NOTICIAS DE GALAPAGOS

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CONTENTS

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Enquiries may be addressed to:

Dr. Peter Kramer	Universität Essen, 4300 Essen 1, Universitätsstrasse 5, Fed. Rep. of Germany.
Mr. G. T. Corley Smith	Greensted Hall, Ongar, Essex, CM5 9LD, England.
Dr. D. Challinor	Smithsonian Institution, Washington DC 20560, USA.

NEWS FROM ACADEMY BAY

THE TWENTIETH ANNIVERSARY

The 20th Anniversary of the Charles Darwin Foundation will be celebrated in the Van Straelen Hall at Academy Bay in the presence of Dr Peter Kramer, formerly Station Director and now President of the CDF. By happy coincidence, Dr Kramer has just been appointed an Officer of the Order of the Golden Ark, in recognition of his services to conservation in the Galapagos. By another happy coincidence, Mr Guy Mountfort, CDF Counsellor and an early protagonist of conservation not only in the Galapagos but in critical areas of every continent, has been awarded the Gold Medal of the World Wildlife Fund.

A retrospective look over the Foundation's first 20 years is given in a separate article in this anniversary number.

CAPTIVE BREEDING OF GIANT TORTOISES

By March 1979, 751 tortoises of various endangered sub-species hatched at the Station were either still being reared there or had already been released on their native islands. This does not include the very considerable numbers raised in the wild with at least partial protection by the Galapagos National Park Service, whose chief naturalist, Lcdo. Fausto Cepeda P., gives the following breakdown:

ISLAND	*RACE*	*NUMBERS REPATRIATED*	*STILL AT REARING CENTRE*
Española (Hood)	G.e. hoodensis	79	42
Pinzon (Duncan)	G.e. ephippium	182	22
Santiago (James)	G.e. darwini	109	14
San Cristobal (Chatham)	G.e. chathamensis	101	14
Isabela (Albemarle)	G.e. vicina	64	82
Isabela (Albemarle)	G.e. becki	14	28
		549	202

Much publicity has been given to the rescue of the giant tortoises from the threat of extinction – and rightly so. It was the giant tortoises that gave their name to the islands, started a revolutionary train of thought in young Charles Darwin's mind and inevitably became the symbol of the CDF: but we must never forget that the tortoises form only a tiny fraction of the extraordinary natural wealth of the archipelago.

PROTECTING THE FLORA

There are two main threats to the Galapagos flora: the competition of introduced plants and trees on the inhabited islands; and goats wherever they have been introduced. To combat the infiltration of foreign plants from farms in the colonized zones, the National Park Service will need more men, at least until the scientists can devise less labour-intensive methods of checking the relentless invasion.

Goats have been eliminated on Plaza, Santa Fé, and Española and there are reasonable expectations that on Pinta and Marchena the notable reductions already achieved by the hunters will eventually lead to complete eradication. This leaves the vast herds on the bigger islands, notably Santiago (James) and Isabela, as the major problem, so far with no feasible solution in sight. As a holding operation, critical areas of endemic vegetation have been enclosed with goat-proof fences. These experiments have proved as successful as their small size permitted. Now the Mary Skaggs Foundation has provided funds to finance three much larger (100 x 100 metres) enclosures that should guarantee the preservation of much of the endangered flora until the goat problem is solved. The erection of these new quadrats will involve the GNPS in the Herculean task of carrying 20 tons of fencing over a desperately difficult terrain. At the same time Dr Herbert Hawkes is generously promoting experiments with much lighter electric fences, while the Frankfurt Zoological Society is providing boats to transport the wardens and modern rifles to speed up the eradication of goats and other destructive introduced species.

In an article elsewhere in this issue, Dr Ole Hamann suggests the creation of an experimental nursery garden at the CDRS, where certain endangered plant species could be raised on the lines of the successful tortoise rearing programme. This would be open to visitors and might stimulate support for botanical conservation just as visits to the tortoise breeding centre have done on the zoological side.

GALAPAGOS ISLANDS SYMPOSIUM

A two-day symposium about the Galapagos Islands was held on April 6–7, 1979 at the Morrison Auditorium of the California Academy of Sciences in Golden Gate Park, San Francisco. This meeting, jointly sponsored by the Academy and the Charles Darwin Foundation for the Galapagos, was open to the public. Illustrated lectures were presented by the following specialists:

I. CONSERVATION PRIORITIES

Dr Peter Kramer – Conservation Priorities in Galapagos.
Miguel Cifuentes – Environmental Conservation in the Galapagos: Present Practices and Future Prospects.
Dr Hendrik Hoeck – Ongoing Conservation Projects at Galapagos.
Howard Snell – Land Iguana Conservation Project.

II. MARINE RESEARCH

Dr Robert Hessler – Observations of the Offshore Deep-seabed from the Research Submersible "Alvin".
Dr George Bartholomew – Energetics of the Swimming Marine Iguanas.
Dr P Dee Boersma – The Galapagos Penguin and the Flightless Cormorant: Reproductive Behavior and the Marine Environment.
Dr John E McCosker – Ichthyological Studies at Galapagos.
Steve Hoffman – Sex-Related Foraging in Hermaphroditic Hogfishes.
Dr Sylvia Earle – Submarine Plant and Animal Distributions in Relation to the Galapagos Nearshore Thermocline.

III. EFFECTS OF EXOTIC SPECIES ON GALAPAGOS ENDEMICS

Dr Ole Hamann – The Adaptive Strategies of Threatened Galapagos Plants.
Dr Deborah Clark – The Role of Introduced Black Rats in Galapagos Ecosystems.

Tui de Roy Moore – Effects of Tourism: Observations of a Resident Galapagos Naturalist.
Dr David Clark, et al. – Effects of the Little Fire Ant on the Indigenous Ants of Santa Cruz, Galapagos.

IV. TERRESTRIAL RESEARCH
Dr Paul Colinvaux – The Galapagos Since 18K: Paleo-ecology in Light of the Climatic Record.
Dr Henk van der Werff – Galapagos Floral Studies.
Dr Robert Bowman – The Ecology of Song of Darwin's Finches.
Dr Peter Grant – Reproductive Biology of Darwin's Finches.
Dr James Patton – Evolutionary Genetics of the Galapagos Finches.

OUT OF THEIR ELEMENT

After three years as staff scientist at the CDRS, Dr Robert Tindle still delights in watching the Bottle-nosed Dolphins, just like any tourist on a first visit, except that he knows they are called *Tursiops truncatus.* One of the many nice things about dolphins is that they seem to like man as much as man likes them; but friendliness can be carried too far. Recently Dr Tindle, on board the fishing boat "Saturno", was admiring their antics as they rode the bow-wave, when one leapt 15 feet into the air – right into his arms. The result of this strange encounter was that the half-ton dolphin was stranded on the deck while Dr Tindle was hurled into the sea. Each was eventually restored to his proper element, Dr Tindle with nothing worse than bruised ribs and the dolphin apparently unharmed. The boat was less fortunate, with two bent metal mast-stays and a hole in the cabin roof.

VISITORS TO THE STATION – SEPTEMBER – DECEMBER 1978

September	Sylvia Harcourt: arrived to assist Keith Christian on his land iguana program.
	Dr Ko de Korte and Miss Simone den Brinker: arrived to work on frigate birds project.
October	Biologo Leonardo Mariduena took up post as staff scientist.
	D M Bridgen: installation of radios donated by RACAL.
	Priscila and Lorena Martinez, students from Univ. of Guayaquil: tourist impact on red-footed boobies.
	Dr Allain Sourinia and Fernando Arcos of INOCAR: to collect plankton from lagoons.
	Julie Bourke, volunteer worker at the library since May, left.
	Ted Murphy, Univ. of Hawaii, and Pedro Rizzo, INOCAR, came to instal a mareograph in Academy Bay.
November	Drs Tom Simkin, Lee Siebert and Charles Wood, (Smithsonian Institution); Dr Robert Smith (US Geological Service); Dr Pete Hall (Escuela Politecnica de Quito); Patricio Ramon and Tui de Roy; volcanology of Fernandina.
	Ines Serrano and Bertha Peralta, students from Univ. of Guayaquil: tourist impact on blue-footed boobies.
	Dr Franz H Ulrich and wife. Deutsche Bank.
	Dr Peter Grant: continuing long-term study of Darwin's finches.
	Dr R Edberg, Swedish Academy of Sciences.
	Econ. Santiago Sevilla, former Minister of Finance.
December	Prof G Baerends and wife, Groningen University.
	Dr & Mrs James Kushlan: ecology of the lava herons.

