NOTICIAS DE GALAPAGOS

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CONTENTS

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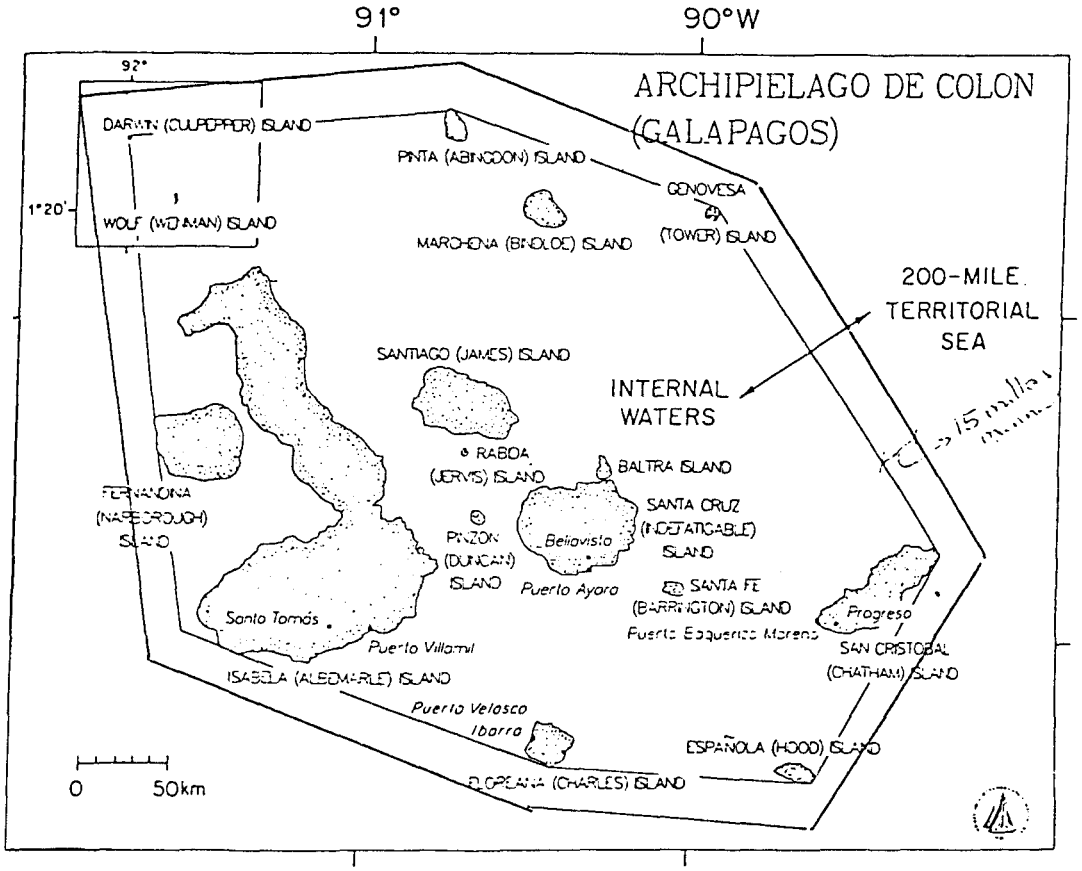
NEWS FROM ACADEMY BAY

PROCLAMATION OF A GREAT GALAPAGOS MARINE RESERVE

A most important development in conservation took place on 29 April 1986 when His Excellency, President León Febres-Cordero promulgated a Decree establishing a Marine Resources Reserve for the Galapagos Islands. The area involved is vast and includes the entire internal waters of the archipelago, together with a surrounding zone 15 nautical miles wide, in all some 80,000 square kilometres (30,000 square miles), as illustrated in this sketch map.



The Charles Darwin Foundation has been urging the creation of a protected marine area for many years (see Noticias 25, 27, 37, 42, 43) but progress has been slow owing to the difficulty of reconciling the various local and national interests involved, which fall under the jurisdiction of the different ministries responsible for the law of the sea, defense, fisheries, tourism and development. The new reserve will be administered by a Commission representing the seven ministries and institutions concerned and will be presided over by the Minister of Agriculture, who is already responsible for the Galapagos National Park. The Commission is authorized "to seek the assistance and collaboration of the Charles Darwin Research Station and such national and international organizations as it considers necessary". The CDRS will naturally give all the help within its means and has already installed a modest marine laboratory, as well as maintaining a research vessel.

The extension of protection from the land to the sea was becoming increasingly necessary. Since the Darwin Station was inaugurated, a flourishing tourist industry has grown up and the resident population has notably increased. The Galapagos waters are still generally in a nearly pristine state but the increasing danger of pollution from the discharge of waste from cruise ships and human settlements is obvious. Occasional small oil slicks have been noted. Two ships have been stranded on rocks in recent years. Tourists and residents make growing demands on the stocks of fish, lobsters and coral. Foreign fishing vessels have been a problem at various times. It is good that such dangers should be countered before they become too serious and that the conservation activities of the Galapagos National Park Service and the Charles Darwin Research Station should be given legal support.

The Galapagos waters are of outstanding national and international importance. Situated at the confluence of the great Eastern Pacific currents, they are of unique scientific importance and the marine resources may prove even more significant than the terrestrial resources, which have hitherto been studied much more thoroughly. Moreover, much of the terrestrial wildlife, particularly nesting seabirds and marine iguanas, is dependent on the sea for its survival. CDF supporters will appreciate that this splendid initiative will make increasing demands on the resources of the Research Station and the National Park Service.

In his capacity as President of WWF International, H.R.H. Prince Philip, Duke of Edinburgh, who is also Honorary Life Member of the Charles Darwin Foundation, sent his congratulations to President Febres-Cordero and his Government on the example they had given of what governments worldwide should be doing to preserve species and habitats for their own and mankind's long-term benefit.

Yom Ex Calloway,

On behalf of WWF I wish to congratulate your Government on the decision to declare the Waters of the Galapagos Archipelago a protected area. Your decision is a fine example of what governments worldwide should be doing to preserve species and habitats for their own and for mankind's long-term benefit.

We are furthermore very pleased that the declaration of this most important reserve is made in celebration of WWF's Twenty-Fifth Anniversary. WWF has always considered it a priority to support your Government in its effort to protect and manage the unique wildlife of the Galapagos Islands. We look forward to continued fruitful co-operation in the future.

Yours sincerely

Philip

Mr Leon Febres Cordero

President Leon Febres-Cordero at the Smithsonian Institution, where he accepted the post of Honorary Chairman of the campaign to raise a 1,650,000 U.S. dollar endowment fund for the Charles Darwin Foundation. He announced a contribution of $150,000 on behalf of the Government of Ecuador. In the picture he is flanked by Robin and Rick Werner who received medals for their work in support of the appeal.

By the summer of 1986 $1,200,000 had been subscribed and with continued effort the target may yet be reached. Further contributions may be made either through any national WWF organization or directly to The Nature Conservancy, International Program, 1785 Massachusetts Avenue N.W., Washington D.C. 20036, U.S.A.

RECOVERY OF THE MARINE IGUANA POPULATION AFTER THE EL NINO CATASTROPHE

Andrew Laurie has been studying the population dynamics of the marine iguanas since the 1981-82 breeding season (Noticias 35-40). This fortunate timing has enabled him to compile statistics both for the two "normal" seasons before the phenomenal El Niño event, which caused such massive mortality, and for the two seasons following that catastrophe. If the iguanas' reproductive rate had remained at the slow pre-Nino level, it would have taken decades to restore the populations to their 1981 size. In fact there were dramatic changes in breeding performance. On Santa Fe island, before the Niño event, only 40% of the females nested each season; this proportion fell virtually to zero in the bad season of 1983-84, then rose remarkably to 88% and 85% in the next two years. Not only did the proportion of females breeding double but the number of eggs in a mean clutch rose from 2 to 3. Yet another factor was that young females grew much faster and their average age at first breeding was reduced from 4.5 to 2.5 years. This re-assuring development was primarily due to the recovery of the algae which form the staple element in the marine iguanas' diet and which had largely disappeared when the sea temperature rose during the abnormal El Niño year. Another stimulus to body growth and breeding was the reduced competition for the available food supply following the reduction in population numbers. There were even days when the iguanas were so replete that they did not feed at all.

Andrew Laurie will join the Galapagos voyage of the R/V Robert Gordon Sproul in 1987 in order to collect further information on predation, food supply, feeding behaviour, nesting and mating on various islands, which he needs to complete his study. This should supply the CDRS and GNPS with the scientific information on which to base their long term conservation policy.

THE ESPANOLA TORTOISES — A VERY SPECIAL CASE

The Española (Hood Island) tortoises were the most endangered of the races still surviving when the Darwin Foundation was organized. Only a dozen were left and they had not reproduced for decades. They were all taken to the Darwin Station where eventually, after much trial and error, they bred successfully. The first juveniles were released on their ancestral island in 1975, when they were 5 years old. By 1986, 184 young Española tortoises had been repatriated and only 7 dead had been found. A further 66 were being reared at the CDRS. This situation encouraged the Galapagos National Park Service (GNPS) to try a further experiment and this year they repatriated a group aged one year as well as another group aged 4 years. Both groups will be carefully monitored and compared to see how they progress. If juveniles can be successfully released at the age of one year, the pressure on the rearing establishment would be reduced. Unfortunately, however successful this experiment proves, it cannot be automatically repeated on other islands which are infested with destructive introduced species. Española is happily free from predators such as rats, pigs and dogs, which kill the young tortoises, and the GNPS has eliminated the goats that were destroying the vegetation on which they depend.

The Española tortoises (*Geochelone elephantopus hoodensis*) are exceptional in that they are one of only two distinct wild populations in the world (the Arabian Oryx is the other) entirely consisting of animals raised in captivity. Père David's deer is another captive-bred species which may be returned to the wild.

