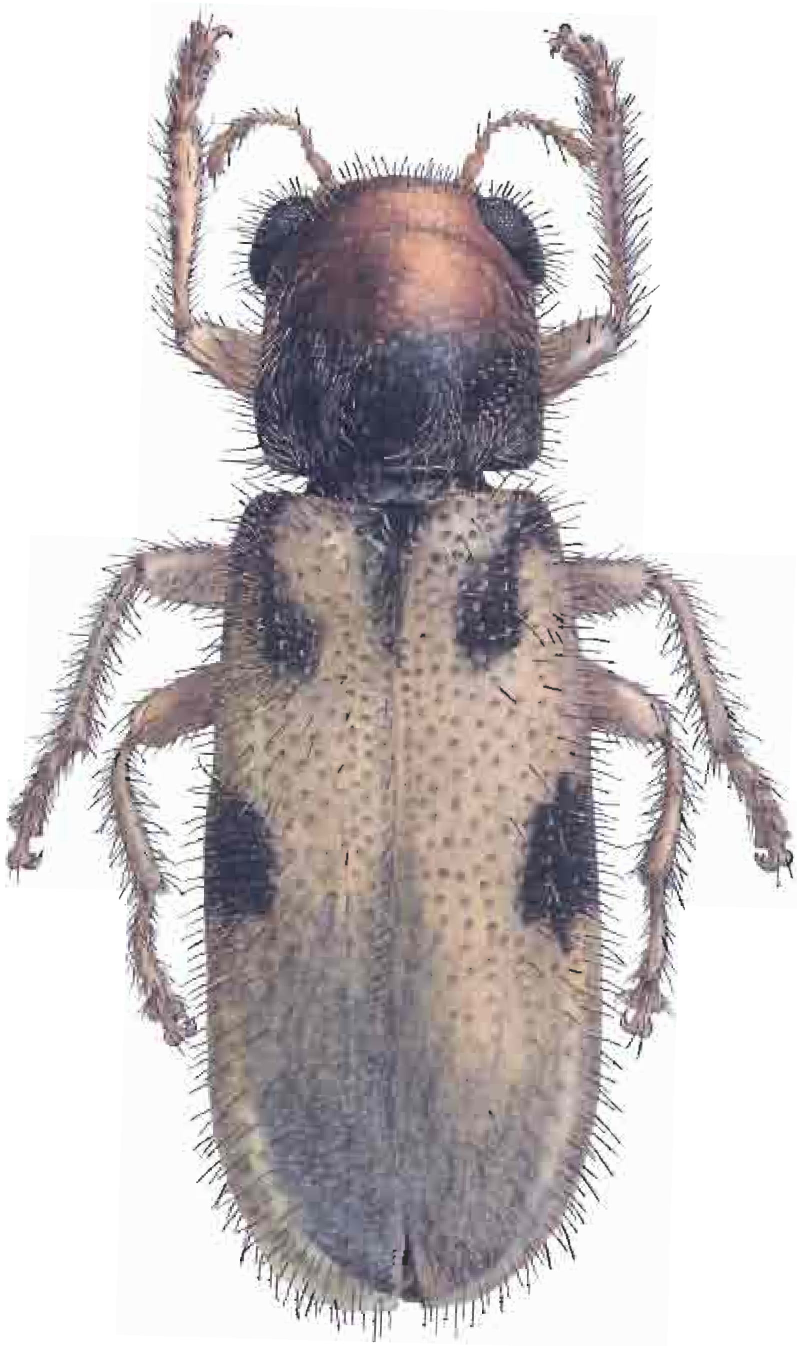
GUANA



1992

alog sosternus guana n. sp. Barr 2000

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.

20.iv.93

Dr. Henry Jarecki
Byewood Timber Trail
Rye, NY 10580

Dear Henry:

Herewith my summary report for 1992. I have not repeated material included in my "Preliminary Report" of 4 December, 1992, or any of Lianna's materials. To get a full picture of the scale of our 1992 activities, this report has to be seen in the context of those other documents: What a year!

Our cover this year is the new chrysomelid beetle being described by Mike Ivie and Barr, (I don't know who Barr is). Since entomology is Big this year, I will launch right into it.

Following this introduction, Mike Ivie's report, a copy of his group's newsletter, a list of the Chrysomelidae (that is just one family of beetles, but the one nearing completion), and 10 pages of sample chrysomelid illustrations from the text. Mike does not say whether just some, or all, of these occur on Guana, but I have pointed out one which does, and which will be named <u>Pachybrachis guana</u>. There will be many more new species in other families, so be thinking of names (there can be only one <u>guana</u> in each genus because no two species can have the same name).

Next, David Grimaldi's report on the fruit flies: an excellent example of AMNH participation in our project.

Roy Snelling continues to produce great results fast. He writes his stuff up and publishes it in newsletters. This is very useful for all concerned. His big news is the new species of <u>Psorthaspis</u>, a gorgeous spider-hunting wasp (see his page 18, middle column, bottom).

Barbara Thorne provides a report from the termite group next. Then a letter from Kevin Hoffman, whose mantsipids have so impressed me already. I hope he will come this year.

Margaret Collins introduces us to Warren Steiner, a specialist on flightless beetles, and his wife Jil

Swearingen, a specialist on ants. The two of them would like to join us in 1993, and that seems a good idea, pending consultation with our established entomologists Ivie and Miller. I know Roy Snelling, who has collected ants, would appreciate help from them (not his favorite subject).

Moving on to vertebrate animals, we have been noticed by the U.K. NGO Forum. I also include a report I found in an obscure journal on flamingo behavior that seems quite relevant to us. I'm trying hard to make 1993 the Year of the Birds, and at long last get some action on all those great plans I have been touting for years to get woodpeckers, whistling (tree) ducks, white-crowned pigeons, and even parrots back on Guana. David O. Hill, founder of the Rare Animal Relief Effort (RARE) and long a major player at National Audubon, is planning to come this year with his field assistant wife. I am full of hope that this will move us off the mark.

Christina Leahy's work on kestrels, our small falcons, is going well and she will plan to do more in the June-July session with Lianna. She may also come down in October.

Your old friend Rob Norton chimes in with a bit on VI snakes. While not strictly a Guana publication, he does acknowledge me and Greg Mayer, without whom he would not have written up his note. We would not have been in place except for the Guana project. I'll claim this one as ours.

Blair Hedges and Richard Thomas have been receiving blindsnakes from us for years, and finally have put out a paper. Sadly, it leaves out the fine-grained analysis of the Virgin Island situation, but that should be their next effort. I include just excerpts of their paper.

Last year in China I met Razi Dmi'el, a physiologist who does the very sort of stuff Bill MacLean started, and who seems ideal to carry on at Guana. My correspondence with him and his colleague Gad Perry is included. I hope he will come. Gad says they need a couple of hours of computer time every few days. We should be able to manage that.

Finally comes first draft of the Iguana pinguis paper Numi and I have submitted to Restoration Ecology, a new journal. It is out for review. This is the first successful attempt ever to restore a population of rare reptiles that has been quantitatively documented as working. It surely is working!

I will be gone for the first two weeks of May, but faxes will reach me by about 18 May at:

415-381-9414

From 1 June until early July, I can be faxed in Hong Kong at:

852-980-2181

Or, written to c/o Wing Chan, 44 Shui Hau Village, Lautau, N.T., Hong Kong.

I'll be back in RI by mid-July, and so in a more convenient place for making Guana plans than usual.

All the best,

Skip

REPORT OF PROGRESS, BEETLES OF GUANA IS AND SURROUNDING BVI

Michael A. and LaDonna L. Ivie
Montana State University
Bozeman, MT 59717

(406) 994-4943

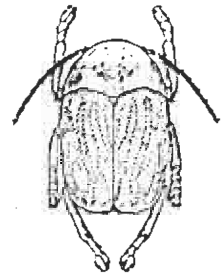
Since 1978, we have been working informally toward a faunistic treatment of the Beetles of the Virgin Islands. In 1991, this effort was formalized, and the level of activity greatly accelerated. To date, we have, with co-PI Richard S. Miller, a faunal list of over 900 species for the Virgin Islands as a whole, with a continuing high rate of species addition. It is hoped that within 3 years, a book will be finished detailing the beetle fauna, with keys, illustrations, and distribution data. In the meantime, much collecting, curating and primary publication must be finished. Over 40 cooperators are working to make this a reality.

In 1992, we spent 2 weeks on Guana Is., from 18 to 31 October. During that time we collected with several specialized techniques, including beating sheets, berlese funnels, and several types of traps. This yielded many new records for the islands. However, not only did we collect several thousand beetles specimens from Guana, Tortola, and Virgin Gorda, we established 6 long-term flight intercept trapping sites, with 2 each on the above mentioned islands. Each of these traps produces several hundred specimens per month, and sampling continues monthly. A total of 12 trapping months has already occurred, exceeding all previous trapping of this type in the Virgin Islands together. This technique yields large numbers of previously very rare or unknown species.

Curation continues, with the goal being to have all material mounted, labeled, identified, and data-based by August. Several papers resulting from this material are in progress. Two, the Cleridae of the Virgin Islands and the Chyrsomelidae of the Virgin Islands will include new species from Guana Island. These include Phlogistosternus guana Barr and Ivie and Pachybrachis guana Clark and Ivie.

It is hoped that next year our team can return to Guana, to continue the specialized sampling. The continued discovery of new records and species indicates that we have yet to fully collect the fauna of any of the islands.

VIRGIN ISLANDS BEETLE FAUNA



PROJECT NEWSLETTER

Volume 1, Number 2 — 01 December 1992

RESUBMISSION AND FIRST EXPEDITION OVER

Things have been busy since the last VIBFP Newsletter. In October, after furious flurries of activity, and thanks to all those who responded to the call for letters of support, the VIBFP proposal for years 2-4 was submitted to NSF. With all of the enthusiasm shown so far, this project should be a real winner.

Just to keep life in the lab interesting, 2 days after the resubmission, I left on the initial collecting trip under the first year of funding. Of course, everything that could go wrong, did (First Law of Field Work Thermodynamics), from uncooperative weather to disappearing shipments, and broken-down ships, through mysterious office closures (do YOU know when Hurricane Thanksgiving Day, St. Ursula's Day or Prince Charles' Birthday fall?). But, thanks to the many Virgin Islanders who helped us, we were able to have a fully productive trip.

Island Resources Foundation of St. Thomas, provided us with a home base, an address, a FAX machine, phones, equipment construction, a storage room, and invaluable access to their impressive library and Rolodex resources that contributed so much to our success. We even slept on their boat for a few nights. Thanks go to IRF's Dr. Ed Towle, Sandra Tate, Austin Gumbs, Kathleen Strube and Judith Towle.

The Conservation Agency, through the largess of Dr. Henry Jarecki and the intercession of Drs. "Skip" Lazel and Scott Miller, provided 2 weeks of room and board at the Guana Island Wildlife Reserve, boat access to other of the BVI, and long-term trap sites. This generous assistance allowed for a much longer and more productive collecting period than would have been possible on our own resources.

Ms Jennifer Bjork and the Virgin Islands National Park provided housing on St. John, and other assistance.

Drs. Arnold and Hulda Grodman of Virgin Gorda opened their home to us, and provided our introduction to Father Thomas R. Hughes, Jr., who joined the project as a collector.

Drs. David Nellis and Ann Swanback of the VI Bureau of Fish and Wildlife arranged our permits for the USVI (yes, a new law requires collecting permits in the US Virgin Islands), and introduced us to several valuable contacts.

Mrs. Sebulita Christopher (BVI Ministry of Natural Resources), Ms. Rosmond DeRavaiere (BVI National Parks Trust), Dr. Gillian Cambers (BVI Ministry of Natural Resources), Mr. William Cissel and Ms. Zandy Hillis (Buck Island Reef National Monument), Dr. Darshan Padda (University of the Virgin Islands), and many other people provided permits, assistance, valuable advice, introductions to land owners and other types of cooperation.

Ms Carol Mayes (The Nature Conservancy, St. Thomas), Dr. Liao

Wei Ping (Guangzhou University, yes, China, but he's on Guana), Father Tom Hughes (St. Mary's Anglican Church, Virgin Gorda), James Comisky (Smithsonian-Man and the Biosphere, St. John), and Dr. Jozef Keularts (UVI, St. Croix) will be servicing long-term traps.

Then there were the many people who brought specimens, offered simple but important courtesies, and in general made the trip a success. Considering we changed islands 27 times in 31 days, we needed all the help we could get.

What did we accomplish besides paperwork? Nine semi-permanent flight intercept trap stations and a long-term uv light were sited and installed, considerable quantities of berlese and hand collected materials from St. Thomas, St. John, St. Croix, Tortola, Guana and Virgin Gorda were added, and materials needed for the next trip were stockpiled on 4 islands.

Preliminary sorting has already yielded a new family for the VI (Melandryidae), another genus of lycid, several more weevils, and a single elytron of an unknown, but definitely unique cerambycid! Most of the material is, of course, known species, but new island records are piling up, and several previously small series are being augmented.

The search for the last VI beetle species goes on!

Michael A. Ivie, editor

THE NEXT TRIP

In January, Rich Miller, Mike Ivie and Derek Sikes will return to the Virgin Islands to install 6 new semi-permanent flight intercept stations, another long-term uv light trap, and collect more berlese and hand material. The trap sites will be in unique habitats, access to which were negotiated during the October/November trip. These will include the best preserved forest in the Virgin Islands -- the Corning Estate on St. Thomas, and the first material from Buck Island Reef National Monument.

COOPERATORS MEETING IN BALTIMORE

On Tuesday evening, 08 December, the first VIBFP Cooperators Meeting will be held at the Baltimore Convention Center. Several issues will be discussed, including the procedures for obtaining illustrator and publication support. Co-PIs Miller and Ivie will outline the goals and timetable for the project, and seek input from Cooperators.

Hope to see you there!

DATA BASE GAINING

Rich Miller is putting the finishing touches on the design of the VIBFP database. Below is just a small example of the types of analyses this data format makes possible.

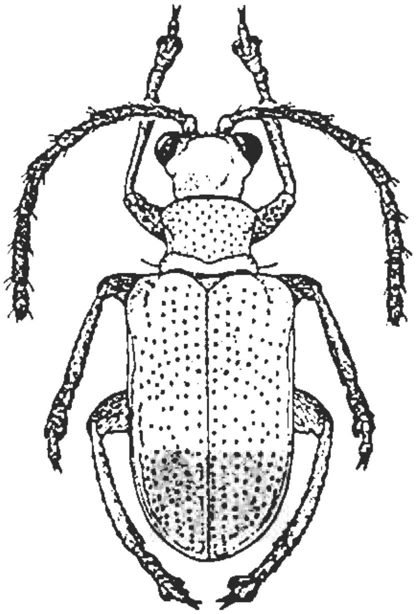
	Island Size (Km)	Total # spp.	Total # "Endemics"	Island % Endemicity	Total % V.I. Endemicity	total % Fauna
St. Croix	230	423	160	37.8	17.7	46.6
St. Thomas	77	4	106	26.2	11.7	44.6
Tortola	54	133	20	15.0	2.2	14.7
St. John	52	448	121	27.0	13.4	49.4
Anegada	39	89	11	12.4	1.2	9.8
Virgin Gorda	21	37	4	10.8	0.4	4.1
Guana	3	163	11	6.7	1.2	180 *

* What does this mean? (Lazell)

Chrysomelidae of the Virgin Islands

Binomial Name	Intrafamilial	ST	SJ	TO	VG	AN	GU	SX
Lema dorsalis (Olivier)	Criocerinae							+
Lema nigripes Weise	Criocerinae							+
Cryptocephalus anegadae Clark and Ivie	Cryptocephal					+		
Cryptocephalus krugi Weise	Cryptocephal		+				+	+
Cryptocephalus perspicax Weise	Cryptocephal		+	+			+	
Cryptocephalus stolidus Weise	Cryptocephal	+	+	+		+	+	+
Diachus nothus (Weise)	Cryptocephal		+				+	
Pachybrachis mendicus Weise	Cryptocephal	+	+			+		
Pachybrachis guana Clark and Ivie	Cryptocephal	+	+				+	
Triachus verinus LeConte	Cryptocephal	+	+			+		
Chlamisus straminea (Suffrain)	Chlamisinae					+	+	+
Aulacochlamys carinaticollis (Lacordaire)	Chlamysinae		+					
Alethaxias blakeae Clark and Ivie	Eumolpinae				+			
Chacosicya crotonis (Fabricius)	Eumolpinae	+	+	+			+	+
Chacosicya hughesi Clark and Ivie	Eumolpinae				+			
Metachroma leiotrachelum Blake	Eumolpinae	+	+					
Myochrous dubius (Fabricius)	Eumolpinae							+
Acalymma bivittatum (Fabricius)	Galerucinae							+
Acalymma innubum (Fabricius)	Galerucinae	+	+	+				
Ceratoma ruficornis (Olivier)	Galerucinae	+						+
Diabrotica sinnuata (Olivier)	Galerucinae							+
Erynephala maritima (LeConte)	Galerucinae					+		

Binomial Name	Intrafamilial	ST	SJ	TO	VG	AN	GU	SX
Aedmon varicornis (Blake)	Alticinae	+	+	+				
Alagoasa bicolor (Linnaeus)	Alticinae	+	+		+			+
Aphthona inornata Blake	Alticinae		+					+
Chaetocnema brunnescens Horn	Alticinae	+	+			+		+
Chaetocnema elachia Blake	Alticinae	+						
Chaetocnema obesula LeConte	Alticinae	+						
Chaetocnema perplexa Blake	Alticinae							+
Cyrsylus volkameriae (Fabricius)	Alticinae	+	+				+	+
Epitrix fasciata Blatchley	Alticinae							+
Heikertingerella krugi (Weise)	Alticinae		+					
Homoschema nigriventre Blake	Alticinae	+	+	+			+	+
Homoschema obesum Blake	Alticinae	+	+				+	
Homoschema pingue Blake	Alticinae							+
Longitarsus chlanidotus Blake	Alticinae							+
Longitarsus oakleyi Blake	Alticinae						+	+
Longitarsus rhabdotus Blake	Alticinae	+						
Longitarsus varicornis Suffrain	Alticinae		+					+
Lysathia occidentalis (Suffrain)	Alticinae	+	+	+			+	+
Macrohaltica jamaicensis (Fabricius)	Alticinae							+
Megistops bryanti Blake	Alticinae						+	
Megistops tabebuiae Blake	Alticinae			+				
Monomacra tibialis (Olivier)	Alticinae	+						
Omophoita albicollis (Fabricius)	Alticinae	+		+				+
Omophoita cyanipennis (Fabricius)	Alticinae	+						+
Phyllotreta fallaciae Csiki	Alticinae	+	+					+
Syphrea cubana (Bryant)	Alticinae		+	+				
Syphrea maldonadoi (Blake)	Alticinae	+	+			+		+
Syphrea sanctaecrucis (Fabricius)	Alticinae	+	+	+	+		+	+
Chalepus sanguinicollis (Linnaeus)	Hispinae	+	+	+			+	+
Charidotella latevittata (Boheman)	Cassidinae	L?						
Charidotella sexpunctata (Fabricius)	Cassidinae							+
Coptocyla jamaicana Spaeth	Cassidinae	L?						
Deloyala guttata (Olivier)	Cassidinae							+
Hilarocassis exclamationis (Linnaeus)	Cassidinae	+						+
Metriona glaucina (Boheman)	Cassidinae		+					
Stolas cyanea insulae Blake	Cassidinae	+						
TOTALS 58		29	27	12	4	8	15	32



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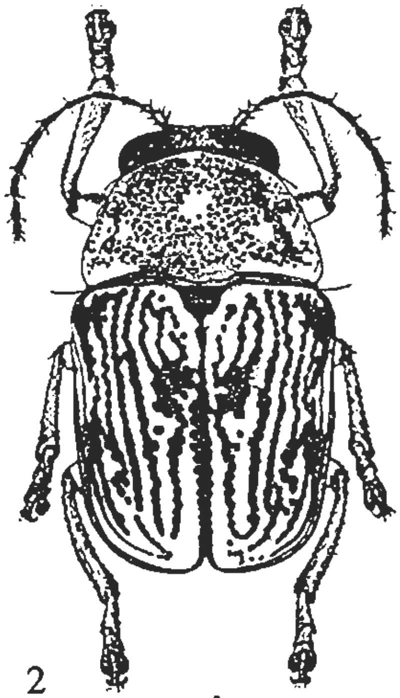

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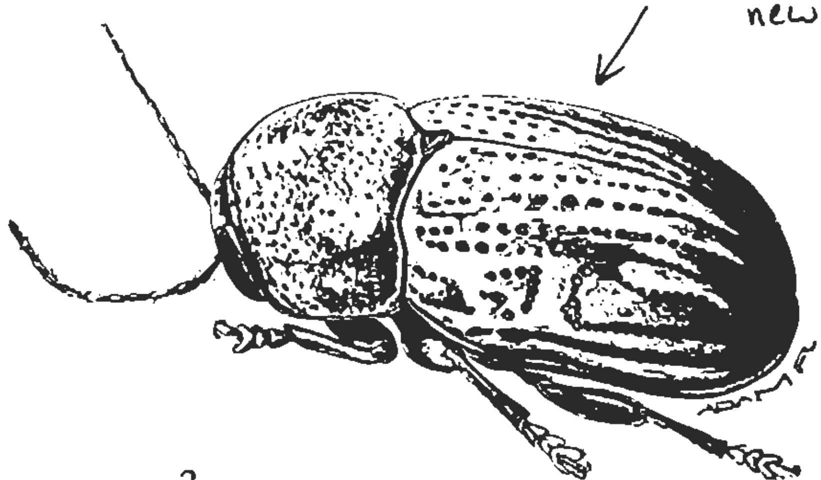
Pachybrachis guana

new species



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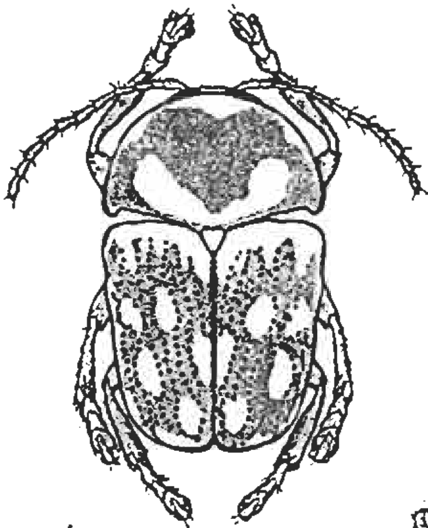

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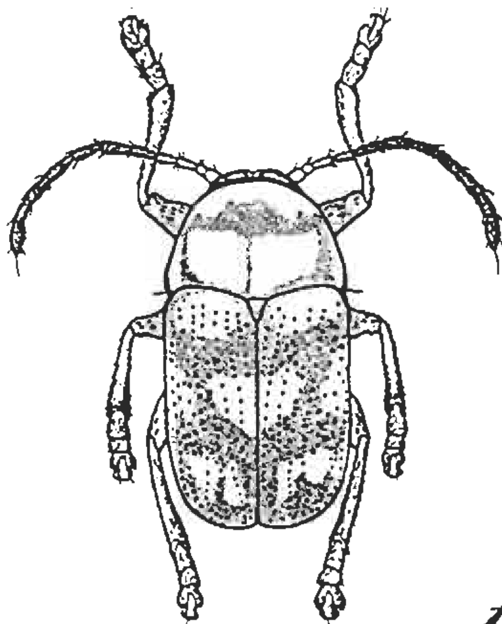

