

NOTICIAS DE GALAPAGOS

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THE CHARLES DARWIN FOUNDATION FOR THE GALAPAGOS ISLES

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NEWS FROM ACADEMY BAY

THE 25th ANNIVERSARY OF THE GALAPAGOS NATIONAL PARK

On 4 July 1959 the Government of Ecuador established the Galapagos National Park and a few days later the Charles Darwin Foundation came into being to provide international support for its conservation. The fruitful results of this alliance of national government and international science during a quarter of a century were celebrated in Quito by a week of scientific symposia, meetings, exhibitions, film shows, the emission of commemorative stamps and the institution of a triennial "Charles Darwin Foundation Prize" for the best work on Galapagos environmental conservation.

The week ended with a reception at the Ministry for Foreign Relations. The Minister, Dr. Luis Valencia, a friend of the Galapagos for many years, declared that the celebrations had not only made the unique character of the archipelago better known to both Ecuadoreans and foreigners but, above all, had created an awareness of the need to preserve the Galapagos.

The Charles Darwin Foundation was represented by its Vice-President, Dr. Ole Hamann, and its Secretary General, Señor Juan Black.

FIRE AT THE DARWIN RESEARCH STATION

On the night of 7 May a disastrous fire broke out in the administration building of the CDRS at Academy Bay on Santa Cruz Island. While it proved possible to prevent the fire from spreading to the other buildings, the lack of water and appliances thwarted all efforts to save the building and the valuable office and field equipment which was kept there. With the aid of equipment lent by the National Park Service, the staff transferred their activities to the laboratory, the library and the Van Straelen exhibition hall. Although the work continued without much interruption, this has been a serious setback to the CDRS and the financial consequences will be hard to bear, particularly at a time when world economic conditions have already led to loss of income and cuts in scientific staff. It is hoped that supporters will bear this in mind when making their annual contributions.

THE CONTROL OF INTRODUCED MAMMALS

The extraordinarily heavy rainfall during the 1982-3 El Niño phenomenon stimulated a luxuriant growth of vegetation and it was feared that this abundant supply of food would increase still further the enormous numbers (80-100,000) of goats on Santiago (James) Island. However, when Luis Calvopiña, who has been studying the goats for some years, returned to the island in February and March, he could find no significant change and concluded that the improved food situation had been offset by higher mortality among the kids, due to the torrential rains. The same considerations seem to apply to other Santiago pests — pigs, rats and donkeys. Plans are being worked out for a major assault first on the pigs, then on the goats, whenever sufficient funds become available. A small scale project would hardly be worthwhile.

Expeditions to monitor the situation following the successful control campaigns of recent years have found no traces of wild dogs either on Santa Cruz or southern Isabela, where they came close to exterminating the endemic Land Iguana populations. While there cannot yet be absolute certainty that there are none left, it does seem that the worst threat has been averted — that the dogs would cross the Perry Isthmus and invade the ecologically invaluable and sensitive northern part of Isabela (Noticias 33). On the other hand, goats did succeed in crossing the harsh lava of the isthmus and will now have to be hunted on the Alcedo volcano.

GOOD NEWS ABOUT THE HOOD TORTOISES

When the Darwin Foundation arrived in the Galapagos, the Española or Hood Island Tortoise, *Geochelona elephantopus hoodensis*, seemed doomed to extinction. The few survivors were in competition with the numerous goats for the scant supply of food and were so scattered that they had ceased to breed for perhaps half a century. In desperation the CDRS director, Roger Perry, removed the four that he could find to the Research Station, where mating took place and, in due course, surprisingly successful methods of incubation were evolved. Eventually 2 males and 11 females were collected and genetic variation was improved by the generous gift by the San Diego Zoo of another male, now the Station's top-ranking stud animal.

In 1975, the first captive-bred *G. e. hoodensis* (hatched in 1970) were released on their arid ancestral island, where the food situation had meanwhile been improved by the complete elimination of the goats. The youngsters survived and slowly the population has been built up by annual transfers from the breeding pens so that by 1984 145 had been released.

Meanwhile there came alarming news of the discovery by herpetologists that the sex of tortoises is not determined genetically but by incubation temperature. One temperature produces all males, another all females. Did this mean that the years of devoted work at the Station might have resulted in repopulating Hood with a single sex? The CDRS methods, though more successful than those of the zoos, had been relatively primitive (beginning with converted bird-cages) and temperatures had not been controlled with any great accuracy. As it is impossible to determine the sex of very young tortoises without destroying them, doubts have persisted.

Now Cruz Márquez, who has taken charge in the absence of a staff herpetologist, reports there is at last clear evidence that the early repatriates, born in 1970-71, include both males and females. Giant tortoises live to a great age and they come to maturity at a correspondingly late age, so a population explosion is not to be expected immediately. But the future of *hoodensis* seems secure.

Captive breeding of the more endangered races of giant tortoise continues. In the 1983-84 season, numbers in the rearing house were:

Hood	46
Isabela (Cerro Azul)	58
Isabela (Sierra Negra)	10
Santiago	19
Pinzón	21
Santa Cruz	16
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	170
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THE ENDANGERED LAND IGUANAS

The programme for re-establishing the breeding colonies of Land Iguanas, *Conolopus subcristatus*, at Cartago Bay on Isabela and at Cerro Dragón on Santa Cruz continues to give encouragement. National Park wardens and CDRS scientists visiting Cerro Dragón have found no traces of feral dogs since the recent control campaign but there are still numbers of cats, which remain a threat to the captive-bred iguanas if they are repatriated while still small. Monitoring at Cartago Bay produced observations of 48 of the 149 captive-bred youngsters which had been released there at intervals since 1982. They are still small and not easy to see, but those that were found were in good shape, possibly helped by the exuberance of the vegetation following the El Niño rains. No traces of dogs were found and very few of cats. This is highly satisfactory and congratulations are due to all the many men and women involved in both the captive breeding and the dog control projects. Since the dogs virtually wiped out the two colonies in the early 1970's (see Noticias 36), captive breeding has continued at the Darwin Station but the outlook for the re-establishment of both populations is now much better than anyone dared hope a few years ago.

PENGUINS, CORMORANTS AND FLAMINGOS IN 1984

It was obvious that the extraordinary El Niño event of 1982-3 would have a detrimental effect on the breeding of some of the rarer Galapagos birds: on the Flightless Cormorants and Galapagos Penguins because the higher temperature of the sea reduced the food supply; and on the Flamingos because of the flooding of their restricted nesting areas. Surveys of all three species were taken early this year under the direction of José Villa, Deputy Director of the Darwin Station, and Carlos A. Valle, a scholarship research student, who stepped into the breach as there was no staff ornithologist in residence, owing to recent economies. The counts were reassuring and the conclusion was that the three species were rapidly re-establishing themselves. As the populations are so small, any new threat provokes anxiety, and the latest El Niño was of a severity never previously recorded. But these birds have existed here for thousands of years and the evidence of the rocks and gullies shows that, over the millenia, there have been other extraordinary El Niños. Yet the penguins, cormorants and flamingos survived these earlier cataclysms,

and there is no reason to fear that they will not survive this last one. They are restricted to very limited areas by the supply of food and breeding sites and there is nothing to suggest that their numbers were notably greater in the past nor that, given adequate protection, they are bound to decline in the future.

A WORKSHOP ON NATIONAL PARKS

Fausto Cepedo, chief naturalist of the Galapagos National Park Service, took part in a "mobile workshop" on national parks and equivalent areas during February 1984. A group of conservation officials, drawn from all the nature reserves of Ecuador, spent 19 days visiting representative protected areas, ending with a week in Galapagos, to work out detailed plans for future development. Galapagos was Ecuador's first national park but there is today an imposing list of others in various stages of organization. They include:

<i>Name</i>	<i>Area</i>
1. Parque Nacional Galápagos	773.000 hectares
2. Parque Nacional Yasuni	679.730 hectares
3. Parque Nacional Sangay	271.925 hectares
4. Parque Nacional Cotopaxi	33.393 hectares
5. Parque Nacional Machalilla	55.095 hectares
6. Parque Nacional Podocarpus	146.280 hectares
7. Reserva Ecológica Cayambe-Coca	403.103 hectares
8. Reserva Ecológica Cotacache	204.420 hectares
9. Reserva Ecológica Manglares	35.042 hectares
10. Reserva Ecológica Cuyabeno	254.760 hectares
11. Area Nacional de Recreación Cajas	27.323 hectares
12. Area Nacional de Recreación Boliche	1.077 hectares
13. Reserva Geobotánica Pululahua	3.000 hectares

INTERNATIONAL CONSERVATION AWARD TO SECRETARY RIPLEY

The 100,000 dollar "Olympic" prize for achievement in the field of ecology and conservation was awarded jointly to Prof. Francesco Nicosia of the Art Restoration Centre at Florence and to Mr. S. Dillon Ripley, Secretary of the Smithsonian Institution from 1964 to 1984 and a Founder Member of the Charles Darwin Foundation. Mr. Ripley's contributions to science and conservation are enormous. He is a prolific writer, particularly on ornithology, and his publications include the 10-volume *Handbook of the Birds of India and Pakistan*, which he wrote in collaboration with Dr. Salim Ali. His acquaintance with the Galapagos spans many years. He first went there as a young research student in 1937 and his latest visit, with his wife, was in 1977, when he went in search of the elusive Galapagos Rail, one of the subjects of his distinguished monograph, *Rails of the World*. The CDF is deeply indebted to him for long years of support and offers its congratulations on this well merited award.

