

NOTICIAS DE GALAPAGOS

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NEWS FROM ACADEMY BAY

MINISTERIAL VISIT.

In October 1977 the Charles Darwin Foundation for the first time held its General Assembly and Executive Council meetings in Quito. Afterwards as many as possible of the participants took advantage of the Ecuadorean Government's invitation to pay a brief visit to the National Park headquarters and the Charles Darwin Research Station in the Galapagos. The party was led by His Excellency Dr. José Ayala, Minister for External Relations, and included Ambassador Luna, Dr. Bahamonde, Ing. Teodoro Suarez (Head of the Forestry Directorate, which includes the Department of National Parks and Wildlife), Mr. and Mrs. Dillon Ripley, Dr. and Mrs. Herbert Hawkes, Dr. Ole Hamann, Dr. Catherine Coolidge, Dr. Tom Fritts, Dr. Louise Emmons, Licenciado Miguel Cifuentes, Superintendent of the Galapagos National Park, the Director of the Charles Darwin Research Station and the President and Secretary-General of the Charles Darwin Foundation.

A tour of the central islands of the archipelago in Beagle III enabled the Minister and his party to see something of the wonders of the Galapagos and the work of the National Park Service and the Charles Darwin Research Station, while Mr. Ripley, one of the founding fathers of the Charles Darwin Foundation, could appreciate the changes since his first visit in 1937 – and more importantly, the values that have been preserved by the combined effort of the national authorities and international scientists.

Although time did not permit visits to the outlying islands, the Minister's party was fortunately able to see a few of their specialities, such as the Waved Albatross, the Galapagos Penguin and the Galapagos Storm Petrel, which were wandering outside their breeding zones, as well as a fine cross-section of the more widespread flora and fauna – not to mention sharks, dolphins and killer whales hunting sea-lions.

The crew of Beagle III, under their captain, Fiddi Angermeyer, in addition to the highly efficient discharge of their navigational duties, found time to introduce their guests gastronomically to a variety of fishes and lobsters.

RESCUE OF THE LAND IGUANAS

One new feature of conservation work which the Minister was able to inspect was the series of pens constructed under the guidance of Dagmar Werner to house the survivors of the massacres by feral dogs of the land iguana populations of Santa Cruz and the Cartago Bay area of Isabela. (Noticias 25 and 26) Nothing comparable had been attempted previously as the hitherto little understood social system of the iguanas, especially the peculiar male-female relationship, appears to be unlike that of any genus hitherto known. There were complications such as the Station and the Park Service had never experienced with their tortoise-rearing programme but, thanks to the biological researches of Dr. Werner, enough had been learned to prevent even a single death among the 85 survivors since October 1976 and her further studies may lead to successful breeding in captivity.

Until now, only two species of land iguanas have been recognized, *Cenophus pallidus* on Barrington (Santa Fe) and *C. subcristatus* on all the other islands where the genus occurs. No attempt has been made to review the classification since Van Denburgh in 1912 and Dr. Werner is coming increasingly to consider that the various isolated populations may have diverged enough to be regarded as subspecies, if not as separate species. It is, therefore, of scientific importance to preserve the remnants of the Santa Cruz and Cartago Bay populations. Even more important is the need to solve the problem of bringing the feral dogs and cats under control before they spread further, particularly on Isabela, and eliminate other iguana populations. It is comforting to learn that the dogs which formerly preyed on the hatchlings of the rare San Cristobal tortoises have inexplicably disappeared but there is no reason to expect a similar deliverance elsewhere and every effort is being made to find some effective means of countering the menace.

Meanwhile 47 of the rescued land iguanas are in the Research Station pens and 38 on the tiny satellite island called Venecia just off the coast of Santa Cruz. Dr. Werner has returned to her basic research work and Mr. and Mrs. Howard Snell have taken over the duties of advising on conservation. Initially their task seemed more akin to civil engineering than to zoology as they were engaged in transporting tons of soil to Venecia so that the iguanas can dig their living holes and nesting burrows to the required depth.

PATROL BOATS FOR THE NATIONAL PARK

On 12 June 1977 His Excellency the Ambassador of the German Federal Republic formally handed over to the Galapagos National Park Service three patrol boats, the gift of the Frankfurt Zoological Society, which has provided such generous support for Galapagos conservation in recent years. The ceremony took place at Puerto Ayora on Santa Cruz Island. The Government of Ecuador was represented by Senora Ayala, wife of the Minister for External Relations and by Ing. Arturo Ponce, Head of the Department of National Parks and Wildlife. International interest was represented by all the Ambassadors accredited to Ecuador.

This impressive gift raises the Park Service's number of patrol boats to four. The target set out in the Master Plan is seven, plus a larger and faster supply vessel. Until further notice, the Darwin Station's research vessel, Beagle III, will continue to meet this latter need; together with the four patrol boats, this should ensure a fairly adequate protective service. The Darwin Foundation is aware of the anxiety felt in many places on account of the increasing tourist traffic. At the same time, there is no wish to deprive people of the pleasure and educational value of visits to the islands and, given the firm control now exercised by the National Park Service, there is no present reason to fear the effect of ten thousand visitors a year. Moreover, from a practical point of view, the exclusion of tourists would result in a fall in support for conservation, for which funds are so urgently needed. Ideally, the visitors would pay for the protection of the wonders they come to see. Both the National Park Service and the Darwin Foundation are convinced that introduced animals constitute a greater menace than the present number of visitors. Nevertheless the scientific monitoring of the long-term impact of tourists must continue even though the Frankfurt Zoological Society's generous gift of patrol boats will make the control of visitors much more secure. This question is discussed in an article by Drs. MacFarland and Tindle elsewhere in this issue.

GIANT TORTOISES: THE RETURN OF THE NATIVES

The San Diego Zoological Society, with their invariable generosity towards the CDF, offered to return their only male Hood tortoise to its native Galapagos (Noticias 25, page 19). This rare specimen has arrived safely at the Research Station's rearing centre and is an important addition to the breeding population of the sub-species, which only recently was on the verge of total extinction. It raises the world total of known adult males from two to three, promising a significant increase in genetic variability.

Meanwhile, between June and November 1977, the National Park wardens released on their respective native islands a further 103 young tortoises belonging to the various endangered sub-species raised at the Station. These included no less than 27 of the once "doomed" Hood tortoises. This may not yet rank as a population explosion but it is in striking contrast with the situation in 1969 when the Station Director, Roger Perry, collected the few scattered survivors, which had not reproduced for decades, and embarked on his adventurous project of saving *hoodensis* by breeding it in captivity.

FIRE ANTS

The fire ant, *Wasmannia auropunctata*, was introduced into the archipelago many years ago. It has now spread to all the inhabited islands and to at least one uninhabited island visited by tourists and scientists. Two Ecuadorean university students, Srta Concepcion Guayasamin and Srta Olga Pazmino, taking advantage of scholarships given by the PUCE and Metropolitan Touring, each researched this problem from a different angle and made it the subject of theses which were published and on which they were awarded their degrees. That the fire ants are a nuisance is a fact well known to camping scientists who have suffered their painful bite. But, more importantly, these latest researches show that they are also a serious threat to the delicate ecosystems of the islands. The fire ants consume little vegetable matter and feed mainly on other invertebrates, thus endangering the native invertebrate fauna; where they are found in considerable density, none of the numerous native ant species survives.

