The Conservation Agency

Exploration, Education, and Research

President
James D. Lazell, Ph.D.
401-423-2652

6 Swinburne Street
Conanicut Island
R.I. 02835 U.S.A.

April 26, 1990

Dr. Henry Jarecki
Byewood, Timber Trail
Rye, New York 10580

Dear Henry:

A belated works and progress report for 1989, and my proposal for 1990:

Hurricane Hugo curtailed our plans for 1989, but quite a lot was accomplished even so. Basically my plan for 1990 is to attempt to do exactly what we had planned for 1989: a reduced presence in July and our big month of work 20 October to 20 November.

Termites.-Reports from Collins and Thorne follow and are self-explanatory. Margaret needs a week or so on Guana in late July to assay the situation in that (previously usual) month of our activity; then she can knowledgeably make the shift to October-November.

Other Arthropoda.-Vitor's collections post-Hugo were remarkable. His letter follows. Hurricanes are good for insects. Scott Miller is making real progress in getting entomological work done by his colleagues, as attested by our increasing list of publications, below. He promises more, bigger, better papers in the near future. He has a beetle paper in press.

Birds.-Liao amassed 179 pp. of notes which I have copied and have in hand. Most is in Chinese, of course, but that is not a problem because Wenhua can read it to me. It is easy for me to scan it because I recognize bird names and kinds of data even in Chinese. Liao and I hope he will complete some aspects of his study thwarted by Hugo and, especially, be able to include a hurricane-aftermath section in his paper. Our plan is to work up a final draft in October-November which he will present at the International Ornithological Congress in New Zealand in December. This will be a summary of our ornithological knowledge

of Guana with emphasis on its unique values as a dry island Antillean refuge and sanctuary. There is enormous potential here for instant fame and acclaim.

Bird restorations look good. As ever, we have the promise of more flamingos as soon as any are available. White-crown pigeon plans are well advanced. Next comes the Puerto Rican woodpecker, extirpated from the Virgin Islands in the early 1800's. It is about 10 inches total--bill to tail tip-length, and looks like this:

We are working our way to the parrots, which I believe we will get in a few years.

Robert Chipley has submitted a draft, copy enclosed, of his quail dove work to Caribbean Journal of Science. He and I and Rob Norton have (finally!) published our bird paper in the same journal: copy below. So bird work is going very well.

Reptiles and Amphibians.-Greg's July session went well and was needed for continuity of our population/evolution studies. The plan, of course, was to switch last year to October-November, but Hugo scotched that. So, we will plan the shift for this year. To make the shift we have know, in any given year, how the population is at the same time we have done previous surveys. Then in that year, we see how it is in the new time period (October-November). Without the same-time control, we could not interpret new-time different numbers. Lizards were not visibly affected by the hurricane. Frogs were undoubtedly benefitted.

Appended is the draft of an invited paper on our reptiles and amphibians submitted for a synposium volume to the Puerto Rico Department of Natural Resources. I attended this excellent symposium on conservation throughout the Puerto Rico Bank islands 6-9 April 1990. With Greg Mayer and Bill MacLean there, Guana was very well represented. We made an impressive showing. I think computers are really very stupid and wish BVI government officials would pay as much attention to us as P.R. Government people do. We are forging a great alliance there.

Community College and Permits.-For the sake of completeness I include herein my letter to Dr. Provo. Still no solid response.

NEW PUBLICATIONS

KORMILEV, N.A. 1989. A new species of the genus Lophoscutus Kormilev from Mexico (Hemiptera:Phymatidae: Macrocephalinae). Pan-Pacific Entomologist 65(4):451-453. (Uses Guana material for comparison; rare, big species; true bugs.)

LAZELL, J. 1989. Guana a Natural History Guide. The Conservation Agency, Jamestown, R.I.:22 pp. + 6 plates.

NORTON, R., R. CHIPLEY, and J. LAZELL. 1989. A contribution to the ornithology of the British Virgin Islands. Caribbean Journal of Science 25 (3-4):115-118. (Copy appended.)

PAPE, T. 1989. Revision of Opsidia Coquillet (Diptera: Sacrophagidae). Entomologica Scandinavica 20:229-241. (Sacrophagids are "flesh flies," a nasty lot which lay their eggs on or in living hosts, where their disgusting maggots develop. They are of economic importance--fortunately not on Guana--so need studying. We have few, but ours were especially valuable as they come from such a previously little-known area.)

PROCTOR, G.P. Ferns of Puerto Rico and the Virgin Islands. New York Botanical Society Memoir 53:389 pp. (This impressive volume chronicles both--all two--of Guana's ferns: Pteris vittata, the wall fern--common on our cisterns--on p. 158; and Nephrolepis multiflora--the sword fern--which grows up through the rocks at the Peak and other outcrops--on pp. 265-6. We are also tabulated on p. 352. This book costs $79.50! We could easily buy it from N.Y. Bot. Soc., Bronx, NY 10458. They will probably respond to phone orders.)

So, five publications in one year... That's more like it! And I only wrote one-and-one-third. That's better. Still, we need lots more. The book, Island..., languishes unloved: every publisher says the field is glutted. The field was empty in 1985, when Yale turned us down. Incidentally, the critical (of Stephen Jay Gould) remarks cited as the reason for turning us down by Yale can be read--much expanded and with more venom--in Dawkins in his great 1987 book The Blind Watchmaker:copy sent under separate cover.

Lesson: in this world it mostly matters who you know and who knows you. I said it first and got it right, but I am not named Richard Dawkins, so the world got to wait a little longer.

PROPOSAL, 1990

A brief session, like last year's, will involve Greg Mayer and his lizard crew and Margaret Collins and--maybe--a termite assistant. We do not need collecting permits for this work, but it would be great to get that issue resolved so that if the crew sees something they want to collect (like a boa), they can do it.

The real thrust will be 20 October to 20 November. At present I plan a team of about 20 involving 400 bednights. Scientists would be me, Liao, Miller, another entomologist, Collins, Mayer, MacLean, Proctor, Goodyear, James (the worm man--for a few days), Chabora (fruit flies--a few days), and one or two others for short periods. I will be working on details this summer while on Lantau Island, Hong Kong.

All the best,

Stig

P.S. The Draco paper, describing--among other wonders--Draco jareckii from Batan, has been submitted to Harvard. The color illustrations are done. We await reviews..

National Museum of Natural History · Smithsonian Institution
WASHINGTON, D.C. 20560 · TEL. 202- Entomology, NHB- M.S. 105

February 7, 1990

Dr. James Lazell, President
The Conservation Agency
6 Swinburne Street
Conanicut Island, R.I. 02835

Dear Dr. Lazell :

Enclosed please find my report on activities for 1989 on Guana Island. I apologize for the length, but DID include a brief summary.

I am sending a copy to Dr. Barbara Thorne, with whom I consulted in preparation of this report, with the request to send any comments, additions or corrections directly to you. Hope this will help time-wise.

Good luck on the over-all report, and hope that things work out well for the next season - I am dying to see how the termites are reacting to Hugo.

Sincerely yours,

Margaret S. Collins

Margaret S. Collins
Entomology

NESTING BIOLOGY AND POPULATIONS DYNAMICS OF *Nasutitermes nigriceps* (Haldeman) ON GUANA ISLAND, B.V.I.

Margaret S. Collins and Barbara L. Thorne

INTRODUCTION

The tropicopolitan termite genus *Nasutitermes* (Nasutitermitinae) is the most speciose of all Isoptera genera, containing approximately 75 described species from the Neotropics alone. Unlike almost all other termites, *Nasutitermes* typically build "carton" nests (composed of partially digested wood and salivary secretions) in trees. Other nest-building termites build mounds on the ground, but the arboreal nesting habit has enabled *Nasutitermes* to successfully colonize a whole new habitat. *Nasutitermes* nests can reach massive sizes, housing well over a million termites. The arboreal nesting behavior of *Nasutitermes* has commonly been postulated as a reason for their ecologically prominant and numerically conspicuous presence in the Neotropics, but in fact little is known of the nesting biology and population dynamics of *Nasutitermes*.

Nasutitermes nigriceps (Haldeman), found on Guana Island, is an appropriate focal species for a study of *Nasutitermes* colony and population dynamics. It is a geographically widespread termite with among the largest nests ever measured for the genus. Guana Island serves as a model study site for this species because nests are abundant, *Nasutitermes* food is plentiful, and termite predators are relatively rare. Our research is centered on the following questions:

1] Do single *N. nigriceps* colonies (termites affiliating with a single queen and king) occupy single arboreal nests, or do single colonies also establish and move among satellite nests?

2] If an established nest falls or receives damage, can the termites rebuild and relocate in a new (proximate) location? Do they move their physogastric queen?

3] The wood and vegetative materials consumed by termites are generally nutritionally poor. Nutritional stress within a termite colony is particularly acute during production of the annual reproductive (alate) brood. Can *N. nigriceps* store food, perhaps in the form of occasionally described 'nodules' found within their carton nest matrix? These 'nodules' have never been reported for any other termite, and thus are quite intriguing.

The following report details some of our approaches to researching these topics.

(see report by M.S. Collins

Report on Termite Studies, Guana Island, 1989

Working with Dr. Barbara Thorne and Ralph Rusher, nests of Nasutitermes nigriceps (Haldeman) were screened for the presence of formed nodular inclusions hereafter referred to as "Mushroom bodies". Only one nest, the giant that fell in the North Beach woods had them, bringing the total to two.

The termite N. nigriceps is widespread in the Neotropics on both island and continental land masses, ranging from Mexico south to Brazil, and widely in the Caribbean (Araujo,1970). Wherever found, the nests are conspicuous; they are not only numerous, but also are the largest built by any carton-nest building type (Thorne, pers. comm.). This is the only carton-nest builder found so far on Guana, Beef and George Dog of the British Virgins.

