noticias de GALAPAGOS

CHARLES DARWIN FOUNDATION FOR THE GALAPAGOS ISLANDS

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NOTICIAS DE GALAPAGOS

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THE CHARLES DARWIN FOUNDATION FOR THE GALAPAGOS ISLES

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CONTENTS

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PRESIDENT FEBRES CORDERO
SUPPORTS THE CDF ENDOWMENT FUND CAMPAIGN

At a ceremony held in January at the Smithsonian Institution in Washington, D.C., His Excellency, President Léon Febres Cordero announced his enthusiastic support for the campaign mounted by The Nature Conservancy to raise an 1,500,000 U.S. dollar endowment fund for the Charles Darwin Foundation. In a speech accepting the post of Honorary Chairman of the appeal, he said:

> "The Government of Ecuador wishes to thank The Nature Conservancy for taking this initiative in defending the natural environment of the Galapagos Archipelago. The Charles Darwin Research Station is already functioning in the islands and does honour to the man for whom it was named. There, contemporary scientists continue to work in the great tradition that Darwin inspired and with devotion to the conservation of Nature for the future.
>
> Much remains to be done and what has to be done implies much scientific research and great expense. We appreciate the efforts of The Nature Conservancy and its valuable support for this noble goal. Many thanks to you all in the name of Ecuador and in the name of the Galapagos Islands which have been declared a Patrimony of Mankind and are worthy of that appelation."

In spite of the current economic problems of his country, President Febres Cordero, on behalf of the Government of Ecuador, pledged a contribution of 150,000 U.S. dollars to the Fund. This was immediately matched by an offer of the same amount from the U.S. Agency for International Development. While these two magnificent donations do not yet reach the target, they do bring it into sight on the horizon. If enough of our faithful supporters now rally to the appeal, the Darwin Foundation's finances can at last be given a firmer basis.

It may seem miraculous that, without any reliable and predictable source of income, the Darwin Foundation has been able to achieve so much in the last quarter of a century. But we ought not to be dependent on miracles. Moreover the uncertainties have resulted in the inefficient use of even the inadequate funds available because of the interruptions imposed on conservation projects by unpredictable fluctuations in receipts. The Endowment Fund will not solve all problems but it will provide a stabilizing factor and reduce the waste caused by "stop and go" procedures.

So now is the time for supporters to carry the appeal over the target. Contributions earmarked "for the Campaign for the Galapagos Islands" may be made through any national W.W.F. organization or directly to The Nature Conservancy, International Program, 1785 Massachusetts Avenue N.W., Washington D.C. 20036.

NEWS FROM ACADEMY BAY

CONSERVATION PROBLEMS AND PROGRAMMES

Lack of funds at the Charles Darwin Research Station (CDRS) has compelled a reduction in the number of the staff scientists, whose primary function is conservation. Consequently there has been some redistribution of responsibilities. Marcia Williams, who arrived with her husband in 1985, has taken over the direction of ornithology and entomology as well as herpetology. Mario Hurtado combines the duties of assistant station director with his familiar speciality of marine biology. Jonas Lawesson has recently taken charge of botany, including forestry and the eradication of introduced plants. Luis Calvopiña continues to lead the team devoted to the study and control of the introduced mammals which do so much damage to the native wildlife. This delineation of duties does not interfere with the close co-operation between the various disciplines: for instance, the herpetologists, when repatriating captive-bred Land Iguanas to their natural homes, require the help of the predator controllers on account of the marauding cats, and of the botanists on account of the supply of plant food. Similarly almost all conservation projects are planned, researched and carried out in the closest collaboration with the Galapagos National Park Service (GNPS).

THE GIANT TORTOISES

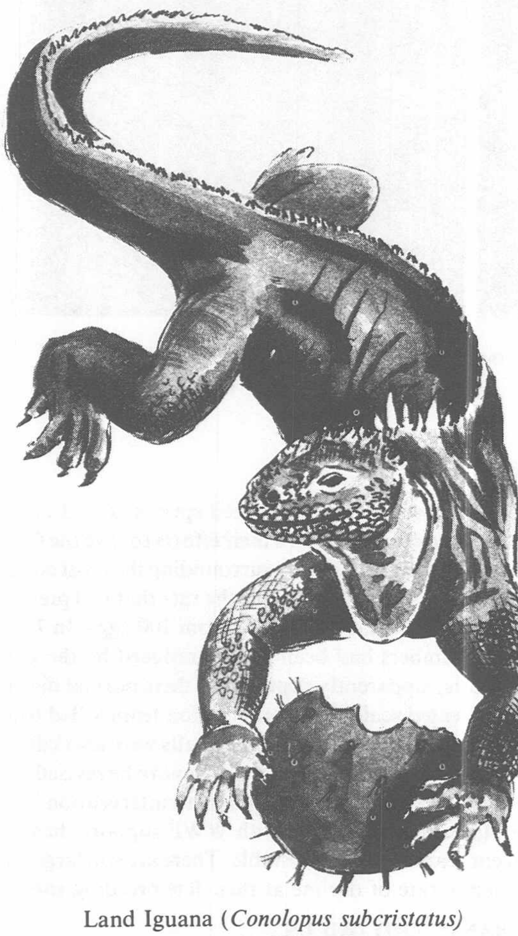
The captive-breeding of tortoises at the CDRS was begun twenty years ago and batches of the young animals have been regularly restored to their respective ancestral islands for the last fifteen years. As these long-lived reptiles mature slowly, none seems so far to have reached reproductive state. (Nobody yet knows when Galapagos tortoises begin to breed nor how long they live). When Marcia Williams recently visited Española (Hood) Island, where the entire population consists of captive-bred juveniles as the few surviving adults were taken to the CDRS in 1965 for breeding purposes, she found that the tortoises were not in very good shape. This was probably due to the effect of the prolonged drought on their food supply, which was temporarily deficient in spite of the fact that the introduced goats, formerly so destructive to the vegetation, had been eliminated some years ago. Two tortoises, aged 6 and 13 years, were dead; these were the first captive-bred losses to be recorded on the island. Another disappointment was the discovery of 4 carapaces of adult tortoises by her assistant, Cruz Márquez, while he was making a census of the tortoise populations on Cerro Azul and Sierra Negra (Isabela). There can be little doubt that they had been killed by poachers, a practice that had largely ceased since the establishment of the CDRS. More encouraging tortoise news is given by Susan Metzger & Ron Marlow elsewhere in this issue, and in spite of the occasional setbacks the tortoise programme remains an outstanding success.

Because of the advantages of operating with the natural climate and food (or by sheer good luck?) the CDRS has always been more successful than the great zoos in hatching and raising giant tortoises. But there have been ups and downs; deaths of hatchlings in their first year have occurred from a number of causes and methods have been tried to counteract them. The latest experiment has been to hatch half the 1985 eggs of the Cerro Azul, Santiago and Española races in open-air incubators while hatching the other half as usual inside the tortoise house. The results are awaited with interest. With Swedish support, a comprehensive survey involving both laboratory and field studies will be launched in 1986-87 to investigate the present status of the tortoise and land iguana populations in the wild and the captive breeding and restocking programmes of the CDRS & GNPS.

THE LAND IGUANAS

Ten years ago the wild dogs came close to extinguishing the important Land Iguana populations on Santa Cruz and at Cartago Bay on Isabela. There are of course other populations on other islands but variation is one of the outstanding characteristics of the Galapagos and it was decided that every effort should be made to save all of them. The few survivors were taken to the CDRS where, after trial and error, methods of breeding these peculiar animals were successfully developed in the Station's pens. However the level of hatchings and first year survivals fell off in 1984 and new solutions were sought. With the help of Howard and Heidi Snell, old friends of the CDRS who have been involved with the rescue operation from early days, a new "air-conditioned" incubation system was devised under which 74 hatchlings were produced from 79 Cartago Bay eggs: a remarkable achievement. This system will be applied experimentally to some of the tortoise eggs in the next breeding season.

The problems of re-introducing the captive-bred iguanas to their former territories are even greater than those of raising them. There is no point in breeding little iguanas at great expense to feed cats, yet there was clear evidence that at least some of the earlier repatriates had been eaten by cats and efforts to counteract this threat had been only partially successful. One theory was that, being raised in captivity, the young iguanas were too tame to defend themselves. As an experiment and for purposes of comparison, 32 of the latest batch of hatchlings were released at Cartago Bay very shortly after birth; the others will be kept at the CDRS and not repatriated until they are bigger.



Land Iguana (*Conolopus subcristatus)*
Drawing by Hilary Bradt

In addition to establishing a breeding centre at the Station, the CDRS and GNPS teams settled a few survivors of the Santa Cruz population on a tiny off-shore islet called Venezia. They laboriously deposited tons of soil there to provide breeding burrows. It was a semi-captive system and it was hoped that it would be safe from the dogs. So it was — but the black rats reached it across the water. Every effort has been made to eliminate these rats but new recruits can be expected. Meanwhile the iguanas have bred and Howard Snell and Cruz Márquez have transferred a dozen of the hatchlings to their natural home near Conway Bay, where attempts will be made to protect them from the marauding cats in the hope of re-establishing the former colony.

Yet another Land Iguana project is being expanded. During the wartime occupation of Baltra (South Seymour) by U.S. forces, the island's entire Land Iguana population disappeared. However, some years before the war, a number of Baltra iguanas had been transferred by a visitor to neighbouring North Seymour, where some of them survive to this day, though they do not breed successfully. CDRS are now doing research to determine the causes of this reproductive failure. Meanwhile a few taken to the Station's pens are breeding successfully and larger corrals are being built to permit breeding on a larger scale.

