NOTICIAS DE GALAPAGOS

Published by

THE CHARLES DARWIN FOUNDATION FOR THE GALAPAGOS ISLES

An International Organization

created under the auspices of

THE GOVERNMENT OF ECUADOR

UNESCO

THE INTERNATIONAL UNION FOR CONSERVATION OF NATURE

CONTENTS

No. 29. *1979*

Published with the financial assistance of UNESCO

The Charles Darwin Foundation for the Galapagos Isles is supported by several national and international bodies but it remains largely dependant on the generosity of individual donors.

Contributions to scientific and conservation work in the Galapagos can be made through the various national organisations of the

WORLD WILDLIFE FUND

or

THE SMITHSONIAN INSTITUTION, WASHINGTON DC

or

THE CHARLES DARWIN FOUNDATION, GREENSTED HALL, ONGAR, ESSEX, ENGLAND.

NOTE:
Cheques for the WWF national organisations or for the Smithsonian Institution should carry the words "for conservation in the Galapagos Islands".

US citizens are entitled to tax deductions only on gifts to a non-profit organisation in the United States.

Enquiries may be addressed to:

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

NEWS FROM ACADEMY BAY

MEETING AT ACADEMY BAY

For the first time in its history, the executive of the Charles Darwin Foundation met in the Galapagos in November at the invitation of the Government of Ecuador. The business sessions in the Van Straelen Hall were preceded by a formal opening at which the National Anthem was sung in the presence of General Guillermo Durán, member of the Supreme Council of Government, and seven of his cabinet ministers. The Minister of Agriculture, whose department is responsible for national parks, addressed the assembly, congratulating the Foundation and the National Park Service on their remarkable achievements in the fields of science and conservation. There were still grave problems to be solved, particularly those arising from the introduced animals and plants that were doing such damage to the native species, but he believed that the answers were contained in the Master Plan. He hoped that the government would shortly publish a supreme decree giving force of law to this plan and would provide increased budgetary support for the control of alien species. The Minister paid tribute to all the international supporters of the Charles Darwin Foundation, who had made this success story possible, and in particular to H.R.H. Prince Philip, honorary life member of the Foundation.

RESCUE OF THE LAND IGUANAS

General Durán and the Ministers visited the Darwin Station and admired the rearing house and the corrals, where the endangered races of giant tortoises have been saved from extinction. They then proceeded to the new land iguana enclosures, where survivors of the Santa Cruz and Cartago Bay populations, massacred by wild dogs, are temporarily housed. The official party was particularly impressed by the tiny hatchling land iguanas, the first ever to be bred in captivity.

This is a notable achievement. These huge lizards exist only in the Galapagos where they were once very numerous. There are still a number of populations scattered over several islands – an exceptionally large one on Fernandina, where there are no introduced animals – but some have been completely exterminated and others reduced to dangerously low numbers. How far these populations are to be considered distinct species, sub-species or races is a matter still under investigation: there are certainly noticeable differences. However, irrespective of taxonomic considerations, it is the obvious duty of the Darwin Research Station and the National Park Service to try to save them all.

The present operation was initiated by a visiting scientist, Dr Dagmar Werner, who, on discovering in 1976 that sudden irruptions of wild dogs were decimating the populations at Cerro Dragon (Santa Cruz) and Cartago Bay (Isabela), interrupted her study of the social structure and behaviour of the land iguanas to mount a rescue campaign. She returned to her researches when Howard and Heidi Snell, Peace Corps Volunteers, arrived to take charge of the iguana breeding programme. This expensive project has been generously supported by the Government of Ecuador, the WWF, the San Diego Zoological Society, and, directly or indirectly, by numerous individual benefactors. All concerned are entitled to feel proud of the results.

The first problem was to form compatible groups of males and females, which was anything but simple as the social system of the land iguanas seems different from that of any other known reptile, and the inevitably cramped conditions in the temporary pens made everything more difficult. A few eggs were laid towards the end of 1977 but none of them hatched. However, five clutches were laid in the early part of 1978 and these were incubated in three different systems.

On 5 June the first captive land iguana emerged from the shell after 110 days of incubation. In July, 12 more eggs hatched. Three of these youngsters died almost immediately and two more at a later date, but the rest are apparently thriving on a diet of flowers, leaves and insects. Incubation experiments are continuing.

"The First Land Iguana Bred in Captivity" *Photo: by Howard Snell*

Concurrently with the experiments at the Research Station, another breeding project involved the transfer of 38 surviving Santa Cruz iguanas to Venecia, a small satellite island, where it is hoped they will be safe from the dogs. This islet has the same climate and vegetation as their previous breeding area but lacks suitable soil for digging burrows. It was, therefore, necessary to carry 100 tons of soil to Venecia – an enormous task. Burrowing has begun. Breeding, it is hoped, will follow.

Meanwhile work has started on large corrals, (100 x 100 metres) on the plateau behind the CDRS, which will reduce the congestion in the temporary pens and improve breeding prospects by creating conditions approximating to those in the wild.

Surveys of all the other land iguana populations are under way, particularly on Isabella, the largest island, where the dangers to which the small scattered groups are exposed vary on each of its five major volcanos; dogs, cats, rats, pigs, donkeys and cattle all do harm in different ways although they are not all present in any one area. The sheer size of this island, with its rugged terrain and volcanos up to 5000 feet in height, is a most daunting factor, particularly when combined with a complete cross-section of the most damaging introduced animals. The NPS and the CDRS are tackling the problems of conservation on Isabela with determination, as other endemic species besides land iguanas are at risk.

CONTROL OF INTRODUCED SPECIES

It has been obvious for some time that much the greatest threat to the native flora and fauna of the Galapagos arises from the "exotic" species, introduced by man. Two interrelated factors have prevented the liquidation of this threat: lack of funds and lack of knowledge. Following the recent meetings of the Executive Council, the Darwin Station and the National Park Service are hopeful of increased support to enable them to stage a more vigorous attack on both fronts in 1979.

The NPS is convinced that by the end of 1978 the last goats had been eliminated on Hood Island (Espanola). It was once thought that this island of 58 square kilometres was so large that the goats could never be totally eradicated. The job has been finally completed organising a large force of hunters with walkie-talkies, almost on the lines of a military operation. Such an expenditure of manpower seems extravagant but Hood is now believed to be entirely free of all introduced animals and can again provide a satisfactory home for its native tortoise, *Geochelone elephantopus hoodensis*, until recently believed to be doomed to extinction. Such a once-and-for-all expenditure is economically justifiable as the NPS can now concentrate on other targets and it proposes to apply the same intensive methods first to Pinta (Abingdon) and then to Marchena (Bindloe). James (Santiago) still seems too big for an eradication campaign but we once said that about Hood. The government has promised to provide funds to double the number of hunters and experiments are being made with electrified fences.

A deeper understanding of the various introduced pests that endanger both flora and fauna should eventually provide more effective controls than hunting. Luis Calvopina and others continue the study of the James Island goats. One new departure on James was to build a goat-proof fence across the narrow neck of the Pinacle Peninsula on Buccaneer Bay to protect its large community of endemic plants. Robert Tomkins (our first Australian staff scientist) has begun his investigation of how to prevent the extinction of the Hawaiian Petrel, the splendid pelagic bird that is menaced by rats, cats, pigs and dogs, when it comes ashore to nest. Hans Kruuk (at present with the Institute of Terrestrial Ecology in Scotland) is due in Galapagos in January to make a pilot survey of the dog problem; he will then discuss his findings with the U.S. Fish and Wildlife Service with a view to devising more effective action than has been possible with present methods. Michael Konecny (University of Florida), who has already made three preliminary visits to the Galapagos, hopes to begin his basic investigation of the feral cats later in 1979. The CDRS is also in touch with the New Zealand Wildlife Service, which is actively countering similar threats by cats to island ecosystems.

As these problems are not peculiar to the Galapagos, any successes our researches may achieve could have world-wide application and be welcomed by conservationists everywhere.

PATA PEGADA – *Pterodroma phaeopygia* (Hawaiian Petrel)

THE VICE-PRESIDENCY

Dr Alfredo Luna Tobar, Director General de Soberanía Nacional in the Ministry of External Relations, has been elected Vice-President of the Charles Darwin Foundation.

MARINE MAMMALS

The Galapagos Archipelago is poor in native mammals and the only large ones that have succeeded in establishing themselves naturally in these remote islands are marine species. They fascinate both tourists and scientists.

Dr Fritz Trillmich of the Max Planck Institute has recently spent two years studying the sea lions and fur seals, while his wife investigated the marine iguanas. Their reports will be found elsewhere in this issue. One point needing emphasis is Dr Trillmich's estimate that the endemic Galapagos fur seal, once the victim of commercial exploitation and not so long ago considered doomed if not actually extinct, now has a population of some 40,000 – roughly the same number as the sea lion. Let it be said without false modesty that this is a triumph of conservation, due to enlightened legislation and effective protection.