Both researchers argue that the control of this pest is, in its own field, of comparable importance to the control of introduced mammals. While the fire ant has been successfully eradicated on Santa Fe Island (Noticias 25) there is little prospect of achieving a similar result on the inhabited islands by present known methods. However, the National Park Service has taken firm action to prevent the spread to unaffected islands.

COURSES IN CONSERVATION

The National Park Service and the Charles Darwin Research Station have continued during 1977 their joint programme of conservational education by holding three types of courses in the Van Straelen Hall on Santa Cruz Island. In addition to the training courses for

Auxilliary Guides, there was a month-long intensive course for those wishing to qualify as Naturalist Guides, at least one of whom must now accompany the larger parties of tourists. This year there was also the seventh "Galapagos Natural Science and Conservation Course." All the military and civil officials, clergy and teachers of the archipelago were invited (125 attended) together with distinguished authorities from mainland Ecuador and international scientists to give lectures and lead the discussions. In the past these courses have concentrated on natural history and conservation, but this year the scope was broadened to include the socio-economic impact of conservation measures on the local population and how the development of the National Park might affect agriculture, fishing, education, public health and employment.

BREEDING FAILURE OF THE FERNANDINA PELICANS

Professor C. Wayne Eshelman of the Central Oregon Community College, together with his wife and son, have been studying the breeding biology of the Brown Pelican on Fernandina and adjacent Isabela. It was a bitter disappointment that every single nest they had under observation, whether it contained eggs, unfledged or fledged young, was suddenly deserted. The cause of this phenomenon is not yet clear but the Eshelmans have returned to Fernandina and an explanation may be forthcoming. A comparable event took place on Hood (Espanola) Island in 1965, when virtually the entire Waved Albatross population deserted the breeding site. This was a year when the warm Nino current had brought unusually heavy rains and for once the mosquitos on the normally arid Hood had hatched out. Dr. Roger Peterson, who was there filming, considered that the ferocious attacks of the mosquitos drove the Albatrosses into abandoning their breeding attempt. An alternative explanation was that the arrival of the warm water had drastically reduced the food supply, making the rearing of young impossible that year.

Another object of Professor Eshelman's study was to discover whether, even in the relatively pristine waters of the Galapagos, increasing traces of DDT and DDE are present in the Pelicans' eggs. However, while it is obviously prudent as a long-term exercise to monitor pollution even around remote Fernandina, it is not suggested that this is in any way connected with the present breeding failure.

The Eshelmans have a second string to their bow as they are also investigating the population ecology of the endemic rice rat, *Nesorysomys narboroughi*. Fernandina (Narborough) provides the ideal base for a rice rat study because, so far as is known, this island has never suffered from the introduction of the black rat, which has eliminated the native species on some other islands.

A CHANGE OF DIRECTORS

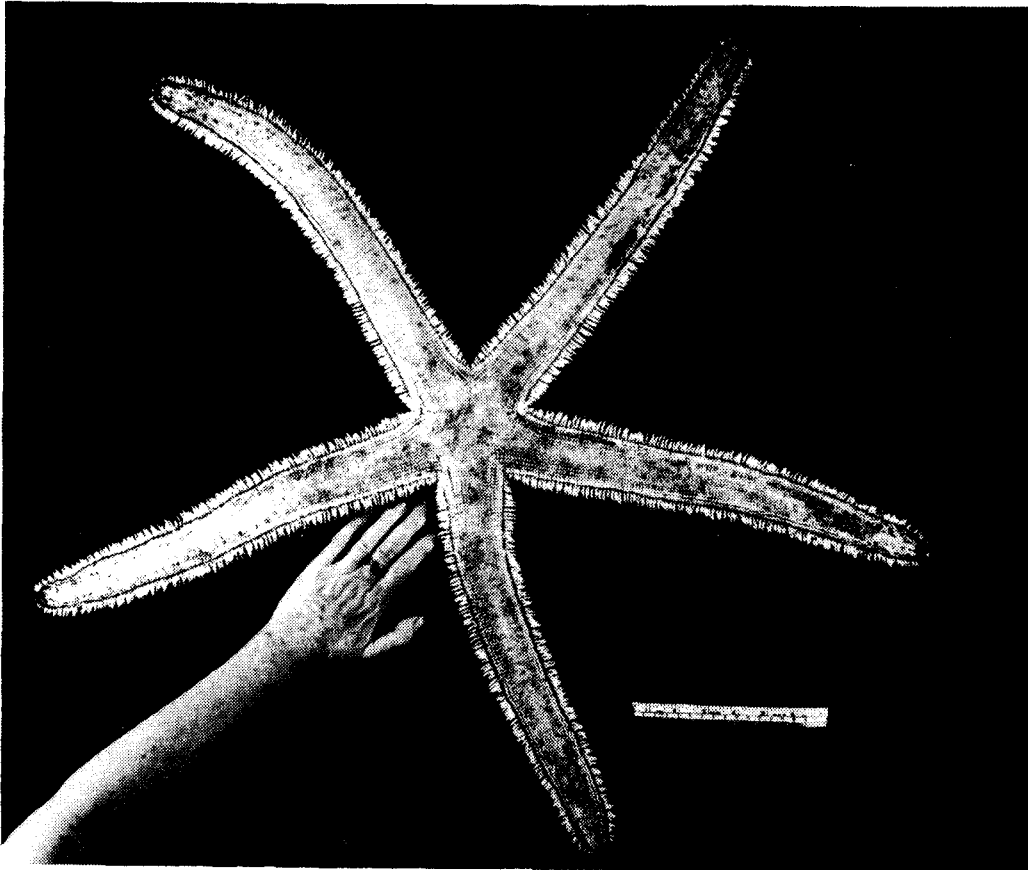
Since early 1974, the Charles Darwin Research Station has been under the able direction of Craig MacFarland. He already knew the Galapagos intimately because, as a visiting scientist, he had done years of basic research on the giant tortoises and had become deeply involved in the highly successful programme of breeding these in captivity. The rescue of the endangered races owes much to his initiatives. But as Director his brief was much wider and he tackled his multifarious duties with courage and determination, particularly the endemic problem of the CDRS — lack of the funds to do what was obviously necessary. Now, he and his wife have decided to return to the United States at the beginning of 1978. All friends

of the Galapagos owe them a deep debt of gratitude and our best wishes will go with them and their children in their new life.

A new Director, Dr. Hendrik Hoeck, has been appointed. While his recent zoological researches and conservation activities have been centred in the African National Parks rather than in Ecuador, the fact that he is a citizen of neighbouring Colombia shows that he is very much at home in South America. He has already visited the Station to acquaint himself with its problems and will arrive with his wife to take over in January.