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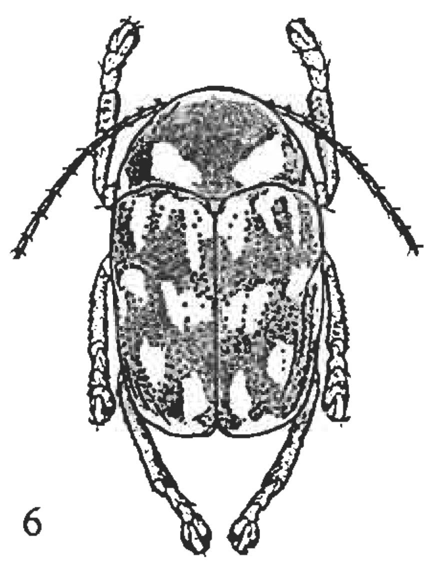

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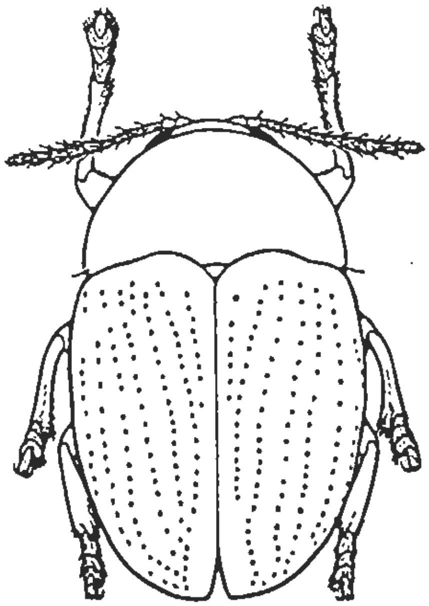

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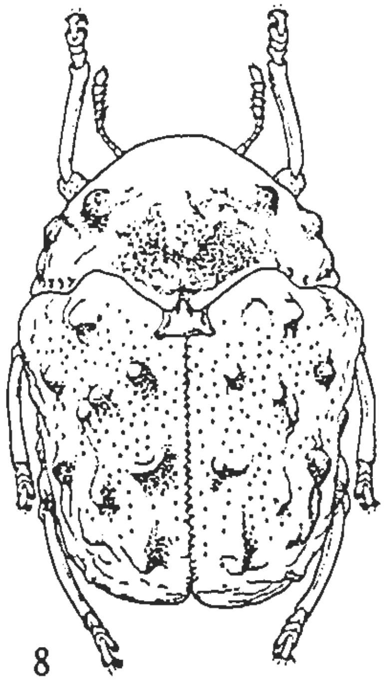

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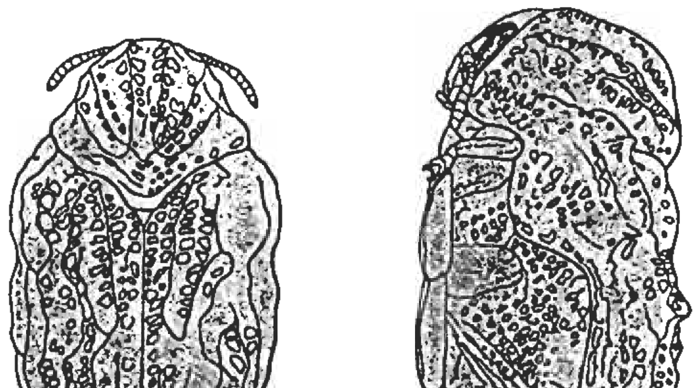

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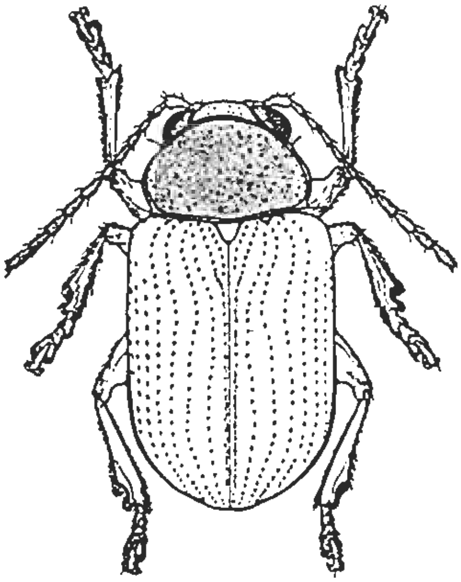
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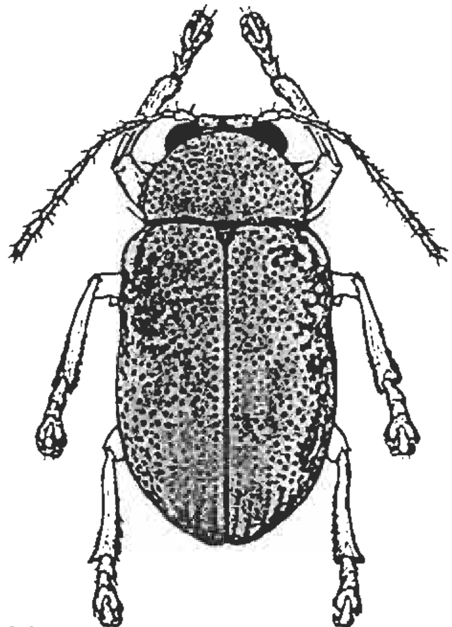
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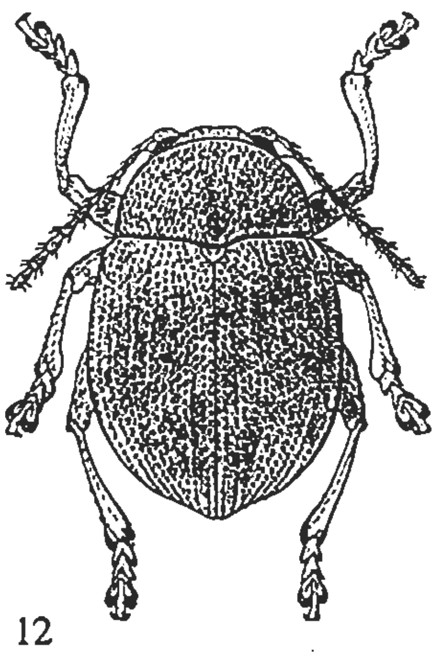
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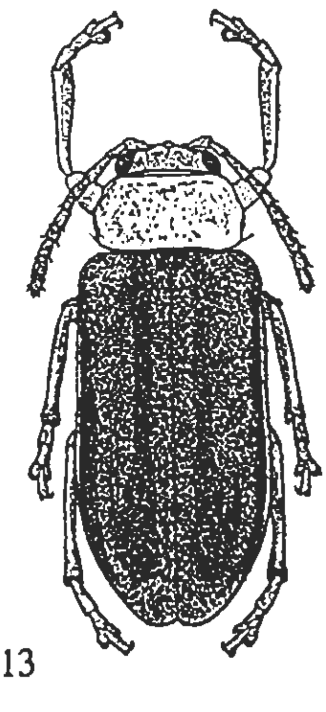
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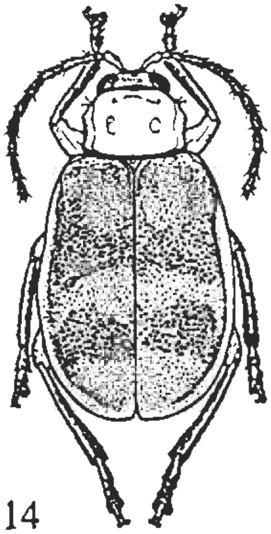
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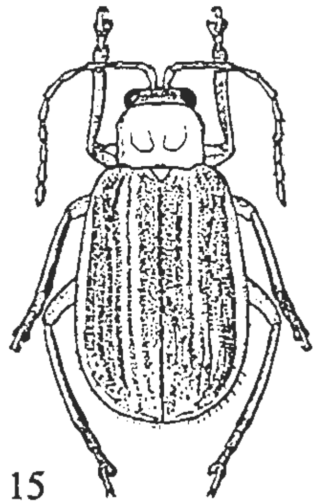
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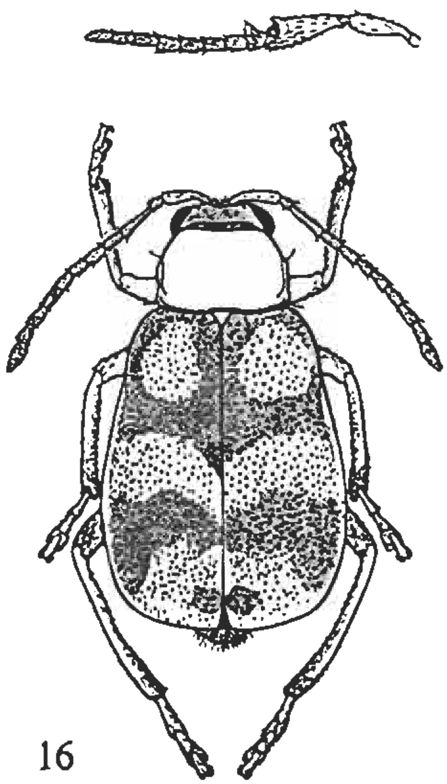
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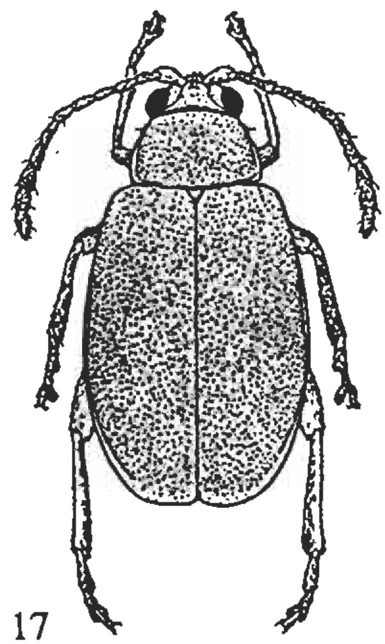
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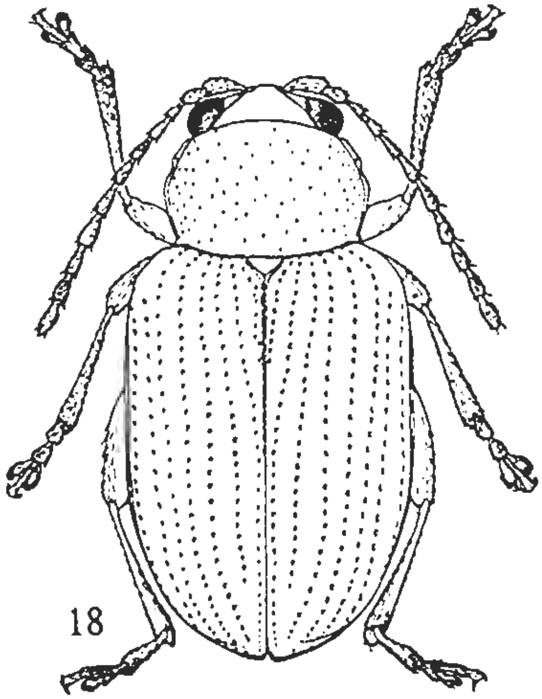

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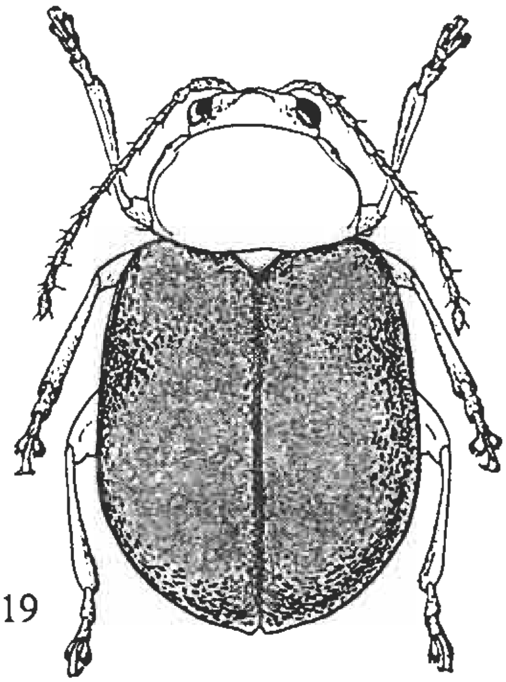

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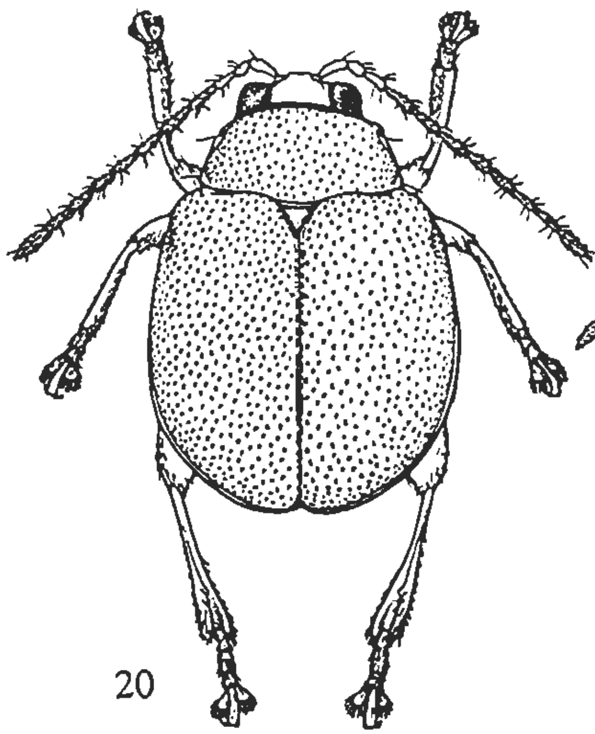

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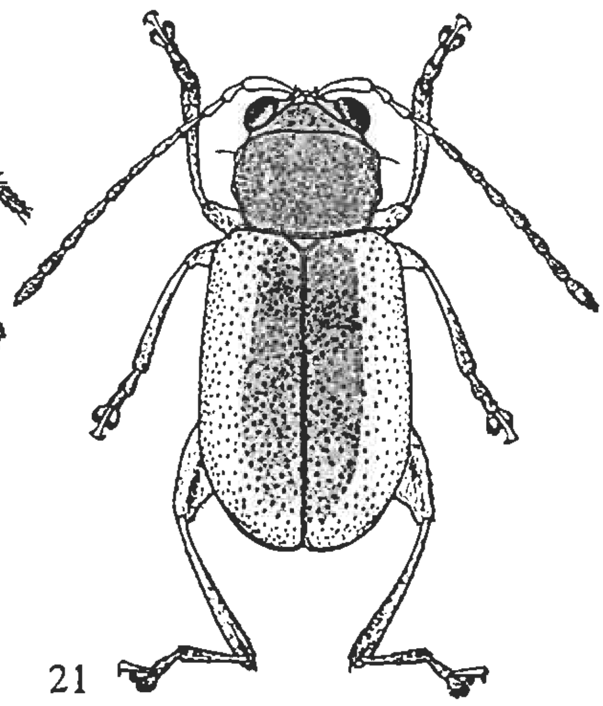

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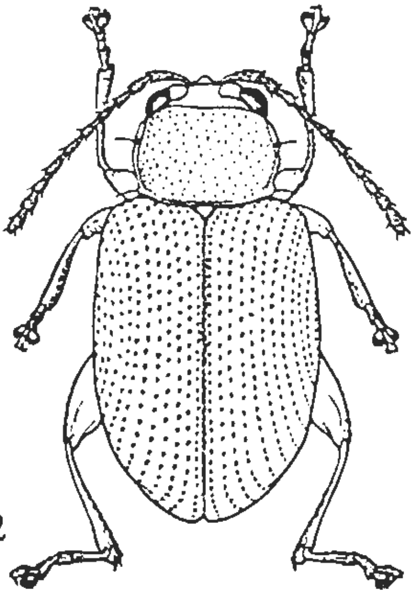

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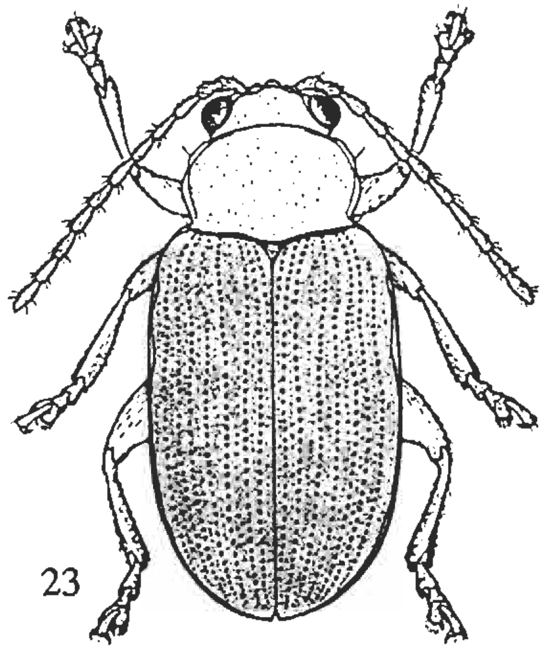

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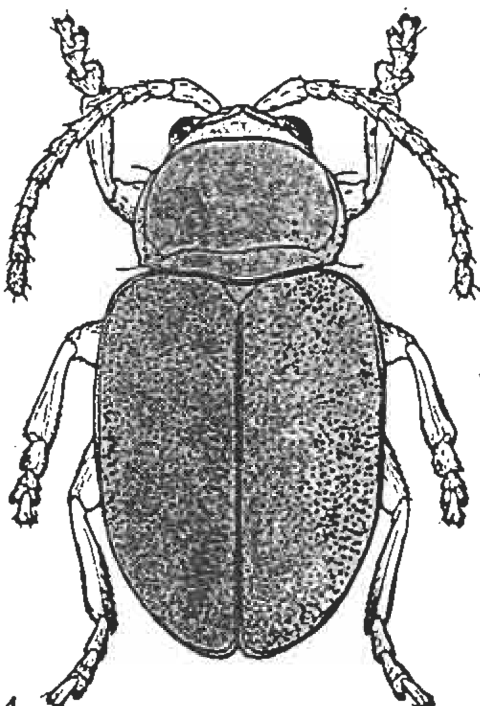

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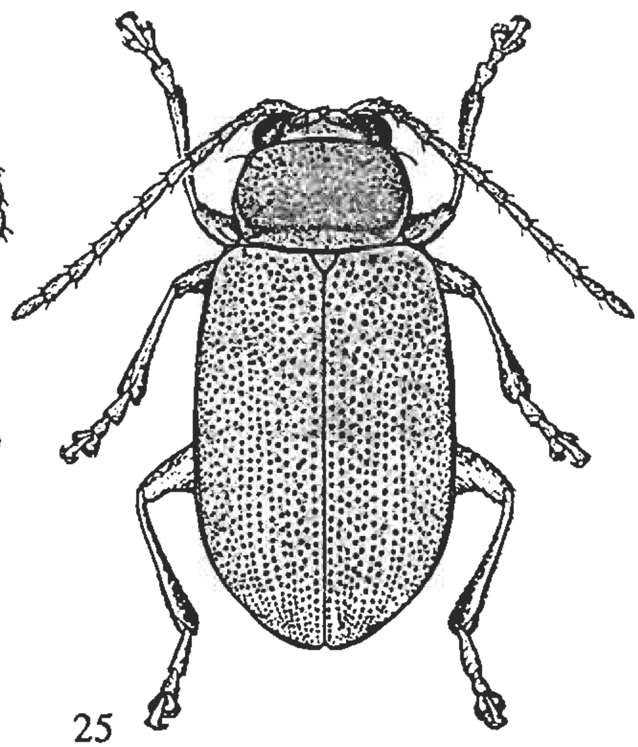

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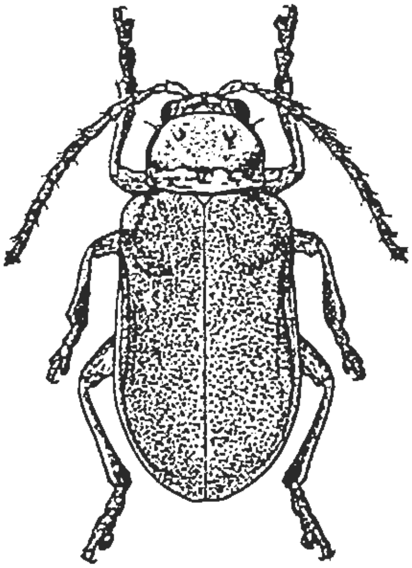

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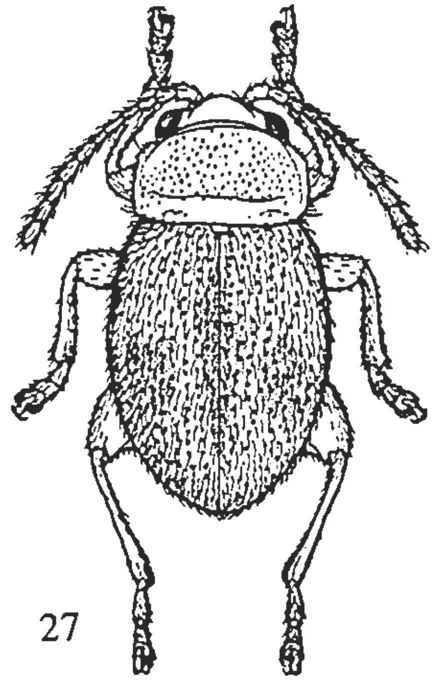

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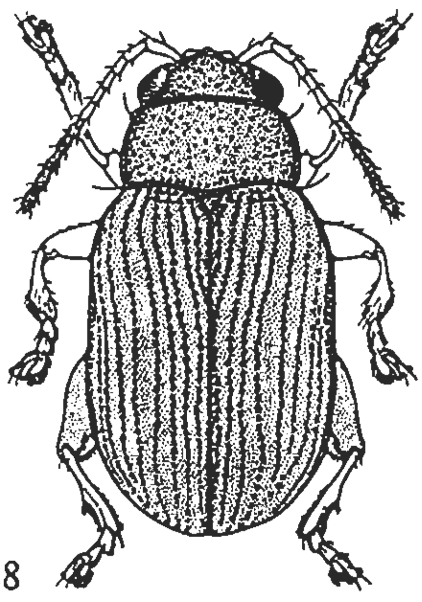

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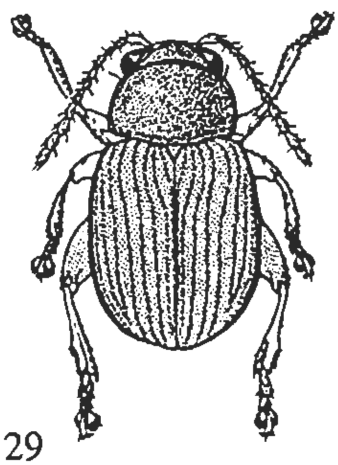

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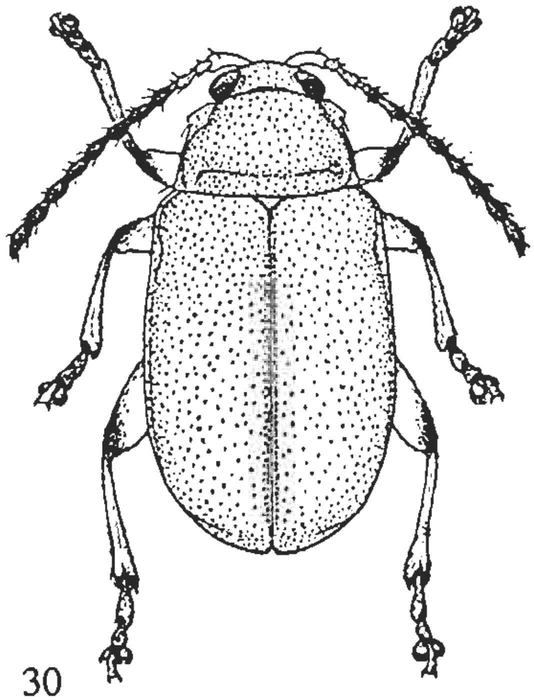