Today there is a new problem. Deep concern has been aroused by the large-scale "incidental" killing of porpoises during tuna fishing operations and a party of scientists on board the *Regina Maris*, a brigantine of the Ocean Research and Education Society, spent July – October investigating the situation. In the early part of 1979, an expedition from the U.S. National Marine Fisheries Service hopes to make a major aerial survey of porpoise populations off the Galapagos coasts. These fact-finding missions should eventually contribute to the protection of the porpoises.

SEMINAR IN SAN CRISTOBAL

A most useful seminar was held on 3 and 4 July on San Cristóbal (Chatham) Island, the chief fishing centre of the archipelago, to discuss the government's proposal to extend the National Park to include a marine zone. The meeting was organised jointly by the National Park, the Darwin Station and the Fishermen's Co-operative to discuss the effect which this extension might have on the local community. The discussions were attended by the local authorities and also by the relevant authorities from mainland Ecuador who came to explain the government's intentions and hear the fishermen's views. They included: Contraalmirante (r) Edmundo Mena, Subsecretario de Recursos Pesqueros; Capt de Fragata U.N. Julio Navarrete, Dirección de la Marina Mercante; Dr Franklin Bahamonde, Ministerio de Relaciones Exteriores; Dr Manuel Rosales, Ministerio de Recursos Naturales y Energéticos; Dr Rául Icaza, Director, Instituto Nacional de Pesca; Ing. Arturo Ponce, Ministerio de Agricultura y Ganadería; Ing. Vicente Gonzales, Subdirector, Escuela de Pesca de Manta.

Galapagos Sea Lions *Zalophus wollebaeckii*

MARINE RESEARCH

The most cursory glance through the lists of scientists visiting the Galapagos during the last few years shows a dramatic increase in the numbers engaged in marine biology and geology. The convergence of the major currents of the eastern Pacific on the archipelago has produced an exceptional diversity of marine life, much of it unique. Recently great interest has been aroused in the "Galapagos Rift" not only from the geological or geophysical points of view, but also on account of the discovery of peculiar organic beings at almost incredible depths. The influence of the warm El Niño current on the climate and on both the marine and terrestrial life of the Galapagos, as well as being of scientific importance, also affects the fishing industry and the economic welfare of considerable parts of the west coast of South America. The recent agreement on co-operation between the National Institute of Fisheries, the University of Guayaquil and the Charles Darwin Research Station (Noticias 28) was designed as a useful step towards greater activity in marine research. While the Charles Darwin Foundation lacks the funds to undertake any major oceanographic investigations, which must be left to far better endowed bodies, it could make a significant contribution to marine research if it found sponsors to provide a modest marine laboratory. At its last meeting, the Charles Darwin Foundation's Council set up a small committee to recommend action.

A NEW ASSISTANT DIRECTOR

Patricio Ramón took up his duties as Assistant Director of the Darwin Research Station in August 1978. He is a graduate of the Escuela Politecnica Nacional in Quito and is the first geologist to join the Station's resident staff. He is no stranger to the Galapagos, where, as a scholarship student, he was engaged on three projects, including the geological mapping of the island of Española (Hood). His report on the latest eruption of the Fernandina Volcano is included in this issue.

TWO ANNIVERSARIES

The Charles Darwin Foundation celebrates two anniversaries in 1979. January 4th 1964 saw the official inauguration of Charles Darwin Research Station on Santa Cruz Island, followed by the signing of the agreement between the Government of Ecuador and the Foundation. The achievements of the Station during 15 years and the outstanding problems are discussed in this issue under the title "The Tasks Ahead".

July 23rd will be the 20th anniversary of the organisation of the Charles Darwin Foundation itself. It is hoped to issue a special number of *Noticias de Galapagos* to mark the occasion.

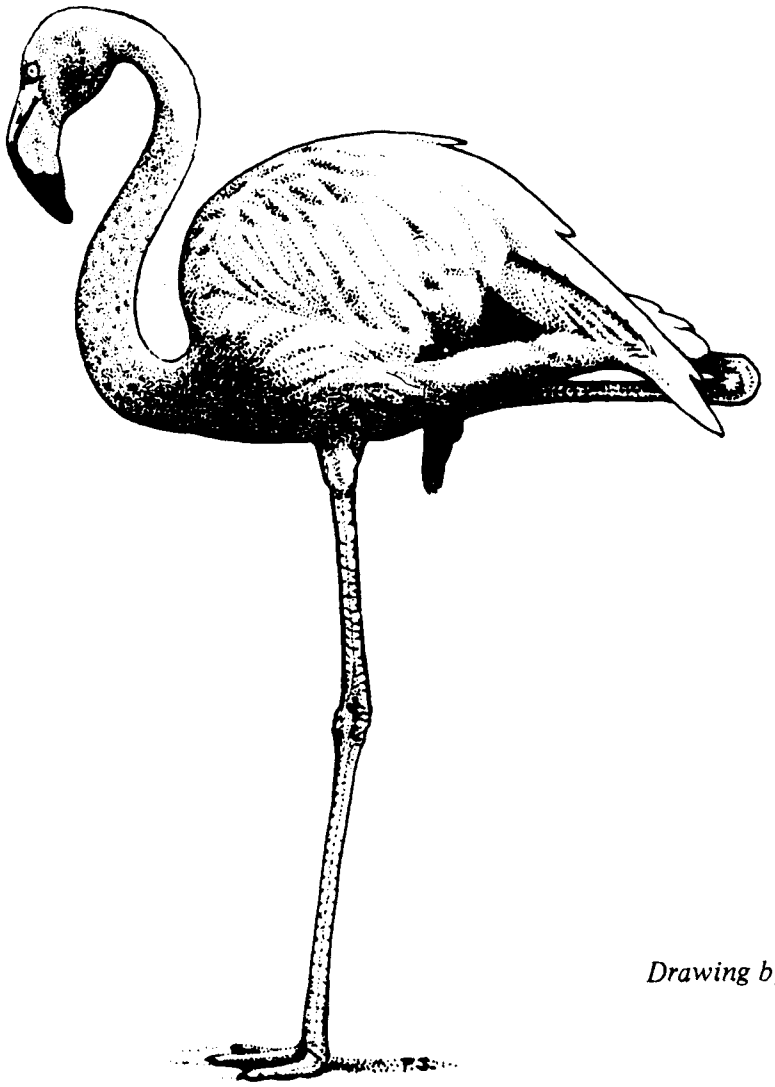
VISITORS TO THE STATION – APRIL TO AUGUST 1978

April 7	Robert Tomkins, Staff Scientist, took up his duties.
April 24	Roland C. Clement, International Council for Bird Preservation.
April 29	George R. Campbell, Chairman, Southwest Florida Alligator Association.
May 5 – 16	Dr Nestor O. Bianchi, Dra. Maria Susana Merani and Ing. Zootecnista Fernando N. Dulout. Instituto Multidisciplinario de Biología Celular, La Plata, Argentina. Estudio Citogenético y Caracterización del ADN de Oryzomis bauri.
May 9	Rosa Vazquez and Yolanda Celleri, Universidad Central, Quito. Tourist impact and breeding biology of the waved albatross.
May 9	Prof. Peter Grant (Continuation of study of Darwin's finches) returned to Canada.
May 17	Juan Alcivar, Tito Rodriguez and Mario Hurtado, students from Universidad de Guayaquil and Instituto Nacional de Pesca, began research on spiny lobster bacalao and marine turtles.
May 29 – June 2	International Delegation of Journalists organised by UNESCO.
May 29 – June 9	Dr Roger Lewin of the "New Scientist", one of the UNESCO party.
May 30	Peter Boag and Laurene Radcliffe (Darwin's finches) returned to Canada.
May 30	David Steadman and Miguel Pozo began study of Galapagos fossils.
June 4	Stanford Alumni Association party led by Prof. Colin S. Pittendrigh, Director of Stanford's Hopkins Marine Station, and Prof. Tjeerd H. van Andel from Stanford' Geology Department.
June 11	German research vessel, R/V "Sonne", visited the Station. Oceanographic and Geophysical research on the ocean floor of the Pacific. Gunther Reck, Tito Rodríguez and Miguel Pozo embarked.
June 20	Keith Christian, Colorado State University, began ecological research on land iguanas.
June 17 – July 27	R/V "Alpha Helix", with team to study the physiological and behavioural adaptations of marine iguanas. Principal Investigators: Professors G. A. Bartholomew, A. F. Bennett, W. R. Dawson, V. H. Shoemaker, F. N. White.
June 27	Hand-over of the "Andino" vehicle donated by the Consejo Supremo de Gobierno.
June 30	Fritz and Inka Trillmich left after completing their studies of pinnipeds and marine iguanas.
July 11 – 14	Thomas Borges, Smithsonian Tropical Research Institute.
July 14	Ana Armendariz and Sofia Rivera arrived to study Santa Cruz ground finches.
July 21 – 25	Delegación del Ministerio de Finanzas: Sra. Judith de Reyna; Subsecretario de Presupuesto, Economista Miguel Salazar y Sra; Lcdo. Julio Cesar Moscoso y Sra; Sra. Mercedes de la Torre; Dr. Alfonso de la Torre y Sra.
August 4 – 15	Russel E. Train (President, WWF – U.S. Appeal) and family; U.S. Ambassador Elliot Richardson and family; Beagle III cruise.
August 5	Dr Mike Blakely, Curator, Oklahoma Zoo.
August 11 – 28	R/V "Regina Maris": Dr Dee Boersma, study of sea birds; Dr Warren Stuntz and Ms Mary K. Nerini, study of porpoises.
August 11 – 25	Dr F. W. Huchzermeyer, Univ. of Pretoria, S. Africa.
August 29	F. Nigel Hepper, Royal Botanic Gardens, Kew, England.