By May 1986, a total of 893 captive-bred Galapagos tortoises of various races had been repatriated to their islands of origin and a further 358 youngsters were being raised at the Darwin Station.

Young giant tortoises in the Rearing Center at the CDRS.
Photo by Andy Wilson.

A BOTANICAL WORKSHOP AT THE DARWIN STATION

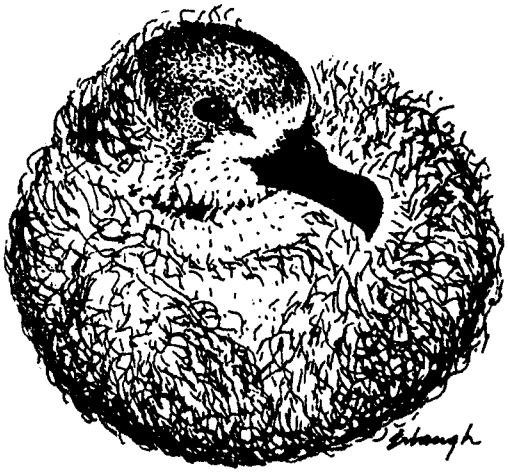
Since Charles Darwin's visit a large number of botanists have studied different aspects of the Galapagos flora but there has been too little co-operation between them and their results, particularly unpublished raw material, are often not available to the Research Station. It is therefore proposed to organize a "Workshop" at Academy Bay sometime during the spring (March—June) of 1987 to co-ordinate botanical information and devise conservation measures.

This is desirable from the purely scientific point of view, but, as Jonas Lawesson points out in a separate article in this issue, it is also urgently necessary to develop a general strategy and raise funds to combat the increasing threats to the native vegetation. The aims of the Workshop are to:

1. Compile the existing data on Galapagos flora and its dynamics. The studies undertaken by means of transects and permanent quadrats will be of special interest.
2. Assess the present status of the Galapagos flora, followed by a classification by priority of certain areas, vegetation types or taxa in need of urgent preservation measures.
3. Assess the change and threats to the Galapagos vegetation presented by human impact (introduced organisms, habitat destruction).
4. Develop and design an appropriate management program for the next 10-15 years against introduced plants and other threats to the Galapagos vegetation.
6. Discuss plans for the use of exotic tree species in Galapagos. Is it possible to grow such species without the risk of their spreading into National Park areas?
6. Discuss and design research projects for the next 10—15 years in the fields of botany, forestry and conservation.
7. Discuss the status of the Galapagos Islands as a biosphere reserve. Is an ecologically stable co-existence between the human inhabitants and the natural areas realistic? What is the present human impact on the natural environment and what will it be in the future?

THE CAMPAIGN TO SAVE THE HAWAIIAN PETREL

Felipe and Justine Cruz have been happy to report that 1986 was another good year in the fluctuating fortunes of their WWF-supported struggle to save the Galapagos race of the Hawaiian Petrel from extinction. (The Hawaiian race is believed to be in even greater danger). There were no extreme weather conditions this season and the petrels were able to raise fledglings from 75% of their (single) eggs in the largest remaining breeding colony on Floreana Island. This remarkable figure was achieved by excluding rats and cats almost completely from the nesting area. It must however be remembered that the figure applies only to one colony and that this project, which is expensive, gives no protection to the dwindling petrel populations on other islands.



Three month old petrel chick
Drawing by Cathy Erbaugh

VISITORS TO THE GALAPAGOS NATIONAL PARK

During the year 1985 the number of visitors to the National Park was 17,850. This total has not varied very much in recent years but it is interesting to note that this time more than a third of the tourists were Ecuadoreans, 6,279 compared with 11,571 foreigners. In the first half of 1986 there was an increase in the number of visitors sufficiently large to cause some anxiety.

RE-OPENING OF THE CRISTÓBAL BONIFAZ BUILDING

Thanks to the generous support of WWF/Sweden and the Olle Nakquist Fund, the CDRS administration building, largely destroyed by fire, has now been restored. It was re-inaugurated on 28 February in the presence of the Swedish Ambassador, the Under-Secretary for Foreign Affairs, the Secretary General of the Darwin Foundation, the local civil and military authorities and the widow and children of the late Don Cristóbal Bonifaz, former Vice-President of the Darwin Foundation.

JOINT OPERATIONAL PLANNING

A joint meeting of the Charles Darwin Research Station (CDRS) and the Galapagos National Park Service (GNPS) was held for a week in September 1985 to agree overall plans for conservation; Craig MacFarland, President of the Charles Darwin Foundation, was in the chair. Owing to the complexity of the scientific, technical, financial and administrative details it was necessary to hold a further meeting in January 1986 but finally a comprehensive programme was worked out closely co-ordinating the activities of the two organizations.

MEETING OF THE PERMANENT COMMISSION FOR THE SOUTH PACIFIC

The Permanent Commission for the South Pacific chose the Darwin Research Station as the site of its 18th Ordinary Assembly, held from 17—24 August 1985. The various South American delegations discussed conservation problems within their 200 mile zones and the adjacent waters. They voted 33 resolutions including one congratulating the CDRS on its achievements in scientific investigation and the preservation of the Galapagos ecosystems.

GALAPAGOS CONSERVATIONISTS RECEIVE WWF AWARD

Following the 48th meeting of the CDF Council at Gland in March 1986, in recognition of their services to the Galapagos, H.H. Prince Sadruddin Aga Khan, Vice-President of the World Wildlife Fund International, conferred the WWF's Award for Conservation Merit on three Ecuadoreans: Miguel Cifuentes, Superintendent of the Galapagos National Park; Juan Black, Secretary General of the Charles Darwin Foundation; and Eugénia del Pino, member of the CDF Council and biology teacher at the Catholic University of Quito.

THE GIANT TORTOISES AND THE GREAT FIRE ON ISABELA

by

Cruz Marquez

Charles Darwin Research Station

The forest fire on southern Isabela Island in 1985 began when farmers were burning off the brush. Owing to the prolonged drought the vegetation was like tinder and the wind quickly carried the flames beyond the farms and into the National Park. The worst consequences were prevented by the combined efforts of local volunteers, the Ecuadorian armed and civil defence forces, water-carrying planes from Canada, the U.S. Forestry Service and the Charles Darwin Research Station. After heroic exertions in almost unbearable heat the fires were gradually brought under control but it was only after 75 days that nature, in the form of heavy rain, finally ended the conflagration which had by then covered some 20,000 hectares (50,000 acres).

There are two distinct races of tortoises on southern Isabela, each confined to its own volcano, *Geochelone elephantopus guntheri* on Sierra Negra and *G.e. vicina* on Cerro Azul. The populations of both have been sadly diminished by man, dogs and pigs and, until the Darwin Foundation was organized, their survival was in serious doubt. To compensate for inadequate breeding in the wild, their numbers are now supplemented by captive breeding at the Darwin Station. The fire was centred between the two volcanoes so neither subspecies was safe.

As the huge fire reached closer and closer to the areas where the tortoises were located, the National Park Service decided to evacuate a selection of both races, including males, females, sub-adults and juveniles, to places of refuge on the coast where the terrain was almost devoid of combustible vegetation, but within reach of supplies of water and food. A corral was built for each race with walls of lava 1 meter high. At San Pedro Cove, where the Cerro Azul tortoises were to be held, an old corral was found and improved. We can only speculate about who built it long ago to house tortoises before loading them on to their ships — naval vessels? whalers? settlers? Twelve tortoises were brought there while sixteen from Sierra Negra were taken to an improvised corral further up the coast.

Transporting these heavy animals to the coast under the equatorial sun was a major problem. There was no suitable equipment to meet such an emergency. They were carried on the shoulders of two or four Park Wardens (depending on their weight) suspended by ropes, ventral side up, from freshly cut tree trunks. Unfortunately two sub-adult tortoises died from the heat during the slow trek. In the event, owing to the combined exertions of all the various gallant fire-fighters, the flames never reached the tortoise areas; but the evacuation of a number of each sub-species to a safe place provided a nucleus to guarantee their survival if the worst happened. Once the fires had been extinguished the tortoises were returned to their usual habitat.

The other reptiles of southern Isabela seem to have escaped with relatively little damage. The snakes (*Alsophis*), lava lizards (*Tropidurus*) and geckos (*Phyllodactylus*) are more commonly found on the lower slopes of the volcanoes while the fires raged most fiercely at the higher elevations and even inside the caldera of Sierra Negra. The great Land Iguanas (*Conolophus subcristatus*) were never in real danger as the present habitat of the tiny population, which is all that remains of the once numerous colonies, was separated from the fire by the huge lava flow formed by the 1925 eruption. The threat to the iguanas comes from the dogs, pigs and cats introduced by man. But for the dedicated intervention of the herpetologist, Dr Dagmar Werner, and the captive breeding and repatriation programs of the Darwin Station and the National Park Service, there would probably be no Land Iguanas at all in southern Isabela. Even with the success of the captive breeding project, the outlook is still full of difficulty and uncertainty.

But let us at least be thankful that the reptiles suffered as little as they did from the devastating fires. As for the rest of the flora and fauna, only time will show the extent of the damage. The fires aroused an unprecedented amount of world-wide concern for Galapagos wildlife. If only this undoubted sympathy could be paralleled by a comparable volume of financial support!

THE TEN YEAR STRUGGLE TO SAVE THE ENDANGERED LAND IGUANAS

by

Cruz Marquez, Howard and Heidi Snell, Solanda Rea, Marcia Wilson and Fausto Cepeda

The land iguana captive-rearing program at the Charles Darwin Research Station (CDRS) is celebrating its tenth anniversary. There have been many notable successes over these years, but many challenges still face us. Personal sacrifices as well as co-operative efforts between the CDRS and the Galapagos National Park Service (GNPS) have made the program what it is today.