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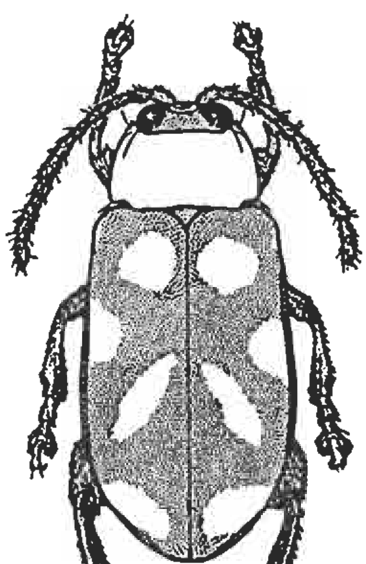

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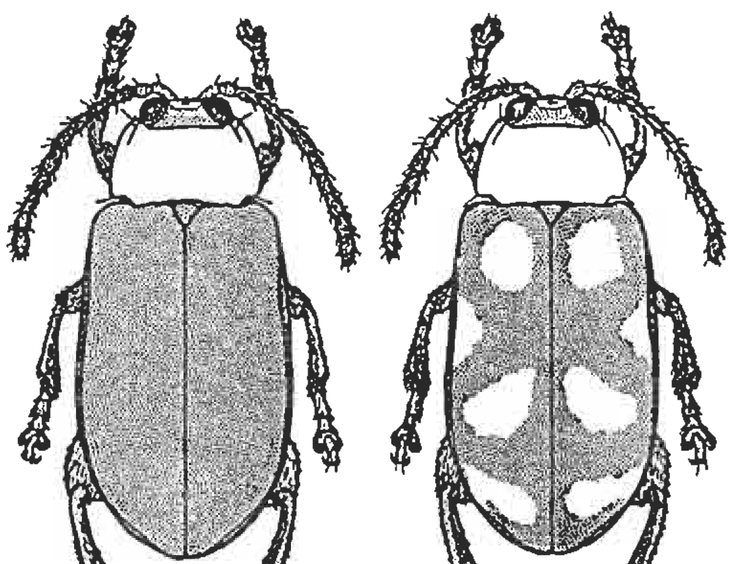

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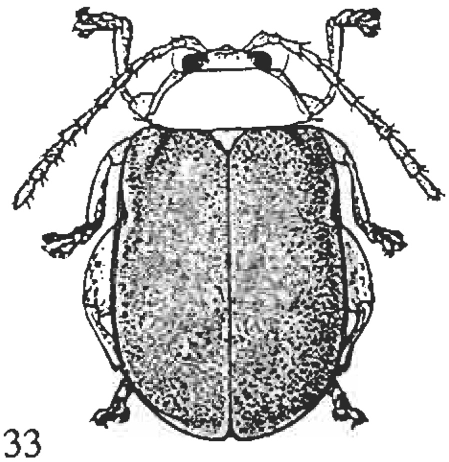

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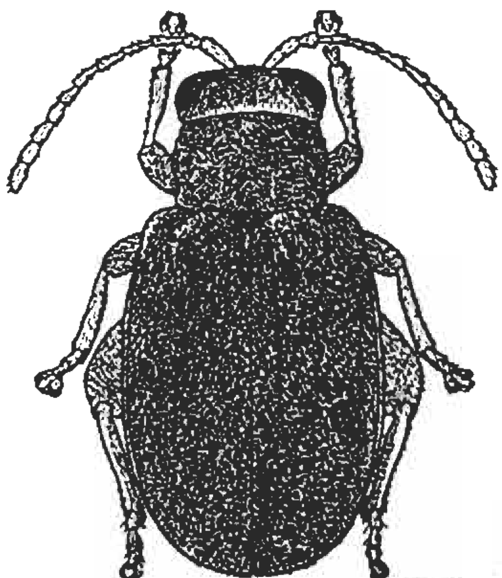

34

American
Museum of
Natural
History

Dr. James D. Lazell
The Conservation Agency
Conanicut Island, RI

8 April, 1993

Dear Skip,

I suspect that you will be pleased to finally find, enclosed, a copy of a VERY PRELIMINARY report, on the drosophilid flies of the Virgin Islands. I have highlighted where Guana Island is mentioned. This dinky little report will eventually become a monograph, I hope; but between now and then I have thousands of specimens to process, mostly from Hispaniola.

I should say that the few species mentioned in here are a small fraction of all the flies that were collected. Species belonging to at least 20 families (perhaps 45 genera, 60 species) were collected, but it will be a while before we even have generic identifications on most of them. By far the most valuable thing for my research was a series of nearly 100 specimens of a tiny little acalyptrate fly in the family Asteiidae (the generic limits within the family are totally useless, so a genus i.d. is also useless). These flies are actually very rarely collected, and I at least doubled the size of the AMNH collection for this family with this series. I'm interested in this family because there are some representatives fossilized in Dominican amber. The asteiids were found by sweeping up and down trunks and along the undersides of large tamarind trees (trees are where dipterists have always found Asteiids -- presumably they are breeding in wounds in the bark) -- but never have they been found in such abundance. Even more odd is that I found several other Diptera aggregating with these asteiids, and 2 species of drosophilids in particular. These are mentioned in my report (*Drosophila richardsoni* and *Rhinoleucophenga* sp., the latter is one of the rarities I was after on the island).

Sorry I missed the minisymposium at the end of October. I really enjoyed my stay, even with the phenomenal hangover I got at Foxy's.

Best wishes,

Sincerely,

David

Dr. David Grimaldi
Associate Curator, AMNH
Visiting Lecturer, Cornell Univ.*

*until June 1, 1993: 607-255-3123.

P.S. I need to get that copy of the vertebrate survey of Hispaniola that I showed to you on Guana. Do you have it, or is it still on Guana? If you have it, I will gladly have a copy made for you.

Central Park West at 79th Street New York, New York 10024-5192, USA Telephone (212) 769-5000

PRELIMINARY REPORT ON THE DROSOPHILID FAUNA OF THE VIRGIN ISLANDS,

Dr. David Grimaldi
Dept. of Entomology
American Museum of Natural History
Central Park West at 79th St.
New York, New York 10024-5192

5 April, 1993

This is a preliminary report on species identities, relative abundance, and distributions of drosophilid flies (commonly called the small fruit flies, or "pomace" flies) from the Virgin Islands. More accurate species identifications and more comprehensive distributional data will be presented in a future report, but that will take a while to prepare since it involves numerous, detailed dissections and comparisons. This is part of my research program on the Systematics and Biogeography of the Caribbean Drosophilidae, some of which is funded by the U.S. National Science Foundation.

Drosophilid flies are popularly known primarily through one very important species, *Drosophila melanogaster*, the common laboratory fruit fly. Actually, nearly 3300 described species in the family Drosophilidae exist, with perhaps 2000 undescribed ones residing in collections and yet to be found in the field. It is a predominantly tropical family, with the Neotropics being by far the most diverse region, as well as the least studied region for these flies. Major works pertaining to the systematics of the Neotropical Drosophilidae are: Williston (1896); Sturtevant (1921); Duda (1925, 1927); Wheeler (1981, 1986); Vilela (1983); Grimaldi (1987, 1990, 1993); and Vilela and Bachli (1990). Preliminary observations on the Caribbean fauna indicate that there are resident species in most of the major groups (e.g., genera, species groups), but still a depauperate fauna in comparison to the Central American mainland. Notable absences from the Caribbean are any species in the genus *Amiota*, and very few in the large genus *Scaptomyza*. The actual species diversity, distributions, and degree of endemism in the Caribbean is the subject of my research.

Two trips were made with AMNH Scientific Assistant Julian Stark to the U.S. and British Virgin Islands, during early March, 1992 and early October, 1992. These 2 visits afforded a ripe opportunity to examine differences in the fauna between 2 seasonal extremes: the dry season (early March) and the, presumably, wet season (October). While St. John was indeed quite wet and rainy during October, our visit to Tortola and Guana (immediately north of Tortola) found a surprisingly dry habitat -- drier, in fact, than during our March visit. At sea level, around Lameshur Bay, there were dramatic differences between the two seasons. During October, fallen fruits and a moist leaf litter supported vigorous populations of a few species of drosophilids in this area, where none were found during March.

Specimens were critical point dried (essentially freeze-dried) from absolute ethanol, point-mounted, labeled, and carefully identified using dissections of male (sometimes, female) genitalia. These specimens are in the research collections of the Entomology Dept., American Museum of Natural History, where they will serve as vouchers and material for ongoing comparative research. This is the most appropriate repository for the specimens since it is the world's largest collection of these flies, representing at least one-third of the described species of the world and with several hundred undescribed species in it, and since I am one of the few active researchers in the world on the family. Duplicate specimens will be sent to the Entomology Dept., National Museum of Natural History, Smithsonian Institution.

THE FLIES

Genus Diathoneura

Distinguishing Features: An entirely Neotropical genus closely related to *Cladochaeta* possessing: large oral cavity, labium large and broad, apex of labellum with small fleshy tubercle; eyes generally bare (without fine pile); female with oviscapt, having pegs and generally with a large apical peg; arista with 2 or more ventral branches (vs. 1 in *Cladochaeta*). There are also several diagnostic features of the male genitalia.
Habits: Breeding sites are largely unknown, although Pipkin (1966) has bred some from decaying flowers and fruits. I generally find them most abundantly around thick, moist leaf litter, so they are probably breeding there. Several species, from Ecuador and Costa Rica, have bizarre male sexual ornamentations on the head.
Diversity: Wheeler (1981) listed 28 species, but indicated that limits between this genus and *Cladochaeta* were obscure. This problem was clarified by Vilela and Bachli (1990), who transferred 5 additional species to *Diathoneura* (from *Cladochaeta*). Vilela and Bachli also described 2 additional species, from mixed series of type specimens. Thus, 35 described species exist, but this is a fraction of the total diversity: probably several hundred actually exist (mostly from South and Central America), based on my observations of specimens in the AMNH collection.

Only 6 species are reported from the Caribbean: *dubia* (Sturtevant), 1921 (reported from throughout Central America [Wheeler, 1981]; type locality is Cuba?); *euryopa* Duda, 1925 (reported from Jamaica and Costa Rica [Wheeler, 1981]; type locality is Costa Rica); *nana* (Williston) 1896 (reported from Panama [Wheeler, 1981]; type locality is St. Vincent); *smithi* Vilela & Bachli, 1990 (type and only known locality: St. Vincent); plus the 2 species identified below (*metallica* and *opaca*).
Local Species:

Diathoneura metallica Sturtevant, 1921

Distinguishing features: A tiny species with a velvety black scutellum and metallic orange notum; front of head is pollinose blue when viewed from above; face, antennae, and palps are mostly dark brown to black; pleura mostly ochre, with dark brown band at level of the wing base, another band on the katepisternum; legs light yellow, abdomen shiny black.
Distribution and Habits: Dissections of specimens from St. John and other Caribbean islands from where it is reported are needed to confirm the species identity. Specimens in the AMNH which are externally very similar are from Cuba, Hispaniola, and Puerto Rico. The type locality is Cuba.

Diathoneura metallica (or at least a species very similar to it) is one of the most common drosophilids found on St. John, but it appears abundant only in the moister sections of forest (e.g., Reef Bay trail, in moist stream beds during the dry season), versus the drier trails (e.g., Cinnamon Bay and Water Catchment trails). They were collected during both March and October on St. John. A series of only 8 specimens were collected from the forest on top of Mt. Sage, Tortola.

Diathoneura opaca (Williston) 1896

Distinguishing features: An obvious species to identify, on the basis of a thorax with the dorsal half velvety black. I have yet to do numerous dissections of many specimens accumulated from around the Caribbean and Central America, to determine if this apparently widespread species is, indeed, a single species. Type locality: St. Vincent, BWI.
Distribution and Habits: The species identity of the one female that was collected off Cinnamon Bay trail in March is difficult to confirm, given the need for male genitalic characters to detect subtle species differences.

Diathoneura smithi Vilela & Bachli, 1990

Distinguishing features: Notum and scutellum ochre; pleura with 2 dark brown bands, just below wing base and a lower one; face and antennae light; front of head light brown; arista with 6 dorsal and 2 ventral branches; legs entirely light yellow; abdomen entirely brown, not shiny; wings hyaline.
Distribution and Habits: Only a single male was collected off the Reef Bay trail on St. John and a female was taken from Mt. Sage, Tortola, so it is not abundant on either island. The species was just recently described from a mixed series of cotypes originally collected ca. 1895 from St. Vincent. These new records extend the distribution of this species considerably into the Caribbean.

Diathoneura sp. *B*

Distinguishing features: A small, entirely dark brown fly (even the halteres), with a light brown face and legs; arista with 3 long dorsal, 2 ventral branches; wing hyaline.
Distribution and Habits: Known only from a single male taken during March from the forest on top of Mt. Sage.

Genus Drosophila

Distinguishing Features: Defined by Grimaldi (1990) as possessing a well-developed facial carina, usually with a flat edge; eyes bright red with dense pile; 2 or more ventral branches of arista; oviscapt with numerous stout pegs around its edge.
Habits: A large and varied genus, generally breeding in decaying fruits, flowers, leaves, necrotic rot pockets in cacti, etc... Cosmopolitan.
Diversity: This genus was recently pruned of several large subgenera (e.g., *Scaptodrosophila*, *Hirtodrosophila*, endemic Hawaiian species) and small subgenera (e.g., *Lordiphosa*, *Engiscaptomyza*), and it is still the largest genus of drosophilids with well over 1000 described species. Some subgenera are arranged into species groups.
Local Species:

Subgenus Drosophila

Distinguishing Features: Facial carina high and broad, often with flat edge (and even with a small median furrow on the edge); eyes with dense pile; eggs with 4 (rarely with 3) apical filaments.

Drosophila cardini SPECIES GROUP

Distinguishing Features: (see Sturtevant, 1942: 31, and Heed, 1962 and other papers).

Drosophila (*similis*?) Williston, 1896

Distinguishing Features: Abdomen rather shiny, mostly ochre, with diffuse brown bands on posterior margins of most tergites; arista with 5 dorsal and 2 ventral branches.
Distribution and Habits: Reported by Wheeler (1981) from Mexico to Trinidad (type locality: St. Vincent BWI); an apparent subspecies, *D. s. grendadensis* Heed, is described from Grenada.

This is the most common species of drosophilid on St. John and, in fact, probably in the Virgin Islands. An interesting discrepency was found in the relative abundance of both sexes in 2 microhabitats: 73 females and 40 males were collected off Cinnamon Bay Trail in March, while 213 males and 105 females were collected around a small, isolated pool in a moist stream bed off Reef Bay Trail at the same time. It is unclear why there would be a reversed abundance of the sexes at the 2 sites.

Drosophila repleta SPECIES GROUP

Distinguishing Features: A very distinctive group for the pattern of small dark spots covering the dorsal part of the thorax, each lying at the base of a seta. The spots can be coalesced in some species, forming elaborate maculated patterns. This is a very large species group, ca. 90 species, with a New World, predominantly Neotropical, natural distribution (there are about 4 tramp species). A fine, extremely useful revisionary monograph on the group is that of Vilela (1983). It is well represented in the Caribbean, with [number] endemic species. Some species are renowned for their breeding sites, which are the necrotic rot pockets of various cacti. The flies can be rigidly monophagous, and even entirely dependent physiologically on the yeasts growing in the rotting cacti. Work on this subject is reported in various papers by Heed et al. [citations].

Drosophila richardsoni Vilela, 1983

Distinguishing Features: Like most species in the species group, external characters are few, and male genitalic characters are most reliable. For this species, the male genitalia has an aedeagus that is short and stout, slightly upturned apically, and with a pair of prominent lateral flanges.
Distribution and Habits: On St. John: 14 males, 2 females were collected 8/X/92 by sweeping over fallen fruits on the forest floor near the VIERS station. On **Guana Island:** 24 males, 6 females were collected 10-17/X/92 by sweeping along trunks and beneath overhanging limbs of large tamarind trees. This latter method of collecting also captured a large number of asteiid flies. This species was not collected at mashed banana bait; nor was it collected in March.

Originally described from 12 males, 13 females originating from Mayaguez, Puerto Rico (Vilela, 1983). A culture of this species is in the National Drosophila Species Stock Center, Bowling Green Univ. (stock no.), which came from females bred from an organpipe cactus in Puerto Rico. The distribution is extended slightly eastward by these records. It would be interesting to see if this species occurs on St. Croix, which is on the other side of the Puerto Rican bank.

Subgenus Sophophora

Drosophila (S.) malerkotliana (?)

Distinguishing Features:
Distribution and Habits: Native distribution is the Indopacific, but recently was introduced to Mexico. Genitalic dissections are needed to confirm the i.d., but if the i.d. still stands, this is the first record of this species introduction into the Caribbean.

Drosophila (S.) melanogaster

Distinguishing Features:
Distribution and Habits: Probably the most common, widespread fruit fly in the world. Introduced virtually everywhere that man lives. Oddly, 6 males that were collected on St. John (Lameshur Bay) in October, but none were collected in March, suggesting that very dry weather limits their populations. One male was collected 7/III/92 on Mt. Sage, but this habitat seems at the limit of their range, in terms of tolerance to cooler and wet conditions. In Hawaii, for example, *D. melanogaster* rarely is found above 2400 ft.

Drosophila (S.) simulans

Distinguishing Features: Very similar to *D. melanogaster*, but distinguished externally on basis of smaller epandrial lobe.
Distribution and Habits: Another "supertramp" species like *melanogaster*, and very closely related to it. Only a single male was found, on St. John (Lameshur Bay, 8/X/92).

Drosophila (S.) sp.
(*alagitans-bocainensis* species group)

Distinguishing Features:
Distribution and Habits: A very common fly on the fallen fruits at Lameshur Bay, St. John, during October (44 males, 8 females were collected by sweeping). No specimens were found in March. A single male was collected on Mt. Sage, 7/III/92. Wheeler & Magalhaes (196x) revised this group, so a species identification could be certain when the dissections are completed.

Genus Leucophenga

Distinguishing Features: Easily istinguished by the primitive presence of a pair of prescutellar setae; large eyes; wing with the apical portion of the costal vein having a row of 4-7 blunt, thorn-like pegs; abdomen of females usually with distinctive pattern of spots, males often different that females, sometimes with 1 or more abdominal tergites silvery and highly reflective.
Habits: Most host records are of rearings from mushrooms. However, the abundance of *Leucophenga* in drier habitats suggests additional hosts.
Diversity: A large genus of nearly 170 species worldwide, by far most speciose in Africa and Asia. 6 species are recorded by Wheeler (1981) as being in the Caribbean: *bimaculata* (Loew) 1866 [reported from Cuba and Mexico, type locality ?]; *elegans* Duda, 1927 [reported from the "West Indies", and

El Salvador to Bolivia; type locality?]; *frontalis* (Williston), 1896 [reported from Costa Rica to Brazil; type locality is St. Vincent]; *maculosa* (Coquillett) [reportedly widespread from the northern U.S.A. to Argentina and Chile, Hawaii, and throughout the Caribbean; type locality ?; probably introduced to most places from eastern U.S.]; *neovaria* Wheeler, 1960 [reported from West Indies, El Salvador to Colombia]; and *obscuripennis* (Loew), 1866 [reported from Cuba, Costa Rica, to Brazil].

Local Species:

Leucophenga sp. **A**

Distinguishing Features: Female with large palps; male tergites 2 and 3 with reflective silver (see figs. for differences in abdominal patterning); both sexes with thorax ochre, tip of scutellum white, clouds over cross veins, at base of wing, and at apex of vein R_{2+3}; wing with 6-7 costal pegs.
Distribution and Habits: A single male was collected, off of Reef Bay Trail in March. No other specimens of this genus were collected, even on St. Thomas or Tortola, but 6 individuals of the same species were collected during March on **Guana Is.**, in much drier habitat.

Leucophenga sp. **B**

Distinguishing Features: Palps large; scutellum with tip barely white; apical setae of scutellum crossed for one-half their length; no clouds on cross veins; abdomen mostly black, with tergite 3 mostly white and having small dark triangle in the middle; male with tergites 3-5 and part of 6 silvery white, others velvety black.
Distribution and Habits: Only 2 individuals were collected in the Virgin Islands, both from St. John: 1 female on Reef Bay Trail, 5/III/92, and a male at Lameshur Bay, 8/X/92. Identification of the species needs to be confirmed with dissection and comparison with types.

Leucophenga sp. **C**

Distinguishing Features: Wing entirely clear, no clouds; dorsal part of thorax yellow, pleura white; abdomen with the following markings: tergites I, II yellow; tIII with a black band; tIV, V with a dark median spot and pair of smaller lateral spots; tVI with just a pair of lateral spots.
Distribution and Habit: A single male was collected, from St. John: Lameshur Bay, 8/X/92, while sweeping over leaf litter in the forest.

Genus Hirtodrosophila

Distinguishing Features: Variable in coloration, dorsal part of the thorax varying from black and dark brown to light yellow, but usually contrasting with a light yellow pleura; pleura can have brown stripes; eyes usually bare or only finely pubescent; facial carina either absent or very narrow and shallow; arista always with a single ventral branch (excluding the apical fork), or none at all; ovipositor: [describe]; male genitalia: [describe].
Habits: Always found in aggregations of rendezvousing adults on fleshy or pliant fungi. The larvae are breeding in this substrate.

Diversity: Formerly a subgenus of *Drosophila*, but recently removed from that genus to one of its own (Grimaldi, 1990). With approximately 150 described species worldwide. At least the Neotropical species are very poorly known: in one area in Panama, I collected nearly 30 species! 3 species are known from the Caribbean, 2 of which occur on St. Vincent: *pleuralis* (Williston), 1896, and *thoracis* (Williston), 1896, the latter species having been recorded as also being from the southeast U.S. (Wheeler, 1981).
Local Species

Hirtodrosophila sp. **A**

Distinguishing Features: Notum mostly brown, lighter anteriorly; pleura with dark katepisternum and dark stripe anterior to wing base (remainder of pleura cream-colored). Abdomen with tergites 1-5 mostly dark brown, tergites 6-7 cream-colored; facial carina narrow, low; arista with 8 long dorsal branches, 1 ventral one
Distribution and Habits: Known only from 2 specimens collected, both from St. John: Lameshur Bay, 1 male, 1 female, 8/X/92. Species identity can only be confirmed about dissecting genitalia and comparison with types.

Hirtodrosophila sp. **B**

Distinguishing Features: Arista with 4 dorsal branches, 1 short ventral one; facial carina narrow, short; dorsal part of thorax dark brown, shiny; a dark brown stripe runs along pleura just anterior to wing base; abdomen mostly dark black-brown, with: tergites II-IV interrupted in middle with light yellow triangular area, tV with a dark broad band and triangle, and tVI with a pair of paramedian yellow spots.
Distribution and Habits: 7 males, 7 females were collected on white fungus growing on wood in forest on Mt. Sage, Tortola, 23/X/92 (M.A. Ivie, coll.). Species identification must be confirmed with dissection and type comparisons.