CRISTOBAL BONIFAZ

At its meeting in the Galapagos, the Charles Darwin Foundation paid tribute to its late Vice-President, Señor Cristóbal Bonifaz. A pioneer conservationist in Ecuador at a time when conservation had few protagonists, Don Cristóbal worked for the establishment of nature reserves and national parks in continental Ecuador as well as in the Galapagos. He served on the Executive Council for many years and was its principal spokesman in Quito. His death leaves a much lamented gap in the ranks of the early supporters of the Charles Darwin Foundation.

C.T.C.S.



Drawing by Peter Scott

GALAPAGOS SEA LIONS AND FUR SEALS

by Fritz Trillmich

The order Pinnipedia (most closely related to the Carnivores) comprises three families:

a) Earless seals: true seals or phocids (Phocidae)
b) Eared seals: sea lions and fur seals (Otariidae)
c) Walruses (Odobenidae)

All species recorded in Galápagos waters belong to the family of the eared seals (Otariidae). They can easily be distinguished from the true seals (Phocidae) by their external ears and their way of locomotion. True seals have very weak foreflippers, and cannot turn their hindflippers forwards under the body. Therefore, their flippers are not much help in terrestrial locomotion which is achieved by sinusoidal movement of the body, or a hitching shuffle. Eared seals can walk efficiently on land, however, with their strong forelimbs and rotatable hind flippers.

When swimming, true seals propel themselves with sideways thrusts of the hind flippers, whereas sea lions and fur seals swim with winglike up and down strokes of their foreflippers.

Three species of eared seals have been recorded from the Galápagos, the Galápagos sea lion, the Galápagos fur seal, and the South American sea lion (only one report of the discovery of a dead male, by Wellington and DeVries 1976). The S. American sea lion will be omitted here.

I. *Galápagos sea lion* – *Zalophus californianus wollebaeki*
Spanish: *Lobo de un pelo (de Galápagos)*
French: *Otarie de Galápagos*
German: *Galápagos Seelowe*

SYSTEMATICS AND CLOSEST RELATIVES

The Galápagos sea lion is considered by Scheffer (1958) to be a subspecies of the California sea lion (Zalophus c.californianus). Morphologically it differs from the Californian race mainly by its smaller size. The considerable confusion about Galápagos sea lion systematics is fully reviewed in Orr's (1966) article on the mammalian fauna of the Galápagos.

FIELD IDENTIFICATION (see also Fig. 1)

Adult males are easily recognised by their very jutting foreheads and great size. Females are smaller and lack the protruding forehead. Neck and abdomen appear relatively longer than in fur seals, the snout is long and narrow and not as upturned as in the fur seal. Sea lions have much smaller eyes, relative to head size, than fur seals. Some males have light grey backs, but all other animals look almost black when wet. On land the fur lightens as it dries. Coloration is somewhat polymorphic, most animals are light grey-brown to golden-brown, or occasionally grey or blackish. The adult fur is inconspicuous especially when wet.

As a rule sea lions move slowly when on land, and have great difficulty in climbing.

The dark brown of newborn pups fades gradually until after 3 – 5 months it has become very light brown, almost adult color. Pups molt into the adult fur when about 5 months old.

Initially, immature fur seals and sea lion pups may be confused with each other, but head form and land locomotion can always clearly distinguish them, as well as the type of fur on closer inspection.

STATUS OF THE POPULATION

The Galápagos sea lion population is at present estimated at about 40,000 animals. Tourist sites with big sea lion colonies are Pta. Suarez (Española), South Plaza Island, Mosquera (in the channel between Baltra and North Seymour), Rábida, South James Bay (Santiago), and Pta. Espinosa (Fernandina). The last colony has strongly decreased in numbers during the last years.

This species has never been commercially exploited, although occasionally adults have been killed for their skins, or to provide sea-lion tooth necklaces for tourist sales. This seems (almost?) to have died out in the last few years.

An epizootic disease, the exact nature of which is still unknown, has spread throughout the population since about 1970, and may have killed as many as 50% of the animals. But some infected animals are known to have recovered, so that we can be sure extinction of the subspecies is not to be feared from this cause.

DISTRIBUTION WITHIN THE ISLANDS AND HABITAT

Sea lions breed on all major islands and many small islets and are regularly seen on all islands, and even rocks, save for a few small extremely steep ones. As breeding habitat, sea lions prefer gently sloping beaches, whether sandy or rocky. Any such area easily accessible even at low tide (no extended intertidal with rough rocks or difficult lava formations), is very likely to harbour a sea lion colony; although in some areas introduced dogs may have vitiated such habitats. Park wardens repeatedly report observations of dogs killing sea lion pups.

NATURAL HISTORY

The Galápagos sea lions reproduce mainly during the cooler garua season (May–June to December–January). The reproductive season lasts for about 6–8 months, depending on the size of the local population. Births occur 1–3 months earlier on Fernandina, the most western island of the archipelago, than on Espanola, the island furthest to the southeast. The causes for this time difference in the onset of the reproductive season are unknown.

Females bear one pup (no unequivocal evidence of twin births exists) which they nurse until the next is born. Some mothers will then nurse both pup and one year old immature together. As long as a mother does not have another pup, she may continue nursing an initial one for up to 3 years, or even longer.

The mother usually stays with the newborn pup for the first week. After this, she regularly goes off to feed by day, coming back almost every night to suckle the pup. When approaching the shore from the sea, she begins to utter a special pup-attraction call, continuing on land as she moves up to the place she left her pup. Usually the pup responds at once, running to its mother and beginning to suckle, after being subjected to her final olfactory check.

Mothers nurse only their own pups.

Females come into oestrus roughly one month after parturition. After copulation the fertilized egg remains floating in the uterus for about two months. It then implants and begins to develop. As this development takes about nine months, an annual cycle of birth and copulation is thus made possible.

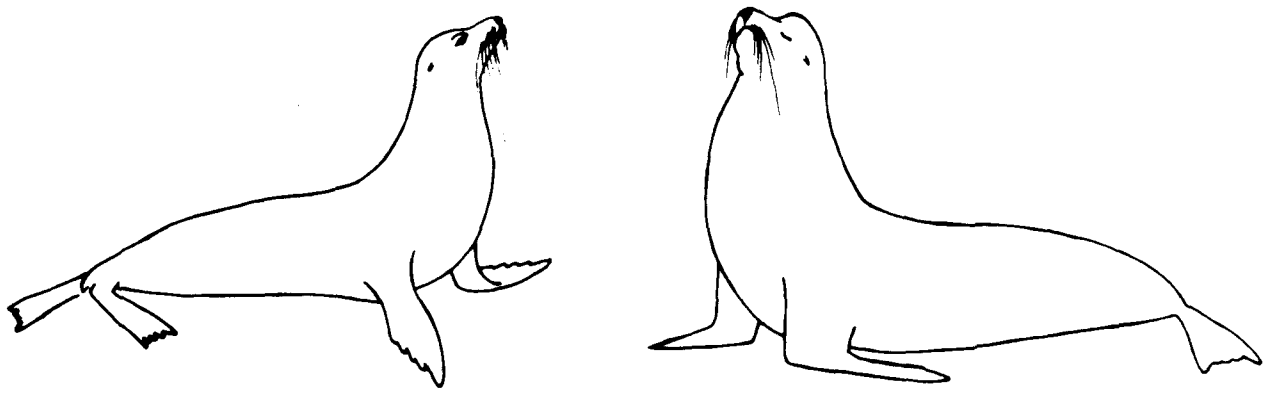


Fig 1. *left* adult female sea lion, *right* adult male sea lion.