Light (1911) suggested that a single colony might have more than one nest, a situation now referred to as polycalic. During the summer of 1988, using agonistic behavior to indicate contact between termites of different colonies, or nest clusters, it was established that the Sea Grape association extending the length of White Bay beach was occupied by a single highly-polycalic colony. The different nests in the woods at North Beach seem also to constitute a polycalic system, probably stemming from the giant nest that fell just prior to our arrival on Guana. This nest was later moved closer to the trail and sawn into halves.

The mushroom bodies have been found, so far, in nests that contained functional primary reproductives. The first nest, the "cistern" nest, had a greatly enlarged queen, many eggs and very young termites ("larvae"), and a very large population of adult soldiers and several sizes of workers. A zone of the nest packed with mushroom bodies extended around the middle . Many of the mushroom bodies showed extensive tunnelling and had galleries packed with very young termites.

Samples of these inclusions from the cistern nest, along with nest material and a portion of the colony to be maintained alive were brought back to the Museum in 1988. The mushroom bodies and nest matrix freed from termites were forwarded to Dr. Barbara Thorne, who had seen such inclusions in a nigriceps nest in Panama and was interested in further study of them. She secured the cooperation of a chemist, Dr. Karen Bjorndal, at the University of Florida, who agreed to analyze nest and inclusions. The summer of 1989 permitted securing additional samples of that nest material and the inclusions. Her preliminary analyses show these bodies to be different in composition from the nest matrix, as follows :

(next page)

Component	Nest	Nodule	Remarks
Cutin (wax)	Higher than in nodule	Lower than in nest	Could come from termite bodies rubbing on walls
Lignin	ca 32-40 %	ca 32-40 %	
Nitrogen content of matrix	lower outside of nodule	higher inside of nodule	Some nodules had inner cores of darker matrix surrounded by yellow nodule material
Cellulose	17 %	30 %	
Caloric content	About the same in both		
% Dry matter	20-30 %	5-9 %	

When detailed analyses are available we can complete a MS entitled "Architecture of Nasutitermes nigriceps nests with notes on distinctly constructed nodules embedded within the carton nest. Isoptera, Termitidae" , in preparation.

These nodules were first reported on by Hubbard, 1877, who described them as masses of stored food. His first suggestion, that the nodules were fungus gardens comparable to those maintained by some African termites, was discarded after microscopic examination revealed few spores and hyphae, in amounts no greater than could be accounted for by accidental inclusion. He concluded that the nodules were stored food bodies constructed by the termites a mouthful of packed plant material at the time, cemented together by some agent (probably saliva). The nodules are dense and fine-grained. They will take a fine polish. The higher nitrogen and cellulose content compared to that of the nest material suggests that the mushroom bodies constitute a concentrated nutrient source ; galleries excavated in the conclusions may also provide a convenient assembly point for feeding the young. Hubbard and E.A. Andrews both felt that the nodules are stored food constructs. If this is indeed the case, it represents the only instance on record of food storage by a carton-nest building termite.

Further questions to be answered :

1) Are the mushroom bodies produced seasonally ? What other events in the colony are associated with nodule production ? (The nodules could be associated with the production of winged reproductives or with a burst of egg-laying activity and production of large numbers of young requiring to be fed).

2) Could non-nodule-producing species reach abundance on an island with such extremes of temperature and water availability as George Dog ? What role do the nodules play in the enormous success of Nasutitermes nigriceps?

3) Are the mushroom bodies formed in calies that lack functional reproductives ?

Other Observations

1) "Cistern Nest" survivors :
A tree adjacent to the one that housed the cistern nest was found to have an expanded calie, started immediately after removal of the main nest in 1988. It was filled with very large workers and fully pigmented soldiers, and lacked either eggs or young individuals. This suggests that the foragers left out in runways associated with the cistern nest had congregated after its removal and enlarged an existing small nest unit. It further suggests that adult workers and soldiers (the foragers) can live for at least a year. We do not have precise data on length of life for members of the several castes in intact colonies in the field, and this kind of observation provides some information for both workers and soldiers. It also raises some questions :

How long can a completely-orphaned colony of foragers survive in the field ? If reproductives are added to the isolated group, what would be the source ? Does a nest fragment containing foragers plus eggs and babies have a better chance to replace the reproductives and continue an extended existence ? Are adult reproductives of either sex necessary to initiate reproductive differentiation in the young termites ?
Answers to these questions are of great importance to our understanding of caste determination and differentiation, and factors controlling colony organization in these very specialized animals.

2) The giant North Beach colony was building another arboreal nest near thefallen halves, one of which contained an intact royal cell and large numbers of young termites. Ralph Rusher and Vitor Becker reported that the sawn halves as well as the new nest had survived Hurricane Hugo. Following the progress of this colony should provide much useful information.

Status of Species Survey, Guana and Adjacent Islands

1) No new species have been found on Guana Island since the last report ; however, actual wings and body fragments of Cryptotermes brevis, the Furniture Termite, have been recovered from the long table where we gather for pre-dinner socialising.

2) A dry-wood termite, Incisitermes snyderi, has been found to be the most abundant representative of the family Kalotermitidae on Guana. This species, widely distributed in the Antilles, Mexico, and southern United States, is highly flexible in ecological requirements, and has some status as a pest of timber in outbuildings, untreated posts and poles, and sometimes in houses. Small young colonies have small soldiers, and I originally thought that many of the dry-wood termites collected belonged to a related species, I. bequaerti , but observations of the type material at the American Museum of Natural History revealed that we have only snyderi on Guana. Infestation of outbuildings can be avoided by the use of treated timber and by maintaining plenty of suitable dead wood, preferably as branches from stumps, or dead branches on live trees, for the utilization of the termites. The value of winged termites as food for amphibians, reptiles,

birds and mammals such as bats suggest that efforts to reduce the population of termites would be detrimental to the ecology of the island. Further, there is an ant that regularly inhabits abandoned galleries of, I. snyderi , or produces similar ones in close association with the termite galleries. Unravelling the nature of this association will be an interesting project for future study.

BRIEF SUMMARY, 1989 FINDINGS

1) Mushroom bodies were found by Ralph Rusher in the large North Beach nigriceps colony that fell and was sawn in half, bringing the number of nests found with the inclusions to two.
2) Preliminary chemical analyses reveal that the mushroom bodies have a somewhat greater nutritive value than the surrounding nest material. Further results are awaited.
3) After exhaustive search with Dr. Thorne and Mr. Rusher, mushroom bodies have been found in only two nests ; these nests also had functional reproductives and large numbers of eggs and young.
4) The number of termite species known for Guana is reduced by one, as small representatives of I. snyderi had been mistakenly designated as I. bequaerti. This error was corrected with the aid of Dr. Kumar Krishna and the type material at the American Museum of Natural History.

QUESTIONS TO BE PURSUED IN FUTURE

1) Are mushroom bodies produced seasonally ? What events are occurring in the colony that initiate construction of mushroom bodies ? What role do they play in the economy of the colony ? Are they associated with the ability of Nasutitermes nigriceps to colonize intermittently-dry, wind swept islands such as George Dog ?

2) Can members of one nest complex differentiate members of another complex in the same species ? Can we do so by analyses of their cuticular hydrocarbons ? Agonistic behavior seems to be associated with chemical cues, and these most probably reside in the surface lipids and waxes. To that end, samples of nigriceps foragers have been dried and forwarded to Dr. Michael I. Haverty, USDA Forest Service at Berkeley, for analyses of the cuticular hydrocarbons. If results look promising, he will be given samples from sources on Beef, George Dog and Tortola, as well as more from Guana.

Respectfully submitted :

Margaret S. Collins
7 February 1990

March 26, 1990

Dr. Henry G. Jarecki
Chairman
The Falconwood Corporation
Four World Trade Center
Fifth Floor
New York, NY 10048

Dear Dr. Jarecki:

Termite studies in the coming year will be directed towards:

1. continuing observation of nodule formation in sub-colonies from the giant termite nest fallen and dissected near the trail to North Beach, Guana Island; harvesting nodule samples for further analyses and test of palatability to different species of termites, particularly to subterranean tests of the Caribbean and the continental United States; implanting of periodic monitoring of nodule production with Ralph Rusher during intervals when Dr. Thorne and I are not on the island.

   Note: Dr. Thorne has observed that termites other than nodule producers consume the nodules avidly; thus, the nodules have potential value as toxicant-bearing bait for hard-to-reach subterranean pests. This information is to be treated with strict confidence until adequate test have been run and, if warranted, an announcement made by our group.

2. using established desiccation-tolerant test procedures, samples of worker or pseudo-worker termites found in the BVI are to be dried completely prior to storage and later extraction for analysis of cuticular hydrocarbon composition; survival times during drying are to be recorded, for use in theoretical and applied studies; voucher specimens of winged formed and soldiers sufficiently indicate inter-specific variability and to supply the major termite collections of the world are to be obtained; data to be shared in the forthcoming study of the termite fauna of the Caribbean by a team of termite specialists using modern techniques for species designation.

3. assembling demonstration material for the Guana Island Museum and circulation to the proposed community college program on Tortola.

Timetable: determining rate and timing of production of nodules in nests of Nasutitermes nigriceps and collection of wing form will require observation at intervals through the year. Dr. Thorne will not be available through the fall and winter. Dr. Collins will be able to work in the latter part of July-August and October with other times to be determined.

Sincerely yours,

Margaret S. Collins
Research Associate
Smithsonian Institution

cc: Dr. James Lazell
The Conservation Agency

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032690\cmr(i)

Vitor O. Becker
P.O.Box 70-0023
73300-Planaltina, DF

0160

Brasilia, 23 January 1990

Dr James D. Lazell
6 Swinburne Street
Conanicut Isd. 02835 - USA

Dear Skip.

The trip was fantastic despite the hurracane.

I was right to insist goin on a different time of the year. As expected I collected dozens of species new to the list (more than I could predict). I think we can easely add 50 species more to the list.