The conservation program began in 1976, under emergency conditions. Feral dogs were attacking an estimated 500 iguanas at Conway Bay on Santa Cruz Island. Dr Dagmar Werner, a visiting scientist, and the National Park Service organized the rescue of the remaining 60 animals and initiated the captive and semi-captive rearing programs.

After news of a similar disaster in the Cartago Bay area on Isabela Island, 30 more iguanas were added to those in the already cramped quarters at the CDRS.

On North Seymour, a different problem presented itself. There were no introduced predators, but still the young iguanas were not surviving. In 1980 the Station decided to bring a pair of adults to the station and try to raise the young there.

The impetus for the captive breeding program and the reasons for continuing it are evident in the history of the islands and the problems they face today. Various isolated populations of iguanas may have diverged sufficiently during the evolutionary history of the Galapagos to form distinct subspecies, if not separate species. Thus the station is attempting to save distinct life forms from extinction.

But this is not enough. The ultimate goal of any captive rearing program is to be able to re-introduce an animal into its native habitat. To achieve this a three-pronged approach is needed: breeding in captivity; predator control; and repatriation.

Marcos Carrera assists Cruz and Cirilo as they prepare to weigh an iguana from Isabela
Photo by Andy Wilson

In June of 1978, the first young land iguanas were successfully hatched in captivity. Beginning initially with the simple intention to incubate eggs, an experimental process began forming over a period of several years. As a result, hatching success increased significantly. However, in 1983 and 1984, hatching dropped to dangerously low levels, probably due to an incubator which allowed fungus to accumulate on the eggs. In 1985 Howard Snell designed a new electric incubator which maintained a constant temperature yet did not promote fungus growth. At the same time a new concept called "water potential", which is the amount of water available in the soil substrate, took on considerable importance. By using a new substrate known as *vermiculite,* and controlling the water potential, hatching success shot up to the highest level ever.

Hatchling iguana emerging from its shell.
Parents taken from North Seymour in October 1985. Hatched March 1986 in incubator at CDRS.
Photo by Andy Wilson

Once a land iguana has emerged from the shell, however, its struggles really begin. Dr Snell and his wife, Heidi, conducted considerable research on the iguanas of South Plaza Island and found that, in the wild, only about 10% of the hatchlings survive their first year (Snell 1984). In contrast, the survival of the captive-reared juveniles was 4—6 times greater than that of juveniles monitored in the wild.

The CDRS has also enjoyed success with its semi-captive breeding program on the tiny offshore islet called Venezia. When the Conway Bay iguanas were under attack by wild dogs, 38 survivors were relocated on Venezia while the other 22 were brought to the Station. Because of a lack of soil on the islet, over 90 tons of earth were transferred from the iguanas' former home to Venezia. This soil provided a nesting area 10 meters by 10 meters by 1 meter deep. By 1982, several young iguanas were counted and the 1985 census indicates that about 200 land iguanas now inhabit this tiny patch of soil and rock.

However, it is not enough to rear iguanas. The animals must be returned to their original habitat. Here the second and third prongs of the iguana program assume critical importance: feral animal control and repatriation.

With the success of the Galapagos National Park Service's dog erradication campaign on southern Isabela in 1981-82, young iguanas were introduced into their native habitat once again (Reynolds 1982). However, subsequent checks were unable to locate any of the first group of repatriates (Celleri 1982). Some remains were found in cat faeces, while some iguanas probably dispersed from the release site.

Because of severe overcrowding in the CDRS pens and the continued absence of dogs in the Cartago Bay area, a further 149 iguanas were released in December 1983 and 32 more in May 1985. All told, 220 iguanas have been released in the area. A recent census indicated the population in the area is at least 100 animals, of which 80% are repatriated animals who began their life in the CDRS incubator.

At Conway Bay the feral dog and cat problem has so far proved insoluble. Consequently, to date, none of the captive-reared Santa Cruz iguanas have been released. Since the Venezia islet is separated from Santa Cruz by only 6 meters of water, there is a constant threat of dogs crossing the narrow channel. Should that happen, we would lose the population we have worked so desperately to save.

The islands of Baltra and North Seymour present an entirely different problem. When a U.S. airbase was constructed on Baltra during World War II, the iguanas were all killed. However, by an unlikely streak of luck, a few years earlier a small population had been transferred to the nearby island of North Seymour. There the Baltra iguana held its own but after several censuses it became apparent that the hatchlings were not surviving (Snell and Snell 1979). In 1980, a pair of these iguanas were brought to the station to insure their survival. Unfortunately, the female was killed by her mate. In October of 1985, the CDRS and GNPS again went to North Seymour, this time bringing back 6 females and 2 males, and the CDRS is already incubating several clutches of eggs from these animals. However, there is a dilemma about what to do with the offspring. The animals' ancestral island, Baltra, is now an airbase and is not included in the National Park. Cats and dogs roam the area freely. On the other hand, North Seymour is safe from introduced predators but has a poor hatchling survival rate.

The CDRS and GNPS thus continue to struggle with man and nature to forge a future for the threatened iguanas. It is not enough to have the most successful iguana rearing program in the world. Nor can we merely study the iguana until it disappears from history. Working together, not only in the Galapagos, but all over the world as well, we can bring together the resources to conserve our threatened wildlife. Additional research is required and also the funds to implement recommendations arising from that research. Controlling the feral predators is critical. The Galapagos land iguana is a lifeform unique in the world. We must not let it become extinct.

ACKNOWLEDGEMENT

We wish to acknowledge the dedicated work of Cirilo Barera in the iguana rearing program.

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PROBLEMS OF PLANT PROTECTION IN THE GALAPAGOS

by

Jonas E. Lawesson

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Given the limited resources of money and manpower, the main emphasis of conservation during the first quarter of a century in the history of the Galapagos National Park was on the protection of the unique animal species. Tortoises, iguanas, fur seals and some birds seemed in the most immediate danger. The marine ecosystems appeared to be suffering relatively little damage although the long term need for protection was recognized, hence the repeated appeals since the 1960s for the inclusion of a marine zone in the National Park. The flora was given an intermediate priority. It received some protection but not nearly enough, because the native Galapagos vegetation is threatened in various ways: by introduced domestic animals that have run wild and multiplied; by direct human interference; and by the spread of aggressive, introduced plants.

The Galapagos archipelago has a high proportion of endemism for plants just as it has for animals. Of the 500 species of native flora, about one third are found nowhere else. Owing to the harsh island conditions and factors such as small populations and poor dispersal capacity, some species are always exposed to risk but today the dangers arise chiefly from changes brought about by man during the last 150 years.

Introduced animals (goats, pigs, donkeys, cattle) do enormous damage to most forms of vegetation and, if unchecked, this leads to erosion. The four islands with human residents (Floreana, San Cristóbal, Isabela and Santa Cruz) have been severely affected and some of the changes are irreversible. Goats were also introduced into some uninhabited islands as a source of food but twenty years of arduous hunting by the Galapagos National Park Service (GNPS) with support from the Charles Darwin Research Station (CDRS) have eliminated them from six of these islands and in each case there has been a most gratifying recovery of the vegetation. There remains the intractable problem of Santiago which, although it no longer has any human residents, is infested by tens of thousands of goats and pigs. Ambitious plans for their eradication are under way but the task will take years to complete. Meanwhile small plots have been fenced in to protect those plant species under immediate menace.

A more localised problem is the rising demand of the human population for timber. Although nine tenths of the land area of the archipelago has been set aside as a National Park, where there are no residents, it has always been accepted that the settlers should, under permission, be allowed access to their traditional sources of supply for wood, water and sand. The sudden increase in population, particularly the extraordinary expansion of the town of Puerto Ayora since the establishment of the Darwin Research Station and the rise of the tourist industry, has put an unexpected strain on the limited forestry resources, as wood is required in ever-increasing quantities for building and fuel. Inroads are being made into the woodlands, especially into the stands of *Piscidia carthagenensis*. Consequently the GNPS and the CDRS some time ago started a small nursery to investigate the optimal conditions for growing native timber trees. It is now proposed to set up timber plantations on private farms and thus reduce the human impact on the forests in the National Park.

The most complex problems for the preservation of the flora arise from the exotic plants introduced by the settlers, which compete with the native species. There are about 240 introduced species, alien to the Galapagos environment, and their number is increasing. Some of them are invading the National Park on an alarming scale. This is especially true to *Psidium guajava, Cinchona succirubra, Lantana camara, Passiflora edulis, Cedrela odorata* and *Persea americana*. The GNPS and the CDRS are at present engaged on an assessment of these aggressive species. Experiments on controlling them have been carried out for some time: for instance *Psidium guajava* is being treated with various arboricides in the hope of finding a really successful agent. In the higher parts of Santa Cruz the GNPS has regularly cut down the *Cinchona* trees which are relentlessly penetrating the unique *Miconia* and pampa zone, but the outlook seems hopeless unless sufficient men and money can be found for the total eradication of this aggressive invader. This unfortunately is too generally true of all our plant protection activities. Work has hitherto been largely concentrated on Santa Cruz because the GNPS and the CDRS are based in the island and it is more cost-effective to expend our limited resources near our base than to spread them over the whole archipelago. In consequence the situation on the other inhabited islands is even worse.

This is true for instance of the highly important evergreen *Scalesia* forests. The genus *Scalesia (Compositae)* is endemic to the Galapagos. Some species grow into trees, the most common of which is *S. pedunculata.* It occurs on Santa Cruz, San Cristóbal, Santiago and Floreana and it is in these last two islands that it is under the most immediate threat from introduced animals. On Santiago the situation is so grave that it has been necessary to protect a few mature individuals with goat-proof fences. On Floreana there are still some small populations but these are under pressure from the aggressive *Psidium guajava* and *Lantana camara* (see Noticias 43). Fortunately on Santa Cruz large stable forests remain.