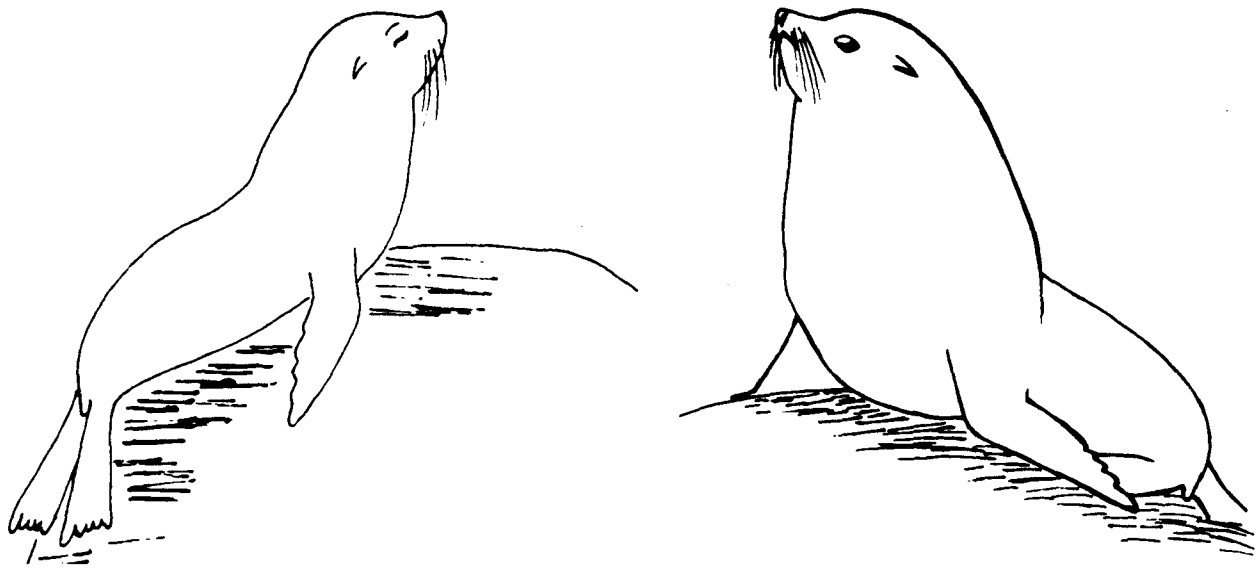


Fig 2. *left* adult female fur seal, *right* adult male fur seal.

drawings by Krisztina Trillmich

Pups begin to swim independently of the mother when about one to two weeks old. They very often play and sleep together in groups. Any adults which happen to be sighted with such groups are not protecting or guarding the pups in any way, they are merely "disinterested" animals having a rest. Shortly after the molt the young begin to fish for themselves, thus becoming increasingly independent of the mothers' milk.

Adult males claim sections of the coastline as territories which they defend vigorously against trespassers. They hold these territories for from 10 days to 3 months or longer, depending on the population density and the time of the season. Generally, the denser the population of a beach and the closer to the peak of the reproductive season, the shorter is the territory maintenance of individual bulls.

The bulls court females in oestrus for extended periods, following them incessantly. Most copulations take place in the water. Although bulls sometimes try to herd females, they have no direct influence on their distribution on land, and cannot prevent their moving freely between the territories of different males.

During my two-year study of the behaviour of the Galápagos sea lion, I failed to make a single convincing observation of the formerly described "paternal" behaviour of sea lion bulls to pups (see Eibl-Eibesfeldt 1955, Barlow 1972, 1974). If bulls have been observed "chasing" pups and juveniles out of the water onto land, this phenomenon may equally well be due to a flight reaction of the youngsters from any fast-moving animal advancing upon them. A female suddenly entering a tidepool just as easily sends pups stampeding up onto land. Bulls seen chasing sharks away from the colony are not necessarily defending pups or juveniles, but may be following the normal mobbing response of sea lions against sharks, shown even by immature sea lions. ('Mobbing' means a group harassment of a predator by its potential prey).

Sea lions feed mainly during the day. In fresh vomit found occasionally, small fish ('sardines') up to 20 cm long predominate.

II. *Galápagos fur seal* – *Arctocephalus galápagoensis*
Spanish: *Lobo de dos pelos (de Galápagos)*
French: *Phoque au fourrure (de Galápagos)*
German: *Galápagos Seebar (or G. Pelzrobbe)*

SYSTEMATICS AND CLOSEST RELATIVES

The Galápagos fur seal is recognised as a separate species in the latest revision of the systematics of the southern fur seals (Repenning et al. 1971). Earlier investigators (King 1964, Scheffer 1958) had thought it a subspecies of the South American fur seal (Arctocephalus australis). But as Repenning at el. (1971) could show a reliable difference in the skulls of the South American fur seal and the Galapagos fur seal, it seems reasonable to consider the latter a species of its own.

FIELD IDENTIFICATION (see also Fig. 2)

The Galápagos fur seal is much smaller than the sea lion. Adult males have a conspicuously thick neck, but the forehead protrudes only slightly. Females are more slender and considerably smaller than the males. Both are easily distinguished from the sea lions by their larger eyes, shorter nose and completely different calls. The fur when dry appears dark brown and fluffy (or rarely, gold-brown or silver-grey). Wet animals look almost black. A fur seal's ears stick out far more obviously than a sea lion's. This is very useful in distinguishing between swimming fur

seals and sea lions. Fur seals have the habit of resting head down in the water with only the rear flippers visible. Fur seals jump easily from rock to rock, move faster and gallop much more than sea lions.

New born fur seals are far smaller (ca. 3.4 kg) than newborn sea lions (ca. 5 kg). Their fur is almost black at birth, sometimes with grey or white margins around the mouth and nose. The fur gradually lightens to a chocolate brown. During their fourth month they undergo a molt into the adult fur.

STATUS OF THE POPULATION

Extensive sealing during the end of the last and early in this century nearly exterminated the Galapagos fur seal. In the 1940s local fishermen already knew of the existence of great colonies on Pinta and Marchena (F. Angermayer, pers.comm.). Later, the species was also found to be widespread and abundant on Fernandina and northern Isabela. The present population is estimated at about 40,000 animals.

Resting fur seals can regularly be seen from the boat on Gordon Rocks (east of Plazas). The fur seal grottos near James Bay on Santiago provide the best opportunity for close range observation of this species.

Fur seals are less affected by the epizootic disease than sea lions. But adult males, having been seriously injured in territorial fighting and therefore open to infection, frequently die of it.

DISTRIBUTION WITHIN THE ISLANDS AND HABITAT

The densest and largest fur seal populations inhabit Isabela and Fernandina in the west, and Pinta, Marchena, Genovesa and Wolf in the north. Of the central islands of the archipelago, Santiago, Santa Cruz, Rábida, Seymour Norte, Baltra and Pinzón harbor fur seal populations, the order indicating decreasing population size. While very small breeding colonies may exist on Floreana and San Cristobal, Española is visited only occasionally by stragglers, and no observations have been made on Santa Fé.

Fur seal habitat is often very rugged, so that the animals must jump and climb a lot. Shady resting places abound. Small caves, pockets in the lava, or holes between or below boulders are of vital thermoregulatory importance, especially for small pups, who often cannot enter the water near their birthplace without the risk of being washed out to sea.

Fur seal colonies are always close to deep water (200 fathoms or more). Local upwelling of colder water from the deep, besides having a beneficial effect on lowering ambient temperature, may be a necessary condition for the nourishment of a sizeable fur seal colony. Around Cerro Azul (Isabela), predation by introduced dogs seems to have brought about the confinement of breeding colonies to places cut off from land access by steep cliffs.

NATURAL HISTORY

The reproductive season of the fur seals lasts from August through November. In 1977 the birth peak on Fernandina was in the first week of October.

A female bears one pup, and stays with it until coming into oestrus and copulating with the territorial male, usually about a week after parturition. She then goes off to feed (usually at nights), returning to the pup every day or every other day. Mother-pup recognition functions essentially as described above for the sea lion.

Fur Seal *Photo: by Fritz Polking*

If the mother has a one-year old juvenile, she usually abandons the newborn, at the latest after copulation. Aggression of the one-year-old grows against the newborn pup as it tries ever more desperately to get to the mother's teats. She defends it half-heartedly from these attacks, and very often the older pup succeeds in driving the other away, even before the mother comes into oestrus. In rare cases direct fratricide is observed.

Young Galapagos fur seals are dependent on the mother's care for about 2 years. If the mother gives birth again after this period, she usually drives off the 2-year old. But if she does not give birth again, she can be seen later on still nursing a 'baby' about as big as herself.

Pups play together in groups, first in little puddles and isolated pools, later also in calm open water. As with adults, pups are almost never found sleeping in body contact, quite unlike sea lions where both adults and pups love to sleep almost in a pile. During their second year of life juveniles begin to hunt for themselves, and become increasingly independent, nevertheless they still search out their mothers regularly, and drink for hours on end, when they meet her.

Males establish territories before the first females come into oestrus. They defend these territories for about 4–6 weeks without once going out to feed. They are usually ousted by a challenging male or leave when thoroughly exhausted. As the peak of the reproductive season approaches, the duration of such territory maintenance shortens to about 2 weeks.

More than 90% of the copulations take place on land. A territorial male initiates copulation by approaching females in oestrus and mounting. Females ready to copulate usually submit to him without much resistance; but when approached by a trespassing male, they defend themselves vigourously and almost always successfully. Such a fight is often interrupted by the approach of the territorial male, who chases off the trespasser and checks up on the female, sniffing her face.