LOOKING BACK
ON
TWENTY YEARS OF THE CHARLES DARWIN FOUNDATION

by G T Corley Smith

Thor Heyerdahl is satisfied that pre-Columbian sailors from the American mainland reached the Galapagos in their balsa rafts. Whether they were deliberately exploring or whether they discovered the islands unintentionally when the ocean currents carried their light vessels deep into the Pacific, they never settled there permanently and could not have seriously affected the wildlife. Certainly the Spaniards were reluctant discoverers when they drifted there in 1535, and, as these arid volcanoes had no gold, no fertile land, nor souls to save, they never even tried to occupy them. For the Spaniards they remained *Las Islas de los Galapagos* – The Islands of the Tortoises – and the occasional visits of pirates and naval vessels, spread over the next two and a half centuries, could have done little lasting damage.

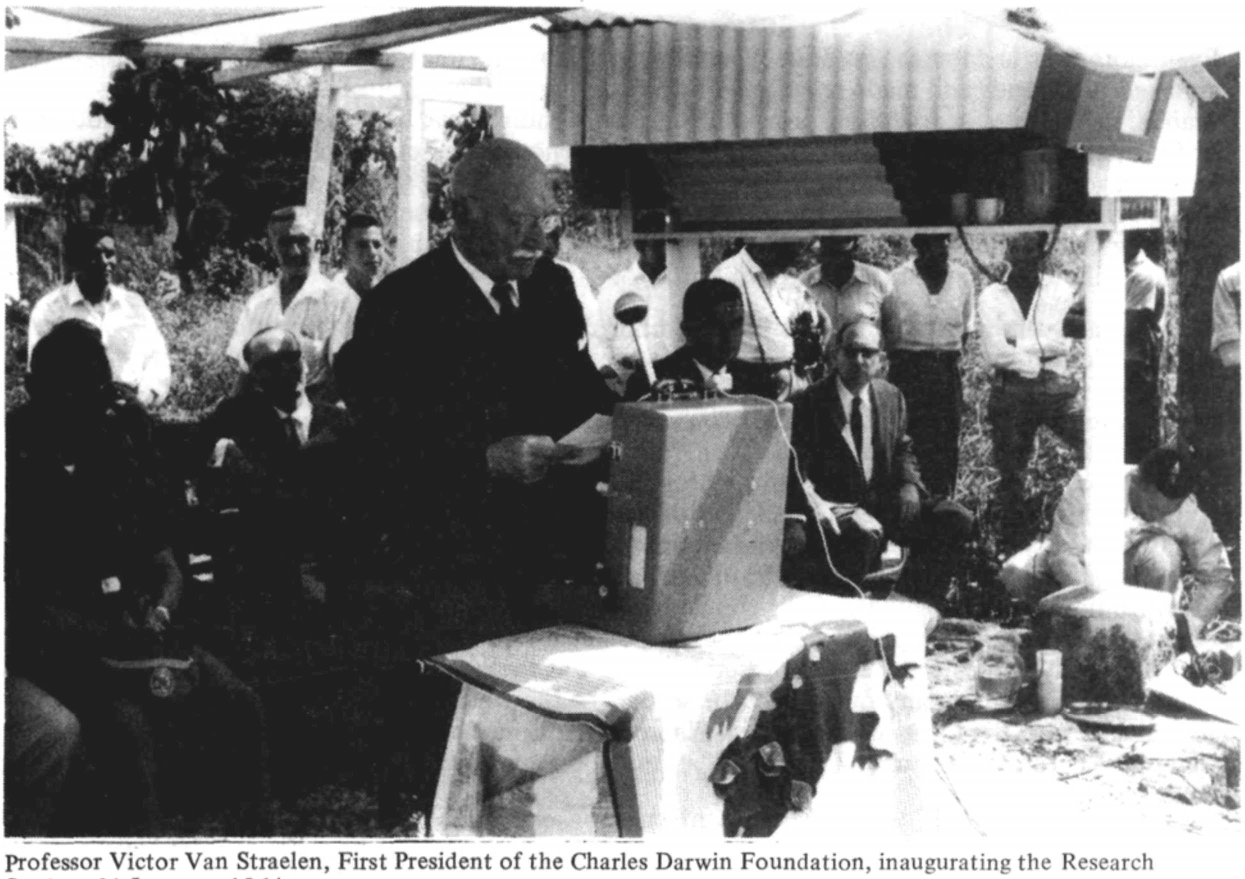
It was only towards 1800 that the real trouble began, when Captain Collnett of the Royal Navy recommended the archipelago as an excellent base for hunting the Pacific whales, because Atlantic catches were running down due to overkill. So the whalers and sealers invaded the Galapagos waters and, by the time that they stopped coming because they had nearly wiped out both whales and fur seals, they had also drastically reduced all the various populations of giant tortoises, loading them by the hundred into their ships' holds, as a delicious change from salt pork.

Even more drastic damage was done when the newly independent Republic of Ecuador annexed the islands and made repeated efforts to colonize them from 1832 onwards. The islands, so suitable for tortoises, proved ill-adapted to human settlement, whether by Ecuadoreans or Europeans, and after a century of misery and violence, the population of the entire archipelago was only that of a modest village. So much had been sacrificed for so little. Because, though the settlers themselves did not thrive, their abandoned domestic animals did. Goats, pigs, dogs, cats, donkeys, cattle, (not to mention black rats and mice) ran wild and multiplied, and are still doing far greater damage to both flora and fauna than man ever did directly.

As though that were not enough, at the beginning of the present century international scientists joined in the destruction. Because of the immense difficulties of reaching the Galapagos round Cape Horn, relatively few 19th century scientists had followed Charles Darwin there, despite the interest his visit had aroused. Then Lord Rothschild found a short cut by mounting a collecting expedition based on California, under the leadership of Rollo Beck. In 1905-6 Beck set out again with a party of scientists organised by the California Academy of Sciences; they made the first comprehensive survey of the natural resources of the Galapagos and incidentally gave the name to Academy Bay. Their year-long expedition contributed much to knowledge, nothing to conservation. They collected voraciously and depleted still further the dwindling stock of wildlife. Conservation was a concept virtually unknown to their generation. Scientists simply accepted that the Galapagos fauna was doomed to extinction and that their duty to posterity was to preserve as much as they could in museums. There is no point in blaming them, any more than the settlers or the whalers: they were all acting in accordance with the ideas of their times. When the Panama canal was opened, access to the Galapagos became easier and more scientists and zoo-men arrived to make more and more collections.

It was not until the 1930s that any effort was made to halt the degradation. Dr Victor Wolfgang von Hagen and other early Galapagos enthusiasts vigorously advocated both protective legislation and the establishment of a scientific station in the archipelago. The Government of Ecuador decreed some of the islands as nature reserves and in 1935, exactly 100 years after Charles Darwin's visit, von Hagen led the "Galapagos Memorial Expedition" to San Cristobal (Chatham) Island to erect a monument to the great naturalist, with an inscription written by his only surviving son, Major Leonard Darwin. It was a gallant effort but produced no positive action. The Government appointed no wardens in the islands to enforce its decree and international scientists failed to set up even a modest research station. Dr von Hagen pleaded his cause in Europe, where in 1937 Julian Huxley headed an imposing "Galapagos Islands Committee" with representatives of the British Association, the Royal Society, the London Zoological Society, the Fauna Preservation Society, the Society for the Promotion of Nature Reserves, the Linnean Society and the Royal Geographical Society; but nothing had been achieved when war came in 1939. Discussion continued in the United States between Dr Waldo Schmitt and Dr Alexander Wetmore of the Smithsonian Institution but that too died out with Pearl Harbour. The Galapagos served as a temporary US air base until 1945 and, even if a scientific station had been set up, it is doubtful whether it could have survived the pressures of a world war.

During the decade following the war there was no remedial action; in fact, the situation grew decidedly worse as human settlement began on a much larger scale and the destructive feral animals multiplied. Then, in 1954, a young ethnologist from the Max Planck Institute, Irenaus



Professor Victor Van Straelen, First President of the Charles Darwin Foundation, inaugurating the Research Station, 21 January, 1964. *Photograph by A. Gille, UNESCO.*

Eibl-Eibesfeldt, landed as a member of a scientific mission. He was fascinated by what was left of the unique wildlife but appalled by the threat to its survival. He had little hope of a rescue for the whole archipelago but thought that the unsettled islands might still be saved. He sent a memorandum to two new post-war bodies, the United National Educational, Scientific and Cultural Organisation (UNESCO) and the International Union for Conservation of Nature (IUCN). He was lucky: these were the years when the idea of nature conservation was beginning to catch on. In 1957 UNESCO and IUCN, with the support of the International Council for Bird Preservation, the New York Zoological Society and Life Magazine, organised an expedition composed of Eibl-Eibesfeldt, Robert I Bowman, Alfred Eisenstein and Rudolf Freund. They endorsed the old plan to set up a research station and recommended Santa Cruz Island as the site.

