

NEWS FROM ACADEMY BAY

CHANGES OF CHARLES DARWIN FOUNDATION OFFICERS

At its meeting in Washington D.C. in September 1981 the Council of the Charles Darwin Foundation decided on some changes in the duties of its officers, consequent on Mr. G.T. Corley Smith's wish to retire after ten years service as Secretary General of the Foundation. His duties will be divided between Señor Juan Black, the new Secretary General, who will have his office in Quito (postal address: Casilla 38-91, Quito) where he can maintain close contact with the Darwin Station and the Ecuadorean authorities, and Dr. Ole Hamann (University of Copenhagen, Institute of Systematic Botany, Gothersgade 140, DK 1123 Copenhagen K.) who will become the Charles Darwin Foundation's Secretary for Europe. Señor Black will take over in March, Dr. Hamann in July. Until further notice Mr. Corley Smith will continue to edit *Noticias de Galapagos* and deal with the related correspondence. Dr. Peter Kramer will continue as President and the Secretariat for the Americas will operate unchanged from its base in the Smithsonian Institution.

Both Señor Black and Dr. Hamann have been associated with Galapagos conservation and science for many years. The former was the first conservation officer to be appointed by the National Park, while the latter served at the Darwin Station as a UNESCO scientist and has visited the islands repeatedly in the course of his botanical studies.

SCIENTIFIC STAFF

The Darwin Station now has its full quota of staff scientists. Malcolm Coulter has been chosen as ornithologist in succession to David Duffy. They had both been working on plans to save the Hawaiian Petrel.

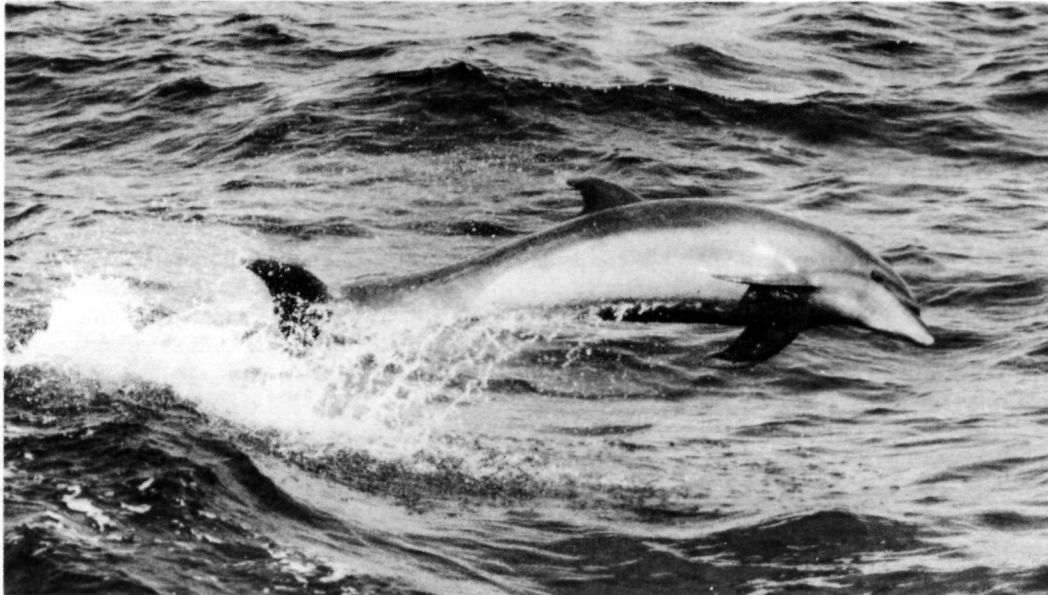
Luang Tan Tuoc has taken up his duties as the first staff botanist to be appointed at the CDRS. He has recently been doing research at Aberdeen University but previously had experience of "applied" botany in Vietnam. He will advise the National Park Service in its struggle to eradicate alien plants and trees, which are invading sections of the Park from the settled areas.

TRAINING COURSES FOR WARDENS AND GUIDES

Since her appointment as staff scientist in charge of educational programmes, Olga Herrera de MacBryde has stimulated new departures but has also continued and expanded the traditional activities begun in the 1960's. In 1981 the annual two-week training course was attended by 55 Park Wardens, including four from the National Parks in continental Ecuador. The two-week course for Auxiliary Tourist Guides attracted 62 participants, mostly Galapagos residents. For the more exacting 4-week course for Naturalist Guides, 20 applicants were selected (Ecuadoreans, Americans and Europeans) and 16 of them were successful in the final examination.

VOLUNTEER OBSERVERS

The strengthening of the CDRS scientific staff is a cause for congratulation but it still does not provide complete coverage for all the natural events taking place in the 3,000 square miles of National Park, scattered over 30,000 square miles of ocean. So Sylvia Harcourt has been recruiting qualified tourist guides and providing them with booklets to record interesting observations and thus enrich the Station's records. One field in which the cruise guides are particularly well placed is whale-spotting and their sightings, of some international significance, are being incorporated into maps. In 1981, baleen whales were the most frequently recorded species, followed by pilot, sperm, killer and humpbacked whales and, (a little less certainly) pigmy and goose-beaked whales. The distribution of dolphins and porpoises is also being plotted.



Dolphin Photo by Fritz Pölking

FLAMINGOS ON ISABELA

Owing to their small numbers and vulnerability, the Galapagos flamingos are the cause of constant if mild anxiety. Hearing that it was proposed to extend the settlement of Villamil towards the ponds frequented by these timid birds, the Superintendent of the National Park and the Director of the Darwin Station went to Isabela to consult with INGALA (the National Institute for Galapagos) and the local authorities. It was decided that the village should expand on to the lava fields in the opposite direction.

Sylvia Harcourt, acting staff ornithologist, was informed by Don Tupiza, local representative of the CDRS, that flamingos were nesting near Villamil. After wading and swimming through liquid mud for 10 minutes, she reached the breeding site and was able to count 85 nests with eggs and a further 13 being built. This record number is splendid news and Miss Harcourt considers the mud provides good protection against both men and feral animals.

IS THERE A MATE FOR LONESOME GEORGE?

A note of particular interest is that a dried tortoise scat was found on Pinta (Abingdon Island) in March 1981 by Ole Hamann and Linda Cayot. Although it was impossible to age the scat with certainty, it does appear quite old. The puzzling point, however, is that if the scat were over 10 years old (i.e. before the discovery of Lonesome George, the sole *known* survivor of the Abingdon race) it seems that the combined effects of wind and rain would have broken it down into fragments. The scat is intact and was found in such a position that it was not protected from the elements. Can there be another tortoise on Pinta?

OUTBREAK OF MATRIMONY AT THE DARWIN STATION

David Duffy, staff ornithologist, married his assistant, Maria José Campos, before leaving for a new sea-bird research post in South Africa. Andrew Laurie took time off from his 3-year study of marine iguana problems and returned from England with his wife, Haruko. Trevor Price ended his 3-year stint as a member of Peter Grant's group studying Darwin's Finches and married Mao Ortuño, CDRS secretary.

**VISITORS AND EVENTS AT THE CHARLES DARWIN RESEARCH STATION:
JULY—DECEMBER 1981**

JULY

John Faaborg and assistants returned to continue studies of the Galapagos Hawk.
Mr. & Mrs. Morrison Waud, donators of the Van Straelen Hall, had dinner with CDRS staff and officials of Galapagos National Park Service (GNPS).
José Villa returned from an international meeting in Lima accompanied by Ing. Merilio Morell, Head of the Dominican National Parks, who will work with CDRS and INGALA (National Institute for Galapagos) as an advisor on ecodevelopment.
Howard and Heidi Snell, Sylvia Harcourt and S. Steckbaur returned from a 6-month study of land iguanas on Plaza.
Captain Baker from yacht "Nisha" visited Station and offered a donation for darkroom equipment.
Seminar by Howard Snell on "Reproductive Success of Land Iguanas as a Measure of Darwinian Fitness".
Tjitte de Vries, Arturo Ponce and Gunther Reck arrived as members of the CDF Commission to help with CDRS and GNPS planning for next 2 years.
Howard and Heidi Snell returned to USA.
Lindblad cruise visited Station with Sylvia Earl, Graham Hawks, Stephen Gould, and Duncan Porter on board.
Tjitte de Vries continued Frigate Bird studies on Tower Island.
Mike Konecny and assistants arrived to work on tortoise thermoregulation.
John Faaborg gave a Seminar on Galapagos Hawks.
Maria Catalina de Salcedo resumed work as Secretary.
Seminar by Trevor Price on Daphne Finches.
Cecilia Solís and Patricia Carrera arrived from Universidad Católica to work as assistants on the goat and albatross projects respectively.
Warwick Reed, former Director's Aide, visited the Station.
David C. Duffy, staff ornithologist, and Maria José Campos, his assistant, married and left to take up a research post in S. Africa.
Sylvia Harcourt took over as acting Ornithologist.

AUGUST

Maria del Carmen Andrade, Universidad Católica de Quito, arrived to study lava lizards as part of her degree course.
Annual course for National Park Wardens commenced, for 2 weeks.
Julio Bertrand, from WWF, visited the CDRS.
Dr. Syuzo Itow, Nagasaki University, Japan, arrived to continue his botanical ecology studies for 3 weeks.
Trevor Price left after completing his study of finches on Daphne.
Jesús Erce arrived from Madrid to work as an assistant for one month.
Chela Vásquez left the Station after completing her study of the egg rolling behaviour of the Albatross. She is now a guide on M/V Bucanero.
Annual Auxiliary Guides course started, for 2 weeks.
Warren Hoge, New York Times, visited CDRS.
Visit by James Bacon and Al Lieberman from San Diego Zoo, for consultation on the herpetology programme.
Fritz Trillmich arrived from Germany for 2 months, to continue his fur seal studies on Fernandina.
Ian Frost and Melinda Beck left for Canada, after working as assistants in the Marine Biology Programme.