Fur seals feed mostly during the night. Occasionally collected vomit samples showed that their diet is small fish and squids.

Literature cited:

Barlow, G. W. 1972. A paternal role for bulls of the Galapagos Islands sea lion. Evolution 26, 307-308.

Barlow, G. W. 1974. Galapagos sea lions are paternal. Evolution 28, 476-478.

Eibl-Eibesfeldt, I. 1955. Ethologische Studien am Galapagos-Seelowen. Z. Tierpsychol. 12, 286-303.

King, J. E. 1954. The otariid seals of the pacific coast of America. Bull. Brit. Mus. Nat. Hist. Zool. 2: 309-337.

Orr, R. T. 1966. Evolutionary aspects of the mammalian fauna of the Galapagos. In: R. I. Bowman (ed.) Proc. Symp. Galapagos int. Scient. Project Univ. Calif. Press, Berkeley and Los Angeles, 276-281.

Repenning, C. A., R. S. Peterson, and C. L. Hubbs 1971. Contributions to the Systematics of the Southern Fur Seals, with particular reference to the Juan Fernandez and Guadalupe species. In: W. H. Burt (ed.), Antarctic Pinnipedia, Antarctic Research Series 18, 1-34.

Scheffer, V. B. 1958. Seals, sea lions and walruses. A review of the Pinnipedia. Stanford University Press, Stanford, California.

Wellington, G. M. and T. de Vries 1976. The South American Sea Lion, Otaria byronia, in the Galapagos Islands. J. Mammalogy 57, 166-167.

Author's address: Max-Planck-Institut fur Verhaltensphysiologie, Abteilung Wickler, D-8131 Seewiesen, W. Germany.

PENQUINS IN THE GALAPAGOS

by Dee Boersma

Dr Boersma, Assistant Professor in the University of Washington, has been studying the little-known Galapagos penguin over a period of several years. Her latest visit was on board the "Regina Maris" in 1978.

Penguins, in their black and white tuxedos, ranging from the frozen seas of Antarctica to the warm desert islands of the Galapagos, have fascinated people. Scientists have endured dark Antarctic winters and isolation to study these curious, tame, and human-like birds. For example, in the early 1900s, scientists braved gales and crevasses in mid-winter to visit Emperor penguin rookeries on the Ross Sea because they believed that by studying penguin eggs the developmental relationships of other organisms could be understood. Of the 17 species of penguins, the Emperor penguin is the largest, and stands over a meter in height, while the Little Blue penguin is about 20 cm tall. The third smallest, about 30 cm tall, is the Galapagos penguin.

Penguins are Southern Hemisphere species, but one, the Galapagos penguin, frequents waters just north of the equator. All are found in relatively cool waters. Unlike other penguins, the Galapagos penguin does not migrate but remains in the archipelago throughout the year. Although individuals occasionally wander to other islands, breeding is confined to Isabela and Fernandina, the most westerly islands of the archipelago, where the nutrient rich Cromwell Current upwells. The Galapagos penguin is dependent on the food resources of this current.

Male Galapagos penguins have more pronounced markings and are larger than females, but otherwise the sexes look alike. Penguins are monogamous and may remain paired even on successive breeding attempts. Male Galapagos penguins usually select the nest site and may provide a little nesting material. However, I observed one over-zealous male supply his mate with enough mangrove leaves to partly bury both her and the eggs. The division of labor between the sexes is equal: both incubate the eggs and feed their young.

The Galapagos penguin offers scientists a unique opportunity to test theories on the importance of environmental variability in shaping natural history traits. The Galapagos environment may not appear as severe as Antarctica, but the penguins have problems coping with both fluctuating food resources of the Cromwell Current and intense heat. To minimize the effects of a harsh environment, the penguin has evolved three adaptations: a long life span, frequent reproduction and a molt before breeding.

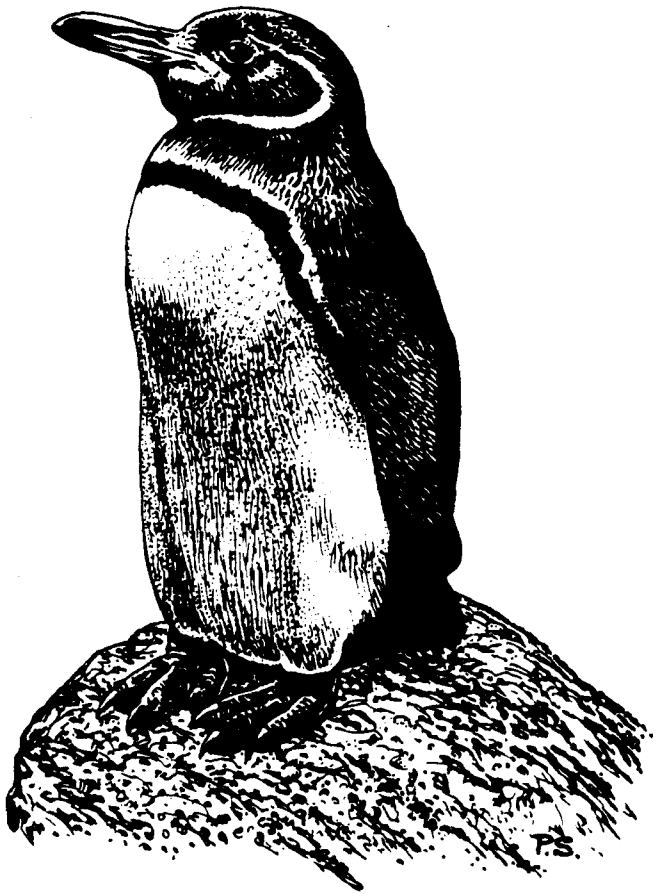
Adults live more than 10 years, so that even with repeated reproductive failures they can rear two chicks during their lifetime. Their frequent reproduction (some pairs lay eggs three times in 15 months) increases the probability that eventually they will have young during optimal environmental conditions.

When penguins molt they lose all their feathers at once, instead of just a few at a time like other birds. The Galapagos penguin molts twice a year, but other species molt only once a year. Before each molt the penguins almost double their body weight to survive the 15-day fast while they grow new feathers. Because of the intense solar radiation in the Galapagos, a suitable shady area in which to molt is required to avoid heat stress.

Many penguin species breed in dense rookeries, but the Galapagos penguin, in contrast, is solitary, and lays its two eggs in a lava tunnel, crevice or protected ledge. The barren Galapagos topography prevents pairs from nesting in dense aggregations because the birds cannot readily excavate nesting burrows in the unweathered lava. Furthermore, Galapagos penguins cannot cluster their nests in the open because nesting sites must be shaded so that the adults and eggs do not overheat in the hot sunlight.

A common problem for all ground nesting birds is predation. The Galapagos Islands, when compared to continental South America generally, lack predators; seabirds there have higher reproductive success than their mainland counterparts. Humans have introduced a variety of mammals to the Galapagos, but of these only dogs, cats and rats prey on penguins. Fortunately, most of the penguins breed on Fernandina and on three small islands off the coast of Isabela where only native predators live: these – rice rats, crabs, snakes and hawks – mainly eat eggs and young which are deserted and would die anyway. Thus, predators have little effect on the population. The greatest chance for death is during the first year when the young penguin is still inefficient at capturing food.

Many species of penguins are common, with populations numbering in the millions; but there are only 6,000 to 15,000 Galapagos penguins, making them the rarest penguin. Their continued existence appears promising as long as the cool food bearing waters on which they depend bathe the islands. Over exploitation of small fish could endanger them, but their remoteness, shyness and dispersed breeding habits should insure their survival.



Galapagos Penguin

Drawing by Peter Scott

FEEDING BEHAVIOUR AND SOCIAL BEHAVIOUR OF THE MARINE IGUANA

by Krisztina Trillmich

Max-Planck-Institut fur Verhaltensphysiologie, Abt. Wickler, D-8131 Seewiesen, W. Germany.

During my 18 months stay in Galapagos, I collected data on the feeding and social behaviour of marine iguanas (Ambly rhynchus cristatus); this report summarises the preliminary results.

FEEDING BEHAVIOUR

Marine iguanas are the only reptiles feeding almost exclusively on marine algae. Besides algae they were found to feed frequently on the faeces of conspecifics and more rarely on the faeces and afterbirths of sea lions.

I studied the feeding behaviour of marine iguanas in detail on Fernandina (Cabo Hammond) and on Caamano (the little island in Academy Bay, Sta. Cruz).

Marine iguanas of different sizes search for food in different ways. To analyse the kind of differences, about 100 animals were caught on Fernandina (C. Hammond), their weight and length measured, and they were then released after having been marked individually with little plastic tags. The animals were followed and their behaviour recorded in detail during the subsequent 3 weeks.