REDISCOVERY OF A GIANT SEA STAR

While diving at Tagus Cove, Jerry Wellington discovered a huge sea star which turned out to be *Luidia superba*, A. H. Clark 1917. While it was not a new species it was only the second specimen to be recorded, the first having been collected in 1888 by the Albatross off the coast of Columbia at a depth of 33 fathoms. Wellington's specimen is the largest five-armed sea star ever known, with a 415 mm. arm radius.



FRIENDS OF THE GALAPAGOS RECEIVE MAJOR INTERNATIONAL AWARDS

The Secretary-General of the United Nations has awarded the 1977 International Pahlavi Environment Prize jointly to Sir Peter Scott and Commander Jacques Cousteau for their services to nature conservation.

Sir Peter Scott, Chairman of the World Wildlife Fund and of the Fauna Preservation Society and Director of the Wildfowl Trust, has been an active member of the executive council of the Charles Darwin Foundation for the Galapagos Isles since its earliest days. He first visited the archipelago in 1961 to make a documentary film for the BBC and since then has returned repeatedly, the last time in 1976. Commander Cousteau, whose outstanding television films have been shown all over the world, has likewise worked in the Galapagos. Both men have for years dedicated their lives to wildlife conservation and the preservation of the environment in all parts of the world. Both were once naval officers and, not unnaturally, have a special interest in the protection of the seas and oceanic islands.

The 1977 Paul Getty Prize for Conservation has been awarded to Major Ian Grimwood for his work in saving wild animals and establishing nature reserves. Major Grimwood, who has devoted himself to the cause of conservation in every continent, went on a mission to the Galapagos in 1966 at the invitation of the government of Ecuador. Together with Dr. David Snow, former Director of the Charles Darwin Research Station, he studied the problems of the Galapagos and submitted to President Yerovi a report entitled: "Recommendations for the administration of the proposed Galapagos National Park and the development of its tourist potential."

In their different ways, all three prize-winners have made tremendous contributions to international conservation and, in particular, have helped to make the Galapagos one of the foremost National Parks in the world.

G.T.C.S.



Galapagos Sea Lions.

Drawing by Peter Scott.

SCIENTISTS AT THE RESEARCH STATION IN 1977

The Charles Darwin Foundation has the duty of furthering both science and conservation in the Galapagos. Fortunately the two not only overlap but are positively complementary in that each aids the other. The researches of some scientists may seem a trifle recondite to many CDF supporters but the growing importance of the Research Station and the National Park from the scientific point of view is testified by the rapidly increasing number of scientists making use of the facilities. The Station's 500th visiting scientific mission is expected in 1978.

It should be understood that, apart from the all too tiny number of "resident scientists" and the Ecuadorean scholarship students, the scientists are funded by universities, learned societies, etc., and are not a charge on the CDF's precarious finances. The following list, which does not claim to be complete, is only intended to give a general idea of the wide variety of studies undertaken by scientists from an equally wide variety of countries, and ranging from emeritus professors to under-graduates — not forgetting writers and film producers. The names are set out in no particular order but they were all at the Station sometime in 1977, whether for a matter of days or for part of a three-year stint.

Dr. Warren Walker Oberlin College, Ohio.	Locomotion of the Giant Tortoise.
Dr. David Williams U. S. Geological Survey and Sr. Pedro Basabe Escuela Politecnica Nacional, Quito	Fumaroles and hot springs.
Dr. Robert E. Ricklefs University of Pennsylvania	The organization of passerine bird communities.
Dr. Lyle F. Leggett Universidad Nacional, Lima, Peru	Fish parasitology. Preliminary observations.
Mr. Gaetan du Chatenet Mus. National d'Histoire Naturelle, Paris	Artist and writer.
Miss Birgit Voigt University of Copenhagen	Antagonistic behaviour of the Galapagos Sea Lion.
Dr. Ole Hamann University of Copenhagen	Dynamical studies of vegetational cover on Santa Fe and Pinta.
Mr. Henning Adersen University of Copenhagen	Plant ecological studies.
Dr. Hampton L. Carson University of Hawaii	Preliminary survey of the <i>Drosophilid</i> fauna.

Dr. Earle Chapman and Dr. John Stanbury School of Medicine Harvard University	Iodine-proteic balance between human settlers and the environment.
Dr. Francisco J. Palacio Woods Hole Oceanographic Institute U. S. A.	Management of a proposed Marine Park in Galapagos.
Dr. J. de Korte University of Amsterdam	Clepto-parasitic study of <i>Fragata minor</i> .
Dr. Tjitte De Vries Universidad Catolica, Quito	Continuation of long-term monitoring of tourist impact.
Dr. Francis Dor Por Hebrew University Jerusalem	Observations in the mangrove areas of Santa Cruz.
Dr. Wayne Eshelman Central Oregon Community College U. S. A.	Population ecology of the rice rat – <i>Nesomysomys narboroughi</i> .
Dr. Thomas H. Fritts San Diego Zoological Museum U. S. A.	Evolutionary divergence in populations of giant tortoises.
Dr. Lynn Hendrix Yaquima Valley College, U. S. A.	Revegetation on Fernandina since the volcanic eruption of 1968.
Ms. Miriam Steinetz de Manaán Ohio State University	Zooplankton studies in ponds and lakes.
Dr. John Faaborg and Mr. Curt Griffin University of Missouri	Polyandry in the Galapagos Hawk.
Dr. John D. Pettigrew California Institute of Technology	Nocturnal adaptations in the visual system of the Swallow tailed Gull.
Sr. Patricio Arana Espina Instituto Nacional de Pesca Ecuador.	General observations on fisheries in Galapagos.
Mr. John Perlman San Francisco Chronicle	Scientific writer.

Dr. Fritz Trillmich Max Planck Institute West Germany	Ethological studies of the Sea Lions.
Mrs. Kristina Trillmich Max Planck Institute	Ethological studies of the Marine Iguana.
Dr. Dagmar Werner Basel University	Ecology and social behaviour of the Land Iguanas.
Dr. Robert Tindle Resident Scientist	Tourist impact on sea-bird colonies.
Sr. Luis Calvopiña Resident Scientist	Feral goat problems.
Dr. Peter Grant McGill University, Canada	Bird ecology.
Mr. Peter Boag, Mc Gill University	Morphological variation in <i>Geospiza fortis</i>
Miss Laureene Ratcliffe Mc Gill University	Mating selection and recognition between 3 species of Darwin's finches.
Mrs. Susan C. Rainey University of California, Berkeley	Socio-economical aspects of human settlement in Galapagos.
Mr. James Harrison University of Guelph Canada	Charles Darwin biography.
Mr. Irving Stone San Francisco	Biographical novel about Charles Darwin.
Dr. James L. Patton and Mr. Ron Marlow University of California, Berkeley	Biochemical genetics of Galapagos tortoises.
Dr. C. P. Hickman Jr. Washington and Lee University U. S. A.	General Ecology of Galapagos Islands.
Dr. James A. Mears Academy of Natural Sciences Philadelphia	Origins and relations of the <i>Altenanthera</i> (<i>Amaranthaceae-Gomphrenoideae</i>) Taxa of the Galapagos.