The GNPS and the CDRS are currently engaged on assessments both of the Scalesia situation and of the more aggressive introduced species. It seems inevitable that if action cannot be taken some Galapagos species will become extinct. For instance on Floreana there are, or were, several species never found anywhere else: *Psychotria angustata,* only collected twice; *Lippia salicifolia,* not found for many years; *Darwiniothamnus tenuifolius,* now reduced to very small populations. Henning Adsersen (pers. com.) estimates that perhaps 100 of the 500 native Galapagos species are vulnerable if not actually endangered. Their preservation depends on the availability of adequate human and financial resources.

SCALESIA GORDILLOI
A NEW GALAPAGOS PLANT SPECIES

by

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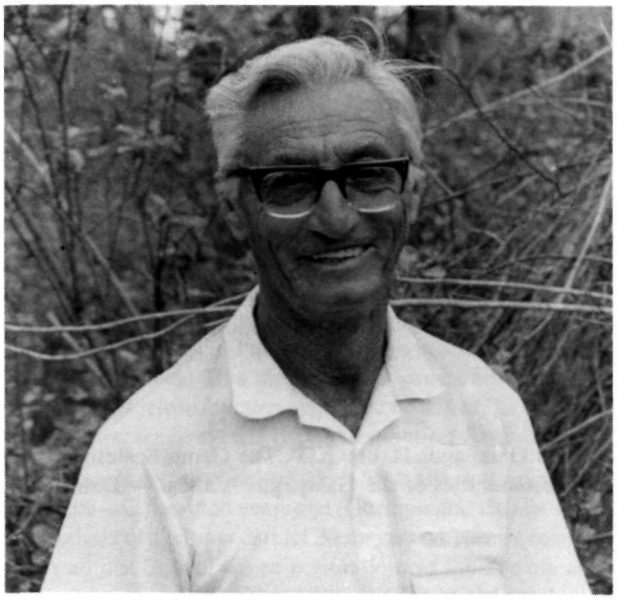
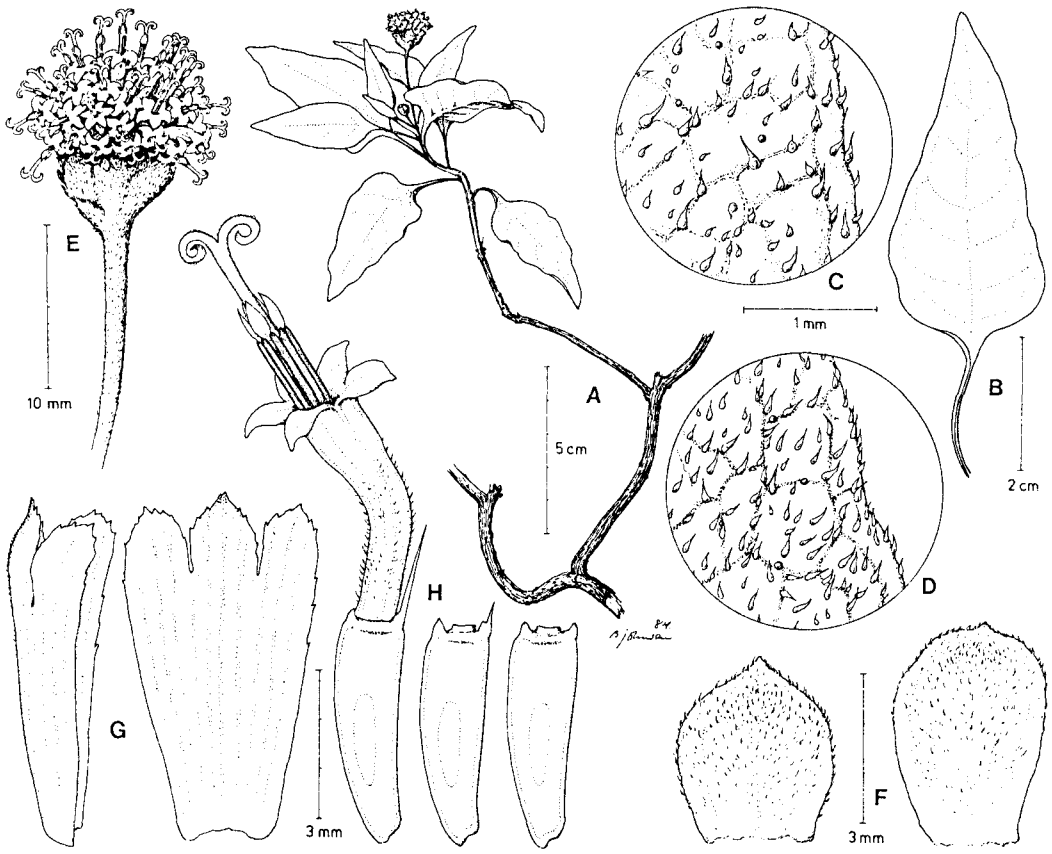
During a visit to the Galapagos in 1982 for the purpose of studying the mangrove communities we were escorted round San Cristóbal by Señor Jacinto Gordillo, a local teacher and naturalist, who has long been the resident representative of the Charles Darwin Research Station in that island. He drew our attention to a species of Scalesia near Puerto Baquerizo, the administrative capital of the archipelago, which he considered to be a hitherto undescribed species. Subsequent study has shown that his acute powers of observation had led him to a correct diagnosis and we therefore decided to name the new species in his honour, *Scalesia gordilloi.*



Jacinto Gordillo, a resident of San Cristóbal,
who for many years has represented the CDRS in that island.

The genus *Scalesia* is endemic to the Galapagos and, with the inclusion of *S. gordilloi*, now contains 15 species (21 taxa). The Scalesias are erect, usually single-stemmed shrubs or small trees from 0.3 to 15 metres in height. Their morphological diversity is parallelled by their diversity of habitat (Eliasson 1974, Hamann 1981) ranging from the humid highlands to the restricted area of loose lava rocks in the arid coastal zone, to which the new species is confined. Few Galapagos islands are without representatives of the genus and a number of islands have more than one. San Cristóbal now has 4 but none of these overlaps with *S. gordilloi.*

S. gordilloi is easily recognised by the combination of entire leaves with minute glands, few-flowered, relatively small heads and small paleae (Fig. 1). It grows to a height of about 1.5 metres.



Scalesia gordilloi, type specimen.
A: Flowering shoot. B: Fully developed leaf. C: Upper surface of leaf. D: Under surface of leaf.
E: Head. F: Phyllaries. G: Paleae.
H: Flower and fruits, the fruits with variously developed pappus, either as pointed sets or as blunt callosities.

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THE FUTURE OF THE FERNANDINA RICE RATS: EXTINCTION OR CAPTIVE BREEDING?

by

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While studying fur seals on Fernandina (Narborough Island) and enjoying the company of the endemic rice rats (*Nesoryzomys narboroughi*) I became concerned about the future of the latter species. Actually, two species of the genus *Nesoryzomys* are known from Fernandina, the smaller one of which (*N. fernandinae*) has only recently been described from skulls found in owl pellets (Hutterer and Hirsch 1979). The two Fernandina species are the only surviving *Nesoryzomys* rats in the Galapagos Archipelago (if the smaller one still exists). A good survey of Fernandina is needed to determine the present status of *N. fernandinae*. Earlier, Santa Cruz, Baltra, Santiago and Isabela also had *Nesoryzomys* species (see Clark 1984 for a tabulation of all species of Galapagos rice rats).

At least on the first of these 3 islands the introduction of the black rat (*Rattus rattus*) led to the extinction of the endemic species. This happened on Santa Cruz in the incredibly short period of perhaps only 4 years while on Santiago black and endemic rats apparently co-existed for at least 70 years (Clark 1984). It seems likely that extinction of the endemic rats on Santa Cruz was hastened by a disease or parasite which the black rats had brought with them (Brosset 1963), while on Santiago the black rats may slowly have outcompeted the native rat species. Similarly the native *Oryzomys* rice rat species on San Cristóbal went extinct after the introduction of the black rat, leaving only the population on Santa Fe. The conclusion seems inescapable that wherever the black rats are introduced the native rats will succumb.

Given this sad conclusion, how likely is it that black rats will be introduced to Fernandina and replace the last two *Nesoryzomys* species? Or that the same would happen to *Oryzomys bauri* on Santa Fe? Unfortunately, I think such an introduction is bound to happen given enough time. Clark (1984) in her review of the native land mammals of the Galapagos therefore states: "It is imperative that the surviving species be protected from a similar fate" (of extinction). "Thus, all necessary safeguards should be maintained against the accidental introduction of ... black rats on Fernandina and Santa Fe." I fully agree with this; but it seems to me that given all possible safeguards against introduction the probability of accidents is still high. The stranding of a ship on Pinta in 1984 has demonstrated that unfortunate events of this sort can neither be predicted nor prevented short of banning all ship traffic from the area. Tourist boats as well as fishing or cargo ships frequently have rats on board and therefore, given enough time, the introduction of black rats to Fernandina seems a distinct possibility. If this happens the last two *Nesoryzomys* species will, within a relatively short period of time, go extinct. The same could, of course, happen to *Oryzomys* on Santa Fe.

With this somewhat depressing assessment of the future, what is the best strategy for the conservation of these species? Obviously all possible care should be taken to prevent accidents. One may even consider closing Punta Espinosa for tourism; but I think this is undesirable because Fernandina and its fate would then become of less concern to the general public. What can be done instead?

Let me first give the reason why I would like to limit the rest of this note to a consideration of the Fernandina rice rats excluding the Santa Fe *Oryzomys bauri*. The Santa Fe rice rat has proved to be hardly distinct from the mainland (Peruvian) species *O. xantheolus* (Gardner and Patton 1976, Patton and Hafner 1983). Its genetics, karyotype and skull morphology point to a very close relationship with that species so that Patton and Hafner (1983) even suggest that it may have been introduced during the last few hundred years, perhaps by aboriginal sailors. This means that a genetically very similar species exists on the mainland from where stocks for reintroductions could be obtained. In other words the *Oryzomys* species as such would not disappear entirely even if it went extinct on Santa Fe.