During my stay in Washington, after the trip I managed to identify many of the new species collected. When I finish with the material I shall send you a new improved version of the list (I am waiting for the material which was mailed from Washington, as I could not carry everything).

My stop in Cuba was also very productive. Not only for the material collected but for the arrangements for future work there. I am planing to return to Cuba in May. Greg Mayer is coming with me (certainly he has told you about our plans).

What are your plans for Guana this year? Is the group going back? When? It is very unlikely that I could do it again this year. At the end of September, after my presumed return from Cuba, I am planing an expedition to Mato Grosso, near Cuiaba, to a place called Chapada dos Guimaraes (known by the entomologists as 'Chapada'), with Arnold Menke, an hymenopterist from the Smithsonian. Whould you like to join us?

Well Skip, many thanks again for all your help. The possibility to participate in your program has brought very good results to me. Not only the excellent material from an interesting region such as the Caribben that we had nothing in your collections in Brazil, but especially because it openned other doors to carry out work in other places in the region. I am very happy and gratefull for this opportunity.

Looking forward to hearing from you again, I remain

Yours ~~Sincerely~~

PS Enclosed are the copies of my air fares.

BISHOP MUSEUM

1525 BERNICE STREET • P.O. BOX 19000-A • HONOLULU, HAWAII • 96817-0916 • (808) 847-3511 • FAX (808) 841-8968

November 17, 1989

Dr. J.G.E. Lewis
Taunton School
Taunton, Somerset TA2 6AD
UNITED KINGDOM

Dear Dr. Lewis:

I noticed your recent paper on centipedes from the U.S. Virgin Islands. If you wish to see further specimens from the Virgin Islands, you may be interested in the following.

I participated in general entomological survey in the British Virgin Islands (especially Guana Island), yearly in July from 1984 to 1988, sponsored by The Conservation Agency. While I was concentrating on Lepidoptera and Coleoptera, my colleagues and I collected any centipedes that were encountered. The centipedes from 1984 through 1986 are deposited in the Smithsonian Institution, those from 1987 and 1988 are here at Bishop Museum. The former would be available through Jonathan Coddington, I could arrange a loan of the latter if you wish.

It might also interest you to know that the President of The Conservation Agency, James Lazell, has collected a number of scolopendromorph centipedes throughout the West Indies during his herpetological excursions. He often encounters the larger ones while collecting lizards. His specimens will be found at the Museum of Comparative Zoology, with more recent specimens at the Smithsonian.

Also, let me take the opportunity to thank you belatedly for the centipede reprints you sent me a couple years ago.

Sincerely,

Scott E. Miller
Chairman
Dept. of Entomology

cc: J. Lazell

Telephone Taunton 76081

TAUNTON SCHOOL
TAUNTON
SOMERSET TA2 6AD

Dr Scott E Miller,
Bishop Museum,
1525 Bernice Street,
PO Box 19000 A
Honolulu - Hawaii

4 . i . 1990

Dear Scott

Thanks for your letter of 17 November and your offer of specimens from the Virgin Islands. I'd like to work on them but will not have time for a few years. I have a considerable waiting list: just finishing Nepal, Sulawesi next then I'd like to look at a collection from New Caledonia. As a school teacher I do most of my work in the holidays so progress is slow.

If you ever need a name for a large scolopendromorph I'd be happy to oblique but can't cope with a collection.

I enclose a reprint of the Virgin Is. paper.

Best wishes

Sincerely

John

(DR. J.G.E. LEWIS)

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29 October 1989

Skip:

I just found the following notes from Mike Ivie regarding numbers of beetles in the Virgin Islands (USVI and BVI), as of December 1988.

78 families of Coleoptera.

500 ± genera of Coleoptera.

843 + species of Coleoptera; some 200 of these are known only from the Virgin Islands, but this is probably artificial owing to poor knowledge of the faunas of Puerto Rico and the other Greater Antilles.

Unfortunately, he has never given me a figure for number of species known from Guana Island.

Best Regards,

Scott

Scott Miller

BISHOP MUSEUM

1525 BERNICE STREET • P.O. BOX 19000-A • HONOLULU, HAWAII • 96817-0916 • [illegible] • FAX (808) 841-8968

January 20, 1990

Dr. Henry Jarecki
Mocatta Corporation
Four World Trade Center
New York, NY 10048

Dear Henry:

You should have recently received an official statement from the Bishop Museum Registrar regarding the donation of 2740 insects from Guana Island in 1989.

The total is lower this year than previously, since only Vitor was able to get to the island, and he had to concentrate his efforts on labor-intensive small moths. He was able to make some very important collections, however. The combination of the new season and unusual (!) weather allowed sampling of many species we had not seen before.

Although I was not able to go to Guana, Vitor and I had a very productive visit to the Smithsonian Institution in November. This allowed incorporation of my early Guana Island work with Vitor's more recent work, and allowed many identifications by comparison to historic specimens from elsewhere. We have not yet totaled up the new number of moths known from Guana, but it is rising steadily!

As you know, as a staff member of the receiving institution, I cannot provide a specific evaluation of the value of the donated specimens for IRS. However, I will say that the per specimen value you were provided in 1984 by the Museum of Comparative Zoology (e.g., $0.75 per specimen) remains a reasonable average value for this kind of specimen.

I hope that the necessary repairs have been effected, and that the Guana Club is back in full swing by now! Thank you again for your continued support of our research, even with hurricanes.

Sincerely,

Scott E. Miller
Chairman, Dept. of Entomology

cc: V. Becker; J. Lazell

The Conservation Agency

Exploration, Education, and Research

President
James D. Lazell, Ph.D.
401-423-2652

6 Swinburne Street
Conanicut Island
R.I. 02835 U.S.A.

January 25, 1990

Dr. Jorge Moreno
Department of Natural Resources
PO Box 5887
Puerta de la Tierra, PR 00906

Dear Dr. Moreno:

I am writing at the suggestion of Jim Wiley. This Agency wants to attempt re-establishment of the white-crowned pigeon in the British Virgin Islands, where they were extirpated as breeding birds by hunters about 1950.

We believe we should attempt to get young birds from the Greater Puerto Rico Bank because these are most likely to be genetically similar to the original population. At present there do not seem to be enough in the USVI to make a transfer feasible. We, therefore, believe Roosevet Roads is the most likely area.

Our notion would be to bring over about six squabs at fledgling stage and hand rear them. The building where we would raise them is within sight of our mangroves. Artificial nests could be put in the mangroves so the birds would be tempted to nest.

Firearms are now illegal in the BVI and we have had no trouble from poachers. We maintain a continuous presence of Guana Island and believe we can ensure the safety of the birds from humans.

If you could help us in this project, please let us know.

Most sincerely,

James D. Lazell, Ph.D.

jsc

MEMORANDUM

TO: Dr. Henry G. Jarecki
Gloria Jarecki
Lianna Jarecki
Jurgen Keppler
Susanne Meyer
Ralph Rusher

FROM: Dr. James Lazell

SUBJECT: Plans to restore bird species to Guana

DATE: April 18, 1990

The conference in Puerto Rico with the Department of Natural Resources and the US Fish and Wildlife Service was a great success. Our plans to restore bird species to Guana met with approval. Our contact in Puerto Rico is

Dr. Jorge Moreno

Department of Natural Resources

Post Office Box 5887

Punta de la Tierra, PR 00906

Telephone (809) 722-7517

Our first move should be white-crowned pigeons in May or June. Lianna has agreed to go to Puerto Rico, learn to care for the birds, and bring them to Guana. They should be fledged and free-living in two weeks but Lianna need not nurse them all that time if Jurgen, Susanne, and/or Ralph will feed them. Puerto Rico will supply the formula for "pigeon milk" and it can be kept frozen until warmed up for feeding the squabs. I envision bringing six birds this year. I have visited their nesting grounds on Puerto Rico and, candidly, Guana is better habitat.

Keeping them on Guana is a matter of food supply. They will probably not leave as long as .ey have plenty of food. Once free and flying, they will eat our native fruits, such as sea grape and pigeon pl (not mangoes or papayas) and native wild seeds, but should also

be supplied with raisins, currants and cracked corn. They have a natural tendency to home back to the place where they fledged.

The Puerto Rico Department of Natural Resources wants to send over someone, probably in July, to put radio transmitters on Guana white-cheeked pintail ducks. We have dozens of those, but Puerto Rico has very few. After they discover something about the ducks' travel habits, Puerto Rico may want to nick a few of our ducks for re-stocking there. Good. We have something they want.

And, they have Puerto Rican woodpeckers extirpated from the Virgin Islands before 1900. These are gorgeous red, black and white birds. They should be our next move.

More later. I depart for Hong Kong on the first of May.

MEM\PRBIRD.418

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11/28/88

Notes on the Biology of the Bridled Quail-Dove (Geotrygon mystacea)

Robert M. Chipley
The Nature Conservancy
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Study Site: The study was conducted on Guana Island, British Virgin Islands. The island, so named for a rock outcrop resembling an iguana's head, lies 3 km off the north coast of Tortola and is about 300 hectares in size, with a peak elevation of 245 m. Site of the Guana Island Club, the island has no permanent residents. There are few trails and guests rarely venture onto most parts of the island. Since 1982 it has been the site for several scientific studies sponsored by The Conservation Agency. Due to the owner's interest in conservation, the island is a de facto nature reserve. The present study was carried out 11-26 July 1984, 8-23 July 1985, 11-29 July 1986, and 8-29 July 1987.