Independent of sex, animals below 1.2 kilograms body weight left the colonies only during low tide to feed in the intertidal. Animals below 0.5 kg body weight (yearlings?) always kept close to the high tide line and fed there on algae in cracks or below boulders. Animals with body weights between about 1.2 and 1.6 kg feed during low tide in the intertidal, but swim also out to sea and dive during high tide. They usually do so between 10.00 and 15.00 hours, preferentially with the rising tide. Animals above 1.6 kg feed exclusively by diving outside the intertidal zone. They prefer the noon hours and/or incoming tide.

Weather conditions permitting, almost all animals go feeding every day. The time when the peak number of animals feeds in the intertidal shifts from day to day about one hour, well correlated with the regular shift of the lowest low tide. Every fourteen days the animals change over from feeding at the evening low tide to the next morning's low tide. Obviously the animals have a way of predicting the hour of low tide; however, the way in which they measure the lunar periodicity of the tides is unknown.

In bad weather (strong wave action) the number of animals going out to feed during low tide drops drastically and the animals stay in the intertidal for much shorter periods. They try to compensate for this by making more feeding excursions. Under conditions of very strong wave action (intertidal almost constantly covered with breakers) the marine iguanas stay in their colonies all day. In this way they may go without food for more than a week.

Observations on about 40 marked adult males of more than 1.6 kg on Caamano and C. Hammond over a period of about 5 weeks show that these animals return 2-3 times during their feeding excursions to the shore where they heat up on sun exposed rocks, often well away from the colony. Very big old males tend to swim out to sea to feed only every other or every third day. Territorial males (during the reproductive season, see below) starve for up to 6 weeks, losing 15-25% of their body weight.

Marine Iguana. *Photo by Fritz Pölking.*

SOCIAL BEHAVIOUR

Marine iguanas sit together in colonies of about 20-500 (rarely up to 1000) animals. Colony site and membership are almost constant. It only rarely happens that a whole colony shifts (presumably in adaptation to external factors, e.g. sunshine, wind direction, currents close to the shore). Colony composition may change during the reproductive season.

The distribution pattern of individuals inside the colony has been studied on C. Hammond (Fernandina) and Caamano. Individuals show clear site preferences, i.e. they tend to return every day to exactly the same spot or rock in the colony. A nearest-neighbour analysis of a colony on Fernandina showed a clear preference of animals belonging to the same size class to sit together. This is true at least outside the reproductive season when the sex of the animals does not at all influence their grouping tendencies. As males grow to bigger size than females, one frequently encounters all-male groups.

TERRITORIAL BEHAVIOUR AND REPRODUCTION

On Caamano in October/November (on Fernandina about one month earlier) the males begin to establish territories either inside the colonies or on nearby areas. At this time large males often appear in the colonies. Such immigration of males has been observed on C. Hammond and on Caamano. They leave again at the end of the reproductive season. The males immigrating into the colonies on Caamano came from Sta. Cruz as proven by recoveries of marked males.

The territories serve exclusively for reproduction and are vigorously defended against all other adult males.

A territory may comprise one or several big blocks or a flat area of lava. Therefore, territory size varies between 1 and about 10 m^2.

The establishment of a territory frequently involves violent and sometimes bloody fights for hours on end. The boundaries of almost all territories change slightly until the end of the reproductive season: but normally short boundary displays between neighbours known to each other are sufficient to maintain the boundary of established territories.

The period of actual copulation extends only over about 3 weeks. On Caamano these were the first 3 weeks of January; on Fernandina reproduction takes place about one month earlier, on Espanola one month later. Normally only territorial males copulate successfully. They copulate with the females while the latter are on their territories. Attractive resting places for females or areas crossed frequently by many females on their way back and forth from the feeding grounds, therefore lead to high reproductive success of males able to hold territories on such areas.

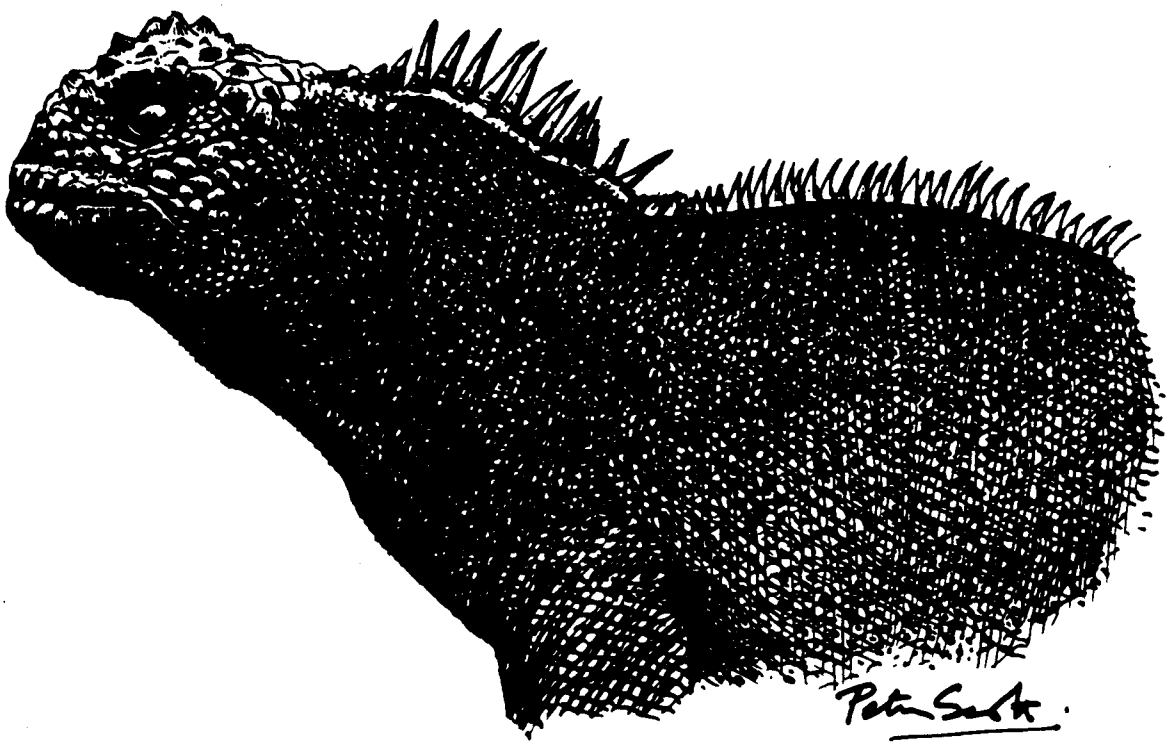
The territorial males test with a stereotyped behaviour sequence the readiness of the females to copulate. Successful rapes by territorial males have never been observed. Adult females appear to copulate only once. Courtship and copulation will be analysed from protocols and films.

To analyse the total activity of territorial males, 10 males were observed on Caamano at regular intervals over a period of 2 months (Dec. 1977 and Jan. 1978). They differed with respect to their size, origin (some had immigrated from Sta. Cruz) and the structure and size

of their territories. This material will give an idea about individual differences in activity, the course of activity over the whole reproductive season, correlations of activity with size and type of territory, number of other animals inside the territories, and the reproductive success of the respective male.

Observations of the marine iguana females during the period of egg laying show that egg laying occurs about 5 weeks after copulation. Clutch size depends on the size of the female. Clutches consist of 1-3 eggs. Although the size of the oviducts of really big females seems to provide enough space for four eggs, four egg clutches have not been found.

Observations on marked females over a two week period on Caamano and C. Hammond prove that the females on these islands guard and defend their nests for up to about 10 days against other females just as described before for the Espanola females. The duration of guarding depends on several factors like number of other females present, distance of the nest from the nearest look-out rock, how much females are endangered by the hawk etc.



ERUPCION DEL VOLCAN FERNANDINA: AGOSTO 1978

La isla Fernandina, consistente en un gran volcán de escudo, manifestó nuevamente su actividad con una gran erupción, luego de haber transcurrido mas de un año desde la ultima erupción.

La erupción tuvo lugar en la base de la plataforma noroccidental en el interior de la caldera, a partir de una fisura que se encuentra a unos 930 m. de altura. Este sitio esta opuesto al lugar de las anteriores erupciones, las cuales fueron generalmente al lado suroriental de la caldera. Los flujos de lava fueron extruidos por ventos alineados a lo largo de la fisura mencionada anteriormente y finalmente alcanzaron el lago en donde siguieron su avance antes de detenerse. La longitud recorrida por los flujos en distancia horizontal es aproximadamente de 3 km.

Ceniza volcánica y "pelos de Pele" llegaron hasta la costa en Cabo Douglas y restos de escoria se encontraron aproximadamente desde la costa de 200 m. hacia arriba hasta la cumbre, en donde estaba ampliamente distribuida en las inmediaciones del sitio de erupción.