Dr. James N. Norris
National Museum of Natural History
and

Ms. Katina E. Bucher
Mrs. Marsha Cox
Ms. Duane Hope
Smithsonian Institution
and

Dr. William Fenical
Scripps Institute of Oceanography
and

Mr. Bruce Howard
University of California, San Diego
and

Dr. Mark M. Littler
Ms. Dianne Littler
University of California, Irvine
and

Dr. Howard Sleeper
Salk Institute
San Diego, California

Mr. Derek Green
Resident Scientist

Sr. Fernando Calderon and
Sr. Rodrigo Moncayo
Florida Institute of Technology

Dr. Thomas Casadevall
Escuela Politecnica Nacional
Quito

Dr. Kurt Rehn
Universidad Catolica
Quito

Emeritus Prof. Irene Manton
University of Leeds
England

Sr. Eduardo Zambrano
Instituto Oceanografico de la Armada
Ecuador

Dr. Pekka Lehtinen
University of Turku
Finland

Field studies of intertidal and subtidal benthic
marine Algae. (Smithsonian Marine Algal
Program in the Galapagos)

Population ecology of the Green Turtle
(continuation)

Biology of the lava lizard.

General geological observations.

Biochemical study of the Genus *Schistocerca*.

Electron microscopy of marine phyto-plankton.

Phytoplankton studies.

Phylogenetic studies of the Order *Araneae*.

Dr. John E. McCosker California Academy of Sciences and	Study of Galapagos shorefishes (California Academy of Sciences Ichthyological Expedition).
Dr. Robert R. Warner University of California and	
Dr. Leighton R. Taylor University of Hawaii	
Dr. William G. Reeder University of Wisconsin	Arachnids and myriapods – continuation of ecological studies.
Dr. Karl Gunther Reck and Dr. Pedro Ortiz Instituto Nacional de Pesca Ecuador	Long term studies of the biology of the Galapagos lobster (Panilurus)
Mr. David Attenborough Dr. John Sparks Mr. Maurice Fischer Mr. Lyndon Bird Mr. Hugh Maynard BBC, England	Filming parts of a TV series: “Life on Earth”
Mrs Hiroko Fujimoto Asahi Broadcasting Corp. Japan	TV film on Galapagos Wildlife.
Mr. Takeshi Hara Mr. Kensaku Tagawa Mr. Hideo Sato Nippon Hoso Kyokai, Tokyo	TV film on Galapagos Wildlife.
Mr. David Doubilet National Geographic Society and	Filming underwater life.
Mr. Steve Grosvenor Editor, National Geographic Magazine U. S. A.	
Mr. Gerard M. Wellington University of California Santa Barbara. and Mr. David Laur	Coral species zonation patterns in the Eastern Pacific.

Mr. Steve Hoffman
Smithsonian Tropical Research Institute
and
Mr. Peter Pressley

Behavioural ecology of sequential hermaphroditism
in the labrid fishes *Bodianus diplotenia* *B. eclancheri*
and *B. rufus*.

Mr. Y. Yoshioka
Tokyo Broadcasting Corp.

TV film on Galapagos Wildlife.

Prof. Wolfgang Wickler and
Dr. Uta Seibet
Max Planck Institute
West Germany

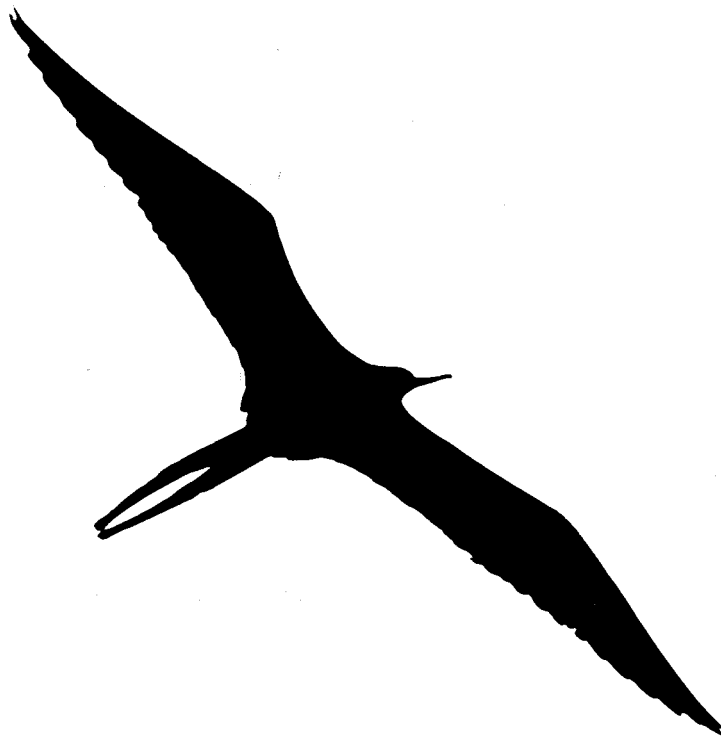
Exploration of new fields for research in the
Galapagos.

Mr. & Mrs. Howard Snell
U. S. Peace Corps Volunteers

Preservation of endangered populations of Land
Iguanas.

Mr. B. Ned Kelly
BBC, England

TV film series: "The Voyage of Charles Darwin"



Frigate Bird (*Fregata Minor Ridgwayi*)

Photo by Fritz Pölking.

ICHTHYOLOGICAL STUDIES AT GALAPAGOS

by John E. McCosker, Leighton R. Taylor, Jr., and Robert R. Warner

Studies of the Galapagos fishes began with specimens captured by Charles Darwin while aboard HMS Beagle. All of the 15 specimens he captured were later described by Jenyns (1842) as new to science, and in the subsequent 135 years the reported number of Galapagos shorefishes has been increased to 289 (Rosenblatt and Walker, 1963; Walker, 1966). Although several ichthyologists have actively studied the Galapagos shorefishes during the last decade (in particular, Messrs. R. H. Rosenblatt, B. W. Walker, E. S. Hobson and G. M. Wellington) a comprehensive cataloguing of the fauna has not been completed. It was our intent to perform an extensive diving survey of those fishes living in depths of -20 to -50 meters in order to complement earlier shallow water studies. Our goal is to complete, in association with other workers, an annotated checklist of the Galapagos ichthyofauna.

The 1977 California Academy of Sciences' Galapagos Expedition succeeded in photographing, observing and collecting numerous fishes previously unknown from Galapagos as well as several which are new to science. The expedition visited all the major islands, and several offshore banks, except the islands Isabela, Fernandina, San Cristobal, Darwin, and Wolf. Fishes were collected by hand spear, hook and line, and anesthetics and are presently housed in the fish collection of the California Academy of Sciences. Specimens have been distributed to the Charles Darwin Research Laboratory, Bernice P. Bishop Museum, and the Scripps Institution of Oceanography.