Genus Microdrosophila

Distinguishing Features: Very distinctive for the narrow face, with a slight carina; eyes with dense pile; wing tip pointed; the arista usually has numerous, long branches. Females lack an oviscapt, and male genitalia are also quite distinctive.
Habits: I collect these flies most commonly around decaying wood, especially around trees and wood shavings that have been recently sawed.
Diversity: 37 species are described, but only 1 is from the New World (*quadrata* [Sturtevant], 1916, from the U.S.). The Neotropical ones are undescribed, although it is unclear how many there may be.
Local Species:

Microdrosophila sp.

Distinguishing Features: A small, mostly yellow fly with a light brown, diffuse band along the length of the pleura, just below the wing base. Wing tip is pointed, characteristic of the genus; tergites are

mostly yellow, with light brown, diffuse bands on posterior margins; the arista has 7 dorsal and 2 ventral branches.
Distribution and Habits: 11 males and 4 females were collected off the Reef Bay trail in March, and 8 males and 3 females off the Water Catchment trail (none off Cinnamon Bay trail). 2 females and 3 males of the same species were collected from the forest on top of Mt. Sage, Tortola, soon thereafter.

Genus Paramycodrosophila

Distinguishing Features: A rather rare genus identified by the tan and black mottled body, a blackened "lappet" at the base of the wing near the subcostal break (as in the genus *Mycodrosophila*), a narrow facial carina, the arista has 1 ventral branch, and the oviscapt has a large ventroapical peg.
Habits: Always found on fungi.
Diversity: 13 species are described, which have an interesting distribution: 9 species are Indopacific (including Australia), 1 is from the southern U.S., 2 are from Central America and the Caribbean, and 1 species (*P. nephelea* Wheeler, 1968) is known only from Jamaica.
Local Species:

Paramycodrosophila sp.

Distinguishing Features: Body coloration typical of genus; see fig. for male genitalia.
Distribution and Habits: Only 2 males of this species were collected, off Reef Bay Trail in March. None were collected on Mt. Sage, St. Thomas, or Guana (the latter island is no doubt too dry for this genus).

Genus Rhinoleucophenga

Distinguishing Features: With pair of large prescutellar setae, typical of steganine drosophilids; eyes large, completely bare; front of head with numerous fine setae; wing completely clear; male genitalia small, unsclerotized; a comb-like row of sclerotized teeth on the ventral lobes of the epandrium (apparently these lobes are not surstyli, or, if they are, they are entirely fused to the epandrial lobes).
Habits: Of the few records of larval breeding sites, they all are known as predators of scale insects and white flies.
Diversity: A small Neotropical genus with only 12 described species, but species limits with American species of *Gitona* are obscure (Wheeler, 1981). There are probably at least a dozen additional, undescribed species. Two species are reported from the Caribbean, both originally described as Gitona: *bivisualis* (Patterson), 1943 (also reported from s. U.S.A., to Mexico and El Salvador), and *fluminensis* (Lima) 1950 (reported from Brazil as well as the Caribbean) (Caribbean records??).

Rhinoleucophenga sp.

Distinguishing Features: A small, mostly yellow species, with short branches on arista (describe).
Distribution and Habits: A large series of an as yet unidentified species was collected on Guana Island in October, by sweeping along the trunks and overhanging limbs of large tamarind trees. This seems a very peculiar habit for the flies, but may have been an aestivating site during a period of unseasonably dry weather. Other Guana Island specimens are the following: 1 male, 1 female, 13-

26/VII/86 (Miller & Pogue, colls.); 2 males, 1-14/VII/84 (Miller, coll.). They were probably collected with a Malaise trap, since they are all covered with lepidopteran scales. One specimen was collected from St. John: Lameshur Bay, 8/X/92, by sweeping along the forest floor.

Species which should occur on St. John, but for which no records exist:

Taxa widespread in the Caribbean:

Chymomyza: Several species are known from the Caribbean, but they do not appear to have widespread distributions. A cosmopolitan genus of about 60 species, all of which are attracted to injured tree trunks, so thriving populations probably require older forests. Perhaps 2 species occur in the Virgin Islands.

Cladochaeta. An enigmatic genus of tiny, yellow drosophilids; all host records indicate that the larvae are parasitic on spittlebug nymphs. Entirely New World, mostly Neotropical. Formerly with 13 species, my current revision has found 105 new species. I have found 7 species on Hispaniola (all new species), 2 from Puerto Rico, 3 from Jamaica (all new), and 5 from the small Lesser Antillean island of Dominica (all new). Thus, I expect that 2, perhaps 3, species would occur in the Virgin Islands.

Drosophila. Several species in the subgenus *Drosophila* are well represented in the Caribbean: *calloptera*, *cardini*, and *repleta* groups, only the last group is well adapted to subsisting in very arid habitats (many breed in cacti). No *calloptera* group flies were collected in the Virgin Islands, and several additional species of the *cardini* and *repleta* group flies should also be present.

Mycodrosophila: A genus of shiny black flies found on fungi; 2 species are known from the Caribbean. There should be at least 1 species in the Virgin Islands.

Rhinoleucophenga sp.: A large series of an as yet unidentified species was collected on Guana Island in early March. The genus no doubt occurs on the other Virgin islands.

Stegana: 2 described species are known from the Lesser Antilles, and I collected several other species on Hispaniola. It is quite likely that 1 or 2 species occur in the wetter, higher islands of the Virgin Islands. These flies are rarely collected

Zygothrica (*bilineata* [Williston], *circumveha* Grimaldi, and *microstoma* Duda have circumcaribbean distributions).

One genus which is quite rare, and the only one endemic to the Caribbean, is *Mayagueza* Wheeler (named in reference to the type locality, Mayaguez, Puerto Rico). Only a small series of specimens is known, from the type series (in the AMNH), and a newly discovered specimen from the Bahamas (in the collections of the British Museum). The genus is monotypic *(M. argentifera*), and the most closely related genus is the Old World genus *Acletoxenus*. Larvae are predatory on scale insects and white flies, as are related genera. Given that Mayagueza has been found on an island drier and more distant from Puerto Rico than are the Virgin Islands, I would fully expect this genus to eventually turn up in the Virgin Islands.

Thus, it is quite likely that as many as 20 additional species of drosophilids have yet to be found in the Virgin Islands.

Collecting on Guana Island, British Virgin Islands and Puerto Rico

Roy R. Snelling
Department of Entomology
Natural History Museum of L.A. Co.
900 Exposition Boulevard
Los Angeles, California 90007

As in 1991, I spent the month of October, 1992, collecting on Guana Island in the British Virgin Islands. A few other islands were visited briefly during that month, but my main focus was on Guana. As reported in SPHECOS 23 (July 1992), Guana is a small (340 hectares) island lying to the north of the east end of Tortola. Although some sugar cane was grown there long ago, little trace remains of that era and the island has largely reverted to dry forest.

My collecting report in SPHECOS-23 listed 12 species of bees then known to occur there (but failed to include *Apis mellifera*, present but not abundant). Last year I got only two females of the *Hylaeus* (the first *Hylaeus* for the entire Puerto Rico Bank); this year I managed to get a good series of both sexes, mostly on *Capparis cynophallophora*. Much of my bee interest this year was in attempting to garner some data on floral visitation by the various bee species on Guana. Fortunately for me, George Proctor, a botanist with the Departamento de Recursos Naturales in Puerto Rico, was on hand to name stuff for me!

Coelioxys abdominalis Guérin is a lovely little bee. It was much more abundant than any *Megachile*, not only this year, but last year as well. Question: how is it that a cleptoparasite is more abundant than its presumed host? My best guess at this point would be that it hits the nests of *Centris lanipes*. Recall that Friese (1923, Die Europaischen Bienen (Apidae), I:45) asserted that both *Megachile* and *Anthophora* are hosts for *Coelioxys*. While he has been pooh-poohed since then, maybe, just maybe, he was on to something.

There appears to be only one *Exomalopsis* on Guana and it mostly visits *Solanum persicifolium*, which it "buzzes." But I can't identify the darned thing! Timberlake's key (1980) simply does not work for the Greater Antillean *Exomalopsis*. Somebody needs to look at these more critically than Tim did.

I had an opportunity to see a couple of nesting sites of *Centris decolorata* on Puerto Rico. One very populous site was on a beach near Aguada. Thousands of males cruising through the site. They would sometimes land and walk around for a bit, then resume flying. They paid absolutely no attention to the females! On the other hand, females attempting to gather nectar and/or pollen from flowers of *Canavalia rosea* were fair game. Are males present at the site to discourage parasites such as *Mesoplia rufipes* or bombyliids? In any case, this beach-nesting *Centris* seems worth studying - maybe a good student project? Among the thousands of males I found one metander!

Also spent five days collecting on Mona Island. Wonderful place. I hope next year to go back and get onto the nearby island of Monito (essentially uncollected).

In the following list, species newly collected on both Guana and Mona Islands are marked (*).

Bees of Guana Island, BVI

COLLETIDAE

Hylaeus (Hylaeana) sp. (undescribed). Collected on *Capparis cynophallophora, Cardiospermum micranthum* and *Schaefferia frutescens.*

HALICTIDAE

Lasioglossum (Dialictus) sp. 1: on *Coccoloba uvifera, Cakile lanceolatum, Jacquemontia pentantha, Cardiospermum micranthum, Schaefferia frutescens, Capparis cynophallophora* and *Ipomoea pes-capri braziliensis.*

Lasioglossum (Dialictus) sp. 2: on *Capparis cynophallophora, Jacquemontia pentantha, Antigonon leptopus* and *Schaefferia frutescens.*

**Habralictellus* sp.: on *Capparis cynophallophora* and *Schaefferia frutescens.*

Augochlora sp. 1

Augochlora sp. 2: on *Ipomoea pes-capri braziliensis* and *Jacquemontia pentantha.*

MEGACHILIDAE

Megachile (Pseudocentron) undescr. sp near *poeyi* Guérin: on *Ipomoea pas-capri braziliensis, Jacquemontia pentantha, Antigonon leptopus* and *Cardiospermum micranthum.*

**Megachile (Eutricharaea) concinna* F. Smith: on *Ipomoea pes-capri braziliensis.*

Coelioxys abdominalis Guérin: on *Ipomoea pes-capri braziliensis, Antigonon leptopus, Cardiospermum micranthum, Jacquemontia pentantha, Solanum persicifolium* and *Cakile lanceolatum.*

Coelioxys abdominalis (Guérin).

ANTHOPHORIDAE

Exomalopsis (E.) sp.: on *Solanum persicifolium,* and *Jacquemontia pentantha.*

**Centris smithii* Cresson.

Centris haemorrhoidalis (Fabr.): on *Solanum persicifolium, Caesalpinia bonduc* and *Stigmaphyllon periplocifolium.*

Centris lanipes (Fabr.): on *Solanum persicifolium* and *Caesalpinia bonduc.*

Anthophora tricolor (Fabr.): on *Solanum persicifolium, Ipomoea pes-capri braziliensis, Antigonon leptopus* and *Caesalpinia bonduc.*

**Melissodes trifasciata* Cresson: on *Ipomoea pes-capri braziliensis* and *Antigonon leptopus.*

Xylocopa mordax F. Smith: on *Canavalia rosea, Jacquemontia solanifolia, Ipomoea pes-capri braziliensis, Coccoloba uvifera, Caesalpinia bonduc, Tecoma stans, Centrosema virginianum* and *Cardiospermum micranthum.*

APIDAE

Apis mellifera Linne

Bees of Mona Island

HALICTIDAE

Lasioglossum (Dialictus) sp. 1: some collected on *Croton sp.*

**Lasioglossum (Dialictus)* sp. 2

[Presumably one of these is the same as the bee recorded by Ramos (1946, The Insects of Mona Island (West Indies), *Jour. Agric. Univ. P. Rico,* 30:1-74) as "*Halictus* sp." collected at Playa Sardinera.]

Agapostemon viequesensis Cockerell [= *A. portoricensis* in Ramose, 1946]

MEGACHILIDAE

Megachile (Pseudocentron) undescr. sp near *poeyi* Guérin [= *Megachile* n. sp. in Ramose, 1946]. Has been reported from flowers of *Moringa moringa* and *Pisonia albida* on Mona and I got it on *Caesalpinia bonduc.* This is the bee reported by Wolcott (1941, suppl. to "Insectae Borinquensis," *Jour. Agaric. Univ. P. Rico,* 25:33-150) as *M. vitrasi* Pérez, a misidentification. This bee is common on Puerto Rico and in the Virgin Islands.

Megachile (Eutricharaea) concinna F. Smith.

ANTHOPHORIDAE

Melissodes trifasciata Cresson [Recorded by LaBerge 1956].

Anthophora tricolor (Fabr.) [= *A. krugii* Cresson of Ramose; reported on *Moringa moringa* and *Colubrina colubrina.*]

Centris haemorrhoidalis Fabr. [teste Ramose, 1946]

**Centris decolorata Lepeletier* [= *C. versicolor* Fabr. of Ramose; misident.]. Ramose reported it from *Lantana* sp. and *Moringa moringa*; I got it also on *Caesalpinia bonduc* and *Canavalia rosea.*

**Centris smithii* Cresson, on *Caesalpinia bonduc.* First record outside of Virgin Islands.

Centris lanipes Fabricius. Ramose reported it from *Moringa moringa, Colubrina colubrina* and *Pisonia albida:* additionally, I collected it at *Malpighia* sp. and *Caesalpinia bonduc.*

Xylocopa mordax F. Smith [= *X. brasilianorum* of Ramose]

APIDAE

No specimens of *Apis mellifera* have been found on Mona. If we're lucky nobody will bring in any colonies. What a delight to work in an area without honeybees!

COLLECTING REPORTS

Guana Island – 1992
by
Roy Snelling
(Dept. of Entomology, Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, CA 90007)

The Guana Island trip was a smashing success: I was able to add quite a few species to the list of those I collected last year (see **Sphecos** 23:12-14) (a complete list of the known Aculeata wasp fauna is included below). In part this is due to my use of two Malaise traps, but most of the additional species were netted, not trapped. The traps were especially useful for the little stuff, mostly non-aculeates.

Entomology was pretty well represented on Guana this year. I was there for the entire month of October. Other entomologists, visiting for shorter periods of time, included a batch of termite folks (the inimitable and indominitable Margaret Collins; Mike Haverty; Barbara Thorne; Jan Krecek). The AMNH was represented by Dave Grimaldi and Julian Stark (nice folks!). Also had the pleasure of meeting Mike and Donna Ivie, hard working beetle collectors; Mike is doing a study of the beetles of the Virgin Islands and was putting out some pretty impressive pitfall traps.

Because the rainy season was delayed, collecting results were quite different from the same period in 1991. Some species that were abundant then throughout the month of October were scarce until near the end of the month, after the rain finally started. I also spent a lot of time on the trail along Long Man's Point, the elongate point NW of the hotel area, bounding Muskmelon Bay on the north. This area is more arid than much of the island and combines a greater diversity of microhabitats than any other area.

The sphecid taxa that last year I reported to be conspicuous by their absence in 1991 (*Bembix* and Sphecinae) were collected this year. Perhaps the surprize catch of the season was two males of a species of *Pseudomethoca* (Mutillidae), both in the wooded area behind North Beach; one in a Malaise trap and one that landed on the trail right in front of me. Little guys, less than 4.5 mm long, all black. There appear to be no records for Mutillidae in the Puerto Rico Bank (Puerto Rico and the Virgin Islands), but I haven't searched the literature very intensively.

The seven species of Bethylidae are really no surprise; there likely are more. None of those that I collected can be definitely identified at this time, but I expect some, at least, to be undescribed. Mike Ivie has agreed to send me the Hymenoptera from his traps and Berleses, so we can expect a lot of really great material to turn up.

It wasn't all hard work (though most nights, by the time I hit the sack I was convinced that no matter where you go on Guana, it's always via an uphill trail, usually steep and rocky). One night a few of us went over to Jost Van Dyke Island to a little bar called Foxy's. The guy behind the bar was so delighted to have an Indian in his place that he kept my tequila flowing at no charge. He also kept Grimaldi well supplied with rum, though for a different reason. Shore one helluva boat ride back!

Although most of the month was spent on Guana, we made day-trips to several other islands. Anegada Island: outermost of the BVI, 13 miles long, 1 mile wide and 26 feet at the highest! Completely inundated by major hurricanes. But, even the iguanas survive. Ginger Island. Virgin Gorda. Tortola. Eventually, I'll get to all – or at least most, of the BVI. Maybe.

Following the month at Guana I went to Puerto Rico. Thanks to my good friend Juan Torres I had a place to stay and transportation. Collecting was good in most areas but my best results were in bees and this **Sphecos** crowd don't care for bees (or, they can read about it in **Melissa**). Met another termitologist, Susan Jones (Gad, they seem to come outa de woodwork!). Juan, Susan, and I spent five days on Mona Isl. Got some more goodies out there (see list). Two highlights of the Mona jaunt were some fabulous tasting barracuda and Susan's rat (of which there is a tale): The three of us shared a cabaña at Playa Sardinera; I chose to sleep outside (couldn't abide Juan's snoring). When I got up on the fourth morning and went inside to use the facilities, I noticed a ravaged bag of dry Gator-Aid™ on the floor. Juan exited the bathroom and warned be that there was a rat (live) in the toilet bowl. Well, 2+2=?!: rat got into Susan's Gator-Aid™, developed a powerful thirst, fell into toilet bowl from which he couldn't exit. Ergo, it was Susan's rat and Susan's problem (but she didn't know it yet). Short time later, as I was walking over to the "mess hall", Susan yelled at me that there was a rat in the toilet bowl and I was to come take care of it. She took it amiss that I refused to do so, it being her rat and her responsibility; as a biologist and liberated women she should be able to handle it. She ultimately did, but I suspect will never forgive me for not coming to her rescue. She also wouldn't admit the humor of the situation. Well, one more cross for me to bear (Not to mention the outraged readers who think I am a male chauvinist pig!). Ah, well – such is life.

ACULEATE WASPS OF GUANA ISLAND

* Indicates taxon not previously collected on Guana or Mona.

*DRYINIDAE

One alate female, genus unknown.

*BETHYLIDAE

**Anisepyris* sp.

**Epyris* sp. (*tricostatus* group). A metallic greenish species, the female of which keys to *luteicornis* (from Venezuela) but clearly isn't. The male doesn't key to anything.

**Epyris* sp. 2. (*rufipes* group). Another greenie, keys to *E. cubanus* and is evidently similar to that species but I've no material at hand for comparison.

**Holepyris* sp. 1. Probably *H. incertus* (Ashmead).

**Holepyris* sp. 2. Males only; very similar to those of sp. 1, possibly only variants.

**Pristocera* (?) sp.

**Pseudisobrachium* sp. 1

**Pseudisobrachium* sp. 2

*MUTILLIDAE

**Pseudomethoca* sp. Two males, both taken in the woods behind North Beach. Apparently no mutillids have been recorded from the Puerto Rican Bank, although there are a number of species on Hispaniola.

TIPHIIDAE

Myzinum haemorrhaoidale (Fabricius). Specimens also collected on Virgin Gorda Island.

SCOLIIDAE

Camposomeris dorsata (Fabricius). Both sexes were common this year, visiting flowers of *Ipomoea pes-capri braziliensis*.

**Camposomeris trilasciata* (Fabricius). One female, taken in the hotel area.

VESPIDAE

Polistes crinitus (Felton). Common. Also on Virgin Gorda and Tortola.

Polistes major (Beauvois). Still not a confirmed resident.

Mischocyttarus phthisicus (Fabricius). Common. Also at East End, Anegada Isl.

POMPILIDAE

Pepsis rubra Drury. Common.

**Pepsis rulicornis* (Fabricius). Three females, all collected in the plantationa area.

Psorthaspis sp. Two more females were collected this year, one by Julian Stark; also got 3 males that almost certainly belong to this species, much less spectacular than the females. Like the females, they don't match up with anything recorded from the West Indies by Bradley.

Aporus prolixus Bradley

**Poecilopompilus flavopictus* (F. Sm.)? Several names have been applied to *Poecilopompilus* in the islands of the Puerto Rico Bank: *flavopictus* (F. Sm.); *mundiformis* (Rohw.); *mundus* (Cress.); *hookeri* (Rohw.). The two females collected on Guana match Rohwer's description of *P. mundiformis*, but so will females of *P. flavopictus* from Central America, so who knows?

SPHECIDAE

Tachysphex alayoi Pulawski. Common this year. The eyes are bright red in live specimens.

Tachytes chrysopyga (Spinola)

Tachytes tricinctus (Fabricius)

Liris ignipennis (F. Sm.)

Liris luctuosus dahlbomi (Cress.)?

Liris sp. 1. Also on Anegada Isl., Ginger Isl., and Virgin Gorda Isl.

Liris sp. 2

(Delete "*Liris* sp. 3" from my previous list; this appears to be merely an unusually large and robust example of sp. 2)

**Sceliphron assimile* (Dahlbom)

**Sphex ichneumoneus* (Linné)

**Prionyx thomae* (Fabricius). Also collected on Ginger Island.

**Hoplisoides ater* (Gmelin). Females mostly collected searching in short grass behind White Beach.

**Epinysson* sp. Both sexes were collected, females don't wholly agree with Rohwer's description of *E. basirufus* (preocc. and renamed *boringuinensis* by Pate), described from Puerto Rico, but the differences may only be cosmetic.

Ectemnius craesus (Lepel. & Brulle)

Ectemnius sp.

Cerceris sp. This agrees pretty well with the description of *C. margaretella* Rohwer, described from Puerto Rico (males only). But, as with so much of the fauna, the Caribbean *Cerceris* are too poorly known and I derive no comfort from the fact that my samples are apparently conspecific with the Puerto Rican wasp.

Stictia signata (Linné)

Bicyrtes spinosa (Fabricius). Also collected at East End, Anegada Isl.

**Bembix americana* Fabricius. Also collected at East End, Anegada Isl.

(*Microbembix monodonata* (Say). Not collected on Guana, but fairly abundant at East End, Anegada Isl.)

ACULEATE WASPS OF MONA ISLAND

*BETHYLIDAE

**Holepyris incertus* (Ashmead)? Apparently conspecific with Guana Island material.

**Holepyris* sp.

**Pseudisobrachium* sp.

All bethylids are from malaise traps.

TIPHIIDAE

Myzinum haemorrhaoidale (Fabr.). Ramos recorded this in the genus *Elis*.

VESPIDAE

Polistes crinitus (Felton)
Mischocyttarus phthisicus (Fabricius)
Zethus rufinodus Latr.
Euodynerus apicalis (Cress.)
Pachodynerus tibialis (Sauss.)

POMPILIDAE

Priocnemis sp.
Episyron conterminus posterus (Fox)
Anoplius amethystinus (Fabr.)
Anoplius hispaniolae Evens

SPHECIDAE

Sphex ichneumoneus (Linné)
Sceliphron assimile (Dahlbom)
Prionyx thomae (Fabricius)
* *Tachytes chrysopyga* (Spin.)
Tachytes tricinctus (Fabricius)
**Liris* sp. 1 (= Guana sp. 1)
Liris sp. 2 (= Guana sp. 2). This is the one I recorded last year as *Liris* sp.

**Liris* sp. 3. One female from Sardinera is similar to those of species 1, but apical margin of clypeus is not concave.

Tachysphex alayoi Pulawski
Bicyrtes spinosa (Fabricius)
Stictia signata (Linné)
Trypoxylon (*Trypoxylon*) sp.