Further stimulus came from the International Zoological Congress, which met in London in 1958 to celebrate the centenary of the public statement of the evolutionary theories of Darwin and Wallace. By some obscure strategem, Sir Julian Huxley, Professor Victor Van Straelen and Dr Kai Curry-Lindahl persuaded the Congress to break its rigid rule of never passing resolutions and 3000 of the world's most distinguished zoologists voted a motion urging immediate action to save the Galapagos. Under the auspices of the Government of Ecuador, UNESCO and IUCN, an organising committee was set up with Sir Julian as acting chairman, and, thanks chiefly to the dynamic efforts of Van Straelen, the Charles Darwin Foundation for the Galapagos Isles was created in Brussels on 23 July 1959, the centenary of the publication of the *"Origin of Species"*. Huxley was Honorary President, Van Straelen, President; Luis Jaramillo, Vice-President; Jean Dorst, Secretary-General; the Executive Council also included J-G Baer, Cristobal Bonifaz, François Bourlière, Robert Bowman, Harold Coolidge, S Dillon Ripley and Peter Scott. Was it just good luck or was it due to extraordinary foresight that so many of the founding members later achieved international fame in the world of science and conservation?

Victor Van Straelen and Robert I. Bowman inspecting the new Station. *Photograph by A. Gille, UNESCO.*

Finance was inevitably a big problem in the beginning – as indeed, it has remained ever since. There is not space here to list all the societies, foundations and individuals, who have given support to the CDF during its twenty years and it seems invidious to make a selection. Yet it must be recorded that for the first dozen years, the running of the Research Station was made possible by the fact that its Director was on UNESCO's staff; that the Government of Ecuador, the Belgian Ministry of Education, the Royal Society in Britain, the Max Planck Society in Federal Germany gave official or quasi-official support; that the World Wildlife Fund, the Smithsonian Institution and the Frankfurt Zoological Society, collect each year very large sums from individual donors, without whose support the CDF could not have succeeded.

The first Director, Raymond Lévêque, arrived on Santa Cruz Island in 1960 and faced the daunting task of setting up a research station on a remote island lacking water, electricity, skilled labour and most materials and with poor communications with the outside world. At the same time he had to make a start with his scientific and conservation duties, which involved a preliminary exploration and census of the archipelago's resources, scattered over a wide area of difficult terrain. In 1962 he was succeeded by André Brosset and in 1963 by David Snow. These three pioneers, aided by the station manager, Edgard Pots, had pushed construction forward to the point where the official inauguration of the Research Station could take place on 21 January 1964. Not only had much progress been made with the laboratory, seismological and meteorological stations, workshop, water tanks, electricity and accommodation but a rough census of species had been begun, visiting scientists were at work and the first steps in conservation had been taken, including setting up the strict tortoise reserve on Santa Cruz.

The inaugural ceremony brought together a strange gathering. There were the highest representatives of the Government, the Ambassadors of the countries supporting the CDF, representatives of the Ecuadorean Universities and a whole shipload of scientists, arriving to begin their researches in a wide variety of disciplines. They were members of the "Galapagos International Scientific Project", organised by Robert L Usinger and Robert I Bowman on behalf of the University of California and under the auspices of the Government of Ecuador, the US National Science Foundation, the California Academy of Sciences and the CDF. Marshalled by Harold Coolidge, speaker after speaker rose to address the sweltering delegates as they sat among the cactus and thorn scrub under the burning equatorial sun, pledging support for this novel international experiment. It was a moment of triumph for the Foundation's President, Victor Van Straelen; it was as though he was launching the ship which he had laboured so hard to design and build. But he was not to sail far in her. On 14 February in the Ministry of Foreign Affairs in Quito, he signed the basic agreement between the CDF and the Government of Ecuador and died a few days later on his return to Belgium.

This was the end of the first phase and the beginning of a long period of steady development. Van Straelen's obvious successor was Jean Dorst, who had been the first Secretary General, and who served a further ten years as President. David Snow was succeeded by Roger Perry, who served for six years, the longest tenure of any Station Director. Building on the foundations laid by Van Straelen and the three pioneering Directors, Dorst and the CDF Council moulded the organisation we know today, even if chronic lack of funds (one year the Director had to go unpaid) kept developments small in scale. Vigorous exploration of the rugged terrain gave a much closer approximation to a general census of the islands' resources, though even after 20 years there are still many gaps. Frequently the discoveries were encouraging; not so the realisation that there might be as many as a quarter of a million goats rapidly destroying the vegetation.

Miguel Castro, the first CDF Conservation Officer with (left) Roger Perry, Station Director and (right) the late Eric Shipton, mountaineer and explorer.

Photograph by Sven Gillsäter

The first conservation officer, Miguel Castro, was appointed with the support of the New York Zoological Society, and a start was made with the seemingly insoluble problem of controlling the introduced rats, cats, dogs, pigs, goats and donkeys, at least in some critical areas. Captive breeding of the various endangered sub-species of giant tortoise was begun in 1965 with eggs taken from Duncan (Pinzon) Island where the black rats had killed every hatchling for the last half century. The eggs were incubated at the CDRS in converted bird cages until the San Diego Zoo, inspired as much by surprise as by admiration at the success amateurs had achieved with such primitive equipment, made possible the building in 1969 of the present tortoise house and the expansion of the rearing programme. But these methods were inapplicable on Hood (Espanola) Island, where a mere dozen elderly survivors were competing with hordes of goats for the remnants of the food supply. Scattered over a vast area, male apparently no longer met female and there was no sign that any breeding had taken place for decades; there were certainly no young. So, as they seemed to have no future if left to their own devices, Perry collected the few he could find, one male and three females, and took them to the Station, where eventually they bred. By March 1979, in addition to the 42 Hood hatchlings still being reared at the CDRS, there were 79 thriving young tortoises on Hood Island – and no goats. It is encouraging to compare this with an extract from David Snow's report (Noticias No. 2) on the giant tortoise census of 1963: "Only one tortoise was found on Hood in the course of searches by three men for two days. The vegetation of Hood has been terribly ravaged by goats; when the tortoise was found it was feeding in company, and in competition, with 15 goats."

Altogether by March 1979 over 750 young of the six most endangered sub-species had been successfully raised at the station and all the races of giant tortoise known to exist when the CDF was founded (and even two believed extinct at that time) are now safe for posterity, apart from the Abingdon (Pinta) sub-species, in which case the sole surviving male will be the last of his kind unless a mate can be found for him in some zoo or collection. This is still not impossible. The San Diego Zoo found a male Hood tortoise in its collection and generously returned it to the Galapagos, where it is a genetically valuable addition to the previous breeding stock of only two male Geochelone elephantopus hoodensis.

These were important successes but the most vital development of this period was the organisation of the Galapagos National Park Service (GNPS). Its beginnings were modest. Its first officers, Juan Black and Jose Villa, arrived in 1968 to take charge of conservation and were accommodated at the Darwin Station until such time as the GNPS could build and equip its headquarters. Thus began the intimate collaboration between the Park Service and the Station which has continued ever since with such excellent results.

One fortunate feature of the CDF's first 20 years has been the degree of continuity in its personnel. Founding fathers such as Hal Coolidge, Jean Dorst, Dillon Ripley, Peter Scott (and until his death in 1978, Cristobal Bonifaz) have remained on the Executive Council throughout in spite of the increasing demands on their time as they rose to eminence in their respective fields. Peter Kramer knew the Galapagos first as a visiting ornithologist in 1962-3, later as Station Director and finally as successor to Jean Dorst as President. Similarly, Craig MacFarland had spent two years studying the giant tortoises before he succeeded Peter Kramer as Director. Moreover, a number of visiting scientists – Bowman, Colinvaux, Eibl-Eibesfeldt, Grant, Harris, de Vries, to name but a few – have returned time after time to the islands, thus acquiring over the years a perspective and a depth of local knowledge which has been invaluable to the Station. And there is a curious comradeship among those who have struggled for conservation in the Galapagos, men and women from different countries and different walks of life, who may not have had any other link but who are bound together by this sole purpose. Its importance cannot be measured – it is simply inestimable.

Under Peter Kramer the Research Station expanded in size and scope. He was able to increase the attention devoted to education in its widest sense: not only did he continue the biology classes in the local schools, the seminars for teachers and officials and the training courses for park wardens, but he established closer relations with the mainland universities, set up a Galapagos Information Centre in Quito and promoted a series of publications in Spanish to give Ecuadoreans wider access to the basic facts about their extraordinary archipelago. It was in his time that the boundaries between the inhabited areas and the National Park were finally delineated, giving the Park 690,000 hectares, nearly nine-tenths of the total land area. Kramer also served in his dual capacity as UNESCO expert and CDF representative on the small committee which drafted the vital "Master Plan for the Galapagos National Park", (summarised in Noticias 23) which was accepted as the basis for subsequent government policy.

About this time two important international conferences were held to report on and to promote scientific activities at the CDRS. In 1972 a Galapagos Science Conference was held at the Smithsonian Institution to revise the earlier programme of priorities for conservation research and fundamental scientific investigation; and in 1974 a Galapagos Symposium was held in San Francisco, under the auspices of the American Association for the Advancement of Science. Abstracts of the papers read were printed. Scientific investigation has always been a vital part of the Foundation's activities and the re-assessment of priorities for research in the light of changing circumstances and knowledge is a recurring necessity. A new revision is under way during this 20th anniversary year.