The following species previously unreported from the Galapagos have been identified: the parrotfish *Calotomus spinidens* (Quoy and Gaimard), family Scaridae; the wrasse *Hemipteronotus taeniourus* (Lacepede), Labridae; and the moray eel *Echidna zebra* (Shaw), Muraenidae (previously reported but lacking positive identification by McCosker and Rosenblatt, 1975). Apparently new species of the following genera were collected and photographed: *Liopropoma*, family Serranidae; *Chromis*, Pomacentridae; *Ekemblemaria*, Chaenopsidae; and *Taenioconger*, Congridae. The apparently new species of garden eel, genus *Taenioconger*, deserve special mention. Whereas similar eastern tropical Pacific localities which we have studied (e. g. Gulf of California, Costa Rica, and Panama) are inhabited by two or three species of garden eels, ecologically separated by water depth and/or substrate differences, the Galapagos is apparently inhabited by a single species living in depths of -5 to -60 (or more) metres and occupying a range of substrate types including sand, gravel, and broken shell. The absence of other garden eel species is perhaps indicative of reduced larval vagility of garden eels as compared to other eels.

The new and newly reported species do not appreciably change the level of Galapagos shorefish endemism. The newly reported *Calotomus spinidens*, *Hemipteronotus taeniourus*, and *Echidna zebra* are widespread Indo-Pacific species that are also known from the eastern tropical Pacific (cf. Rosenblatt, et al., 1972). The new species will require further specimen comparison before their description. The *Liopropoma* specimens were compared with individuals from Cabo San Lucas, Mexico, and appear to be conspecific (R. H. Rosenblatt, pers. comm.). The garden eel specimens appear most similar to *Taenioconger digueti* Pellegrin from Baja California but differ in certain body proportions. The damselfish are very similar to and perhaps conspecific with *Chromis* from the mainland of Peru.

None of the new species, including the chaenopsid blenny *Ekemblemaria*, appear closely related to an Indo-western Pacific ancestor; their closest congeners, in fact, are mainland eastern Pacific forms.

Our driving observations indicated that there is a paucity of fishes below the nearshore thermocline. A narrow and distinct band exists separating shallow from deeper water shore-fishes. This zone of limited overlap occurred at -20 to -30 meters at most locations and probably changes elevation seasonally. Shallow water fishes are apparently replaced by ecological cognates below the thermocline; for example, the deep-water butterflyfish *Chaetodon falcifer* replaces the shallow-water *Heniochus nigrirostris*, *Pimelometopon darwini* replaces *Bodianus diplotaenia*, and *Chromis* sp. replaces species of *Eupomacentrus*. In that our studies were made during the warm season when the thermocline is depressed, we suspect that future surveys during the cold season will allow a better understanding of deeper living shorefishes.

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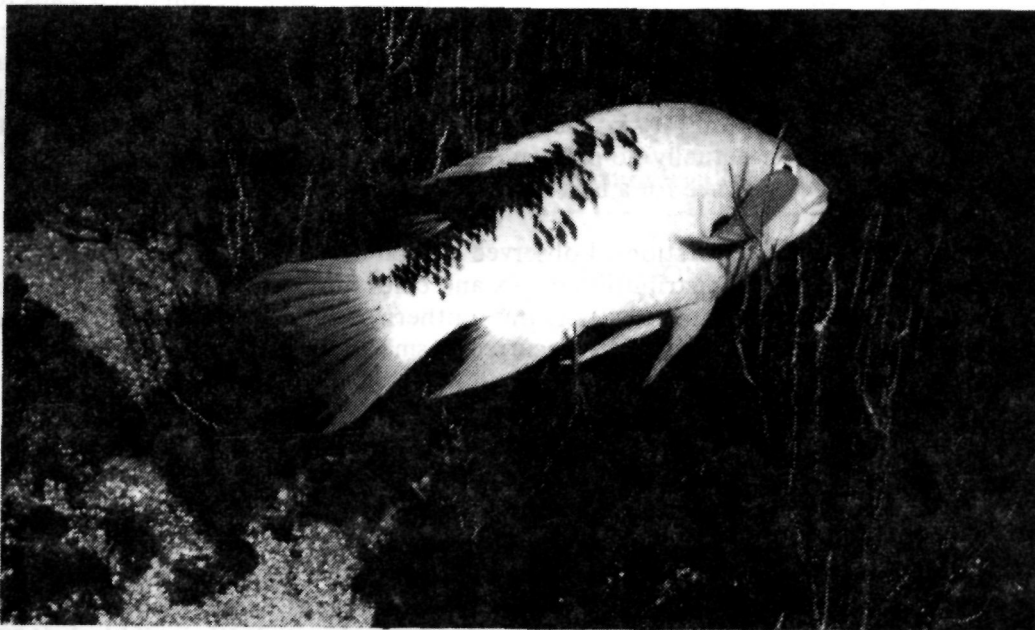
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Garden eel colony. Garden eel specimens were collected for the first time from Galapagos.



Vieja (Bodianus eclancheri).

Photo by L. R. Taylor, Jr.

PATTERNS OF SEX AND COLORATION IN THE GALAPAGOS WRASSES

BODIANUS ECLANCHERI AND *PIMELOMETOPON DARWINI*

by Robert R. Warner

The Galapagos Islands are unique in their mixture of tropical and temperate species of the fish family Labridae (wrasses). A prominent member of this species assemblage is the Vieja or Hogfish, *Bodianus eclancheri*, which is found in the temperate waters off the South American mainland as well. *B. eclancheri* is a large species, with individuals occurring up to 500 mm in standard length (SL). This large size is typical of many other members of the subfamily Bodianini.

Bodianus eclancheri is an important species in that it possesses a harlequin coloration. Individuals may be all black, all orange, all white, or a variable mixture of patches of all three colors. The only consistent pattern in the coloration is the black axil of the pectoral fin. Since coloration supposedly has a high survival and/or sexual signaling value, a harlequin species is of the utmost evolutionary interest. These are large, epibenthic fishes, roaming actively about in waters of moderate to high visibility. Why has natural selection not acted to produce a uniform, supposedly optimum coloration which conveys high fitness, in terms of either survival or reproduction?

The question of coloration in *B. eclancheri* is also interesting in terms of sexuality. The other members of this subfamily which have been investigated have been shown to be sex-changing hermaphrodites (Warner, 1975; Warner and Robertson, in press; S. Hoffman, in preparation). Protogynous (female-to-male) sex change has been postulated to be associated with strong sexual selection (Warner et al., 1975). Strong sexual selection often leads to sexual dichromatism as well, such as in the comparatively bright plumage of many male birds. The lack of a distinctive male coloration in this species suggests that sexual selection may not be occurring, or at least is not taking place on the basis of coloration. If sexual selection is not operating, natural selection for sex change may not exist either. So we are faced with two questions. (1) Is there actually no pattern of coloration associated with sex or size? (2) If this is so, is there evidence for a lack of functional sex change in this species?

In order to investigate these questions, I observed coloration patterns and collected 17 specimens for analysis of the distribution of sex and coloration with size. The species was rather uncommon (6-8 sighted per dive) off the southern and central islands, and entirely absent in the northern islands. It usually occurred in small localized groups of three to four individuals, with a graded size series in each group.