**Oxybelus* sp. Several specimens were taken along the road above Playa Uvero ("Camino del Inferno"). There are no prior records of *Oxybelus* in the Puerto Rico Bank. Two species (*analis* Cresson and *confusus* Alayo) are known from Cuba; confusingly, *confusus* is not in the Big Blue Book (while it may be somewhere amidst the 167, or so, "additions & corrections" to BBB, I've not the patience to seek it out). [No, Roy, it was overlooked, but subsequently added in one of my many errata installments - editor] submitted to: NOTES FROM UNDERGROUND

ANTS OF GUANA ISLAND, BRITISH VIRGIN ISLANDS

I've now twice had the opportunity to collect ants in the British Virgin Islands, on a small piece of real estate known as Guana Island. My report in SPHECOS 23 last year briefly described Guana and provided a simple map to the collecting areas indicated on my data labels, so I'll not repeat all that, noting only that it's a small (ca. 340 hectares in area), low (highest point 246 m), dry forest island.

The entire month of October 1992 was spent on Guana, except a few day-trips to Anegada, Cooper, Ginger, Tortola and Virgin Gorda Islands. In 1991 I was also there during October and collected 11 species of ants. My latest trip added 18 species (asterisked on following list) in addition to those collected last year, so I guess I can say that it was a pretty successful month.

There were a few surprises, mostly in the form of range extensions for species known from elsewhere in the Puerto Rico Bank but not previously recorded from the Virgin Islands. Things like Mycetophylax conformis, Trachymyrmex jamaicensis, Camponotus sp. 2, Discothyrea sp. and Amblyopone sp.

The last named is represented by two males taken in a malaise trap. Since they are not associated with any workers, there's no way to hang a name on them now. Only one Amblyopone is known from this area of the Greater Antilles, A. falcata, described last year by John Lattke from Puerto Rico. Most interesting, however, is a single male ponerine also from malaise trap. I thought at first it was a Hypoponera - until I had it pointed up so I could examine it. Turned out to be a Discothyrea species, but there things get difficult, since there appear to be no prior records for the genus in the Greater Antilles. Several known from Central and South America and one from the U.S. The systematics of Discothyrea is very imperfect at present and is based solely on workers; ergo nothing farther can be done with my lone specimen at this time.

At present Odontomachus has not been taken, but I suspect must be present. Similarly absent are native species of Paratrechina (P. longicornis is introduced from the Old World); whether they were once present and subsequently displaced by P. longicornis or never had been there cannot now be answered. But, of the several native species of Paratrechina present on Puerto Rico, all are decidedly scarce in the drier forest areas on the south side.

Camponotus sp. 1 and sp. 2 are both undescribed and are apparently widdely distributed in the Puerto Rico Bank. Both are common on Puerto Rico, where they have been misidentified by Wheeler and all subsequent authors as C. ustus Forel. The types of C. ustus are from St. Thomas (American V.I.) and, while in pretty poor condition, are very definitely not the same as the ants commonly identified as C. ustus. However, the several infraspecific taxa from Hispaniola attributed to C. ustus do appear to be correctly so placed. The variety described from Colombia (var. arhuacus Forel) is something else. C. ustus is common on Mona, but apparently consistently absent elsewhere in Puerto Rico, and I've seen no recent collections of it from any of the Virgin Islands. The two undescribed species will be described in "The Ants of Puerto Rico" (co-authored with Juan Torres); we hope to have the manuscript finished and submitted later this year.

Myrmicines were the usual mixed bag of mostly native species as well as a few introduced species: Cardiocondyla emeryi, Monomorium floricola, Pheidole megacephala. Of these, only M. floricola appears to be common, but never a problem for native ants. Wasmannia auropunctata and Paratrechina longicornis appear to share honors as co-dominant ant species on the island, although Wasmannia is largely restricted to the forested areas. But, while common enough, it does not appear in any way to be a limiting factor for the other ants. Clark, et al. (1982, Biotropica 14:196-207) have noted that W. auropunctata proved to be a very destructive competitor for other ants following its introduction into the Galapagos.

Mycetophylax conformis has not been previously reported from the Virgin Islands, but it does occur on Puerto Rico. Nests are small and inconspicuous; the cryptically colored workers forage at night and are very timid. My Guana record is based on a single female collected in a flight trap.

Another fungus-grower not hitherto reported from the Virgin Islands is Trachymyrmex jamaicensis although it is common in Puerto Rico. Nests were common on Guana, usually on or near trails. They are easily spotted by the conspicuous light brownish refuse piles, normally located some distance (up to ca. 30 cm) from the entrance. The entrance itself is about 5-7 mm diameter, sometimes with a short turret. Workers forage mostly at night, but even at midday a few may be found moving very slowly through leaf litter. Fruit pulp is commonly used as a substrate for the fungus which is grown in lacey "curtains" suspended from roots or (occasionally) stones.

Two species of *Rogeria* were collected in flight traps as sexual forms only. *R. foreli* is represented in some numbers by both sexes; *R.* sp. is based on a single male. Other *Rogeria* in this part of the Caribbean include the one recorded by M. R. Smith (1936, The Ants of Puerto Rico) as *R. curvipubens* Emery. According to Kugler's unpublished revision of *Rogeria*, Smith's material represents an undescribed species collected on Tortola and Puerto Rico, but known only from workers. Kugler also states that true *R. curvipubens* has been collected on St. Thomas and St. Croix, in addition to Jamaica and, on the mainland, Mexico south to northern South America; males are unknown. So...

That's it for now. With luck, next year will answer some questions and generate new ones.

Ponerinae

*Amblyopone sp.

*Discothyrea sp.

Leptogenys pubiceps Emery

*Pachycondyla stigma (Fabricius)

Myrmicinae

*Cardiocondyla emeryi Forel

Crematogaster steinheili Forel

Cyphomyrmex minutus Mayr

*Monomorium ebinimum Forel

" floricola (Jerdon)

*Mycetophylax conformis (Mayr)

Pheidole fallax Mayr

* " megacephala (Fabricius)

* " moerens Wheeler ?

* " susannae Forel

*Rogeria foreli Emery

*Rogeria sp.

Solenopsis germinata (Fabricius)

* " sp. 1

* " sp. 2

*Trachymyrmex jamaicensis (Andre)

Dolichoderinae

Dorymyrmex antillana Forel

*Tapinoma melanocephalum (Fabricius)

Formicinae

*Brachymyrmex heeri Forel

" obscurior Forel (= B. "obscurus" in SPHECOS 23; lapsus)

Camponotus sexguttatus (Fabricius)

" sp. 1 (undescribed)

* " sp. 2 (undescribed)

*Myrmelachista ramulorum Wheeler

Paratrechina longicornis (Latreille)

Roy Snelling

UNIVERSITY OF MARYLAND AT COLLEGE PARK

COLLEGE OF LIFE SCIENCES • DEPARTMENT OF ENTOMOLOGY

24 March 1993

Dr. James D. Lazell, Jr.
The Conservation Agency
6 Swinburne Street
Conanicut Island, RI 02835

Dear Skip,

Enclosed is the report on the 1992 Termite Project on Guana Island. We are pleased with the progress of the work, and appreciative of the opportunity to do research on Guana Island.

Let us know if you need any further information, and please contact us when it is time for formal proposals for work in October 1993.

With best wishes,

Barbara

Barbara L. Thorne
Assistant Professor

301-405-7947

1300 SYMONS HALL • COLLEGE PARK, MARYLAND 20742-5575 • (301) 405-3911 • FAX: (301) 314-9290

PROGRESS REPORT: THE TERMITE PROJECT ON GUANA ISLAND

Work Accomplished October 1992

Dr. Barbara L. Thorne
Department of Entomology
1300 Symons Hall
University of Maryland
College Park, Maryland 20742-5575

Dr. Michael I. Haverty
Pacific Southwest Research Station
USDA, Forest Service
P.O. Box 245
Berkeley, California 94701

Dr. Margaret S. Collins
Department of Entomology
Smithsonian Institution
Hall 27, NHB MS 165
Washington D.C. 20560

Dr. Jan Krecek
Institute of Organic Chemistry and Biochemistry
Czechoslovak Academy of Sciences
166 10 Praha 6
Czechoslovakia

I. Cuticular hydrocarbons of *Nasutitermes acajutlae*

During the week of October 17-21, 1992, Drs. Barbara L. Thorne and Michael I. Haverty sampled fourteen nests of the arboreal termite *N. acajutlae* on Guana Island. Live termites were collected using rolled tubes of moist corrugated cardboard inserted into nests for at least 24 hours. Two of the colonies we sampled were in the vicinity of the North Bay Beach House, two were on the upper portion of the Guanaberry Trail, and the remaining ten were within 100 meters of the shore on the plantation area near White Sands Beach.

The primary objective of our study was to use characterization of cuticular hydrocarbons to determine whether adjacent or nearby arboreal nests of *N. acajutlae* are part of the same colony or whether each nest is a discrete termite colony. A secondary objective of our study was to compare techniques for characterizing the cuticular hydrocarbon profile of individual colonies. For this purpose, subsamples of 100 workers from the same colony were either extracted on site with 10 ml of hexane or dried above an incandescent light and later extracted in Haverty's laboratory in Albany, CA.

With a few exceptions, we were able to collect three subsamples each for hexane extraction and drying/extraction from each colony. In those instances when we had an insufficient number of workers, we gave priority to hexane extractions of fresh material. Therefore, all of our intra- and intercolony comparisons will be made with hexane extractions of fresh material. The cuticular hydrocarbon mixture of *N. acajutlae* is relatively simple when compared to other species of *Nasutitermes*. Three alkenes (C39:1, C41:1, and C45:1) predominate. Other hydrocarbons occur in minor quantities or are sometimes not detectable or absent.

In general, all colonies are qualitatively similar, however, we cannot state that they are qualitatively identical. All colonies have the same late-eluting normal alkenes with a single double bond (C38:1, C39:1, C40:1, C41:1, C43:1, and C45:1). The primary difference among the colonies is the concentrations of the abundant hydrocarbons, C41:1, C43:1, and C45:1, and the presence/absence or concentrations of the early eluting normal alkanes (C25, C26, C27, C28, C29), and a few late-eluting alkenes with multiple double bonds.

We have yet to do a statistical analysis of the hydrocarbon data (see below). Empirical observations of the chromatograms of each subsample indicate that, with a few exceptions, subsamples of each colony are qualitatively and quantitatively identical. Samples from different colonies may be qualitatively identical in some cases, but no colonies appear to be quantitatively identical. To test the actual similarity among all of the 14 colonies we will conduct a discriminant analysis of the relative proportions of the various hydrocarbons, select discriminating variables, plot the first two canonical variates and calculate Mahalanobis distances between the average of the canonical variates of each pair of colonies. The significance of these Mahalanobis distances will indicate similarities and perhaps relatedness of the colonies.

Drying samples before extraction generally resulted in chromatograms with a larger number of compounds that were detectable. That is to say that subsamples of the same colony had different apparent profiles when dried before extraction. This is probably because nearly all of the water was removed from the cuticle and so the hexane was able to penetrate and extract the hydrocarbons out of the cuticle more efficiently.

The results of these studies will be prepared for publication in the Journal of Chemical Ecology. We anticipate completing the statistical analyses and first draft of the manuscript in May 1992. This journal is well-suited for publication of studies involving the ecological and evolutionary implications of chemical analyses.

II. Taxonomy and Biogeography of the Termite *Nasutitermes acajutlae*

Work on Guana Island inspired a re-examination of the taxonomy of one of the most ecologically conspicuous groups of termites in Central America and the Caribbean Basin: the *Nasutitermes nigriceps* complex. Polymorphism within this group has been recognized for decades, but no suite of morphological characters had been recognized to make clear taxonomic divisions within the complex. Our detailed morphological analysis revealed new diagnostic characters which consistently separate *N. nigriceps sensu stricto* (distributed throughtout Central America as well as on the Cayman Islands and Jamaica) from *N. acajutlae* (found in Puerto Rico, the Virgin Islands, and on some of the Lesser Antilles islands south to the population on Trinidad). This distribution pattern is logical and fully compatible with Caribbean geology and biogeographic theory, as summarized by Donnelly (1988) and Lazell (1989).

We have a draft of our first paper on this topic, a manuscript coauthored by Thorne, Haverty & Collins, titled "Taxonomy and Biogeography of the Termites *Nasutitermes acajutlae* and *N. nigriceps* in the Caribbean and Central America". After further revision we will submit this paper to the Annals of the Entomological Society of America. A second paper on nodules found within *N. acajutlae* and *N. nigriceps* nests (Thorne, Collins & Bjorndal) will be written this summer, with anticipated submission to a journal in the fall of 1993.

III. 1992 Collections and Research by Collins and Krecek

A) New localities recorded for previously collected termites:

Nasutitermes costalis does indeed establish colonies on Guana Island, in wetter areas. The previous record was valid.

Neotermes mona is relatively abundant in dead and living wood of larger shrubs and trees on the north slope of the Island, below G-House.

Anegada Island has three dry-adapted termite species: *Incisitermes snyderi*, *Procryptotermes corniceps*, and *Nasutitermes acajutlae* living in the native vegetation. *Cryptotermes brevis* is found in buildings.

B) J. Krecek collected larged samples of *Nasutitermes acajutlae* soldiers for chemical analysis of defense secretions. His technique is suitable for collection of large samples of either workers or soldiers, and can be applied to a variety of studies. Chemical analysis of defense secretions of samples of the *nigriceps/acajutlae* complex will provide comparative data for a comprehensive study of population differences within this group.

C) Observation of agonistic behavior between samples of termites of different colonies or species suggest that termites behave differently once removed from the nest site. Further refinement of protocol is necessary.

D) Cooperation with other members of the Caribbean Survey team provided the information that the small termite from Guana Island identified as *Parvitermes discolor*, also found on Puerto Rico, has dimorphic soldiers. The large, or major soldier, is rare and has not yet been collected on Guana. Presence of dimorphic soldiers may warrant placing this species in a different genus. Small nasutes, such as *Parvitermes*, are the object of intense scrutiny by an international group including Krecek (Czechoslovakia), Constantino (Brazil), Roisin (Belgium) and Scheffrahn (USA). The termite collections of the Smithsonian and the AMNH are central to these efforts. Improving accessibility and information transfer is a major goal of M.S. Collins' current work at the Smithsonian.

FUTURE RESEARCH:

Guana Island has now become a focus for growing interest in termite biology and biodiversity in the Caribbean. Research efforts by ourselves and some of our colleagues are in progress in the Dominican Republic, Puerto Rico and on the Cayman Islands. We are now giving serious attention to launching a long-term, multidisciplinary research program on Termites of the Caribbean, involving a group of six termitologists from the United States and abroad doing comparative work in different parts of the Caribbean Basin.

Our marked nests and monitoring program on Guana Island represent an invaluable study site for long-term study of a key group of Caribbean termites, the arboreal species *N. acajutlae*. Our future research plans involve the following projects:

1] Stability of hydrocarbon profiles from year to year within colonies.

The intercolonial or among nest quantitative differences in cuticular hydrocarbon mixtures of *N. acajutlae* are interesting, especially when contrasted with a similar study of intercolonial differences in the Formosan subterranean termite, *Coptotermes formosanus*, conducted by Haverty and Dr. J. Kenneth Grace of the University of Hawaii. The colonies of *C. formosanus* in Honolulu, Hawaii, Hallandale, Florida, New Orleans and Lake Charles, Louisiana (all non-native locations for this insect) appear to have no genetic variation and their cuticular hydrocarbon profiles do not vary quantitatively among colonies within a location. On Oahu, Hawaii, the cuticular hydrocarbon mixtures do not even vary quantitatively over time.

Given this comparative work and our preliminary results from Guana Island, an important aspect of our research on Guana would be to varify consistency in hydrocarbon mixtures of the same colonies over time. At a minimum, we would like to sample the same colonies for another year; preferably for two or more subsequent years. Ideally, we would like to obtain hydrocarbon samples of these same colonies at different times of year during one or more years. This study would document the stability of hydrocarbon profiles for single colonies of one species of *Nasutitermes* over time. If hydrocarbon profiles (mixtures) do not change over time, then we can feel secure in sampling the same species at other locations in the Caribbean at any time of year. If hydrocarbon profiles of *N. acajutlae* differ seasonally, then we must be certain that the collections that we make from other locations are from nearly the same time period. These studies are critical to our continued surveys of the termite fauna of the Caribbean Basin.

2] Long term study of nest growth of individual *N. acajutlae* colonies

We have now marked, photographed and recorded size dimensions from arboreal *Nasutitermes acajutlae* nests on Guana Island. These nests span a broad size range. Annual monitoring of growth and activity of these nests will enable us to study patterns of nest growth and expansion. It is well established that *Nasutitermes* nest volume is correlated with population size, but long term studies on growth of individual *Nasutitermes* nests have never been conducted. The fact that Guana Island is a protected habitat makes this type of research feasible.

3] Expanded data base on Guana Island, and on nearby Islands

In future visits we would like to continue to explore sites on Guana Island, expanding our data base on the cuticular hydrocarbon profiles and nest growth of *Nasutitermes acajutlae*. Using our data from Guana Island as a basis, we hope to apply for a USDA Competitive Grant to defray costs of boat travel and other research expenses for sampling on other islands in the British Virgin Islands.