One week-old petrel in front of nesting burrow
Photo: Felipe Cruz

THE HAWAIIAN PETRELS

The complexity of the problems of protecting endangered species is well illustrated by the fluctuating fortunes of Felipe & Justine Cruz and their helpers in their efforts to save the Galapagos race of the petrel, *Pterodromo phaeophygia,* from extinction. In 1984, by surrounding the most concentrated breeding colony on Flöreana with poisoned baits, they virtually excluded the rats that had previously preyed on the chicks and achieved the remarkable result of fledging 72 chicks from 100 eggs. In 1985, the control of rats was made much easier because their numbers had been greatly reduced by the prolonged drought but this blessing turned into disaster as cats, apparently deprived of their normal diet of rats and mice, invaded the petrel colony on an unprecedented scale. The conservation team killed 64 cats (compared with 5 in 1984) but the number of chicks fledged fell to 23, and some adults were also killed in their nesting burrows. (Rats do not kill adults or *fledged* chicks.) Clearly tactics will have to be revised; but in spite of setbacks due to unpredicatable climatic events and to the fact that all human intervention is bound to produce changes in the balance of nature, the Floreana experiment, with WWF support, has already demonstrated that the extinction of this magnificent seabird is not inevitable. There are still large numbers of these petrels on the high seas, if only the desperate rate of decline at their few breeding sites can be halted.

THE PENGUINS, CORMORANTS AND GULLS

The future of the Galapagos Penguin and the Flightless Cormorant has caused great anxiety in recent years, first because of the invasion of wild dogs along the coast of Isabela and more recently because of the drastic reduction of both populations by starvation during the 1982-83 El Niño, when the rise in temperature of the sea severely affected the food supply of all seabirds. The dog invasion was successfully halted by the CDRS-GNPS eradication campaign and, as Carlos Valle explains in a separate article, the cormorants are almost back to their pre-Niño numbers while the penguins' recovery is now proceeding satisfactorily after a slow start. But these two birds will always remain a cause of special concern for three main reasons: they cannot fly; their habitat is very restricted; there are so few of them. By their recovery from the El Niño devastation, they have demonstrated their capacity to survive the most severe natural disaster but they must be given constant protection against changes induced by man and particularly against the feral animals man has introduced.

The Lava Gull is even rarer than the penguin and the cormorant — it is probably the rarest gull in the world — but it seems perfectly capable of looking after itself. The other endemic Galapagos gull, the beautiful Swallow-tail, virtually disappeared from the islands during the El Niño period, but it is an opportunistic breeder and not dependent on any annual cycle, so its numbers should be quickly restored.

THE FIRE ANTS

Not often noticed by visitors, unless they have the misfortune to be bitten by one, the Fire Ants have a highly disturbing effect on the ecology of all the islands where they have been introduced. Not only do they exterminate the native ants but they affect a range of other insects and gastropods — and who knows what else eventually? In spite of strict regulations on the disinfection of food, clothes and equipment of scientists and wardens, Fire Ants have been discovered a second time on Santa Fe, an island otherwise free from introduced species. The most drastic action will have to be taken to eliminate them before they can spread. The problem of the unintentional introduction of alien organisms into the archipelago and their dispersal from one island to another will remain for all time. There is no easy solution — but constant, expert vigilance can reduce the danger.

THE CONTROL OF INTRODUCED MAMMALS

As with the native species, the distribution of introduced species varies from island to island, so each has its own set of problems. (A few fortunate islands are completely free from alien animals). The Black Rats are probably the most widespread and the most intractible invaders. On tiny islets such as Mosquera, Venezia or Pitt, eradication has been possible but there is no guarantee against renewed infestation. Rats can be held in check in a limited area during a breeding season, as has been done on Floreana, but no permanent solution can be expected until science produces an effective method of control. Consequently, as explained on other pages, the Research Station can incubate and rear Pinzón tortoises until they are big enough to resist the rats, but when they are repatriated to their native island they cannot breed successfully there because the rats will continue to kill every hatchling as they have done throughout living memory. And so the struggle must go on.

Goats have been eliminated on small and medium-sized islands — Plaza, Rábida, Sante Fe, Marchena, Española — and the last few of the 40,000 on Pinta should be removed by 1986. In all these cases erosion has been checked and the vegetation is recovering. Ole Hamann, CDF Vice-President, reports that on Pinta the recovery is spectacular. Santiago, with its 100,000 goats and 20,000 pigs, is a much more serious problem. The mere logistics of eradicating such numbers of animals on a large, rugged and waterless island are alarming, even if a constant flow of funds could be guaranteed. Nevertheless, after much study, a vigorous start was made in 1985, concentrating first on the pigs. This was a good moment as the severe drought, which did so much damage to some native species, had also affected the pigs and goats. One immediate result of the campaign has been to reduce the pressure on the marine turtles whose nests on the beaches were constantly dug up by the pigs. This campaign will last for years.

BOTANY

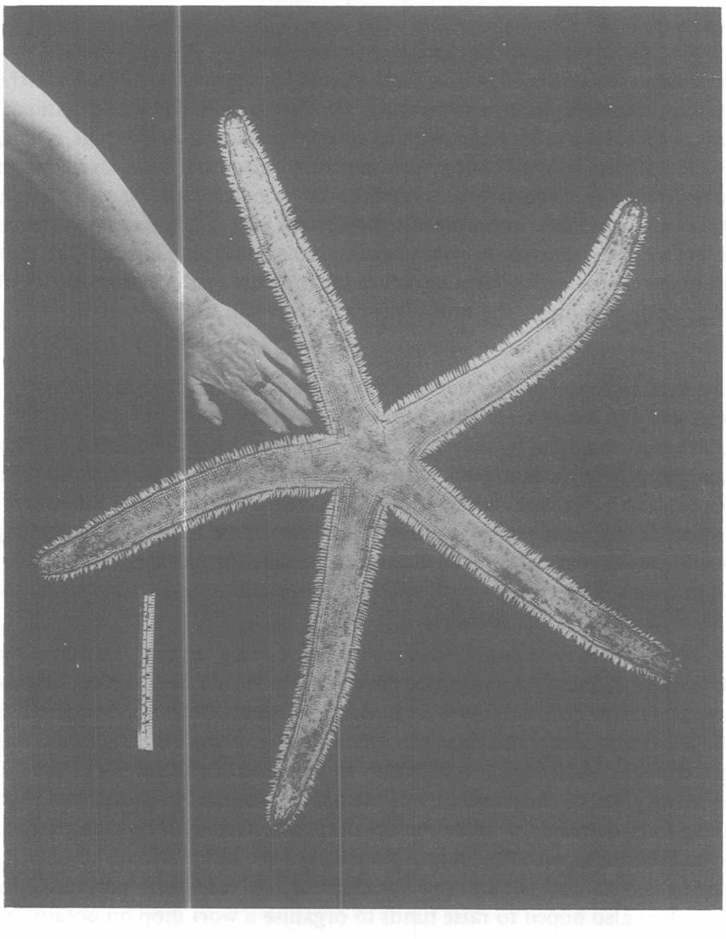
The two constant threats to the indigenous vegetation of the islands are destruction by goats and pigs (discussed above) and the invasion of introduced plants from the farms outside the National Park's boundaries, seeds being brought in by the wind and by straying cattle. On Santiago (James) Island, where the worst goat and pig problem exists, plots have been fenced off to protect particularly endangered plant species until the goats can be brought under control. The narrow peninsula at Buccaneer Bay has likewise been given a goat-proof fence and rare plants have been transferred there. The struggle against the spread of introduced trees goes on year after year. Some can be killed by poison, others have to be dug up by labour-intensive methods. Experiments with different arboricides are giving encouraging results but the campaign will have to continue for decades.

On Santa Cruz Island there is an additional problem requiring urgent solution. Owing to the rapid expansion of the village of Puerto Ayora since the establishment of the Darwin Research Station, large numbers of native trees have been cut down for building purposes. Nurseries have been started to provide native trees to fill the empty spaces but these are at best slow-growing and the project has been hampered by the prolonged drought. Although it is contrary to the general philosophy of the CDRS and GNPS, consideration is being given to the possibility of introducing carefully selected faster-growing trees as a means of satisfying local demand for timber before desperate harm is done to the native woodlands. The CDRS has been collaborating with the Plants Campaign of the International Union for Conservation of Nature in preparing a botanical programme for the next few years with particular emphasis on these forestry problems. It is also hoped to raise funds to organise a workshop on botany, plant ecology and forestry management.

It may be years before the effects of the great fire on Isabela can be fully assessed, but it is hoped that an interim report will be included in Noticias 44.

MARINE BIOLOGY

Hitherto the Darwin Foundation has devoted more of its energies to protecting the terrestrial rather than the marine species. This has been chiefly due to its limited resources and the fact that the land animals and plants were in more urgent need of protection. The marine species, apart from the fur seals and sperm whales, suffered relatively little from 19th and 20th century exploitation, and even these have now recovered wholly or partially. (Noticias 29 & 42). Nevertheless, it is increasingly desirable that *legal* authority should be provided to support the considerable unofficial marine conservation activities of the GNPS and the CDRS — because, in spite of twenty years of appeals, no sea area has yet been formally included in the Galapagos National Park (Noticias 37). Many of the land species are intimately dependent on the ocean's resources for their survival. Moreover, owing to the fact that the archipelago is situated at the conjunction of the great Eastern Pacific currents, the ecology of its waters is unique, and the biologists who have researched there speculate that the underwater resources may prove to be even more important scientifically than the terrestrial. Therefore, when President Léon Febres Cordero, following his visit to the islands, issued on 11 July 1985 his "Plan for Immediate Action in the Province of Galapagos", it was a source of great satisfaction that this included provision for the creation of "a marine reserve to be incorporated in the Galapagos National Park". The GNPS and CDRS are actively collaborating with the national authorities to give practical application to this proposal.



Giant Sea Star, *Luida superba,* discovered by Gerard Wellington while diving at Tagus Cove. This is the largest five-armed sea star ever known and only the second recorded specimen of this species.