AGOSTO 8:
Se reciben las primeras noticias de nubes sobre la caldera. Por la noche se puede divisar un resplandor inclusive desde Sta. Cruz. Este dia se produjó un sismo de magnitud 4.5 a las 15 55 (UTC) con epicentro en las Islas Galapagos. Se supone que este dia se inició la erupción siendo precedida por el sismo indicado.

AGOSTO 9:
Se pudo ver una gran nube sobre el volcán. El resplandor de la erupción se refleja en esta nube dándole a la misma una coloración anaranjada. En Pta. Mangle se pudo oir ruidos como de aviones.

AGOSTO 10:
Un grupo de personas delegados por la Estación Charles Darwin, llegan a la cumbre del volcán (Howard y Heidi Snell, y Alan y Tui Moore). De la laguna en la caldera se desprendian vapores y los ventos estaban humeantes y resplandeeientes. Habia contínuos derrumbes en las paredes de la caldera. A las 1410 fue sentido un ligero temblor en el borde WNW de la caldera. Los ventos especialmente en lado sur se hicieron activos y comenzaron a arrojar lava.

AGOSTO 11:
El vento en el lado NE comenzó a arrojar lava. Los otros ventos continuaban activos.

AGOSTO 12:
Por la noche los flujos de lava terminaron y aparentemente la actividad estaba terminando.

AGOSTO 13:
Durante la mañana los ventos aun estaban humeantes, pero no producian ruido. El grupo inició su descenso hacia Cabo Douglas.

AGOSTO 15, 16:
El Dr R. W. Tindle de la Estación Charles Darwin, a bordo del velero "Regina Maris", pudo observar un resplandor rojizo sobre la cumbre del volcán.

AGOSTO 17:
Desde Punta Espinoza se notó un aumento de intensidad en el resplandor de la nube la cual en algunos momentos tomaba la forma de un hongo a varios cientos de metros sobre la cumbre. El Dr Tindle decidió realizar una ascención a la cumbre.

AGOSTO 18:
El grupo llegó al borde de la caldera a las 16:30 y realizó observaciones constantes durante la noche. Se pudo observar que existian tres ventos activos los cuales estaban arrojando grandes cantidades de lava, la cual llegó a cubrir la mayor parte de la plataforma NW del interior de la caldera. Los flujos llegaban a la laguna, produciendo grandes cantidades de vapor. Despues de algunas horas esta actividad cesó, para dar lugar a una "segunda fase" caracterizada por la violenta, aunque no continua, eyeccion de escoria al rojo vivo con una enorme liberación de energía. Posteriormente esta fase cesó, pudiendose ver unicamente densas nubes de vapor y escuchandose fuertes ruidos como de cañones o tambien como de aviones.

El viento suplaba fuertemente desde el SW. Durante la noche no se pudo observar el resplandor rojizo sobre el volcán al igual que los dias anteriores; esto sugiere que las erupciones de los dias anteriores (16 y 17) fueron mucho mas violentas que esta última.

AGOSTO 19:
El Dr Tindle regresa a la costa y permanece hasta el 4 de Septiembre. Hasta el 27 de Agosto se pudieron observar nubes que se elevaban desde la caldera hasta unos 2.000 pies sobre ella, especialmente durante el dia, para desaparecer durante la noche.

AGOSTO 24:
Aparentemente se produjo una nueva erupción.

AGOSTO 26:
Parece que se produjo otra erupción.

SEPTIEMBRE 4:
El Dr Tindle regresa a Sta. Cruz. Cabe anotar que durante su permanencia en Fernandina no sintió ningún movimiento de tierra o temblor.

SEPTIEMBRE 6:
Un grupo de cientificos de la Estación Charles Darwin, realizó un vuelo sobre la isla Fernandina, durante el cual se pudo comprobar que la erupción había terminado y unicamente unas pocas fumarolas señalaban el sitio de los ventos activos. Se realizaron varias fotografias desde el avión para estudios posteriores.

SEPTIEMBRE 19:
Patricio Ramón y Howard Snell realizaron un ascenso al borde la caldera. Se pudo notar que el nivel de la laguna había descendido notablemente y que no existía evidencias de actividad volcánica, excepto varias fumarolas en el sitio de erupción. Durante su permanencia no sintieron sismos.

Estas son los principales hechos que ocurrieron durante esta última erupción. Mayores detalles se encontraran en los informes definitivos y finales que seran elaborados por las personas que fueron testigos de esta erupción.

Patricio Ramon M.
Subdirector
Estación Cientifica Charles Darwin

Inauguration of the Charles Darwin Research Station, 4 January, 1964.
Front Row: Col. Freile and General Gándara (Junta de Gobierno); G. T. Corley Smith (British Ambassador, now Sec. Gen. of CDF); the late Victor Van Straelen (President of CDF); the late Robert Valeur (Ambassador of France); Maurice Birnbaum (US Ambassador – partially cut off): The bearded figure in the second row is David Snow, Director of the Darwin Research Station, 1963-64.

Photo by A. Gille (UNESCO).

THE TASKS AHEAD

by G. T. Corley Smith

January 4th 1979 marks the 15th anniversary of the formal inauguration of the Charles Darwin Research Station, while on July 23rd the Charles Darwin Foundation itself will celebrate its 20th birthday. It may seem that much time had elapsed between the two events but the Station was functioning on a modest scale long before the official opening. In those early days, there were tremendous problems in building a laboratory, a workshop and accommodation, creating water and elecricity supplies and so much else on a remote though extinct volcano far out in the Pacific, with inadequate communications by sea and virtually none by air. Yet the biggest problem, then as now, was to raise the money to get on with the job.

The inaugural ceremony took place under the burning equatorial sun in an open space between cactus and bare thorn scrub because there was still no building large enough to hold the gathering. The more important of the sweltering dignitaries were accorded chairs: the scientists sat where they could. One generalisation about the thoughts of this diverse assemblage seems permissible: it is unlikely that even one of those present could have foreseen the extent of the Darwin Station's success in the next fifteen years. Nor, such was our ignorance at that time, could anyone have realised how much there was to do and what extraordinary riches were awaiting investigation. What did become clear as exploration proceeded was that the Darwin Foundation had not been organised a moment too soon if the unique resources of the Galapagos were to be saved for posterity.

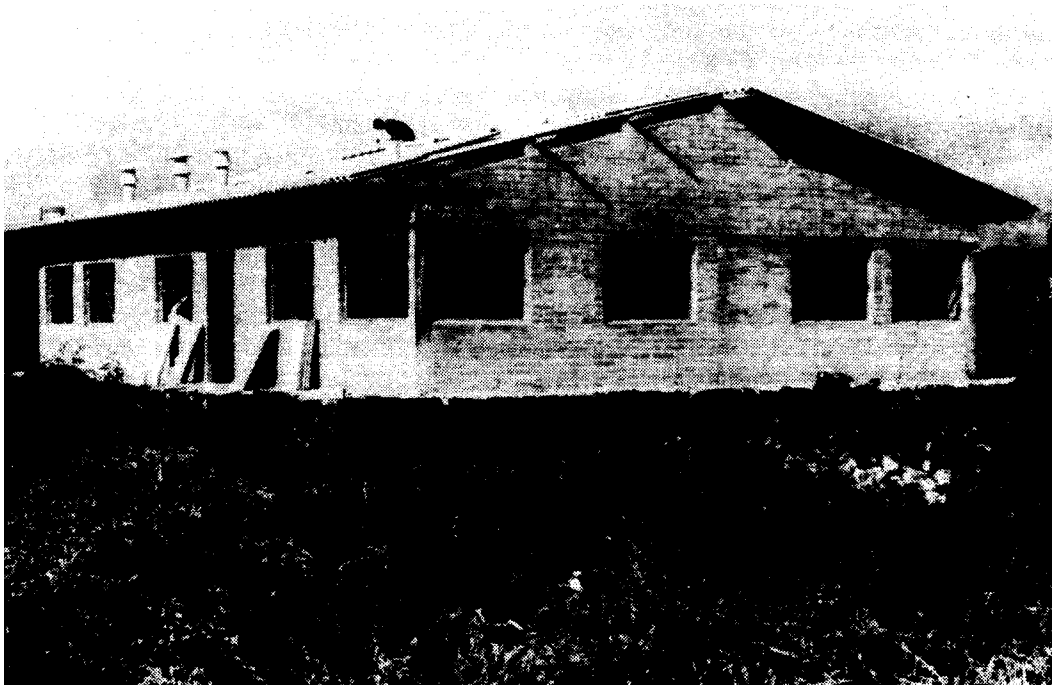
Much has been accomplished but much still remains to be done. This year of anniversaries seems an appropriate time to consider anew what priorities should be given to the many tasks ahead. At its meeting, in November 1978, the Foundation's Council decided to undertake this survey in two stages; first by correspondence with a wide selection of experts and then by a small committee to draft final recommendations.

The following are some of the problems needing re-examination.

CONSERVATION

The most important development of the last 15 years has been the creation of the Galapagos National Park Service.