In 1974 Peter Kramer returned to his academic work in Germany and also took up the burden of the Presidency of the CDF from the long-serving Jean Dorst. In turn, Craig MacFarland, whose work had previously been concentrated on the giant tortoises, took over the increasingly onerous duties of Station Director. His four years covered a period of rapid expansion, particularly of administrative duties. In some respects this could be accepted philosophically as the price of success. More and more scientists from many lands came to work at the

The old Jeep – "El Poderoso" – still in service carrying fodder for tortoises though not looking quite so smart as when donated in 1964.

Research Station (eventually the total of 500 visiting scientific missions was passed); hundreds and hundreds of tourists wanted to visit the CDRS and it would have been churlish not to show them round and explain our activities. The increase of visitors to the islands necessitated the constant monitoring of "tourist impact" to ensure that greater numbers did not result in disturbance of the wildlife. Courses had to be organised to train more National Park wardens and also guides to accompany every party of tourists. Ecuadorean students working at the Station needed specialised supervision if they were to profit from their scholarships. But all this ate up man-hours and more staff was required than resources permitted. The increase in activities was not accompanied by any comparable increase in finance and the Director was compelled to devote too much of his time to fund-raising. It is obviously regrettable than a man, chosen chiefly for his qualities as a scientist, should have to expend so large a proportion of his efforts on such an unfamiliar task, but this is a problem which has harassed successive Directors.

Naturally, with MacFarland's expert advice, the captive breeding of giant tortoises went triumphantly ahead; and now came the pay-off as increasing numbers of youngsters were repatriated to their native islands. On the debit side, massacres of two important populations of land iguanas by feral dogs compelled the CDRS to take the survivors into protective custody and to initiate a daring new programme of captive breeding at the Station. But MacFarland was usually involved in developments far removed from herpetology. For instance, there was un upsurge of interest in Galapagos marine resources (which, many believe, will equal the terrestrial in their importance to science) and much effort was devoted to the exploration and the mapping of potential underwater parks. A number of joint marine research projects were initiated in collaboration with other bodies such as the Oceanographic Institute of the Navy, the National Institute of Fisheries and the Universities of Guayaquil and Hawaii.

The expansion of the Galapagos National Park Service under the Master Plan provided more wardens, thus making possible far greater activity in the control of introduced animals and plants, in all of which the CDRS was inevitably involved. Moreover this development of the GNPS, together with the rapid expansion of tourist traffic and the growing participation of the Universities and the Polytechnics in the scientific work of the Station, led to a most gratifying increase in official Ecuadorean involvement and support for the CDF. The Foundation therefore proposed that the structure of its Executive Council should be changed to include *ex officio* representatives of the Ministries and institutions most involved. This was immediately accepted and the consequent integration of the national authorities into the CDF has proved of the greatest benefit to Galapagos conservation.

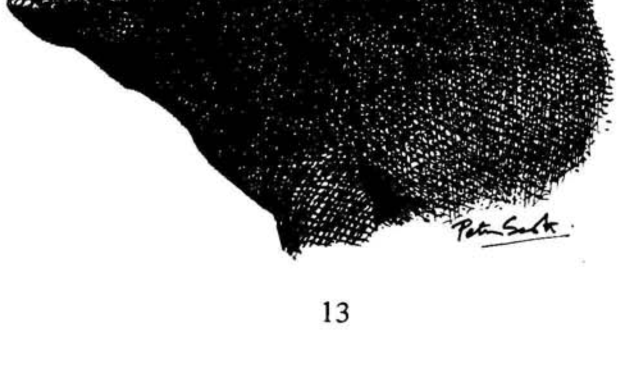
It was in these circumstances that Hendrik Hoeck became Director in 1978 and took charge of a Research Station full of problems but likewise full of promises. When Peter Kramer returns there to preside over the 20th anniversary celebrations, it will no longer be necessary to hold these in a clearing among the cactus because the Van Straelen lecture and exhibition hall will be completed. Galapagos will no longer be a name known, outside Ecuador, to only a handful of scientists and yachtsmen: since the organisation of the Darwin Foundation, its wonders have been revealed to millions of people the world over by newspapers, illustrated magazines, books, radio and most dramatically by television.

Looking back through the documents on which this account is based, it is difficult to avoid a dangerous feeling of smug satisfaction. Consider the near despairing conclusions of Von Hagen at the time of World War II; or the relative modesty of even the highest hopes of

Eilb-Eibesfeldt and Bowman in the late 1950s; or how little Snow could think of attempting with his pitifully restricted resources when the Station was inaugurated; or even the achievements recorded by Dorst and Laruelle in their report on "The First Seven Years": then compare all this with the present situation and the ongoing programmes of the GNPS and the CDRS. True, there seem to be more conservation problems today than in 1964, but that is due in part to knowing so much more about the islands and in part because we are now tackling the problems which were previously accepted as insoluble. Likewise on the research side, owing to the innate capacity of any scientist worth his salt to discover two new problems for every one he solves, we become increasingly aware of depths in our ignorance which we had not previously suspected.

On the positive side, we can point to the creation of a vigorous National Park Service; thanks to this, poaching and encroachments of settlers on the Park are no longer major problems and, although numbers of visitors have greatly increased, they are controlled and are not a serious threat provided the limits laid down in the Master Plan are respected. No known species has become extinct since the CDRS was set up; by captive breeding every remaining race of giant tortoise and, it is hoped, every population of land iguana will now survive. There are today an estimated 40,000 fur seals (formerly believed doomed to extinction) and as many sea lions. A number of long-term projects to protect the native vegetation are under way. The destructive goats are being gradually eliminated on one island after another and, on the larger ones where this is not yet possible, critical areas are being protected by fencing. Marine biology is now making great strides and a marine laboratory is planned with UNESCO support. Increasing attention is being paid to geology (including marine geology) thus doing more justice to the archipelago's reputation as one of the world's most active volcanic regions. And in all these fields – zoology, botany, geology – Ecuadorean students and graduates are playing a growing role. In spite of the damage done in the past, there is no other place where organic evolution can be so effectively studied as in the Galapagos Islands. This alone gives them universal significance. How right that on the initiative of the Ecuadorean Government the United Nations should now have conferred World Heritage status on the archipelago!

Yes, there is reason to feel proud on our anniversary, but we must look forward as well as back. There is still so much that needs doing to protect the incredibly rich resources of the Galapagos and the Charles Darwin Foundation is acutely aware of the financial limitations on its ability to do what it knows to be necessary. Nevertheless, after 20 years of struggle, it can at least be said that not only has a halt been called to two centuries of degradation but the tide has been turned back and the Galapagos Islands already rank as one of the most important National Parks in the world.



THE FEEDING ECOLOGY OF DARWIN'S GROUND FINCHES

B R Grant and P R Grant
Division of Biological Sciences, University of Michigan,
Ann Arbour, MI 48109, USA

"But it is the circumstance, that several of the islands possess their own species of the tortoise, mocking-thrush, finches, and numerous plants – these species having the same general habits, occupying analogous situations, and obviously filling the same place in the natural economy of this archipelago – that strikes me with wonder."

C Darwin, 1845

Darwin's astute observations on the Galapagos stimulated a sequence of ideas leading to his theory on the origin and evolution of species by natural selection. They have led many people since to ponder the question of how exactly the changes involved in species formation come about.

Darwin remarked on the perfect gradation of beak sizes among the finches, and speculated that one species might have been modified into various forms owing to the scarcity of other bird species in the archipelago. Scientists have generally agreed that this is what happened. David Lack followed Darwin in wondering how this modification could have occurred. A visit to the islands in 1938-39 and a study of museum specimens led him to suggest that when a few birds fly from one island to another and establish a new population, changes occur through an accumulation of different mutations (Lack 1947). Given enough time the changes would be so profound that the two populations would no longer be capable of inter-breeding, and hence should be considered two species. These two populations might come together through some individuals dispersing from one island to another. They would then remain on the same island as distinct species if they did not interbreed freely and did not compete severely for food. Natural selection might play a role in facilitating their coexistence by exaggerating the differences between them; for example, by favoring the largest members of the larger species and the smallest members of the smaller one. Lack argued that a repetition of these processes of change has produced, from one original ancestor, the 13 species we see today on the Galapagos (and one on Cocos Island).

It is a surprising fact that our knowledge of the adaptive radiation of Darwin's Finches is based almost entirely on studies of dead birds. These studies include a particularly detailed treatment of their anatomy by Bowman (1961). In the hope of learning much more by studying living finches, we began studies of the feeding ecology of the six species in the ground finch group (*Geospiza* spp.) in 1973. We have attempted to explain beak size and feeding variation 1) within populations, 2) between populations, and 3) between species.

VARIATION WITHIN POPULATIONS

Some populations of Darwin's Finches are very variable in beak size and shape. Our understanding of species formation would be imporved if we could explain why single populations vary so much. One possibility is that species hybridize frequently. However, this does not appear to be the case. A study being conducted by P T Boag and T D Price on Isla Daphne Major is designed, in part, to find out how frequently hybridization occurs.