GALAPAGOS CAVE FAUNAS

Extending the researches of the Belgians N. & J. Leleup (1965), who discovered a scientifically important blind soil and groundwater fauna (including 15 species of eyeless invertebrates and one fish), Stewart and Jaramila Peck of Carleton University, Ottawa, spent two months exploring 25 lava-tube caves and similar sites in search of cave-evolved insects and arthropods. Their most notable discoveries included 5 species of blind spiders and one species each of blind opiliones, gryllid cricket, cockroach and staphylinid troglophiles. The Pecks suggest that there is still much to learn about insect and terrestrial arthropod communities in the Galapagos, especially the cave and soil insects of the larger and higher islands. As caves are generally considered to be ecologically sensitive habitats, they advise careful study of visitor impact, particularly on caves situated on private property outside the National Park boundaries. There may be little danger at the moment but watch should be kept on potential contamination and over-exploitation.

RARE TWIN BIRTHS OF GIANT TORTOISES

When the Charles Darwin Research Station (CDRS) was inaugurated, it looked as though the endemic giant tortoise of Hood (Española) Island, *Geochelone elephantopus hoodensis*, was doomed to extinction. Only a handful were known to survive, competing with herds of goats for the scant food supply on this arid island, and none seemed to be under 50 years of age. It appeared that they were so few and so scattered that they no longer met for mating. In 1965 the CDRS director, Roger Perry, in despair collected those he could find (one male and two females) and transferred them to a corral at the Research Station. After a period of trial and error, the first captive *G.e. hoodensis* were born in 1970. As other elderly survivors were discovered, the breeding stock was gradually raised to two males and twelve females and finally a third male was presented by the San Diego Zoo, thus increasing the genetic variety of the little herd.

By 1984, 1376 *hoodensis* eggs had been laid and the Station and the National Park Service could be congratulated on achieving a high level of annual hatchings, varying between 20 & 28%. Cruz Márquez, a CDRS staff zoologist, reports that out of all these hundreds of *hoodensis* eggs, none had produced twins until January 1985. These were hatched from the same yolk and had a common umbilical cord. One weighed 52 grams, the other 17, a total weight greater than that of a single hatchling. On the second day the smaller one died but the larger was successfully separated from it by surgical thread and continues to grow normally. Cruz Márquez considers that without this human intervention, both twins would have died. This certainly happened with twins of *G.e. vicina*, born in the wild on the Cerro Azul volcano about the same time. Their malformation was identical but they were dead when he found them while making a census of all the tortoise populations.

The Hood tortoises are being repatriated year by year to their ancestral island where conditions have meanwhile been improved by the erradication of the goats.

VISITS AND EVENTS AT THE CHARLES DARWIN RESEARCH STATION (CDRS)

1984

NOVEMBER

Segundo Coello and Fernando Huerta begin their study of the reproduction of the *bacalao.*

CDRS Director, Günther Reck, goes to Madrid to take part in the General Assembly of the International Union for Conservation of Nature (IUCN).

Armando Vasquez (National Institute of Fisheries) begins his research on zoo-plancton and fish spawn.

Andrew Laurie returns for the sixth year of his study of marine iguana populations.

Henning Adsersen arrives from Denmark as acting staff botanist.

Fritz Trillmich, Gerry Kooyman, Philip Thorson and Carlos Drews conclude yet another season of research on the fur seals.

Matilde Velasco and Maria Calle, Univ. of Guayaquil, come to check material in the library, herbarium and laboratories and give a training course for local teachers.

Mireya Pozo and Maria Cornejo, Univ. of Guayaquil, come to serve as volunteers on the Hawaiian Petrel preservation project.

DECEMBER

Günther Reck and Mario Hurtado (CDRS) leave for Guayaquil to take part in the Charles Darwin Foundation's Executive Council meeting.

Visit of a NOAA group to discuss possible areas of co-operation.

Visit of representatives of the Technical University of Esmeraldas to discuss joint projects for 1985.

Aka and Ulla Norberg arrive from Sweden to study aspects of finch morphology.

Elizabeth Pillaert and Mary Jones come to work on the preservation of Galapagos anatomical specimens.

R. Curry, D. Wiggins, J. Gibbs, S. Fogle and P. de Maynadier continue the Peter Grant group's long-term study of finches and mockingbirds.

Gary Ramirez and Edison Flores, Tech. Univ. of Esmeraldas, complete their botanical projects.

1985

JANUARY

Howard and Heidi Snell return from USA to continue their land iguana investigations.

David Anderson and Sharon Fortner come to study the feeding and reproduction of boobies.

Rick Miller, Gary Lagerloef, Linda Magnum, Darrel Jack and José Rivera from NOAA come to collect data from the four underwater stations that have been measuring sea temperatures and pressures since 1979.

A group from WWF/Sweden brings funds to restore the CDRS administration building and support reptile studies.

The biologist Carlos Garcia and the geologist William Chavez of Guayaquil Univ. arrive, one to study methods of rodent control and one to search for fresh water on Santa Cruz.

Marcia Wilson arrives from USA with her husband to take up her post as terrestrial ecologist on the Charles Darwin Research Station staff.

FEBRUARY

Mitch Aide, Univ. of Texas, comes to study pollination and reproduction of plants but the intense drought makes his project impracticable.

Heinrich and Irene Schatz arrive from Austria to study terrestrial invertebrates.

The President of the Rockefeller Foundation visits CDRS.

The President of the Republic, Ing. Léon Febres Cordero, accompanied by the Ministers of Defense and Industry, visits CDRS.

Members of the Commission for the Revision of the Galapagos Master Plan hold meetings with the CDRS Director, Günther Reck.

Jorge Escobar and Guillermo Prado, Univ. of Esmeraldas, begin their forestry projects.

Guillermo Archibald, head of the Panama Wildlife Reserve, comes to study the management of the Galapagos National Park.

Minister of Public Works and his party visit CDRS.

MARCH

Juan Black (Sec. Gen. of CDF), Enrique Saenz and Pedro Maldonado (National Development Council) come to discuss the CDRS budget and financial situation.

Hal Whitehead, Vassili Papastavrous and Linda Weilgart (Newfoundland Inst. of Cold Water Science) begin study of sperm whales in the Galapagos Grounds.

Fire breaks out on southern Isabela.

Ambassador of Sweden visits CDRS.

Ken Margolis and members of Nature Conservancy discuss fund-raising at CDRS.

APRIL

Günther Reck lectures on Galapagos conservation at Ambato Tech. Univ.

Paul Lewis, State Univ. of Ohio, begins study of *Opuntia.*

Chris Vanbeveren, Antwerp Univ., comes to map vegetation.

Film team from American Broadcasting Corp. visits CDRS.

Günther Reck and Miguel Cifuentes (Superintendent of Galapagos National Park) leave for Quito to attend seminar on conservation problems.

The President of Congress, the Inspector General of the Nation, the Ecuadorean Group of CDF and Juan Black arrive to take part in a further stage of the seminar on Galapagos problems.

José Egred, of Quito Observatory, comes to service the seismograph.

Peter Glynn, Bob Richmond, Gary Robinson, Fernando and Priscila Rivera arrive to study the effects of the 1982-83 El Niño on the East Pacific coral reefs.

MAY

Stewart and Jarmila Peck begin their investigation of the blind arthropods in the Galapagos caves.

Reconstruction of the administration building begins.

Ana Puyol leaves for England to follow a course in environmental education.

JUNE

Training Course for auxiliary tourist guides begins.

CDRS Director invited by Swedish government to visit various European national parks and to engage in fund-raising for CDF.

Tjitte de Vries, Giovanni Onore, Robert Gara and Edmundo Maldonado of Catholic Univ. of Quito begin a survey of fire damage on Isabela.

Beagle IV sails to Guayaquil for overhaul and repairs.

JULY

Maria Calle of Guayaquil Univ. comes to study algae. Rosemary and Peter Grant return to continue their group's long-term research on finches and mockingbirds.

Tjitte de Vries continues his studies of frigate-birds on Tower (Genovesa).

Wallace Harmon and Bill Clark arrive from USA to study the extent of the spread of the avian disease *Trichomas gallinae,* introduced by domestic pigeons.

Juan Black (CDF) and Arturo Ponce (Min. of Agriculture) come to help outline plans for the future conservation of the marine area.

Jonas Lawesson, the new CDRS staff botanist, arrives from Denmark.

AUGUST

Günther Reck and Miguel Cifuentes go to Guayaquil for the meeting of the Executive Council of the CDF.

The 18th session of the Permanent Commission for the South Pacific held at CDRS.

Ole Hamann (IUCN) Vice President of CDF, visits the zone of Isabela ravaged by fire.

Carlos Garcia and Enrique Catelo of Guayaquil Univ. begin their study of introduced rats and mice.

Craig MacFarland, President of CDF, visits CDRS together with a group from WWF/US.