Methods: Birds were captured in nets placed at several locations at low elevations on the western slope of the mountain occupying the eastern part of the island, on either side of Quail-Dove Ghut (see figure). Doves were then driven uphill into the nets, with a final rush to cause them to fly into the mesh. All the birds were caught in the lower shelves of the net. The mesh of nets used after the first year was 2-3/8 inches. Captured birds were marked with color bands in patterns to allow individual recognition. To facilitate identification of marked birds from the year at a distance and thus to aid in estimates of population size, a strip of yellow adhesive tape was affixed along the length of a tail-feather. All observations of doves were noted, and repeated tallies were taken along four routes, the two principal of which were in Quail-Dove Ghut and Harris Ghut. Birds proved difficult to catch; generally at least two people were needed to drive a bird into the net. On only one occasion (of a total of 23 birds trapped) did a bird become entangled in a net on its own when no one was around. In 1985, 6 were caught (of which one was killed in the unattended net; see below); in 1986, 15, but in 1987, only 2, with approximately the same amount of net hours and effort each year. All doves were caught in the late morning (earliest at 1030) or afternoon, though nets were generally open by 0800.

Radio transmitters were used in 1985, 1986 and 1987. Four transmitters were available for use each year. Weight of the radios was approximately 7 grams; the first two years they were attached beneath the tailfeathers and the last to the upper back,

in both instances using quick-drying epoxy glue. I used a 3-element Yagi receiving antenna and a CE-12 receiver from Custom Electronics. Radios did not impede birds from flying, as I saw radioed birds fly on several occasions. Whenever a signal disappeared, I walked to the highest point of the island to listen for it, where presumably radio signals would be heard not only from all points of the island but also on facing parts of two adjoining islands, 3 or 4 km away.

Of 11 birds to which transmitters were affixed, three disappeared overnight and signals were never again heard nor were the birds ever again observed; two transmitters apparently failed in that the signals slowed down considerably, grew fainter and then disappeared, four fell off but were relocated, having remained attached for 6-12 days, and two were still transmitting when I left the island. The range of period of signals from attached transmitters was one through 13 days and the average was five days. Radio transmitters proved useful in several respects: first, they allowed me to locate two of the three nests I discovered; second, they permitted locating roosting birds at night; and third, they allowed some determination of home range. In addition, the sudden disappearance of three radios, all overnight, with no previous diminution of signal, suggests that it is possible that birds may move from island to island.

Review of Species Biology

Range: According to the A.O.U. Checklist (6th ed.), this Caribbean endemic is resident on Puerto Rico (including Vieques and probably Culebra islands), in the Virgin Islands (except Anegada), and in the Lesser Antilles (from Saba and Barbuda south to St. Lucia). In fact, it is known by sight records only from a couple of localities in Puerto Rico (Raffaele 1983), and is absent from many of the smaller and flatter Virgin Islands which lack suitable habitat (pers. obs.).

The Genus Geotrygon: The neotropic genus Geotrygon, including some 15 species, is found from central Mexico to Argentina. It is well represented in the West Indies, with five species present, including four endemic to the region. A sixth quail-dove of a closely-related monotypic genus, Staroenas cyanocephala, included by some authors in Geotrygon (A.O.U. Checklist, 6th ed.) is also endemic to the region. Geotrygon is best represented from Costa Rica to Colombia, where 9 of the 11 species found outside the West Indies are found. Outside Colombia, no species is endemic in the rest of South America. At least one West Indian species, G. caniceps, found only in Cuba and on Hispaniola in the Dominican Republic, has diminished to the point of endangerment (Dod 1981, Garrido 1986). This dove exists in several sites on the Zapata Peninsula of Cuba, where it seems to be well protected (pers. obs.).

Mostly Acacia muricata!

Sexual Dimorphism: Only 4 of the 15 species of Geotrygon are markedly sexually dimorphic. In the present species, there appears to be a slight sexual dimorphism in that the female seems slightly smaller than the male and with the iridescent colors somewhat muted; Garrido (1986) reports that G. caniceps and G. chrysia also display a similar very slight sexual dimorphism. At least with G. mystacea, one almost has to see the birds together, however, to notice this difference. I did not find it possible to sex individuals by sight with any degree of confidence.

Results of the Study

Habitat: On Guana Island, the species is confined to dry evergreen forest on those slopes of the main peak protected from the dissicating effects of the prevailing easterly trade winds, particularly in and near ravines. This community is characterized by a canopy to 6-10 m (with a few emergents to 14-15 m), mostly Bursera simaruba and Pisonia subcordata, with an open undergrowth dominated by Eugenia spp. The bird is also seen very occasionally in marginal habitat (sea-grape woods near beach and dry evergreen thicket near a salt pond only a few meters from woodland), but never in the more arid cactus thorn scrub (characterized by presence of Agave missionum and several species of cactus, notably Hylocereus trigonus) which covers the greater part of the island. Suitable habitat for the quail-dove covers only about a quarter of the island (see Figure 1). [Note: Figure 1 is a map of the island with the range of the Quail-Dove shaded in.] The birds were easiest to find and observe in or near two ghuts easy to reach by foot, Quail-Dove Ghut (A) and Harris Ghut (B). A few observations were made in Palm Ghut (C), but Grand Ghut (D), reached best by boat from the rest of the island, was visited only twice.

Behavior: The Bridled Quail-Dove forages exclusively in the litter of the forest floor, feeding mostly on fallen fruits (particularly berries of Eugenia spp.), sometimes using its bill to stir up litter, even occasionally throwing leaf litter into the air with a sideways motion of the head; I also observed it apparently feeding on litter arthropods. If disturbed, it walks or runs away from an intruder, occasionally making short flights and alighting on a low limb or rock, where it bobs. It often preens from the top of a rock. The birds are easy to approach, routinely within 5 m; occasionally one will approach a stationary observer to within 1 m. Behavior and ecology of this species closely match what has been written of other members of the genus. Forest-inhabiting terrestrial birds, most have stripes on the sides of the head; they forage for seeds and fruits on the forest floor, are generally solitary or found in pairs, and most are shy and inconspicuous; nests are platforms of sticks placed in vines, bushes, stumps or trees at low or medium elevations,

with a clutch size of one or two eggs (Meyer de Schauensee and Phelps 1978; ffrench 1973; Lack 1976; Skutch 1949; Seaman 1966; Wetmore and Swales 1931).

Vocalizations: The usual call is a two-part hoo hoooooo, given up to 12 times a minute and sounding rather like blowing over the top of an empty bottle; the first part is lower in volume and of short duration, apparently sometimes omitted and probably often not audible from a distance; the second note rises in the middle and then falls. The bird calls most often from a perch, but also from the ground and occasionally from the nest. The note is not difficult to imitate and one can often get a response to imitated calls. A second vocalization is associated only with courtship and breeding. It is a gutteral croaking call which rises and then falls, followed by several rapid low staccato notes on the same pitch. It is of lower volume and does not resemble the usual call.

Rcosting: I was able to observe 5 birds on the roost at night. One was discovered by chance, while all others were individuals with attached transmitters. Due not just to darkness but difficult-to-penetrate habitat, it usually took at least an hour to locate birds with transmitters.

The birds roosted on branches near the trunk of a tree, from 3.5-7 m off the ground (average of 4.8 m for 6 observations). One individual roosted in the same general area for at least six consecutive days. The earliest I recorded this individual in the area of roost was 1720.

Courtship and Nesting: In the following discussion, I am putting my observations in the logical order of courtship through fledging, though the observations are from different nests and two seasons.

transmitting (?)

In the course of four field seasons, I discovered three nests; two in 1986 were found by tracing a radioed bird to the source of the signal, while one in 1987 was found by watching a bird found gathering nesting material. Each nest represented a different stage in the nesting cycle. I observed no signs of courtship nor other indications of breeding in 1984 or 1985, both of which were very dry years during which the salt pond on the island virtually dried up.

The first nest, at an elevation of 190 m, was up about 2.5 m on top of a broken-off dead stump, well concealed within a tangle of vines and bushes, with overhanging branches of another tree. This was the only nest I was able to climb up and look into. It contained two light buff eggs at the beginning of 11 days of observation; at the end of the period, the nest contained one young. The second, at an elevation of 100 m, was at 5 m on a horizontal limb; a juvenile about to fledge was still at the nest

at the time I discovered it. This nest was found only two days before I left the island for that year. The third, at 120 m elevation, was at 6 m on a horizontal branch; watched for 16 days, it represented nest construction through egg-laying and approximately 10 days of incubation; the egg (fragments of which I found on the ground) in this nest was destroyed by a predator, presumably a Pearly-eyed Thrasher (Margarops fuscatus); see section on predation below.

The only other Geotrygon nest I have observed, that of G. caniceps, was found in January 1988 on the Zapata Peninsula of Cuba, in a moist woodland with a wet substrate and dense, tangled underbrush. In placement and structure it closely resembled the first mystacea nest I located. The nest, a flimsy platform of a few twigs, was located at 2m on the top of the main trunk of a small coppiced tree and contained one egg.

My observations on courtship of the Bridled Quail-Dove, all in 1987, consist of those observed away from the nest, and aspects of courtship observed at the nest, in particular, the displays given when one bird returned to the nest while the other was sitting on it and later incubating. Much of the courtship activity I observed away from the nest occurred in the afternoon and following morning after the nest had been plundered.

All courtship activities away from the nest occurred on branches or vines, 2-7 m above the ground. Courtship maneuvers include bobbing of the head and mutual preening (allopreening), particularly the back of the neck. Allopreening has also been observed in connection with courtship in G. montana (Lill, 1969). The most characteristic courtship maneuver is raising both wings or less frequently one wing, outstretched, above the back, always accompanied by the courtship call. Both members of the pair performed this display.

I witnessed this pair copulate once, on a vine, at 2 m. This was observed on the fifth day after I discovered the nest. Copulation was preceded by bill-rubbing and then rapid head-bobbing by the male before mounting the female, which crouched down, lifting her wings. Afterwards both birds gaped and the male gave the distinctive courtship call.

Nest Construction: In my observation of the third nest I discovered, nest construction took place only in the morning; for three consecutive days the birds were not present at the nest in the afternoon (days 2 through 4). Though Skutch (1949) states that original construction of the nest of montana, as in the case in the pigeon family in general, is performed by the male, I observed both birds participating in nest building, although the bird which I presumed to be the male and which was identifiable during short flights by the absence of one tail-feather did most nest construction.