SEPTEMBER

Dolph Schluter and David Anderson (Peter Grant Group), Michigan University, arrived to continue studies of finches on various islands, including Wenman, Culpepper, Fernandina, and Española.

Annual Naturalist Guides course started, for one month.
Friedemann Köster and José Villa, left for Washington to attend the 40th Executive Council Meeting of the CDF.
Lief Andren, International Oceanographic Commission, visited the CDRS for 4 days.

OCTOBER

Ricardo Enriquez, Universidad Central de Quito, arrived to begin a one year study of tortoise ecology on Santiago.
Dieter Heunemann arrived from Germany to film fur seals, in conjunction with Fritz Trillmich.
Ross Tocher, Michigan University, visited the Station and went on a 5-day trip around the islands. He will advise on park management.
Norbert Rauch and family returned from Germany to continue the marine iguana study on Punta Núñez.
Prince Bertil of Sweden and members of the Royal Family visited the Station as part of their trip around Galápagos.
Rolf Meir arrived from Switzerland to study ant ecology.
Fernando Ortiz Crespo, Universidad Católica, visited CDRS.
Hermann Schempp from the German Embassy visited CDRS.
Sam McNaughton, Syracuse University, USA, and his wife visited Galápagos. He is supervisor of Linda Cayot's tortoise study.
Juan Black, Secretary-General designate of the CDF, visited the Station for a week.
Fritz Trillmich gave a seminar on maternal behaviour in Galápagos Fur Seals.
Bob and Donna Reynolds left for vacation in USA.

NOVEMBER

Andrew Laurie returned from England to continue his marine iguana study.
Gary Robinson, Sylvia Harcourt and Alan Moore spent three days at Villamil investigating fauna of the salt lagoons and assessing possibility of constructing a nature walk-way around the lagoons, as part of an INGALA project.
Catherine Rechten, Max-Planck Institute, returned to Germany after completing the first part of her studies of the Waved Albatross.
Maria Eulalia de Balfour started work as part-time station secretary.
Ingrid de Quevedo started work as full-time station secretary.
Catalina de Salcedo finished work as station secretary and left for Quito to have her baby.
Jimmy Iglesias arrived from INEP as assistant for the Marine Biology program and Manuel Alvarez from the Universidad de Guayaquil as assistant for the Entomology program.
Andrew Laurie left for three weeks work on Santa Fé.
Yael Lubin, staff entomologist, returned after four months in USA.
Director, Subdirector, Manager and station scientists to Floreana to advise INGALA on ecological problems of constructing a road to the highlands.
Gary Robinson on three-day trip to N. Santa Cruz for black coral study.
Lucho Calvopiña, Sylvia Harcourt and Friedemann Koster took two-day trip to Santiago, for goat census and check for signs of cats.
NOAA group arrived for annual check of equipment at Wenman, Caleta Iguana, Roca Vicente and San Cristobal. Friedemann Koster, Gary Robinson and Sylvia Harcourt were invited for the one week cruise, on Beagle III, to carry out diving surveys and bird census work. (Beagle III is no longer CDF property).
Lucho Calvopiña and Hugo Loza went to Quito to represent CDRS in the "Jornadas Ecuatorianas de Biología".
Two new scholarship holders, Edith Herrera and Mercedes Buestán arrived from Universidad de Guayaquil, to work on projects in Marine Biology as part of their degree courses.
Beagle IV made three one-day trips to Bartolome with students from 8th and 9th years of the Colegio Nacional Galápagos as part of the environmental education program.
Pepe Villa joined trip on M/N Santa Cruz, as CDRS representative, with group from Ecuadorian newspapers, television and tourism.

Two new scholarship holders, Inés de la Vega and Laura Endara, arrived from Universidad Central de Quito to work on fire ant projects, as part of their degree.

Dolph Schluter and David Anderson returned from studying finches for three months on Fernandina, Tortuga and Española.

DECEMBER

Dolph Schluter left CDRS to return to USA.

Beagle IV left for Villamil with Pepe Villa, Alan Moore, Humberto Ochoa, Fausto Garcés, as part of an INGALA commission.

Esmeraldas Haro, Universidad de Guayaquil, arrived as assistant to Norbert Rauch, (Max-Planck) studying marine iguanas.

Sylvia Harcourt left for a two week holiday in Ecuador.

Bob and Donna Reynolds returned from their vacation in USA.

Mark Eckstein arrived to assist Andrew Laurie with marine iguana studies.

Beagle IV toured the islands for one week with representatives of National Park Service, CDRS and INGALA, to make an inventory of visitor sites.

Andrew Laurie returned to Santa Fé for another five weeks with his assistant and wife, Haruko.

Peter Wirtz, Max-Planck Institute, arrived with two assistants to study behaviour of blennoid fish.

Juan Black visited the Station for four days for meetings.

Olga MacBryde, Education Co-ordinator, returned to USA.

Rolf Meier returned to Europe after completing his fire ant project.

Lucho Calvopiña went to Santiago for a goat census.

Linda Cayot, Gary and Gayle Robinson went for a one week holiday in Ecuador.

Christmas Party for all station employees.

Members of Peter Grant Group arrived, Bob and Susan Curry to study mockingbirds on Genovesa, Lisle and James Gibbs to study finches on Daphne.

Trevor Price (P. Grant Group) and Mao Ortuño, formerly station secretary, were married at Tortuga Bay.

SOME RECENT BOOKS

Galapagos - Islands Lost in Time, by Tui de Roy Moore, George Allen & Unwin (London). 144 p.p. First published by Viking (New York) \$25.

Charles Darwin: A Man of Enlarged Curiosity, by Peter Brent. Heinemann (London). 536 p.p. £12.50.

The Zoology of the Voyage of The Beagle, by Charles Darwin, in 3 volumes. Nova Pacifica, New Zealand.

THE CONTROL OF FERAL ANIMALS AND INTRODUCED PLANTS

From 1800 to 1960, man was the principal predator and agent of wildlife destruction in the Galapagos. Since the establishment of the Darwin Foundation, such iniquities as the killing of giant tortoises for food and their collection for the pet trade have been for the most part eliminated. However, the success of the Research Station, together with the publicity needed for fund raising, led to the creation of a tourist industry and there was renewed anxiety over the invasion of the fragile ecosystems by thousands of visitors. Thanks to the organization of the Galapagos National Park Service and the enforcement of its regulations, little harm seems to have resulted so far. There is no room for complacency but constant studies of "tourist impact" over the last ten years have shown that, with reasonable limitations on numbers and adjustments to meet changing circumstances, the National Park can be made safe from man as well as for man.

Today the main threat to the environment comes from the introduced animals and plants which have gone wild and multiplied. Much success has been achieved in reducing the countless thousands of feral goats: they have been eliminated on Plaza, Santa Fé, Rábida, Española and Marchena and brought under control on Pinta, but they still remain a grave threat to the precious ecosystems of Santiago.

The campaign to save the endemic flora from the goats continues. But the flora also suffers from the competition of introduced plants and the Darwin Station has now appointed a staff botanist to co-operate with the National Park Service on the eradication of alien vegetation which is spreading from the farms into the Park in a dangerous way.

Much of this issue is devoted to feral animal problems. This reflects the present preoccupations of the Foundation and its Research Station. No known species has become extinct since the CDRS was set up and the only one currently endangered is the Hawaiian Petrel: but there are *populations* of animals on various islands which are in hazard. Ideally the Charles Darwin Foundation would like to preserve every indigenous animal population on its native island and to eradicate all introduced species. With hitherto known techniques, even if adequate funds were available, it must be admitted that the chances of eliminating rats and cats, let alone some of the thriving insects and plants, are remote.

Any attempt to control pests without adequate research could be a danger in itself. The CDRS has devoted years of study to the situation with the help of visiting scientists in addition to its own staff. Some aspects will only become clear in the course of time because, on islands afflicted with more than one pest, the elimination of one may have serious repercussions on the others. The following papers by several authors and covering various periods show different approaches and attitudes towards the problems created by different species on different islands. The Executive Council of the Darwin Foundation will be holding a seminar in Quito immediately prior to its March 1982 meeting, solely to discuss these feral problems.

G.T.C.S.

CHANGES IN THE BIOLOGY OF SANTA CRUZ ISLAND BETWEEN 1935 AND 1965

by

Alf Kastdalen

One of the problems bedevilling both scientific research and conservation in the Galapagos is the difficulty in discovering how far changes are due to man and the animals and plants he has introduced and how far they result from climatic variations and other factors. Records have been kept since the Darwin Research Station was set up but we lack data on earlier periods which could throw much light on today's problems. Fortunately Mr. Kastdalen, a farmer and gifted naturalist, recorded many years ago the changing fortunes of plants and animals which he had noted during the three decades before the inauguration of the CDRS. Since then there have been further changes. His observations of the fluctuations in animal and plant life are of great value, and fill a gap that would otherwise have remained a blank for ever. We are most grateful for his permission to print this account.

This paper is not the product of special research but only of observations which I have been able to make as occasion permitted. The years and dates are in some cases only approximate because I have kept no notes until now.

We came here on August 12, 1935. From then until about the year 1941 it was much wetter than it has been later, although 1953 was also very wet. To illustrate this change, a creek near our house used to flow, on average, about five times per year in our first years here, and once, in about 1939, flowed 14 times; but it has now been dry since 1953.

On the other hand, it seems that the *garua* (heavy mist) has actually been more intense during the last 20 years or so than for a long time before. Some of the effects of these climatic changes will be mentioned in the sections that follow.

THE VEGETATION OF THE HIGHLANDS

The year before we came here there had been a drought of about four months' duration in which a great part of the grassy region and the *Miconia* belt had been burned off. The greater part of this area became covered with a carpet of liverworts more than an inch thick and in places almost two inches thick. These carpets of liverworts were commonly used as doormats and pads for saddles. The reason why they have not developed after later fires seems to be that the climate has been drier, and also that in those years there were no large animals in the hills to disturb the carpet.