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Example cuticular hydrocarbon chromatogram of *Nasutitermes acajutlae* from Guana Island.

```
File:           C:\CHEMPC\DATA\G92DN12.D
Operator:       L.NELSON
Date Acquired:   5 Jan 93    1:37 pm
Method File:    HCPARAM.M
Sample Name:                    NASUTITERMES ACAJUTLAE  GUANA ISLAND 1992
Misc Info:                      100 WORKERS    NEST 1-2     DRIED
ALS vial:       1
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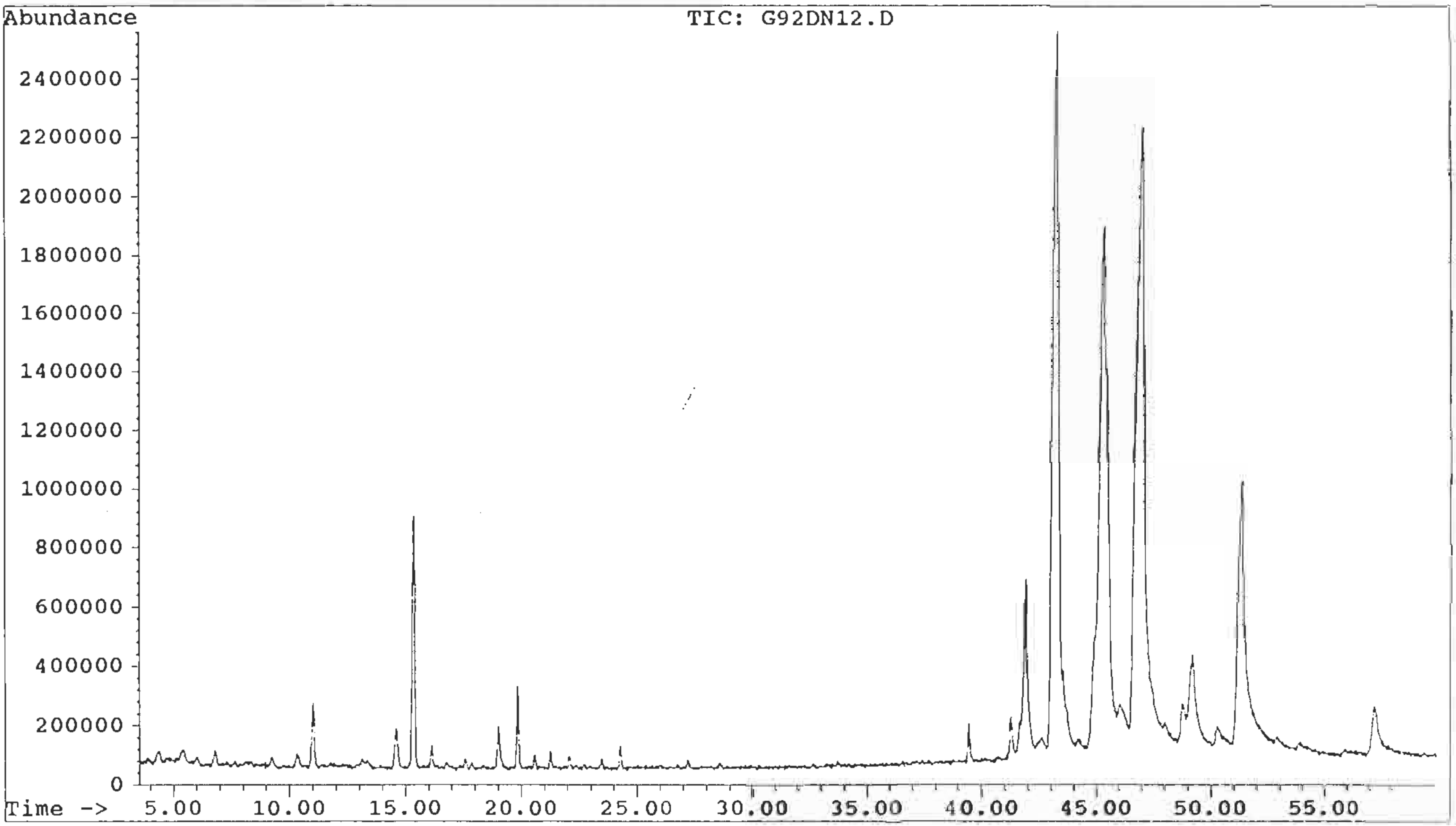


College of Sciences
BIOLOGY PROGRAM

CLEMSON UNIVERSITY

17 December 1992

Dr. James Lazell
The Conservation Agency
6 Swinburne St.
Gonanicut Island, RI 02835

Dear Skip:

Thanks for sending the two mantispids from Guana Island. They were a male and female of the undescribed species I've mentioned previously. This species is sexually dichromatic, with the males being mostly yellow (especially on the thorax) and females mostly brown. More than half of the 42 species I dealt with in my dissertation show some kind of gender-based color dimorphism. I'll be interested in seeing the third specimen sent to the LACM, because this is the only species I've seen from Guana Island.

I graduated in May and have unfortunately been kept busy working on things other than mantispids. I continue to identify arthropods for the Cooperative Extension Service so I'm still allied with the Entomology Department, but I'm also in a temporary position teaching introductory biology in the Biology Program. The teaching keeps me busy during the semester, however, I'm currently on a four week break before the next semester's classes begin and hope to spend most of my time working on preparing the dissertation for publication. I plan on publishing it as a monographic revision of the subfamily in the New World, and the species from Guana will be described in it along with 14 other new species from Central and South America.

I appreciate Wenhua's offer of doing some illustrations. However, I've already illustrated the diagnostic characters of the species for my dissertation.

I'm very grateful for the offer to provide assistance for a visit to the island, and I truly hope I'll be in a position to take advantage of the offer next year. I talked with Mike Ivie from Montana State University last week, and he spoke quite highly of his recent visit to the island.

Sincerely,
Kevin M. Hoffman
Kevin M. Hoffman
Visiting Lecturer

110 LONG HALL • CLEMSON, SOUTH CAROLINA 29634-1902 • TELEPHONE 803-656-2416

National Museum of Natural History · Smithsonian Institution
WASHINGTON, D.C. 20560 · TEL. 202-357-2865

20 April 1993

Dr. James D. Lazell
The Conservation Agency
6 Swinburne Street
Conanicut Island, RI 02835

Dear Dr. Lazell:

In talking with Dr. Margaret Collins at the U.S. National Museum, I learned of your interest in having surveys of the insect fauna of Guana Island. For several years I have been studying tenebrionid beetles of the West Indies, and have long wanted to visit the Virgin Islands. They are important localities for studies of species distributions among other islands, in addition to having a set of unique endemic species that are not well documented. Members of this large family live in many different habitats and are a major part of the biodiversity of Caribbean islands.

I have a particular interest in the flightless species that live in sandy coastal areas and scrub forests because they are perfect subjects for studies of island biogeography. The genus Branchus is of current special interest but there are no known V.I. records thus far. There is an urgent need to collect specimens and document their existence because the narrow, fragile habitats are rapidly being disturbed by human activities and invasion of introduced plant species.

A search for Branchus on Guana is warranted; earlier discussions with Scott Miller and Michael Ivie have suggested that the habitats there are suitable for these burrowing beetles. Other groups of interest should also occur there, and I am curious to see what might have been missed by earlier collectors as well as what introduced species may have gotten established. My wife, Jil Swearingen, is interested in studies of ants and their interactions with plants, especially seed dispersal. She also is interested in fieldwork contributing to faunal studies and conservation. With even a short stay on Guana, I think our focussed collecting efforts will result in new discoveries, and supplement ongoing studies by others with new material and data.

With hope to be able to contribute to your research efforts.

Sincerely,

Warren E. Steiner, Jr.

Warren E. Steiner, Jr.
Museum Specialist

FLAMINGOES RETURN TO BVI

A major attempt is now underway to re-introduce Bermuda captive bred Caribbean flamingoes *Phoenicopterus ruber ruber* to the British Virgin Isles. This initiative stems from the success of the Bermuda Aquarium, Museum and Zoo (BAMZ) in captive breeding this threatened species. Since 1967, the Zoo has had 24 consecutive seasons of breeding the Caribbean flamingo, and has sent surplus Bermuda-bred birds to zoos around the world.

Once common throughout the Caribbean, the Caribbean flamingo has been absent from BVI since the early 1950s. In 1983, the US-based Conservation Agency (TCA) began working with interested parties on the possibility of re-establishing a breeding colony of flamingoes in BVI. The first, trial, phase involved the export of eight Bermuda-bred flamingoes to Guana Island Wildlife Sanctuary in November 1986. These birds were monitored until 1991, when the last birds flew off to join other Caribbean colonies.

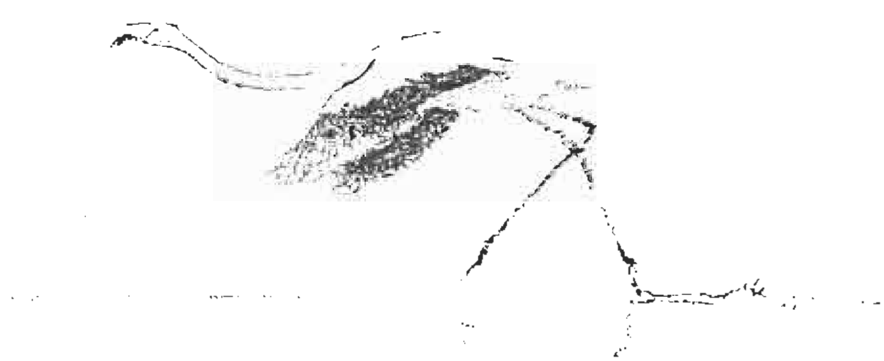
By 1990, it had been determined that Bermuda-bred flamingoes could adapt to the wild, but that Guana Island itself could not support a large colony. The second phase involved TCA and the BVI National Parks Trust surveying, selecting and preparing a release site, that could support large numbers of flamingoes. The extensive salt ponds of Anegada Island, also historically the site of BVI's largest flamingo colony, were selected to provide the BVI colony.

In the autumn of 1991, BAMZ was able to commit twenty captive-bred birds to the re-introduction project and in conjunction with TCA, began working out the logistics of effecting a release in early 1992. A total of 20 birds from the BAMZ current population of 55 were flown to BVI on 7 March 1992. In order to increase the chance of early success, several known breeding pairs were included in the release. The site chosen for the re-introduction is the two connecting salt ponds, known as Flamingo Pond and Bones Bight Pond, which provide an extensive and undisturbed wetland habitat.

John A. Barnes,
Department of Agriculture, Fisheries and Parks, Bermuda.

FORUM NEWS

CONSERVATION NEWS 7 NGO FORUM FOR THE UK DEPENDENT TERRITORIES JUNE 1992



Zoo Biology 10:53–63 (1991)

Flamingo Breeding: The Role of Group Displays

Elizabeth Franke Stevens

National Zoological Park, Washington, D.C.

Group displays in flamingos have been presumed to play a role in stimulating synchronous nesting and in facilitating pair formation. This study compares the group displays and breeding success of a captive flock of Caribbean flamingos *(Phoenicopterus ruber ruber)* at the National Zoological Park between 2 years: the frequency and synchrony of group displays were measured for a flock of 17 in 1988 and then again in 1989 after flock size was increased to 21. In 1989 the rate of occurrence of display activity increased 48%, the synchrony of group displays increased 100%, the frequency of mounts and copulations almost doubled, and for the first time in the flock's history two fertile eggs were produced. The use of sprinklers to simulate rain had no effect on the group displays. The amount of naturally occurring rainfall in 1989 was almost twice that in 1988. The increased frequency and synchrony of group displays could be attributed to increased flock size, change in sex ratio, addition of strange individuals, or increased rainfall. This study, however, provides evidence for a relationship between behavioral stimulation from group displays and components of breeding success in flamingos.

Key words: behavioral stimulation, flock size

INTRODUCTION

Flamingos are among the most social of birds. They are commonly found in very large flocks, which during the breeding season of lesser flamingos can number over 1 million birds. Flamingos seldom breed in flocks smaller than ten pairs [Campbell and Lack, 1985]. Given this propensity to live in flocks of such extraordinary size, it is surprising they breed in captivity at all. Of the 49 captive flocks of Caribbean flamingos *(Phoenicopterus ruber ruber)* listed in the *ISIS Summary for Birds*, only 13 (27%) flocks had successfully produced chicks in the period from 1983 through 1988, and only two (15%) of these successful flocks consisted of 20

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Address reprint requests to Dr. Elizabeth Franke Stevens, Conservation and Research Department, Zoo Atlanta, 800 Cherokee Ave., S.E., Atlanta, GA 30315.

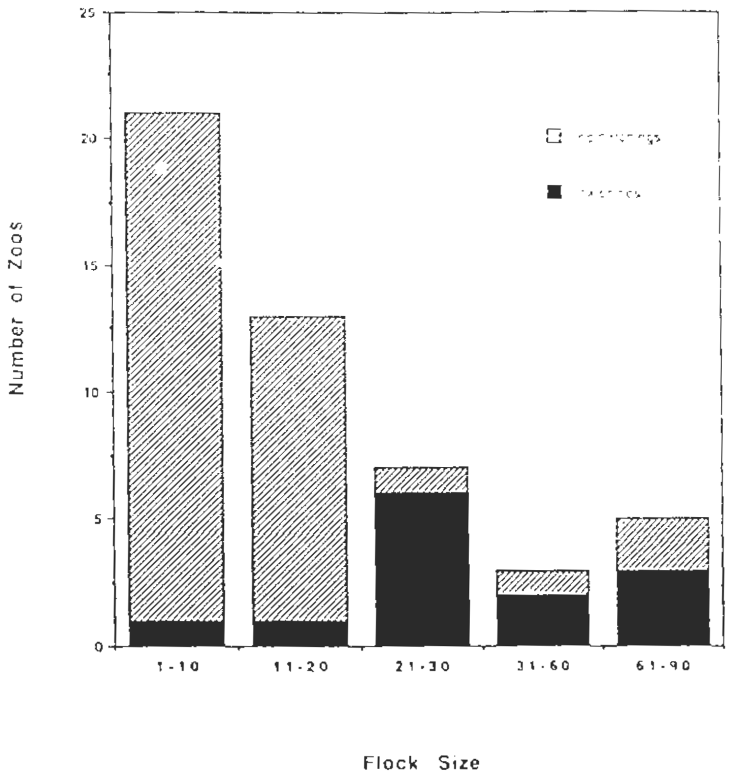


Fig. 1. Flock size and reproductive success. The breakdown of the 49 zoos in the ISIS Bird Summary holding Caribbean flamingos according to flock size and success in producing flamingo chicks from 1983–1988.

individuals or fewer (Fig. 1). Flocks with more than 20 flamingos had a significantly greater chance of successful breeding ($\chi^2 = 20.96$, df = 1, $P<0.001$).

Wild flamingos are adapted to breeding in unpredictable environments with seasonal rains; they are found in salt lakes and brackish coastal lagoons. Factors which initiate breeding are unknown, yet suitable environmental conditions appear to be necessary. At all known nesting sites flamingos breed only if there has been sufficient rainfall [Ogilve and Ogilve, 1986]. Rainfall is considered essential for two reasons: it provides the right conditions for building their mud nests and for the rapid proliferation of their small food items (crustaceans, algae, and unicellular organisms).

Flamingos perform highly ritualized group displays before breeding. Although these displays can occur year-round, their frequency increases dramatically during the breeding season [Studer-Thiersch, 1974] when they appear to stimulate synchronous nesting and to facilitate pair formation [Studer-Thiersch, 1974, Ogilve and Ogilve, 1986]. Large flock size presumably serves to enhance the excitatory effects of group displays.

Group displays have been described in detail [Kear and Duplaix-Hall, 1975, Studer-Thiersch, 1974], yet there has been no attempt to quantify the occurrence of group displays, and no studies have determined the relationship between display behavior and breeding success. The objective of this study was to determine whether an increase in flock size influences group displays and whether group display activity correlates with breeding success. Because rainfall appears to be an important stimulator for breeding behavior, this study also investigated whether "rain" sprinklers could be used to induce group displays.

METHODS

The Study Flock

This study examined the display behavior of a flock of Caribbean flamingos at the National Zoological Park (NZP) in Washington, D.C. This flock had constructed nests, but had only produced one infertile egg in 8 years; the lack of success was presumed to be a consequence of the small flock size. There were 17 flamingos in the flock from 1980 to 1988. Five months prior to the 1989 breeding season flock size was increased by 24%, by adding four young adult captive-bred females. The addition of these four birds balanced the sex ratio (from 10:7 in 1988 to 10:11 in 1989). Throughout this study all of the flamingos were adults; four birds were age 3 to 5 years and the rest ranged in age from 11 to 25 years. All flamingos were sexed by laparotomy and individually marked with high-visibility bands, males on the right leg and females on the left.

The flock was housed in an outdoor exhibit (approx. 14,000 sq. ft.) containing a pool (approx. 3,000 sq. ft.) and a nesting island (approx. 1,000 sq. ft.) which was kept constantly moist. The diet of the flock did not change during the 2 years of this study. The pool was 3 feet deep at its deepest point. The soil on the nesting island was a mixture of topsoil and peat and was loosened and tilled prior to the breeding season (early March) each year. At this time, a net was also erected to exclude the flock from the large grassy area in the exhibit in order to concentrate their activities in the breeding pool. Rain sprinklers consisted of shower heads directed at the central third of the breeding pool. During the study period, these rain sprinklers were activated for 1 to 2 hours at different times each day, except on rainy days.

The Group Displays

The group display of the Caribbean flamingo comprises five ritualized displays: Head-Flag (HF), Wing-Salute (WS), Inverted Wing-Salute (IWS), Twist Preen (TP), and Wing-Leg Stretch (WLS) [see Studer-Thiersch, 1975b; Ogilvie and Ogilvie, 1986]. This study further distinguished the HF with vocalizations from HF without vocalizations (HF vs. HF + V); thus a total of six displays was recorded.

Observations

To test whether the lack of breeding success was due to insufficient behavioral stimulation, the frequency and intensity of group displays in the flock were examined during the breeding season in 1988 and then again in 1989 after the four birds were added to the flock. Observations were conducted from 0700 to 1900 on April 11 through May 27, 1988, and from 0800 to 1700 on April 18 through May 27, 1989, for a total of 541 hours of observation in 1988 and 364 hours of observation in 1989. Observations occurred in all weather conditions except thunderstorms. The observation time was shortened in 1989 for security reasons.

The observer, equipped with binoculars, checksheet, and a watch sat in front of the exhibit, approximately 10–20 meters from the birds, and sampled the flock during the first 30 seconds of every minute. For each sample, the observer recorded whether or not each display occurred (one–zero sampling [Altmann, 1974]) and the number of flamingos performing each of the six displays. If, for example, four birds were observed to perform both HF and WS during one sampling period, then both displays were given a score of 4. Because all of the displays are conspicuous and unambiguous, and because there were rarely more than three displays performed during one sampling period, the task of recording the number of flamingos performing each display presented no difficulties. In addition, the observer recorded all occurrences of copulations and attempted mounts during the entire observation period, and noted the band numbers of the pair involved. The observer also recorded the times the rain sprinkler was on.

The observers were FONZ (Friends of the National Zoo) volunteers who were experienced in behavioral methodology. They received additional training specific to this study. The same observers participated in the study during both years. During the first week in 1988, I recorded data alongside the observers to ensure that they adhered to the correct methodology. The criterion for inter-observer reliability was 85% agreement over 20-minute sample periods.

Data Summary

The data for each hour of observation were summarized into four measures of display activity: 1) the *frequency of each display:* the number of samples, out of a total of 60 per hour, during which a given display occurred; 2) the *frequency of display activity:* the number of samples during which at least one display occurred. For example, a score of 21 indicated that out of the 60 samples that hour, one or more displays occurred during 21 of those samples; 3) the *synchrony of each display:* the sum of the number of birds recorded to perform a given display divided by the number of samples in that hour during which that display was performed; and 4) the *greatest synchrony of all group displays:* the greatest number of display performances recorded in one sample for that hour (the number of birds performing each display summed over all displays). The score could be a number greater than the number of birds in the flock because one bird could perform more than one display during the sampling period. A score of 15 indicated that during that hour, the greatest synchronous group display activity in one sample consisted of 15 display performances.

RESULTS

Frequency of Each Display

Figure 2 presents the mean number of samples per hour during which each display was observed in 1988 and in 1989. In 1988 WS was observed in significantly more samples than any of the other displays (ANOVA, $F = 39.58$, $df = 5$, $P < 0.0001$; Newman-Keul's range test, $P < 0.05$). HF, HF + V, and TP occurred with equal frequency, but significantly more frequently than IWS and WLS ($P = 0.05$, Newman-Keul's range test). In 1989, HF, HF + V, and WS were observed with equal frequency and significantly more often than the other three displays (ANOVA, $F = 17.97$, $df = 5$, $P < 0.0001$; Newman-Keul's range test, $P = 0.05$). Each display, except for WS and TP, was observed with a significantly higher frequency in 1989 than in 1988 (Fig. 2).

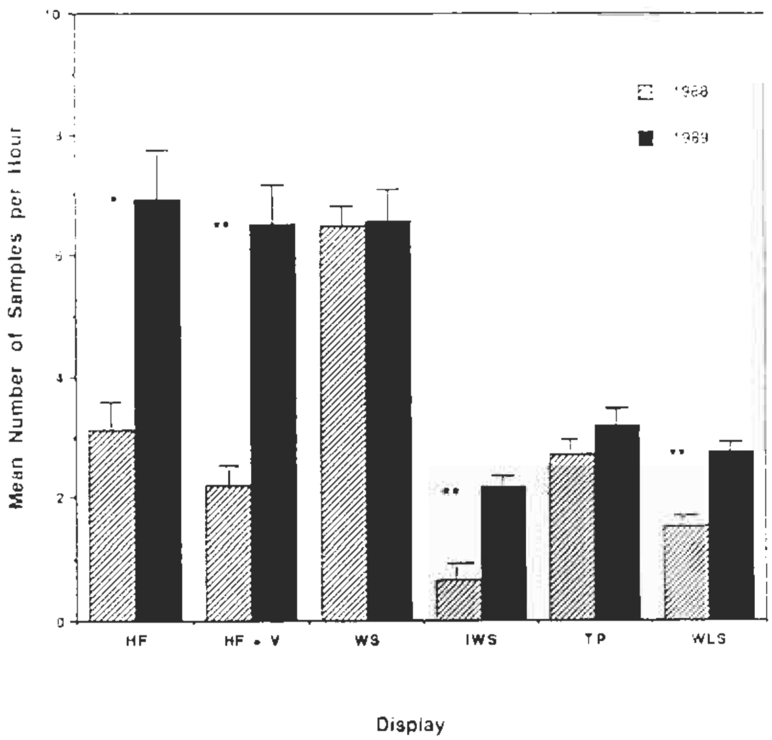


Fig. 2. Mean frequency per hour of each display in 1988 and 1989: the mean number of samples per hour during which each display was observed. HF = Head-Flagging, HF + V = Head-Flagging With Vocalizations, WS = Wing-Salute, IW = Inverted Wing-Salute, TP = Twist-Preen, WL = Wing-Leg Stretch. *$P = 0.0002$, t test, $n_8 = 47$, $n_9 = 41$. **$P = 0.00$, t-test, $n_8 = 47$, $n_9 = 41$.

Frequency of Display Activity

Figures 3a and b depict the mean rate of occurrence (frequency per hour) of group displays for each day in both the 1988 and 1989 breeding seasons. Figure 4 shows the mean frequency of group displays by hour of the day in 1988 and 1989.

The mean hourly rate of group displays in 1988 (Fig. 3a) decreased significantly across the 47 days of the study. The rate of group displays in 1989 (Fig. 3b) did not, however, change with time.

The rate of displays in 1988 was not evenly distributed across time of day (Fig. 4, ANOVA, $F = 3.50$, $df = 11$, $P < 0.0001$). Group displays occurred significantly more often between 1700 and 1900 (Newman Keul's Range test, $P = 0.05$). In 1989, however, there was no significant difference between any of the means for hours of the day (ANOVA, $F = 1.82$, $df = 8$, $P = 0.07$). An analysis of the 1988 data for the same hours sampled during 1989 (0800 to 1700) revealed results similar to those for 1989: there was no effect of time on the frequency of display activity (ANOVA, $F = 1.61$, $df = 8$, $P = 0.12$).

The overall mean frequency (± S.E.) of group displays per hour was 12.0 ± 0.74 in 1988 and 17.8 ± 1.21 in 1989. When the mean frequency of group displays per hour was examined by using a student t-test, the mean frequency was significantly greater in 1989 ($t = 4.07$, $P < 0.0001$).

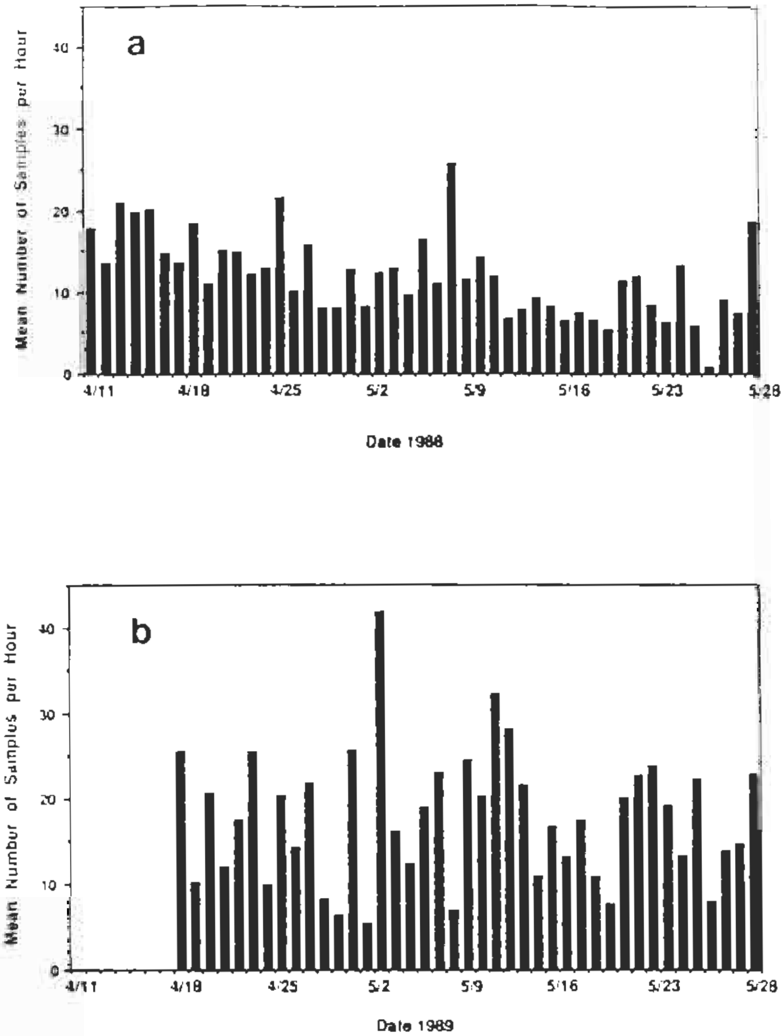


Fig. 3. **a:** Mean frequency per hour of group displays for each day in 1988: the mean number of samples per hour during which at least one group display was observed. The mean frequency per hour decreased significantly across the 47 days of the study period ($R^2 = 0.424$, $n = 47$, $P < 0.010$). **b:** Mean frequency per hour of group displays for each day in 1989: the mean number of samples per hour during which at least one group display was observed. The mean frequency per hour did not show a significant increase or decrease across the 41 days of the study period ($R^2 = 0.002$, $n = 41$, NS).

Synchrony of Each Display

The mean number of synchronous performances of each display per hour in 1988 and 1989 is shown in Figure 5. Every display, except for TP, had a significantly greater number of synchronous performances in 1989 than in 1988 (see Fig. 5).

Greatest Synchrony of All Group Displays

The greatest synchrony of all group displays for 1988 was 19 and this occurred during just 1 hour (out of 541 hours). There were only 12 hours (2% of observation

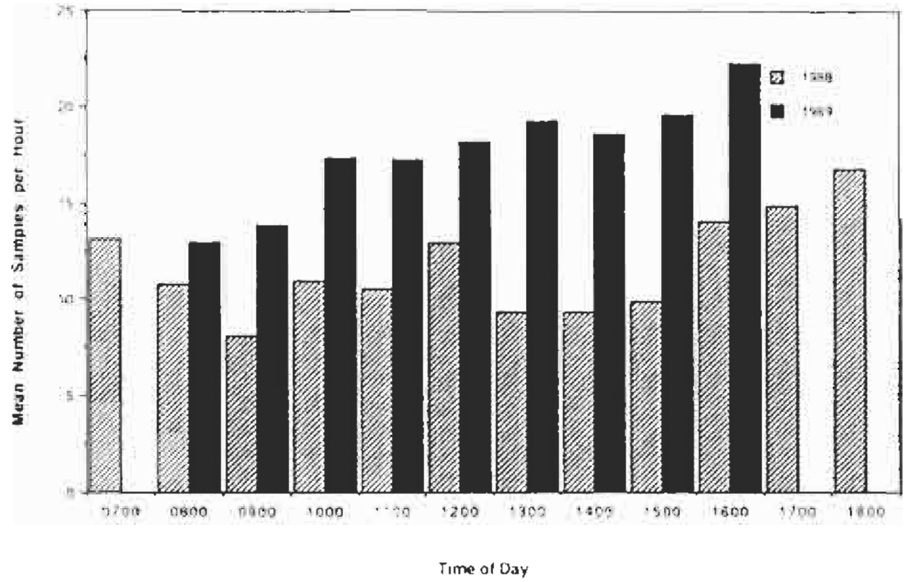


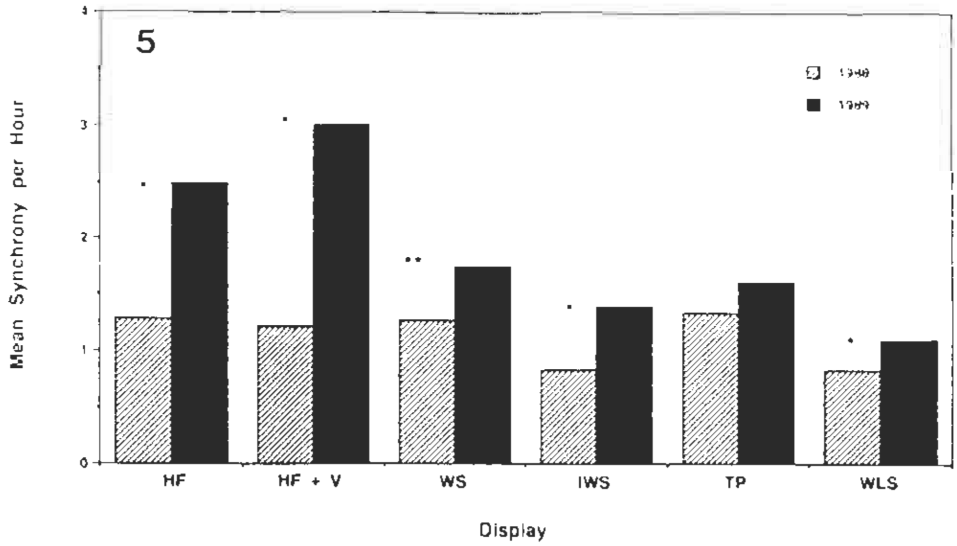
Fig. 4. **Mean frequency per hour of group displays by time of day in 1988 and 1989**: the mean number of samples per hour during which at least one group display was observed. For both years, between 0800 and 1700, the frequency of group displays was random with respect to time of day (see text).

hours) during which greater than ten displays were performed simultaneously. In contrast, in 1989, the greatest synchrony of all group displays was 27; there were 94 hours (26% of the 364 observation hours) during which greater than ten displays were performed simultaneously, and 44 hours (12% of the observation hours) during which greater than 14 displays were performed simultaneously. The mean for the greatest synchrony of group displays was significantly higher in 1989 than in 1988 ($t = 12.29$, $P = 0.000$, t-test, $n_1 = 541$, $n_2 = 364$; the mean for 1988 was 3.4 ± 0.11; the mean for 1989 was 7.4 ± 0.31).

The greatest synchrony per day is a measure of the *highest* degree of synchrony achieved per day; that is, it is the highest score for greatest synchrony of all group displays for each day. The mean of the greatest synchrony per day was twice as high in 1989 vs. 1988: 15.8 ± 0.31 in 1989 vs. 7.8 ± 0.53 in 1988 (Fig. 6; $t = -7.26$, $P = 0.000$, t-test, $n_1 = 47$, $n_2 = 41$).