Nest construction followed a general pattern; the bird searched the ground near the nest for a suitable twig; after rejecting one or more, the bird generally chose a twig about six inches long with no attached leaves, it always followed the same route to the nest. First it walked to a particular rock, hopped to the top, turned about 90 degrees to face the nest, then flew to a particular branch where it paused briefly, and then flew about 10-12 m to the nest. The sitting bird, when it became aware its mate was about to arrive, usually began to lift its wings slightly so that the tips moved up and down at a rate about twice per second; this maneuver was not accompanied by vocalizations, nor did it ever appear in any courtship activities I observed away from the nest. Occasionally, when the male was the sitting bird, it would raise its wings completely above its back as in courtship, and give the courtship-related call. The arriving bird usually placed the twig beneath or near the sitting bird's head; the sitting bird was therefore the intentional or inadvertant architect of the nest. This was often followed by the standing bird head-bobbing and then preening the head and neck of the sitting bird. During most active nest-building, the male brought twigs to the nest at a rate up to 20 times per hour. Nest construction had stopped by the fifth day but then resumed on the 14th through 17th days, during incubation.

Active nest construction occurred only when one or the other of the pair was sitting on the nest. At one point, after the nest had been plundered but the female was at the nest, the male was taking its customary route to the nest with a twig; as the male got to its last perch at which point it usually flew to the nest, the female left the nest; the male stayed briefly on the perch, dropped the twig, and left. This was the final time I saw either of the birds at the nest, though they remained nearby for a subsequent two days, at which point I left the island for the year.

Associated with switching positions at incubation, whichever bird arrived at the nest brought a twig. Skutch (1949) observed that montana also brought a contribution to the nest when switching positions at inclubation; he did not, however, observe aspects of courtship activity associated with this exchange at the nest. Some differences in behavior between the sexes was noted; when the male was incubating and the female arrived with a twig, the male greeted her with aspects of courtship activity, including the giving of the distinctive courtship call; I never heard the female give this call at the nest. In the first nest, an incubating dove remained at least 6 hours, from 1020 to 1620. Though Skutch (1949) states that the typical pattern of incubation in montana and in other pigeons is for the male to site during the day and the female to replace him in the afternoon to remain for the night, I found that in the first nest, one bird replaced the other between 1145 and 1215 and again

on the same day before 1610. In the third nest, I witnessed one exchange at 1027, when the male replaced the female at the nest, bringing a twig; then, while the male sat, the female, following a different route from that used by the male, returned with a twig 8 times in 33 minutes, at increasing intervals, before leaving the area. Each visit to the nest was accompanied by the sitting male's wing-lifting or wing-raising, sometimes giving the courtship call. At this instance, the male remained on the nest for at least the next 6 hours. On the following day, the switch occurred at 1052, with the male again replacing the female; the female had left the nest untended for 4 minutes, between 1041-1045. Again the female displayed nest-building behavior, returning twice with a twig over the following 12 minutes, before again leaving the area. The male remained on the nest again for at least the next 6.5 hours.

In regard to nest defense, the first time I climbed up to look into the first nest I discovered, the sitting bird merely flew away; at this time the nest contained 2 eggs. The second time, 10 days later, when one young bird was in the nest, the sitting bird defended the nest by flapping at my hand with its wing, then leaving the nest but returning immediately, raising both wings and flapping at my hand again; both times it uttered a low cry. Skutch (1949) states that such nest defense is typical columbid behavior.

The one fledgling I observed was about 2/3 size of an adult and had dark rather than red eye; the white stripe below eye was present. The bill was the same color as the cere--pinkish, as opposed to the pinkish-red cere and yellow bill of adult. Instead of creamy buff breast feathers, its breast and abdomen feathers were a dark chestnut brown, as were the back feathers; it lacked the iridescent greenish-purplish hue of the adult's upper back and nape [check this]. In a nestling of G. montana, Skutch (1949) noted differences in plumage, eye-color and bill color from the adult.

Predators: Though the mongoose is absent on Guana Island, feral cats may occasionally take an adult bird. In 1984 I observed a cat at the mouth of Quail-Dove Ghut and found dove remains in a hollow under a rock up that ravine on the same day; an effort was made to eradicate feral cats which by 1987 were found only in low numbers. The main predator on the island appears to be the Pearly-eyed Thrasher. Seaman (1966) states that quail-dove egg loss through predation by thrashers is particularly high. This species also attacks and kills adult birds of other species. In 1984 I observed a thrasher pecking at the skull of a freshly-killed Mangrove Cuckoo (Coccyzus minor) which in turn had thrasher feathers in its bill; in addition, a quail-dove in an unattended net was killed, presumably by this species. I never observed a thrasher to molest an adult quail-dove, but the third nest I discovered apparently fell victim to this species. Over a

period of two weeks and 31.5 hours of observation at this nest before it was abandoned, I saw a thrasher very near the nest 11 times, often approaching the sitting bird as closely as 50 cm and once nearly jumping on top of it but at no time actually attacking it. On the third day, apparently before the egg had been laid, I saw a thrasher hop up to the unattended nest and look into it. Skutch (1949) records that G. montana on the nest depresses the forebody and lowered the head and breast when nest-robbing aracaries are nearby; I observed identical behavior in a sitting dove whenever a thrasher approached the nest. On the sixteenth day, within 24 hours of when I had seen a thrasher very near the nest 4 times, I returned at 1615 after a 4-hour absence to find the nest unattended and bits of a buff-colored eggshell on the ground immediately beneath it. Shortly thereafter the doves abandoned the nest.

Home Range: I found no evidence for any well-delimited territoriality by foraging birds. Individuals ranged throughout all elevations on the island, from 1 to 210 m, save the very peak, where the habitat was inappropriate. Among the birds to which I affixed transmitters, there was virtually complete intersection of individuals' home ranges during the period I tracked them with those of all other individuals.

Using a minimum polygon defined by the points of location determined by radio tracking, I measured the home ranges of 6 birds for which there were at least 8 locational readings. Dates of recordation and numbers of readings are given for each.

1.	7/11-7/15/85	12	3.78 h
2.	7/12-7/20/86	15	9.0 h
3.	7/13-7/20/86	21	4.3 h
4.	7/14-7/16/86	8	2.0 h
5.	7/9-7/23/87	35	3.01 h
6.	7/22-7/28/87	26	4.34 h

Flocking or Feeding Aggregations: In 1984 I encountered up to 5 birds at a time; the average number seen per encounter was 2.35, based on 48 encounters. In 27.6 hours of walking four routes, I saw 4.1 birds per hour. In 1985, I saw up to 3 at a time; in 20 encounters, there 1.6 birds per encounter; in 31.5 hours of walking these routes, I saw 1.02 birds per hour. In 1986, I encountered up to 5 birds at once and found 44 birds in 40.5 hours of walking the routes, or 1.09 birds per hour; based on 33 encounters, I saw 1.33 birds per encounter. In 1987 I encountered no more than 2 birds at a time; the average number seen at an encounter was 1.2, based on 24 encounters. In 36 hours along the same routes, I saw 0.80 birds per hour.

Though it might appear from these figures that the population size may have declined from a height in 1984, the apparent change in numbers might also result from a difference in detectibility

of the birds from the first to the subsequent years. This difference is based on at least two factors: greater thickness of foliage during the wetter years and less time spent foraging, including a lesser tendency to form feeding aggregations. The first year, 1984, was particularly dry and conditions were unfavorable relative to the other years. The second year was also dry, but the third and fourth years (these also being the years in which I found the birds breeding) were wetter, with a plentiful crop of Eugenia berries. The tendency to flock or at least form feeding aggregations was noted primarily in the first and least favorable year and not at all in the final and presumably most favorably year.

Dispersal: The Bridled Quail-Dove seems a sedentary species; I observed it to take only relatively short and low flights. In addition I never saw one either fly above the canopy or perch higher in a tree than 7 m, nor did I ever see one outside woodland. Yet there is some indication the birds move at least occasionally from island to island. Seaman (1966) states that the bird was definitely unreported on St. Croix from 1891 to 1923 but presumes that it always existed there; it is now found on several localities on that island. He discounts recolonization from another island on the grounds that the quail-dove is a poor flyer and there are no reported instances of it crossing the open ocean; St. Croix is about 50 km from the nearest source for recolonization. Audubon (1840) claimed to have seen its close congener, the Key West Quail-Dove (G. chrysia), flying over water; also, that species has turned up in South Florida occasionally (Sorrie 1979). It seems far more likely that it turns up accidentally than that there is a small undiscovered breeding population. This, coupled with the fact that three of my transmitters disappeared overnight, never to reappear, suggests at least the possibility that movement of doves from one island to another is not a rare event. In addition, an unexpected find was that no color-banded birds were seen in subsequent years. This was particularly surprising between 1986 and 1987, since 15 birds (including those to which radios were affixed) had been color-banded in 1986.

Population Size on Guana: Only in 1986 were enough birds marked to allow even a very rough estimate of the numbers of birds on the island. In that year, 11 non-radioed birds were banded; of 38 subsequent observations of those doves which were not being tracked, 6 were of marked birds. Using a means of population estimation described by Kenward (1987) through reobservations of tagged birds, this indicates a population size of 66, with a standard error of 30. Though this is of course a very imprecise result, it allows establishment of the likely maximum number of birds on the island at 130.

* Lots of quail dove records at Dry Tortugas of obviously dispersing birds. Check w/ Bill Robertson, Everglades Nat. Park: 305-247-6211

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Caribbean Journal of Science, Vol. 25, No. 3-4, 115-118, 1989

A Contribution to the Ornithology of the British Virgin Islands

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ABSTRACT.—Observations representing additions to what is known of the distribution and breeding of birds in the British Virgin Islands are presented for 34 taxa. Most records are from 1980-1989.

