NOTICIAS DE GALAPAGOS

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CONTENTS

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NEWS FROM ACADEMY BAY

GALAPAGOS GIVEN WORLD HERITAGE STATUS

On 29 July, the Director General of the United Nations Educational, Scientific and Cultural Organization (UNESCO), Mr Amadou-Mahtar M'Bow, and General Fernando Dobronski, Ecuadorean Minister of Education, visited Academy Bay to make the formal declaration that the Galapagos National Park had been selected for inclusion in the World Heritage list. It was one of the first four "Natural Areas" to be chosen for this distinction, the others being Yellowstone (U.S.A.), Simien (Ethiopia) and Nahanni (Canada).

Mr M'Bow expressed his pride in the achievements of the Charles Darwin Foundation, created under the auspices of UNESCO, one of whose essential duties was the conservation of the environment. The Galapagos Islands, he said, would henceforth enjoy international protection, thanks to the firm commitments of the Government of Ecuador, the world scientific community and UNESCO.

THE TWENTIETH ANNIVERSARY OF THE CHARLES DARWIN FOUNDATION

The 20th anniversary of the Charles Darwin Foundation was celebrated at Academy Bay on 28 October 1979. The newly installed President of the Republic, who was unable to be present on this occasion, although he had twice visited the Research Station before his election, was represented by the Vice President, Dr Oswaldo Hurtado. The official party included the Minister of Finance and Mrs Fernando Aspiazu, the Minister of Natural Resources and Mrs Mauricio Dávalos, the Director General of Forestry and Mrs Carlos Aguirre, Mr and Mrs Moisés Simmonds (DITURIS), Galapagos Congressman Lcdo. Rodrigo Cisneros, Dr Miguel Moreno (Director, Natural History Museum) and Mr Hernán Correa (Manager, Metropolitan Touring). They were welcomed by the Charles Darwin Foundation's Vice-President and Mrs Alfredo Luna Tobar, the local authorities and the staffs of the Galapagos National Park Service and the Darwin Research Station.

The ceremonies took place in the Van Straelen Hall, named in honour of the CDF's first President. Since 1973 this handsome building (designed and constructed by the former station manager, Mr Rolf Sievers) has served for holding many kinds of meetings and particularly the training courses for park wardens and authorised tourist guides. Now, thanks to the support of Mr and Mrs Morrison Waud, the World Wildlife Fund, the U.S. Peace Corps and many who helped with funds or services, Dr Hurtado and the other distinguished guests were able to inaugurate a multi-purpose building, serving not only as a lecture room and information centre but also as an exhibition hall, where the outstanding features of Galapagos natural history are explained and illustrated by photographs, maps and art work, the gifts of numerous institutions and individuals.

THE LIBRARY

The visit of the Vice-President of the Republic and his party was also the occasion for the formal inauguration of the expanded library. Until relatively recently the library and the collections of plant and animal specimens – our little museum – were housed in the laboratory. With the expansion of research, sharing the limited space became an increasing nuisance to scientists, whether they were working at the benches or trying to read in peace. So books and collections were moved into what had been the Director's house, and this also gave space for

a modest reading room. But documents, books and collections grew and so did the number of visiting scientists and students. Lack of space and the danger of deterioration through heat and humidity made it necessary to refuse valuable collections of specimens offered by grateful scientists. In 1980, thanks to the generosity of Mr and Mrs E. H. Heaton, it became possible to enlarge the building and install air-conditioning to preserve both books and specimens. In addition to a virtually complete collection of publications on Galapagos science, there are now over a thousand volumes on the natural sciences in general and a growing Spanish section. The new library will substantially aid both research and the training of Ecuadorean science students – a subject which is discussed elsewhere in this issue by Dr Eugenia del Pino.

RESCUE OF THE LAND IGUANAS

It should cause little surprise that the campaign to save the threatened land iguanas has had its ups and downs. Nobody had previously tried to breed or raise land iguanas in captivity and the field was completely unexplored, so the only approach to the manifold problems was one of trial and error. Esperanza (Hope), the first *Conolophus* to be born in captivity, died in January 1979 and four others were lost soon after. This seems to have been due to the diet of papaya which suited adults but apparently not youngsters. The latter and some 40 later hatchlings are now fed on flowers and grasshoppers, so far with success. These are all descendants of the Cartago Bay (Isabela) population, most of which was massacred by dogs.

Land Iguana (Conolophus Subscristatus): Drawing by Heidi Snell

There were also problems with the offspring of the remnant of the Santa Cruz population. Eggs were heavily attacked with fungus and only 3 of the first batch survived. However, with experience, hatching success and rearing are making good progress and there were nine new hatchlings in the incubator by Christmas and more on the way. Also there was clear evidence that those Santa Cruz iguanas which were removed to semi-captivity on the tiny islet called Venezia were at last breeding.

Howard and Heidi Snell, who have been in charge of this programme, ought to feel well satisfied with their achievements. Of course it has meant that they have had to devote most of the first two years of their three year stint to solving the urgent problems of diet, incubation and fighting. Now that the battle for survival appears to have been won and that bigger corrals have been built with the support of the Ministry of Finance, they can turn their attention increasingly to longer-term matters, including an intensive study in dog-free areas of the land iguana's growth, reproductive effort and success, survivorship and other factors of population dynamics. This information is valuable not only to science but also to the breeding programme and the eventual repatriation of the various captive populations to their home territories.

CONTROL OF INTRODUCED ANIMALS

Goats have now been eradicated from the islands of Plaza, Santa Fe, Rabida, Espanola and most recently from Marchena. So much progress has been made on the once infested Pinta that there are now hopes that 1980 may see the last of them on that island also. On all the above islands the improvement of the vegetation since goats were brought under control has been most encouraging and so has the effect on the dependant animals. Efforts can now be concentrated on the largest islands where the worst problem still remains, though it should be lessened by new equipment and improved methods.

This year should also see the most comprehensive efforts so far to deal with the threats to the native species from other introduced animals. A major campaign to control the feral dogs will be launched. The dogs are increasingly destroying both land and marine iguanas, fur seals and sea lions, tortoises and turtles. They are already a menace to the highly endangered Hawaian Petrel when it comes on shore to nest and each expansion of their range causes deep concern for the Flightless Cormorant and the Galapagos Penguin, which are highly vulnerable when on land. The control programme will begin with an attempt at the complete eradication of wild dogs on Santa Cruz and part of Southern Isabela.

At the same time there will be an intensified drive against the destructive feral pigs in the nesting areas of the giant tortoises on Santa Cruz, Santiago (James) and the Sierra Negra and Cerro Azul regions of Isabela. Pilot studies of the cats and donkeys have already been begun to assess the degree of damage these feral animals are causing.

Approaching these problems from another angle, detailed methods to protect the surviving Hawaian Petrels from dogs, cats, pigs and black rats are being formulated. The long-term study of the Land Iguanas and their survival problems will be complemented by a 3-year investigation of the population dynamics of the Marine Iguanas, which have also come under attack in some areas. The study of the sea turtles and the parasitism of their eggs by an introduced scarab beetle will be vigorously pursued.

Together, these projects form the biggest conservation campaign yet mounted by the CDRS and the GNPS. This has been made possible by the combined support of the World Wildlife Fund, the Smithsonian Institution, Frankfurt Zoological Society, Stanford Alumni Association, U.S. Fish and Wildlife Service, Fauna Preservation Society and many individual benefactors.

PENGUINS IN PERIL

Numbers of the rare Galapagos Penguin have been found dead. Suspicion has fallen on fishing boats operating in the very limited area where these penguins are found. There is no evidence to suggest that they were deliberately killed. In the case of dolphins, it is well established that far more are killed inadvertently in the course of fishing than are deliberately slaughtered – in spite of the publicity given to particular incidents. The number of dolphins killed has been greatly reduced by regulations and changes in fishing methods. The CDF's Council, meeting in Guayaquil, unanimously endorsed an appeal to ship-owners to instruct their captains to use the utmost care to avoid harming penguins (and for that matter turtles) when fishing in those waters.

Galapagos Penguin: Photograph by Fritz Pölking

POLICIES FOR THE NEXT TEN YEARS

Perhaps the most important product of the 20th anniversary celebrations was the decision to organize a "workshop" or "working party" to hammer out a basic programme for the next ten years. The undoubted success of the CDF's first twenty years was not without its dangers: on the one hand success might encourage a rash expansion of activities before adequate financial resources to support them had been secured; on the other hand, success might lull those responsible into satisfaction with past achievements, when what was needed was new initiatives. Priorities needed to be re-examined.