Another possibility is that in varied environments a large degree of genetic variation is fostered by natural selection, because individuals of different phenotypes (in this case bill shapes and sizes) are adapted to exploit different parts of the environment (Van Valen 1965). We investigated this possibility on the north coast of I. Santa Cruz and I. Daphne Major by studying the feeding behaviour of individually marked birds (*G. fortis*) of known size (Grant et al 1976). Three sets of observations suggest that this explanation is correct. 1) On I Santa Cruz different phenotypes were distributed in different habitats; small-billed birds were found most frequently in parkland habitat, which has a rich supply of small grass seeds, and large-billed birds were found most frequently in woodland habitat where seeds tend to be larger and harder. 2) On I.Daphne Major large-billed birds select the harder kinds of seeds and fruits, such as those of palo santo (*Bursera malacophylla*), more than do small-billed birds. 3) For these moderately hard seeds, the large-billed birds have an advantage over smaller birds in being able to crack the seeds and extract the kernels quicker.

For natural selection to play a role in maintaining a large beak-size variation in a population, there must be a substantial genetic variation responsible for the beak-size variation. We know this to be so from studies of *G. fortis* on I. Daphne Major, where estimates of the heritability of beak size are remarkably high, i.e. bill size of offspring bears a strong resemblance to bill size of their parents (Boag and Grant 1978).

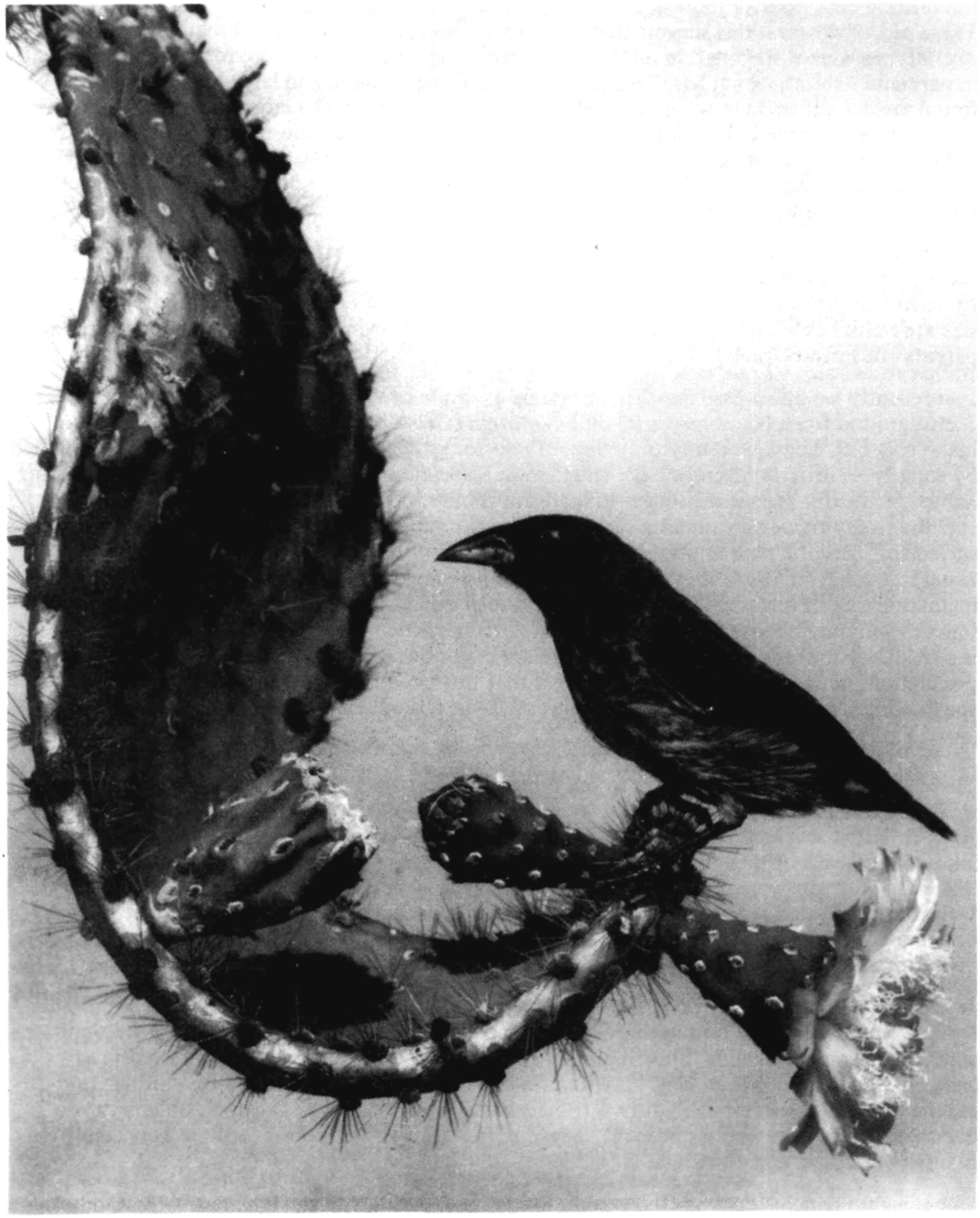
Just recently we discovered another intriguing example of variation in a population of a large cactus ground finch (*G. conirostris*) on I Genovesa (Grant and Grant 1979). Here, breeding males sing one, and apparently only one, of two song types. The two groups of males, classified by song type, differ in average beak length and, associated with this, they differ also in feeding habits. In the dry season the longer-billed form probes into the fruits of *Opuntia helleri* and eats the fleshy tissue surrounding seeds. The shorter and relatively deeper-billed form tears the surface off *Opuntia* pads and feeds on the fleshy fibrous pulp. The two forms were in about equal frequency in 1978, suggesting that local environmental conditions are responsible for maintaining both forms at high frequency in the population. We do not know whether certain females will only choose to mate with a male of a particular song, although we suspect there is a tendency in this direction. In fact there are many questions unanswered with this population, but our observations do suggest that this situation represents an early stage of speciation, the splitting of one population into two, reproductively isolated, populations.

VARIATION BETWEEN POPULATIONS

There are considerable differences in bill dimensions between populations of the same species on different islands. In order to study this variation between populations, I Abbott and L K Abbott visited seven islands in the first half of 1973 (Abbott et al 1977). Vegetation was studied by means of quadrats, and types and abundances of food were quantified. Hardnesses of seeds and fruits were measured with a calibrated seed-cracking machine made at McGill University. Detailed feeding observations were made on the birds. Birds were caught in mist nets, weighed, measured, individually banded for subsequent recognition and released. These procedures have been followed in all our studies on the Galapagos.

It was found that not only do islands differ in plant species, but the diversity of seeds and fruits which the finches feed upon, when grouped into size-hardness categories, differ significantly among islands. This finding necessitates a modification of Lack's theory, as suggested later by Bowman (1961). When finches disperse from one island to another, they encounter not the same but slightly different conditions. Therefore the evolutionary diversification of the finches probably began with various adaptations to these new conditions in different island environments.

Our general conclusion from these and other studies is that the particular array of foods on an island, and competition for them with other species, have played a large role in determining the size and shape of finch beaks on that island.



Cactus Finch – Geospiza Scandens *Photograph by Alan Root*

VARIATION BETWEEN SPECIES

Lack observed that certain combinations of finch species never occurred on the same island. Those species which never occur together are similar in beak size, e.g. the two cactus finches *G. conirostris* and *G. scandens.* Our studies have shown that species with bills of similar size feed on food items of similar size (Abbott et al 1977), so in the case of the above pairs they would probably be severe competitors if they occurred together on the same island. The implication here is that one of a similar pair of species is missing from an island because it has been competitively excluded by the other; this assumes, of course, that there has been enough time and opportunity for the "missing" species to disperse to the island in question.

What is the minimum difference between species that will allow them to coexist? The answer seems to be 15% in at least one bill dimension, for we found there was always at least that difference between coexisting species of ground finches (Grant 1979). Evolutionary adjustments of one species to another, reducing the likelihood of interspecific competition, may have contributed to that minimum difference. For example, 12 out of 14 pairs of species are more different in bill shape where they occur together than where they occur on different islands. Natural selection may have favoured the most divergent members of most of these pairs when they came together, as outlined earlier in this article. The two exceptional pairs are *G. difficilis* and *G. fuliginosa,* and *G. difficilis* and *G. fortis.* They occur on the high elevation islands of I. Pinta and I. San Salvador. Perhaps these species avoid competition by occupying different habitats, as suggested by Lack for the first pair. This situation is being investigated currently by D Schluter.