VISITS AND EVENTS AT THE CHARLES DARWIN RESEARCH STATION

January 1984

Minard Hall of the National Polytechnic, came to collaborate on geological studies.
Elizabeth Potts, a volunteer helper, returned to the Royal Botanical Gardens at Kew, England.
Rudolf de Groot began his ecological and conservation studies.
Heidi Snell and Doreen Hobell arrived to complete their research on Land Iguanas.
The Ambassador of Czechoslovakia and party visited the Station, accompanied by the manager of the National Institute for Galapagos and Representative Manuel Valencia.
Prof. William A. Weber and his students returned to the University of Colorado on finishing their studies of mosses and lichens.
Friedemann Köster ended his three years as Director of the Charles Darwin Research Station.
The first official conference of tourist guides with officers of the National Park Service and the CDRS was held.

February

Günther Reck took over as Director of the CDRS.
Arne Jermelov of the UNESCO Intergovernmental Oceanographic Commission and Mario Escobar of Co-Operation in Worldwide Monitoring of Marine Pollution visited the Station.
The Mobile Workshop on national parks and equivalent areas arrived at Academy Bay.
The President of the Republic and his family, the Inspector General, the Minister of Industry and Commerce and his Undersecretary visited the Station.
Günther Reck (Station Director) and Miguel Cifuentes (Superintendent of the National Park) went to Panama to attend the meeting of the Darwin Foundation's Executive Council.
Dieter Plage's camera team, making a series of documentaries, were joined by Colin Willock, manager of Survival/Anglia Television, his wife and Wulf Kochler.

March

Ralph Davidson of WWF arrived at the Station.
Enrique Sáenz, personal advisor to the Minister of Finance, came to study the financial situation of the National Park Service and the Darwin Station.
Tjitte De Vries and Carlos Valle resumed their study of the migrations of the Great Frigate-bird.
David Anderson returned to USA on terminating his finch project.
Conley McMullen completed his pollination research and returned to Virginia Polytechnic.
Yves Finet and Bonnie Burns arrived from Belgium to collect molluscs.

April

Spencer Beebe, Vice-President of Nature Conservancy in the U.S., visited the Station.
The Minister of Natural Resources, Ing. Gustavo Galindo, visited the Station.
The Cardinal Archbishop of Quito and the Archbishop of Guayaquil called at the Station.
Derek Green, for many years in charge of the marine turtle project, paid a return visit.
Peter Pritchard, herpetologist, paid another visit.
A Chinese delegation, led by the Vice-President of the Chinese Parliament, came to see the Station.

May

Tomio Sasaki and Ernest Gusella came to make wildlife video tapes.
Fire destroyed the administration building (7 May).
Linda Hamilton, Rachel Brubaker, Robert Curry and Scott Stolenson, members of Peter Grant's team making long-term studies of Darwin's finches, returned to U.S.A.
John Wright and David Good came to study lizards and salamanders on Santa Cruz, Darwin, Wolf, Pinta and Marchena Islands.
Robert Lavenberg, Ann and Dan Cohen, Bill Bussing, Andy Jaks, Marty Meisler and Jim McLean came to study the reef fishes of the northern islands of the archipelago.
Juan Black, Sec. Gen. of the Darwin Foundation, arrived (9 May) with architect Hugo Galarza and accountants to assess the situation following the fire.
Under the auspices of the Canadian Broadcasting Corp., Nancy Archibald and Rudolf Kovanic came to make television films.
Lisle Gibbs and Steven Latta of the Peter Grant group returned to U.S.A.
Malcolm Coulter, formerly staff ornithologist, returned to make a short study of the Blue-footed Booby and to review the programme to protect the Hawaiian Petrel on Floreana.
Mario Hurtado took up his post as staff marine biologist.

A SALUTE TO OUR FOUNDERS

by

Peter Kramer

Twenty-five years ago, on 23 July 1959, sponsored by the Government of Ecuador, UNESCO and IUCN, the Charles Darwin Foundation was established according to Belgian law. Under the stimulus of alarming reports from I. Eibl-Eibesfeldt and Robert I. Bowman and a resolution by the 1958 International Zoological Conference, much-needed action was at last taken to halt the decline of the unique ecosystems of the Galapagos Islands. A most distinguished organizing committee of scientists and conservationists was formed consisting of:

Honorary President
President
Vice-President
Secretary-General
Secretary for the Americas
Council Members

Sir Julian Huxley
Victor Van Straelen
Luis Jaramillo
Jean Dorst
Robert I. Bowman
Jean-G. Baer, Cristóbal Bonifaz Jijón, François Bourlière, Harold J. Coolidge, Bernhard Rensch, S. Dillon Ripley, Peter Scott, W. Randolph Taylor.

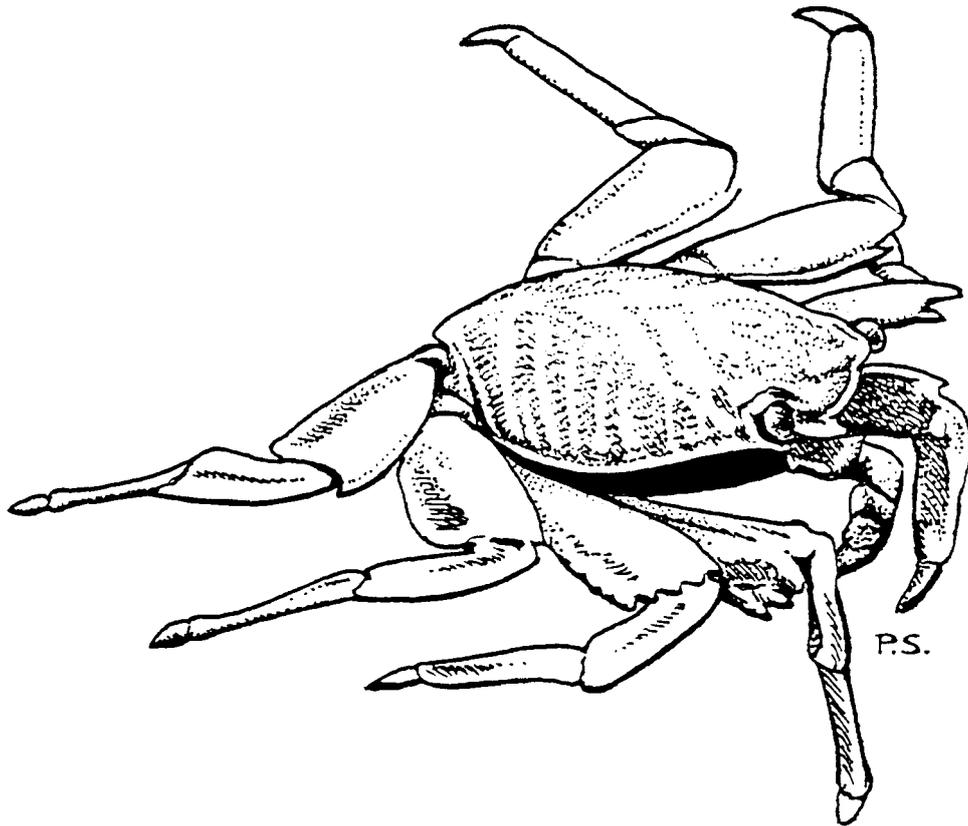
A quarter of a century has taken its toll of these Founders but some are still members of the Executive Council and have meanwhile risen to positions of eminence in the world of conservation and science. Dr. Coolidge is Honorary President of the International Union for Conservation of Nature; Professor Dorst, after serving 15 years first as Secretary-General, then as President of the CDF, became Director of the National Museum of Natural History in Paris; Mr. S. Dillon Ripley became Secretary of the Smithsonian Institution and President Emeritus of the International Council for Bird Preservation; Sir Peter Scott is Honorary Director of the Wildfowl Trust, President of the Fauna and Flora Preservation Society and Chairman of the World Wildlife Fund International.



Victor Van Straelen and Robert Bowman at the Inauguration of the Darwin Research Station, 1964.
Photo by A. Gille (UNESCO)

These last twenty-five years have seen the reversal of two centuries of deterioration of the environment and have given us confidence that the grave problems still remaining, many of them unsuspected in 1959, will be tackled courageously in order to ensure the long-term preservation of the unique Galapagos ecosystems. Profound changes have already taken place and this is in large measure due to the fortunate circumstance that a group of outstanding and far-sighted men joined together to launch the Foundation on its successful course under the dynamic leadership of the late Professor Van Straelen, who died at the end of his arduous journey to Academy Bay on Santa Cruz Island to inaugurate the Charles Darwin Research Station.

The Charles Darwin Foundation was indeed lucky to have had such Founders and it is to them, whether they are still with us or not, that we pay tribute on this our twenty-fifth anniversary.



Sally Lightfoot Crab
Drawing by Peter Scott

THE CHARLES DARWIN FOUNDATION CHANGES ITS PRESIDENT

Peter Kramer will no longer be President of the Charles Darwin Foundation but he will continue to serve Galapagos science and conservation in yet another capacity.

Peter first went to the Galapagos as a young research scientist in 1962-63, studying the behaviour of Darwin's finches and the rock crabs. In those days he was so fleet of foot that he could out-run and capture a wild goat. What he may have lost in speed he had made up in wisdom and scientific knowledge by 1970 when he returned to Academy Bay as Director of the Charles Darwin Research Station, a post he held for 3½ years. In addition to the inevitable administrative duties, each station director has made his own individual contribution to the development of Galapagos conservation: Peter's personal emphasis was on closer relations with mainland Ecuador, particularly in the field of education and, of course, he played a vital role in the elaboration of the Master Plan for the Galapagos National Park, setting out the guidelines which have led to such notable progress in the last ten years.

