (31 March) a party from the Darwin Research Station was on its way to study the eruption's products and effects on the lake.

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