The *Nesoryzomys* species, however, are clearly distinct from all known mainland rice rats and presumably reached the archipelago 3.00 — 3.5 million years ago (Gardner and Patton 1976, Patton and Hafner 1983). As the morphological analysis of the now extinct *Nesoryzomys* species from the other islands has shown that these were probably all just little diverged populations of the one big and one small species (l.c.), it seems as though the conservation of the Fernandina species might actually conserve the full set of all *Nesoryzomys* species ever in existence.

I suggest therefore an experiment with captive breeding to insure the genetic future of this genus. Such a program could investigate the species' resistance to diseases and parasites and would make them manageable for eventual reintroduction to little islands cleared of black rats. Ideally such a program should establish several colonies in different locations at zoological gardens or similar institutions with the knowledge and the funds to maintain such a colony at sufficient size to prevent inbreeding depression. This could also be avoided through regular interchange between captive colonies. With those stocks safely maintained, the genetic future of the genus would seem assured even if an accidental introduction of black rats to Fernandina should occur.

I admit that it is generally undesirable to permit the export of endemic animals. However, I think that in this case there are valid reasons for granting such permission to a few qualified institutions. Abuse of such a permit, e.g. by trading with the animals, seems very unlikely, since there is no reason to assume that anyone not concerned in the management of genetic resources or in conservation in general would be interested in acquiring a rat which looks just like a black rat.

In summary, I surmise that a captive breeding program is the only way of really insuring the genetic future of the last two *Nesoryzomys* species in case of an accidental introduction of black rats to Fernandina. If this note could stimulate discussion and perhaps action for the future of the Fernandina rice rats it will have achieved its aim.

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ISLA DE LA PLATA AND THE GALAPAGOS

by

J. Bosco Nowak

According to legend, Isla de la Plate (Silver Island) was so named because it was there that Francis Drake divided up the huge booty from the Spanish treasure ship he had captured in 1579. It lies close to the coast of mainland Ecuador and does not form part of the Galapagos which lie a thousand kilometres deeper into the Pacific. Nevertheless, as it also lies near the equatorial line, its wildlife has many features in common with that of the archipelago. J. Bosco Nowak, who held a scholarship to study at the Darwin Research Station and is a Galapagos naturalist guide, has visited this somewhat forgotten island and has written this disturbing report on present conditions there. Ed.

In October 1985, Maria del Carmen Marcillo and I visited La Plata Island. At Punta Machete we were surprised to hear the very familiar roar of a bull Galapagos sea lion. At the foot of the cliffs there was a complete colony: a territorial male, five adult females, two sub-adult females, a juvenile and, at a certain distance from the harem, three not fully grown males. The bull was patrolling the beach. All five adult females seemed close to giving birth. A sight strange to us was a female repeatedly chasing away some red-headed vultures, which were probably trying to feed on sea lion excrement. There are no vultures in the Galapagos.

This would seem to be the first record of a colony of Galapagos sea lions, *Zalphus californianus wollebecki,* outside the archipelago. From my years of experience as a Galapagos naturalist guide, I feel quite sure of my identification; this was definitely not a colony of the South American sea lion, *Otaria byronia.* Sr. Zaccarias Intriago, the caretaker of the island, which he has known for over 35 years, told us that for as long as he could remember these "*perros del agua*" (literally "water dogs") had been there, but that it was only in recent years that they had established a permanent colony. Previously they arrived during the hot season and left again when it grew colder, and this was still true of some but not all of them. During recent El Niño years (when the ocean temperature is higher than normal) Sr. Intriago estimated that the population had been well over 50. On these occasions the fishermen would drive them off the beach or even kill them. They disliked them because they eat a fish called *corrina* and because the bulls sometimes attacked them in their canoes, often at great distances from the island. The sea lions' best protection is the steepness of the cliffs and the danger of landing on their beach from the sea because of the big waves and the submerged lava flows.

The other Galapagos species which has colonized Isla de la Plata is the Waved Albatros, *Diomedea irrorata,* but its numbers have recently been sadly reduced and in two days of searching we found only two pairs. In 1975 the population was estimated at somewhere between ten and fifty pairs. We found a dead adult which had clearly been killed by the fishermen who go on shore to hunt for feathers: its head had been torn off and its breast stripped.

It was interesting to establish that the breeding seasons of the albatrosses and of the sea lions synchronize with those in the Galapagos. There were other similarities that reminded us of the archipelago: the Masked and Blue-footed Boobies, Red-billed Tropic Birds, Magnificent Frigatebirds, Brown Pelicans and White-vented Storm Petrels. Then there are the familiar *Palo Santo* trees and plants like *Croton, Maytenus* and the beautiful *Cordia lutea.* We were so impressed by the similarities that we ended up searching for giant tortoise fossils in the secondary sediments. But there are also differences from the Galapagos. I thought I was watching a carpenter bee but it turned out to be a tiny, dark hummingbird. There are no hummers in the Galapagos and the La Plata mockingbirds belonged to the mainland coastal species, not to any of the four endemic Galapagos species.

The Galapagos suffered their greatest threat when human beings arrived, began destroying the environment and introduced alien animals and plants; something similar is happening on La Plata. Fishermen hunting for feathers could exterminate the albatrosses and reduce the boobies which have already become so shy that one cannot approach them closer than 30 meters. A goat population which we estimated at 300 is destroying the vegetation and leaving the fragile soil exposed to erosion.

Let us give thought to how this island, which is officially part of the Ecuadorian national park system, can be given efficient protection. It took me a long time to decide to publish this report but, if nothing is done to save Isla de la Plata, I should feel I was in some way responsible for the continuing destruction of this unique ecosystem.

GALAPAGOS LITERATURE — FACT AND FANTASY

by

David Cameron Duffy

Those remote island volcanoes named "Galápagos" after their most famous aboriginal inhabitants, the giant tortoises, have inspired an extraordinary number of publications. Most of these are scientific articles and books that pour out in an ever-increasing stream. Galapagos has, in addition, inspired a small but distinguished body of fiction. Many of the works are little known, but they are as important to understanding Galapagos as are the scientific works.

Galapagos literature began with the late 17th century British buccaneers, "the literary pirates", whose published accounts of their adventures made the Galapagos known to the reading public and also started a fashion in travel stories. This led Daniel Defoe to write *Robinson Crusoe,* a landmark in the history of the novel, which owed much to the buccaneers' tales. His model, Alexander Selkirk, had actually been marooned farther south on Juan Fernandez Island but he belonged to the same piratical fraternity and had visited the Galapagos at least once. The lonely island setting was a great artistic convenience to Defoe, as it had been to Shakespeare in *The Tempest*: it freed the author's imagination from the constraints of reality. Following in Defoe's footsteps, other writers expanded the boundaries of imagination further and further and began a vogue in desert island stories. Germany, in particular, produced hundreds of escapist *Robinsonaden.*

The most distinguished of the authors who located their fantasies specifically in the Galapagos was Hermann Melville. He knew the islands well, having served there in the whaling ship *Acushnet;* nevertheless, while given a realistic setting, his stories take on an almost mystical character. His collection of Galapagos tales, *Las Encantadas,* was published in 1854, four years after *Moby Dick.* The stores are told by a seaman and, although they deliberately depart from fact, they nevertheless capture the other-worldly essence of the islands. One takes the reader on a climb up the unclimable *Roca Redonda;* another recounts the experience of the girl Hunilla, the only survivor of an expedition to extract oil from tortoises; yet another re-tells the tale of the legendary Oberlus, the alcoholic hermit, who grew vegetables which he traded for rum with passing ships. He also shanghaied members of their crews to serve him as slaves.

Las Encantadas are quiet tales of irony and pathos in a Galapagos setting that Melville paints as evil. The tales lack the sweep and majesty of *Moby Dick* but, with their companion piece in *The Piazza Tales, Benito Cereno,* they have come to be regarded as Melville's finest stylistic efforts. His evocation of the giant tortoises and his description of the islands themselves ("Take five and twenty heaps of cinders dumped here and there ...") have been particularly admired. *Las Encantadas* may have been exercise for a larger novel *Tortoises or Tortoise Hunting* which seems to have fallen by the wayside when Melville turned to writing magazine pieces.

C.S. Forester, the creator of Horatio Hornblower, wrote *Brown on Resolution.* In contrast to the complex and doubting Hornblower, one of the most interesting heroes of nautical fiction, Brown, a simple seaman, is one-dimensional, a man with a single-minded dedication to duty, who succeeds in delaying a World War 1 German cruiser from making necessary repairs so that it can be caught and sunk by the British. Forester invented Resolution Island by combining characteristics of islands such as Genovesa (Tower) with its circular bay and Tagus Cove on Isabela (Albemarle) with its steep sides. Brown's island is hot, waterless and steep-sided; his situation is hopeless; but he does his duty. Forester does not expect his hero to reason why, only to reason how. Forester does not reason for him.

A story with an historical foundation is John Jenning's *The Salem Frigate* (1946), a retelling of the voyage of the U.S. Frigate *Essex,* which gave its name to Punta Essex on Isla Isabela during the War of 1812 between Britain and the United States. The novel is a sea yarn with no pretensions to being anything except a good read. In its pages on Galapagos the interest is primarily culinary, with a truthful description of how fresh meat was supplied by the capture of tortoises, marine turtles, land iguanas, fur seals and fish.

These stories have a varying degree of relationship with the reality of Galapagos but there are other books that use the islands as an escape from the real world into realms of pure fantasy: the moon would serve their purpose equally well if it were more easily accessible. A little-known example of this approach is the unfinished novel, *Los Monos Enloquecidos (The Maddened Monkeys),* by the Ecuadorian author, Jose de la Cuadra. The novel was written in 1931, but the Spanish Civil War and subsequent events intervened

and it was not published until 1951, when a surviving manuscript was recovered, ten years after the author's death.