Gradually the *Miconia* recovered most of the area it had lost in the fire, but about 12 or 13 years later there came another fire which burned off an even greater area, and the year after that another fire burned much of the remaining *Miconia* zone. But the fires have not been the only factor contributing to the reduction of the *Miconia*. A lot of the lower part of the belt has died through drought; while in some very wet and cold *garua* seasons much of the upper part of the belt has died of what seemed to be excessive cold and humidity, and the bushes in the middle part of the zone were also affected.

The more intense *garua* is probably also responsible for the fact that the trees and bushes are much mossier now than when we first came here. At present, they are as mossy at the level of our farm (750 ft.) as they were in the lower part of the *Miconia* belt (about 1,200 ft.) when we arrived.

THE SCALEZIA ZONE

When we came here, the area from our farm to the east, and for about two kilometres to the west, was covered with dense thickets of *Psychotria rufipes*, with some *Chiococca alba* and *Tournefortia rufosericea* in the more fertile parts, intermingled with small trees of *Zanthoxylum fagara* and *Acnistus ellipticus*. The

larger trees, *Psidium galapageium*, *Scalesia pedunculata* and *Pisonia floribunda* were growing (and are still growing) mainly on very rocky land, and here and in places where the soil was poor *Justicia galapagana* and *Alternanthera halimifolia* were abundant, while further to the west *Justicia galapagana* was dominant.

In the areas to the east of us during the first five or six years of our stay, *Psychotria rufipes* was rapidly declining while *Alternanthera halimifolia* and *Justicia galapagana* were taking its place. The change was so rapid that great areas that were almost completely covered with *Psychotria* were, a few years later, covered no less completely by *Alternanthera* and *Justicia*. The reason for this change is a mystery to me.

During the first five or six years of our stay it seemed that *Scalesia pedunculata* was disappearing. The trees became less common every year, and there were only mature trees and no young ones were coming up to replace the old ones which were dying. Then in 1944 and 1945 there were prolonged droughts of about four months' duration in each year. During these dry periods most of the under-brush died, and the damage was further increased by the wild cattle and donkeys which came up from the arid zone in search of food and moisture. This extensive damage to the under-brush, coinciding with prolonged droughts, made an ideal combination of circumstances for the regeneration of the *Scalesia* (it seems that *Scalesia pedunculata* will not seed properly except in dry weather). The succeeding *garua* season showed a simply fantastic recovery of the *Scalesia* forest. Where formerly there had been only scattered or single trees, there were now forests of young *Scalesias*. When we went hunting we had to cut a path with a machete, since the stands of young trees were too closely spaced to get between them.

In these years the cattle were not as abundant as they became later, and when the *garua* season came they went back down into the drier zones. If they had not done so the recovery would not have been so spectacular, for one of the cattle's favourite foods is young *Scalesia* trees. In later years the wild cattle increased tremendously and a large number of the animals have stayed in the hills, so after later dry periods the increase in the number of *Scalesia* trees has not been as spectacular as after the first two dry periods.

In periods of extremely heavy rainfall, *Scalesia* trees growing on ground with rather poor drainage all die. *Psidium galapageium* has a much greater resistance to waterlogged ground, and *Hippomane mancinella* even more.

INTRODUCED PLANTS

It seems to me that the humid zone of the Galapagos is botanically one of the most isolated regions in the world. In contrast to many islands, which have humid conditions right down to the shore, the Galapagos Islands have a dry zone near the shore and humid conditions only in the highlands. Because of this dry region, it is practically impossible for plants with little drought tolerance to be introduced by the ocean currents; therefore the only plants to become established in the Galapagos humid zone must either be brought by birds or by the wind, or they may be dry zone plants which become adapted to humid conditions. Before the arrival of man, this probably prevented the introduction of a number of species better adapted to conditions in the humid zone than the native plants. Conditions in the humid zone are clearly favourable for the development of tropical rain forests: the reason why they have not developed seems to be isolation.

With the arrival of man on the scene the picture has changed. He has voluntarily or accidentally introduced several new species which are well adapted to the conditions, such as *Trema* sp., *Ochroma lagopus* (balsa), *Persea americana* (avocado), *Chinchona* sp., *Psidium guajava* (guava), *Eugenia jambos*, *Hibiscus tiliaceus*, and bamboos. These, and even such plants as coffee and several introduced pasture grasses, are fully able to compete with the native elements. Avocados crowd out all other native vegetation where they become established, and so do *Hibiscus tiliaceus* and *Eugenia jambos*.

It also appears that with introduced trees the forest zone will extend much higher than it does now, because avocados, balsa and *Chinchona* will grow well above the present timber line and a few of these trees are

already established there. So it seems to me to be just a matter of time — how long, it is of course impossible to say — before most of the *Miconia* zone and the grassy region will be forested with introduced trees. Below the present timber line, it may also be only a matter of time before the introduced trees take over the uncultivated part of the humid region.

The dry zone vegetation however seems much better able to hold its own, although some relatively minor changes are going on here too, due to introduced plants and animals and possibly climatic factors. It will take years of study, in wet as well as dry years, to find out the relative importance of these various factors.

INTRODUCED ANIMALS

The date of the introduction of donkeys into Santa Cruz is unknown; as also is their influence on the vegetation, although they seem to have had some damaging effect on the *Opuntias*. They were fairly abundant in the dry zone when we first came here in 1935, but they did not yet occur in the humid zone nor in the northern part of the island, where they now are. They spread into the humid zone mainly where the wild cattle have gone before them and opened up the undergrowth. They appear to have been increasing in number until the severe drought in 1963, when the population received a severe setback.

The date of introduction of feral dogs is also unknown, as also is the cause of their extinction: all one can say is that wild dogs did for a time exist here. The people of the Norwegian Ulva expedition (c. 1925) shot a couple, and my father saw dog tracks at Tortuga Bay in 1935 which could only have been made by wild dogs. Since then, they have not been seen or heard.

The wild cattle were introduced in 1923 by Captain Rafael A. Castro, who still lives here. He released a bull and two cows at Academy Bay and then sailed off. When he came here there were still only relatively few wild cattle, restricted to the dry and transition zones in the southeastern part of the island. Until 1940 the rainfall was abundant, so they did not have to go up into the humid zone. Conditions were in fact more favourable in the lower zones, with better pastures and warmer weather. Then in approximately 1940 the cattle started to spread into the humid zone, partly, I believe, because of drier weather and partly because of increasing population.

The cattle had a considerable effect on the vegetation wherever they spread: annual plants increased in relative abundance, and a certain fern which used to be common disappeared almost completely. In general, practically all the plant species which the cattle eat have decreased greatly, thereby decreasing the food supply while the population was increasing. In the long run this was bound to have disastrous results. We farmers noticed the consequences: the fences had to be stronger and stronger in order to keep the cattle out of the farms where the food supply was more abundant.

The climax came in the drought of 1963, which was the longest in all the time we have been here. The cattle population, protected by the local authorities, had increased unduly, and a couple of years before ticks had been introduced with some cattle from Isabela. So, in this drought the cattle suffered not only from lack of food and water but also from a heavy infestation of ticks. This was too much for them to stand, and they died in great numbers, as also did the wild pigs and donkeys. The wild cattle that are left now are so few that it looks as if the remainder will be exterminated by the hunting, legal and illegal.

The wild pigs were released in approximately 1927 by a Norwegian farmer who raised pigs, then abandoned his project and just released his pigs and left the island. The pigs are descended from two stocks, black wild pigs from Floreana and a more improved white breed from the mainland. When we came here the pigs were abundant in the vicinity of the then existing farm area but had not reached the region of Santa Rosa or Salasaca. Wild pork was for many years practically our only meat supply. The pigs in the *Miconia* belt were living mainly on the rhizomes of the fern *Pteris aquilina* and the berries of *Miconia*, and in the *garua* season on the Hawaiian Petrel, *Pterodroma phaeopygia*.

The pigs up in this rather cold region usually made themselves beds of dead fronds of *Pteris aquilina* and

moss, and many developed a dense coat of wool-like hair under their bristles. It is also of interest that in later years the tusks of the boars have become on average much bigger than they were during the first years of our stay — apparently at least twice as big, though I have not made actual measurements. So it seems that natural selection may, under appropriate conditions, produce striking results in a single human lifetime.

The wild pigs had also developed a herd system as a protection against stray dogs: if attacked, the sows and young pigs collected in the centre of the herd while the boars ran around on the outside chasing away the attackers. But this defense system was helpless against hunters with guns.

The pigs in the lower regions lived mainly on the fruit of *Psidium galapageium* in season, and for the rest of the year on herbs and grasses and grubs of the stag beetle, which live in dead *Scalesia* trunks. One year they fed largely on the pupae of sphingid moths; in that year the whole island swarmed with sphingid caterpillars in fantastic numbers, and the leaves of all the *Convolvulaceae* on the island were eaten.

It seems that the wild pigs are now well on their way to extinction or at least to great scarcity. Like the cattle, they suffered a severe setback during the drought of 1963.

The goats were introduced some time after 1925 by settlers who brought goats for milking from Barrington, Baltra and Santiago. They have spread tremendously, but what their long-term effect on the vegetation will be is still hard to tell. The great differences between wet and dry years make it much more difficult to assess the effect of introduced animals in the dry zone than in the humid zone, where annual differences in weather are usually less extreme.

The black rats were introduced a few years before we came here. Their introduction caused the extinction of the native rats, but beyond that I do not know what their influence has been on the native fauna and flora. Their population undergoes constant fluctuations, and when it is declining we often see sick rats infested with maggots and barely able to walk.

Mice were introduced into this island shortly after World War 2, and rapidly spread all over the island. For the first year or so after their appearance they were much more abundant than they have been later. In fact from my observations here I have the impression that a species recently introduced into a new region tends to be more abundant when it has just occupied its new territory than ever after.

After the introduction of mice the population of Barn and Short-eared Owls increased considerably. Both species increased, but *Tyto alba punctatissima* more than *Asio flammeus galapagensis*: in fact we never saw *Tyto* until some time after the mice were introduced.