INTRODUCTION

The British Virgin Islands (BVI) lie at the eastern terminus, latitude 18°30'N, longitude 64°W, of the Greater Antilles on the Puerto Rico Bank, 105 km east of San Juan and 130 km WNW of Anguilla, the northernmost large island of the Lesser Antilles. Tortola is the largest of the archipelago (65 km²), with Anegada (35 km²) and Virgin Gorda (23 km²) following in size. The islands, volcanic in origin, rise to a maximum elevation of 520 m at Sage Mountain, Tortola, the highest point east of Puerto Rico. In contrast, the second-largest, Anegada, is unique. Rising only 8 m above sea level, its eastern two-thirds are limestone while the western one-third is accreted sand. During the Pleistocene period, the British and U.S. Virgin Islands, Vieques, and Culebra formed a continuous land mass with Puerto Rico; as sea level rose, mountainous areas formed separate islands and keys creating isolated biomes and endemic life forms (Heatwole, 1976).

Early lists of birds from the BVI were compiled by collectors and explorers in the region, including Schomburgk (1832), Cory (1890), Clark (1905), Wetmore (1927) and Danforth (1935). More recent lists and studies of the birds of the BVI have been carried out by LaBastille and Richmond (1973) and the group led by Mirecki (1976). Local residents J. Lapper and J. S. R. Roy have contributed several important observations since 1958.

METHODS

Norton (1981, 1984, 1988) has surveyed resident and migrant avifauna on several islands of the BVI group from 1980–1989 with particular emphasis on nesting seabirds at Anegada. Chipley surveyed birds on eight islands from 10–18 April 1980 and on Guana Island 11–26 July 1984, 8–23 July 1985, 11–29 July 1986 and 8–29 July 1987. Lazell conducted land vertebrate species surveys on 44 islands of the 46 or more) in the BVI group from 13 March to 22 April 1980 and on Guana Island 2 March–10 April 1982, 3 March–10 April, 27 June–31 July and 6–19 November 1984, 26 June–2 August 1985, 1 July–2 August 1986 and 1 July–31 July 1987. We are able to make the following additions to what is known of the distribution and breeding of the birds of the BVI. In the accounts initials refer to the authors or the observers listed in the acknowledgments.

LIST OF TAXA

Fulmarus glacialis (Linnaeus). Northern Fulmar. One was observed closely at the stern of a fishing boat by J. S. R. Roy in August 1975. This observation represents the first record from the West Indies.

Puffinus gravis (O'Reilly). Greater Shearwater. One was seen by L. Henriques following a sailboat on 6 July 1980, between Virgin Gorda and Anegada.

Oceanites oceanicus (Kuhl). Wilson's Storm-

Petrel. Twelve were seen migrating along the 100 fathom line on the southern edge of the eastern Puerto Rico Bank on 25 May 1988 (RLN).

Phaethon lepturus Daudin. White-tailed Tropicbird. A nesting pair was found at Guana Island on 13 March 1982 (JDL). Two pairs were noted in courtship flight off Cooper Island on 17 June 1988 (RLN). This species is more widespread as a breeder on the outer islands than Mirecki (1976) expected.

Phaethon aethereus Linnaeus. Red-billed Tropicbird. Nesting records for several islands (Broken Jerusalem, Carrot Rock, Dog, Ginger, Guana, and West Seal Dog—JDL), provide evidence that this species is of greater abundance than the preceding.

Pelecanus occidentalis Linnaeus. Brown Pelican. Breeding had not been confirmed in the BVI by Mirecki (1976), but colonies have been observed and photographed at Guana Island in 1984–1988 (RMC and JDL) and Little Tobago (Norton, 1988).

Phalacrocorax auritus (Lesson). Double-crested Cormorant. The first record of the species in the BVI was observed on 14 March 1981 at Anegada (ML, RV, RLN) Two *P. olivaceus* (Humboldt) (Olivaceous Cormorant) were noted at Peter Island during the winter of 1975–1976 (Mirecki, 1976).

Anas crecca Linnaeus. Green-winged Teal. One was observed at Anegada on 13 March 1981 (RV) for the first record in the BVI archipelago. A single bird was noted at Josiah's Bay pond, Tortola, on 9 January 1989 (RLN).

Pandion haliaetus (Linnaeus). Osprey. Reports of nesting in the BVI in the past decade have been perpetuated in the literature. Immature Ospreys, for example, were found during summer at St. Croix where RLN examined a rudimentary nest at Krause Lagoon. The North American subspecies *P. h. carolinensis* and the West Indian subspecies *P. h. ridgwayi* differ in plumage characteristics discernable by experienced observers. There have been no substantiated reports or evidence of eggs or young Ospreys found on the eastern Puerto Rico Bank or St. Croix (contra Nellis, 1979).

Rallus longirostris Boddaert. Clapper Rail. One was observed at Anegada 15 March 1981 (RLN) for the first record from that island.

Haematopus palliatus Temminck. American Oystercatcher. Individuals were seen on 12 July 1984 at Guana Island (RMC) and 25 July 1988 on Necker Island (JDL) for the first records for those islands.

Pluvialis dominica (Müller). Lesser Golden-Plover. One was observed (RV) at Anegada on 24 August 1980 for the first record for that island.

Himantopus mexicanus (Müller). Black-necked Stilt. Several pairs were found nesting at Guana Island in April 1982, January 1985 and July 1986 through 1988 for the first breeding records for that island (JDL, RMC).

Bartramia longicauda (Bechstein). Upland Sandpiper. One was observed at Anegada (RV) on 24 August 1980 for the first record for that island.

Philomachus pugnax (Linnaeus). Ruff. One was seen at Anegada on 23 August 1980 (RV, RLN) and on 14–15 March 1981 at Anegada (RV, RLN, ML) for the first records from the BVI.

Stercorarius parasiticus (Linnaeus). Parasitic Jaeger. An immature was observed chasing one *Sterna maxima* Boddaert (Royal Tern) at Hodges Creek, East End, Tortola on 17 July 1988 (RLN).

Larus ridibundus Linnaeus. Common Black-headed Gull. A winter-plumaged specimen was observed at Tortola on 17 November 1985 (RG) for the first record from the BVI.

Rissa tridactyla (Linnaeus). Black-legged Kittiwake. A specimen was found in BVI waters on 2 February 1984 and examined by RLN.

Sterna sandvicensis eurygnatha Saunders. Cayenne Tern. First observed on 23 August 1980 with Sandwich Terns breeding at Anegada (Norton, 1984), this South Amer-

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ican subspecies has been found at Anegada nesting with and among its conspecifics and also on other islands on the eastern Puerto Rico Bank (Schaffner et al., 1986).

Sterna dougallii Montague. Roseate Tern. Surveys conducted by RLN in the BVI of this threatened species indicate that breeding has taken place at Anegada, East Seal Dog, Round Rock, and Watson Rock, sites not listed by Mirecki (1976). Poaching is still prevalent in the Territory (RLN).

Sterna forsteri Nuttall. Forster's Tern. A single bird was noted (RG) at Tortola on 17 November 1985 following Hurricane Kate; this is the second record from the BVI.

Sterna fuscata Linnaeus. Sooty Tern. A small breeding colony exists on Fallen Jerusalem observed in June 1987 and 1988 (RLN) for the first report from that cay.

Chlidonias niger (Linnaeus). Black Tern. An observation at Anegada on 24 August 1980 (RV, RLN) represents the first report from that island.

Aratinga pertinax (Linnaeus). Brown-throated Parakeet. This species was reported to be feeding on garden-plot vegetables (BL) and roosting in mangroves (BH) at East End, Tortola, in the spring of 1988.

Coccyzus minor (Gmelin). Mangrove Cuckoo. A nesting record at Salt Island (JDL) on 14 March 1980 represents the first record from that island.

Otus nudipes (Daudin). Puerto Rican Screech-Owl. Strong evidence suggests the very secretive and rare owl of the eastern Puerto Rico Bank either nests or roosts at Guana Island. One was regularly seen and heard during the summer months there prior to 1980 (MR); pellets and feathers presumably from this species were collected in two caves on Guana Island in 1984 through 1988; pellets were also collected in 1985 from a cave on Great Camanoe (RMC, JDL); these materials are at The Conservation Agency, Jamestown, RI.

Anthracothorax dominicus (Linnaeus). Antillean Mango. Reports from Anegada and Beef Island in recent years add some evidence that the species has not been completely extirpated from the eastern Puerto Rico Bank by the more aggressive *Eulampis holosericeus* (Linnaeus) (Green-throated Carib). RLN observed two at Anegada on 18 June 1988 during the most impressive spring bloom of Century Plants (*Agave* spp.) observed in several years.

Hirundo fulva Vieillot. Cave Swallow. On 26 June 1988, local dive boat operators (SA, DM) reported 'Sand Martins' (Bank Swallows [*Riparia riparia* (Linnaeus)]) to be flying in and out of the ship's drainage ports during the vessel's visits to Road Town. Norton interviewed cruise-line staff and dive company personnel, one of whom (SA) is from Britain and familiar with cliff-nesting swallows (i.e., martins). He described plumage characteristics and behavior of the Cave Swallow which has been known to nest in a barge which travelled to Vieques from Fajardo, Puerto Rico (Sorrie, 1975).

Vireo altiloquus (Vieillot). Black-whiskered Vireo. First recorded by LaBastille and Richmond (1973) at Anegada, this species has been observed there annually during summer, 1980–1988 by RLN. On 14 July 1985 the first record from Guana Island (RC) provides evidence of a widespread population. Mirecki (1976) did not record it from Anegada or Guana Island. This vireo is, however, absent during fall, suggesting a migratory population.

Dendroica palmarum (Gmelin). Palm Warbler. A single bird was observed on Tortola on 20 April 1980 (RLN) for the first record from the BVI.