LANTANA CAMARA L., A THREAT TO NATIVE PLANTS AND ANIMALS

by

Felipe and Justine Cruz, Principal Investigators, Petrel Project

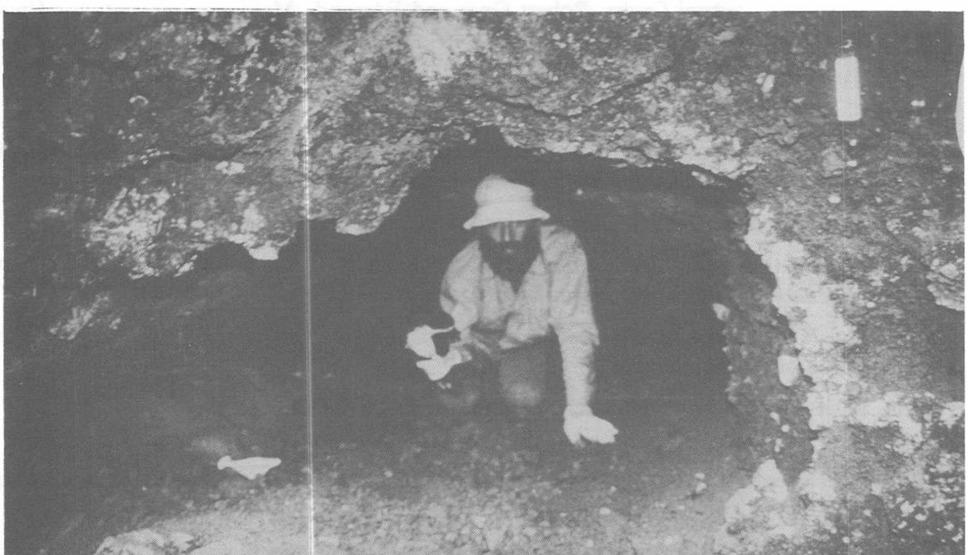
and

Jonas E. Lawesson, Resident Botanist

Charles Darwin Research Station

For a long time, the Hawaiian or Dark-rumped Petrel, *Pterodroma phaeopygia,* in the Galapagos Islands, has been threatened by introduced mammals, documented by several authors (Tomkins, 1980; Duffy, 1984). Many efforts have been made to control these threats from predators but until now very little attention has been directed to threats originating from the vegetational changes represented by introduced plant species. While the control of the animals threatening the petrel on Floreana Island are meeting with some success, the introduced aggressive plant, *Lantana camara* L. (Verbenaceae), is spreading into the breeding area of the petrel, thus becoming a threat to this bird and also to some other plant species.

L. camara L. is a native plant of tropical America but is now used extensively as an ornament in all warmer areas of the world. It grows easily into a 1-2 metre high shrub, and is therefore often used as a hedge. *Lantana* reproduces itself easily by means of fruits, usually eaten by birds, but also vegetatively. Because of its easy reproduction, dispersal, and vigorous growth, *L. camara* represents a severe problem around the world when it escapes into natural areas, as seen in S. Africa, Australia, Hawaii, and the USA. When conditions are optimal, the area invaded by *Lantana* turns into an impenetrable 1-2m high stand. The magnitude of the problem of erradication, once *Lantana* has become established, is illustrated by the following citation: "There is little doubt that, where the country lends itself to it, clearing standing *Lantana* with a bulldozer, followed by discing, is the best starting point". (Bartholomew, 1980).



Felipe Cruz measuring and banding an adult petrel at mouth of nesting cave
Photo: Justine Cruz

The introduced *L. camara* (vernacular name: Supirosa) which is a close relative to the native *L. peduncularis,* is known in Santa Cruz, San Cristóbal, and Floreana. Except for Floreana, the problem of *Lantana* is not grave as yet, but measures to eradicate it from gardens, etc., should be started now, while the elimination of this dangerous species is still possible.

On Floreana, *Lantana* was introduced in 1938 by Ainsley and Francis Conway on their small farm in the central S.E. of the island. Francis wrote that they established a garden with many varieties of fruits and flowers, which included the first recorded *Lantana* plants in Galapagos. While clearing for their garden they would throw cuttings of *Lantana* over their improvised fence and the extra growth helped to keep out the marauding wild cattle and pigs. She adds that the "... balsams and lantanas spread into the jungle trails and the pampas."

Not surprisingly, dense thickets of *Lantana* resulted, and in these areas the population of rats is higher, perhaps because the plants' seeds are a good food source. The native Galapagos finches readily eat and disperse the seeds and during dry spells cattle and donkeys also take the fruit. By 1983 several extensive areas in the highlands close to Cerro Pajas and Cerro Ventana had been covered by stands of *Lantana.* The former vegetation types found in these areas were *Scalèsia peduculata* forest and a dry vegetation represented by *Croton, Macraea,* and *Darwiniothamnus.* In the areas now being invaded by *Lantana* some small populations of rare plant species are found and are therefore in danger of being eliminated. This is true of 2 of the 3 populations of *Lecocarpus pinnatifidus* Decaisne (Compositae) and of a population of *Scalesia villosa* (Compositae). Both species are endemic to Floreana.

The impending spread of this agressive weed to the crater area of Cerro Pajas, where the Dark-rumped Petrel nests, is of grave concern. If the plant is allowed to follow its normal growth pattern the resultant dense thicket will keep the petrels, which nest in burrows, from occupying their historic breeding site. As *Lantana* advances there is little doubt but that the Petrels will be forced out of the largest remaining nesting colony in the Galapagos. Likewise little doubt remains that important vegetation types, including rare endemic species, will also become extinct.

Every effort should be made to raise funds to finance an immediate erradication campaign on Floreana. A positive result would help to save the endangered Dark-rumped Petrel as well as the beautiful *Lecocarpus.*

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A VERY SPECIAL DIVE IN GALAPAGOS WATERS

by

Henk Kasteleyn, Naturalist and Dive Guide

Scuba diving is done all over Galapagos. This is the story of a very special dive on the 28th of October, 1985. Close to the N.E. side of James (Santiago) Island is a small islet known as Cousins. It is a beautiful site for scuba diving, with lots of fish, sharks, black coral and other invertebrates, sometimes turtles and an occasional sea horse.

Towards the end of this particular dive, I saw a school of half-beaks near the surface. After having a closer look at them, I swam over to my buddies Carolina (guide) and Alfonso (passenger). Alfonso had to end the dive because his air supply was running out, so I went over to Carolina to tell her this. She was at that moment observing some large hammerhead sharks (2.5 metres) that came cruising by. Together we started to swim slowly up to the surface. On our way we followed a pair of spotted eagle rays which swam away from the reef. We were at that time at 15 m. depth. Looking up I saw a huge dark "cloud". I was in front and started swimming towards it, thinking it was a big school of small fish, such as we had seen before at Roca Redonda. Quickly I swam up towards the middle of this shape, which was moving to the right. It was big and dark and did not change in form, so I realized it was probably not a school of fish after all. I thought of the *Encantada,* the yacht we were diving from, since in this dive, being the first to jump in, I had looked up to see her dark, sleek hull and the divers following me. But it could not be this 21 meter schooner because the big "cloud" was at some 5 meters depth. Only when I reached the left part of this gigantic form did I see the huge shark tail. It was a whale shark!

Although we did have a good visibility of almost 20 meters, the whole monster was not visible from head to tail. Behind this largest fish in the world swam four or five hammerhead sharks. On their own, hammerheads are not small, but compared to this member of the same family they seemed insignificant. Their length was the same as the upper lobe of the whale shark's tail.

With hardly any movement the whale shark glided through the water. Carolina and I followed with a lot of kicking and finning and were just able to gain a little on it. Slowly we came to its middle and from here we were able to appreciate the whole fish. It was beautiful: a moving wall of fishmeat, approximately 20 meters (65 feet) long, light grey on the underside, dark grey to black above. It had round white spots like tennis balls, and the slightly curved white lateral line stood out gracefully against the dark background. The dorsal fin was small, only one meter high.

As we reached its head, the animal veered slightly to the right and downward, so we came above it. The eye was relatively small but the head tremendously broad, almost as wide as I am long. Very close above and below the head, almost touching it, were a few amberjacks. Naturally very curious, these fish often circle divers. These are large fish, between 1 and 1.5 meters in length, but by the side of this giant they looked rather like small pilotfish cruising with an ordinary shark.

Whale sharks feed on plankton, as do the baleen whales, which are not fish but mammals. The gullet is very small but the mouth can be opened extremely wide. Along the interior front part of the gill arches they have a kind of sieving device with which they can filter the water. Unlike the real whales, a whale shark can leave its mouth agape because the gill slits permit a constant flow of water. The very mobile lower jaw and gill arches make it possible for the mouth to open wider than the full width of the body (transverse section). In this immense space a diver, even with air tanks, could fit without any difficulty.

This gentle giant was not feeding and it slowly headed for deeper waters. Looking down we saw over the bottom a magnificent formation of seven spotted eagle rays sailing by. In the meantime we had used up our air fairly quickly, excited as we were and swimming too fast. Alfonso had had to give up early, and I could not follow the shark deeper than 15 meters. At this point Carolina, who had stayed at 10 meters, saw me alongside this giant. She later described me as a small puppet next to a strange large fish.

It was at least the second time a whale shark had been seen by divers in the waters around Galapagos. A miraculous meeting, it does not fit any framework I have known; there is simply no comparison for such a gigantic animal.

WHATEVER HAPPENED TO THE FLOREANA MOCKINGBIRD?

by
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When Charles Darwin visited the Galapagos Islands in 1835 during the voyage of the *Beagle*, the Floreana (Charles Island) Mockingbird was still common. Less than sixty years later, scientists were unable to find a single mockingbird on Floreana; the species had become extinct on its principal range. Fortunately, the species, *Nesomimus trifasciatus*, survives today on two small islets, Champion and Gardner-by-Floreana, near the coast of Floreana. The mystery of the disappearance of the species from Floreana itself, however, has never been resolved. Whatever happened to the Floreana mockingbird?

It is certain that *N. trifasciatus* once inhabited Floreana, though a few investigators have expressed doubt that mockingbirds ever actually lived there. Swarth (1931) noted that Darwin's two specimens of *N. trifasciatus* did not necessarily come from Floreana; members of the *Beagle* crew could have collected these birds when they visited Gardner-by-Floreana. Thornton (1971) further speculated that the species may never have inhabited Floreana. He noted that cats and dogs, which he supposed were the exterminators of the species on Floreana, are also present on other islands where mockingbirds have survived, implying that it isn't likely that these introduced animals would have exterminated one species of mockingbird but not others.

N. trifasciatus, though, was common on Floreana when Porter visited the island in 1813 while patrolling the archipelago in the U.S. Frigate *Essex*, (Porter, 1815). It seems certain that even if Darwin did not collect mockingbirds on Floreana, he did *see* mockingbirds there in 1835. In the *Zoology of the Voyage of the Beagle*, Darwin (1841) listed Charles Island (Floreana) as the habitat of the species and noted that mockingbirds "were attracted by the houses and cleared ground of the colonists". At the time of Darwin's visit, Floreana was the only colonized island in the archipelago, so his comments must have applied to *N. trifasciatus* on that island. Recent discovery of mockingbird fossils by Steadman (in press) has since proved that mockingbirds were once abundant on Floreana.