When we came here there was only one kind of earthworm, a small kind somewhat more than an inch long, apparently native, and the soil was everywhere loose and powdery. Then a couple of years later we saw the first big earthworms, about four inches long. This earthworm has since spread to most of our land and most of the original farm area. When it first spreads to a new area it soon becomes extremely abundant, and in wet seasons the whole top-soil is turned into mud. Then when dry weather comes the soil becomes hard and breaks up into clods, and when rain comes again the clods break up into a grainy structure which persists from then onwards. If the humus content of the soil remains high the soil becomes muddy every season, but not if the soil is poor in organic matter. There is no apparent effect on the subsoil.

At present there are two kinds of large earthworm (both introduced) whose ecology seems to be somewhat different. They do not replace the original small species, which is just as abundant as it ever was. It seems to live on organic matter in an earlier stage of decay than the other two, and is also often found in pure humus where the others are not found.

The fire ant was also introduced, probably between 30 and 40 years ago, for when we arrived here it existed only in a small area about half way between the farms and the beach. Since then it has spread through most



Barn Owl on Santa Cruz Photo by Fritz Pölking

of the humid zone, where it has become a terrible nuisance. Where it spreads all native ants disappear, and it becomes far more abundant than were all the others put together. Since it is a moisture-loving insect it has not become so dominant in the dry zone. It does not seem to harm the vegetation.

NOTES ON OTHER ANIMALS

When we came here, the Hawaiian Petrel, *Pterodroma phaeopygia*, was extremely abundant in the nesting season. It nested in holes in the ground, often in loose soil, and whole hills would be full of their burrows. But as the introduced pigs spread, these nesting colonies were destroyed and only birds nesting in cliffs, caves and holes under rocks survived. In recent years only these latter sites have been occupied. But now that the pigs are declining the petrels should have a chance of increasing again.

The Galapagos Hawk, *Buteo galapagoensis*, was very common when we first came, and very tame; but since they were fond of chickens they were bitterly persecuted and shot in great numbers. The few hawks left on Santa Cruz are much shier, but still not shy enough to escape from fire-arms.

I remember how, in one of our first years, we were hunting in the region of the Cerro de Camote and had killed some wild pigs and were taking out the intestines. The hawks came in flocks to eat them, and were so tame that they let me come and grab them by the wings and throw them up into the air; whereupon they merely let themselves drop down onto the meat and started eating again.

Two species of rail are known at present, the Galapagos Rail (*Laterallus spilonotus*) and the Paint-billed Crake (*Neocrex erythrops*), but I am now certain that there is a third. It is very rare; my father and I have each seen it only twice, and only the last time did I see it well enough to be sure it is a different species. It is somewhat larger than *Neocrex* and is a very poor flier; but it has the habit of settling on trees and bushes after it has been flushed, in contrast to the others which settle on the ground again. It has a heavier bill than the other two species and its legs hang straight down when it is flying. In colour it seems to be somewhat lighter than the other two.

I was told that the centipede *Scolopendra galapagensis* was very common in the hills in 1925, when the Ulva expedition was here, and we saw two in the first year that we were here. But since then we have not seen any except in the dry zone, apart from one which I found about ten years ago near the summit of the Cerro de Camote. It is difficult to suggest any reason for its disappearance from the highlands except possibly the more intense *garua* seasons of latter years.



Galapagos Hawk Photo by Fritz Pölking

AN INCIDENT WITH FERAL DOGS ON VOLCAN CERRO AZUL, ISABELA

by

Uno Eliasson

In 1966-67 I spent nine months plant-collecting in the Galápagos archipelago. The existence of the Charles Darwin Research Station greatly facilitated my work and I was able to visit all islands in the archipelago except the remote islets of Wenman and Culpepper. All the five large volcanoes on Isabela were climbed. Thanks to help from, above all, Mr. Roger Perry, at that time Director of the Darwin Station, I managed to work on Fernandina and to spend two nights on the floor of the caldera in March 1967, fifteen months before the collapse of the caldera.

In December 1980 I again worked on Santa Cruz, Santa Fe, Floreana and Santiago. It was interesting to see the islands again after fourteen years and to note several changes in the distribution and frequency of some species. Although there is some positive development in the protection of native species many negative tendencies remain and some problems need urgent attention. Introduced species of plants and animals are a serious threat to the indigenous flora and fauna. The goat problem seems to be getting under control; on the other hand, feral dogs have become much more numerous. When working on Santa Cruz in areas where feral dogs had been reported I was equipped with a paralyzer, a spray-bottle with tear-gas, to be used in case of attack by dogs. This has surprised some persons who apparently look upon dogs merely as pets. I, too, like dogs, but an adventure with feral dogs on Volcán Cerro Azul on south Isabela in 1967 made me realize that these animals are sometimes very different from the dogs we normally encounter. I will relate briefly this incident; my story is translated from field-notes. Some explanatory sentences have been added, whereas detailed botanical data have been omitted. The story is aimed as a warning to others not to stay in dog-infested areas without some kind of defense weapon. My companion on the trip was Dr. Ian Thornton, later Professor of Entomology at La Trobe University, Melbourne, Australia.

We left Puerto Ayora at midnight 24-25 April on the small fishing-boat Santa Marianita. The boat went via Villamil to Caleta Iguana, the southwestern corner of Isabela, where we arrived around 2 o'clock in the afternoon. The anchorage was small with a heavy swell. We prepared ourselves for the climb by eating salt-tablets and trying to drink as much water as possible.

We started the climb at 3 o'clock. The coastal *barranco* (cliff) was steep, about 100m high, and not easily climbed. Scattered *Opuntias* were growing at low elevations. Above the barranco the vegetation was quite dense and mainly comprised *Zanthoxylum*, *Scalesia cordata*, *Croton*, and *Cordia*. Occasionally we had to use a machete to cut our way through the vegetation. The forest belt extended to an elevation of about 400m, above which was open grassland. A narrow transition belt with *Zanthoxylum* and *Pteridium* dominating was recognizable. The open grassland covered the slope of the volcano to an altitude of 1250-1300m with an abundance of grasses, sedges, and ferns. The bracken, *Pteridium*, was most common in depressions. *Zanthoxylum* trees, many of them dead, were scattered through the lower part of the grassland. Near the rim of the caldera were patches with further woody species, including *Scalesia cordata*.

The slope was steep and the climb fatiguing. We had not been able to sleep well the previous night, since the sea had been very rough. I felt rather exhausted and was perspiring freely, and carried only two litres of water — which had to last until we came back to the boat. We knew that there was to be a full moon that night and intended to walk to the rim of the crater by moonlight. Our plan was to reach the rim around midnight and then to return to the coast the next afternoon. We saw large numbers of free-ranging cattle, the bulls outnumbering the cows. We were pleased to see that the animals were much shyer than those I had previously seen on Volcán Sierra Negra, and they usually ran away when we approached closer than 100m.

We were both very tired and exhausted when at about 5.30 p.m. we experienced one of the most unpleasant adventures of my life, an incident that will always remain clear in my memory. I was walking a few metres

behind Dr. Thornton and we had reached an elevation of 500-600m. I remember I looked up and saw what I first thought might be a white calf at a distance of some 30m. I found it strange and again raised my eyes, now to see a pack of thin, long-legged dogs, 8 to 10 in number, white with dark patches, and dalmatian-like in appearance. According to Dr. Thornton the dogs were resting in a depression in the ground when they first caught sight of us. As a pack they came straight towards us and then started to spread out in order to surround us. I did in fact carry a weapon — a small revolver — but it lay unloaded and wrapped in a plastic bag at the bottom of my ruck-sack. Unfortunately, we had left the machete lower down the slope after passing through the dense forest, intending to retrieve it on our return.

I took off my helmet and rushed a few metres towards the dogs, waving my helmet and shouting. This had no effect. The dogs approached yet closer. They were silent; there was no barking, no waving tails; their eyes expressed neither anger, nor joy; we were their prey. There was discipline in the group and it was apparent which of the dogs was the leader. We realized that we had to remain close together. Trying to escape down the steep, uneven slope would have been futile. A bite in the leg would have been enough to make one of us fall, and then the dogs would have attacked to kill. Dr. Thornton had a walking stick which he waved in front of himself, thus stopping the leader at a distance of two metres. The other dogs were standing about one metre beyond, forming a sinister half-circle. Fortunately they never closed the circle. All dogs were silent, whilst we were shouting. The leader stood ready to jump but Dr. Thornton's stick was continuously waving. The others were also ready to attack but apparently awaited a sign from the leader; again, the discipline was abominably perfect. Our behaviour probably puzzled the dogs and after some 20 seconds or so — we found it much longer — the leader turned and ran away. The other dogs followed and within a few seconds all disappeared. Now we noted that the event had been watched by three big bulls some 50m away.

We were shocked and spent a few minutes discussing the event and whether we would be wise to climb to the summit. However, since the top of Cerro Azul was very poorly known botanically, as well as entomologically, we decided to continue. I took out my revolver, loaded it, and kept it easily available. We went on, much more intent than before.

As already mentioned, we had intended to complete the walk by moonlight. However, when the sun sank below the Pacific the question arose as to what might happen if the dogs returned in the dark. The moon was not to rise for a couple of hours. Would there be enough light to use my revolver, if I had to (which, of course, I hoped I would not!)? We concluded that it would be dangerous to continue in the semi-darkness and decided to put up our tent and spend the night where we were at an altitude of 970m. The top of Cerro Azul is at about 1600m; so we would still have a long climb the next day.

We went into the tent and tried to get some sleep. For a long while, we lay listening to the nocturnal sounds of Cerro Azul. A short-eared owl was heard; then the sound of a running animal approaching. Could it be dogs? No, this was a heavier animal, probably a bull. If the dogs came back, how would they behave? We did not know. We regarded it as unlikely that the dogs would blindly attack the tent. Perhaps we could get them one by one to the narrow opening in the tent and shoot them, if necessary. After a couple of hours the moon rose above the rim of the crater. Then we heard the dogs howling like wolves in the distance. We were silent, listening. Now, again, we felt as prey must feel. The dogs were heard again, closer. Then silence. After a while the dogs were heard barking. They were coming closer. Then suddenly a new sound, a cow bellowing, but in a different way than normally. Again we heard it; and again. Then silence. Just silence. Apparently a cow had been killed.