The first step was to circulate a questionnaire on Galapagos problems to a large number of experts who had worked in the islands. Their replies were presented from many different angles. Some dealt with a scientific speciality (such as Prof. Syuzo Itow on the importance of

vegetation mapping), some with a broad subject such as education, or a particular area (such as the paper on Santa Fé Island by Drs. Christian and Tracy, reproduced in this issue) while others discussed the long-term and universal significance of Galapagos conservation, as this extract from a wide-ranging paper by Prof. Peter Grant illustrates:

"On the subject of conservation I have one general comment to make. Conservation has been dominated by what I refer to frivously as the big-is-beautiful attitude. Certain large and conspicuous animals have great appeal to everyone. If they are endangered there is considerable concern, and a large effort is made to see that the species or population does not go extinct. This is praiseworthy on all counts, but it is an ecologically restricted view. The environment of this species is usually viewed as an integral part of the environment. Conservation, in my opinion, has to be an activity which preserves the integrity. I think everyone would agree with this in principle, but not necessarily in practice. And the danger is that in caring primarily for the welfare of the large animals, smaller ones and plants may be allowed to go extinct through neglect or lack of concern. This, then, is an argument for the conservation of natural habitats, and those in near-natural state, as of prime importance, possibly of top priority.

"My long term view is that ecological principles, which appear now to be of esoteric interest to just a small group of professionals will be commonplace knowledge in a hundred years' time. I believe the socio-biology movement is the beginning of a long trend in making people more aware of their probable origins and evolution, the reasons for many patterns of human behaviour and the position or role of the human species in a vastly complex environment. But unfortunately there will only be a minute amount of natural habitat left in the world in 100 years' time. For many people then, more than now, natural habitat will be a concept only, never to be experienced first hand, only to be read about or seen in photographs or on film. In other words, I see an increasing need for people to experience habitats in pristine or near natural state, but a decreasing supply of such habitats. Hence the importance of Galapagos. It is not just a unique part of Ecuador. If conserved properly it will be one of the few riches of the world; to use a metaphor, its value will consistently increase through inflation !"

These varied contributions were considered by a small group, who worked in the Ministry of Foreign Relations at Quito from 18 to 27 February. The officers of the Foundation and the Galapagos National Park Service were represented but others were included in the "workshop" to provide an element of independent criticism, their only common denominator being experience of the Galapagos Archipelago and concern for its future. The report will be published in both Spanish and English and submitted to the next meeting of the Executive Council.

NEW COUNCIL MEMBERS

At the meeting in Guayaquil on 28 February 1980 the resignation of Prof. M. F. Mörzer-Bruyns was accepted with regret and Dr M. S. Hoogmoed was elected to the Council. The Ecuadorean Minister of Finance was elected as an *ex officio* member of the Executive Council.

APPOINTMENT OF A STATION DIRECTOR

A new Director of the Charles Darwin Research Station will be required to succeed Dr Hendrik Hoeck from 1 January 1981 for a minimum period of 3 years. A biologist with fluency in English and Spanish would be preferred. Requests for a detailed job description should be sent to Mr G. T. Corley Smith, Secretary General of the Charles Darwin Foundation, Greensted Hall, Ongar, Essex CM5 9LD, England.

A SELECTION OF EVENTS AND VISITORS DURING 1979

JANUARY

6	Esperanza, the first Land Iguana born in captivity, dies.
11	Dr and Mrs William Reeder, Texas Memorial Museum, to study arachnids.
16	Prince Henrik of Denmark visits CDRS. Dr Hans Kruuk, Institute of Terrestrial Ecology, Scotland, begins pilot study of Feral Dogs. Dr Dagmar Werner and Kristine Lein return to continue long-term study of Land Iguanas. Steve Bullock, Smithsonian Institution – installation of radio antennas. Karin Allgower, Heidelberg Univ. – study of the effect of the scarab beetle, *Trox suberosus*, on marine turtle hatching success.
25	Fernando Volponi, seismologist and Alba S. Volponi, astronomer, ZONDA Station, Argentina, visit CDRS.

FEBRUARY

2	Cerro Azul volcano on Isabela erupts.
3	Ted Murphy, Univ. of Hawaii – to install mareograph for CDRS.
5	Prof. Robert Bowman, San Francisco State Univ. – continuing study of Darwin's finches.
6	Dr. Thomas Lumpkin, Univ. of Hawaii: to study algaes.
7	Instituto Geográfico Militar, Ecuador. Aerial observations of Cerro Azul eruption made impossible by weather conditions. Jacinto Gordillo and Patricio Ramón go to Cerro Azul.
9	Ab. Jaime Roldós visits CDRS during his presidential election campaign.
23	Naval training ship 'Guayas' visits CDRS.
24	Admiral Alfredo Poveda Burbano, President of Supreme Council of Government, visits CDRS.

MARCH

22	Lecture on feral dogs in Galapagos by Dr. H. Kruuk
26	Gilbert S. Child, FAO, Rome, visits CDRS.

APRIL

22	Doug Wilson, Univ. of Hawaii – rock sampling for analysis.
24	Drs. John Treherne and William Foster, Cambridge Univ. – study of marine insect, *Halobates*.
28	*Kana Keoki*, ship of Univ. of Hawaii – study of geophysics.

MAY

1	Dr. Michael Harris, Institute of Terrestrial Ecology, Scotland – continuation of long term study of Galapagos sea birds.
4	Chilean training ship 'Esmeralda' visits CDRS. Instituto Geografico Militar – attempt to make aerial photographs of the islands frustrated by bad weather.
9	Freddy Elhers' television film team from Quito.
14	Marine Contamination Control Party, Ecuadorian Army, visits CDRS.
17	Dr. John Faaborg's group, U. of Missouri – continued study of Galapagos Hawk.
18	Dr. Ian Swingland, Oxford Univ. – studying Giant Tortoises.
23	"Operation Drake" – party of young volunteers on world cruise in the sailing ship "EYE OF THE WIND", help with CDRS and GNPS projects.

JUNE

9	Joel Lloyd, National Academy of Sciences, visits CDRS.
11	Dr Peter Grant's group continue their long-term studies of finches.

19–24	Delegation of the Ministry of Finance tours Galapagos.
22	NOAA team and CDRS personnel install mareographs and other marine equipment around the islands. Ab. Jaime Roldós visits CDRS on his presidential election campaign.
29	Thomas E. Emmel, U. of Gainesville, visits CDRS.
JULY	
10	Dr. Carleton Smith, Awards Institution, visits CDRS.
11	Prof. Charles Remington, Yale Univ., studying Galapagos insects.
23	Dr. T. de Vries and wife to continue their hawk studies.
27	Dr Minard Hall and Hugo Yepez, Quito Polytechnic, to continue study of Española Geology.
28	Galapagos is proclaimed a WORLD NATURAL HERITAGE by the Director General of UNESCO, Mr. Amadeo Mantar-M'Bow, and the Minister of Education, General Fernando Dobronsky Ojeda.
AUGUST	
1–29	Naturalist Guide Course.
3	Fritz and Inka Trillmich, Max-Planck Institute to continue study of Sea Lions and Fur Seals.
7	Michael Konecny, U. of Florida starts Feral Cats study
17	Daniel Clapp, sculptor, visits CDRS to sketch tortoises for bronze statue for San Diego Zoo.
20	Lecture by Dagmar Werner on concluding her 3-year study of Land Iguanas.
24	Prof. Syuzo Itow, Nagasaki Univ., Japan, continued study of plant ecology.
SEPTEMBER	
1	Drs. Peter Castro and Michael Huber, Smithsonian Tropical Research Institute – collecting Galapagos Mollusks.
3	Drs. Herbert and Briggite Biebach, Dominique Limberger and Michael Taborsky arrive to work with Dr Trillmich.
18–30	Dr. David Houston, Univ. of Glasgow, visits CDRS.
OCTOBER	
9–12	Dr Jerry Barnard, Smithsonian Institution, visits CDRS.
22	Drs. Deborah and David Clark – continued study of black rats.
27	Dr. Oswaldo Hurtado, Vice-President of the Republic and party arrive for the 20th anniversary of the CDF.
29	Admirals Raúl Sorrosa, Mario Jaramillo, Carlos Flores; Sr. Eduardo Hana Najera, SENDIP; and Ab. Jaime Hurtado visit CDRS.
31	Dr Eileen Schofield, New York Botanical Garden, visits CDRS.
NOVEMBER	
2	Juan Carlos Matheus and Andrea Mantilla – collection of molluscs for Natural History Museum, Quito.
6	Prof. Amotz Zahavi, U. of Tel-Aviv – Colour patterns of Finches.
13	Volcan Chico on Isabela, erupts. Patricio Ramon, CDRS and F. Cepeda, GNPS, observe the eruption.
16	NOAA group to continue observations and install more mareographs.
22	International Seminar on National Parks begins.
22–29	NOAA team with CDRS and GNPS personnel check mareographs around the islands.
DECEMBER	
22	Trevor Price (Peter Grant group) continues long term study of Darwin's finches.
30	Merrit McGahan, U. of New Mexico, visits CDRS.