When he left the islands in December 1973, he modestly hesitated to accept the offer of the CDF Presidency in succession to Jean Dorst, who so splendidly had served the Foundation for its first fifteen years as Secretary-General and President. Moreover the arduous demands of paper-work and travel on the time of any CDF president were bound to conflict with his career as a university teacher. When he accepted the post in 1974 he was already aware of the rival claims of academic research and conservation. It seems that, at least for the immediate future, the latter has prevailed as he has now taken up the post of Director of Conservation of the World Wildlife Fund International.

We could say that our loss is the WWF's gain: but Peter is not lost to us. From its earliest days, the WWF has given unfailing support to the Galapagos and, from his new post, Peter will be able to direct future projects with an unrivalled knowledge of the islands' needs and peculiar conditions. The Darwin Foundation owes so much to the WWF: perhaps this is one way in which we can make repayment. For our part, we can only express our deep gratitude to Peter for more than twenty years devoted service to Galapagos science and conservation.

As Peter has to leave us, we are happy to be able to welcome another old friend as our new President. Craig MacFarland and his wife, Jan, have already spent years in the islands. Like Peter, Craig first came to Galapagos as a research scientist and did some most constructive work on the giant tortoises from 1968 to 1971. When Peter became President, Craig succeeded him as Director of the Research Station from 1974 to 1978 and now follows him again as President of the Charles Darwin Foundation.

It is remarkable how the cause of Galapagos conservation has generated enduring fidelity among our group and the Foundation is indeed fortunate in enjoying such continuity in its leadership.

G.T. Corley Smith

PROTECTING THE HAWAIIAN PETREL

by

Felipe and Justine Cruz, Jaime Astudillo and Hugo Sanchez

After years of frustrated effort, the first good news about the Hawaiian Petrel was given in Noticias 39. Although numerous, this splendid oceanic bird seemed doomed to slow extinction, due to the relentless depredations by introduced rats, cats and pigs, until Felipe Cruz and his wife, local residents in Floreana, began to implement a long-term project mounted by Malcolm Coulter, staff ornithologist at the Darwin Research Station, and financed by the World Wildlife Fund. The project only covers one colony on one island: elsewhere the petrels continue to be decimated. Nevertheless the preliminary results of the 1984 protection campaign show a remarkably steep rise in breeding success since predator control measures were introduced. Given the men and the money, the only Galapagos bird immediately threatened with extinction can be saved.

The Hawaiian (or Dark-rumped) Petrel, *Pterodroma phaeopygia*, begins its breeding season on Floreana Island in early December. After a month of aerial courtship and nest-making, a single egg is laid in a burrow and then incubated by both birds in turn, taking spells of 7 days each over a period of about 50 days. When the chick hatches, one of the parents remains with it in the nest for 2-3 days, feeding it with regurgitated oil and semi-digested sea-food. After that the chick remains alone in the nest for some 120 days, being fed by its parents every 3-5 days. By then it should be ready to fly and fend for itself.

In the colony at Cerro Pajas, rat control begins in December and continues until June, by which time the chicks should be out of danger. We control the rats by distributing poison baits (see the article by David Duffy in Noticias 39) throughout the breeding area. In the first days of December, the consumption of poison (Racumin) was as high as 9,000 grams a day, but by the end of the month it had fallen to 1,400 grams a day, a level maintained until the end of May. This shows a drastic reduction in the number of rats in the colony, and this year we do not seem to have lost any chicks by predation.

So far we have had no trouble with either pigs or cats, although we have found traces of the latter around the boundaries of the colony. We set traps for the cats without any success but we did succeed in shooting four.

For this fourth year of our petrel studies we decided to monitor 100 active nests, visiting them once a week. Most of the eggs were laid in February, only a few in January or March. The last of the eggs hatched at the end of April, and we now (June) have 72 chicks aged between 1.5 and 3 months. We shall continue to monitor them until September by which time we reckon that the last of them will have flown.

As a control we also have 40 active nests in the same colony which we shall visit only once more. This should help to show what effect monitoring visits have on breeding success. We could not find any separate colony with enough active nests to serve as a control. It was a pity that the colony at Cerro Verde had been destroyed by the force of the 1983 El Niño and that the colony at Cerro Azul had been invaded by the Fire Ant, *Wasmannia auropunctata*. In this area *Wasmannia* must have extended its range by 150 metres during 1983-84.

Without the devastation caused by last year's El Niño and with the rigorous control of rats and cats, this has certainly been a successful reproductive season for the petrel colony on Cerro Pajas. In 1982, before rat control was practised, 13 chicks were fledged in the 43 nests we monitored. In 1983, with control, 48 chicks were fledged in 104 nests. In 1984, 72 chicks were fledged in 100 nests.

INTERIM REPORT ON THE MARINE IGUANA SITUATION IN THE AFTERMATH OF THE 1982-3 EL NIÑO

by

Andrew Laurie

Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ

Dr. Laurie has been studying the population dynamics of the Marine Iguana since 1980, as reported in Noticias 35-39. His original three-year research programme, supported by the Leverhulme Trust and The Royal Society was disrupted by the unprecedented severity of the 1982-83 El Niño phenomenon which drastically reduced the various iguana populations scattered across the archipelago (see Noticias 38). His research project was extended for a fourth year to permit him to study the effects of the cataclysm and his interim observations are summed up in this report. He is returning to Galapagos for a fifth year, this time funded by the Max Planck Institute at Seewiesen, in order to follow up further developments in the breeding of this unique Galapagos lizard. The fact that he was already studying the animal under normal conditions puts him in a particularly strong position to assess the changes due to this climatic catastrophe and emphasises the advantages of long-term research.

The sea level and sea-surface temperatures in Galapagos had returned to the normal range for the time of year by September 1983, and the dense mat of *Giffordia* algae had begun to disappear by early November and was almost completely gone by December. The response of the marine iguanas was almost immediate. There was no more than normal mortality after August 1983 and the adults had returned to an average of ten per cent below their pre-El Niño weights by November. Overall mortality over the previous 12 months was estimated at 65% on Santa Fe, with the 1982 hatchlings suffering the highest mortality (90%). On other islands the overall mortality rate varied from 45% to 70% and was lowest of all at Caleta Webb, Isabela. It appears to have depended to some extent on the relative importance at each site of sub-tidal and inter-tidal feeding, with the sub-tidal feeders generally surviving better than the inter-tidal feeders. Higher sea levels made inter-tidal feeding relatively more difficult than sub-tidal feeding, and the invading indigestible algae were more abundant in the inter-tidal zone.

At our control station, on Santa Fe island, where there are no complications due to introduced predators, David Harris and I prepared to watch the iguanas as usual through the breeding season, but it very soon became apparent that the course of events was going to be very different from normal. There were only 25% of the normal number of territorial males, despite large numbers of non-territorial males nearby, and each territorial male defended a larger territory than normal but gained access to about the usual number of females. Many of the previous years' territorial males had died during El Niño but, in the main colony, the most successful male from the 1981-1982 season returned to his former, prime, territory after spending the 1982-1983 season as a bachelor male, and seven of the males from inferior territories returned for the third consecutive season to the same territories.

Territorial defence was less intense than normal, with fewer extended fights; but the main difference was in the reactions of the females, who consistently avoided the males' approaches. Not a single copulation was observed although almost continual surveillance of the main colony was maintained during daylight hours. In each of the two previous years about 60 copulations were observed within a much shorter time. In the 1981-82 and 1982-83 seasons the males finished mating by early January, but in the 1983-84 season territorial defence continued right through until early March, with the difference that the territory holders fed more frequently and lost significantly less weight than in a normal year.

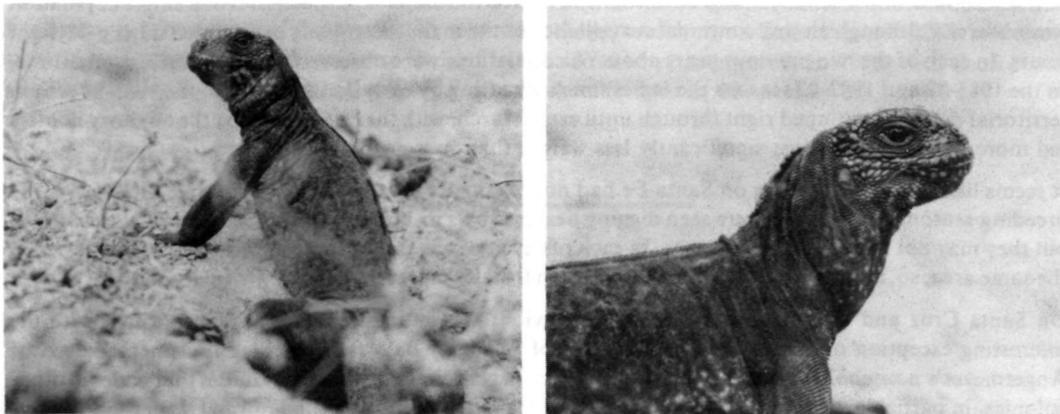
It seems likely that the females on Santa Fe had not regained breeding condition in time for the 1983-84 breeding season. Ten females were seen digging nest burrows in January, which is the normal time for it, but they may not have actually laid eggs. In each of the previous three years about 1,800 females nested in the same area, so, allowing for 65% mortality, the ten females represent only 1.7% of a normal year's total.