There was no apparent correlation of coloration with either size or sex (Table 1). Very small individuals were in the juvenile coloration, which consists of four dark stripes (either dark orange or dark grey) over a lighter background of the same colour. Some irregular black blotches are present in the posterior portions of the lighter stripes. Among adults, field observations indicated that tricolored individuals may be more common in larger size classes. Overall, field tallies of coloration indicated that the most common coloration was orange with black dorsal blotching (34% of 53 individuals observed), then all black (15%) white/orange/black (11%), black with orange head (11%), orange with black head (9%), all orange (9%), all white (6%) and juvenile (6%).

The sexual pattern of this species is intriguing as well. Males are found in both the largest and smallest size classes (Table 1). This is very different from the distinct trend of increasing frequency of males with size as is present in functionally sex-changing labrids (e. g. Warner, 1975). However, the sex ratio is skewed towards females, and all the male gonads that were examined histologically appeared to have been derived from ovarian structures. This indicates one of two possibilities. (1) *Bodianus eclancheri* could be a secondary gonochore. In this condition, the species is made up of pure females and males, and no sex change occurs during the adult lifespan. But males are derived from females, essentially changing sex before maturity, and have gonads that are secondary in the sense of Reinboth (1970). (2) Another possibility which could fit the observed pattern of sex with size is where sex change occurs over a very wide range of sizes. Both phenomena could be occurring, and both indicate that sexual selection, in the sense of strong differential reproductive success of larger males, has probably not been a factor in the recent evolution of this species. Clarification on this subject should be forthcoming from a study of the mating system of *B. eclancheri*, currently being undertaken by S. H. Hoffman of the University of California, Santa Barbara. Frequency analysis of a larger sample of individuals combined with an aging study, should reveal whether secondary gonochorism or variable size of sex change is the predominant sexual pattern in this species.

Another bodianine wrasse occurs in the Galapagos: *Pimelometopon darwini*, also called Vieja. *P. darwini* was observed in deep (30m) water on most dives in the southern and central islands. It closely resembles its congener *P. pulchrum* of the north temperate Eastern Pacific. Young individuals are dull rose in color and larger individuals develop a large yellow spot near the base of the pectoral fins. Histological analysis of the gonads of two male *P. darwini* (406 and 416 mm SL) indicated that their testes were anatomically derived from ovarian structures. This suggests the possibility of sex change in *P. darwini*.

TABLE 1. Size, sex and coloration of 17 individuals of *Bodianus eclancheri*.

Ripe females have mature eggs.

Active females have oocytes that are undergoing vitellogenesis.

All males were actively producing sperm.

Secondary males have testes anatomically derived from ovaries (cf. Reinboth, 1970).

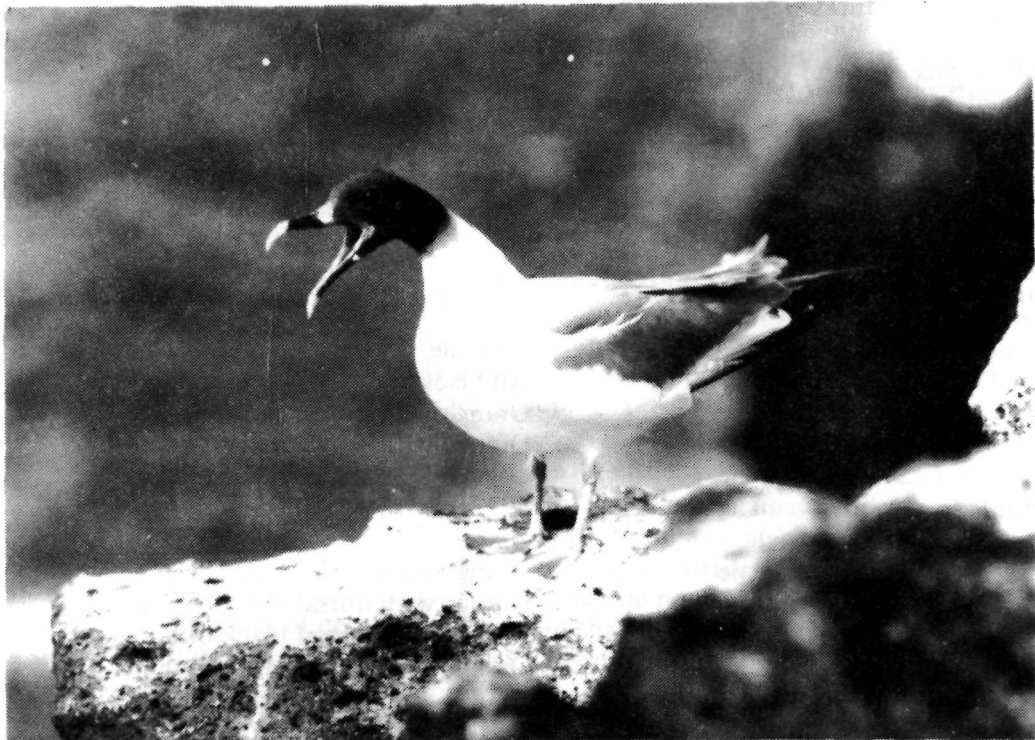
SL (mm)	SEXUAL CONDITION	COLORATION
161	Inactive female	Juvenile
220	Ripe female	All black
220	Ripe female	Orange with dorsal black blotches
222	Inactive female	Orange with dorsal black blotches
252	Secondary male	Orange with dorsal black blotches
277	Inactive female	Orange with dorsal black blotches
281	Active female	All black
290	Secondary male	Orange with dorsal black blotches
294	Active female	Orange with dorsal black blotches
295	Inactive female	Orange with dorsal black blotches
300	Inactive female	Orange with dorsal black blotches
300	Inactive female	Orange with dorsal black blotches
304	Secondary male	Black with orange head

TABLE 1 (CONTINUED)

SL (mm)	SEXUAL CONDITION	COLORATION
329	Secondary male	All black
355	Inactive female	Orange dorsum, white venter, dorsal black blotches
392	Ripe female	Orange with dorsal black blotches
453	Secondary male	Orange dorsum, white venter, dorsal black blotches

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Swallow-tailed Gull.

Photo by Fritz Pölking.

RECOVERY OF VEGETATION ON PINTA AND SANTA FE ISLANDS

by Ole Hamann

INTRODUCTION: The vegetation of many areas within the Galapagos National Park has suffered much from the activities of feral mammals. Grazing by introduced goats has seriously degraded the plant cover of several islands, the degree of destruction depending on such factors as the number of goats present, the length of time they have been on a particular island, and the type of vegetation originally growing there. Ultimately whole ecosystems are threatened.

In order to get exact information on the effects of introduced mammals on the natural vegetation an investigation has been carried on since 1966 by the Charles Darwin Research Station with the support of UNESCO. Permanent plots (quadrats) were established in selected areas to provide information on both seasonal and long-term changes in the vegetation. All quadrats have been checked regularly by a succession of scientists working at the CDRS. A comparison of vegetation in quadrats influenced by introduced grazers with vegetation in quadrats without such influence has clearly shown how destructive the introduced goats are (Hamann 1975).