The exact date of the extinction of *N. trifasciatus* on Floreana remains uncertain. The last specimen from the island was collected by Kinberg, the surgeon of the *Eugenie* which stopped at Floreana in 1852 (Sundevall, 1871). Habel was the last scientist to see resident mockingbirds on Floreana; he described the song and habits of *N. trifasciatus* there during his expedition in 1868 (Salvin, 1876). Scientists of the *Albatross* expeditions searched Floreana in 1888 and 1891, but found no *N. trifasciatus;* the species had become extinct sometime between 1868 and 1888. Habel implied that mockingbirds were common on Floreana in 1868, so the process of extinction must have required some time after this date. I suspect that the last mockingbirds disappeared from Floreana about 1880.

The species, though, did not disappear completely; *N. trifasciatus* can still be found today on the little islands of Champion and Gardner-by-Floreana. There was a brief period before the turn of the century when it was thought that the entire species had vanished. This ended when members of the Harris expedition were pleasantly surprised to discover living *N. trifasciatus* on Gardner-by-Floreana in 1897. Subsequent exploration by the Academy expedition in 1905 revealed the species' presence on Champion as well. The same expedition, though, almost eliminated that population; Gifford (1919) thought that after collecting eleven specimens on Champion, "two more days of hunting would have made the species extinct there".

I have been studying Galapagos mockingbirds throughout the archipelago since 1981, in collaboration with P.R. Grant. We have monitored the Champion population since 1980, and in 1984 I made comparative observations among the four species of mockingbird that suggest an explanation for the extinction of *N. trifasciatus* from Floreana. Before I present my hypothesis, though, I will discuss the alternative explanations that have been proposed.

Several theories for the extinction of the Floreana mockingbirds have been suggested. Swarth (1931), Thornton (1971) and Harris (1973) thought that dogs or cats must have been involved. Rothschild and Hartert (1899) believed that "human influence" in the form of hunting explained the extinction. These hypothesis fail to explain why humans or introduced predators have not caused the extinction of other mockingbird species on Isabela, Santa Cruz, and San Cristóbal, which have been inhabited nearly as long as Floreana has been.

Steadman (unpubl. Ph.D. thesis) proposed a more detailed model for the extinction of mockingbirds on Floreana. He suggested that the disappearance of *Opuntia* led to the extinction of *N. trifasciatus* on Floreana. *Opuntia* has become very rare on Floreana, probably because of destruction by goats, though rats and mice can also kill cactus trees by burrowing through the trunks. He suggests that *N. trifasciatus* is more dependent on *Opuntia* cactus than are the other three mockingbird species in the Galapagos; this idea is based on Steadman's observations that mockingbirds on Champion seem to feed and nest exclusively in the cactus trees that are still common there. The extinction of *N. trifasciatus* on Floreana, then, may have been caused by the loss of *Opuntia* plants that were essential to the nesting and feeding of the resident mockingbirds.

I believe this is an inadequate explanation for the extinction of *N. trifasciatus* on Floreana for two reasons. First, *N. trifasciatus* is not as dependent on *Opuntia* as Steadman has implied. On Champion I have found successful nests of this mockingbird species situated in trees other than *Opuntia*, including *Parkinsonia*, *Cordia*, and *Croton*. On Gardner-by-Floreana, *Opuntia* is less common, and the trees smaller, than on Champion, and here I found more nests in *Croton* and *Cordia*. On both islets mockingbirds spend considerable time foraging on the ground and in vegetation other than *Opuntia*. It may be true that *Opuntia* is used extensively by *N. trifasciatus* when it is available, but my observations suggest that this mockingbird species could survive without it. Secondly, *Opuntia* has also become rare on San Cristóbal and on Española, but *N. melanotis* and *N. macdonaldi*, the resident mockingbirds on these two islands respectively, are still common. The feeding and breeding ecology of *N. trifasciatus* is not different enough from these two species for the rarity of *Opuntia* to account for the disappearance of the Floreana population.

I suggest that the distribution of rats in the archipelago provides the key to the extinction of the Floreana mockingbird. My studies on San Cristóbal in 1984 indicated that introduced black rats (*Rattus rattus*) can have a large detrimental impact on mockingbird nesting success. Clutches in at least 31% of the nests I studied at Cerro Brujo on San Cristóbal were destroyed by rats, and on one occasion I found a rat 10 meters up in a tree containing a mockingbird nest. These observations support the assertion of Venables (1940) that "the most probable cause of the high nest destruction (on San Cristóbal) ... is the introduced black rat." I suspect that the impact of cat predation, in contrast, is small. I found feathers in only 8.1% of the 136 cat scat I examined on San Cristóbal; most of these were probably the remains of the more common finches rather than of mockingbirds killed by cats. None of the 36 adult mockingbirds I banded at Cerro Brujo disappeared during the six weeks I worked there, though cats were common in the study area. Dogs are less numerous than cats on the islands, and they are even less likely to be potent predators of mockingbirds.

Why would rats account for the extinction of *N. trifasciatus* on Floreana if they have not led to the disappearance of other mockingbird populations? Other mockingbird species now survive in the presence of black rats on Isabela, Santa Cruz, Santiago and San Cristóbal. It is important to note that all of these islands supported *native* rat populations prior to the introduction of black rats (Eckhardt, 1972; Steadman and Ray, 1982). As suggested by Clark (1981), the impact of introduced black rats on endemic organisms, including mockingbirds, is likely to have been more severe on those islands that did not originally support native rats. Floreana, where mockingbirds *did* disappear, was never inhabited by native rats. I believe that the extinction of the Floreana mockingbird was caused by the introduction of black rats to an island that did not previously support a native rat population. I hypothesize that the mockingbirds there, having never had the chance to adapt slowly to the presence of native rats, succumbed quickly after black rats were introduced to the island. Introduced nest predators seem to have quickly decimated native bird populations on other islands in the Pacific area where predators were previously absent (e.g. Jehl and Parkes, 1982). Introduction of black rats to Floreana, and the beginning of the mockingbirds' disappearance, probably occurred at the time of human settlement of the island in 1832, if not before.

The only mockingbird to have gone extinct on an island where black rats replaced native rats was the population of *N. parvulus* on Baltra, which vanished during or after the Second World War. However this was probably caused by persecution and, more importantly, habitat destruction by humans during the occupation of the island by soldiers during the war (Thornton, 1971). On every other island where black rats replaced native rats, the mockingbirds have survived. The only major island where mockingbirds are absent, other than Floreana, is Pinzón. In agreement with my hypothesis, there is no evidence that this island ever had a native rat population (Eckhardt, 1972). Black rats are now abundant on Pinzón, where they have killed virtually every hatchling tortoise for half a century so that population recruitment is now dependent on captive breeding at the Darwin Station.

I suspect that mockingbirds once lived on Pinzón in the absence of native rats, but that they also became extinct following the introduction of black rats; extinction could easily have taken place before the first scientific visits to this island were made in the late 1800s (Darwin and the *Beagle* did not stop at Pinzón). No fossils of mockingbirds have yet been found on Pinzón, but I predict that they will be discovered eventually.

This hypothesis, if correct, has two unfortunate implications for other mockingbird populations in the Galapagos. First, it implies that reintroduction of *N. trifasciatus* to Floreana from either Champion or Gardner-by-Floreana would have little chance of success unless black rats were controlled or eradicated on the larger island. Removal of black rats from Floreana would be very difficult, if not impossible. Secondly, if my ideas are valid, mockingbirds, along with other endemic animals, would have little chance of survival if black rats are ever introduced to islands that have never supported native rat populations. Such islands include all the northern islands (Darwin, Wolf, Pinta, Marchena, and Genovesa) inhabited by *N. parvulus* as well as Española and Gardner-by-Española, where *N. macdonaldi* is endemic — and also both Champion and Gardner-by-Floreana where the remaining *N. trifasciatus* live. I am confident that the continued dedicated conservation efforts of the Galapagos National Park Service and the Charles Darwin Research Station will ensure that rats are never introduced to these islands, and that the mockingbirds and other endemic animals will survive. That constant vigilance is necessary was demonstrated by the threat of rats landing on Pinta when a cargo ship was recently stranded there (Noticias 42).

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STATUS OF THE GALAPAGOS PENGUIN AND FLIGHTLESS CORMORANT POPULATIONS IN 1985

by

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The Galapagos Penguin (*Spheniscus mendiculus*) and the Flightless Cormorant (*Nannopterum harrisi*) are among the rarest seabirds of the world. Both species are endemic to the Galapagos Islands where their distribution is almost entirely confined to less than 400 kilometers of coast line around the islands of Fernandina and Isabela.

During the three years since the El Niño — Southern Oscillation (ENSO) of 1982-1983, I conducted four penguin and cormorant censuses using the same method as in previous years (see Boersma 1977, Harcourt 1980). The results of all these counts were compared for the purpose of showing the population trends throughout the last fifteen years. This article summarizes these findings and interpretations.

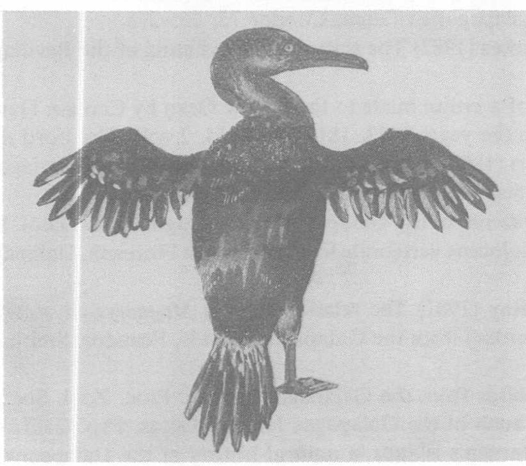
PRESENT POPULATION SIZE

Estimations of the population size of the Galapagos Penguin and the Flightless Cormorant previous to 1970 were vague and anecdotal. The first realistic figures were those of the 1970 surveys when Boersma estimated 6,000 — 12,000 penguins and Harris 1,400 — 1,600 cormorants. In September-October of 1985 I counted 665 penguins and 843 cormorants around Fernandina and Isabela and estimated a total population of 1,500 — 3,000 penguins and 900 — 1,200 cormorants.