The night was cold and too disturbed to make sleep possible. Before sunrise we ate our food and then climbed to the top of the volcano collecting plants and insects. Late in the afternoon we returned to the fishing-boat at Caleta Iguana. No further dogs were seen. We arrived exhausted and dehydrated, and during the next two hours I drank five litres of water. We were happy we had been able to fulfil our plans.

Postscript. The feral dogs are a serious threat to the native fauna of the Galápagos Islands. If the dogs on southern Isabela are permitted to multiply to such an extent that they cross the Perry Isthmus, then the indigenous reptiles and other wildlife of northern Isabela will be threatened. For this reason I believe that an even greater emphasis should be given to the eradication of dogs on this island. The protection of the unique Galápagos fauna is an urgent matter. Organizations for the protection of wildlife should strongly support the dog eradication program in the Galápagos Islands.

FERAL DOGS OF SOUTHERN ISABELA

by

Bruce D. Barnett

The coastal dogs of Isabela are of singular appearance. They are generally large, standing 50 to 70cm at the shoulder, attain a length of up to 140cm and possess conspicuously large ears (15cm). High daily temperatures during most of the year make it necessary for the animals to regulate their body temperatures with minimum expenditure of energy. As a possible consequence, most of the dogs in this area are short-haired and mostly white with brown or black spots. Autopsies of several animals have revealed an average litter size of five young. Considering that domestic dogs breed at roughly six-month intervals and that there are approximately 500 dogs on this part of Isabela, half of which are females, a possible 2500 new animals may be introduced into the population each year. This high influx of new individuals, however, is most likely counter-balanced by a high juvenile mortality and a relatively short lifespan for adult dogs. Preliminary age estimates of the coastal population show a predominance of young animals, with few over five years of age. Significant infestation with nematode heart-worm and the general hardships associated with life in this region may aid in explaining the absence of older dogs.

The social structure and predatory habits of the dogs appear a consequence of prey size. From fecal analysis and examination of stomach contents, those prey include for the most part marine iguanas (35%) and Galapagos penguins (32%) with the remainder of the diet consisting of juvenile sea-lion (8%), Audubon shearwater (7%), blue-footed boobies (6%), Sallylightfoot crab (6%) and traces of dog, cat and black rat (2%). With such small prey there is no need for large hunting packs and, indeed, we have observed small groups of 1 to 3 individuals on most occasions. We have, however, seen groups of up to 16 animals, usually in areas near sources of fresh or brackish water. On several instances, we have watched dogs apparently drinking sea-water, but it is unlikely that they have evolved an excretory system efficient enough to remove the high concentrations of ions from this water to utilize the moisture. It is more probable that this behaviour results from a deficiency of one or more minerals in the diet. Further study of the physiological relations of the dogs is necessary, however, to make any definite conclusion.

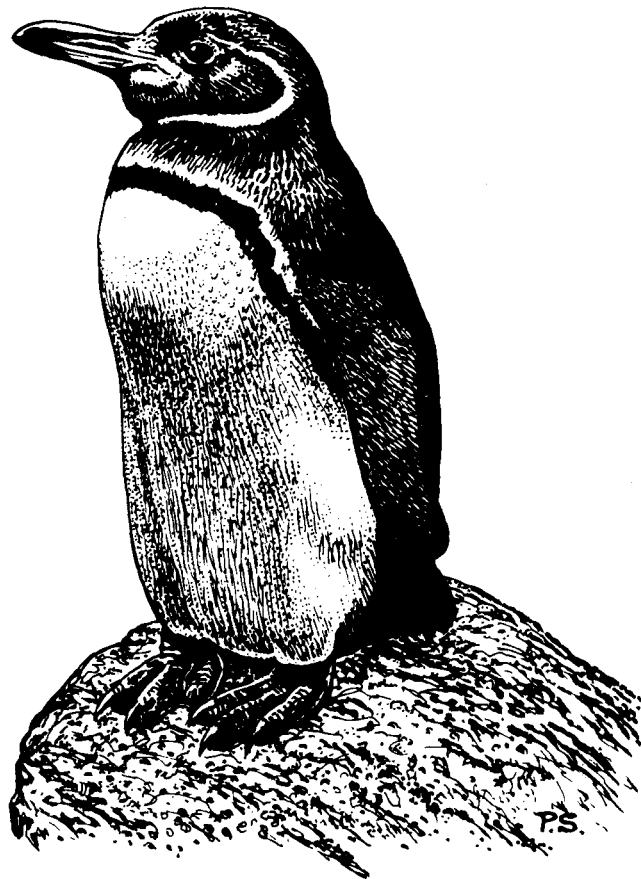
Hans Kruuk of the Institute of Terrestrial Ecology in Scotland conducted a preliminary survey of the coastal dogs in February and March of 1979 and estimated that they annually consume 27% of the iguana population in the region of Caleta Webb alone. This figure is based on the nutritive requirements of the dogs and the observed preference for larger iguanas. Subsequent censuses of iguanas in this area by researchers from the Darwin Station show a predominance of small and medium sized individuals while prey remains left by the dogs and found in the feces support the observation that large iguanas make up the bulk of the diet. The removal of these large, breeding members of the population suggest that iguana mortality outpaces the production of new individuals. In the last two years, penguins have become an increasingly important food source and, if this trend continues, we fear they may suffer a similar fate.

Dog populations have also been studied in the highlands of Cerro Azul. We estimate this population between 100 and 200. These animals are similar in appearance to the coastal dogs, but the generally cooler climate removes the necessity of short hair and light coat colour. Although pack sizes in the highlands tend to be larger (3-5 individuals), the domestic trait of a reduction of the "pack instinct" of proximity tolerance, which prevents of stable social relationships within a large but closed social group, may help to explain the observed fluidity in pack size in this area.

On the south slope of Cerro Azul alone, we have counted up to 1000 head of feral cattle and these animals make up 50% of the dogs diet in this region. The remainder of their diet consists of endemic species of beetle (14%), grasshopper (11%), grasses and ferns (11%), domestic dog (6%) and traces of cat, ground finch, and black rat (8%). As a rule, with domestication, the more specialized an individual (or breed) becomes, the less flexible or utilitarian it is. An example of these limitations can be seen resulting from changes apparent in the domestic dogs' morphology, with respect to their wild counterparts. Changes in

tooth structure have enabled domestic dogs to become effective scavengers and possibly reduced their effectiveness as true predators. This is obviously the case on Cerro Azul, where we have observed several unsuccessful attempts to bring down an intended prey. These attempts usually lead to the maiming of the prey, which later dies of its injuries with a great deal of suffering.

An interesting situation appears to be occurring where both feral dogs and cattle co-exist. Without the presence of a natural controlling factor for the growth of cattle populations, the dogs have assumed this role and perform a unique ecological function as regulators of cattle numbers. However, it is likely that these dogs can also migrate down to the coastal regions of the island and replenish the populations in this area of Isabela. Therefore, eradication of these individuals is necessary for the well-being of the endemic island fauna. An unfortunate side-effect of this strategy, however, will be the unchecked growth of cattle populations on Cerro Azul. The animals are quite destructive to the flora of the highland regions and have already turned vast areas into virtual short-grass deserts by cropping a large portion of the native vegetation and endangering the remainder by destroying the natural watershed characteristics of the lower slopes. It is thus of the utmost importance that the National Park Service in conjunction with the Darwin Station devise a means of controlling the numbers of cattle on this portion of Isabela.



Galapagos Penguin *Drawing by Peter Scott*

MARINE IGUANAS — WHERE HAVE ALL THEIR BABIES GONE?

by

Andrew Laurie

Dr. Laurie recently completed the first stage of his 3-year investigation of the population dynamics of the marine iguanas, which he has undertaken with the support of the Leverhulme Trust and the Royal Society. He gives his preliminary findings regarding the grave threat to many local iguana populations and his personal views on the control of feral predators in general.

Perched high on a pinnacle of rock I watched in awe as wave after wave swept in from the south and crashed with a noise like thunder onto the rugged, rocky coastline below me. Spray shot skywards, soaking me to the skin; dark clouds blotted out the sinking sun and I began to feel quite cold. But, being warm-blooded, I sat there a moment longer and spared a thought for the serried ranks of cold-blooded reptiles also perched high up above the sea but nevertheless chilled by the cold spray and cooling breeze. Rough seas or bad weather mean poor foraging for the marine iguanas of the Galapagos Islands, and big swells on the southern coast of Santa Fé had prevented the sea-going Iguanas from gathering their daily ration of seaweed for several days. They had retreated higher up the cliffs and some had taken to eating crabs or gull chicks, drowned or abandoned by their parents. It is a tough life, ruled by the tides and the sun, and, resistant as the iguanas are to the pounding of the Pacific swell, there is a limit to how much they can withstand while feeding in the intertidal zone.

A group of sea lions gambolled in the dusk, riding the big waves in and out of a narrow channel to dice with death in their favourite rock pools, now foaming cauldrons of white water. I left them to it and made my way through the half-torpid iguanas to our windswept camp 100 metres above the sea. We chose to camp at Miedo on the south coast of Santa Fé because there is an enormous breeding colony of marine iguanas here, and I am in Galapagos for three years to find out something about the population dynamics and social organization of these animals. We have made furniture of driftwood washed up in a little cove below the camp, and we carry all our supplies, including fresh water, from the landing place 3kms away across a cactus-covered plateau. On calm evenings we fish for hawk-fish and groupers, sharing the cliff-edges with unperturbed iguanas. During the day, when we want to catch them, they run away warily, but they seem to know when we are after fish and not after them, and they sit there watching us or even eating our bait.