The main purpose of the present study was to continue the investigation in areas where introduced grazers have recently been eradicated or greatly reduced in numbers. The study clearly showed that a recovery was under way. The investigation was carried out on Santa Cruz, Santa Fe and Pinta. Copies of the final report will be made available to the CDRS and to the authorities of the National Park.

GENERAL REMARKS ON THE RESULTS:

ISLA SANTA CRUZ: In the area above the barranco behind the CDRS two permanent quadrats were established in 1966. The yearly checks have shown that the vegetation of the area, dominated by *Opuntia echios* var. *gigantea*, *Bursera graveolens* and *Jasminocereus thouarsii* var. *delicatus*, is practically stable and without any disturbance. These two quadrats serve excellently as a reference to other arid zone quadrats in the archipelago.

The quadrats in the *Scalesia* forest (Caseta area) displayed in 1970-72 an almost pure and rapid growing stand of *Scalesia pedunculata*, indicating that this endemic species has great ability to colonize clearings in the forest. Now, in 1977, the vegetation (in the one remaining quadrat) appears to be approaching a more stable stage of development, with limited up-growth and limited mortality of *Scalesia pedunculata*, but with other tree species moving in. It suggests a mixed forest as the final stage of succession in this natural vegetation of a humid area in the Galapagos.

Although the quadrat in the *Miconia* zone was not found, the area above Media Luna displayed many new plants of *Miconia robinsoniana*. The *Miconia* shrubs are probably starting to win back ground lost in previous years, when both fires and cattle grazing reduced the extent of the *Miconia* zone. However, the introduced *Cinchona succirubra* was also abundant, so the National Park Service will probably have to repeat the eradication campaign recently carried out (Noticias 25) in order to control this threat to the native vegetation. Moreover, cattle were encountered in the area in clear violation of the National Park regulations.

ISLA SANTA FE: In 1971 all goats were finally eradicated on the island. The quadrats now give evidence of a recovery of the vegetation. The regeneration is rapid for some species like *Scalesia helleri* and *Waltheria ovata*, but slow for other species like *Bursera graveolens* (see also de Vries 1977). The density of the vegetation has increased in some areas, whereas the diversity generally has not changed, at least not in the quadrat areas.

ISLA PINTA: By the end of October 1977, park wardens estimated that maybe no more than a thousand goats were left on the island. This is a drastic reduction in a very few years: the number of goats on Pinta was in 1971 estimated to be at the very least 20,000 (Noticias 21). The effect of the removal of the heavy grazing pressure is now evident: a rapid recovery of vegetation is under way, as shown in the quadrats. Apparently the history of introduced goats on Pinta island has been so short that most plant species have survived in sufficient numbers to start a recolonization – once the goats were removed. The recovery is most striking in the humid highlands (see also de Vries 1977), probably because the growth there takes place as sprouting from old surviving stems or rhizomes. But also in the arid lowlands many species show a rapid come-back, mainly from seeds. Especially *Scalesia baurii* ssp. *hopkinsii* and *Darwiniothamnus tenuifolius* now occur in great numbers at low and intermediate altitudes.

Near one of the quadrats situated in a fumarole area, an interesting floristic record was made: *Psilotum nudum* was found growing among ferns on moist rocks. It is the first record of *Psilotum* from Pinta.

CONSERVATIONAL ASPECTS:

The study demonstrates that the long-term programme on eradication of introduced mammals especially goats, is producing results: the vegetation of Santa Fe and Pinta is recovering. This recovery, for a number of reasons, may proceed differently on the two islands, and also differently at high and low altitudes on Pinta. The study of permanent quadrats gives information on the successional processes. Knowledge of these processes – from different types of vegetation and from various islands – will be useful for the management of the National Park, as it can serve as the basis on which decisions of priorities for conservation programmes can be made.

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TOURIST IMPACT STUDIES ON SEA-BIRD POPULATIONS DURING 1976

Tourist impact studies on populations of several species of sea-birds (Waved Albatross, Flightless Cormorant, Great and Magnificent Frigatebirds), plus general observations on tourist impact on vegetation and geological features were carried out from 1972 by Drs. M. P. Harris, T. de Vries, C. MacFarland and a variety of collaborators, including National Park personnel and Ecuadorian scholarship students. Harris and de Vries summarized the results in a comprehensive report covering 1972-76. Briefly, these initial studies have shown very little direct and immediate effect of tourism on regularly-visited sea-bird colonies in Galapagos and the few problems occurring from 1969 to 1973 with other species (e. g. the feeding of land iguanas on Plaza Sur leading to unnatural tameness and the possible break-down of the normal social system) and the damage to vegetation and geological features have been eliminated by establishing and enforcing strict rules for tourist operations.*

However, the tourist traffic in the Islands will probably mount sharply in 1977, as two new 85-90 passenger ships are to start operations. Moreover, although the 1972-76 studies of impact, the evaluation of control methods and the previous ten years' data on sea-birds are encouraging, it is still *unknown* whether less noticeable behavioural changes in the visited sea-bird and pinniped colonies might be detrimental to the populations in the long term (e. g. subtle effects such as increased heart-beat rates as have been found recently in visited nesting birds in the Seychelles and decreased weight-gain rates of pups as have been found in visited colonies of Alaskan fur seals). Constant vigilance and detailed data over long periods must be maintained.

To these ends, the studies to obtain incubating and chick-rearing data and distributional censuses on the Magnificent Frigatebird (*Fregata magnificens*) and the Great Frigatebird (*F. minor*), each at paired sites, one tourist-visited and the other a non-visited control site, were continued on Tower (Genovesa) and Seymour during 1976. The CDRS representative on San Cristobal, Jacinto Gordillo, continued studies of pure and mixed colonies of both species of frigate-birds, including one visited and several non-visited sites near Wreck Bay on that island. Likewise, censusing of the three booby species at tourist-visited and non-visited control sites on Tower, Seymour and Daphne, and monitoring and banding of the Waved Albatross at one visited and two control sites were continued.

In addition, the programme was expanded to include:

- Similar detailed studies of incubating and chick-rearing frigatebirds in several colonies at Punta Pitt (San Cristobal), areas which have never been visited by tourists, but in which the tourist companies are now showing interest.
- Similar detailed studies on the Red-Footed Booby.

* Tourist visits are restricted to certain sites and in all cases, including sea-bird colonies, are controlled by trained guides. The visitors are restricted to clearly-defined pathways marked out by the National Park Service.



Red-footed Booby with young

Logistically, the following was involved:

- From January to June, J. Gordillo and C. MacFarland supervised two Ecuadorian students conducting detailed studies on the two species of frigatebirds and the Red-Footed Booby on San Cristobal.
- From July to September, R. W. Tindle took over this supervision, and also supervised two other students carrying out the frigatebird work on Tower and Seymour.
- Another student, L. Mariduena, who also worked in Galapagos during half of 1975 on the booby census, continued this task from May to November under the supervision of Tindle and MacFarland.