Seiurus motacilla (Vieillot). Louisiana Waterthrush. Single birds were observed on 6 September 1977 on Jost Van Dyke (RRV) and on 4 August 1988 at Passea Ghut, Tortola (RLN), for the first and earliest records in the BVI, respectively.

Geothlypis trichas (Linnaeus). Common Yellowthroat. Two birds were seen at Anegada on 14 March 1981 (RV, ML) for the only reports from that island. A single male was seen on 20 April 1980 on Tortola (Norton, 1981).

Molothrus bonariensis (Gmelin). Shiny Cowbird. This parasitic species has been re-

corded from Anegada on 25 May 1988 (RLN); a fledgling was noted being fed by a *Tyrannus dominicensis* (Gmelin) (Gray Kingbird) on 7 April 1988 at Paraquita Bay, Tortola for the first record of successful breeding in the BVI.

Icterus galbula (Linnaeus). Northern Oriole. A single male was observed (RLN) in Road Town, Tortola on 20 April 1980 for the first record from the BVI.

Acknowledgments.—We wish to thank Steve Ashby, Dr. Nicholas Clarke, Ruth Gairdner, Lisa Henriques, Brian Holloway, Jill Lapper, Bert Lettsome, Marsha Litchfield, David Mansfield, George Marler, Gregory Mayer, George and Janet Mitchell, Mary Randall, Rowan Roy, Paula Selby, Dr. John Smith, and Richard Veit for sharing their observations and unpublished notes and to Dr. Raymond Paynter of the Museum of Comparative Zoology at Harvard for assistance to JDL.

Work by RMC and JDL in 1980 was sponsored by The Nature Conservancy and the Ministry of Natural Resources, British Virgin Islands. Since 1980 work on Guana Island was supported by The Conservation Agency through grants from The Mocatta Corporation. Seabird surveys in 1986–1988 were supported by the National Parks Trust.

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Accepted: 11 September 1989.

THE HERPETOFAUNA OF GUANA ISLAND: DIVERSITY, ABUNDANCE, RARITY, AND CONSERVATION

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ABSTRACT. - Guana Island, 340 ha and 246 m elevation, supports 15 known species of terrestrial reptiles and amphibians. Two marine turtles nest. Three species, a frog, a snake, and an amphisbaena, were not found in early years of search but are now known to be egregiously abundant, locally common, and regular in occurrence, respectively. Caution must, therefore, be used in stating that any island lacks a possible species. Two species, tortoise and rock iguana, are restorations. Iguana pinguis is doing especially well.

INTRODUCTION

The island of Guana, in the British Virgin Islands (BVI) lies just 480 m N of eastern end of Tortola and, following Morris et al (1977), would have separated from Tortola ca 6,200 yr BP. Guana, at 340 ha and 246 m elevation, would have a predicted herpetofauna of four species following Mac Arthur and Wilson (1967). In fact, there are certainly 13 native terrestrial species. Only one of three potential Eleutherodactylus frog species has been found, but circumstantial evidence hints that a second, E. schwartzi, may occur in the special Bromelia pinguin habitat near the south end in Pinguin Ghut (Figure 1). The distinctive, two-note, "bo-peep" call has been reported and this

species is known from the even smaller island of Great Dog (33.2 ha; UPR-RP 5517-8: Heatwole et al, 1981).

Because Guana is so well preserved ecologically (Lazell, 1989a), lacking goats and mongooses, I believe it to be a fine site for attempts to restore species probably present but extirpated in the past. Among reptiles these include the rock iguana, Iguana pinguis, and the tortoise, Geochelone carbonaria. Because these sorts of restorations or outright introductions are controversial, I give special consideration to each case below.

The history of herpetological investigation on Guana is relatively long and provides cautionary tales for biogeographers. Grant (1932) first reported on the island, claiming eight species, but with specimens of only five. Heatwole et al (1981) added a third snake, Typhlops richardi.

I first visited Guana in 1980 as part of an overall survey of the fauna of the British Virgin Islands (Lazell, 1980). I returned in 1982 and did quantitative sampling for some species and added more, bringing the vouchered herpetofauna to eight species (Lazell, 1983). Regular annual herpetological investigations began in 1984, notably including Gregory Mayer and a staff of up to five field assistants. The known fauna was expanded to 15 by the restorations (Lazell, 1986) and additional captures (Mayer and Lazell, 1988).

SPECIES ACCOUNTS

Eleutherodactylus antillensis.-There were vague reports of frogs occasionally seen or heard on Guana but no actual specimen was collected until 8 November, 1984, when Tricia Giovannone secured one of about six males heard calling (MCZ 107528). We now know this species to be egregiously abundant, with literally thousands calling on suitable nights. The generally dry decade from about 1976 to 1987 made optimal conditions rare. Since then rainfall has been more normal and frogs are heard regularly from July to November. Claims are often made that Eleutherodactylus have been introduced to an island with suitable ecology and within the expected range of the genus (Censky, 1989). Such cases should be critically evaluated. Unless one were present on Guana at just the right time, one could easily assume the absence of Eleutherodactylus. Even when frogs of four species were calling on Tortola, none were heard on Guana. Certainly months, and possibly years, go by with no evidence of these frogs even when they are present in suddenly demonstable profusion.

Chelonia mydas.-The only definite nesting record is for North Beach, 22 July 1987. This species continues to be harvested for the restaurant trade in the BVI. The killing of sea turtles should be immediately halted and outside pressure should be put on the British Government to comply with internationally held positions on these endangered species.

Chelonia imbricata.-I follow Simpson (1961) and Van Gelder (1977) in regarding interbreeding species as congeneric. In this specific case see Lazell (1989b). Recent nesting records are

for 7 July 1987 and 6 July 1988. Ornithologist E.J. Fisk drew pictures of hatchlings--clearly this species in head squamation--emerging from their nest 28 January to 2 February 1958. Adults and juveniles are regularly seen at all seasons in Guana waters. My remarks on the continued slaughter of sea turtles in the BVI under C. mydas, above, apply with equal force to this species.

Geochelone carbonaria.-The status of these attractive tortoises as native or introduced has never been resolved (Lazell, 1980; Censky, 1988). It may be analogous to the situation in Iguana iguana reported by Lazell (1973) and MacLean (1982): some apparently native populations and some certainly introduced. Five adults from Water Island, U.S. Virgin Islands, and one from St. Thomas (3 males and 3 females) were released on Guana in 1985. Two adults have been found dead. One was lost, but one, a female, is MCZ Z-38017. Young tortoises have been found in February 1988, but not since. Occasional wild-caught specimens have been found on Tortola and Virgin Gorda. A pair are living in the Botanical Garden at Road Town, Tortola (Robert Norton, pers. comm., April 1990).

Hemidactylus mabouia.- A common species first collected in 1980; found in the woods as well as in edifices.

Sphaerodactylus m. macrolepis.-Extremely abundant. Populations were estimated at White Bay using pit traps and square meter sampling at 2,600 per hectare, and at North Bay by pit trap only at 1,600 per hectare. Guana sphaeros have been the subject of physiological studies: MacLean (1985, 1986).

Anolis cristatellus wileyae. The most conspicuous species on Guana Island. A hectare plot was laid out in April 1984 (Figure 1) in general scrub, the most common vegetation cover on Guana. On smaller plots within this area, dubbed "herp hectare," we used various multiple catch and removal methods to estimate densities of all three Anolis species. The point estimators for A. c. wileyae were between 4,000 and 7,200 per hectare.

Anolis stratulus.-This species is also extremely abundant and seen though not collected by Grant (1932). Within the herp hectare--far from optimal habitat for this tree species--densities were estimated at 3,000 to 5,400 per hectare.

Anolis pulchellus.-This is the least common of the three anoles, but frequent in the scrub vegetation, more frequent at edges, and common to abundant in cutover fields. Within the herp hectare, fairly good habitat for this species, we estimated 1,000 to 1,800 per hectare. Grant (1932) collected one.

Iguana pinguis.-Grant (1932) claimed iguanas were present on the Island but gave the species as I. iguana. Oscar Chalwell, who still works on Guana, reports (pers. comm.) that no iguanas were still surviving in 1935. I believe the original species was I. pinguis and Grant was reporting hearsay. Based on my belief that iguanas did occur here, and that these were Iguana pinguis, I began transport of individuals in 1984. In all, eight were stocked: four males and four females from Anegada. At time of writing (April 1990), I. pinguis is regularly seen on the Island and reproduction is apparent because small juveniles have been seen annually since November 1985. A large individual, possibly

one of the original eight, occupies an area which includes part of herp hectare, and a juvenile seems to live wholly within it. Iguana pinguis on Guana will be the subject of ongoing research and a separate paper in the future. A male is shown in Figure 2.

Ameiva exsul.-These large, terrestrial, diurnal lizards are everywhere abundant. Geographic variation among the islands of the Puerto Rico Bank calls for greater study. No population estimates have been made on Guana.

Mabuya mabouya sloanii.-The "slipperyback" is regularly seen on Guana and museum vouchers are available (Mayer and Lazell, 1988). No population estimates have been attempted.

Amphisbaena fenestrata.-This fossorial form was unvouchered from Guana until March 1984 (Mayer and Lazell, 1988). However, I knew it was present because Oscar Chalwell (pers. comm., March 1982), on being shown a Typhlops, said: "There is another kind of that here too. It has rings and it bites". Amphisbaenas were regarded as extremely rare until Thomas Sinclair came to Guana as a field assistant in July, 1988. He found this species regularly, several per day, in a zone around the island at 160-185 m. While most common there, it is notable that several have been collected at sea level and the first, MCZ 166995, was collected in herp hectare. This is an example of a species which seems rare and possibly endangered until its optimal habitat is discerned; then it moves into the ranks of the common.