Like the marine iguanas, we have been living in, on or beside the sea. We hear it constantly and watch its moods with fascination. We are sprayed by it 1km inland at Miedo and have never yet dared to enter the rough, open sea, contenting ourselves with baths in sheltered rock pools in the company of inquisitive sea lions. We share our camp with finches and mocking birds and voracious rice-rats with insatiable appetites for plastic and paper. Diminutive doves gather at safe distances, only venturing near the camp in the early mornings, while over on the rocks behind camp live a number of ancient land iguanas, whose day starts with a warm up in the sun at about 7.30 a.m., after which they move back into the shade until feeding time at about 2 p.m. and then return to soak up the last of the sun outside their holes before finally retiring for the night around 6 p.m.

It is July 1981; Dick Watling and I have spent the last two days sitting on rocks by the sea and peering through binoculars at baby iguanas, sometimes waiting an hour or more at each place to make sure that we have seen even the most recalcitrant, which tend to stick to the safety of their cracks and crevices for long periods. The young iguanas are between 25 and 30cms long now, and have grown almost 2cms since they hatched nearly three months ago. It was then that Justin Marshall and I surrounded the sandy nesting ground with a fence of plastic sheeting and captured more than 600 newly hatched iguanas as they emerged from their holes and made for the sea. We marked each individual with a unique colour-coded combination of glass beads threaded on nylon line and attached to the crest on the back of the neck. Now, almost three months later, I want to know how many are still surviving. It is an exercise in comparisons: I am investigating the effects of introduced predators such as cats, rats, pigs and dogs on marine iguanas populations, and Santa Fé, where there are no such feral predators, serves as a standard with which to

compare survival of the hatchlings on other islands.

During the last two days we have identified almost 300 of the 600 hatchlings marked, so survival seems quite good; particularly so as in this cold, overcast weather there is little chance of being able to spot all the hatchlings. They dislike being out on such days and prefer to huddle together in their holes and crevices. So far I have not found any marine iguana colony with a survival rate of hatchlings as high as at Miedo. The same applies to the younger animals in general. I have circumnavigated all the major islands now, and gone ashore to census the major iguana colonies, determining the age composition of the populations at each place. In general, on all islands with introduced predators the marine iguana populations are unbalanced, with a predominance of old animals and very few young animals or hatchlings.

Last week we were at Muñeco on the northern coast of Isabela where we found evidence that cats have been responsible for killing almost all the hatchlings. We found remains in nearly all cat faeces examined and there were half-consumed carcasses of hatchlings on the nesting grounds. Hatchlings made up less than 1% of the population counted, compared with more than 10% in most areas which have not been colonized by introduced predators. More worrying even than this is the fact that there are no young animals in between hatchling size and adult size. Populations can withstand one or two bad years but at Muñeco and at many other sites on Isabela and on some other islands it appears that the hatchlings suffer complete predation by the end of the first year. The result is that these populations are aged and effectively sterile and have been in serious decline for many years. It is striking that the small offshore islands of Crossman and Tortuga (which have no feral predators) have enormous and virile populations, yet iguanas are practically extinct on the adjacent shores of Isabela. There is no doubt that many of the marine iguana populations of Galapagos are in severe danger of extermination once the present populations die of old age. It could be that iguanas will only survive on islands without introduced predators or at places with steep cliffs which are inaccessible to the predators.



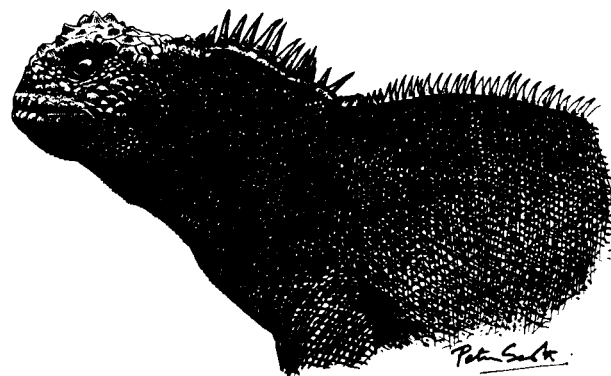
Marine Iguanas *Photo by Alan Root*

During the next two years I hope to be able to gather more detailed information on the factors controlling marine iguana distribution, abundance and population composition and to be able to compare the population dynamics and social organization of colonies of islands with and without introduced predators. I can provide information, but what is done with it is another question.

The disastrous effects of introduced mammals on the native fauna and flora of Galapagos have been described again and again. Goats have been eradicated from some islands and a dog eradication programme has recently been started on Isabela. However, as in all such cases, the consequences of elimination, or attempts at elimination of one species may have serious repercussions on other species or even on the endemic species it was designed to protect. On Isabela the only marine iguana colony with a viable recruitment rate is at Caleta Webb, where until recently dogs slaughtered the adults and dug up the eggs but may also have kept the cats at bay, and hence reduced predation on the vulnerable hatchlings. The wary young animals are too quick to be caught by dogs but fall easy prey to patient cats which wait outside their holes for them to re-emerge. Now that attempts to eradicate the dogs are being made, it will be interesting to see how the iguanas fare. Control of cats, even if it ever proved possible, could lead to an increase in the rat population.

The problems seem never-ending. As I travel from the windswept cliffs of southern Santa Fé to the sunbaked lava fields of predator-free Fernandina, where one can hardly move without treading on an iguana, I sometimes wonder whether we are fighting the right battle. New species have been arriving in Galapagos from the moment the islands emerged from the sea, and man has acted and is acting as simply another vector of countless species to the islands. Total eradication on every island of all species brought in by man would be impossible. Perhaps what is needed, rather than over-ambitious attempts to totally eradicate feral animals on an island the size of Isabela is more emphasis on local control and the protection of certain breeding colonies of the species which it is the National Park's policy to conserve.

I am not suggesting that we do nothing; simply that we change our outlook. It remains to be seen whether feral dogs can be eradicated, but there is no possibility of eradicating cats, given our present control techniques. Any control operations would have to be periodically repeated and will inevitably be difficult and expensive. It is therefore essential that the overall seriousness of cat predation be carefully evaluated, the locations where it is most serious identified, and the most efficient control methods be found so that at least some of the presently endangered populations of marine iguanas can build up again into healthy well-balanced communities.



Iguana *Drawing by Peter Scott*

DOG DAYS ON ISABELA

by

Alan and Tui Moore

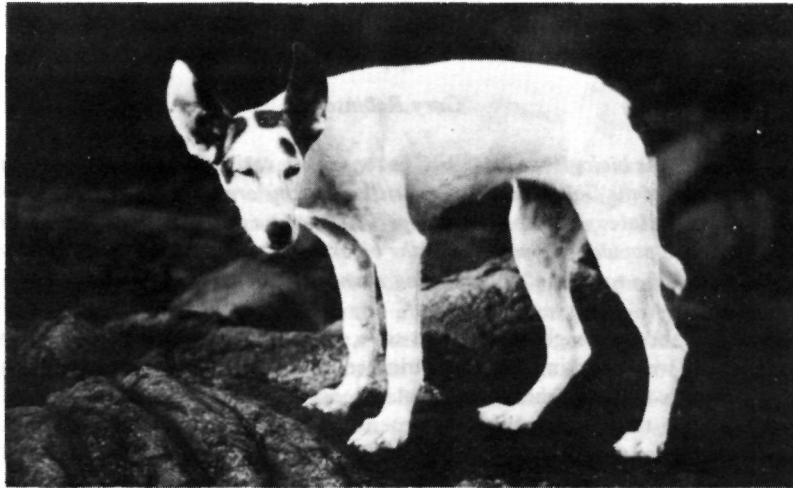
The midnight calm over our campsite was shattered as loud barking and growling erupted only a few feet from our tent door. A half hour later the angry animal was still persisting with its enraged racket, so we climbed out of our sleeping bags somewhat apprehensively and, shining our flashlight into the dog's eyes, ran toward it, yelling as loudly as possible, and causing our nearby camp-mates to believe we were being eaten alive. Nevertheless, to our relief the dog fled without another sound across the lava fields under the full moon! A few years earlier, on our first encounter with these feral dogs that have roamed the rugged volcanoes of southern Isabela Island for many generations, our meeting was not so uneventful. On that occasion a pack of eight of these long-legged, long-snouted, hefty beasts had attacked our party of four. We had taken refuge on a steep lava outcropping as the dogs encircled us. Teeth bared, they began to move in on all sides, until at last they retreated under a shower of stones.

But tonight we had barely regained our tent when not one, but six dogs appeared and again besieged our camp with wild barking. Soon another pack chimed in down the coast. Eventually they broke out into chilling howls and we were comforted to know that, in case of real problems, the Park wardens in the next tent had a rifle. The strange concert continued for several hours. What had gone wrong? We had been here almost three weeks on the first trip of the feral dog eradication campaign and, just as we thought we were beginning to achieve significant results in reducing the dog population, they were turning out in record numbers.

There were six of us involved in this new project launched in 1981 by the Galapagos National Park and the Darwin Station with funding from the Frankfurt Zoological Society. Every day we and the four Park wardens hiked several miles along the coast, laying poisoned baits at regular intervals. By placing the baits hidden under dark ledges in the lava we would allow the dogs to find them with their keen sense of smell, while the native animals, who seek their food primarily by sight, would be in no danger of locating them. Even as we worked we could observe the devastating activities of the dogs. It appeared that the adult dogs devoured one medium-to-large marine iguana every day, and more when eating small ones. Considering that there were at least 100 dogs in the vicinity of Caleta Webb, our first work site, this translated into staggering numbers of hapless reptiles consumed each year. We were amazed that there were any left at all. Despite this large scale depredation, on several occasions we were able to watch as dogs approached the marine iguanas closely without the latter showing the slightest fear, obviously not comprehending the dogs' deadly intentions. Having evolved in an environment totally devoid of large carnivores, the iguanas were clearly unable to cope with these introduced predators. The shoreline of Caleta Webb was littered with iguana carcasses, although the dogs frequently consumed their entire prey, bones and all, leaving no sign of their feast. While in coastal areas marine iguanas constitute the dogs' primary food source, we also encountered the twisted remains of hundreds of masked and blue-footed boobies, pelicans, penguins, flightless cormorants, sea lions, and fur seals. And we knew that only a few miles away the dogs were responsible for destroying almost all the giant tortoise eggs and young.