Data for a complete year (i. e. all months) on incubation, chick-rearing and feeding regimes, is now available for both the frigatebirds, in tourist-visited and in control sites. This mass of information is being analyzed by T. de Vries, R. W. Tindle and students.

In 1978, it is planned to extend these detailed studies to include the other two species of booby (*Sula dactylatra*, *S. nebouxii*) on Espanola, Tower, North Seymour and Daphne Islands and the flightless cormorant (*Nannopterum harrisi*) on Fernandina and Isabela Islands. These detailed studies on the three boobies and the cormorant will have to be carried out for several years to provide the critical information needed. Students are at present being recruited from Ecuadorian universities for this work. The ongoing banding-study of the Waved Albatross (*Diomedea irrorata*) will continue and a new monitoring of the population of Galapagos Penguin (*Spheniscus mendiculus*) is planned for the forthcoming months. The frigatebirds will continue to be censused but not studied in as great detail as over the past two years except on San Cristobal. Once the mass of data on the frigatebirds is completely analyzed, detailed studies will be undertaken again at the other sites.

These studies are an absolute necessity for two reasons: (1) they will provide the base-line data necessary to detect and halt possible trends in decline or artificially-caused distributional shifts, particularly those which are not obvious at first glance, and (2) they will provide the necessary information for determining tourist flow-patterns, e.g. areas which can and cannot be visited; the numbers of visitors and the frequency per week with which sites can be visited; closed seasons for several sites; the necessity of restricting visitors to marked trails or areas at certain distances from animal colonies; restrictions regarding noise, photography, and other activities; and hours that are best for visits.

C. MacFarland and R. W. Tindle.

These continuing studies are supported by the World Wildlife Fund, the Fauna Preservation Society, the London Zoological Society, the International Council for Bird Preservation and Dr. J. Wheelwright.

SMITHSONIAN INSTITUTION'S GALAPAGOS MARINE ALGAL PROGRAM

The Smithsonian recently began a two-year Marine Algal Program in the Galapagos Islands. Dr. James Norris, National Museum of Natural History, headed a team of scientists who began surveying the marine flora in the summer of 1977.

Marine algae are primary producers in the ocean's food chain, profoundly affecting other sea life. Considering their key role in marine ecosystems, it is imperative to have an adequate knowledge of these plants and their interaction with biotic and physical factors of the environment.

Since the establishment of the Smithsonian's research table at the Charles Darwin Research Station in 1966, a number of S. I. scientists have been involved, mostly in terrestrial research. Until recently, the islands have had little marine biological research.

Using the Charles Darwin Research Station as a base, Dr. Norris and Ms. Katina Bucher (co-investigators) and their team set out aboard the station's research vessel, M/Y BEAGLE III to survey the marine seaweeds. Plants from the intertidal zone to 40 meter depths were collected for systematic and chemical studies. The expedition selected study sites on most of the northern islands except the distant Culpepper and Wenman. A second expedition aboard the MISTRAL, went to the southern islands.

The Galapagos marine system is unique. The archipelago is situated at the convergence point of the major current systems of the Eastern Pacific. The complex interplay of these oceanic currents is partly responsible for the exceptional diversity of marine life and the marked differences between the islands. The El Nino current periodically brings warm tropical waters from the Gulf of Panama; the Peru and Humboldt currents bring cool, high salinity waters from the south to the equator where they join the Equatorial current travelling westwards to the islands; the Cromwell current flows eastwards underneath the Equatorial current and then causes an upwelling of cold, nutrient-rich waters when it strikes the west coasts of Isabela and Fernandina. Consequently these islands are influenced by ocean currents differing in temperatures, salinity and nutrient levels, which fluctuate seasonally. The marine life, reflecting this, is composed of a mixture of tropical, subtropical and temperate elements.

The expedition's purpose is to obtain material and data for ecological, systematic and chemical studies of Galapagos marine algae. Collections and observations made by SCUBA diving revealed some localities to be largely devoid of large fleshy algae and to consist of extensive coralline algal pavements and small algal turfs. These areas had large populations of grazing animals, including sea urchins, fish, marine iguanas and mollusks. The coralline algae may be protected from most grazers by their hard, stony character. Other sites may be nutrient-limited, lacking the upwelling which is predominant on the west coast of Isabela and Fernandina, where the upwelled areas often have rich, dense and diverse stands of large seaweeds.

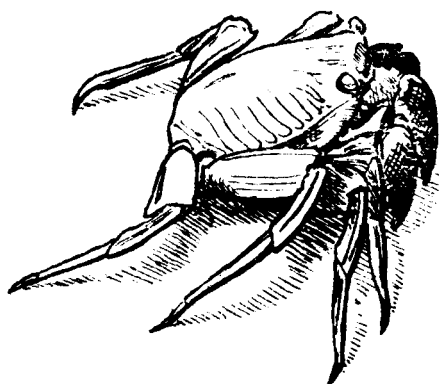
Ecological studies are being conducted by Dr. Norris and Dr. Mark Littler (University of California, Irvine), with the assistance of Katina Bucher, Marsha Cox and Duane Hope of the Smithsonian, Diane Littler (University of California, Irvine) and Fiddi Angermeyer (Captain, BEAGLE III). Permanent transects were established at study sites on Isla Rabida with its warmer subtropical water temperatures and, in contrast, at Tagus Cove, Isla Isabela,

with its colder upwelling of nutrient-rich water. Divers equipped with underwater cameras and strobe lights photographed quadrats at meter intervals from the intertidal zone to 13 meter depths at each study site. These data are being analyzed for inter-island and seasonal variation comparisons of species composition, diversity and community structure of the marine plants and invertebrate animals. The seasonal changes will be recorded by resurveying the same transects during a different season on the February 1978 expedition aboard the BEAGLE.

As tourism increases and more boats visit the islands, these quantitative and descriptive studies of the marine environment will be extremely important. They provide base-line information necessary to monitor any changes and can be utilized for future studies of the impact of tourism on the Galapagos' unique marine ecosystems.

The second party aboard the MISTRAL, included marine natural products chemists from Scripps Institution of Oceanography, Dr. William Fenical, Bruce Howard and Dr. Howard Sleeper. In addition to obtaining further material for systematic and distribution studies of Dr. Norris and Ms. Bucher, research efforts were directed toward those marine algae which produce unique chemical compounds. Seaweeds with unusual chemicals, selected by preliminary analysis during the cruise, were collected. Extraction, isolation, identification and structural elucidation of their natural product is now being carried out in Dr. Fenical's laboratory. The natural products will also be tested for biological activity, to select those with potential as pharmaceuticals, insecticides or herbicides. Ecologically these chemicals may serve as alleochemicals, functioning as antimicrobials, feeding deterrents, or as general toxins. The synthesis of protective chemicals may have adaptive benefit for the plant.

James Norris



Sally Lightfoot Crab (*Grapsus grapsus*).

Drawing by Peter Scott.

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CHARLES DARWIN FOUNDATION FOR THE GALAPAGOS ISLANDS
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