On Santa Cruz and Caamaño the territorial behaviour was much less intense than normal, with the interesting exception of a colony on the west side of Academy Bay whose diet is supplemented by Karl Angermeyer's household scraps. I received reports from National Park Tourist Guides that males in other colonies, in particular the one at Punta Espinosa, were much less active than normal. Later, hardly any nesting took place at Punta Espinosa, and elsewhere on Fernandina the amount of nesting was

considerably below normal, taking into account the depletion of the population. There was no appreciable nesting at James Bay, but at Cabo Berkeley extensive nesting had already finished when we visited the area in mid-March, and at Caleta Webb normal nesting was in progress. On islands such as Santa Fe and Fernandina where nesting is normally early (completed in February) the females, still under their pre-El Niño weights at the start of the mating season, failed to breed; whereas on islands such as Española and Isabela, where breeding is normally late (nesting completed by late March or early April), they had presumably recovered breeding condition, and nested normally. On islands such as Santa Cruz, North Seymour and Caamaño, where the time of the nesting season is intermediate (completed by early to mid-March) there was less nesting than in a normal year but considerably more than on Santa Fe and Fernandina. However, it appeared that at Punta Nuñez and on Caamaño many females were digging nests but not laying eggs. One female who died while excavating her burrow was found not to be carrying eggs, and hand examination of other digging females suggested that they were egg-less. Subsequent excavation of some nest burrows failed to uncover any eggs, and a large number were left unfinished. Some females undoubtedly did lay eggs, and hatchlings have already been reported from Academy Bay and North Seymour by various helpful informants. Interestingly, no hatchlings have been recorded from Fernandina or Santiago but some have been seen on Española.

Back in Britain experiments have been carried out in Colin Orpin's laboratory at the Institute of Animal Physiology, Babraham, to compare the digestibilities of samples of algae collected during and after El Niño. As it was impossible to use the digestive fluids of marine iguanas the experiments were done with artificial saliva and sheep rumen fluid so that at least a comparison could be made between the different species of algae. The main, and very striking difference which emerged was in the organic matter digestibility of *Giffordia* (21% in November 1983) compared with the other species, all of which were over 50% and several of them over 70%. The reason for this difference is not known and further analyses are planned. Veterinary examination by John Cooper, at the Royal College of Surgeons, of marine iguanas which died during and after El Niño show that apart from being generally much fatter with expanded digestive tracts, those which died after El Niño had accumulated considerable fat deposits in their livers.

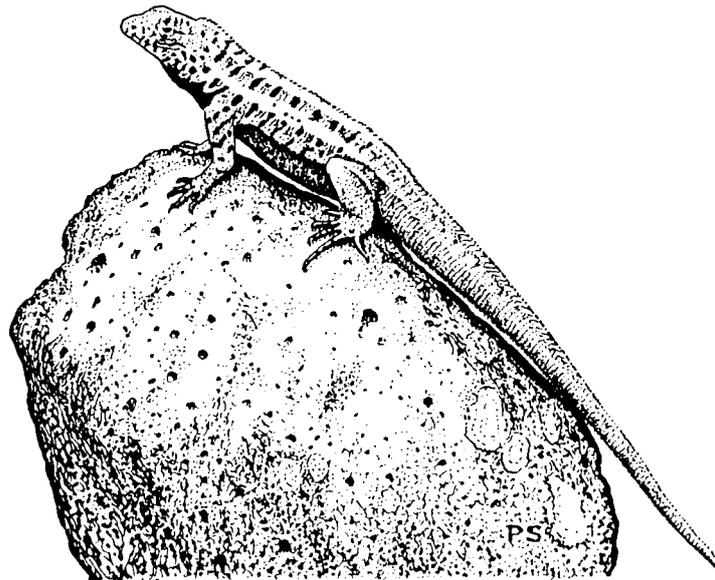
The original aims of the project have been frustrated to some extent by El Niño; very unusual growth and survival rates have been recorded and many of the marked individuals whose reproductive histories were being followed died last year. However, the importance of El Niño in population regulation has emerged, and useful comparisons can be made between the 'normal' year (1981-82) before El Niño and the very exceptional El Niño year (the last El Niño of comparable severity is thought to have been that of 1877-78). Recovery of the population from such heavy mortality in a species with such a low reproductive rate would be expected to take a long time. Using growth rates and reproductive rates recorded on Santa Fé in 1981-82, calculations indicate that the population would take well over one hundred years to return to its 1982 size. However, there are already indications that the reduced population density, possibly through reduced competition for food, has led to increased growth and survival rates and will bring forward the age of sexual maturity. For example, the 1981 hatchlings grew an average of 40mm in their first year and increased an average of 81gms in weight compared with 46mm and 132gms for the 1983 hatchlings.



A baby Marine Iguana emerging for the first time from the burrow where it hatched — a rare sight in 1983, a year when so few were born. Body length about 10 cm, tail 15 cm, weight about 60 grams.

The effects of El Niño on the 1983-84 breeding season were considerable and to complete the study another season of fieldwork is planned for 1984-85. Observations on Santa Fe may provide the first unequivocal data on female sexual maturity, as next season is likely to be the first in which the marked 1981 hatchlings nest. Other islands will be checked for the presence of 1984 hatchlings, the 1985 nesting season will be monitored, and data will be collected on clutch size and egg weights in an attempt to answer the question why large females such as those on Isabela do not appear to lay considerably larger clutches of eggs (as would be expected from energetic considerations) than the smaller females on other islands. It is also hoped to collect data on nest-burrow temperatures and humidity on various islands. There is not, as is stated in the literature, a clear trend from west to east in onset of breeding season: Santa Fé has the earliest season, followed by Fernandina; and southern Isabela and Española have the latest seasons. The fact that the females on early-breeding islands did not breed later this year after recovering their pre-El Niño weights implies that there is a cut-off date after which females refuse to mate. It is possible, but by no means clear exactly how, that differences in incubation conditions between islands might account for differences in timing of breeding seasons. If any readers have any thoughts on the matter, or any other iguanine matter, I would appreciate hearing from them.

I am very grateful to all those, too numerous to mention by name here, who have helped in the past by sending me notes of their observations in the islands and in particular to Teresa Kineke for collecting her and others' observations together and sending me regular bulletins.



Male Lava Lizard
Drawing by Peter Scott

PROBLEMS OF REINTRODUCING NATIVE ANIMALS ON ISLANDS WHERE THEY HAVE BEEN EXTERMINATED

by

Tjitte de Vries

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The symposium held in Quito in March 1982 (see Noticias 38, pp. 18-21) has evoked several commentaries (Noticias 37, pp. 14-17; Noticias 39, pp. 20-23, pp. 28-30). This type of feedback is very important for the Foundation and helps the Darwin Station and the National Park Service to reach sound decisions.

The reintroduction of native animals in deteriorated environments is complicated. I agree with John Faaborg (Noticias 39) that it would be beautiful to have the majestic Galapagos Hawk (*Buteo galapagoensis*) back on San Cristóbal and Floreana. If it ever did occur there. I have found no definite records!). Faaborg states: "I can envision no major natural problems with introducing these birds on empty islands where the species occurred previously ... In terms of diet, the hawk is generalized enough to adapt to about any combination of available foods on these islands, while all the prey species have coexisted with hawks for many years in the past".

But there are conflicting interests which were discussed at the Quito meeting.

Extinction of the hawk on San Cristóbal, if it did formerly occur there, most probably was caused by direct action of man; but at the same time, it must be remembered, their main prey, the Galapagos Dove and the native Galapagos rat (*Oryzomys galapagoensis*) have likewise been exterminated or severely depleted. Hawks would have to feed on lizards, finches, mockingbirds, marine iguanas and at times on the placenta of sealions, all prey items which are not abundant on San Cristóbal. I have always wondered why not even a small population of hawks has survived in the north of San Cristóbal (Punta Pitt), far away from any human settlements. On Santa Cruz, after more than 50 years of human colonization, 2-3 pairs still survive around Conway Bay, in the northwestern part of the island, away from man. Is it perhaps due to a lack of adequate prey that there is no comparable situation on San Cristóbal?

Floreana presents other conflicting conservation problems. Although hawks would take an occasional black rat, their main prey would be placenta of sea lion (periodically), marine iguanas, lizards and ground finches. They might also make excursions to the nearby islets of Gardner, Caldwell and Enderby to prey on the young sea birds, mainly boobies. A hawk population based around Punta Cormorant could visit tiny Champion Island, or even establish itself on Champion and make visits to Floreana (just as the resident pair of hawks on Gardner-near-Hood hunt on mainland Hood). What then, would be the consequence for this miniature satellite of Floreana?

At the Quito meeting there were conflicting opinions on whether it was the hawk that should be reintroduced to Floreana or the Charles Mockingbird, a species which is now extinct on Charles (Floreana) Island itself, from which it took its name. This species has probably the smallest population of any Galapagos land bird; one might perhaps argue that the Mangrove Finch is even lower in numbers but certainly the Charles Mockingbird is confined to the smallest area. The presence of hawks would hardly improve its prospects of survival.

It was such considerations as these that led to the symposium's 12th resolution: "That the re-introduction of native organisms in deteriorated areas has no priority."