Working conditions were not very pleasant at Caleta Webb, as the dogs thrive in one of the most rugged environments of Galapagos. Not a tree grows in the entire area, and heat waves rise mercilessly from the sunbaked lava fields. Our only refuge was a small awning over our kitchen area, and our tiny two-man tents. When we were not being broiled by the sun, the torrential rains of the warm season flooded our camp. Fresh water cannot be found here so our supplies, brought in dozens of large plastic containers, had to be used carefully, lest we run out before the end of the trip.

The day we landed at Caleta Webb a tremendous swell was running so all our gear had to be hauled ashore through six-foot breakers. This made for hilarious scenes such as people completely covered with black beach sand madly chasing water containers and bunches of bananas as they washed up and down the tiny



Juvenile Wild Dog on Isabela *Photo by Tui Moore*

beach. But the Park wardens are well-adapted to life in the field. Daily they would catch fresh grouper off the steep, rocky shore and cook delicious meals from our limited stores.

After some refining of our techniques, the project soon caught momentum. In only three months over 100 dogs were killed, including almost all of those which lived along the western coast of Isabela. There the marine iguanas can bask once more in the sun without becoming a dog's next meal. The project is scheduled to take two years to complete. Many problems will certainly arise. The tremendous area to be covered on the volcanoes Cerro Azul and Sierra Negra are sure to put the Park wardens to the test, yet they feel confident of success. Thought must also be given to the future of the large feral cattle population on Cerro Azul. With the elimination of the dogs, their only predator, it is likely that the cattle population will begin to increase. However, when the dogs are gone, just as has already been the case with the goats removed from several islands, we will be one step closer to seeing the Galapagos wild and pristine, much as they were for thousands of years before man introduced these alien species.



Remains of a Galapagos Fur Seal eaten by dogs *Photo by Tui Moore*

A SURPRISING SHRIMP

by

Gary Robinson

Gary Robinson, staff marine biologist at the CDRS, is conducting various studies to promote the protection of the underwater resources of the Galapagos. There is still no marine area included within the boundaries of the National Park, so commercial exploitation of some species remains a cause for anxiety – hence the study of the quantity, distribution and population dynamics of the black coral to determine whether minimum size limits should be recommended if a total ban on harvesting cannot be imposed.

On a recent excursion aboard Beagle IV to Tagus cove, a remarkable commensal shrimp was discovered quite by accident. We were marking and measuring colonies of *Antipathes panamensis* and *Antipathes galapagensis* as part of a demographic study of black corals. The former species is often used to make jewellery while the latter, though not utilized commercially because of its brittleness and the small size of its branches, is endemic to the Galapagos Islands.

Black corals resemble small marine trees with a spreading hold-fast that anchors the colony to the rocks, followed by a short trunk and upright branches. In *A. galapagensis* the entire surface of the trunk and branches is covered with bright yellow-green to golden polyps about 4mm in diameter. The holdfast of black corals is often undermined by worms and boring clams thereby weakening the attachment to rocks. We were affixing a tag to such a colony when it broke free of the substrate. We therefore decided to take it to the surface to weigh it. The colony was left upon the deck of Beagle IV and, when picked up again for examination, we noticed that some of the polyps had fallen off. Imagine our surprise when the yellow polyps started jumping around the deck! Coelenterates are not supposed to behave like that.

These shrimps that we had accidentally collected resemble some members of the family *Pontoniidae* and are remarkable in their mimicry of *A. galapagensis* polyps. The dorsal surface of the carapace and abdomen possesses scattered projections that appear identical to the form and colour of tentacles of *A. galapagensis* polyps. Since this antipatharian is endemic to Galapagos, it is quite probable that the shrimp is likewise endemic and has not been described before.

There may be a good reason why this shrimp is such an effective mimic of black coral polyps. While diving in Galapagos waters, it is a common observation that the hawkfish, *Oxycirrhites typus*, is nearly always associated with black coral colonies. This beautiful red and white fish possesses an elongate snout which suggests that it picks food from between branches of the corals. Thus the hawkfish, through its feeding, may be the selective agent favouring the evolution and maintenance of mimicry in the commensal shrimp of *A. galapagensis*. The interaction between black corals, commensal shrimps, and the hawkfish, *Oxycirrhites*, needs to be further investigated and serves, by example, to demonstrate the many potentially interesting animal interactions that await discovery and study beneath the surface of waters that surround the Galapagos Islands.

SEASNAKES IN THE GALAPAGOS

by

David Cameron Duffy

Somehow, seasnakes combine two of the worst of human phobias: that of snakes and that of seamonsters. While many of us overcome the fear of snakes, there are few people who fail to wonder and perhaps worry about what is "out there" beyond visibility when snorkelling or diving with tanks.

Seasnakes occur in the eastern Pacific Ocean. In the course of my snorkeling in Galapagos, I wondered how likely I would be to see one there. Thornton doesn't mention them in his 'Darwin's Islands'. The Darwin Station's reference collection was more rewarding. There were six specimens of the Yellow-bellied Seasnake *Pelamis platurus*. Three were from Academy Bay on Santa Cruz (March 1976; August 1970; and November 1971); one was from the channel between Baltra and Santa Cruz in February 1975; one skeleton was found 400 metres inland on Isla Genovesa (Tower) in April 1980. Perhaps the most intriguing specimen was one that a Lava Gull deposited on the decks of Beagle III in March 1973. There is no record of crew and passengers flinging themselves overboard as the gull looked about, wondering at all the fuss, and it is comforting to note that attacks on humans are rare and apparently difficult because the snake's small mouth makes it hard for it to get a grip on most parts of a human body.

In the literature there is a single record of a seasnake between San Cristóbal and Española in February 1906 (*Van Denburgh 1912, Snakes of the Galapagos, Calif. Acad. Science (4) 1: 323-374*).

The Yellow-bellied Seasnake is the most pelagic species, ranging through the tropical and subtropical Indian and Pacific Oceans (*Klemmer 1971, in Grzimek's Animal Life Encyclopedia, ed. by H. Hediger, vol. 6: 437, Van Nostrand-Reinhold, N. Y.*). Seasnakes frequently lie on the surface, often in drift lines, waiting to ambush passing fish.

Seasnakes, being cold-blooded, must have warm waters. The low temperatures of the Humboldt and Cromwell Currents probably keep seasnakes from being common in the Galapagos. Four of the six records for which we have dates occurred in the warm-water season (January to March) when the archipelago is less affected by the Humboldt Current. Even at these times, the snakes must be rare. There are no Galapagos legends of tourists encountering them while swimming. The snakes are doubtless out there but they are less occasion for fear than for appreciation as yet another part of the fascinating reptile fauna. Future visitors to the islands might expand our knowledge of seasnakes and their occurrence by spending a little time watching for them as their boats cruise through the islands.

STATUS OF THE DARK-RUMPED PETREL ON ISLA SANTA CRUZ, 1981

by

Malcolm C. Coulter, David C. Duffy & Sylvia Harcourt

The Dark-rumped Petrel, *Pterodroma phaeopygia*, is a gull-sized seabird that breeds only in the Hawaiian and Galapagos archipelagos. The populations in both areas have been declining for many years. On Santa Cruz 4 colonies have been visited yearly since 1978. We visited these colonies in early August, 1981, and compare our figures with those of previous years.

In the Galapagos this petrel breeds in the highlands on 4 islands: Santa Cruz, Floreana, Santiago and San Cristobal. It may also breed on Isabela, though no nests have been found there. Time of breeding varies from place to place. On Santa Cruz, birds return in May; eggs are laid in June and July. Each pair lays a single egg in an underground burrow. The eggs are incubated for 50 days and the young remain in the burrow for an additional 110 days (Harris, M.P. 1970. The biology of an endangered species, the Dark-rumped Petrel (*Pterodroma phaeopygia*), in the Galapagos Islands. Condor 72: 76-84). Breeding lasts 5 to 6 months.

At Media Luna on Santa Cruz 4 colonies, 'Mike's', 'Corner', 'Creek' and 'Gully', were visited in 1978, 1979 and 1980 by R.J. Tomkins, R. Baker and F. Bass. In these years they found 63, 38 and 32 burrows that were occupied by birds. In 1981 we found 18 active burrows of which 7 had eggs. This represents a decline in number of active burrows by 44% since 1980 and 71% since 1978, with an average yearly decline of 33%. At this rate the population will decline to 10% of the 1978 size by 1984 and to 1% by 1990. If nothing is done to protect the bird, these populations will become extinct within the next 10 to 15 years.

The main cause of this decline is predation by feral animals on eggs and young, and to a lesser extent on adults. We are presently establishing a program of feral animal control to reduce this predation.



Dark-rumped or Hawaiian Petrel Drawing by M. Estey

BIRDS ON DAPHNE MAJOR 1979-1981

by

S.J. Millington and T.D. Price

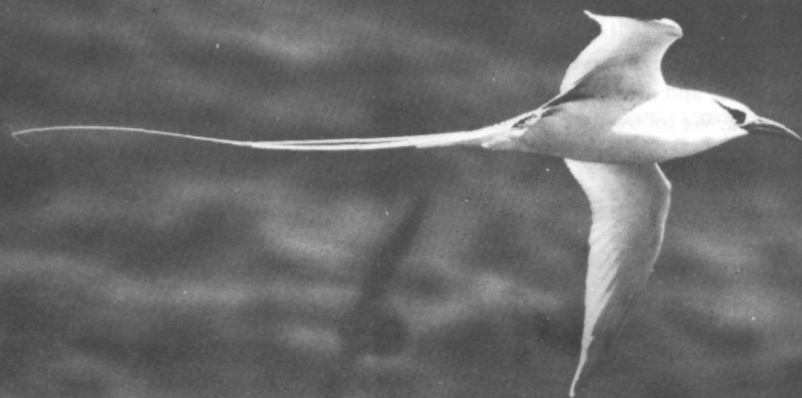
Under the general supervision of Professor Peter Grant, Daphne Major has been tenanted by ornithologists for much of the first half of each of the past six years. The main reason has been to study the finch community (See Grant and Grant 1979).