So far we have discussed variation among species as being partly caused by competition in the past. We will conclude this article by considering competition as a contemporary process affecting the lives of modern finches. If competition between species occurs now, its effects should be detectable in the dry season when food is scarce. In 1978 we made a comparison of wet and dry season diets of the finches on I. Genovesa. In the wet season, January to May, food was abundant and varied. At this time there was considerable overlap in diet among the three species of ground finches on the island, although differences in diet did reflect differences in bill shape to some extent. In November, towards the end of the dry season, finch numbers had declined by well over 50%, with adults surviving better than young. At this time food was scarce, there were fewer food types available, diets of the three species differed substantially and more clearly reflected their different beak adaptation. Thus the large ground finch (*G. magnirostris*) was almost exclusively feeding on the large and hard seeds of *Cordia lutea* and *Opuntia helleri* with its powerful beak. The large cactus ground finch (*G. conirostris*) was feeding on cactus flowers, pulp from cactus pads and the fleshy part surrounding the seeds. The sharp-beaked ground finch (*G. difficilis*) took nectar from the small flowers of *Waltheria ovata* and foraged on the ground for small seeds. These results supported our earlier findings of reduced finch numbers and divergent diets when a comparison was made in 1973 between wet and dry seasons on Genovesa as well as three other sites (Smith et al 1978).

We suggest that competition between the species contributed to the decline in finch numbers between wet and dry season and to the divergence in diets. This suggestion can be explored further by more detailed study of finch populations during such food crises as occur in drought years. P T Boag and T D Price are performing such a study on I. Daphne Major. The results should enhance our understanding of the adaptive radiation of Darwin's Finches, and indirectly help us to interpret the evolutionary history of other groups of organisms around the world which cannot be studied in as much detail.

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Large Ground Finch – Geospiza magnirostris. *Photograph by Alan Root*

BECARIOS DE LA ESTACION CIENTIFICA CHARLES DARWIN

Patricio Ramón, Sub-director, ECCD

En Julio de 1971 llegaron a Galápagos los primeros estudiantes universitarios que se acogian al programa de becas que lo iniciara el Dr Peter Kramer, en ese entonces Director de la Estación y quién estableció contactos con las universidades del Ecuador para implementar dicho programa. Posteriormente se siguió incrementando el número de becarios y se lo hizo extensivo a estudiantes de las principales universidades del pais, siendo el Dr Craig MacFarland un gran impulsador de este programa durante su administracion como Director de la Estación.

El programa se ha venido llevando a cabo con gran éxito y gracias al interés que han demostrado las universidades, el número de becarios ha ido aumentando de año en año, (total becados 76), lo cual ha significado la realización de buenos trabajos de investigación que son de gran utilidad en los proyectos de conservación en Galapágos. Por otro lado, el éxito de este programa, se traduce también en la importancia de las posiciones que actualmente desempeñan exbecarios de la Estación en los ámbitos científico y docente del pais.

Actualmente, nos encontramos empeñados en mejorar el programa de becas. La experiencia que se ha obtenido a través de ocho años que se ha mantenido el programa, nos ha servido de base para rediseñar el mismo, con el único objecto de ofrecer mejores condiciones y facilidades a los becarios para que realizen sus investigaciones.

A continuación, presento una lista por anos y por universidades, de las personas que han realizado investigaciones en Galapágos bajo el programa de becas de la Estación.

1. UNIVERSIDAD ESTATAL DE GUAYAQUIL

ANOS	BECARIOS	TEMA
1972	Manuel Cruz	Alimento de unos animales introducidos
	Hipólito Ronquillo	Distribución y densidad de nidos en áreas de anidación de Tijeretas y Piqueros.
1975	Leonardo Mariduena	Ecología de las 3 especies de Piqueros y el impacto del turismo.
	John Salazar	Ecología de algunas especies de caracoles de tierra.
	Miguel Bermeo Villamar	Taxonomia, ecología y la posible hibridación de las especies de *Tournefortia.*
1976	Stalin Benítez	Asistencia al Geólogo Craig Bow.
	Leonardo Mariduena	Ampliación estudio inicial.
1977	Yadira Saldaña, Teresa Veintimilla	Aspectos de la crianza del Cormorán no volador.
	Leonardo Mariduena	Asistente del Dr John Pettigrew en el estudio de *Creaguus furcatus*
	Jose Miño Ubidia	Composición floral de las lagunas temporales.
1978	Wilson Tito Rodríquez	Pesca de Bacalao
	Juan Bosco Alcívar	Pesca de Langosta
	Mario Vicente Hurtado	Ecología de la tortuga marina.
	Lorena Martínez, Priscila Martinez	Impacto turístico de los piqueros patas rojas.
	Inés Serrano, Berta Peralta	Impacto turístico de los piqueros patas azules.

2. ESCUELA POLITECNICA NACIONAL DE QUITO

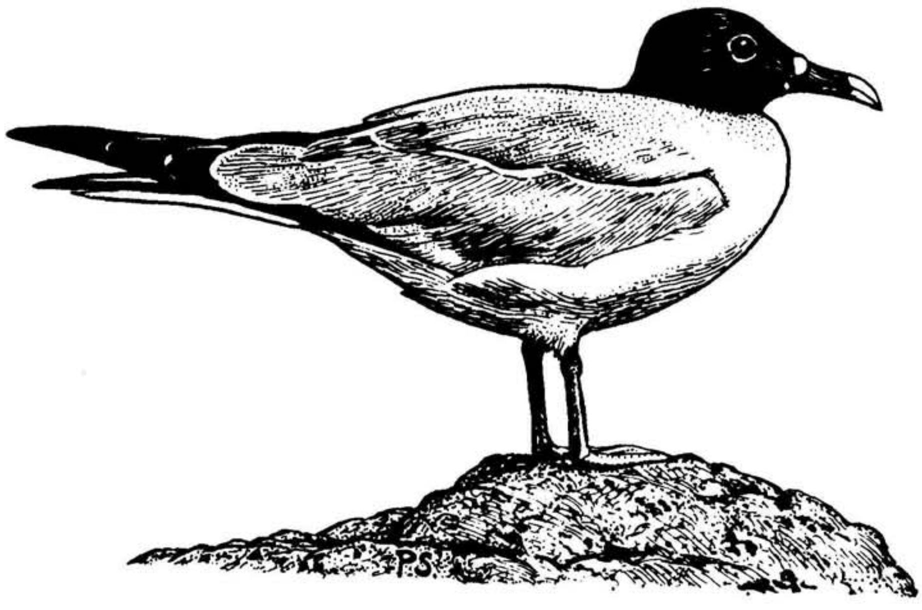
ANOS	BECARIOS	TEMA
1973	Jorge Sevilla, Bernardo Beate	Prácticas y Asistencia
1974	Bernardo Beate, Minard Hall	Actividad del volcan Fernandina.
1975	Renán Cornejo, Galo Plaza Patricio Romero, Patricio Ramón	Estudio del Volcán Sierra Negra.
1976	Bernardo Beate, Jorge Ayala	Geología y Petrografía de la Isla Genovesa.
	Jorge Ayala, Patricio Ramón	Geología y Petrografía de la mitad occidental de la Isla Espanola.
1977	Pedro Basabe	Asistente del Dr David Williams
	Jorge Ayala, Bernardo Beate	Continuación del trabajo en isla Española.
	Patricio Ramón	Asistente en aspectos geologicós durante el VI curso CCNN.
1978	Miguel Pozo	Asistencia al Dr Dave Steadman.

3. UNIVERSIDAD CATOLICA DE QUITO

1971	Luis Albuja	Crecimiento de los Galápagos *Geochelone elephantopus*
	Nelson Cárdenas	Plantas introducidas, su distribución y efectos.
1972	Elsa Cáceres	Ecología de ciertos elementos de la microfauna intersticial
	Magdalena Haro	Distribución de las plantas introducidas.
1973	Miguel Cifuentes	Biología reproductiva de la tortuga marina.
	Edgar Rosero	Medidas y observaciones sobre la reproducción de la rata nativa de la isla Sta.Fe. *Oryzomys spp.* en las estaciones seca y lluviosa.
	Raul Delgado	Diferencias cromosómicas entre *Drosophila.*
1974	Edgar Rosero, Miguel Cifuentes	Continuación de estudios anteriores.
	Luis Calvopiña	Ecología de la población de cabras salvajes en la isla San Salvador.
1975	Flavio Coello	Distribución y densidad de nidos de Tijeretas en is. Seymour, Daphne y Genovesa.
	Margoth Armas	La alimentación del gavilán *Buteo Galapagoensis.*
	Concepción Guayasamin Olga Pazmiño	Distribución y relaciones ecológicas de la hormiga introducida *Wasmannia Auropunctata.*
	Luis Calvopiña	Continuación del estudio anterior.
	Maria Leonor Ortega	Influencia turística en *Fregata magnificens* y *Fregata minor.*
	Maria José Campos	Manejo y función del herbario y museo de la Estación Darwin y producción de mapas de distribución de la Flora.
1976	Etelvina Hernández	Estudio de *Fregata magnificens.*
	Yolanda Silva	Estudio de *Fregata minor*
	Ciana Romero	Estudio sobre *Schistocerca*
	Yolanda Sandoval	Conducta reproductiva de los Piqueros de Patas Rojas.
	Inés Yépez	Comportamiento reproductivo de *Fregata Minor.*
1978	Ana Almendáriz Sofia Rivera	Relaciones ecológicas y comportamiento social de los pinzones de Darwin.