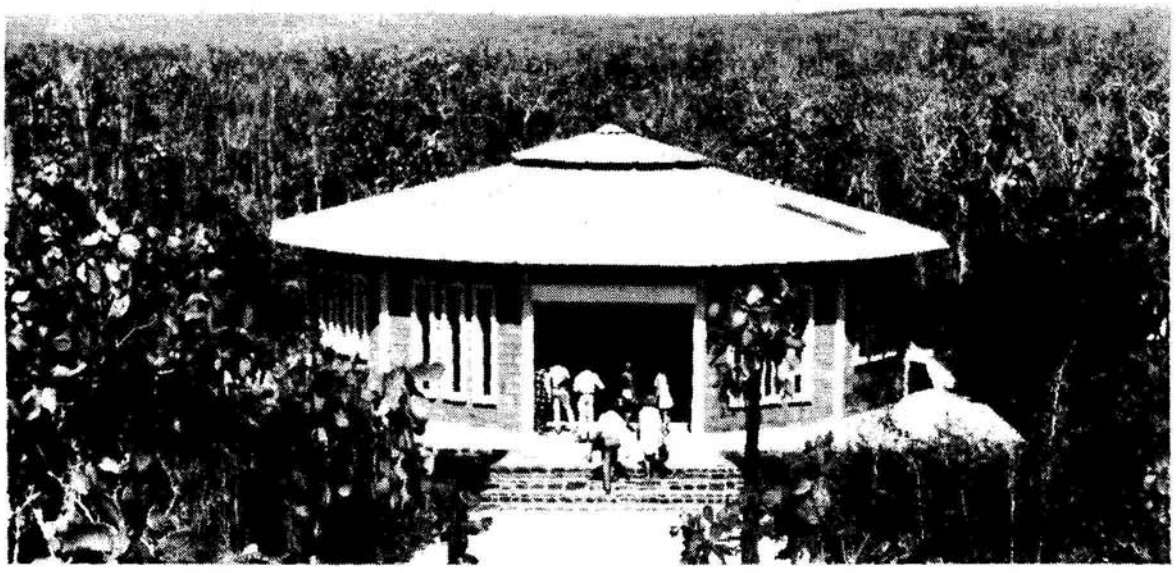
GALAPAGOS ISLANDS SYMPOSIUM

By the kind invitation of Dr George E. Lindsay, the Director of the California Academy of Sciences, a Galapagos Symposium was held on April 6–7 in the Morrison Auditorium in Golden Gate Park, San Francisco, under the joint auspices of the Academy and the Charles Darwin Foundation. The meetings, organized by Dr John F. McCosker, were open to the public and a long series of distinguished speakers addressed large audiences on conservation problems and scientific research in the Galapagos. Many lectures were illustrated. As the symposium occupied four sessions on two days, there is no space to print the proceedings in full in **Noticias** *but several speakers have kindly produced summaries of their contributions.*

WHY WE NEED THE GALAPAGOS : by Peter Kramer

This 20th anniversary of the Galapagos National Park and the Charles Darwin Foundation is a proper occasion to re-examine our purpose and to reconsider the justification for setting aside nine-tenths of the archipelago for conservation and scientific research.

There are good reasons. First, these islands and the seas around them make a notable contribution to the diversity of species because of their peculiar geographic situation and evolutionary history and because, in spite of two centuries of degradation, they are still close to being a product of natural evolution. There is such a high degree of endemism that the Galapagos have been given the status of a separate Biogeographical Province within the Neotropic Realm. Indeed, it would be logical to declare the archipelago and its surrounding waters as one of Unesco's world network of Biosphere Reserves.



Tortoise Rearing House at the Darwin Research Station:
Designed and photographed by Rolf Sievers

Next we should consider the value of the Galapagos land and sea areas as a scientific resource. Oceanic islands provide particularly valuable examples of adaptive radiation and speciation; so the fact that there is no other archipelago at the same time as extensive, as isolated and as undisturbed by man makes the Galapagos of universal significance for evolutionary research. For these reasons the highest priority should be given to the preservation of the archipelago's diversity of species and its unique ecosystems, so important in an age when increasingly industrialized societies are causing a dangerous levelling-out of ecological diversity.

Scientifically, it would be of interest to study how the organisms introduced by man are adapting to Galapagos conditions, but this raises two problems. By these introductions man has interfered with the very quality – oceanic isolation – which has made and still makes the Galapagos what they are. If they lose that, they lose their distinctive attribute of being "a nursery of new species" as Darwin put it. The other problem is that, on the record, all mammals hitherto introduced by man – rats, pigs, cats, dogs, goats – have tended to exterminate indigenous species of flora or fauna and in some cases have already done so. The threat is so great that it has been necessary to take giant tortoises and, more recently, land iguanas into protective custody and breed them in captivity in order to save them from extinction. If the goats had been left to multiply on Plaza, Santa Fé, Hood, Marchena and Pinta, both the vegetation and the dependant fauna would have suffered irreversible damage. The preservation of the native species depends on the early eradication of the harmful introduced species and the enforcement of rigorous controls to prevent the introduction of further dangerous organisms.

There are other fields of research where the Galapagos have much to contribute. The islands are among the world's most active volcanic groups and their setting is important in the global tectonic framework. They could also play a key role in local and world-wide environmental monitoring – meteorological, geophysical and pollution monitoring.

You may be wondering how I have got so far without specifically dealing with the value of the islands from the educational and touristic points of view. This is because I cannot really separate the two, either from one another or from the scientific values. I suspect that those who can are either scientists who feel that no tourists at all should be allowed to invade "their" islands or promoters who want the sea lions on the beach but a hotel and swimming pool right behind it and perhaps a sporting golf course with giant tortoises lumbering across the fairway.

Basically it is the scientific interest that brings tourists and students as well as scientists to the Galapagos. There are thousands of more beautiful beaches elsewhere (including mainland Ecuador) and a lot of science can be done much better in more accessible places; but there is no place on earth where concepts of speciation, adaptive radiation and organic evolution can be more effectively studied, understood, interpreted and taught. And these concepts are of importance to all men. Because of this I should like to take this opportunity to propose to the Government and to the Man and the Biosphere National Committee of Ecuador that they apply for Biosphere Reserve status for the Galapagos Archipelago, including the surrounding waters.

Furthermore, I would urge scientists and supporting institutions in Europe and North America to help the Darwin Foundation to intensify its efforts, by scholarships, teaching courses and publications, to make the Galapagos more available to citizens of Ecuador, be they scientists, students or others who just want to see, read and understand. This is not merely because a strong scientific establishment and an informed and sympathetic public is the

best guarantee for conservation, but because of my deep concern that Ecuadoreans should know more about their fabulous island possession. Because the Galapagos Islands *are* quite literally unique and their scientific importance *is* beyond reasonable question and would still be so if Charles Darwin had never gone near them.

GALAPAGOS SINCE 18K

by Paul A. Colinvaux

The Galapagos Islands at 18,000 years before present (18K) have been shown to have had a drier climate than at present. It is likely that rain was absent from the highlands in most years and that ground cover may have been less complete as well. The modern, comparatively moist, climate has persisted for the last 10,000 years without serious interruption. In glacial times, therefore, all parts of the larger islands were desert. The modern wet highlands have been in existence only 10,000 years but the deserts have lasted perhaps from the formation of the Archipelago more than a million years ago. It is known that there is a very much higher species richness of plants in Galapagos desert communities than in the moist communities of the highlands. Raven has argued that this pattern results because the deserts are older and have had more time to collect species. This hypothesis can be examined by the fossil record provided by plant pollen in sediments. This pollen record can also be used to test general predictions of the theory of island biogeography. Pollen histories are available for all the last 10,000 years at high elevations and for a time which predated the ice-age drought. The pollen record suggests that colonization of the wet highlands proceeds very rapidly and may be complete within 1,000 years of climatic change. Thereafter vegetation is stable. Within the resolution of the pollen record, no pattern of persistant extinction and invasion as predicted by the theory of island biogeography can be seen. It is argued that the ability of vegetation to achieve complete cover over a moist habitat perpetually frustrates further invasion. The species list in the wet islands, therefore, is set, not as a species equilibrium, but when further invasion is made highly unlikely. This mechanism would not apply in desert habitats where cover is never complete. It is argued, therefore, that Raven's observation of more species in the deserts reflects not so much the antiquity of desert sites as the incompleteness of cover there which makes possible continued immigration.