THE TERCENTENARY OF THE LITERARY PIRATES IN THE GALAPAGOS

by

G.T. Corley Smith

Three hundred years ago various piratical crews descended on the Galapagos. One of the leading buccaneers, Captain Bartholomew Sharp, stated their purpose with disarming frankness: "Twas gold was the bait that tempted a pack of merry boys of us, near 300 in number, being all soldiers of fortune." Technically, they were criminals, liable to hanging according to the laws of their own countries, but so long as their exploits were confined to the Spanish colonies their misdeeds were not regarded very seriously — except by the Spaniards. The Spanish Pope, Alexander Borgia, had generously granted Spain most of the New World but the French, English and Dutch had never admitted the Pope's right to share out the earth, all the more so as the Spaniards excluded other nations from even trading with the new lands. This led to a state of endemic warfare in the New World. Even when England and France were at peace with Spain in Europe, it was tacitly accepted that there was "no peace beyond the line" — that is, roughly speaking, west of the Azores. So the Spaniards plundered the Americas and buccaneers plundered the Spaniards, preferably by seizing their treasure ships laden with silver and gold from the land of the Incas.

By any standards they were an interesting lot of ruffians: "Gold was the bait" no doubt for most of them but some must have had other motives. Among these were the simple love of adventure, the desire to see strange new lands and, in a few cases, the thirst for knowledge. Many of them deliberately chose to return home from the Spanish Main by sailing on westward and circumnavigating the earth, as though insisting,

"..... we shall go
Always a little further: it may be
Beyond that last blue mountain barred with snow,
Across that angry or that glimmering sea."

"Always a little further" might have been the motto of the minority for whom loot was not the main attraction and these were the men whose writings made the Galapagos known to the world. Bishop Tomás de Berlanga had sent a masterly description to the Emperor Charles V when he reluctantly discovered the islands in 1535 but his despatch was gathering dust in the archives of the Council of the Indies at Seville and was apparently unknown even in Peru. It was the pirates, particularly the surprisingly literary members of the crew of the *Bachelor's Delight*, who were the first to publicise the Galapagos.

The *Bachelor's Delight* arrived in the Galapagos in 1684. The crew, some seventy strong, set out from Virginia in 1683 in a ship they judged too small for their nefarious purposes. So, by an act of deliberate piracy, quite unconnected with the Spanish question, they captured a "lovely" Danish slave-ship of 40 guns, renamed her *Bachelor's Delight*, and in her braved terrible storms while rounding Cape Horn into the Pacific. Their purpose was to raid Spanish towns and ships and they had heard only vague rumours about the Galapagos. Sir Francis Drake, their highly successful forerunner, had not even mentioned these islands and was believed to have divided his rich spoils, including "26 tunne of uncoyned silver", on Isla de la Plata (Silver Island), much closer to the shores of mainland Ecuador. Sir Richard Hawkins, another Elizabethan sea-dog, dismissed them in one contemptuous sentence: "Some fourscore leagues to the westward of this cape lyeth a heape of Illands the Spaniards call Illas de los Galapagos; they are desert and bear no fruite". Captain Bart Sharp wrote that in 1690 he had "a Design to visit the Isles of Gallapallo" but apparently he never found them or was unable to land owing to the confusing tides and currents, which caused early sailors to question whether the islands were real, enchanted, or simply floating.

The *Bachelor's Delight* decided to look for them. Spanish defences had improved since Drake's time and it seemed prudent for the pirates to lie up further from the mainland. The Galapagos seemed a safe haven to rest and careen their ships and there was the added reason that their commander, Captain John Cook, was gravely ill. As Edward Davis (Cook's successor as Captain) recorded: "knowing that wee had more than an hundred prisoners on board and not knowing where to get water, nor where to find a place of making a Magazeene for flour but that wee should be hunted out and have our flour destroyed, wee sailed to the

Westward to see if wee could find those Islands called the Galipoloes, which made the Spaniards laugh at us telling us they were Inchanted Islands, and that they were but shadowes and noe reall Islands”.

After sailing for three weeks from Peru they reached the islands and took Captain Cook on shore. Cook’s illness (he had not long to live) had a regrettable consequence for students of Galapagos wildlife because William Dampier, the most prolific writer in the ship, looked after him and was thus prevented from studying the flora and fauna of more than one island. Not all pirate captains were treated as tenderly as John Cook. For instance, Bart Sharp complained that his crew “took my ship from me, clapp’d me up Prisoner and advanced one John Watling to the chief Command” — though they did unanimously re-elect him some weeks later.

Although he would not have known the word, Dampier was the first “scientist” to visit the Galapagos. In spite of his terrifying reputation, second only to Drake’s in the Spanish Pacific colonies, he was not a very bold or successful buccaneer and never commanded a pirate ship, but he was driven by a passion to visit unknown lands and to discover and record new facts about the natural world. To protect his notes, he tells us, “I took care to provide myself with a large joint of bamboo, which I stopped at both ends, closing it with wax, so as to keep out any water. In this I preserved my journal and other writings from being wet, though I was often forced to swim.” His bamboo was probably the only possession he never lost during a lifetime at sea, during which he sailed three times round the earth. Wherever he went he noted all that was curious and new in plants and animals. It was unfortunate that his attendance on his sick captain confined him to a single island but he wrote pages about the strange tree cacti, the giant tortoises, the iguanas and particularly the turtles which he described and compared with those in other oceans, discussing their shape, size, weight, colour, habits and sex-life. The fact that Dampier observed, recorded and compared, justifies the claim that he was the first Galapagos naturalist. He did not return round Cape Horn with the *Batchelor’s Delight*, but transferred to another ship, the *Cygnnet*, not because he disliked his Captain but because it gave him the chance to return to England by sailing round the world, seeing new lands, new peoples, new animals and plants. He probably served in a dozen different ships during the twelve years that his first world cruise lasted. Dampier, the pirate, arrived back in England as poor as when he set out, apart from the notes preserved in his “joint of bamboo”.



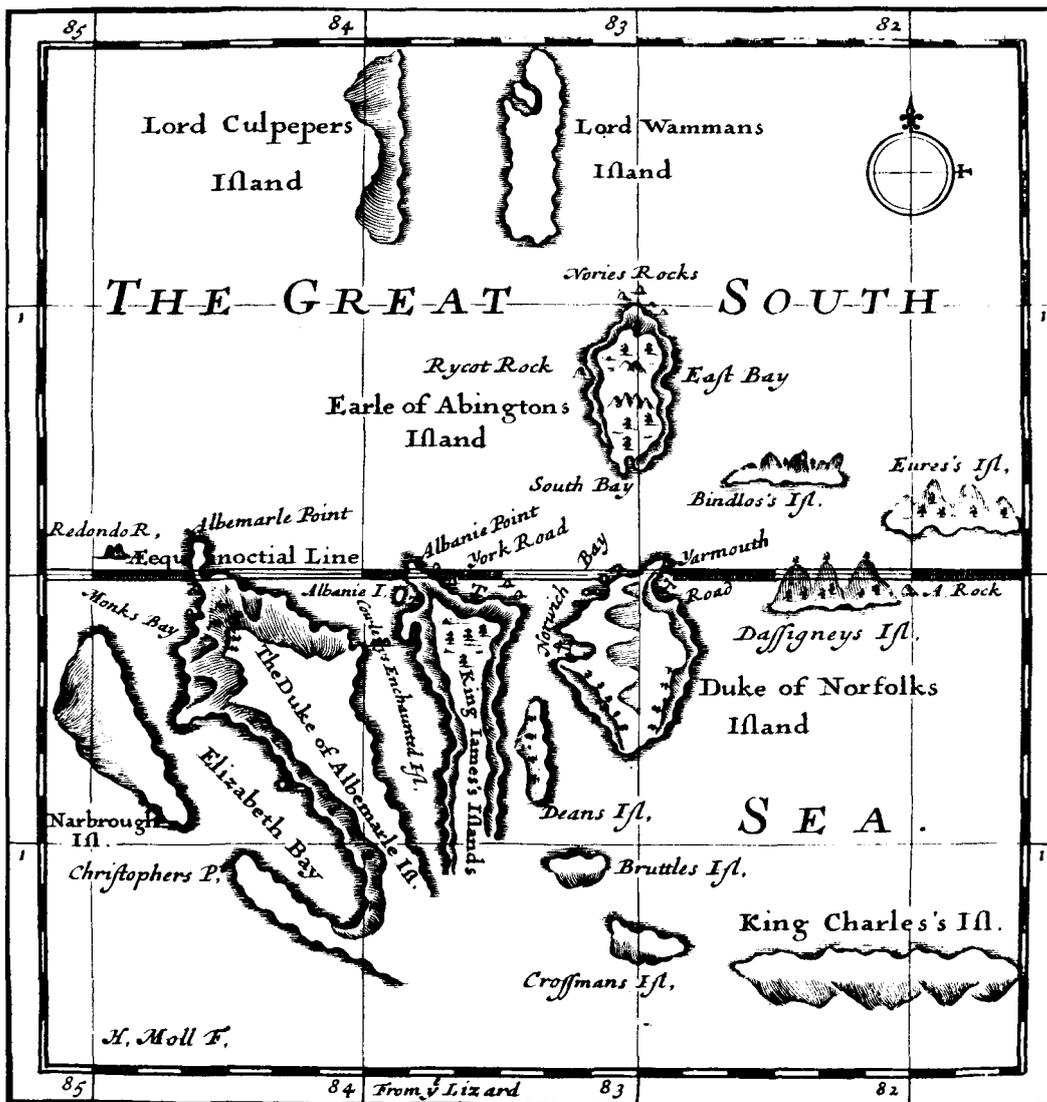
On his return he published his story, *A New Voyage Round the World*, which started a new literary vogue and earned him fame instead of hanging. He dedicated his book to the President of the Royal Society, a newly formed scientific body, which responded to the growing spirit of enquiry of the age. It ran into several editions and translations, and nearly a century later young Horatio Nelson considered it the best travel book he had ever read. Dampier was a distinguished navigator and his interests included meteorology and hydrology as well as zoology and botany, and he published a learned *Discourse of Winds, Breezes, Storms, Tides and Currents in the Torrid Zone*. His books brought him into contact with the foremost of men of science of the day.