The Effect of Rain Sprinklers on Group Displays

To analyze the effect of rain sprinklers on frequency of display activity, the frequency of display activity during the hour prior to the rain sprinkler was compared with the frequency of display activity both during the hour(s) of the rain sprinkler and during the hour following the rain sprinkler (Table 1). Although the frequencies were slightly higher in the hours both during and after the sprinkler, chi-square tests showed that the rain sprinkler had no significant effect on the frequency of group displays either during the hour(s) the rain sprinkler was on, or during the hour after the rain sprinkler (see Table 1).



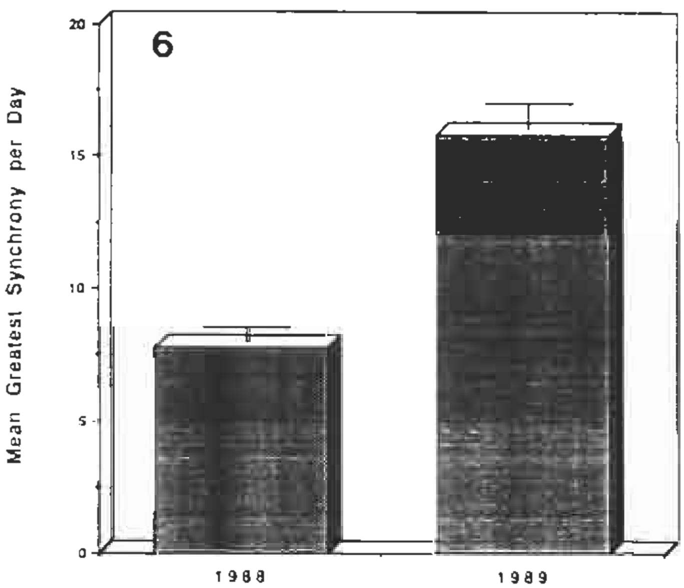


Fig. 5. Mean number of synchronous performances of each display per hour in 1988 and 1989. HF = Head-Flagging, HF + V = Head-Flagging With Vocalizations, WS = Wing-Salute, IWS = Inverted Wing-Salute, TP = Twist-Preen, WL = Wing-Leg Stretch. $^{*}P = 0.000$, t-test, $n_1 = 47$, $n_2 = 41$. $^{**}P = 0.003$, t-test, $n_1 = 47$, $n_2 = 41$.

Fig. 6. Mean greatest synchrony of group displays in 1988 and 1989: the mean of the greatest synchrony for each day. $P = 0.000$, t-test, $n_1 = 47$, $n_2 = 41$.

Frequency of Mounts and Copulations

Mounts and copulations were combined for this analysis as it was sometimes difficult to distinguish between the two. There were significantly more mounts and copulations per day in 1989 than in 1988 ($t = -3.72$, $P = 0.0004$, t-test). There were

TABLE 1. The effect of the rain sprinkler on the frequency of group displays: a) before vs. during the hour(s) the rain sprinkler was on, and b) before vs. the hour after the rain sprinkler was on in 1988 and 1989

	1988[a]		1989[b]	
	Frequency increased	Frequency decreased	Frequency increased	Frequency decreased
a) Before vs. During	19	13	11	8
b) Before vs. After	14	15	11	8

[a]1988 a) $\chi^2 = 1.13$, $df = 1$, $P > 0.20$, b) $\chi^2 = 0.03$, $df = 1$, $P > 0.90$
[b]1989 a) $\chi^2 = 0.48$, $df = 1$, $P > 0.50$, b) $\chi^2 = 0.03$, $df = 1$, $P > 0.50$

127 total mounts and copulations in 1988 with a mean daily frequency of 2.7 ± 0.4. In 1989, there were 236 total mounts and copulations with a mean daily frequency of 5.5 ± 0.6.

For 16% of the mounts and copulations in 1988, and 22% in 1989, the identity of the birds participating could not be ascertained. (Bands were under water or there was too much activity by other birds in the same area.) There were six pairs and one trio identified in 1988; the trio comprised two males and one female. (This female was the only one to produce an egg in 1988 and her nest was tended by both males). In 1989 there were nine pairs observed during mounts and copulations; only four of these pairs were also identified as pairs in 1988. The other five pairs were new combinations of birds. Only one of the four new females was observed to copulate.

Production of Eggs

In 1988 one egg was laid on May 10, but it never hatched and was determined to be infertile. In 1989 two females laid eggs, on June 6 and June 8; both eggs were determined to be fertile by candling (Tomassoni, pers. comm.), but were destroyed by crows after 25 and 13 days of incubation, respectively. The female who laid the egg in 1988 also laid an egg in 1989. None of the newly acquired females laid an egg during the 1989 season.

DISCUSSION

Both the rate of occurrence of displays and the synchrony of displays were significantly higher in 1989, when the flock size was larger, than in 1988. Concomitantly, in 1989, there were more components of breeding than in 1988; there was a significantly higher frequency of mounts and copulations, and for the first time in the flock's history two fertile eggs were produced.

Not only were the overall frequency and the overall synchrony of group displays significantly greater in 1989 than in 1988, but the majority of each of the six displays was performed with higher frequency (four of six displays) and synchrony (five of six displays). Furthermore, whereas group display frequency showed a significant decrease over the study period in 1988, the overall frequency of group displays was maintained at its significantly higher level throughout the 1989 study period.

The cause of the increased rates and synchrony of behavior in 1989 is not completely clear. The increase in flock size (from 17 to 21) could account for greater display activity; however, three other variables could have played a role: 1) rainfall, which could not be controlled; 2) the more balanced sex ratio, which resulted from the addition of four females to the flock; or 3) the presence of strange individuals in the flock (aside from any effects of group size), individuals who also came from an experienced breeding flock. Rainfall was significantly greater in 1989 than in 1988. During the months March, April, and May, there were 15.6 inches of rainfall in 1989 and only 8.8 inches in 1988. As rainfall is an important environmental cue for reproduction in Caribbean flamingos [Ogilve and Ogilve, 1986], the observed increase in group display activity might have resulted from increased rainfall alone. The present study cannot separate effects of rainfall, sex ratio, introduction of strange individuals, and group size.

The increase in group display activity was greater than the 24% increase in flock size. The mean rate of displays per hour increased 48% in 1989 and the mean greatest synchrony increased 100%. Likewise, the frequency of mounts and copulations in 1989 almost doubled, yet the birds involved in almost all mounts and copulations were the original members of the flock. Of the new flamingos, only one was observed to copulate. Thus, the new birds were not solely responsible for either the increase in display activity or the increase in mounts and copulations.

Other authors have suggested that rain (both natural and artificially generated) stimulates displays [Duplaix-Hall and Kear, 1975; Michael and Pichner, 1989] and that flooding stimulates nesting [Brown et al., 1983]. Although the use of rain sprinklers in this study did not reliably increase display activity in the flock of flamingos at NZP, it is possible that the sprinklers did not "rain" over enough of the exhibit or for a long enough period to have an effect. Perhaps flooding the nesting area and using rain sprinklers could be employed simultaneously to achieve the greatest effect. Clearly, more systematic research is needed to determine exactly which environmental and social factors stimulate group displays and reproduction.

Flamingos in captivity lack an important stimulus which natural flocks experience [Allen, 1956]: the stimulus of thousands of other displaying birds around them. It has been presumed that large flock size on the breeding grounds serves to enhance the function of the group displays: to facilitate pair formation and to stimulate nesting and breeding. This study is the first to show a quantitative relationship between group displays and breeding behavior. The results suggest a positive correlation between the behavioral stimulation provided by the increased frequency and synchrony of the group displays and the occurrence of reproductive behavior: mounts and copulations. The challenge remains to identify the causal relations involved.

ACKNOWLEDGMENTS

This study would not have been possible without the assistance of the FONZ (Friends of the National Zoo) Flamingo Watchers and their organizer, Joanne Grumm. I am grateful to Earl Pinkney, Bryon Shipley, and Linda Moore for their help with the flamingo exhibit and to Charles Pickett for his support in the logistics of the project. Pat Teleska and Debbie Seymour provided hours of assistance with data summary. B. Beck, S. Derrickson, D. Forthman, T. Maple, E. Morton, J. Ogden, L. Perkins, C. Pickett, C. Schmidt, P. Shannon, and R.H. Wiley generously provided thoughtful comments to the manuscript.

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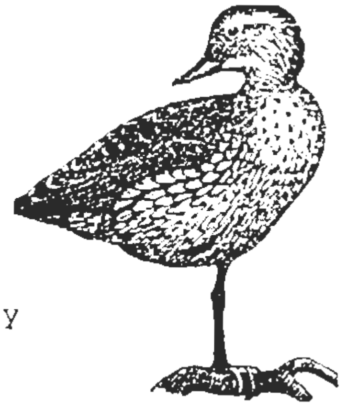
West Indian Tree Duck *Dendrocygna arborea*

Local names: Whistling Duck; Whistler, Mangrove Duck; Night Duck, Yaguaza, Chiriria, Vingeon; Gingeon, Canard Siffleur.



15 December 1992

Dr. James D. Lazell
The Conservation Agency
6 Swinburne Street
Jamestown, RI 02835

Dear Skip:

Many thanks for your note, your book and various enclosures which reached me yesterday. And congratulations to you two on your nearly one year-old marriage. You got married in Feb., we in Mar.; that ought to be easy to keep track of.

"Ribbon of Sand" looks great, and I look forward to reading it. I'm sure it was fun, not to mention instructive, for you to venture out into generally unfamiliar territory. Somewhat like my work on whales, no doubt.

I'd like to respond directly to the two points you made in regards to our working together, or "combine efforts on some real field work" as you put it.

First, Charlotte and I will make a real effort to join you on Guana next October (or some other month if that is preferable). We'll need to talk about this some, as I don't know where it is (the brochure doesn't say) or how one gets there. Does a week sound like a reasonable length of time for a visit?

Second, after much delay, my West Indian Whistling-Duck effort is getting rekindled, and there are several ways in which we could cooperate, I'm certain.

The project has been dragging, and a good deal of it has been my fault. I lost much of the past two years getting my job and my personal life under control. Our Xmas Letter explained much of that. Now, fortunately, with a semblance of an office established in Memphis, I am once again able to return to productive environmental work. Charlotte is supportive of this, happily, and in time will likely be a big participant.

West Indian Whistling Duck = TREE DUCK

The W.I.W.D poster if FINALLY ready to go to print. RARE is unwilling to put a penny (or any staff time) into the project, which it nominally supports, so I have had to do all of it thus far ($3300) with personal funds, and I am in the process of trying to raise the money needed for the printing right now. With any luck, the posters--2500 of an English edition, and 2500 in Spanish--will be ready for distribution by late January. I'll keep you informed of progress.

Enclosed is a small contribution for your organization.

With all good wishes,

Sincerely,

2948 Southern Avenue
Memphis TN 38111

encl.

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.

1/5/93

David O. Hill
2948 Southern Ave.
Memphis, TN 38111

Dear David:

Herewith more Guana stuff. The island is just N of the E end of Tortola, largest of the British Virgins. See maps of enclosed papers.

You will be billed as our 1993 official PI ornithologist; Charlotte will be your field assistant. As long as you appear stuffy, academic, and thoroughly disapproving of the childish antics of herpetologists, mammologists, entomologists, etc., all will go well. NB: field assistants do not have to act like PI's. They can even act like herpetologists if they want. (NB: not like ichthyologists; we do have some standards.)

Apart from rampant birding and (we can hope) photography, we will solicit your input on the following species as repatriations, restorations, or introductions:

WI whistling duck: nested in BVI at least through WWII. "TREE DUCK"
Could Guana support a few? Semidomestic?

PR woodpecker: USVI specimens in ANSP from nineteenth century.

White-crowned pigeon: was here till 1950's. We are negotiating to bring them back.

PR parrot: stories from 1700's. Of course survived on Culebra till 1930's.

Rail: DeBooy's rail may have survived on Virgin Gorda to 1940's. The species is extinct, but why not bring in some Guam rails? (Smaller, longer billed, but terrestrial, as DB's is believed to have been.)

Any other birds we could/should have on the Island? We do not want to make a zoo, but we are willing to subsidize some species in the interest of having dispersers move out and recolonize lost ground. Hunting did in a lot of BVI birds, but legal hunting is gone. There is still egging of tern colonies and, even, slaughter of young pelicans for fish pot bait.

Anyway, come and see.

All the best,

Skip

ALSOPHIS PORTORICENSIS RICHARDI (Ground Snake) **FEEDING**. *Alsophis portoricensis richardi* is an opisthomegadont colubrid snake which can use a highly variable toxic secretion to subdue live prey. The feeding habits of this colubrid are poorly known among the islands of the eastern Puerto Rican Platform, but anolid and sphaerodactylid lizards are presumed to be primary prey in the Virgin Islands (MacLean 1982. Reptiles and Amphibians of the Virgin Islands. Macmillan Caribbean Education, Ltd., London; see also Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainesville, 720 pp.). Here I give two accounts of previously unreported and unusual prey items and feeding behavior for *A. p. richardi* observed at two small cays; Congo Cay located 2.5 km NW of Cruz Bay, St. John, 18°22'N, 64°46'W and Little Saba Cay 5 km S of St. Thomas, 18°19'N, 65°00'W.

On Congo Cay, an *A. p. richardi* was masticating dried fish below a seabird nest. The snake, about a meter in length, appeared to search deliberately among the slab-like rocks to collect in its jaws small, dried fish, *Heranguia* sp., approximately 2-3 cm in total length. The dessicated and hard fish, originally food for brown pelican nestlings (*Pelecanus occidentalis*), had been lost over the side of the nest three meters above ground level. At Little Saba Cay, I observed a large *A. p. richardi* entering a nest containing two eggs of a ground-nesting bird, Zenaida dove (*Zenaida aurita*). The snake was positioning its head over the eggs while the adult dove was standing nearby flicking its wings in a combative posture when my presence disturbed the snake. In both cases, the prey was immobile, desiccated, or hard.

I thank the staff of the Division of Fish and Wildlife, St. Thomas, USVI, for field assistance; James Lazell, Jr., Greg Mayer, and Peter Tolson for their encouragement; and Stephen Corn for critical review of earlier drafts of the ms. Field work was made possible by the Pittman-Robertson Virgin Islands Wildlife Restoration Aid Program (FW-3), U.S. Fish and Wildlife Service, Atlanta, Georgia.

Submitted by **ROBERT L. NORTON**, Smithsonian Migratory Bird Program, National Zoological Park, Washington, DC 20008, USA. Present address: 817 Quince Orchard Blvd. #14, Gaithersburg, Maryland 20878, USA.

Department of Biology - Pennsylvania State University
208 Mueller Lab
University Park, PA 16802
Tel. & Fax: 814-865-9991 / Lab. 814-865-6641
E-mail: sbh1@psuvm.psu.edu

29 September 1992

Dr. James D. Lazell
6 Swinburne Street
Conanicut Island, RI 02835

Dear Skip,

Thanks for the papers. Those *Draco* are quite fascinating!

Enclosed are the Typhlops reprints (& others). I sent the Guana Id. material to MCZ right after I received them from Greg, and removed tissue. Greg probably knows the whereabouts if Jose does not. I was very grateful to get them, but unfortunately they arrived too late to be included in the study. I had already finished the comparisons by the time Greg got them to me. Sorry! I shortly afterwards moved up here (in 1988). The delay in publication of the Herpetologica paper was due to Hillis and politics (trying to impose cladistics on an otherwise nice study). I won the battle, but the paper was delayed.

Best Regards,

S. Blair Hedges
Assistant Professor

Herpetologica, 47(4), 1991, 448–459

CRYPTIC SPECIES OF SNAKES (TYPHLOPIDAE: *TYPHLOPS*) FROM THE PUERTO RICO BANK DETECTED BY PROTEIN ELECTROPHORESIS

S. BLAIR HEDGES[1,3] AND RICHARD THOMAS[2]

[1]*Department of Zoology, University of Maryland, College Park, MD 20742, USA*
[2]*Department of Biology, University of Puerto Rico, Rio Piedras, PR 00931, USA*

ABSTRACT: An analysis of protein variation at 26 electrophoretic loci in the blindsnake *Typhlops richardi* inhabiting the Puerto Rico Bank revealed the presence of three cryptic species. One, *T. richardi*, is restricted to the Virgin Islands, the other two occur on Puerto Rico (and satellite islands) and are sympatric. The large and widely distributed Puerto Rican species takes the available name *T. platycephalus*. The small Puerto Rican species, known from northern and southeastern coastal localities and some satellite islands, is described herein as *T. hypomethes*. Except for body size, morphological differences distinguishing all three species are slight. *Typhlops richardi catapontus* from Anegada is raised to species level and *T. r. naugus* from Virgin Gorda is placed in its synonymy. Thus, the Puerto Rico Bank and adjacent Mona Island are inhabited by seven species of *Typhlops*: *T. catapontus*, *T. granti*, *T. hypomethes*, *T. monensis*, *T. platycephalus*, *T. richardi*, and *T. rostellatus*.

Key words: Serpentes, Typhlopidae, *Typhlops*, Caribbean, West Indies, Puerto Rico, Virgin Islands, Electrophoresis, Systematics

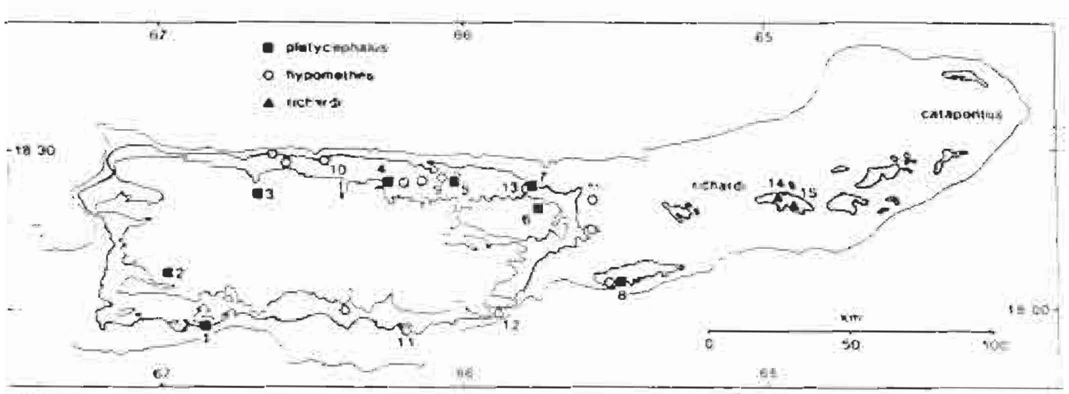
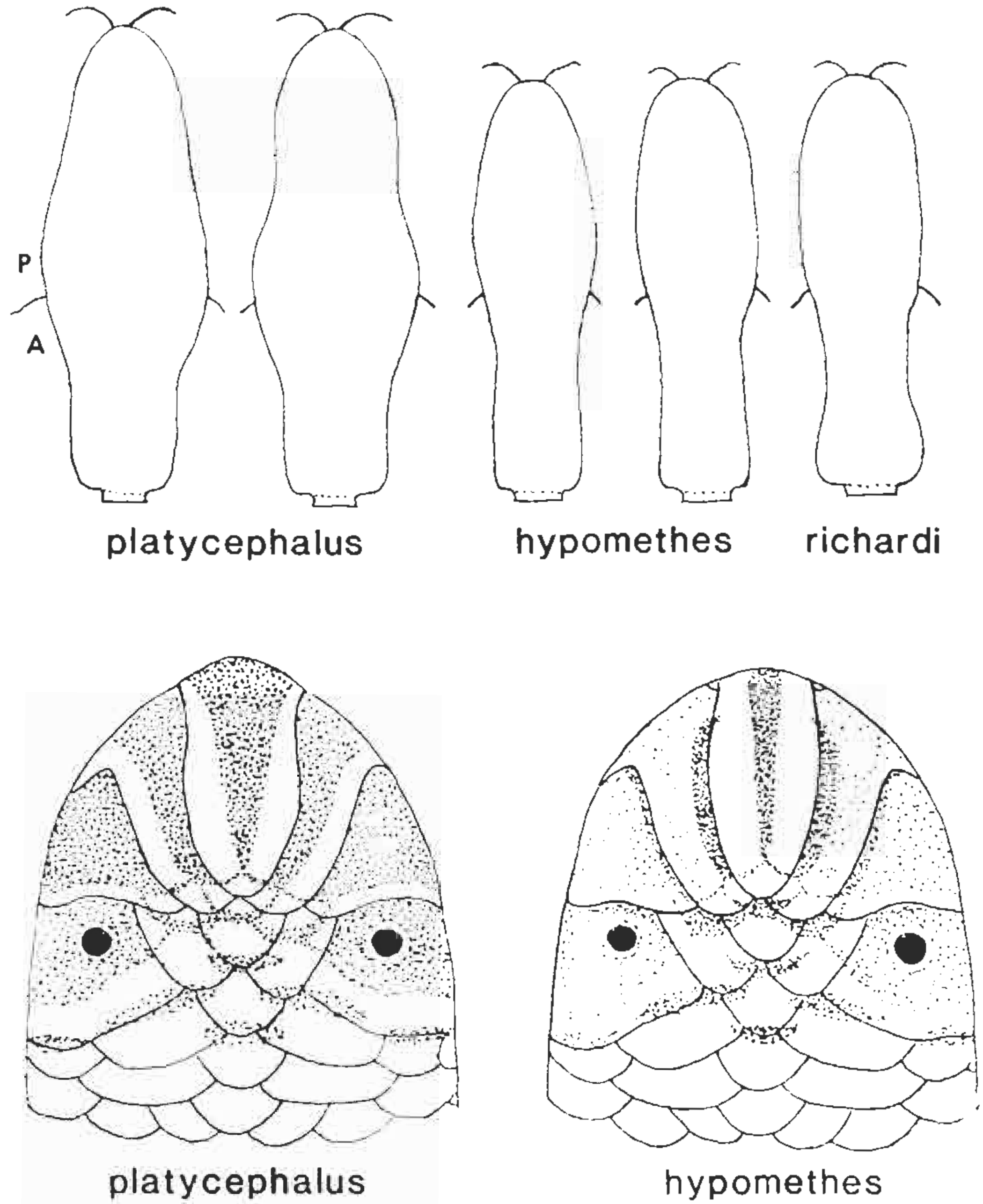


FIG. 3.—The Puerto Rico Bank, showing localities of *Typhlops* sampled in this study. Open circles = *T. hypomethes* (including all known localities), solid squares = *T. platycephalus*, and solid triangles = *T. richardi*. The solid narrow lines = −100 m (surrounding the bank) and +100 m (within Puerto Rico). The ranges of *T. richardi* (excluding Bahamas and St. Croix) and *T. catapontus* are indicated.

67



[illegible]—Above, common rostral shapes of *T. platycephalus*, *T. hypomethes*, and *T. richardi* drawn as [illegible] flattened; lower edge (dotted line) is the labial border. P is the postnasal and A is the anterior nasal. [illegible] are semidiagrammatic representations of head scalation [illegible] coloration in *T. platycephalus* and *T. [illegible]methes*.

Comments.—We consider *Typhlops richardi* to occupy all but the easternmost of the Virgin Islands, Virgin Gorda and Anegada, extending west through Culebra and its cays (known from cayos Luís Peña and Norte). The snakes from Cayo Diablo and Surprise Cay (both close to one another in the string of cays called La Cordillera just east of Puerto Rico) we provisionally refer to *richardi* because of their large size and head width; the populations on these cays need to be more thoroughly sampled to evaluate their taxonomic status. Similar comments apply to the Vieques *Typhlops* identified as *platycephalus*. We use the name *Typhlops catapontus* for the populations on Anegada and Virgin Gorda, provisionally relegating *richardi naugus* to its synonymy. A more exhaustive study of variation in the *Typhlops* of the islands east of Puerto Rico is needed.

Although *hypomethes* resembles *richardi* in snout and rostral shape, it is close to *platycephalus* in certain other features: middorsal counts and the occurrence of tail banding (even though infrequent), suggesting, as do the allozyme data, that *hypomethes* and *platycephalus* share a more recent common ancestor with one another than with any of the other species.

Typhlops platycephalus was originally described (Duméril and Bibron, 1844) as having come from Martinique. Stejneger (1904) deduced that the type material of the Puerto Rican *Diploglossus pleei*, *Anolis cristatellus*, *Anolis pulchellus*, and *Typhlops platycephalus* were transshipped by Plée through Martinique and thus mistakenly ascribed to that island when the species were described (Duméril and Bibron, 1837, 1844). Since neither Stejneger (1904) nor Ruthven and Gaige (1935) appear to have examined the types, we borrowed the holotype of *T. platycephalus* and syntype of *T. richardi*. The latter was described as having come from St. Thomas, Virgin Islands, and, although there has never been any reason to question its provenance, we can confirm that it agrees in size, proportions, rostral shape, and scale counts with the St. Thomas *richardi* (TL = 172 mm, TA = 4.5, HL = 6.2, middorsal scales = 332, scale rows reduce from 22–20 at 32% SVL, reduction to 18 rows at 95% SVL). The holotype of *platycephalus* agrees with the larger of the Puerto Rican species in details of rostral shape, size (TL = 291 mm, TA = 7.0), middorsal scales (365), reduction (22–20 at 51% SVL), and HL (6.2 mm). It does not have a tail band, however, which indicates that it came from eastern, southern, or interior Puerto Rico.

69

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.

24 November 1992

Dr. Razi Dmi'el
Department of Zoology
Tel Aviv University
Tel Aviv 69978
ISRAEL

Dear Razi:

I hope my stuff, mailed in September, crossed your letter of 24 September in the mail, and you got it.

True, I do work on the South China Sea Islands around Hong Kong, but where I want to do some physiological stuff is in the British Virgin Islands, based on Guana. There are several sets of species of lizards that should prove interesting.

Sphaerodactylus geckos have been studied a bit by the late Wm. MacLean (papers enclosed). There are two species in the BVI: widespread, big-scaled macrolepis is good at resisting water loss, and varies geographically in this ability; variability in scale size, or other potentially geographic correlates, has not been studied. Little parthenopion is relatively restricted geographically (to a dry area), shows no apparent geographic variation, and is no good at water loss resistance. It has tiny scales. So, a puzzle. Elsewhere in Sphaerodactylus there seems to be a pretty good correlation: dry country/big scales; wet country/small scales.

There are two species of Iguana: wet country/small scales in I. iguana, dry country/big scales in I. pinguis.