THE VEGETATION TYPES OF SANTA CRUZ AND ALCEDO

by Henk van der Werff

The environmental factors, which influence the vegetation most strongly on the Galapagos Islands are precipitation and soil. Generally, speaking, precipitation increases along the windward slopes of the islands due to condensation in the uplifted air. Only the peaks of the highest volcanoes, for example Wolf and Cerro Azul, do not receive this condensation and are as dry as the coastal areas.

As precipitation influences the weathering of the parent rock, one finds a soil gradient ranging from very shallow soils in the coastal areas to soils several meters thick in the wet uplands. However, the soil gradient may be poorly developed on young volcanoes where not enough time has passed for weathering, regardless of the amount of precipitation.

My work on the Galapagos was aimed at the description of the vegetation types occurring on Sta. Cruz, an older island with well-developed soil, and Alcedo, a younger volcano with a poorly developed soil.

On the southern slope of Sta. Cruz one encounters the following vegetation types going from the coast to the summit:

A. A 'Littoral Zone'. The 'Littoral Zone' is neither floristically nor structurally homogeneous. Since it occupies only a small area and is generally poorly developed, no attempt has been made to divide the 'Littoral Zone' into homogeneous units.

B. The '*Bursera* Vegetation', characterized as a deciduous forest dominated by *Bursera graveolens.* This vegetation type makes a very xeromorphic impression: *Opuntia* and *Jasminocereus* are common, the herb layer is green only during a short period following the rains and shrubs have generally small leaves, which are either densely hairy or sclerophyllous.

C. The 'Transition Vegetation', a semi-deciduous forest composed of the three 'P' species: *Pisonia floribunda, Piscidia carthagenensis* and *Psidium galapageium.* Xerophytic adaptations are largely absent and epiphytes (mostly lichens, mosses and ferns) are more numerous. The shrub layer is dense and the most common species have long, slender, intertwining branches. A floristic analysis indicates that the 'Transition Vegetation' does not occupy an intermediate position between the drier '*Bursera* Vegetation' and the wetter '*Scalesia pedunculata* Vegetation', but that it is much more closely related to the '*Scalesia pedunculata* Vegetation' than to the '*Bursera* Vegetation'.

D. The '*Scalesia pedunculata* Vegetation', a closed evergreen forest which consists almost entirely of *Scalesia pedunculata.* Epiphytes (mostly mosses, ferns and orchids) are common, the shrub layer is open, and terrestrial ferns are larger than in the 'Transition Vegetation'. The '*Scalesia pedunculata* Vegetation' is structurally homogeneous, but floristically it consists of two types: one drier and found at lower elevations (around the Caseta, for instance), the other one wetter and found at higher elevations. Little remains of the wet type on the southern slope of Sta. Cruz due to colonization, but large stands are still found on the northern and eastern slopes.

E. The 'Brown Vegetation', an open evergreen forest, in which the most common tree species are *Zanthoxylum fagara* and *Tournefortia pubescens.* The shrub layer is very dense where gaps occur in the canopy layer; epiphytes are common. Large masses of dark brown liverworts (*Frullania* spp.) have given this vegetation type its name, which is however misleading as equally large masses of *Frullania* spp. are found in the 'Transition Vegetation'. The 'Brown Vegetation' is rare on Sta. Cruz; the area once covered by this vegetation type is now cultivated and only small fragments remain untouched.

F. The '*Miconia* Vegetation', a closed scrub composed of *Miconia robinsoniana.* Large epiphytes, such as ferns and orchids are rare, but the epiphytic moss and liverwort flora is richer than found in any other vegetation type in the Galapagos. Terrestrial ferns are also very common; out of 45 species occurring in 3 or more of ten relevés of '*Miconia* Vegetation', 26 are ferns and 19 non-ferns (monocots and dicots).

Unfortunately, most of the '*Miconia* Vegetation' is found on privately owned land and is being rapidly cut down and replaced by pasture land.

G. The 'Pampa Vegetation', an herbaceous vegetation found on the windward upper slopes of Sta. Cruz. There is no doubt that man's activity (burning and cutting of the '*Miconia* Vegetation') has greatly expanded the range of the 'Pampa Vegetation', but this does not imply that this vegetation type is entirely man-made.

The main difference between the vegetation types on the northern and southern slopes of Sta. Cruz is that on the northern slope the *'Bursera* Vegetation' is found up to 500 m. elevation (on the southern slope up to only 75–100 m) and as a consequence the wetter vegetation types are squeezed into the upper 300 m. elevation range. The drier type of the '*Scalesia pedunculata* Vegetation' as well as the '*Miconia* Vegetation' is almost absent from the northern slope. It should be mentioned that one encounters on Sta. Cruz also some small-scale vegetation types which are correlated to extreme climatic conditions (the vertical *Sphagnum* bogs near the summit) or to a different substrate (the sparse scrub found on Baltra and the adjoining northern part of Sta. Cruz.).

The vegetation types found on Alcedo are quite different from those on Sta. Cruz, which is largely due to differences in substrate. On Alcedo most of the low, dry areas visited by me are covered with thick pumice deposits. The steep caldera walls, which form the highest parts of Alcedo, are generally rather dry and are composed on cinders and volcanic ash. A soil gradient such as is found on Sta. Cruz, with shallow soils in the lowlands and deeper soils in the wet uplands, has only been observed on the south-eastern slope, although old lava flows with a *'Bursera* Vegetation' occur inside the caldera and on the lower parts of the northern and western slopes as well. The thick pumice deposits are vegetated with a sparse or open scrub and a closed herb layer, structurally very different from the *'Bursera* Vegetation'. Where old lava flows come to the surface in pumice fields, the *'Bursera* Vegetation' occurs side by side with the sparse scrub and this demonstrates that the substrate determines whether *'Bursera* Vegetation' or the sparse scrub vegetation will be present.

A 'Transition Vegetation' has only been found on the lower south-eastern slope of Alcedo, where a lava substrate occurs under the appropriate climatic conditions. On the other slopes one either finds thick pumice deposits or a cinder-ash substrate under the climatic conditions appropriate for the 'Transition Vegetation' (this can be judged from the species of epiphytes present or from the vegetation on small patches of lava). The pumice deposits support an open scrub with a dense herb layer, the cinder-ash substrate a closed scrub with a poorly developed herb layer.

Sufficient precipitation for evergreen forest only occurs on the southern slope of Alcedo. Above the area covered with the 'Transition Vegetation' (semi-deciduous forest) one finds an area vegetated with dense, low scrub, covered with the vine *Ipomoea alba.* The shrub layer is formed by *Psychotria rufipes* and *Tournefortia rufosericea.* Small stands of evergreen forest, composed of *Scalesia microcephala* and *Croton scouleri* and similar to the *'Scalesia pedunculata* Vegetation' of Sta. Cruz, are rare; at the edge of such forest patches I have noticed that trees were being pulled down by *Ipomoea alba.* It is as if one witnesses here the change from scrub to forest; some species are growing into trees, but are not strong enough to form a forest under present conditions. It is of interest that *Scalesia microcephala,* one of the potential tree species, is the dominant shrub in the open shrub vegetation on the thick pumice deposits.

At higher elevations, on and near the south-south-eastern caldera rim, stands of a *Zanthoxylum fagara-Tournefortia pubescens* forest occur which are very similar to the 'Brown Vegetation' of Sta. Cruz. These two species have rather hard wood and are less easily pulled down by *Ipomoea alba;* it is also likely that *Ipomoea alba* is less vigorous in the wetter habitat where the 'Brown Vegetation' are almost entirely absent from Alcedo.

It is to be expected that eventually Alcedo will be covered with various kinds of forest, just as Sta. Cruz, but presently Alcedo is in an intermediate phase: it has passed the stage of colonization of bare volcanic substrate, but has not yet reached the floristically and structurally more complex stage of forest, as is found on the older island of St. Cruz.

THE ROLE OF INTRODUCED BLACK RATS IN GALAPAGOS ECOSYSTEMS

by Deborah A. Clark.