Typhlops richardi subsp.-These snakes are ubiquitous. Usually fossorial, they have been collected well off the ground in Nasutitermes nests. I used the method of Herklotts (1951) and

sampled measured plots 1 cm deep as well as grids of holes 35 cm deep. Both methods independently gave point estimators ca 580 per hectare. The taxonomic status of this population is undetermined, but I note Hedges (this volume) has done the work necessary to separte T. richardi from the Puerto Rican T. platycephalus, and thus restore the subspecies in the Virgin Islands to validity.

Epicrates monensis granti.-This small boa was among the first species listed for Guana by Grant (1932), but to date no voucher specimen exists. There are occasional sight records. One was killed ca 1975 inside D House, the western corner of herp hectare, when it entered the building and ate two caged finches. I believe this species is naturally rare except in very local situations. It turns up regularly on Tortola (Mayer and Lazell, 1988). I do not believe it is endangered or threatened. Relief from legislation restricting its collection--at least at the scale of one voucher per island--would answer the numerous questions about its occurrence on Guana, Great Camanoe, Jost Van Dyke, Necker, and Virgin Gorda. This is a species that remains little-known because we are prohibited from learning about it.

Liophis portoricensis anegadae.-I previously discussed the generic status of this snake and all "Alsophis" (Lazell, 1983). My views were based directly on those of Maglio (1970) who admitted that he retained generic names he could not justify. I have since examined many specimens, including skeletons, and find no way to separate "Alsophis" from Liophis. The snake is common on Guana. A mark-recapture study in 1984 gave a point estimator

of 650 with confidence limits of 101 to 3,000 for the Island. The status of the nominal subspecies of L. portoricensis needs clarification. Numerous specimens lie outside the diagnoses given by-Schwartz (1966).

Liophis e. exiguus.-The generic comments above apply equally to this species. At comparable sizes, L. exiguus cannot be separated from L. portoricensis by scale pits as claimed by MacLean (1982), because these are standardly absent in young L. portoricensis. Apart from size, the two species are very similar. This snake is rather rare on Guana, but now that field personnel have become accustomed to its Gestalt, it is found regularly. I suggest this species is likely to be present but rare on many small islands where L. portoricensis is common. It seems most common where its congener is absent (MacLean, 1982).

CONCLUSIONS

Small island biotas are often more diverse than even good field herpetologists may be inclined to believe. Guana provides three examples of different sorts of species that may escape collectors literally for years. Eleutherodactylus antillensis is so cryptic for such long periods of time that we believed it was very rare of absent. Given the right conditions--a rainy spell of days or weeks--it reveals its true abundance. Amphisbaena fenestrata turns out be quite common when searched for in a narrow altitudinal band around the island in microhabitats involving the right sun:shade regime and soil conditions.

Predictably, Guana is a better island than most to search for it on because Guana is relatively well wooded, erosion has been minimal, and shady woodlands prevail at the critical elevation. Liophis ēxīgūūs seemed very rare or non-existant on Guana until the last few years. Possibly the end of a decade of drought brought this snake out into our vision. More likely, I believe, acquainting our field crews with the snake heightened their search images for it. It now seems regular, not rare.

It is a fact of biogeographic interest that every terrestrial species known to occur on Guana has been found, at one time or another, within one hectare of undistinguished scrub habitat: the herp hectare (Figure 1). Some, like Iguana pinguis, could not possibly maintain populations in an area so small. Others, like Amphisbaena fenestrata, may occur in this habitat only as dispersers from more optimal areas. Still, the diversity is remarkable.

Systematic problems continue to plague us. Geographic variation in Ameiva exsul, Typhlops richardi, and Liophis portoricensis requires further study. We may currently recognize too many forms or too few.

Iguana pinguis appears to be successfully established (or reestablished) on Guana. However, N.C. Goodyear (pers. comm.) reports the species continues to decline on Anegada. The reasons need further study. A proposed addition to the BVI National Park System, with removal of goats and other feral livestock, might reverse this trend. If so, then I believe I. pinguis will soon become only threatened. I believe it may soon be possible to

restock this magnificent species to other islands within its historical range. Suitable sites should combine three features: no mongooses; no goats; and no other species of iguana.

Effort should be focused on the British Government to protect sea turtles within the Crown Colony of the British Virgin Islands so as to plug this sink for turtles from BVI and surrounding extraterritorial waters. The continued slaughter of sea turtles in the BVI is unconscionable.

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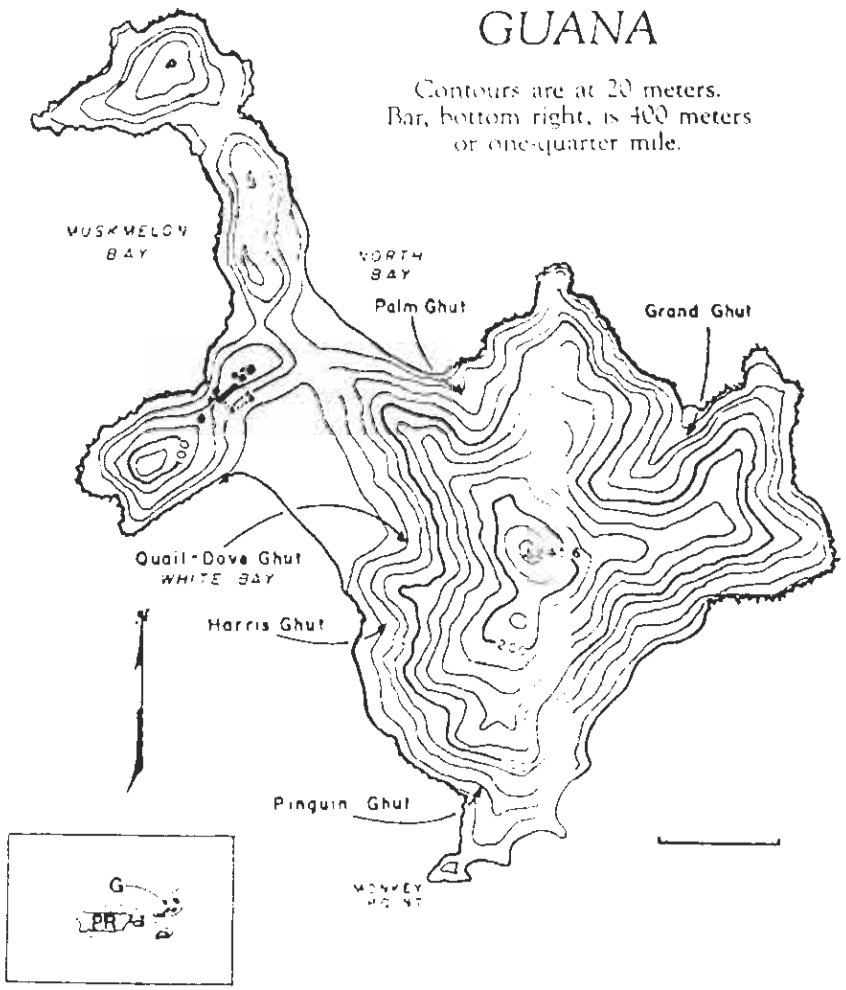
FIGURES

1. Guana Island. Buildings are indicated in black. The "herp hectare" is dotted; note that it is foreshortened upslope in this planar projection: it measures 100 x 100 m on the ground. Inset shows the position of Guana on the greater Puerto Rico Bank.

2. Iguana pinguis. An adult male on Guana Island demonstrates the large, pendulous dewlap noted by Lazell (1989c). Photo by Liao Wei-ping.


GUANA
Contours are at 20 meters.
Bar, bottom right, is 400 meters
or one-quarter mile.
MUSKMELON
BAY
NORTH
BAY
Palm Ghut
Grand Ghut
Quail-Dove Ghut
WHITE BAY
Harris Ghut
Penguin Ghut
MONKEY
PR

The Conservation Agency

Exploration, Education, and Research

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March 26, 1990

Dr. Theodore Provo, President
BVI Community College
Box 3097
Road Town, Tortola
British Virgin Islands

Dear Dr. Provo:

We are enthusiastic about joining with you in an official educational capacity as you put together a degree-granting college. Dr. Henry Jarecki, Guana Island Wildlife Sanctuary, informs me that you have accepted both our organizations as affiliates of the BVI Community College. We were also pleased to learn from him that, based on his conversations with the Chief Minister and Deputy Chief Minister, this affiliation covers our scientific collecting permit obligations to Government in respect of our activities.

We have had considerable success in our modest program to involve BVI students in our biological work in the past. However, the fabric of a Community College will, we believe, provide a greater opportunity in the future. A BVI Community College is uniquely well-suited to develop programs and educate people in environmental and conservation biology. The ecological resources of the islands are singularly rich and the human population is relatively small, providing opportunities too frequently lost forever elsewhere in the Caribbean -- and on tropical islands worldwide. In the coming century environmental and conservation biology and applied ecology will become paramount in human welfare.

As you may know, Dr. William McLean, Vice President, University of the Virgin Islands in St. Thomas, is a regular participant in our work. I will ask him to be our immediate contact with your relevant faculty. We hope to include Community College students and/or faculty in our 1990 program.

Our present plans include field work in July, 1990, led by Drs. Margaret Collins and Gregory Mayer of the Smithsonian Institution. Both work on quantitative aspects of population biology, Dr. Collins on termites and Dr. Mayer on lizards. The principles they elucidate have remarkably wide relevance and application. Although I will be far afield (in China) in July this year, I will see that both Mayer and Collins are aware of your program and ask them to consider taking applications for assistants.

Our major effort this year will be 20 October through 20 November, 1990. At that time we expect to have a diverse team of professionals (including both Collins and Mayer) in the field. At that time, perhaps we can arrange to present our work to your faculty and students and explore ways to directly integrate our programs.

We look forward to a long and fruitful collaboration.

Sincerely yours,

James D. Lazell, Ph.D.
EM

James D. Lazell, Ph.D.

c Dr. William McLean

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