Jose de la Cuadra is one of the most important figures in Ecuadorian literature. He was one of the first *mestizo* writers, choosing his themes and mileu from the evolving society of Ecuador, rather than looking back to Spain or the oligarchic society of Ecuador's past. He died at age 37 but not before he and a circle of Ecuadorian writers had ensured an Ecuadorian literary future.

His novel touches on Galapagos. The protagonist, Gustavo Hernandez, travels the world, first crewing on a convict ship which sinks on the way to Galapagos. Gustavo and some companions make their way to the islands where they are again shipwrecked. He is abandoned by the others who try to escape. They fail and one body washes up on the island and Gustavo uses it as a raft to escape.

Gustavo is a raconteur of great talent, telling tales such as that Roca Redonda is the home of mermaids who, on full-moon nights, lure whalers and fishermen to their doom. He describes a great city in the crater of Fernandina and provides the islands with terrible monsters that come out of the sea after dark, leaving paths where no vegetation will grow.

Gustavo travels on around the world, acquiring family and further adventures. He inherits a farm in the wilds inland from Guayaquil on the Ecuadorian mainland. There he hears of a treasure which can only be extracted by men who have never been touched by Holy Water. Inspired by Galapagos and Darwin, he decides to speed up the evolution of monkeys so that they can dig up the treasure for him. The novel ends at this point, unfinished. The distinguished Ecuadorian author, Alfredo Pareja Diezcanseco, is of the opinion that, had de la Cuadra been able to finish it, *Los Monos Enloquecidos* would have been one of Latin America's most exciting contributions to the adventure novel.

Another work of imagination is *Mas alla de las islas,* a novel by my mother-in-law, Alicia Yanez Cossio, one of the few Ecuadorian women writers. It is very much of the school of Latin American "magical realism" which sometimes appears to have given Latin Americans a monopoly on innovative fiction in the latter half of this century. Reality, death and the supernatural are intermixed in an everyday context. The novel is a series of vignettes concerning a set of characters who represent archetypes of human approaches to nature. All die or are defeated by the islands but out of the sum total of their deaths comes a new wave of colonists, combining the good of each and living in harmony with the islands. The setting could be Galapagos or any other islands but the message is one of reconciliation and co-existence with nature.

The latest (1985) and perhaps the most fantastic of all these novels is *Galapagos* by the North American writer, Kurt Vonnegut. There may have been two reasons for his choice of setting. One is his interest is what he considers to be "the explosive development in the South American novel ... We are seeing a literature that has been hidden in drawers for years". A second reason is the islands' association with Charles Darwin and evolution. In order to achieve absolute isolation, he maroons his collection of characters, an international group taking part in "The Nature Cruise of the Century", on the Galapagos with no chance of rescue, as the rest of the world has been destroyed by nuclear war. Not only does he isolate his characters in space but he also removes them in time and considers their condition a million years into the future. During this period, evolution has produced an enormous expansion in the size of the human brain — with dramatic consequences. "This was a very innocent planet except for those great brains", his narrator concludes.

The islands seem to have driven novelists to the wilder extremes of imagination but, at times, Galapagos fact has rivalled fiction. The most sensational case was that of the multiple deaths on Floreana in the 1930's. There were three very peculiar "family" groups of Europeans who came to live on this otherwise uninhabited island; each cordially hated the other two. The last arrival, the polyandrous "Baroness" Wagner-Bousquet supported by her male companions, proclaimed herself Empress of the Galapagos and announced her intention to establish a luxury hotel for millionaires, despite a lack of water and other amenities. She and one of her lovers suddenly disappeared without a trace. No acceptable explanation of their fate has ever been forthcoming. Another lover left precipitately only to be ship-wrecked and die of dehydration. Another settler, Friedrich Ritter, a vegetarian doctor engaged in the daunting task of reconciling the teachings of Nietsche and Confucius, claimed to have evidence about the disappearances, but died of meat-poisoning before he could divulge it. His mistress also left the island so that only the third family, the Wittmers, remained. The doctor's mistress, Dora Strauch, published her account in *Satan*

Comes to Eden and Margaret Wittmer presented her version in *Postlagernd Floreana.* Not only do the two accounts contradict one another but neither book stands up to critical examination of its own evidence.

Two fictional accounts have been inspired by the Baroness. Maurice Breziere's *Floreana Paraiso Infernal* (1941), despite the lurid title, is a straight-forward but fictionalised retelling of the baroness's story. An Ecuadorian diplomat, Gustavio Vasconez, developed the story extravagantly in his 1973 book, *La Isla de los Gatos Negros,* turning Floreana into a hotbed of international espionage. The baroness becomes a Japanese spy, assigned to assess the Galapagos as a base for the coming war; the dentist is a spy for the Nazis who wish to keep an eye on the baroness, while the Wittmer-like family work for German army intelligence, which is in an alliance with the Americans. While implausible, nothing about the baroness or Galapagos is impossible and the author ties up most of the loose ends of the original story.

More recently a visiting Cambridge biologist, John Treherne, turned aside from his investigations on *Halobates* water striders to try to sort out this "whodunnit" in his book, *The Galapagos Affair,* but despite his painstaking research the full truth still eludes us.

Although factual, the book by Paulette de Rendon, *Galapagos: las ultimas islas encantadas,* published in French in 1946 and in a Spanish translation in 1971, is one of the best evocations of Galapagos and of certain recent historical figures already slipping into legend. De Rendon was stranded in the islands while on holiday in 1940, waiting months for a ship to take her back to the mainland. At that time the total population of the archipelago was only that of a modest village. She evokes — with a touch of poetry — the idyllic setting of "the last of the enchanted islands" and describes such extraordinary characters as Manuel J. Cobos, the ruthless tyrant of San Cristóbal, and one of his many victims, Camilio Casanova, whom he condemned to solitary exile on then-uninhabited Santa Cruz Island, where Casanova somehow survived for three years on cacti, fruits and tortoises. Señora de Rendon loved the islands but was distressed that the miserable human relations of the settlers contrasted so harshly with the loveliness of nature. This is much the most sympathetic and understanding account of the Galapagos before the radical changes that came with the establishment of the National Park and the Charles Darwin Research Station, bringing the islands into closer contact with the outside world.

The baroness aside, the Galapagos seem to be chosen by novelists because of their isolation and their ties with Darwin and evolution. Oddly enough, these are the same reasons that scientists chose to work in the islands. Those who see science and art as totally different might well ponder why, at least in this case, the inspiration should be the same.

SEED GERMINATION STUDIES OF SELECTED GALAPAGOS ISLANDS ANGIOSPERMS

by

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Many problems in the evolution of flowering plants are posed by immigration to oceanic islands. Obstacles that must be overcome by a plant when colonizing such islands include seed transport, germination, establishment, and reproduction. The first of these, seed transport, has been dealt with extensively in the literature, both for oceanic islands in general, and for the Galapagos Islands specifically (Ridley, 1930; Carlquist, 1974). The most recent figures for the Galapagos would indicate that birds have been the most important dispersal agents of flowering plants representing 48.6% of the dispersal events, followed by man (38.8%), oceanic drift (7.0%), and wind (5.6%) (Porter, 1983).

This paper reports on viability and germination tests that were performed on seeds of several species of flowering plants of Isla Santa Cruz. The species chosen for these experiments were among those comprising a larger study dealing with the reproductive biology of Galapagos Islands angiosperms. The objectives of these tests were to determine: 1) seed germination ability; 2) the presence or absence of seed dormancy; and 3) what correlations exist between seed dormancy and plant resident status, habitat and dispersal mechanism.

The seeds used for the viability tests were obtained from plants located in five of the seven major vegetation zones on the southern slope of Santa Cruz (Wiggins and Porter, 1971; van der Werff, 1979). The locations of the study quadrats by vegetation zone were as follows: 1) Arid Zone — near Darwin Station; 2) Transition Zone — 3.5 km N Puerto Ayora near road; 3) *Zanthoxylum* Zone — near Santa Rosa; 4) *Scalesia* Zone — near Los Gemelos and 5) Pampa Zone — 3 km N Media Luna. The seeds were tested for viability using a 0.1% solution of 2, 3, 5 Triphenyl Tetrazolium Chloride (TTC) which acts as an indicator or respiration in the embryo. All of the species included in this study showed positive TTC results indicating that the seeds were viable and possessed the potential for germination.

For the germination tests seeds of each species were divided into two groups. The first group was subjected to five minutes exposure in a 2.6% solution of sodium hypochlorite. This treatment was performed to sterilize the seed coat and in so doing destroy any fungi that might be present. This treatment was found necessary after preliminary tests involving the seeds of several other species had to be terminated due to fungal damage. The second group of seeds was subjected to the same solution, but for one hour duration. This second treatment was mentioned by Rick and Bowman (1961) as being quite effective in breaking dormancy in *Lycopersicon cheesmanii* var. *minor*. The type of dormancy that would be affected by this kind of treatment is one in which there is a structural barrier to germination which might be broken by removal of part of the seed coat by the solution. The seeds were then rinsed very thoroughly in water and placed on moist filter paper in petri dishes and observed for a period of 21 days. The paper was kept moist and the seeds were counted and removed as they germinated. As a precaution against contamination the dishes and water were sterilised by autoclaving. For *Croton scouleri* var. *scouleri* and *Scutia spicata* var. *pauciflora* only enough seeds were available for the control treatment.