WILLIAM DAMPIER
“PIRATE AND HYDROGRAPHER”
Painting by T. Murray, c. 1697-8

(Courtesy of the National Portrait Gallery)

Although of little formal education, he had the basic instincts of a true scientist: the thirst to acquire, record and impart knowledge. After his first long voyage he made two more circumnavigations of the earth, but on these occasions he was no longer a pirate and enjoyed official support. His name is perpetuated in Australia where Dampierland and other geographical features recall his visit. His picture in the National Portrait Gallery in London bears the somewhat unusual caption, "William Dampier, Pirate and Hydrographer". This might not have surprised him though he would probably have preferred to be described as "Author, Naturalist and Explorer"; but at least his portrait shows him holding a book, not a cutlass.

William Ambrose Cowley had transferred to a prize ship taken off the coast of Peru, and thus had the opportunity to travel more widely in the archipelago. While it would be technically incorrect to say that he put the Galapagos on the map — the early cartographers, Ortelius and Mercator, had indicated their approximate position — Cowley was the first to draw a chart showing the individual islands. By modern standards it was a rough affair but it served navigators for over a century. A patriotic pirate, he loyally named the islands after members of the English establishment, whose laws and authority he was flouting. He began with a proper respect for protocol: "The first that we saw lay near the lat. of 1 deg. 30 min. South



First chart of the Galápagos Islands, made by Ambrose Cowley in 1684.
 Source: *Collection of Original Voyages* (1699), Capt. W.A. Cowley
 (Cambridge University Library)

... the which I called King Charles's Island". The next he named The Duke of York's Island, after the King's brother but, on learning that he had succeeded to the throne, he dutifully changed it to King James's Island. Others he named after the Duke of Norfolk and other bigwigs — and finally one for himself. "To the Westward of the Duke of York's Island, lieth another curious Island, which I called the Duke of Albemarle's Island in which is a commodious Bay ... and before the said Bay lieth another Island which I called Sir John Narborough's and between York and Albemarle's Island lieth a small one, which Fancy led me to call Cowley's Incharned Island". The Duke of Norfolk's name has been several times superceded (nowadays the island is generally called Santa Cruz) but Cowley's little "Incharned Island" is still known as Cowley.

Most of the 17th century pirates — or at least most of those who survived storms, fevers and battles — returned to Europe by circumnavigating the earth. Dampier and Cowley, thirsting for further travel, chose this route but the *Batchelor's Delight*, under Captain Davis and with Lionel Wafer still on board, braved the tempests of Cape Horn a second time and arrived at Philadelphia. Wafer mentions that they learned that King James II, on his accession to the throne, had pardoned all buccaneers who renounced their evil ways. Nevertheless there is a story that Wafer was heavily fined when he tried to make his home at Point Comfort on James River in Virginia. In his journal he is deliberately reticent about this apparently painful matter. "There I thought to settle. But meeting with some Troubles I came home to England". In London he followed the example of Dampier, Cowley, Ringrose, Sharp and Davis and published an account of his travels to the Isthmus of Panama and Galapagos.

The buccaneers who returned to England do not seem to have been incommoded in any way or even thought the worse of an account of their piratical past. The reading public loved their stories of adventure in strange lands. They set a new literary fashion and, surprising as it may seem, indirectly influenced the development of the English novel. Alexander Selkirk, the navigator of the pirate ship, *Cinque-Ports*, had been left behind by his captain on Juan Fernandez Island, either against his will or because he thought the ship was leaking too badly to sail back round Cape Horn. He was quite right and the crew of the *Cinque-Ports* had to abandon ship and surrender, spending long years in a Spanish jail. It is an interesting reflection on contemporary attitudes to piracy that the Spaniards did not hang them. Selkirk was eventually rescued by Captain Woodes Rogers and Dampier during the War of the Spanish Succession; he took part in an attack on Guayaquil, visited the Galapagos and returned to Europe via Guam and the Cape of Good Hope. His years of solitude on his island gave him brief celebrity in England when his story was written up in a brilliant essay by Richard Steele.

It is uncertain whether Selkirk ever wrote his own account or merely told his story orally to Daniel Defoe, but his ordeal certainly inspired one of the great books of all time. Defoe cashed in on the current popularity of travel stories and plundered the journals of the buccaneers as enthusiastically as they had plundered the Spaniards. Defoe was a master of English prose and he naturally outshone the laboured writings of the buccaneers, but his great novel, *Robinson Crusoe*, owes much of its colour to the nuggets mined from their journals. *Robinson Crusoe* is a landmark in the history of literature and it created a new literary genre. Translated into many languages, it inspired scores of imitators, particularly in Germany, where hundreds of novels called *Robinsonaden* were published.

It is indeed remarkable that these hard-bitten pirates should have started a literary fashion, let alone that they should have played a role in the development of the modern novel. In so doing, they made the Galapagos known to the reading public of the world. But did they also begin the degradation of the islands' ecosystems? They certainly helped themselves liberally to the tortoises, turtles, iguanas and doves. As Dampier wrote: "The guanoes here are as fat and large as any that I ever saw; they are so tame, that a man may knock down twenty in an hour's time with a club. The land-turtle or tortoise are here so numerous that five or six hundred men might subsist on them for several months. They are extraordinarily large and fat, and so sweet that no pullet eats more pleasantly". Clearly the pirates did not suffer from any conservationist scruples: but pirate ships did not have crews of six hundred (the company of the *Batchelor's Delight* numbered seventy when they left the Chesapeake) and they did not stay for several months at a time. It seems most unlikely that their relatively short visits, spread over years, can have had any permanent effect, though they presumably had some short-run impact on the tortoise population of their favourite islands, Charles (Floreana) and James (Santiago). The regular provisioning of whaling ships in the nineteenth century was quite another matter as the whalers continued for years to load their vessels with enormous numbers of tortoises — with catastrophic consequences.

The buccaneers almost certainly committed one crime against Galapagos ecology, though there seems to be no mention of it in their own or later records. They all mention careening their ships and it is difficult to believe that they hauled them up on James or Charles without rats getting ashore, as they had already done on Juan Fernandez Island, further to the south. Rats were a scourge sailors had to live with and, 130 years later, one of the reasons which obliged Captain Porter of the U.S.S. *Essex* to leave the Galapagos was that the rats were gnawing through the barrels containing his vital water supply.

There is a persistent legend that it was the pirates who introduced goats to the Galapagos to provide a future source of meat and that the Viceroy of Peru sent fierce dogs to destroy the goats. Evidence for this seems to be totally lacking. The various journals do not mention it but they do tell a similar story about Juan Fernandez. Wafer wrote that "The Spaniards had set Dogs ashore at John Fernando's to destroy the Goats there, that we might fail of Provision". If so, the Spaniards failed, because Captain Woodes Rogers recorded that the marooned Alexander Selkirk kept alive on goat meat and "was at first much pestered with Cats and Rats, that had bred in great numbers from some which had got ashore from Ships that put in for Wood and Water. The Rats gnawed his Feet and Clothes while he was asleep, which oblig'd him to cherish the Cats with Goat's flesh; by which many of them became so tame that they would be about him in hundreds and soon delivered him from the Rats". There was no mention of dogs.

It was important for sailors to have a supply of meat on Juan Fernandez, where they could recuperate after the hardships of Cape Horn, but there was no point in releasing goats on the Galapagos, where a chief attraction was the unlimited supply of luscious tortoises, turtles and doves. As Dampier wrote: "I do believe that there is no place in the World that is so plentifully stored with those animals". Moreover, the pirates had no intention of returning to the Galapagos (Dampier was the only one who ever did) so they had no incentive to leave either goats or gold. Captain Porter had four goats which escaped on James Island in 1814. He had parties of men searching for them for days and other parties searching for water for weeks, but there is no mention in his copious nature notes either of other goats or of dogs and he clearly implies that, until he lost his goats, there were no large mammals on the Galapagos. So it seems probable that the buccaneers were responsible for the introduction of rats but not for the goats, dogs and other pests, which constitute the main threat to Galapagos wildlife today.

The pirates' descriptions of the Galapagos Islands and their fauna and flora seem primitive if we compare them with the books and learned papers being published 300 years later by scientists working at the Charles Darwin Research Station; but Dampier was a not unworthy forerunner. Whatever we may think of the morality of the buccaneers, and the records suggest that our attitudes must be very different from those of their contemporaries, their writings did serve to enlarge men's minds and brought news of untravelled seas and unknown lands.

PIRATE LEGACY

by

Gary Robinson

Several large clay jars were found in James Bay, Santiago Island, during a recent underwater site evaluation connected with the proposed marine extension of the Galapagos National Park. They were buried one-third to one-half their diameter in sand at a depth of 12 to 15 meters. Seven complete jars were removed along with several fragments. All the jars were of similar shape, varying in height between 60 and 70cm, with their largest diameter of 30 to 35cm near the top and tapering gradually to a rounded point.