4. UNIVERSIDAD CENTRAL DE QUITO

ANOS	BECARIO	TEMA
1974	Alicia Proaño	Posible hibridación entre dos especies de gastrópodos simpátricos, de zona intermareal alta: *Purpura Pansa* y *Columellaris*
	Manuel Enríquez	Asistente en un estudio de *Tropiduros* con el Dr McVay.
1975	Rosa Gallo	Descripción de los tipos de vegetación y la correlación entre tipo de vegetación y tipo de suelo de Volcán Alcedo.
1976	Olivia Benítez de Blanco	Investigación de la vegetación de las zonas de Miconia.
	Sonia Cueva	Distribución de las plantas introducidas a lo largo de la carretera, en la isla Sta. Cruz.
	Yolanda Páez Francia Cecilia Donoso	Distribución y ecología de la hormiga introducida, *Wasmannia auropunctata.*
1977	Jaime Cilio	Determinación de la población de Lobos Marinos en la isla Floreana e islotes adyacentes y descripción de su hábitat.
	Nela Martínez, Ximena Sacoto	Posibles métodos de control y erradicación de la hormiga introducida.
	Rosa Gallo, Aurora Pazmiño	Aspectos de la biología de la crianza del cormorán no volador.
	Fanny Rodriguez	Impacto turístico en la biología de los piqueros enmascarados.
	Hugo Loza	Impacto turístico en la biologia de los piqueros patas rojas.
1978	Rosa Vásquez, Yolanda Celleri	Impacto turístico en la biología reproductiva del Albatros *Diomedea irrorata.*



Swallow-tailed Gull. *Drawing by Peter Scott.*

THE SURVIVAL STRATEGIES OF SOME THREATENED GALAPAGOS PLANTS

OLE HAMANN

Institute of Systematic Botany, University of Copenhagen

The ecosystems of isolated, oceanic islands like the Galapagos are fragile. Introduction of exotic plant and animal species may lead to disastrous alterations within very few years. In the Galapagos Islands the introduction and subsequent spread of mammals has destroyed many natural habitats and is threatening indigenous organisms with extinction. Rather little is known, however, about the longer-term changes in the Galapagos ecosystems caused by, for example, the constant presence of small numbers of introduced species in certain areas. Similarly, the available information on the adaptive strategies of the Galapagos plants and on the plant-animal interactions is rather scarce. One noteworthy exception is represented by the studies of Rick and of Rick & Bowman on the wild Galapagos tomatoes (Lycopersicon), in which the biosystematics, the mating systems, the pollination and dispersal mechanisms were elucidated in relation to the evolution of Lycopersicon in the islands (Rick 1963, 1966; Rick & Bowman 1961). A correspondingly detailed knowledge of the adaptive strategies of other Galapagos plants would be of great importance for the planning of long-term conservation programs.

THE GENUS SCALESIA

The genus Scalesia is endemic to the Galapagos Islands and contains 20 taxa, according to Eliasson (1974). The morphological diversity of the species is paralleled by their diversity in habitat. Scalesias are conspicuous plants in a number of different vegetation types, ranging from desert scrub of arid lowlands to evergreen forest of humid highlands. Not all species have been investigated from the ecological point of view, but recent observations on S. pedunculata, S. helleri, and S. baurii ssp. hopkinsii indicate that species of Scalesia are pioneers in their way of life. A seven-year study of S. pedunculata in a permanent quadrat on Santa Cruz revealed a characteristic pattern of growth and survival: The Scalesia trees initially showed a rapid increase in both height and girth. After approximately 3½ – 5½ years they reached 7 – 8 metres in height and started to produce flowers. The mortality rate was high during the first 4 – 5 years, decreasing thereafter as the individuals aged. The seeds are able to stay viable for at least 3 years (when stored dry at room temperature), and seed dispersl appears to be adapted for short-distance dispersal: the achenes may remain in the mature fruiting heads for more than one year, gradually being released by wind or by birds foraging among the heads. Both Ground Finches and Tree Finches eat Scalesia seeds (Abbott et al. 1977; Grant, pers. comm.); while the finches try to extract achenes from the fruiting heads, other achenes may get loose from the stiff awns and phyllaries enclosing them and drop to the ground, whereby some seeds may escape predation. It was suggested that S. pedunculata, in spite of its pioneer way of life, was able to persist as a dominant member of the evergreen forest by means of a large reproductive effort and a rapid population turnover, which fits into an environment where the number of competitive forest trees, especially late-successional species, is extremely low (Hamann 1979).

The growth of S. helleri, which occurs in dry coast-near habitats on Santa Fé and Santa Cruz, was measured in a permanent quadrat on Santa Fé during 4 years by T. de Vries and me. The average height of the 20 specimens, which first were recorded and measured in 1973, increased gradually during the four-year period (Table 1). In 1977 the average height of these specimens was 1.90 m, and the tallest was 3.17 m. Apparently the average increase in height per year was rapid in the first 20 months of the life of the specimens, whereafter it became progressively smaller in the next two periods (Table 1). In this respect the species corresponds to the much taller S. pedunculata. The measurements on the 20 specimens of S. helleri and the first observations of flowering suggest that initially a rapid increase in height growth is emphasised; but at the start of flowering, the average increase in height decreases markedly. Judging from the average size of those 38 specimens, which were recorded for the first time in 1977, in comparison with the 20 older specimens, it appears that the 38 new specimens were approximately 1 year old, or less (Table 1).

When goats were present on Santa Fé island, it was thought that S. helleri was in danger of becoming extinct there. However, since the elimination of the goats, the recent spread of the species along the coastal cliffs, some of which continue inland at right angles to the shoreline, demonstrates that the species is well adapted as a pioneer, and that it probably spreads by the means of short-distance seed dispersal, in much the same manner as indicated for S. pedunculata.

The re-growth of S. baurii ssp. hopkinsii on Pinta Island, observed after the great reduction in number of feral goats, follows a similar pattern: S. baurii ssp. hopkinsii has a rather wide occurrence on Pinta in various vegetation types, ranging from dry season deciduous steppe forest at low altitudes to evergreen steppe forest and forest at intermediate and high altitudes. The species was investigated in a permanent quadrat located in dry season deciduous steppe forest at an altitude of c. 220 m. The quadrat was established by de Vries in 1970 and has since been examined five times. The individuals of S. baurii ssp. hopkinsii in the quadrat were distributed on age classes: their maximum possible age could be determined from their first record of appearance in the quadrat. The maximum height of specimens in the age classes was then determined (Table 2). It appears that the increase in height is rapid for approximately the first 14 months, whereafter it becomes much slower. In October 1977 some of the largest individuals were flowering and fruiting, which suggests that the start of flowering could be coinciding with the shift in growth emphasis taking place when the individuals become about 1.5 m tall. It suggests a growth pattern similar to that of S. pedunculata and S. helleri, but future examinations of the individuals are needed to test this assumption.

The three representatives of Scalesia, growing in different habitats and vegetation types on three islands, share a number of characteristics, including rapid growth, early maturity, and an ability to recolonize formerly grazed areas (S. helleri and S. baurii ssp. hopkinsii, but also S. pedunculata) or otherwise cleared areas (S. pedunculata, invading clearings in the evergreen forest originated in various ways). Species of Scalesia are probably to a high degree autogamous. The pollination of members of Scalesia is effected by the endemic Carpenter Bee (Xylocopa darwini), according to Rick (1966) and Linsley, Rick & Stephens (1966). However, Rick also reported that at least some species of Scalesia (S. aspera and S. affinis) were autogamous. Not only was S. aspera found to be self-compatible, but it produced seed abundantly from automatic self-pollinations under conditions of complete isolation.

Thus Scalesias appear to be remarkably well adapted to life on isolated, oceanic islands, but they do not tolerate any heavy grazing; this was demonstrated by the rapid reduction in number of S. baurii ssp. hopkinsii on Pinta, and by S. helleri, which barely survived the feral goat population on Santa Fé. At the moment, S. pedunculata, S. atractyloides, and perhaps S. stewartii are endangered by the heavy grazing of feral goats on San Salvador. The way in which S. helleri survived on Santa Fé, where the goat population in the last years before 1971 was not very large, seems to indicate that even a limited amount of grazing of a Scalesia species growing in *arid* habitats may be a serious threat to the species. Furthermore, the relative paucity of competitors in the evergreen forest of the highlands could make a species like S. pedunculata vulnerable to introduced tree species, especially such that display late-successional strategies.