Based on data from a 3-year field study, a detailed analysis was made of the foraging ecology of introduced black rats *(Rattus rattus)* in Galapagos. The diet was determined for populations in both the hot and the garua seasons, in a broad range of habitats: arid thorn scrub (Pinzon Island); *Bursera* savannah (Santiago Island); Transition Zone (Santa Cruz Island); *Miconia* Zone (Santa Cruz Island); and *Scalesia* forest (Santa Cruz Island). In all situations the rats consumed a mixture of plant and animal foods, with plant materials predominating (an average of 83% of the diet by volume). An extremely wide variety of foods was eaten, including many arthropods and other invertebrates, seeds, fruits, flowers, leaves, stems, roots and fungi; however, the rats were highly selective feeders, ignoring many abundant potential foods and often concentrating on very uncommon items. They discriminated among species of plant, among the parts of a plant, and among parts of small items such as fruits and seeds. Nutritional considerations were important in diet selection. Growing rats (which have a greater demand for protein) ate more animal food than did adults. The less nutritious plant parts were important components of the diet only under conditions of low food availability. The breeding season of Galapagos black rats is correlated with, and may be dependent upon, a higher level of dietary protein.

Black rats are known to be severe predators on young tortoises and are suspected of destroying most eggs and young of the Dark-rumped Petrel on Santa Cruz; however, in this study very few of the 360 rat stomachs analyzed contained vertebrate remains. Invertebrate prey were commonly taken and included endemic snails and the Galapagos centipede; the effects of this predation are not known. Because black rats feed heavily on plant reproductive structures, they may have important impacts on the Galapagos flora, especially in cases of preferential feeding on uncommon species. In addition to these direct effects, the introduced rat may be negatively affecting the Galapagos fauna through competition for food. The overall impact of black rats if probably magnified on islands such as Pinzon, where native rodents have not occurred.

ARE MALES ECOLOGICALLY CHEAP ? SEX – RELATED FORAGING IN HERMAPHRODITIC HOGFISHES:

by Steven G. Hoffman

Protogyny is the most common pattern of hermaphroditism found among fishes. This sexual pattern is an ideal system for testing sex-related hypotheses since an individual normally functions first as a female and then as a male during its lifetime.

I wish to demonstrate an interrelationship between foraging and sexual behavior by examining the ways in which individuals allocate time and energy into these activities. Specifically, I am interested in determining if foraging differences between males and females are the result of the pattern of allocation of time and energy spent in social and mating activities.

My study species included 2 congeners in the genus *Bodianus* (hogfishes, family Labridae– the wrasses). Foraging and mating behavior are easily quantified, involving all individuals on a daily basis. Thus it was possible to correlate changes in behavior with changes in fitness (mating success). Fertilization is external and parental care is absent.

Bodianus diplotaenia, the Mexican hogfish, was observed in April, 1977 off Floreana. In this species, males defend temporary reproductive territories (leks) and achieve the highest mating success. Sex ratio is 1:2.3 in favor of females. Sex change relates to local social conditions, but may have a genetic component as well since the reversal occurs over a limited size range.

Bodianus eclancheri, the harlequin hogfish, was observed in May, 1977 in Tagus Cove on Isabela. This species spawns in groups where many males mate together with single females. Males compete indirectly in sperm production contests. Sex ratio is 1:1 and sex-reversal can occur before maturation. All females in both species mate daily.

By looking at the relative costs and benefits of allocating time to foraging or non-foraging activities, sex-related foraging behaviors are predicted for each species. Lek males maximize their fitness by engaging in intersexual interactions to prevent sex change, attracting females during the mating period, and defending temporary reproductive territories. All females and group spawning males maximize their fitness by allocating energy to gamete production and spend little time in social interaction. Thus I expected lek males to be 'foraging time minimizers' relative to group spawning males and all females, who should be 'foraging time maximisers'. Observational results supported these predictions. Males spent 52% of their time and females 85% of their time foraging in *B. diplotaenia.* For *B. eclancheri,* males spent 70% and females spent 75% of their time foraging. I suggest that foraging behavior is a labile characteristic that varies as a function of the social and mating demands of the individual.

(Further Abstracts of Contributions to the Galapagos Islands Symposium will be published in Noticias No. 32.)

Lava Heron: Photograph by Fritz Pölking

AN UPDATE ON THE STATUS OF ISLA SANTA FE SINCE THE ERADICATION OF THE FERAL GOATS

by Keith A. Christian and C. Richard Tracy
Department of Zoology and Entomology
Colorado State University, Ft. Collins, Colorado 80523

We recently completed a study of the Land Iguana *(Conolophus pallidus)* which included extensive fieldwork by one of us (K.A.C.) between June 1978 and April 1979. Since this was the first long-term field study on Sante Fé (Barrington) since the feral goats were exterminated from the island (except for 2 old males) by the Galapagos National Park Service in 1971, we would like to present an updated report on the status of this island, and suggest priorities for conservation and management programs for the future.

The vegetation has changed remarkably since the feral goats were exterminated. Descriptions and photos published by Orr (1965) and de Vries (1973) indicate that much of Santa Fé was completely barren during the time that the goats were present. Orr (1965) noted that the vegetation on the islet in the bay region was more diverse than on the main island. Today the vegetation on Santa Fé is much denser than it was when Orr and de Vries worked on the island; and although comparative measurements were not made, the vegetation of the main island now appears to be more diverse than that on the islet. However, *Portulaca sp.* is abundant on the islet, and it has not been observed on the main island. This plant may have been completely exterminated by the feral goats, and it has apparently not yet reinvaded the main island from the islet. The Galapagos tomato was believed to have been exterminated by the goats (Thornton, 1971) but one of us (K.A.C.) found several patches in 1979. This plant apparently was reduced to the brink of extinction, but managed to survive in a few patches.

Higgins (1978) recently reported that the population of the Santa Fé species of land iguana *(Conolophus pallidus)* was "clearly in a progressive decline". He reported finding 2 old land iguanas after 12 hours of extensive exploration. In October 1978, one of us (K.A.C.) discovered a communal nesting area containing over 200 female iguanas nesting during a single census of the area (details of the nesting activities will be published elsewhere). Because the nesting period lasted at least 6–8 weeks, it is likely that at least 350 (and possibly more) females nested in this area alone. This nesting area is probably the largest on the island, but eight other smaller nesting areas were discovered later. In a single half-day census, one of us (K.A.C.) counted over 300 nesting females in only two of the nesting grounds. During a day's walk across the island in the non-nesting season 40 to 50 adult land iguanas could be seen, and the sex ratio was invariably 1:1. Assuming that the density of nesting females in the eight smaller nesting areas was approximately the same as in the large nesting area (which was well studied), Christian (published elsewhere) has roughly estimated the adult population of *C. pallidus* to be around 4,000.

Higgins (1978) suggested that, in addition to goats, Galapagos hawks and native rats *(Oryzomis)* also contribute to the demise of the land iguanas. After having observed many nests, hatchlings and adults Christian (published elsewhere) has estimated that native rats do not in any way influence the land iguanas. On the other hand, Galapagos hawks do in fact prey on hatchling and juvenile land iguanas (details will be published elsewhere), but this is a natural process that probably does not significantly threaten a population of this size. As can be seen from Isla Santa Cruz and Isla Isabela, the real threats to land iguanas are feral goats and dogs.

The animals receiving the most impact from tourism on Santa Fé are those around the two beaches where tourist groups disembark. Behavioral differences between the sea lions on Santa Fé (which are exposed to many tourists) and the sea lions at Cape Douglas, Fernandina (which have very few visitors) have been noticed. Those at Cape Douglas are quite wary of humans and tend to flee at the slightest provocation, whereas the Santa Fé sea lions generally tend to ignore humans. This difference is probably not detrimental, but it would be worthwhile to see if there are other more important behavioral differences that can be attributed to tourism. It is interesting that the opposite situation exists for the behavior of the Galapagos crabs, *Grapsus grapsus* at these locations. That is, the crabs of Santa Fé are extremely wary of humans, but those at Cape Douglas can be approached easily. This suggests that the crabs of Santa Fé have been exploited to some degree by human visitors to that island.

THE FUTURE

Although the population of *Conolophus pallidus* appears to be stable, it nevertheless should be monitored in the future since any species existing on only a single island is always in a precarious situation. The real threat to the Santa Fé iguanas is the possibility that feral animals will be reintroduced. During our study, Christian found a female dog that had been left recently by a visiting boat. The prevention of introduced pests to Santa Fé is the single most important task for the future. The education of local fishermen and tourists is probably the most important step to prevent introductions.