The results of the germination tests are shown in Table 1. The percentage of seeds germinated for each exposure period as well as the number of seeds tested (in parentheses) is given. It was arbitrarily decided that seed dormancy would be indicated for those plants in which there was less than 25% germination under the five minute (control) exposure. Using this measure 51.9% of the species tested showed seed dormancy. None of these species showed a significant increase in seed germination after the one hour exposure period. This would seem to indicate either that the dormancy type is not one of a simple mechanical barrier brought about by the seed coat, but perhaps a dormancy requiring some other treatment, for example the removal of a certain chemical from within the seed coat; or that the seed coats required an even longer exposure to the sodium hypochlorite solution. This latter possibility is supported by the observation that several of the species showing dormancy seemed to have seeds with thick, tough seed coats. Examples of this are seen especially well in *Tournefortia rufo-sericea, Croton scouleri* var. *scouleri, Cassia occidentialis,* and *Clerodendrum molle* var. *molle.* This contrasts with several of those plants not showing seed dormancy, such as *Justicia galapagana, Adenostemma platyphyllum,* and *Jaegeria gracilis,* which have seed coats that are not as thick and that showed a significant drop in germination after exposure for an hour to the solution indicating that some of the embryos may have been destroyed.

Table 1 also includes the locations by vegetation zones of the plants tested. The arid and transition zones are considered part of the basically arid ecological zone, while the *Zanthoxylum, Scalesia,* and pampa zones belong in the basically mesic ecological zone (Johnson and Raven, 1973). Also given is the resident status and supposed disseminule dispersal mechanism for each of the plants (Porter, 1983). This information was included to determine what correlations existing between these factors and seed dormancy.

Seed dormancy was found in 63.6% of the endemics, 60.0% of the natives, and only 36.4% of the non-indigenous (introduced weeds and cultivated escapes) species. If the species that were tested are divided into just two groups, indigenous and non-indigenous, 62.5% of the former show seed dormancy while only 36.4% of the latter show this characteristic. This would indicate that the non-indigenous plants are better able to immediately exploit any habitat that might open up, whereas the endemics and natives show a "strategy" of waiting for more favorable conditions before germinating. It is worth noting that the majority of introduced weeds showing greater than 50% germination have a high seed set potential which could compensate in part for a high mortality that might result from more immediate or almost total seed germination in a less than hospitable environment. Unfortunately, these factors also help to explain why some of the introduced weeds and cultivated escapes on the Islands are successful in advancing into areas that are temporarily exposed due to factors such as fires and pasture use. These plants are pre-adapted to making a quick start in these disturbed locations and in turn slowing or halting the return of the native vegetation.

When ecological zones are considered 66.7% of the species in the basically arid zone show seed dormancy while 33.3% of those in the basically mesic zone show dormancy. The explanation for this seems straightforward enough in that plants which would be favored to survive in the dry or xeric conditions represented in the transition zone and especially the arid zone are those with seeds that could remain dormant until the most favorable conditions were present. Whereas the basically mesic zone, being less harsh, might allow a more haphazard "strategy" of immediate germination. Within this mesic zone are found the highest number of non-indigenous species studied, in fact, 66.7% of the species from this area are either introduced weeds or cultivated escapes, and the relationship between lack of seed dormancy and non-indigenous resident status has been mentioned in the previous section.

Dormancy also appears correlated with dispersal mechanism. Of those species with seeds carried internally by birds, 88.9% show seed dormancy but only 16.6% of those carried externally by birds and 36.3% of those introduced by man show dormancy. The one species with wind dispersal also shows dormancy. From these results it would appear that those seeds carried in the digestive tracts of birds need a protective covering, which could also act as a dormancy mechanism. Also suggested is the need of passage through the digestive system to break this dormancy, although in some cases destruction of the seeds has been known to occur after passage through birds (Rick and Bowman, 1961). In addition, all of the plant species studied here which are dispersed internally by birds have a widespread distribution throughout the archipelago indicating that this might indeed not only be a method of promoting germination, but also dispersal among the islands. The dormancy observed in *Darwiniothamnus tenuifolius* var. *tenuifolius* might also be correlated to its dispersal type since it is well known that aerial transport can at times be very harsh due to the extended time and low temperatures which might be encountered. Those seeds transported by man show the least amount of dormancy. This, again, can be explained by the fact that some weedy plants may be better suited if little or no dormancy is present. It is explained for the cultivated escapes by the simple fact that these plants are normally bred, either intentionally or not, so that dormancy is lost (Harper, 1965). *Paspalum conjugatum* appears to contradict this with its low germination. Perhaps it is best considered a native as Black (1973) suggests, rather than a cultivated escape.

In summary, just over half, or 51.9% of the species tested show seed dormancy represented by less than 25% germination. It appears from these tests that factors associated with this degree of dormancy are an indigenous resident status, an arid habitat, and internal dispersal by birds (other animals might also be important). However, dormancy is not an all or none situation in most cases. These tests do not preclude the possibility of a lesser degree of dormancy in the other species. Indeed, this would seem very likely since two characteristics of known value to many weeds and colonizers of open habitats are their ability to germinate in a wide variety of environmental situations, and continuous germination over an extended period of time (Mulligan, 1965; Ehrendorfer, 1965). The weedy character of the Galapagos flora and its

open pioneer habitat are well known (Porter, 1976, 1979; Hendrix, 1981), and many of these species may simply be demonstrating this "strategy" of staggered germination. This greatly increases the chances of sooner or later encountering suitable conditions for growth and perhaps establishment.

ACKNOWLEDGEMENTS

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Table 1. Plant data and results of tests showing the percentage of seeds germinating after exposure to Sodium Hypochlorite solution. The number of seeds tested is shown in parentheses.

Plant Tested & Study Site	Resident Status	Dispersal Mechanism	5 Minute Exposure	1 Hour Exposure	Seed Dormancy
ACANTHACEAE					
Justicia galapagana (T)	endemic	birds (a)	67 (30)	0 (30)	No
ASTERACEAE					
Adenostemma platyphyllum (Z)	introduced weed	man	80 (40)	45 (40)	No
Ageratum conyzoides subsp. *conyzoides* (P)	introduced weed	man	61 (100)	65 (100)	No
Bidens pilosa (Z)	introduced weed	man	90 (50)	80 (50)	No
Darwiniothamnus tenuifolius subsp. *tenuifolius* (S)	endemic	wind	0 (100)	0 (100)	Yes
Jaegeria gracilis (P)	endemic	birds (a)	44 (50)	16 (50)	No
Scalesia pedunculata (S)	endemic	birds (a)	30 (50)	16 (50)	No
BORAGINACEAE					
Tournefortia pubescens (A)	endemic	birds (b)	33 (18)	44 (18)	No
Tournefortia rufo-sericea (T)	endemic	birds (b)	0 (50)	0 (50)	Yes
CACTACEAE					
Opuntia echios var. *gigantea* (A)	endemic	birds (b)	0 (50)	0 (50)	Yes
CYPERACEAE					
Cyperus elegans subsp. *rubiginosus* (A)	endemic	birds (b or a)	24 (100)	27 (100)	Yes
EUPHORBIACEAE					
Croton scouleri var. *scouleri* (A)	endemic	birds (b)	0 (9)		Yes
FABACEAE					
Cassia occidentalis (T)	native	birds (b)	10 (50)	2 (50)	Yes
LAMIACEAE					
Hyptis rhomboidea (P)	introduced weed	man	62 (100)	65 (100)	No
LYTHRACEAE					
Cuphea racemosa (P)	introduced weed	man	86 (50)	66 (50)	No
MALVACEAE					
Bastardia viscosa (A)	native	birds (a)	4 (50)	6 (50)	Yes
Sida rhombifolia (S)	introduced weed	man	14 (50)	14 (50)	Yes
PLUMBAGINACEAE					
Plumbago scandens (T)	native	birds (a)	73 (11)	100 (9)	No
POACEAE					
Paspalum conjugatum (S)	cultivated escape	man	24 (50)	24 (50)	Yes
POLYGONACEAE					
Polygonum opelousanum (P)	native	birds (a or b)	48 (30)	39 (30)	No
PORTULACACEAE					
Portulaca oleracea (A)	introduced weed	man	77 (100)	74 (100)	No
RHAMNACEAE					
Scutia spicata var. *pauciflora* (A)	endemic	birds (b)	0 (12)		Yes
SOLANACEAE					
Capsicum fruitescens (T)	cultivated escape	man	48 (25)	100 (25)	No
VERBENACEAE					
Clerodendrum molle var. *molle* (A)	native	birds (b)	0 (20)	0 (20)	Yes
Lantana peduncularis var. *peduncularis* (A)	endemic	birds (b)	0 (30)	0 (30)	Yes
Verbena litoralis (Z)	introduced weed	man	0 (100)	0 (100)	Yes
ZYGOPHYLLACEAE					
Tribulus cistoides (A)	introduced weed	man	0 (34)	0 (34)	Yes

(A) arid zone, (P) pampa zone, (S) *Scalesia* zone, (T) transition zone, (Z) *Zanthoxylum* zone, (a) external, (b) internal

Resident status and dispersal mechanism from Porter (1983)

When two types of bird dispersal are indicated the first is considered most probable.

BOOK REVIEWS

EVOLUTION IN THE GALAPAGOS

Edited by Professor R.J. Berry

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Contents:
Forward, Sir Peter Scott. Darwin was astonished, J.R. Berry. Islands and evolution; theory and opinion in Darwin's earlier years, A.J. Cain. Darwin and the Galapagos, F.J. Sulloway. Geology of Galapagos, T. Simkin. A new look at evolution in the Galapagos: evidence from the late Cenozoic marine molluscan fauna, M.J. James. Genetical processes in the Galapagos, J.L. Patton. Recent research on the evolution of land birds on the Galapagos, P.R. Grant. Evolution and adaptations of Galapagos seabirds, D.W. Snow and J.B. Nelson. The evolution of breeding strategies in the flightless cormorant (Nannopterum harrisi) of the Galapagos, R. Tindle. Evolutionary divergence of giant tortoises in Galapagos, T.H. Fritts. Seals of the Galapagos Islands, W.N. Bonner. Variation among populations of Galapagos land iguanas (Conolophus): contrasts of phylogeny and ecology, H.I. Snell, H.M. Snell and C.R. Tracy. The mating systems of pinnipeds and marine iguanas: convergent evolution of polygyny, F. Trillmich and K.G.K. Trillmich. Distribution of Bulimulid land snails on the northern slope of Santa Cruz Island, Galapagos, G. Coppois. Changes in the native fauna of the Galapagos Islands following invasion by the little red fire ant, Wasmannia auropunctata, Y.D. Lubin. Relationships of the Galapagos flora, D.M. Porter. Man and other introduced organisms, P. Kramer.