Today the Charles Darwin Research Station (CDRS) is primarily responsible for research and planning and the National Park Service (NPS) for the execution of conservation policy; the two are obviously inter-dependent and maintain intimate daily contact. In the past, man was the chief danger to wildlife but now, despite the enormous increase in the number of visitors, the NPS has this threat firmly under control. National Park boundaries (enclosing nine-tenths of the land area of the archipelago) are clearly marked and within those boundaries tourists must be accompanied by trained guides. Nevertheless, breeding populations of the extraordinarily tame birds and animals may be disturbed in subtle and not immediately noticeable ways by large parties of even the most well-behaved visitors, so the CDRS has to consider prolonging indefinitely its studies of tourist impact; and on the basis of these findings the NPS can make the necessary adjustments in the numbers and routes prescribed for visitors.



The Laboratory

Early Days at the Darwin Station (The House)

The dominant problem for the next stage will no longer be man but the foreign animals and plants introduced by man, which have run wild and multiplied. The native birds and beasts of the Galapagos, being so exceptionally tame, are unable to stand up to the much "wilder" though formerly domesticated species – goats, pigs, dogs, cats – nor the proliferating black rats. Progress has been made with the control of these pests, particularly the goats on the small and medium islands, but no effective methods have yet been discovered for dealing with the growing menace of dogs, cats and rats. Contacts have been made with conservationists working on similar problems in other parts of the world but it may take years of research and endless labour in the field before methods effective in Galapagos conditions are developed. The islands may seem mere pinpoints on most maps but the land area alone is some 3,000 square miles (i.e. greater than the county of Devonshire and half as big again as the state of Delaware), and the 60 or so islands are scattered over a vast area of ocean and studded with hundreds of volcanic craters, some rising to 5,000 feet. The task is immense: but man has upset the balance of nature and only man can restore it or even prevent further deterioration.

The dangers are not limited to present pests. Unwanted seeds, insects and parasites can all too easily be introduced into the delicate island ecosystems (fire ants and scarab beetles are recent examples) and imported diseases could play havoc among native species which had acquired no immunity. It is probably in this way that the increasing numbers of tourists and scientists are most likely to do harm. Scientists need to give thought to these new threats and ways of averting them.

Meanwhile the captive breeding of endangered species will have to be continued and indeed expanded. The breeding of giant tortoises at the Station and their return to their native islands when big enough to stand up to the introduced pests has been perhaps the outstanding success story of Galapagos conservation. In 1978 this was followed by the birth at the CDRS of the first artificially incubated land iguanas, bred from the survivors of the populations that had been massacred by dogs and which had been taken into protective custody at the Station. Behind these conservation successes lies a very great deal of basic scientific research.

Among the questions which need to be continually re-thought are the priorities to be given to the protection of the various species of Galapagos birds. They all merit protection but resources are limited. Priorities are not always obvious. For instance, the Lava Gull may well be the rarest gull in the world but there is no firm evidence that it was ever more numerous in the past or that it is under any particular pressure today. The same may be true of the population sizes of Galapagos Penguins, Flightless Cormorants and Flamingos, though they are evidently much more vulnerable. On the other hand the Dark-rumped or Hawaiian Petrel, a splendid oceanic bird with a three foot wing span, is in immediate peril. If, as is feared, it should become extinct in Hawaii, then its only other breeding place will be the Galapagos, where it is particularly difficult to protect as it suffers heavy persecution from rats, pigs and dogs when it comes on shore to breed in burrows in the moist uplands of a few of the larger islands. All these birds are being monitored by scientists but the degree of protection that can be given to each needs to be continually reviewed in the light of resources, costs and changing circumstances.

The same considerations apply to the menace of introduced plants and trees that are spreading into the Park from the farms in the settled zones and are competing with the unique native species, many of which are in danger of extinction. The NPS is fighting to prevent further penetration, but, given its limited manpower, success must await the development of new and more effective techniques. For this purpose botanists are needed to do the vital research. On other islands, hordes of prolific goats (over 100,000 on Santiago alone) are destroying the vegetation. Critically endangered plant species are being fenced in for protection but the real

solution lies in finding better ways of controlling goats than hunting them with guns.

In the last few years there has been a dramatic increase of interest in the marine resources of the Galapagos. This subject suffered relative neglect in the early days of the Darwin Station, partly because there was so much to do on land, where so many species were in immediate danger, while the underwater flora and fauna seemed relatively safe for the time being. The need for giving a higher priority to marine research has been appreciated for some time and this, together with the development and popularization of Skuba diving, has brought about in the last few years a most gratifying rise in the number of marine scientists working at the Station. Although far too little is yet known about Galapagos marine life, preliminary surveys already suggest that it is as important to science and as fascinating to the layman as the terrestrial life. What is more, the Galapagos waters are still in a nearly pristine condition, not having suffered the ravages of the land areas. Of key importance to the preservation of this great heritage, at a time when the number of ship-borne tourists (many of them divers) has suddenly increased, is the Government's draft legislation incorporating a marine zone in the National Park.

Close relations have been established with the Navy's Oceanographic Institute and the National Institute of Fisheries. Conservation policy, underwater as well as on land, needs to be based on scientific research. To this end the CDRS badly needs a marine laboratory: but first it needs guidelines for the specific purposes such a laboratory is to serve.

SCIENCE

In addition to its duties in connection with conservation, the Charles Darwin Foundation provides a base to permit visiting scientists from a great number of countries to undertake research. These scientists are funded by universities, learned societies, etc. and are not a charge on CDF finances but the Research Station does offer accommodation, laboratory, library, transport, general support and advice. Each scientific mission submits an outline of its proposed investigations which is vetted by the Station and the National Park authorities before permission is granted. So long as their projects do not conflict with conservation, visiting scientists have complete freedom of choice of subject matter. Hitherto all applications for accommodation have been accepted on a "first come, first served" basis but if numbers continue to increase (and the Station has already received over 500 missions) it may be considered desirable to show preference for projects helping conservation. However new construction has recently increased the Station's capacity and, in any case, much "pure" research undertaken in the past (e.g. with tortoises and iguanas) has proved of great direct value to conservation. In 1972 a distinguished group of Galapagos experts met at the Smithsonian Institution to help visiting scientists in their choice of subjects by establishing priorities in both practical conservation research and fundamental scientific investigation. Perhaps the time has come to reconsider these priorities, particularly in view of the rapidly growing importance of marine biology and geology.

EDUCATION

Over the years the Darwin Foundation has been steadily increasing its educational activities. Biology lessons are given in the islands' schools. Publications on the Galapagos are distributed to teachers in mainland Ecuador. Intensive courses are organised to train National Park wardens and both the auxilliary guides and the naturalist guides who accompany visitors on their tours. Most years there is a week-long conference where NPS personnel and scientists discuss problems with the local officials and teachers. An increasing number of scholarships are offered each year

to enable Ecuadorean students to work at the Darwin Station, under the supervision of experienced scientists. Galapagos Information Centres have been established in Quito and Guayaquil and relations with Ecuador's universities and polytechnics are being steadily strengthened.

All this has a practical purpose in that any constructive conservation policy needs widespread public understanding and support. But there is something more. International science owes a great debt of gratitude to Ecuador. The 18th century French Academicians, Humboldt, Darwin, Spruce and hundreds of later visiting scientists learned much in Ecuador. In the last 20 years successive governments have been unwavering in giving indispensible support to the scientific and conservation work of the Charles Darwin Foundation; indeed, with the years, government support has continually increased. International science can begin to repay its debts by aiding scientific education in Ecuador. The CDF must constantly consider ways of doing this more effectively.

These are some of the questions that need to be re-thought from time to time. The Foundation has no endowment and never knows what its income will be from one year to another. Consequently a "budget" in the ordinary sense of the word is impossible and the best it can do is to work out a carefully costed set of projects and implement as much of this programme as the available funds permit. But the Foundation can, indeed must, review its priorities at intervals: our twentieth anniversary seems an appropriate occasion to do so.

SOME RECENT BOOKS BY FRIENDS OF THE GALAPAGOS

THE ENVIRONMENTAL REVOLUTION:
Speeches on Conservation 1962-1977 by H.R.H. The Prince Philip. André Deutsch.

GALAPAGOS: DIE ARCHE NOAH IM PAZIFIK:
by I. Eibl-Eibesfeldt. (Sixth German Edition) R. Piper Verlag.

THE PENITENT BUTCHERS:
The Fauna Preservation Society 1903-78 by Richard Fitter and Sir Peter Scott. Collins/F.P.S.

BACK FROM THE BRINK:
Successes in Wildlife Conservation by Guy Mountfort. Hutchinson.

THE SULIDAE – GANNETS AND BOOBIES:
by J. Bryan Nelson, Oxford U.P., for the Univ. of Aberdeen.

THE BEAGLE RECORD:
Selections from the Original Pictorial Records and Written Accounts of the Voyage of H.M.S. Beagle. Edited by Richard Darwin Keynes, Cambridge U.P.