TRENDS OF THE POPULATIONS

On the basis of their extremely marked sedentary habit (especially in the case of the cormorant) and their restriction to the zone of the coldest water associated with the upwelling of the Cromwell Current, we can surmise that the Galapagos Penguin and Flightless Cormorant populations were never large. From 1970 to 1980 both populations appeared relatively stable (Harcourt 1980). However in August-September of 1983 the numbers of penguins and cormorants were respectively 80 and 50 percent below that of 1980 (Valle 1984). This dramatic population decrease was associated with the abnormal climatic conditions and warm ocean water that occurred during the 1982-83 El Niño — Southern Oscillation (ENSO). After the ENSO the population of cormorants rapidly regained its original level but the number of penguins only started to recover one year later.

The delayed start to the recovery of the penguins and the different patterns of the population increase between the penguins and cormorants are not easy to explain. Both penguins and cormorants are opportunistic breeders (Harris 1969, Boersma 1977, 1978) with a high potential rate of population growth as breeding can be attempted twice each year (Boersma 1977, Tindle & Harris 1982, Tindle 1984). After



Flightless Cormorant, *Nannopterum harrisi*
Drawing by Hilary Bradt

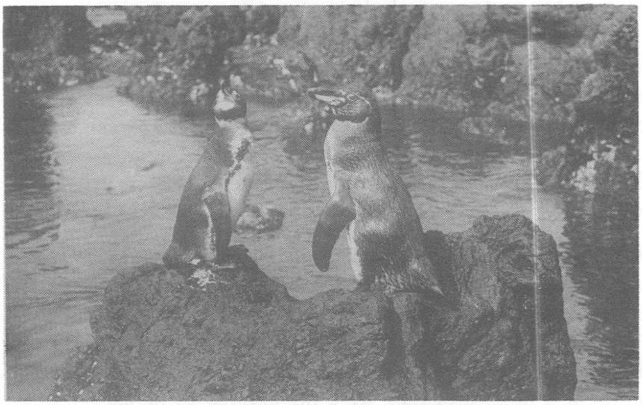
July 1983 the marine conditions appeared optimal for the reproduction of seabirds, including the Flightless Cormorants (Valle 1984b) which feed in the same area as the Galapagos Penguin. Therefore the low reproduction of the penguins during 1984 probably was not associated with a lack of food or other factors in the marine environment.

Circumstantial evidence suggests that the factors causing this low reproduction were intrinsic problems of the population, such as the length of time necessary for the formation of new breeding pairs. Certainly after such a large decrease in the population there is a high probability of the death of one member of most pairs and thus it is likely that a large proportion of surviving penguins were left unmated in 1984. The strong pair bond of the Galapagos Penguin (Boersma 1977), combined with the low numbers and the scattered distribution after the ENSO, could well have diminished the chances of finding a suitable mate, thus delaying pair formation and reproduction.

The latest census shows that in 1985 the number of penguins increased by some 50 percent compared with 1984. This suggests that whatever the problems were that delayed recovery, these have now been overcome. As for the cormorants, there has been no further significant change in population size and they appear to have regained their previous levels in a mere 15 months after the ENSO and to be stable again.

THE FUTURE OF THE PENGUINS AND CORMORANTS

Apart from the Hawaiian Petrel (*Pterodroma h. phaeopygia*), which is threatened with extinction, the penguins and cormorants are the most vulnerable of the Galapagos seabirds. Both species have demonstrated their capacity to resist natural disasters by the way they have survived and recovered from the recent ENSO catastrophe. Any threats to their continued existence come from human intervention. As yet they have been little affected by oil spills, though a few minor instances have been recorded. (Valle unpub.). Fishermen and, potentially, tourists pose a more obvious long term danger. But the immediate threat comes from the alien animals (dogs, cats and rats) introduced by man, against which they have little defence, having evolved in a habitat free from terrestrial predators. The cormorants and penguins are particularly vulnerable because they cannot fly; because they are confined within an exceptionally limited area; and because they have such a small total population. Introduced predators are abundant on Isabela where more than half these two species are found. In 1981 there were an estimated 400 — 500 dogs on the coast of Southern Isabela and penguins formed the second most imporant item of their diet (Barnett & Rudd 1983). Those dogs were killed during the eradication campaign mounted by the National Park Service and the Darwin Research Station in 1981-82 (Calvopiña 1982). This was a most successful operation. However the chance of permanently eliminating all dogs from Isabela is low because there are still some on the volcanoes Cerro Azul and Sierra Negra and there are always new recruits from the farms outside the national park boundaries. The risk of future invasions of dogs into the penguins' and cormorants' nesting areas is high because they can migrate along the coast. Thus the survival of these ecologically fragile populations requires a constant conservation effort to detect and control the threats. Therefore the Charles Darwin Research Station intends to conduct an annual census, the basic object of which is to maintain a close watch on the state of the populations.



Galapagos Penguins, Fernandina
Photograph: Roger Perry

THE STATUS OF THE PINZON ISLAND GIANT TORTOISE

by

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INTRODUCTION

More than any other animal, the giant tortoise (*Geochelone elephantopus*) symbolizes the Galapagos Islands, from the inspiration for the name to the focus of current conservation efforts. Once numbering in the hundreds of thousands, they have been depleted to the point where only 3 of 11 surviving taxa can be considered naturally self-replacing (MacFarland *et al*, 1974a). In 1959 the giant tortoise was afforded protection by the establishment of the Galapagos National Park and, in recent years, the status of all but one of the populations has improved as a result of the aggressive conservation program carried out by the Galapagos National Park Service (GNPS) in collaboration with the Charles Darwin Research Station (CDRS).

The Pinzón (Duncan Island) population has been the subject of considerable attention and it is instructive to briefly review its history before discussing the current status in order better to judge how far we have come and what remains to do.

HISTORY

Pinzón is a low (457m), dry and relatively small island (18.05km^2; Wiggins and Porter 1971). Centrally located in the archipelago between Isabela, San Salvador and Santa Cruz, it offered little as a source of fresh water, wood and good anchorage, essentials for the whaling ships that began frequenting these islands in increasing numbers from the end of the 18th century (Townsend, 1925). The depredation of tortoise populations for fresh meat supplies by these sailing ships was initially incidental to finding a safe anchorage at which to affect repairs and to replenish water and wood stores. Floreana and San Cristóbal were the first to suffer major exploitation. Pinta and Española, the northern and southern-most tortoise islands, also suffered exploitation as the first landfall of ships coming north after rounding Cape Horn or those returning from the northern Pacific whaling waters but neither has a reliable source of fresh water. By 1850 the Floreana population was probably extinct and that on San Cristóbal eliminated from the inhabited end of the island. As it became difficult to get a full load of tortoises on these islands the mariners increased the pressure on the populations of the lower and drier islands. In less than 60 years the Pinzón population was reduced to rarity.

The Pinzón tortoises (*G.e. ephippium*) are relatively small (adults curved carapace length (CCL) = 60.97cm; Santa Cruz adults CCL = 75-150cm) and light (adult maximum weight 76kg; Santa Cruz adult max. wt. 290kg); this was a disadvantage as the whalers preferred tortoises that could be carried by one man. The island is small and it is possible to walk from the landing to any part of the island and return in a few hours. The vegetation is Arid Zone (Wiggins and Porter, 1971), more open, offering less concealment than on the moister islands. These facts encouraged the collection of large numbers of tortoises and it was only the collapse of the whaling industry in the latter part of the 19th century that prevented the extinction of the Pinzón population.

In 1970 the Pinzón population was thought to consist of 150-200 adults (MacFarland and Reeder, 1975). Black rats (*Rattus rattus*) were introduced to Pinzón before 1891 (the date they were first recorded; Patton *et al*, 1975), preying heavily on hatchling tortoises to the extent that it was thought that virtually no recruitment had occurred this century (MacFarland *et al*, 1974a). The CDRS began collecting eggs from natural nests on Pinzón in 1965/66 and transferring them to the Darwin Station on Santa Cruz for hatching and rearing of the young until they were big enough to be safe from predation by rats. In December 1971 the first group of captive-raised tortoises was repatriated and each year since then another group has been released on Pinzón.

CURRENT STATUS

Our observations on Pinzón were made from 3-23 July 1982. Searches were concentrated in those areas where station-raised tortoises were released (MacFarland and MacFarland, 1972; MacFarland *et al*, 1974b). Tortoises were identified using the National Park Service numbering system (Thornton, 1971), weighed, measured and the location recorded. Information on the previous captures made by the wardens was obtained from National Park records. Sex determination was made using the extent of concavity of the plastron, length of tail and position of the vent on the tail. If there was any doubt on the sex of smaller tortoises they were listed as immature.

Of the 85 tortoises encountered, 62 were captive-bred repatriates. They ranged from 22.0 — 86.0cm curved carapace length (CCL). Females ranged from 56.5 — 80.5cm CCL and males 76.5 — 86.0cm CCL. Native-born tortoises ranged in size from 34.0 — 97.0cm CCL with females from 59.6 — 66.0cm CCL and males 74.5 — 97.0cm CCL.

The sex ratio of identifiably mature repatriates was 0.63:1.00 males to females. For native tortoises on Pinzón the sex ratio was 2:1.