The presence of jars in the shallow waters of James Bay is well-known to Galapagos residents. In 1970 some dozens of jars were removed from this site and sent for study to continental Ecuador. What eventually became of them is not known. The new finds are on display in the Van Straelen Hall at the Charles Darwin Research Station.

Both James Bay and Buccaneer Cove on Santiago (James Island) are known to have been haunts of English pirates in the late 17th century. At these locations the buccaneers could find fresh water and giant tortoises which provided them with fresh meat. Heyerdahl (1963) states that in 1684 the buccaneers, including Cowley, Dampier, Davis, Wafer, Ringrose and Cook, spent 12 days in the vicinity of James Bay, dividing and storing their spoils. Eight tons of quince marmalade and large quantities of flour are reported to have been stored at James Bay but no pirate gold.

It is not uncommon today to encounter thick pieces of red clay pottery at the visitor sites at Buccaneer Cove and James Bay. Could these jars be some of those that formerly contained the quince marmalade; and could it be that they are the historical equivalent of the modern tin can, designed to be discarded once empty? Additional information is being sought.

Heyerdahl, T. 1963. Archeology in the Galapagos Islands. Occ. Papers Cal. Acad. Sci. 44: 45-51.



Clay jars from James Bay, Santiago: found on the sandy bottom at a depth of 13-14 metres.

WHY ARE FRIGATE-BIRDS COLONIAL?

by

Tjitte de Vries

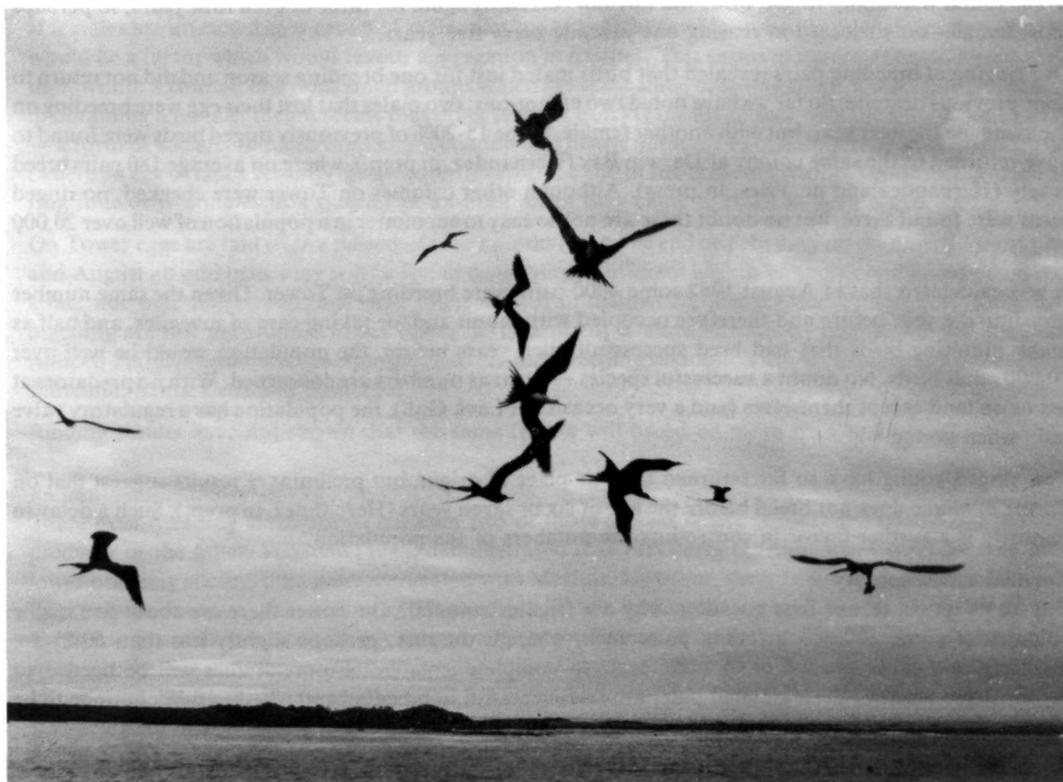
Universidad Católica del Ecuador, Apartado 2184, Quito

Colonial breeding occurs in many bird species. Some of the selective forces favouring coloniality are:

- (1) reduced nest predation resulting from communal defence;
- (2) predator swamping;
- (3) shortage of suitable nest sites;
- (4) increased foraging efficiency; and
- (5) socially induced breeding.

Only the last of these forces seems to be related to the natural history of the frigate-birds, of which there are two species in the Galapagos — *Fregata magnificens* and *Fregata minor*. Since 1975, together with a group of students from the Universidad Católica of Quito, I have studied frigate-birds on Tower and Seymour (Coello et al. 1977). With my wife Cecilia Hernandez I have visited Tower every year since then in July/August (except in 1978 when Ko de Korte went) to observe the colony of *F. minor* in Darwin Bay. With almost one thousand birds ringed, more has now become known on breeding cycles of individually marked birds and the first age of breeding. In 1983 Carlos Valle joined the frigate-bird project investigating inter-island movements and feeding ranges with dyed birds, concentrating on the colonies of *F. minor* on Tower, Pitt, and Hood Island. The present story refers mainly to *Fregata minor* on Tower.

Oceanic islands rarely have land predators and avian predators are insignificant on Tower; bushes and trees for nesting are abundant (*Cryptocarpus pyriformis* and *Bursera graveolens*). *Fregata minor* feeds far out in the ocean, perhaps sometimes in groups following schools of tuna to catch flying fish which are trying to escape from the hunting tuna.



Piratical Frigatebirds

Photograph by Fritz Pölking

Is aggression inevitable?

In "The Biology of War and Peace", Eibl-Eibesfeldt devotes a chapter to the question: Is aggression inevitable? I have often pondered this question while observing frigates. As they seem so destructive to their own species, why should they be colonial? They could easily avoid each other. Males will not only destroy an unattended nest by taking the twigs, but will also devour the eggs or small chicks. Food robbery is a frequent occurrence, particularly at times when a parent is regurgitating food for large young. When the young are less than three weeks old, feeding takes place less conspicuously while the parent is still brooding the chick; but when the parent comes flying in to feed the older, noisily waiting young, several males will be seen soaring above, ready to dive and snatch the fish away with a rapid stab and grab movement. In this context it is interesting to note that in a colony of *F. minor* a number of chicks will start calling, in contrast to *F. magnificens* colonies, where it is only the proper chick which responds to the calling parent (Coello et al. 1977).

One could also ask why it is that only the males are so piratical? Without having a definite answer it is of interest to note that the male is the smaller of the sexes and may consequently be more rapid and manoeuvrable (see de Vries, 1980). Also, it would be of interest to know which males are involved in food robbery — the non-breeding, moulting males, which would be at a disadvantage in hunting flying fish as they lack two or more primaries and some of their tail feathers, or the non-moulting, breeding males? I suspect it will turn out to be the non-breeders.

Does such aggressive behaviour by the males perform functions in the service of the preservation of the species? Wynne-Edwards (1967) treats the eating of unprotected nestlings in a chapter on "socially-induced mortality".

Frigate natural history

Several aspects of frigate biology demonstrate that there is a tendency to keep productivity low. Frigates lay a single egg and make such a flimsy nest that, even if the egg does not fall through, it can easily roll off. Eggs and small young of their own species are eaten when left unattended; slightly larger young are used in a cruel game, being passed like a ball from bill to bill until dropped and left to die. Both parents (in *F. minor*) attend to their young for as long as 16 months and so have a breeding cycle of two years. However, it was found that many ringed birds did not start breeding again for three or even four years, so perhaps most females only succeed in rearing one juvenile every five years.

Our ringing of breeding pairs revealed that birds mated just for one breeding season and did not return to their previous nest site. So far we have noted two exceptions: two males that lost their egg were breeding on the same site the next year, but with another female. Some 15-20% of previously ringed birds were found to have returned to the same colony at Darwin Bay (Hernandez, in prep.), where on average 180 pairs breed yearly (Hernandez and de Vries, in press). Although other colonies on Tower were checked, no ringed birds were found there, but no doubt these are not so easy to encounter in a population of well over 20,000 birds.