Evolution in the Galapagos Islands contains the 17 papers of a symposium, is a timely and comprehensive review of evolutionary studies and a stimulus to further scientific endeavour in the Galapagos and elsewhere.

The main thrust is contained in a series of 9 papers on the evolutionary processes of molluscs, reptiles, birds and seals, with an important essay on Darwin's finches covering interspecific behaviour in adaptive radiation, morphological and song cues in species regulation and natural selection of heritable quantative traits. There is only one paper devoted specifically to the flora. Some of the papers, for example the geology describing the 'hot spot' origins of the islands 3.3 million years ago, and 'Man and other introduced species', give background only and the invasion of the fire ant *Wasmannia auropunctata,* though a fine ecological treatise, contributes little to be main thrust of the volume.

More generally, A.J. Cain writes on 'Islands and evolution' and concludes that, against the chaotic state of science of his day, Darwin's achievement in recognising the meaning of adaptive radiation was indeed remarkable. F.J. Sulloway describes the vicissitudes and ineptitudes of Darwin in his visit to the Galapagos, showing that there was no dawning to him of the significance of these islands to science while he was there. The recognition occurred in hindsight and following a great deal of help from three other shipmates and the ornithologist, John Gould. R.J. Berry in his introduction declares that "the Galapagos did not give Darwin a Damascus Road experience" and that he "might have been bored and homesick during the five weeks he spent on the Galapagos".

Sir Peter Scott has written a short Foreword. The volume is beautifully and economically produced in soft covers with fine illustrations and has an Index. It is at once an academic and popular scientific work — a mine of information creating a new appreciation of the place of the Galapagos in science and fresh perspectives for research.

J. Morton Boyd

EL NINO EN LAS ISLAS GALAPAGOS: EL EVENTO DE 1982-83
THE 1982-83 EL NINO EVENT IN THE GALAPAGOS ISLANDS

Edited by Gary Robinson & Eugénia del Pino

Published, Quito, 1985 by the Charles Darwin Foundation. Softback, XXIV + 534pp.
30 articles, 14 in Spanish, 16 in English

Available from Fundación Charles Darwin Casilla 3891, Quito, Ecuador.
US$12.00 plus postage

In reading this book I have enjoyed the reports and learned much from the scientific studies. But above all I have been deeply impressed by what the book represents beyond the cold academic explanations. When you read it, consider that you are enjoying the privilege of experiencing the reality of Galapagos. This is the joint work of authors from different continents speaking different languages; of renowned scientists and college students; of nature lovers and, especially, of people of Galapagos: men and women who, while knowing their own land, have only now begun to discover the reasons why all the world has fallen in love with their islands.

The volume's 580 pages include articles on climatology, oceanography, marine and terrestrial biology, as well as on socio-economic aspects of the human population. Edited by Eugénia del Pino (Ecuador) and Gary Robinson (USA), it brings together 30 articles by 56 authors, half of them in Spanish, half in English. The editors deserve special gratitude, not only for the quality of the volume but also for the way in which they have overcome the problems of bringing together writers from Galapagos, Guayaquil, Quito, Hawaii, United States, Israel, Switzerland, Denmark, Great Britain and Germany.

The book is divided into five sections. The first consists of six articles on oceanography and climatology, beginning with an historical account of the influence of El Niño on the climate of Ecuador by Plutarco Naranjo, member of the Darwin Foundation's Council. Klaus Wyrtki, a world authority on El Niño, describes its development right across the Pacific. Stanley Hayes follows with an analysis of the variation of the temperature and level of the ocean in the archipelago, while Marco Robalino summarises the meteorological data registered at the Darwin Station and compares them with previous averages. Jane Kogelschatz and colleagues from Duke University and the National Institute of Fisheries present evidence of the variations in the production of nutrients which had such a profound influence on the marine ecosystem of the Galapagos; Gene Feldman carries this further by studying the effect on the seabirds and marine mammals.

The second section consists of a single article by Godfrey Merlen, a naturalist guide, who lived through the event and records his personal experiences and observations. He epitomises the ordeals of Galapagos residents when he writes: "It became necessary to be absolutely *interested* in the rainfall and its effects in order not to despair after sweeping the water from our floor for the nth time. I found ... a fascination in following the idea of the limits of mental and physical tolerance. Galapagos has always been a land of harsh subsistence. The low rainfall has perhaps saved the islands from being over-exploited. Even today in some years it is obligatory to transport brackish water to the farms in the highlands for the survival of the cattle. Yet, with the arrival of the rains, we found just the opposite. The thin topsoil was removed. The cattle stood on small hillocks whilst all around the swirling waters busied themselves with gravity's force, taking with them the very essence of the vegetation's future. How cold are the poles, how hot the deserts, how wet the oceans. What a very small habitat is left to man! How much he needs to care for it."

The third section consists of 10 articles dealing with the changes in marine life and the communities that are dependent on it. The co-editor, Gary Robinson (Santa Barbara City College, California) reports on the mortality of different types of coral, barnacles, sea urchins and other invertebrates. He also mentions the presence of species of fish not previously recorded and the absence of common or endemic species, a theme which is further developed by Jack Grove (Los Angeles County Museum). Andrew Laurie of Cambridge University documents the heavy mortality of the marine iguanas and their problems of reproduction. Dominique Limberger (Max-Planck Institute) explains the effects of El Niño on the fur seals and other species. Catherine Rechten (Max-Planck Institute), who studied the nesting of the albatrosses, concluded that not a single chick hatched. Cecilia Hernandez and Tjitte de Vries (Catholic University of Quito) report the reduced number of pairs of Great Frigatebirds, while Carlos Valle (CDRS) records the collapse of the seabird populations in 1982-83, followed by clear signs of recovery in

January 1984. Felipe & Justine Cruz (CDRS) tell of the success of their campaign to save the Hawaiian Petrels by protecting a breeding colony from the rats, a success that would have been greater but for the deluges which killed some chicks. Arnaldo Tupiza (CDRS) gives a succinct account of the effects of El Nino on the wildlife of the Cemetary Lagoon and the floods at Puerto Villamil, Isabela. He wonders whether it would not have been better to continue the traditional practice of building the houses on stilts. Finally, Ana Maria Sosa (Catholic University of Quito) reports on the reduced numbers of seabirds on the Quinta Playa ponds. The whole of this section shows how marine life and all the organisms dependent on it were disastrously affected.

The fourth section, consisting of eight articles on the effects of terrestrial species, seems to be in contradiction with the third because the botanists Hamann, Luong, Toro, Weber and Beck all agree that, with rare exceptions, the flora flourished. Inconspicuous or unknown plants grew exuberantly, spread out and apparently colonized new areas, perhaps other islands. Ole Hamann writes: "When water was no longer a limiting factor for plant growth, a great number of species were able not only to germinate and grow but also to flower and fruit abundantly both in arid and humid vegetation types. Such species may be said to have reacted positively to the Nino conditions." He adds: "Observations during the next few years will reveal whether new species have been added to the flora but until then it appears that the Nino did not cause a change in the general composition of the vegetation types. However it did change the relative importance of the component species in some places."

As with the plants, most terrestrial animals also benefited from El Niño. Linda Cayot, Friedeman & Heide Köster, Peter & Barbara Grant, Robert Curry and Yael Lubin document such successes in their articles on giant tortoises, finches, mockingbirds and fire ants. Although the expansion of the ants can be regarded as a positive achievement for that species, it had a negative effect on the native invertebrates and brought no joy to the human population.

The fifth section of the book deals with the effects of El Niño on man, a noteworthy achievement of authors and editors. Don Eliecer Cruz, an old settler on Floreana, tells of the trials endured by a Galapagos farmer. Students of the Galapagos National College report the damage to the road across Santa Cruz, to the soil on the farms and to the vegetation, as well as discussing the problems of agriculture, cattle raising, fishing, fire ants and human health. Eugénia del Pino, joint editor, devotes the final article of the book to her visit to Galapagos as El Nino was ending in August 1983. Like so many of us, she found it difficult to believe that what she was seeing was real: a different Galapagos with rivers and gorges, culverts and bridges, with exuberant vegetation on all sides but with sadly reduced populations of seabirds and marine animals.

I have deliberately left to the last my comments on the article by Jacinto Gordillo and the introduction by Peter Kramer, former President of the Darwin Foundation and now the Director of Conservation of the World Wildlife Fund International. Gordillo urges greater respect for nature and describes how public works, which did not take sufficient account of the conditions of Galapagos, particularly the diversion of the natural flow of water by large concrete stuctures, led to the destruction of the newly inaugurated children's playground and serious flooding in the town of Puerto Baquerizo. "Could there be a clearer natural history lesson for architects, engineers, town planners, or even for the inhabitants of Galapagos?"

Peter Kramer voices what is for me the essential message of this book when he writes: "The Darwin Foundation calls upon scientists and planners to make use of this case history when teaching a basic conservation lesson. Populations and biotic communities must be sufficiently protected and large enough to be safe not only when average environmental conditions prevail, but also during times of climatic extremes and stress".

I believe that this book which I have reviewed has one small fault. Its title should be expanded to include: "A basic lesson in conservation".

Miguel Cifuentes Arias
Superintendent of the Galapagos National Park Service

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