The first group of repatriates, the 1965/66 year class, was composed of 29 tortoises of which 19 were observed in 1982. At the time of release they ranged in size from 25.0 — 37.0cm CCL ($\bar{X}$ = 17.4) and in 1982 from 64.5 — 77.5cm CCL. This group was reared at the Station in outdoor pens for 4.1 yrs. before release. In contrast the 1970/71 year class, composed of 11 tortoises of which 9 were seen in 1982, was raised in the temperature-controlled tortoise house under more constant conditions and released at 3.2 yrs. and a $\bar{X}$ = 26.6cm. The 1970/71 class grew faster, reaching a larger size more quickly ($\bar{X}$ = 22.6± 3.4cm CCL, 2.10 yrs.) than did the 1965/66 class ($\bar{X}$ = 17.4± 1.6cm CCL, 2.8 yrs.). However, after release the 1965/66 class grew more rapidly achieving greater size sooner ($\bar{X}$ = 51.9± 3.0cm CCL, 7.1 yrs.; $\bar{X}$ = 68.3± 3.4, 11.4 yrs.) than the 1970/71 class ($\bar{X}$ = 55.4± 4.5cm, 11.6 yrs.). The 1970/71 class experienced a period of at least 10 months immediately following release during which no growth occurred. In contrast the 1965/66 class had ininterrupted growth. The 1965/66 class was released in December 1970; the 1970/71 class in March 1975. Meteorological data for these periods shed no light on the discrepancy in growth.

No reproductive behaviour was observed among the repatriated animals with the exception of an adult native male attempting to mount a medium-sized immature repatriated tortoise of undetermined sex. Secondary sexual characteristics were identifiable on tortoises 16 year old (1965/66 class); sex could not be determined on most of the younger tortoises. The age of first reproduction for the Pinzón race of tortoise is not known but females of the captive-bred 1965/66 class are larger ($\bar{X}$ = 72.5cm) than the native females $\bar{X}$ = 62.2cm) which are supposedly in excess of 80 years old and still reproductively active (MacFarland *et al*, 1974x).

Recently it was discovered that sex determination in many species of sea turtles is temperature-dependent (for review see Bull, 1980); for example, eggs incubated at low temperatures in the normal range develop predominantly one sex while high temperatures produce the other; intermediate temperatures produce intermediate sex ratios. It has been suggested that some incubation procedures for sea turtle eggs may be producing an abnormal percentage of one sex (Morreale *et al*, 1982). Galapagos tortoises have not been shown to exhibit temperature-dependent sex determination but it is likely that they do. The eggs of all endangered populations are incubated at the station (MacFarland *et al*, 1974b) and concern has been expressed by some scientists that skewed sex ratios may be produced or even monosexual broods (Reynolds, pers. comm.). MacFarland *et al* (1974a) reported 36% males for mature Pinzón tortoises and ranging from 20% to 70% in the populations of other islands. We found 39% males for sexable repatriated tortoises. It is not clear what a normal sex ratio for this population would be as the ratio for mature animals certainly reflects the impact of historical and recent disturbance (e.g. 19th century sailors tried to collect tortoises that one man could carry, usually females; Snow, 1964). What is important at this stage is that current incubation methods at the Darwin Station are producing both sexes in nearly equal proportions.

It is of considerable interest that 3 tortoises were observed with number codes notched in the shell that indicate they are native tortoises and of a size that would place them at 5-10 years. Misnumbering is a possible explanation and cannot be discounted, but MacFarland *et al* (1974a) also reported finding a one-year old tortoise in the nesting area. So it seems clear that natural reproduction and recruitment has occurred on Pinzón in the last 10 years, admittedly at a trivial level; nonetheless it represents a potential. It is calculated that from 1964-1974 7,000-19,000 hatchlings were produced on Pinzón and subsequently destroyed by rats (MacFarland *et al*, 1974a), a massive potential for recovery of population levels if only the rats can be controlled.

SUMMARY

The success of the captive-raising program in getting rat-proof tortoises back onto Pinzón is unqualified. These tortoises behave similarly to juvenile tortoises on San Cristóbal and Santa Cruz and have demonstrated good growth records, approaching full adult size. They are assuming the saddleback carapace shape characteristic of their population. Secondary sex characteristics have appeared indicating that the incubation process is not producing individuals of only one sex. The final parameter of reproductively active repatriated tortoises has not yet been observed.

THE FUTURE

A promising development is the discovery of a non-toxic chemical compound 300X more bitter than quinine. Tests are presently being conducted to determine its suitability for use in protecting nests and hatchlings from rat molestation. Continued monitoring of the repatriated tortoises for reproductive behaviour and success is needed. Aggressive inquiry into the use of non-toxic chemical repellents to protest nests and hatchlings from rats should be pursued.

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OBSERVATIONS ON INSECT VISITORS TO FLOWERING PLANTS OF ISLA SANTA CRUZ.
PART II. BUTTERFLIES, MOTHS, ANTS, HOVER FLIES AND STILT BUGS

by

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In Part I of this paper the author mentioned the depauperate condition of the Galapagos insect fauna which is emphasized by the presence of only one species of bee, *Xylocopa darwini*, the endemic carpenter bee (McMullen, 1985). This relative dearth of insects is also apparent in the groups discussed here. Within the archipelago only ten species of butterfly, 144 species of moth, seven species of hover fly, twenty-two species of ant, and one species of stilt bug have been reported (Linsley and Usinger, 1966; Rindge, 1973; Hayes, 1975; Linsley, 1977; Froeschner, 1985).

Even fewer reports have been made as to what flowering plants are visited by these insects. Williams (1911) mentioned observing the Galapagos sulfur butterfly, *Phoebis sennae* (recorded as *Callidryas eubele*) (Pieridae), at flowers of *Cordia lutea* (Boraginaceae), *Opuntia* (Cactaceae), and *Gossypium* (Malvaceae) on Isla Isabela. He also reported that the hawk moth *Enyo lugubris delanoi* (recorded as *Epistor lugubris delanoi*) (Sphingidae) visited *Cordia lutea* at Villamil, Isabela in the bright sunlight, and *Manduca rustica calapagensis* (recorded as *Protoparce rustica calapagensis*) (Sphingidae) visited flowers of *Cordia lutea* and *Clerodendrum molle* (Verbenaceae) at Tagus Cove, Isabela at dusk. Beebe (1923) reported that *Phoebis sennae* made visits to *Cordia* and *Gossypium* on Isla San Cristóbal. He also mentioned that the moth *Atteva hysginiella* (Yponomeutidae) visited *Cassia* (Fabaceae), *Cordia*, and *Gossypium*. Wheeler (1924) reported that the ant *Monomorium floricola* (Formicidae) visited the nectaries of *Cordia lutea* and *Opuntia helleri* on Isla Genovesa.

Hayes (1975) mentioned that the carmine hawk moth, *Agrius cingulatus* (Sphingidae) visited flowers of *Cacabus miersii* (Solanaceae), *Ipomoea* (Convolvulaceae), and *Opuntia* during the day. Also mentioned were *Utetheisa galapagensis* (Arctiidae) which was observed flying around plants of *Scalesia affinis* (Asteraceae) at dusk, *Heliothis cystiphora* (Noctuidae) which visited flowers of *Encelia hispida* (Asteraceae) during the day on Isla Santa Fe, *Paectes arcigera* (Noctuidae) seen near *Cryptocarpus pyriformis* (Nyctaginaceae), and *Pseudoplusia includens* (Noctuidae) which visited flowers of *Clerodendrum molle* and *Cordia*.

The only mention of insect visitors to flowering plants specifically on Isla Santa Cruz, other than *Xylocopa darwini*, is that of Rick (1966). He reported observing flies (Diptera) visiting flowers of *Borreria* (Rubiaceae).

The observations reported here took place on the southern slope of Santa Cruz during the months of October 1983 through March 1984. Observations of insect visitors to flowering plants were conducted in each of the seven major vegetation zone. Tables 1-4 list the flowers and visitors observed during this time, along with locations, level of activity and whether the plants are endemic or non-endemic.

All of the 22 plants listed represent new insect visitation reports to flowers on Santa Cruz. Only three of the 22 have been reported before for the archipelago as a whole. Among the insect visitors *Leptotes parrhasioides, Disclisioprocta stellata, Wasmannia auropunctata, Tapinoma melanocephalum, Paratrechina longicornis, Paratrechina vaga, Toxomerus crockeri, Metacanthus galapagensis,* and the unidentified pyralid moth are newly reported as insect visitors to flowers of the archipelago.

Pollen was actually observed only on the butterfly *Leptotes parrhasioides*. Because of this it would be inappropriate to label all of these insects pollinators. However, the author does echo Linsley (1966) in suggesting that butterflies, moths, flies and ants might have possible roles in pollination because they play this part in continental areas. *Toxomerus crockeri* was very active in several flowers, as were many of the butterflies and moths. Many ant species were also very active in several flowers. This is not highly unusual because of the ant's heavy use of sugar and pollen for food, and although ant morphology is not well adapted for pollen transport, the possibility does exist that with such a high level of traffic throughout an inflorescence a pollination event might occur. The same possibility applies to the stilt bug, *Metacanthus galapagensis*, during its feeding visits to flowers.

The majority of insects was observed during daylight hours. However, the moths were much more active towards dusk with the pyralid and *Agrius cingulatus* active at night.

There appears to be no strong correlation between flower color and insect visitor other than the expected visits made by hawk moths to larger white flowers such as those of *Carica papaya* (Caricaceae) and *Clerodendrum molle* var. *molle*. In general, the insects visited the few different colored flowers that were available. The one obvious trend, that also shared by *Xylocopa darwini*, was toward non-endemic plants. *Justicia galapagana* (Acanthaceae), *Cordia leucophlyctis* (Boraginaceae), *Jaegeria gracilis* (Astraceae), and *Gossypium barbadense* var. *darwinii* were the only endemics observed to be visited by insects other than the carpenter bee. Therefore, these results would seem to further substantiate Linsley et al. (1966) in their observation that insect visitors may have proved more useful in the establishment of the non-endemic (weedy plants and adventives) flora than for the older endemic species.