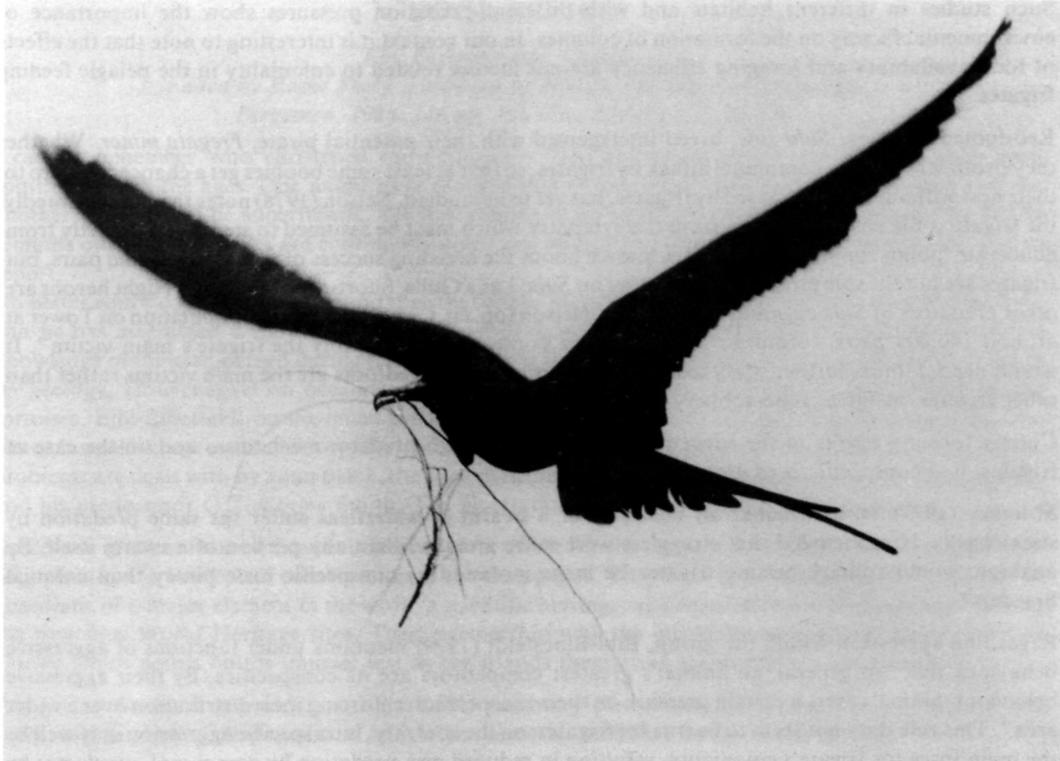
It was calculated that in August 1982 some 4000 pairs were breeding on Tower. Given the same number breeding the year before and therefore occupied with moult and/or taking care of juveniles, and half as many moulting birds that had bred successfully two years before, the population would be well over 20,000 adult birds. No doubt a successful species — as far as numbers are concerned. With no predators at sea or on land except themselves (and a very occasional Lava Gull), the population has a regulatory valve only when young.

Few ringed young have so far returned to their place of origin, but preliminary results suggest that on Tower *F. minor* does not breed before the age of six or seven years (Hernandez, in prep.). Such a delay in maturity is a further factor in controlling the numbers of the population.

Colonial versus solitary

But let us return to our first question; why are frigates colonial? On Tower there are about five major colonies of some 200-600 breeding pairs each, whereas the rest (perhaps slightly less than 50%) are breeding in smaller groups or in some cases in complete isolation. Future studies will be needed to demonstrate whether these isolated pairs are less successful in breeding and whether they continue to be isolated breeders or later become colonial.

There is still another aspect of frigate-bird life to be taken into account. Is it the male who chooses the nest site or, if not, and it is in fact the female who chooses, then one would expect that she would remain faithful to the nest site, a supposition which was found not to be true.



Male Frigatebird carrying nesting material Photograph by Fritz Pölking

If females are attracted by a group of males displaying together and ignore isolated male display, then this would be a factor which would favour aggregation in frigates. This seems in agreement with observations that, within a colony, one finds small groups which are at the same breeding stage. If one male is successful in obtaining a female, then it seems that other females quickly decide to pair with the neighbouring males — a form of socially induced breeding. Subadult and nearly adult males often fight for an abandoned nest (where an egg or chick recently disappeared) even at the end of the breeding season. I could often catch and ring four or five males in a quarter of an hour when they came to roost at such a site.

On Tower eggs are laid over a period of four months (from the end of February till the end of June; in July and August an odd male may still be found displaying). Different islands have different breeding seasons, a fact not well understood, but most likely related to distinct feeding regions. Differences in timing of breeding are not uncommon in sea birds; in Galapagos it was also recently discovered that the Dark-rumped Petrel (*Pterodroma phaeopygia*) had distinct breeding seasons on islands as close to one another as Floreana, Santa Cruz and Santiago.

Ringling results have not shown that the same frigate will breed on more than one island.

An anti-autopredatory strategy

There exist breeding associations between two or more species where at least one species is a potential predator of the other. Wiklund (1982) demonstrated that Fieldfares breeding away from Merlins had a lower breeding success than pairs associated with Merlins. However, these results in a lowland deciduous forest are in contrast with studies by Hogstad (1983) in a homogeneous birch forest where the Hooded Crow was the main predator. In this situation there was apparently no advantage in colonial compared to solitary breeding, and the number of Fieldfare pairs breeding solitary was in fact higher than the number of colonial breeders. Hogstad concludes that “nest predation is scarcely a decisive selective factor favouring colonial breeding in Fieldfares in the heath birch forest. ... The colonial breeding (or clumped distribution) of Fieldfare pairs might therefore be a result of a scarcity of suitable nesting areas, and only secondarily an anti-predatory strategy. It seems unclear which selective factors favour colonial breeding in the Fieldfare, and studies on the effect of food availability and foraging efficiency on the breeding success are needed”.

Such studies in different habitats and with different predation pressures show the importance of environmental factors on the formation of colonies. In our context it is interesting to note that the effects of food availability and foraging efficiency are not factors related to coloniality in the pelagic feeding frigates.

Red-footed Boobies, *Sula sula*, breed interspersed with their potential pirate, *Fregata minor*. Whether they profit when under communal attack by frigates, so that at least some boobies get a chance to sweep to their nest without being harassed by frigates, has yet to be studied. Nelson (1978) notes that "undoubtedly the frigate is the sole beneficiary from the sympatry which must be assumed to stem at least partly from deliberate 'policy' on its part". Little is known about the breeding success of solitary *Sula sula* pairs, but frigates are not the sole pirates and predators on *Sula*; Lava Gulls, Short-eared Owls and Night herons are other predators of *Sula* eggs and small young. Nelson (op. cit.), who estimated its population on Tower at around 140,000 pairs, considers the Red-footed Booby to be "probably the frigate's main victim". It would need, I think, further study to assess whether indeed the redfoots are the main victims rather than other frigates, as far as food-robbery and predation is concerned.

Colony forming results in the concentration of prey, an anti-predator mechanism and, in the case of frigates, it is conspecific predation.

Milinsky (1977) asked whether all members of a swarm of waterfleas suffer the same predation by sticklebacks. He concluded that stragglers were more attacked than any portion of a swarm itself. By analogy, would solitary nesting frigates be more molested by conspecific male piracy than colonial breeders?

Regarding aggression within the group, Bibl-Bibesfeldt (1979) mentions under functions of aggressive behaviour that "in general, an animal's greatest competitors are its conspecifics. By their aggressive behaviour, animals exert a certain pressure on their conspecifics, enforcing their distribution over a wider area". This rule does not seem to be true for frigates; on the contrary, intraspecific aggression may well be the main force for frigate's coloniality, resulting in reduced nest predation by communal *attack*, not by communal *defence* as is usually the case in other colonial species. This is what I would call an anti-autopredatory strategy favouring colony forming.

The biology of frigates presents several intriguing problems of population dynamics. Why they are colonial is just one of them.

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BOOK REVIEW

Key Environments: Galapagos

*Edited by Roger Perry. Foreword by H.R.H. The Duke of Edinburgh.
Pergamon, 1984. 336 pp, 126 illus. £14.95. U.S. \$19.50*

I cannot remember who christened the Galapagos "the enchanted isles", but certainly their spell continues down the ages. One might have thought that so much had been written about them that yet another book would be superfluous. Yet this volume in an interesting new series sponsored by IUCN reminds one that old books are continually going out of date and that there is always something new to report.

No better editor could have been found than the former Director of the Charles Darwin Research Station, and he has assembled a team who include most of those who have made major contributions to our knowledge of the archipelago during the 20 years since the Station was inaugurated: among them, Simkin on geology, Houvenaghel on oceanography, Colinvaux on climate, Porter on flora, De Vries on the tortoises, Eibl-Eibesfeldt on the iguanas and sealions, Grant on landbirds and Harris on seabirds. The editor himself writes on the history, Bowman on Galapagos contributions to science, and conservation problems are dealt with by Juan Black, the present Secretary General of the Charles Darwin Foundation, and his predecessor G.T. Corley Smith. The illustrations are black and white photographs.

Successive governments of Ecuador deserve great credit for the support they have given during the past fifty years to the concept of conservation in the Galapagos. They have been very conscious of being the guardians of a major element in the world's scientific heritage, and ensured that the islands were among the first four World Heritage sites. Their partnership with the international scientific community, as Corley Smith points out, is unique, just as the islands themselves are in many ways unique.

Altogether the book provides a most valuable summary of the history, natural history, ecology and conservation of the Galapagos, and is now the essential reference book on the islands.

Richard Fitter

Chairman, Fauna and Flora Preservation Society

BRIEF NOTICES

Corals and Coral Reefs of the Galapagos Islands by Peter W. Glynn and Gerard M. Wellington, with an annotated list of the Scleractinian Corals of the Galapagos by John W. Wells, was published in 1983. (University of California Press, Berkeley, \$35.00, cloth).

Gerry Wellington, a Peace Corps volunteer, spent 2 years studying the underwater environment and produced a comprehensive plan for a Galapagos Marine Park, extracts from which were published in *Noticias* 24 and 25.

Galapagos Watercolours, by Godfrey William Merlen.

On the eve of the 150th anniversary of Charles Darwin's visit, Godfrey Merlen, who has worked as a naturalist guide in the Galapagos for the last four years, has put on sale a limited edition of prints of three of his watercolours — Galapagos Penguins, Flightless Cormorants and Great Frigatebirds, each 17" x 24". At least half the price is to be donated to the conservation work of the Darwin Research Station. Price per set of three: U.S.\$100, shipping (shipped flat) \$5. Correspondence: G. Merlen, P.O. Box 2542, Quito, Ecuador. Also available from University of Wisconsin Zoological Museum, 250 N. Mills Street, Madison, Wisconsin 53706.

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