The second priority for the conservation of the iguanas of Santa Fé is the protection of the nesting areas. In May of 1979, there was talk of moving the tourist trail on Santa Fé so that tourists could see more iguanas. The following recommendations are strongly suggested: (1) the trail *not* be placed through or near a nesting area, and (2) that the trail not be routed through our previous study area (the location of which can be found in an annual report submitted by Christian to the director of the CDRS in December 1978). For this area detailed vegetation maps, microclimatic data and home ranges of iguanas have been documented which could provide an important data base for botanists and zoologists of the future. To route a tourist trail through this site would destroy the integrity of this data base. These two recommendations could be met and the tourists could see more iguanas if the tourist trail was routed to the east of the point where it reaches the summit of the cliff. The trail could be extended along the cliff edge where there are many iguanas, and our former study site (which lies to the west of the point where the trail reaches the cliff-top) would remain intact. The flora and fauna of Santa Fé are in very good shape compared to many of the Galapagos Islands (which have feral pests). The priorities for this island should be to prevent introductions by educating the people who visit the island and to protect the nesting areas of the land iguanas. If these can be accomplished then Santa Fé can serve as a model of conservation, and we should strive to make the other islands of the archipelago meet this standard.

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LA ESTACION CIENTIFICA CHARLES DARWIN Y LA OPORTUNIDAD DE ESTUDIO

por Dra. Eugenia del Pino V.
Instituto de Ciencias, Pontificia Universidad Catolica del Ecuador

Existe en nuestro pais curiosidad por la naturaleza y el ambiente, sin embargo en el pasado, dicha inquietud frecuentemente no ha sido estimulada y desarrollada a plenitud por la falta tanto de carreras a nivel universitario en Ciencias Biológicas y Naturales, como de fuentes de trabajo. La situación va cambiando paulatinamente pues las universidades ofrecen programas en Biología y Ciencias Naturales y en la actualidad existe acentuado interés por estas ramas científicas.

A diferencia del Ecuador continental en donde se ha realizado poca investigación científica, en las Galapagos, el Ecuador insular, existe una trayectoria científica notable realizada principalmente por investigadores extranjeros. Sus trabajos, incluyendo el de Charles Darwin han contribuido al acervo cultural mundial y principalmente nuestro pues el conocimiento adecuado de las Islas y su ambiente son las bases sobre las que se fundamenta la política ecuatoriana de conservación del Archipiélago.

Biology Lesson for Galapagos Children: Photo by Sven Gillsåter

La Estación Científica Charles Darwin con una clarividencia de la importancia de la investigación para el desarrollo del Ecuador, inició en 1971 un programa de becas para universitarios ecuatorianos, el mismo que ha contribuido a la formación científica de jóvenes investigadores. En donde se puede obtener mejor entrenamiento científico que en los lugares en donde existe una trayectoria de investigación ? – Y para el Ecuador, las Islas Galapagos constituyen uno de esos lugares. Fue una coyuntura feliz el que la Estación Científica Charles Darwin haya iniciado este programa de becas justamente al momento en el que en las universidades se empezaba a sentir un nuevo interés por las Ciencias Naturales y la investigacion y a esto se debe en parte el exito del programa. He vivido de cerca este fructífero contacto entre la Estación Darwin y las Universidades y he podido ver el beneficio personal y científico que se opera en cada becario que ha visitado las Galápagos y el avance de la Ciencia en el Ecuador.

Desde el inicio del programa, estudiantes de las principales universidades del pais han visitado el Archipélago por períodos variables entre uno y 18 meses para colaborar en un proyecto específico con científicos extranjeros. Durante el estudio han recibido entrenamiento y la supervisión adecuada por parte de los científicos de la Estación Darwin. Estos trabajos han servido para la elaboración de tesis en muchos casos y así el universitario ha podido completar su carrera.

En los ocho anos de funcionamiento del programa, al rededor de 100 estudiantes han visitado las Galapagos en calidad de becarios. Los beneficios se traducen en el entrenamiento científico que estas personas han recibido; se traduce tambien en la labor que despliegan los ex-becarios en nuestra sociedad. Algunos han regresado a las Islas para colaborar más de cerca con la investigación y conservación del Archipélago, otros despliegan sus talentos en las investigaciónes y tareas de conservación que se realizan en varias zonas del pais, algunos trabajan en las universidades y por ultimo, muchos son profesores de colegio en donde pueden comunicar a los nuevos jóvenes su interés y respeto por la naturaleza.

Importante resultado ha sido el fortalecimiento de la actividad científica ecuatoriana. Se han publicado, principalmente en la Revista de la Universidad Católica, alrededor de 20 artículos científicos basados en las investigaciones ecuatorianas en Galápagos. Además, la Estación Darwin incentivada por estos resultados y conciente de la necesidad de poner al alcance de los universitarios ecuatorianos y sudamericanos los trabajos clásicos de investigación en Galapágos, se ha impuesto la tarea de seleccionarlos, traducirlos y publicarlos en un futuro próximo.

El éxito de este programa educativo en su corto lapso de funcionamiento ha llevado a los directivos de la Estación Darwin a ampliarlo y actualizarlo. Con la nueva modalidad, la Estación Darwin ha abierto sus puertas para que la iniciativa ecuatoriana pueda vertirse en las Galapágos pues no sólo los estudiantes podrán recibir becas de investigación sino tambien los profesores universitarios y de esta manera podrán conducir proyectos en Galápagos con sus propios estudiantes. Esta modalidad se añade al programa más tutorial que utiliza la guia de investigadores extrajeros. La Estación Darwin ha creado ademas cursos intensivos de técnicas de campo a realizarse cada dos años con la participación de profesores y estudiantes de las diferentes universides del Ecuador.

El programa de becas no podría realizarse sin el apoyo económico del gobierno Ecuatoriano para el funcionamiento de la Estación Darwin y de este apoyo dependerá en el futuro la exitosa expansión del programa de becas y programas educativos de la Estación. No menos

THE SUBAERIAL ORIGIN OF ESPANOLA (HOOD) ISLAND AND THE AGE OF TERRESTRIAL LIFE IN THE GALAPAGOS

by Dr. Minard L. Hall, Ing. Patricio Ramón, Sr. Hugo Yepes

The Galapagos Archipelago, although one of the most active volcanic centers of the world, is best known for its unusual plant and animal life and its bearing on biological evolution (Bowman, 1966; Darwin, 1845). Although descriptive studies of its wildlife are well advanced (Lack, 1947; Colinvaux, 1976), little is known about the rates of evolutionary change. This is due in part to the lack of a good understanding of the age and origin of the islands. Radiometric dating of some of the oldest lavas gives dates around 1.4 million years (Cox & Dalrymple, 1966) which demands an accelerated rate of evolution in order to explain the observed biological life (Thornton, 1971). More recent dating of rocks from Española (Hood) Island has given ages around 3.2 million years by K/Ar methods (Bailey, 1976) and an age greater than 3 million years by paleomagnetic methods (Cox, personal communication, 1977). Española Island has always been considered a block of submarine lavas, recently uplifted from under the sea (McBirney & Williams, 1969). If so, Española could not have served as an island refuge for the earliest animal and plant arrivals. On the other hand, if it can be shown from geological evidence that in fact Española existed as an island more than 3 million years ago and consequently may have served as a refuge for early arrivals, then the biologist will be able to better evaluate the rate of evolutionary processes.

In the course of geological mapping of the western half of this island, Ayala (1979) found some critical evidence that suggests that the island represents the remains of a large shield volcano that grew above sea level. The presence of an uneroded tuff cone, exposed in the lower cliffs of the south coast and covered by the thick sequence of lavas that comprise the island, suggests that these lavas formed subaerially or in shallow water. Because the ages given by Bailey are from rocks at the top of this sequence, much older dates are expected from the rocks towards the bottom of the lava section.

Our preliminary findings are in agreement with a subaerial origin for Española Island. Absolutely no evidence was found that would suggest a submarine origin (for example, the presence of marine sediments, pillow basalts or glassy lava tops). On the other hand studies of certain pyroclastic cones have tentatively shown them to be scoria cones, which normally form subaerially on the flanks of a volcano. Calcareous fragments, which are found dispersed over certain parts of the island and which argued for a submarine origin for Española (McBirney & Williams, 1969), are considered to be relict fragments of caliche that formed in an earlier soil.

Thus it is tentatively concluded that Española probably has been an island, and thus could have served as a terrestrial life refuge, for at least the last three million years.