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Table 1. Summary of flower records for butterflies on Isla Santa Cruz from October 1983—March 1984.

Plant Visited	Insect Visitor	Location	Activity
Justicia galapagana (E) (Acanthaceae)	*Leptotes parrhasioides* (Lycaenidae)	Transition Zone, 3.5 km n. Puerto Ayora	moderate
Tournefortia psilostachya (N) (Boraginaceae)	*Leptotes parrhasioides* (Lycaenidae)	Transition Zone, 3.5 km n. Puerto Ayora	moderate
Mormordica charantia (CE) (Cucurbitaceae)	*Leptotes parrhasioides* (Lycaenidae)	Transition Zone, 3.5 km n. Puerto Ayora	low
Vigna luteola (N) (Fabaceae)	*Leptotes parrhasioides* (Lycaenidae)	Pampa Zone, 3 km n. Media Luna	low
Cuphea racemosa (I) (Lythraceae)	*Leptotes parrhasioides* (*Lycaenidae*)	Pampa Zone, 3 km n. Media Luna	high
Gossypium barbadense (E) var. *darwinii* (Malvaceae)	*Phoebis sennae* (Pieridae)	Arid Zone, Darwin Station	low

Sida rhombifolia (I) (Malvaceae)	*Leptotes parrhasioides* (Lycaenidae)	Transition Zone, 3.5 km n. Puerto Ayora	high
Commicarpus tuberosus (N) (Nyctaginaceae)	*Leptotes parrhasioides* (Lycaenidae)	Arid Zone, Darwin Station	low
Plumbago scandens (N) (Plumbaginaceae)	*Phoebis sennae* (Pieridae)	Transition Zone, 3.5 km n. Puerto Ayora	low
	Leptotes parrhasioides (Lycaenidae)	Transition Zone, 3.5 km n. Puerto Ayora	low
Tribulus cistoides (I) (Zygophyllaceae)	*Leptotes parrhasioides* (Lycaenidae)	Arid Zone, Darwin Station	low

Table 2. Summary of flower records for moths on Isla Santa Cruz from October 1983—March 1984.

Plant Visited	Insect Visitor	Location	Activity
Cordia leucophlyctis (E) (Boraginaceae)	*Disclisioprocta stellata* (Geometridae)	Arid Zone, Darwin Station	high
Tournefortia psilostachya (N) (Boraginaceae)	Unidentified genus (Pyralidae)	Arid Zone, Darwin Station	low
Carica papaya (CE) (Caricaceae)	*Agrius cingulatus* (Sphingidae)	Arid Zone, Darwin Station	high
Clerodendrum molle (N) var. *molle* (Verbenaceae)	Unidentified genus (Sphingidae)	Arid Zone, Darwin Station	moderate

Table 3. Summary of flower records for ants on Isla Santa Cruz from October 1983—March 1984.

Plants Visited	Insect Visitor	Location	Activity
Justicia galapagana (E) (Acanthaceae)	*Wasmannia auropunctata* (Formicidae)	Transition Zone, 3.5 km n. Puerto Ayora	low
Avicennia germinans (N) (Avicenniaceae)	*Paratrechina longicornis* (Formicidae)	Littoral Zone, Tortuga Bay	high
	Tapinoma melanocephalum (Formicidae)	Littoral Zone, Tortuga Bay	high
Cordia lutea (N) (Boraginaceae)	*Wasmannia auropunctata* (Formicidae)	Arid Zone, Darwin Station	moderate
	Paratrechina vaga (Formicidae)	Arid Zone, Darwin Station	low
Mormordica charantia (CE) (Cucurbitaceae)	*Wasmannia auropunctata* (Formicidae)	Transition Zone, 3.5 km n. Puerto Ayora	moderate
Prosopis juliflora (N) (Fabaceae)	*Tapinoma melanocephalum* (Formicidae)	Littoral Zone, Tortuga Bay	low
Setaria geniculata (N) (Poaceae)	*Wasmannia auropunctata* (Formicidae)	Arid Zone, Darwin Station	high
Capsicum frutescens (CE) (Solanaceae)	*Wasmannia auropunctata* (Formicidae)	Transition Zone, 3.5 km n. Puerto Ayora	high
Clerodendrum molle (N) var. *molle* (Verbenaceae)	Unidentified genus (Formicidae)	Arid Zone, Darwin Station	low

Table 4. Summary of flower records for hover flies and stilt bugs on Isla Santa Cruz from October 1983—March 1984

Plant Visited	Insect Visitor	Location	Activity
Ageratum conozoides (I) (Asteraceae)	*Toxomerus crockeri* (Syrphidae)	Pampa Zone, 3 km n. Media Luna	high
Jaegeria gracilis (E) (Asteraceae)	*Toxomerus crockeri* (Syrphidae)	Pampa Zone, 3 km n. Media Luna	high
Cuphea racemosa (I) (Lythraceae)	*Toxomerus crockeri* *(Syrphidae)*	Pampa Zone, 3 km n. Media Luna	high
Polygonum opelousanum (Polygonaceae)	*Toxomerus crockeri* (Syrphidae)	Pampa Zone, 3 km n. Media Luna	low
Diodia radula (I) (Rubiaceae)	*Toxomerus crockeri* (Syrphidae)	Pampa Zone, 3 km n. Media Luna	low
Cordia lutea (N) (Boraginaceae)	*Metacanthus galapagensis* (Berytidae)	Arid Zone, Darwin Station	high

(E) endemic (N) native (I) introduced weed (CE) cultivated escape

GALAPAGOS: A NATURAL HISTORY GUIDE

by M.H. Jackson

Published 1985, Univ. of Calgary Press, XIII + 283 including 100 black & white illustrations and 16 pages full color.
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Despite the recent flood of Galapagos books, this latest one covers a somewhat different field from the rest and so meets a different need. It is neither a slim pocket guide such as M.P. Harris's *Field Guide to the Birds of the Galapagos* nor yet an authoritative compilation of scientific information written by experts on their specialist subjects, such as *GALAPAGOS* in the Pergamon Press's *Key Environments* series. Mr Jackson's guide book falls somewhere between the two and he very properly draws freely on these and other sources. It is a substantial soft-backed volume dealing with the historical background, the environmental setting, conservation problems and information for visitors, as well as eight substantial chapters on the various divisions of wildlife (plants, reptiles, seabirds, etc.). There is also a 15-page bibliography to help those who wish to give further study to particular aspects and a useful checklist of plants and animals.

The author's history is a little less accurate than his natural history but this is not a matter of great moment: scientists often fail to check historical information with the care they would consider obligatory in their own disciplines. Mr Jackson is a sound biologist and knows the islands intimately, having taken part in the Cambridge University Darwin Centenary Galapagos Expedition as well as serving for years as a naturalist guide. He writes simple, straightforward English with a minimum of scientific jargon even in his chapter on Colonisation, Evolution and Ecology. When he is driven to use technical expressions, he explains them.

Altogether this is a useful addition to Galapagos literature. How I wish there had been a comparable book when I first visited the Galapagos a generation ago.

G.T. Corley Smith

ANOTHER DARWIN CENTENARY

On 22 December 1985, one of Charles Darwin's grandchildren, Lady Barlow, reached the age of 100. She has always taken a very keen interest in her grandfather's papers and has published a number of books on his work. Under the name of Nora Barlow she edited *Charles Darwin's Diary of the Voyage of H.M.S. Beagle, Cambridge Univ. Press (1933), Charles Darwin and the Voyage of the Beagle (1945)* and *Darwin's Ornithological Notes (Bull. Brit. Mus. (Nat. Hist.) 1963).* She also wrote *Darwin & Henslow: the Growth of an Idea (1967).* Her publications are frequently cited in current scientific papers, though the change of her name on marriage must frequently obscure her Darwin descent. Her son, Captain Sir Thomas Barlow, was Secretary General of the Darwin Foundation from 1967 to 1972.

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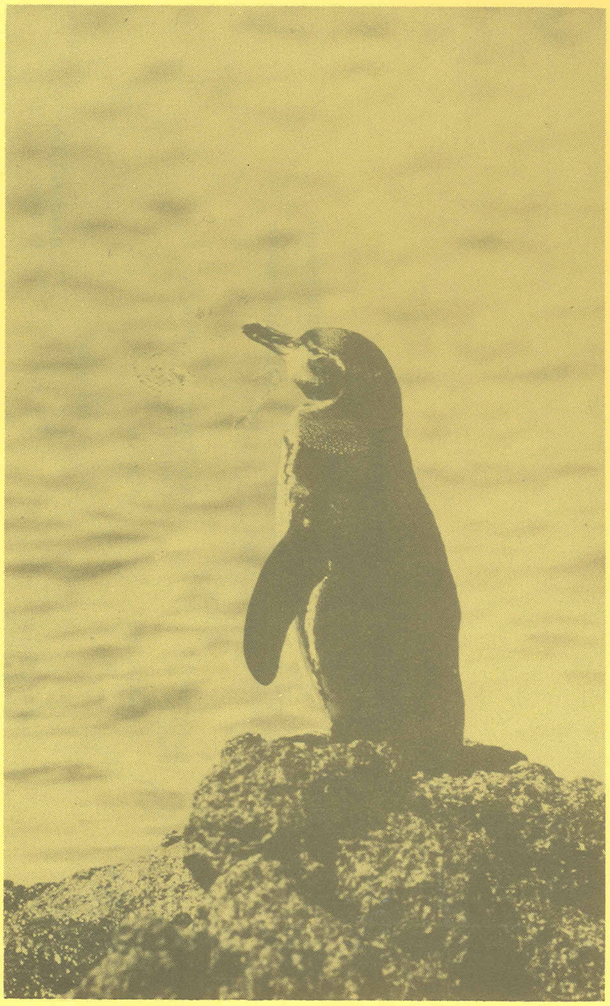

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