PISCIDIA CARTHAGENENSIS

Piscidia carthagenensis is a deciduous tree growing to about 15 m tall. It is indigenous to the Galapagos, but is also known from Colombia, Venezuela and continental Ecuador. The occurrence of P. carthagenensis within the islands is associated with the occurrence of such species as Pisonia floribunda, Clerodendrum molle and Tournefortia psilostachya, which means that the species occurs principally in the "transition zone", the main vegetation type of which is dry season deciduous forest. In the Galapagos, P. carthagenensis is known as "matazarno" and is widely used by the inhabitants on account of its very hard heartwood (fence-posts, construction of houses, boats, etc.).

The wide altitudinal range of distribution of Piscidia originally observed by Svenson (1935) may have been altered considerably in recent years. The number of P. carthagenensis trees on the inhabited islands – where the probably optimum conditions for the species were found in the lower parts of the now cultivated areas – has diminished on account of the fellings by the inhabitants (Jeppesen 1977). Linsley (1966) reported that the activity of Xylocopa darwini had been observed (by Rick) to be intense in flowering trees of P. carthagenensis, but apart from that, very little is known on the growth, pollination, fruiting or disperal mechanisms of the species. As it is being reduced in number, investigations on the life and adaptive strategy of the species are much needed.

MICONIA ROBINSONIANA

The endemic Miconia robinsoniana is an evergreen, large-leaved shrub found at high elevation on Santa Cruz and San Cristóbal islands, where it is the main constituent of the Miconia "zone", which is an evergreen scrub type of vegetation. The extension of the Miconia "zone" has diminished during this century at the expense of pastures and cultivated fields (lower parts of Miconia "zone", outside the National Park area), and at the expense of the treeless highland vegetation, known as the fern-sedge "zone". The reduction in area of the Miconia "zone" has been caused by grazing, burning, and perhaps climatic change, according to Kastdalen (1965) and Hamann (1975). Recently the introduced Cinchona succirubra has spread into both the Miconia "zone" and other highland areas on Santa Cruz.

It has been observed that M. robinsoniana is able to regenerate, although slowly, after fires and grazing. The pollination of the species is, at least partly, effected be Xylocopa darwini, which collects nectar in the flowers. Flowering begins in February-March, according to my observations, but reaches a peak in May. In September-October berries are ripe, and in December all fruits may have been shed. The many-seeded berries are presumably eaten by birds (finches?), but rats (the introduced Rattus rattus) also eat the berries (Clark & Clark, pers. comm.). However, no information on the actual dispersal of Miconia seeds is available.

The result of the present competition between Miconia robinsoniana and Cinchona succirubra may be determined by the difference in dispersal mechanisms of the two species. The individuals of Cinchona succirubra that produce flowers and seeds are mainly those which grow in the farm area at lower altitudes, outside the National Park. From there the small, light seeds are wind-dispersed to the highlands. The success of Cinchona may further be associated with the opening up of the formerly closed vegetative cover by cattle-grazing in the area. Apparently another introduced species, Psidium guajava, is dependent on such disturbance of the natural vegetation in order to compete with the indigenous species

(Jeppesen 1977).

These assumptions are, however, mostly speculative, being based on very few observations; but they could be tested by careful investigations in the field. Obviously a more detailed knowledge of the life of Miconia robinsoniana is needed in order to save this unique species and the vegetation which it characterizes.

As a pre-requisite for long-term conservation planning, research on selected species and on selected types of vegetation should be undertaken, especially concentrating on the vegetative and reproductive strategies of the species and on the plant-animal interactions. It is also suggested that the CDRS consider the establishment of a small botanical experimental field, which could be used for investigations on, for example, germination and growth of seedlings of such long-lived and slow-growing trees as Piscidia carthagenensis. A study on the various phases of life of Piscidia carthagenensis may be a good investment. There is no reason why the technique which succeeded in saving the giant tortoises should not be adapted to certain plant species. As with the tortoise breeding program, projects involving native Galapagos plants may also have a great educational impact.

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TABLE 1 – GROWTH OF SCALESIA HELLERI IN PERMANENT QUADRAT 4, SANTA FE ISLAND

20 specimens recorded for the first time in 1973:

	September 1973 (de Vries)	September 1974 (de Vries)	December 1974 (de Vries)	October 1977 (Hamann)
Average height in m	1.32 $\pm$.08'	1.47 $\pm$.1	1.49 $\pm$.1	1.90 $\pm$.13
Maximum height in m	2.2	2.38	2.42	3.17
Minimum height in m	0.4	0.44	0.46	0.83
Number of specimens in flower		2	5	Nearly all

38 specimens recorded for the first time in 1977:

Average height in m				0.51 $\pm$.06
Maximum height in m				1.36
Minimum height in m				0.13

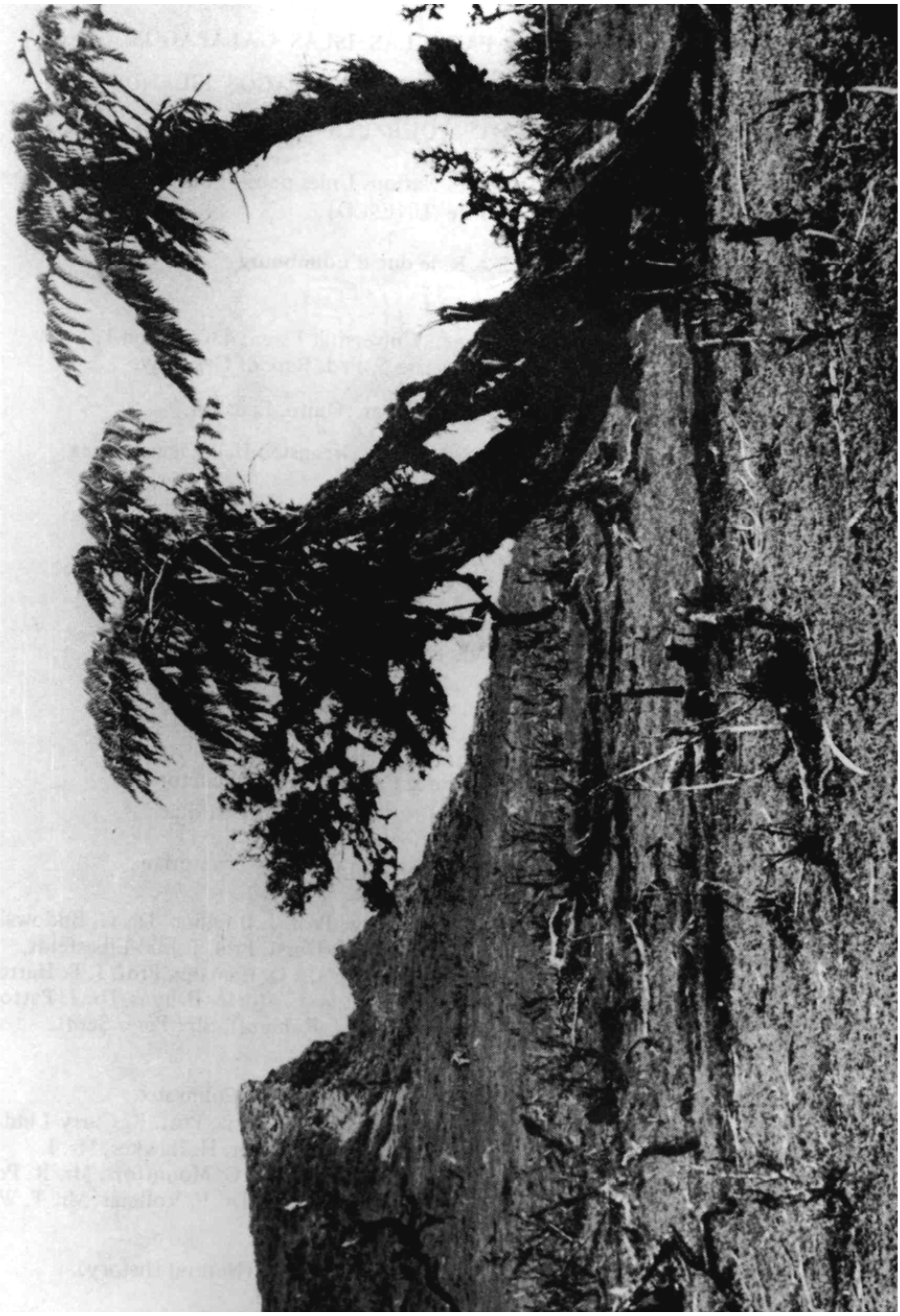
Average increase in height in cm/year during the periods recorded:

Period, number of months	0–20	20–32	32–69
Increase, cm/year in period	79.2	15.0	13.9

' = $\pm$ Standard Error.

TABLE 2 – GROWTH OF SCALESIA BAURII SSP. HOPKINSII IN PERMANENT QUADRAT 2, PINTA ISLAND

Maximum possible age in months	1	8	14	34	39	40	48
Maximum height in m of specimens in age class	0.10	0.32	1.58	1.5	1.5	1.58	1.8
Number of specimens in age class	2	2	41	1	10	2	2



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