This is an account of the birds we observed between 1979 and 1981 when one or both of us were present between January and June, and also once in September. Additional records of species we did not see ourselves are also included. We follow the order of Harris (1974) to which we refer the reader for scientific names.

Each species is prefixed by a letter:

- R Regular non-breeding visitor
- B Breeds regularly
- V Vagrant

- V Hawaiian Petrel. One heard nightly from 21-26 April 1980 and 23-30 March 1981.
- B Audubon's Shearwater. Regular offshore in rafts of up to 100 birds. Breeding still to be proved.
- B Band-rumped Storm Petrel. Breeds but numbers hard to estimate due to nocturnal habits.
- V White-vented Storm Petrel. Occasional offshore.
- B Red-billed Tropicbird. A conspicuous resident. 300 plus pairs probably breed.
- R Brown Pelican. Up to 15 observed round the island.
- B Blue-footed booby. Up to 1000 pairs breed in the craters with a few on the outer slope. Numbers fluctuate greatly: e.g. none breeding in January 1979 but 1000 pairs by May 1979.
- B Masked Booby. Up to 50 pairs breed on the crater rim and outer slope.
- V Red-footed Booby. Single individuals noted on seven occasions.
- R Magnificent Frigatebird.
- R Greater Frigatebird. Both species of Frigatebird are present on Daphne in variable numbers with up to 120 counted on 31 May 1980. The last attempt at breeding was in 1978 when the female died on the nest (personally observed) though males still regularly display. Tropic birds are their chief victims, boobies rarely being parasitised.
- V Great Blue Heron. An immature on 9 February 1979.
- R Common Egret. Single birds recorded occasionally with 3 on 18 April 1980. Feed mostly on lava lizards and sometimes juvenile finches.
- V Lava Heron. Single birds on 17 March 1979, 7 June 1979 and 6 April 1980.
- B Yellow-crowned Night Heron. Two pairs bred in both 1979 and 1980. 3 nests were successful, 1 was abandoned. Although individuals were noted regularly, breeding was not suspected in 1981.
- V Galapagos Hawk. One from 11-14 March 1980. Also recorded in 1973 (Abbot et al. 1977).
- V Peregrine Falcon. Single birds on 11 March 1979, 1 March 1980 and 18 February 1981. Also recorded in 1973 (Abbot et al. 1977).
- R Oystercatcher. 1-3 recorded occasionally, usually between January and March.
- V Yellowlegs sp. 2 in the crater on 19 April 1980.
- R Wandering Tattler. Regular in small numbers (less than 10).
- V Ruddy Turnstone. 1 on 10 March 1979.
- V Willet. 1 on 21 September 1979.
- V Northern Phalarope. A flock of c.2000 offshore on 2 January 1980. Occasional other sightings.
- B Swallow-tailed Gull. Up to 10 pairs breed on the island.
- V Lava Gull. One round a fishing boat on 6 March 1979.
- V Franklin's Gull. Four records including one in the crater 4-9 February 1980.
- V Common Arctic Tern. 1 on 11 April 1980 and 2 the next day.
- B Brown Noddy. Less than 5 pairs breed.



Red-Billed Tropicbird

Photo by Fritz Pölking



Brown Pelican

Photo by Fritz Pölking

- B Galapagos Dove. Resident. 20-30 pairs in 1979 dropped to 6 in 1981.
- V Dark-billed Cuckoo. 1 on 22 February 1981.
- R Short-eared Owl. In January/February, up to 4 recorded in 1979, fewer in 1980 and only 1 in 1981. An occasional visitor between May and June. At least 6 have been found dead on the island between 1975 and 1981. See Grant et al. (1975) for a study of this species on Daphne.
- V Large-billed Flycatcher. 1 on 13 January 1979, 26 January 1979 and 8 April 1981.
- B Galapagos Martin. Breeds in small numbers, up to 25 being recorded. The species apparently vacates the island during the *garua* season, as it is rarely recorded in December.
- R Yellow Warbler. 1-5 commonly present in January and May/June, less frequently between February and April.
- V Summer Tanager. Immature found dead on 29 January 1981. The specimen is now in the CDRS Museum; identity awaits confirmation.
- V Indigo Bunting (*Passerina cyanea*). An adult male was seen on 2 May 1979. Apparently the first record for Galapagos and Ecuador.
- V Blackpoll Warbler. 1 in May 1976. (Boag and Ratcliffe 1979).
- R Small Ground Finch. A regular immigrant in May/June and up to 30 remain throughout the *garua* season. Rare between February and April although a pair bred in 1981 and females occasionally hybridise with the medium ground finch (Boag 1981).
- B Medium Ground Finch. Numbers are variable. C.1200 were estimated in 1973, dropped to c.200 after the drought of 1977 (Grant and Grant 1980). C.500 were present in June 1981.
- R Large Ground Finch. Immigrates in May/June, up to 50 remaining until February when they all disappear.
- B Cactus Finch. Numbers less fluctuating than Medium Ground Finch. Only c.100 were present after the 1977 drought but c.300 were estimated in June 1981 (Grant and Grant 1980).
- V Vegetarian Finch. 1 in May 1976 (Boag 1981).
- V Small Tree Finch. Three records including one from January to March 1980.
- V Large Tree Finch. One singing on 22 February 1980 and 2 on 28 February 1980.

REFERENCES

- Abbot, I., Abbot, L.K., Grant, P.R. (1977). Comparative ecology of Galapagos ground finches (*Geospiza* Gould). Evaluation of the importance of floristic diversity and interspecific competition. *Ecol. Monog.* 47:151-184.
- Boag, P.T. (1981). Morphological variation in Darwin's Finches. (*Geospizinae*) of Daphne Major Island, Galapagos *Ph.D. thesis*, McGill University.
- Boag, P.T., and Ratcliffe, L.M. (1979). First record of a Blackpoll Warbler for the Galapagos Islands *Condor* 81:218-219.
- Grant, P.R., Smith, J.M.N., Grant, B.R., Abbot, I., and Abbot, L.K. (1975). Finch numbers, owl predation and plant dispersal on Isla Daphne Major, Galapagos. *Oecologia* (Berlin) 19:239-259.
- Grant, B.R., and Grant, P.R. (1979). The feeding ecology of Darwin's finches. *Noticias* 30:14-18.
- Grant, P.R., and Grant, B.R. (1980). Annual variation in finch numbers, foraging and food supply on Isla Daphne Major, Galapagos. *Oecologia* (Berlin) 46:55-62.
- Harris, M.P. (1974). A Field Guide to the Birds of Galapagos. Collins, London.

MEMORIAL TO SIR JULIAN HUXLEY

(1887-1975)

Born in a generation which was interested in wildlife chiefly from the angles of hunting and collecting, Julian Huxley became a pioneer of environmental conservation. During his years as Director General of UNESCO he promoted the launching of the International Union for Conservation of Nature and later the World Wildlife Fund.

His influential book, *Evolution, the Modern Synthesis*, made him the natural choice as the principal speaker at the International Zoological Congress, held in 1958 to celebrate the centenary of the publication of the papers of Darwin and Wallace on evolution by natural selection. The Congress voted a resolution urging the conservation of the Galapagos Archipelago and set up a Galapagos Committee of which Sir Julian became Chairman.

Twenty years earlier he had served as chairman of the London Committee for the Galapagos, but conservation had little appeal in those days and nothing had been achieved when war came in 1939. In 1959 he joined the organising committee of the Charles Darwin Foundation and became its Honorary President.

It is now hoped to commemorate his remarkable achievements by establishing a "*Julian Huxley Research Fellowship*" in the biological and human sciences, open to men and women from any country. Provided that a minimum endowment of £100,000 can be raised, the Fellowship will be administered by the Royal Society and Balliol College. Donations may be sent to Peter G. Roberts, Esq., The Bursar, Balliol College, Oxford, England.

G.T. Corley Smith

DR. ROBERT SILBERGLIED

The death of Robert Silberglied in the Washington air crash on 13 January has deprived the Galápagos scene of a talented and dedicated zoologist. During an association of twelve years with the islands he was able to bring a remarkable zest to scientific study there and to make his own significant contributions in the field of entomology.

In 1970, as a graduate student at Harvard, he came to the CDRS to study mechanisms of the insect pollination of flowers. This extended into a broad and valuable survey of island insect faunas. In the Galápagos he seemed to find an environment that both captivated and inspired him; certainly, to those of us who knew him at that time he brought a sense of enthusiasm for his work that was wholly refreshing. The influence of the islands was to be profound and shaped his future career in neotropical entomology.

From the Agassiz Museum of Comparative Zoology at Harvard, Bob Silberglied moved to a post as research scientist at the Smithsonian Tropical Research Institute in Panama, a position that he held when he died. Despite other and widening interests, he was always ready to be drawn to the Galápagos, offering assistance to others from his remarkable knowledge of the islands and their literature. He collaborated with Alan Hayes in his work on the macrolepidoptera of the Galápagos Islands, characteristically making available his extensive field-notes and collections that had been housed at Harvard. It is however for the compilation of a computerized bibliography of Galápagos literature, an herculean task that he undertook with Tom Simkin, that he will be particularly remembered.

Although he made only one further, brief visit to the Galápagos Islands, he was keenly interested in the conservation work of the national park. His became one of the few voices that could speak authoritatively on the largely unassayed problems facing the terrestrial invertebrate fauna of the islands. In this capacity, he was one of the first to be approached as a contributor to the initial, Galápagos volume of a new series of books to be published on the world's Key Environments. That he was able to achieve the wide recognition and success he did in that brief career remains a measure of his gifts and ability. Roger Perry