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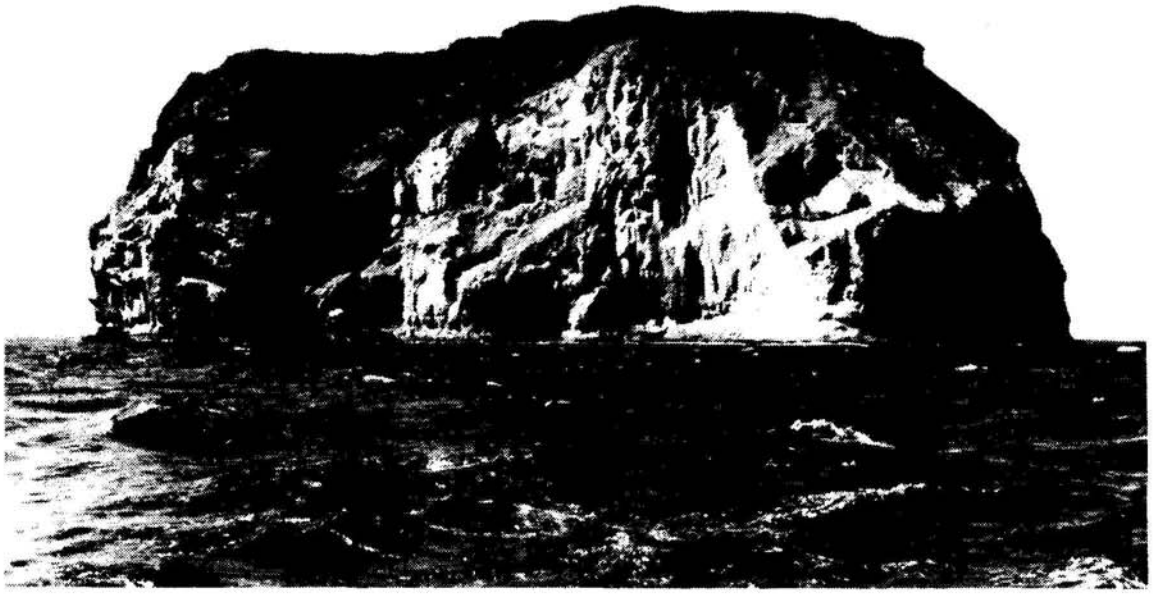
THE EXPLORATION OF ISLA DAPHNE MINOR

by P. R. Grant, T. D. Price and H. Snell*
Division of Biological Sciences, University of Michigan, Ann Arbor, MI48109, USA, and CDRS*



The Island of Daphne Minor: Photo by P. R. Grant

To celebrate the twentieth anniversary of the Charles Darwin Foundation we climbed Daphne Minor (Daphne Chica). It is unlikely that the island has ever been climbed from sea level to the top before. Long time residents of the islands have seen remains of a rope high up on the western cliffs, but the steep, often concave, cliff profile on this side of the island rules out more than a partial ascent from sea level. Possibly American military personnel parachuted onto the island during World War II, and used the rope to climb down and off. The rope has gone and no account of this visit has passed into Galapagos folklore. Our climb was therefore the first of its kind.

One of us (H.S.) and two climbers from Montreal, Canada, Howard Bussey and Kevin O'Connell, spent June 16–18 establishing ropes on the first 120 feet on the south side of the island, and made the first ascent to the top on June 18. Using these ropes the three of us climbed to the top of the island on June 19 and set up a camp on the flat rim of the crater on that side. We stayed overnight on June 19 and 20, descended on the afternoon of June 21 and left almost exactly 48 hours after the initial climb.

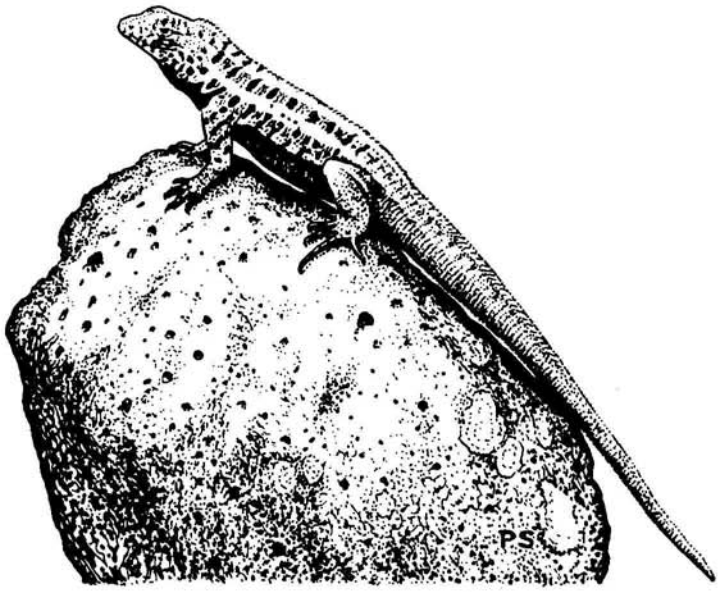
Our purposes were to conduct a biological survey of the island and to determine its maximum elevation.

PHYSICAL CHARACTERISTICS

Daphne Minor is 6 km north of Daphne Major, 9 km west of Baltra and 12 km north of Santa Cruz. Wiggins and Porter (1971) gave its area as 0.08 sq. km., but its elevation was unknown. Kevin O'Connell used a Killsman type C-12 aircraft altimeter to measure the elevation on two ascents from the sea, and two descents into the crater. Actual readings were corrected for (1) atmospheric pressure changes which were recorded separately, (2) instrument errors of $\pm$10 feet ($\pm$15m), as the instrument tended to read high on the way down and low on the way up, (3) reading errors for the instrument of about 5 feet, and of the thermometer of about 0.5^{o}C, and (4) non-ideal atmospheric (temperature) conditions as the working of the altimeter is based on an ideal atmospheric model.

The maximum elevation is 304 feet (93m). The bottom of the crater is 120 feet (37m) above sea level. Daphne Major is nearly one third taller than Daphne Minor, as well as being four times larger (Wiggins and Porter, 1971).

Some other physical features are worth mentioning. Daphne Minor is a tuff cone that has partly collapsed, which has given rise to its steep outer surface. The exposure on the southern side shows that magma has been extruded from a central vent. Magma caps most of the island. The inner slope of the crater is covered with boulders, rocks and some plate-like lava all the way to the bottom. Unlike Daphne Major, which has no indigenous lava, there is no flat, fine-particled, crater floor. The crater is shaped like a cone. The upper part of the inner wall on south, west and north sides has a series of three or four terraces running parallel to the contours for as much as 100 m and up to 10–15 m wide. The rim itself varies in width from about 30 m on the south side to less than 1 m on the north side.



Male Lava Lizard (Tropidurus): Drawing by Peter Scott

PLANTS

We recorded 24 species of plants (Table). None were unusual in appearance, and all have been recorded on Daphne Major during our past studies there. Daphne Minor is a *Bursera – Portulaca – Merremia* island. It differs from Daphne Major in lacking about 15 species, in being poor in grasses, *Opuntia, Croton, Amaranthus* and *Tribulus* and being rich in *Galactia.*

Some plants are extremely rare. Thus we found only 4 *Croton* bushes together on the outer eastern slope and all without flowers and fruits. Four withered *Amaranthus* stems were found on the inner slope, and single stems of *Mentzelia* and *Eragrostis* were found at the bottom of the crater.

Common plants were generally well distributed over the island, but *Chamaesyce amplexicaulis* was restricted to the fine tuff-derived soils of the outer slope and *Chamaesyce punctulata* (and several others), were only found on the shallow lava-derived soils on the rim and in the crater, particularly on the terraces. The largest *Bursera* tree was about 8 m tall and 110 cm in circumference, and therefore thicker in girth than any tree measured on Daphne Major.

Dawson (1966) believed Daphne Minor lacked *Opuntia* cactus. We counted 32 bushes, mainly on the outer slope, and a total of fruits just short of 1000.

BIRDS

The land birds were our chief concern. We put up three 12 m.mist nets and operated them on both mornings to give a total of 200 net-meter-hours. This has been a standard netting time of censusing on other islands (Abbott et al. 1977, Grant et al. 1975, Grant and Grant 1980, Smith et al. 1978). In this time we captured 18 *Geospiza fortis,* 17 *G. fuliginosa,* 4 *G. scandens,* 1 *G. magnirostris,* 1 *Camarhynchus parvulus,* 1 *Dendroica petechia* and 1 *Asio flammeus.* Outside the census time we captured nine more finches in these and other nets. We measured, banded and released all finches. Only 3 *G. fortis* and 3 *G. fuliginosa* were adults. We observed two martins *(Progne modesta)* flying around the top of the island.

Little Ground Finch (Geospiza fuliginosa) on Daphne Minor

We then walked around the island on the 21st June and recorded all birds (banded and not banded). The total population sizes of finches were estimated from the proportion of finches observed that were banded. The estimates can only be rough but are as follows: 60 *G. fortis,* 60 *G. fuliginosa,* 7 *G. scandens,* 1 *G. magnirostris* and 1 *Camarhynchus parvulus.* Therefore we captured and measured between a third and a half of all finches present. From the same census results we estimate there to be 5 *Dendroica petechia,* 10 *Zenaida asiatica* and 1 *Asio flammeus.*

These numbers do not give a correct indication of breeding population sizes, as most of the finches, some of the doves *(Zenaida)* and all of the warblers *(Dendroica)* were in immature or juvenal plumage. A maximum of 9 *Geospiza* finches were in black or partly black plumage; most of these were singing. One of them, a *G. fuliginosa* with a broken leg, was unmated but had a display nest. We captured this individual, and the measurements confirmed our identification. All other black males were apparently mated and were either territorial (1 *G. fortis* and 3 *G. fuliginosa)* or nomadic and accompanied by juveniles or immatures (3 *G. fortis* and 1 *G. fuliginosa).*

One of the *G. fortis* pairs (not banded) was feeding nestlings on the outer slope. We confirmed the breeding of this species on the island by capturing recently fledged young that could not have immigrated from another island. We confirmed the breeding of *G. fuliginosa* by capturing measuring and banding a female, subsequently found incubating three eggs in the only nest we encountered with eggs. Thus the breeding populations in 1979 may have amounted to no more than a few pairs of *G. fortis, G. fuliginosa* and *Zenaida galapagoensis.*

Many of the other birds had immigrated. We can be certain of this with *G. scandens,* because three of them had been banded previously as juveniles on Daphne Major by one of us (TDP) in January and March 1979. It is unlikely that *G. scandens* could normally breed on Daphne Minor as the whole island had less than half the number of *Opuntia* fruits usually found in a single territory on Daphne Major. Other finches could have immigrated from Daphne Major and Santa Cruz. The size and coloration of the beaks suggests a Santa Cruz origin of many of them, and Santa Cruz finches do migrate to Daphne Major (Grant et al. 1975). Undoubtedly some of the immature finches were born earlier in the year on Daphne Minor, but we suspect these were in the minority because on nearby Daphne Major the survival of young finches in 1979 had been extremely poor.

On Daphne Major all finch nests are in cactus, but on Daphne Minor where cactus is not common other nest locations are used. Thus, of 17 empty finch nests found, two were in live *Bursera* twigs, 3 were in dead *Bursera* trunks and one was a few cm above the ground in *Portulaca.* The remainder were in *Opuntia.*

The only seabirds we recorded were swallow-tail gulls with chicks around the coast, tropic-birds in caves on the inner slope and frigate birds roosting.

OTHER ANIMALS

A sample of 26 *Tropidurus* lizards was collected for taxonomic comparison with the Santa Cruz population, but we could find no geckos. Although no marine iguanas were seen, one was recorded (PRG) on the shore on 20 March 1976. We recorded all Galapagos butterfly species (except the fritillary), carpenter bees, locusts, brown grasshoppers, spiders, small snails, two types of flightless beetles and ants. Although these have not been identified yet they appear to be the same as those found on Daphne Major. We did not find any centipedes, but did find one scorpion on the shore.

Altitudes on Daphne Minor and Daphne Major, calculated from 2 to 4 readings except for those indicated by a superscript[1] which are single readings. The average deviations are of the same order or less than the instrument error of about 10 feet.

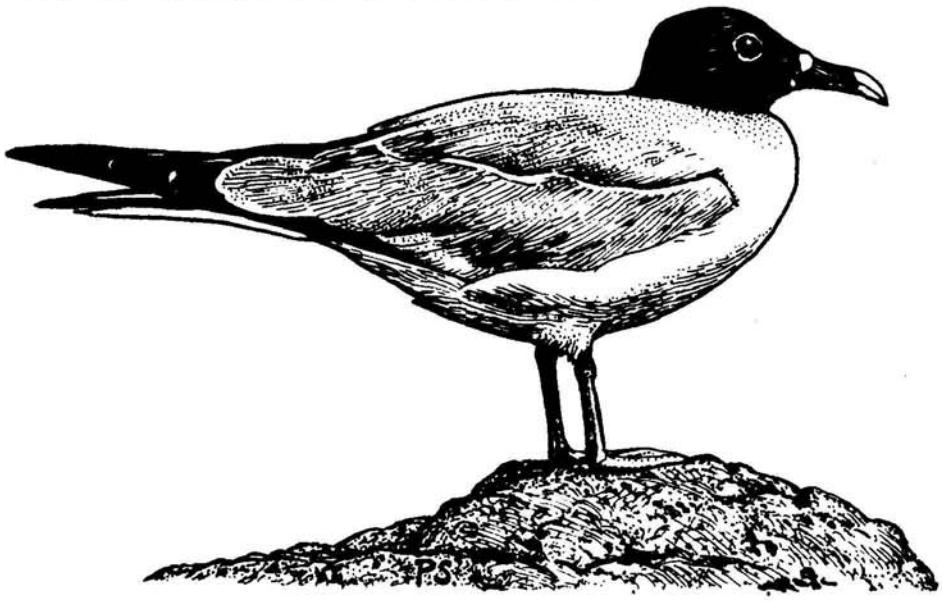
A. Daphne Minor; 19-20 June 1979 (K. O'Connell)

	Average altitude in feet	(meters)	Average deviation in feet	(meters)
South Rim	304	(93)	13	(4)
South West Rim[1]	304	(93)	0	(0)
North Rim	281	(86)	5	(2)
East Rim	235	(72)	9	(3)
Crater bottom	120	(37)	5	(2)

B. Daphne Major; 17-18 June 1979 (P. R. Grant)

	Average altitude in feet	(meters)	Average deviation in feet	(meters)
South Peak 1	391*	(119)	0	(0)
South Peak 2	386	(118)	3	(1)
South Peak 3	384	(117)	4	(1)
Plateau Point [1]	369	(113)	0	(0)
North Peak[1]	347	(106)	0	(0)
Saddle in rim above craterlet	188	(57)	12	(4)
Craterlet	158	(48)	11	(3)
Crater	88	(27)	7	(2)

*Listed by White and Epler (1972, p. 56) as 394 feet.



Swallow-tailed Gull: Drawing by Peter Scott

Plant species recorded on Daphne Minor, with presence of flowers and fruits indicated by a cross. A subjective estimate of abundance is provided in three abundance categories. A more objective estimate is given in the last column. A census route was walked around the rim, and plants were recorded in a 1 m^2 quadrat immediately in front of the last footfall, every 10 m.

Plant Species	Abundance	Flowers	Fruits	Frequency in 25 quadrats on rim
Opuntia echios	Scarce	–	X	–
Bursera malacophylla	Abundant	–	X	14
Croton scouleri	Scarce	–	–	–
Portulaca howellii	Abundant	X	X	13
Herissantia crispa	Abundant	–	X	8
Chamaesyce amplexicaulis	Common	X	X	–
Chamaesyce punctulata	Common	X	X	–
Heliotropium curassavicum	Scarce	X	X	–
Heliotropium angiospermum	Scarce	X	X	–
Acalypha parvula	Common	X	X	–
Amaranthus sclerantoides	Scarce	–	X	–
Mentzelia aspera	Scarce	–	–	–
Galactia striata	Common	–	X	2
Tiliqua (Coldenia) fusca	Common	X	X	1
Desmodium glabrum	Common	–	X	6
Cenchrus platyacanthus	Scarce	–	X	1
Eragrostis cilianensis	Scarce	–	X	–
Tribulus cistoides	Scarce	X	X	2
Ipomoea linearifolia	Common	X	X	4
Merremia aegyptica	Abundant	X	X	18
Sida salviifolia	Common	X	X	3
Abutilon depauperatum	Scarce	X	X	–
Cacabus miersii	Scarce	X	X	–
Boerhaavia erecta	Scarce	X	X	–

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The explorer G. H. L. Mallory, when asked why he wanted to climb Mt. Everest, replied "Because it is there." Howard Bussey and Kevin O'Connell did not have this incentive to climb Daphne Minor. The rock surface was unconsolidated and friable offering a climbing challenge but not enjoyment. We are very grateful to our two climbers for persisting through the first three days by adopting our incentives. We also thank Bernardo Gutierrez of the "San Juan" for a crucial gift of 4" nails, as well as for his general help. Finally, we thank Miguel Cifuentes, Intendente, S.P.N.G., for kind permission to make the climb, and Aviation Electric Ltd. of St Laurent, Quebec, Canada for the loan of the Kollsman altimeter.

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