But Anolis may be the first to look at. There are four species, three abundant and easy to get right on Guana. We know a lot about their habits, habitats, densities, etc. One of them, cristatellus, varies geographically with a pretty good - if modal - dry/big, wet/small scale size correlation. A direct derivative of this species, ernstwilliamsi, occupies a very arid, tiny islet and occasionally colonizes the wetter, big, adjacent island held by cristellus. But ernestwilliamsi is a near-giant (much larger than cristatellus) and has much smaller scales.

There are also a pair of skink species, genus Mabuya. The dark, metallic, more-or-less wet country one is widespread and scarce; we'll have trouble getting them for you. The pallid, dull one from the same tiny, arid islet that *Anolis ernestwilliamsi* comes from, is abundant in the few square meters of its home. No apparent scale size difference, and we have looked closely. There must be some incredible physiological difference, however.

If all this sounds intriguing, our problems will arise in trying to get you set up to work on Guana. Or, would you risk sending or taking live lizards back to Tel Aviv? Do you need an air-conditioned, humidity controlled work area?

If you can work on Guana, that is best. Some of these lizards, like *Anolis ernestwilliamsi* are inexplicably difficult to keep alive in captivity (*cristatellus*, by contrast, is easy).

Let me know what you think. Best to Ofra....

Sincerely yours,

Skip

James Lazell

TEL AVIV UNIVERSITY אונ' ת"א אוניברסיטת תל-אביב

GEORGE S. WISE FACULTY OF LIFE SCIENCES
DEPARTMENT OF ZOOLOGY

הפקולטה למדעי החיים ע"ש ג'ורג' ס. וייז
המחלקה לזואולוגיה

1.I.1993

Dr. James Lazell,
The Conservation Agency
6 Swinburne St.
Jamestown, RI 02835
USA

Dear James,

Thank you for your letter of 24 November and the enclosed material, which I found very interesting. Thank you even more for the kind invitation to come work on Guana, a suggestion which I am considering very seriously.

Working on cutaneous water loss on Guana is an intriguing prospect. Especially interesting to me is the question of the microgeographic variation which seems to occur on Guana, and I would like to correlate environmental conditions with water loss and scale size. Also interesting are comparative questions, dealing with the adaptations of different species to different environmental conditions. Your suggestion to use <u>Anolis</u> appears workable, but we would have to see how it works on the site. However, before I can commit myself I require some information regarding the practical issues involved. These include availability of equipment and the timing and finances of such an expedition.

Am I right in understanding that you have a research station on the island? To conduct this study I would require an analytical balance, an oxygen analyzer, a data logger, some means of controlling the experimental animal's temperature, air pumps and other experimental paraphernalia. If not available on the site, I could bring almost all this equipment with me, but this would probably require quite a bit of paperwork. However, a steady electrical supply and a PC-compatible computer are absolutely necessary.

What are the requirements for obtaining permits to collect and study the species on Guana? For a full study of intraspecific variation, I would require five individuals from each site, and would want to examine at least three sites. An interspecific study would require slightly more animals. In either case, I foresee the study lasting approximately one month.

I would like to have an ex-student of mine, Gad Perry, come with me. Gad is working on his Ph.D. thesis on lizard foraging ecology with Professor Pianka at the University of Texas. Besides having worked with me in the past and being well acquainted with the technical aspects of such work, he is experienced with tropical work, since his field site is in the Costa Rican Jungle. He will be extremely helpful with all aspects of the research.

TEL AVIV UNIVERSITY אוניברסיטת תל-אביב

The best times for me to come over are during our summer break (mid-June till the end of July), since I have teaching and administrative duties here as well as an international conference I am planning on attending in early August 1993 in Scotland. Is this convenient for you? What are the weather and lizard activity patterns likely to be during this time?

Finally, the issue of funding needs to be addressed. I do not presently have a grant which will allow me to come to Guana, nor does Mr. Perry have such support. Are you aware of any agencies that would be interested in funding this study? If so, we should probably apply as soon as possible. If you wish to contact me more quickly, my fax number is 972-3-640-9403, my e-mail address is razdmiel@ccsg.tau.ac.il and Mr. perry can be reached at the Department of Zoology, University of Texas, Austin, TX 78712 or at gad.perry@utxvm.cc.utexas.edu.

Sincerely yours,

R. Dmi'el

Razi Dmi'el
Dept. of Zoology
Tel Aviv University
69978 Tel Aviv
ISRAEL

Merry Christmas and Happy New Year to you and yours

Ofra and Razi

The Conservation Agency

Exploration, Education, and Research

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

1/8/93

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

Dr. Razi Dmi'el
Department of Zoology
Tel Aviv University
69978 Tel Aviv, Israel

Dear Razi:

No permits or paperwork needed for our work on Guana. We have never had a problem bringing in equipment for our studies as long as we notified customs ahead of time. That is the good news.

Now, some problems. We are restricted to the month of October. We have sometimes been able to get July too, but that is unlikely for 1993. October is usually about the best month because it is near the end of the rainy season. That said, however, the last two Octobers have been bone-dry; the "rainy season" isn't much in the best of years, and rains may come at any time from July through November, or pretty much skip over us. Annual rainfall the last few years has been normal, but any prediction of when it may rain is likely to fail. But, that has no effect on the lizards: they are always abundant and active.

We do not really have a research station, just the use of the hotel facilities: 15 units of housing strung out along a ridge. Accommodations are very comfortable (it is after all, a resort hotel), and food is too plentiful - good (everyone complains they get fat). Soda, juices, and beer are covered by our grant, as is wine with dinner. Liquor is sold by the bottle, and that of British or local origin is very cheap. The grant covers room and board for all participants. There are also six plane fares provided - but from U.S. cities. We could get Gad Perry his plane ticket, for example, but then you would have to come up with your own. I have to spread the plane fares around amongst entomologists, ornithologists, botanists, etc., and am always accused of favoring herpetologists.

The buildings are screened and breezy, but not closed and air conditioned. Maintaining a constant temperature anywhere will be very difficult. I don't know what to do about that problem.

There are electricity generators, so regular U.S.-style 110 volt AC current most of the time. But, I've never been there for a month when the generators didn't break down at least once - and last October, both went out simultaneously several times....

There are PC-compatibles on the Island, but access to them might be tricky. They go with the hotel administration and are in the sacrosanct office. But, we can probably work that out if you only need access a few hours per day.

I'll get in touch with the hotel admin folks, Dr. Henry Jarecki (the owner; his corporation funds us), and Gad Perry (to talk about equipment, etc.). I'll know more soon.

Phoned: 1.iii.93
He'll get back....

17.II.93

Dr. James D. Lazell
President,
The Conservation Agency

Dear Dr. Lazell,

Razi Dmi'el has given me a copy of his correspondence with you regarding your kind invitation to come work on Guana. He also suggested I should get in touch with you and get further information.

I would love to come over, but would much prefer July to October if at all possible - I expect to be teaching here in October, which would complicate things somewhat. However, I am currently looking into ways of freeing the coming fall semester for this, as well as a planned excursion to Amazonian Ecuador.

To make plans I therefore need some information on the dates and finances involved. Am I right in understanding that you will be able to pick up my flight and residency expenses? If not, what are the costs involved? In addition to assisting Razi with the water-loss project, I would like to conduct some research on lizard foraging behavior, the topic I am most interested in at the moment. Do you foresee any problem with that, permit- or otherwise? Work on Guana should be most beneficial in that it will allow me to compare species from my Costa Rica study site with closely related species residing in a much drier environment.

I can be reached at the address below, through e-mail (gad.perry@utxvm.bitnet), at phone numbers (512) 471-1456 Office) or (512) 371-3634 (home), and by fax (512) 471-9651, and would greatly appreciate any information you could provide.

Sincerely yours,

[signature]

Gad Perry
Dept. of Zoology
Univ. of Texas
Austin, TX 78712
USA

SUCCESSFUL RELOCATION OF ENDANGERED *IGUANA PINGUIS* TO GUANA ISLAND, BRITISH VIRGIN ISLANDS

NUMI C. GOODYEAR

JAMES LAZELL

The Conservation Agency

6 Swinburne Street

Jamestown, RI 02835 U.S.A.

Running head: Relocation of *Iguana pinguis*

Address for correspondence:

Dr. Numi C. Goodyear

The Conservation Agency

Branch Office: 97B Howland Avenue

Jamestown, RI 02835

Abstract: Eight individual rock iguanas (Iguana pinguis) from Anegada Island were relocated to Guana Island by Lazell in order to establish a second population reservoir for this endangered species. During the glacial maximum Iguana pinguis could have occupied most of the lowlands of the Greater Puerto Rico Bank, the United States Virgin Islands, and the British Virgin Islands. Remains have been found on Saint Thomas and Puerto Rico. By 1930 I. pinguis was restricted to a single population on Anegada. Between 1984 and 1987 eight (five female and three male) I. pinguis from Anegada were released on Guana Island. The relocation has been successful and, in the area currently providing the best habitat, we estimate a density of 9 or 12 animals (all age classes included) per 19 ha, depending on our decision rules for inclusion of data. The optimal area contains a sheep exclosure with relatively dense understory vegetation and numerous exotic as well as native species of plants. Iguana activity is concentrated on east-facing slopes and ridge-tops that get morning sun. Outside the exclosure there is little vegetative understory. Most edible ground cover and shrubs have been eaten by sheep leaving toxic or noxious species (e.g., Croton or Lantana) in the understory. Because I. pinguis adults generally forage on or within a meter of the ground most of the island is currently sub-optimal habitat. I. pinguis occasionally sleeps in trees on Guana; this was never observed in a similar study on Anegada. In more than 3000 hours of observation outside the sheep exclosure study area yielded a total of 27 sightings of adult iguanas in seven areas. Five of these areas are within travel distance of animals inhabiting the sheep exclosure but at least one subgroup inhabits the east end of the cay and does survive in sheep affected areas. Because of uneven habitat quality we suspect that the total adult I. pinguis population on Guana consists of about 20 individuals. Removal of sheep may be critical to continued population growth. Comparative information is given for the other two species of iguanas (I. iguana and I. delicatissima) in the northeast Caribbean. Their possibly-endangered populations have not been documented or revisited, so far as we know, for thirty years. Views on relocation or repatriation of other endangered

Antillean Iguana ("Cyclura") species are advanced with some ideas on minimum viable population sizes and a possible explanation for the extirpation of I. pinguis from much of its former range.

Three species of iguanas occupy the northeastern quadrant of the West Indies (Figure 1). They differ from most other proximate forms and populations south and west in lacking both caudal verticils and enlarged, horn-like snout scales. The relationships and characteristics of all three are poorly known; considerable misunderstanding and misinformation attends them, and to date no character by which one can reliably separate them at the generic level has been proposed (Lazell 1983, 1989). These species are Iguana iguana, I. delicatissima, and I. pinguis. Dodd and Seigel (1991) complained that while numerous attempts to reestablish reptile populations have ostensibly been made, few have been documented to have succeeded. We believe the most critically endangered of these three, I. pinguis, has been successfully established on Guana Island, part of its former range.

Iguana iguana is the most gracile and cristate of the three species. There is a row of enlarged scales along the jawline terminating in a strikingly differentiated subtympanic plate (Lazell, 1973). Enlarged toe "comb" scales are a rare individual variation. Hatchlings are usually quite green and transversely banded. Individuals may retain this color pattern, or -- especially in the Virgin Islands -- may turn gray, and may develop extensive areas of purple or maroon or sooty black. It is frequently stated that this species is arboreal, but it is often densely abundant on small islets without trees, and thus quite terrestrial locally; these are not marginal habitats for the species (Roze 1956; Lazell 1973). I. iguana is widespread both within the northeastern quadrant of the Antilles and southward in the Lesser Antilles, throughout tropical South and Central America. Many of these extralimital populations are horned (the "rhinolopha" grade: Lazell 1973).

Iguana delicatissima has reduced crests and undistinguished proportions. Hatchlings are bright green and generally without pattern. Individuals may turn gray with age but seem never to develop purple tones or sooty black. The row of enlarged jawline scales is conspicuous and may extend to the subtympanic area, but there is never a spectacularly enlarged subtympanic plate. Enlarged, fused, toe "comb" scales are present in about 20 percent of individuals. This species climbs well and often where trees are available, but the densest known populations are largely terrestrial - there are no trees to climb (Lazell 1973). Iguana delicatissima extends extralimitally from the northeast quadrant of the Antilles only southward to the Dominica and Martinique Banks of the Lesser Antilles. No study has been made of its conservation status since the field work for Lazell's (1973) paper was completed three decades ago. We do not know where or in what densities this species survives.

Iguana pinguis has the most reduced crest scales in the genus and, as its name implies, the stoutest proportions. Hatchlings may be quite mossy green, but are often no more than olive or gray-greenish, and are usually prominently banded. Banding fades with age and adults are predominantly gray, sometimes with sooty-black areas (especially on the head and neck); males more frequently than females may have blue dorsal crest scales, fore and hind-limbs, and caudals. A row of enlarged scales begins on the anterior jawline, but diminishes posteriorly; there are never enlarged scales in the subtympanic region. Schwartz and Carey (1977) put this species in the genus "Cyclura" but gave no defining characters that separate "Cyclura" from Iguana. Schwartz and Henderson (1985) claimed "Cyclura" differed from Iguana in possessing caudal verticils, but I. pinguis conspicuously lacks such scales (as do other species often placed in "Cyclura"). Enlarged toe "comb" scales are always present, but not always fused. The species is often claimed to be terrestrial (e.g., de Queiroz 1987), but young individuals climb frequently and even large adults climb well (Figure 2).

Iguana pinguis is entirely confined to the Greater Puerto Rico Bank. It has been extirpated from Puerto Rico and the United States Virgin Islands (Pregill 1981). Until 1984, the only known surviving population was on Anegada in the British Virgin Islands (Barbour 1917; Carey 1972, 1975).

The Anegada population has been declining since 1968 when a foreign firm, the Development Corporation of Anegada, Ltd., began an abortive attempt to lease and develop the cay. Stock retaining walls were bulldozed and previously-penned exotic ungulates (goats, sheep, cattle, burros, and swine) were released to roam the island at large. Based on work completed just after the signing of the lease, Carey (1975) warned that free-ranging ungulates might compete with the iguanas. Lazell (1980) reported the desertification of Anegada years after the stock release. Goodyear (1988, 1991) found both numbers and area occupied on Anegada had dwindled dramatically since Carey's pre-release estimate of 2 per ha made in 1968.

Goodyear's current work on diet and population status (in prep) provides several lines of evidence that cement the relationship between the stock animal release and the decline of I. pinguis. Other threats are posed by dogs (which are known to kill adults), cats (which kill juveniles), and humans historically have killed all age classes.

In July 1984, concerned that the iguana was jeopardized on Anegada and that no measures were planned to protect it, J. Lazell, W. MacLean, G. Mayer, and H. Jarecki decided to transport several pairs of I. pinguis to the Guana Island Wildlife Sanctuary in an attempt to create a subpopulation there. Chapman Grant (1932) had reported iguanas on Guana Island, but gave the species as I. iguana. Oscar Chalwell, however, who has worked on the island since 1928 and was burning charcoal on the island in Grant's time, never saw any iguana on the island or neighboring islands prior to the 1984 relocation (pers. comm. 8 October 1992). The conflicting accounts indicate Grant's report may have been based on hearsay. No I. iguana fossils or subfossils have been found on the Puerto Rico Bank (MacLean, 1982) suggesting it is a relatively recent, possibly post-glacial, arrival. While we do not believe that I. pinguis occurred on Guana in modern times, fossils found on St. Thomas and Puerto Rico indicate this species' distribution encompassed most of the Greater Puerto Rico Bank (including Guana) at glacial maximum, ca. 10,000 yr BP.

Between 1984 and 1986 eight individuals were caught on Anegada and relocated to Guana Island. For five females released, SVL in cm (followed by release date and reproductive status, if detectable) was: 46.0 (29 July 1984; palpably gravid), 44.0 (19 July 1986), 22.4 (27 July 1986), 33.5 and 43.0 (31 July 1986; the larger was gravid). For three males SVL in cm (and release date) was: 41.0 (19 July 1985), 50.4 and 50.9 (31 July 1986).

If the 1984 gravid female successfully nested, that might explain several subadults seen by Lazell on Guana in July 1987. Hatchlings were observed by October 1987, as they have been each year since. Several of these are believed to have grown to be the adults studied in 1991 and 1992.

Methods

This study was prepared for in 1990 and 1991 by the location and taming (using fruit rewards) of four wild adult (SVL >40 cm - Carey, 1975) iguanas. Tamed iguanas, and young individuals, did not flee when approached which allowed us to mark them, "recapture" them (visually), and determine portions of their home ranges by locating identifiable individuals in various parts of the study area. Study animals had portions of their home ranges in an area centered about the Guana Island Club. The approximately 3 ha study area supports a mixture of native and exotic plants and has a relatively dense understory. A sheep-exclosing fence encircles much of the area.

Home Range

Outermost positions occupied by identified iguanas between October 1990 and November 1992 were mapped using a combination of techniques. If the iguanas' positions could be recognized they were plotted directly on 1:3000 maps of the site, otherwise we determined positions by telemetry of transmitters carried by iguanas or placed at the iguanas' former locations. In 1992, four tame iguanas were fed 2 x 4 cm radiotags wrapped in a blanket of chicken skin; two knots secured the skin on either side of the tag. To minimize impact to the iguana we used as little thread as possible. The tags contained L.L. Electronics one-stage transmitters (with collapsed loop antennae) potted in a wax slug coated with dental acrylic. Finished tags were dipped in brightly-colored latex tool-coating material so the tag could be more readily recovered after it had passed through the animal's digestive tract (usually 4 - 7 days). Tagged animals were not supplemented with food while they carried the tag. Bearings to transmitters were recorded from nine mapped telemetry stations. Generally we took readings every two hours from at least two stations. Readings were usually not more than five minutes apart, but were accepted if they were as much as 20 minutes apart. No locations were made using angles less than 30°. To make sure telemetered positions were accurate, direct approaches to the animals were made after each remote determination. Generally radiotagged iguanas were approached at dusk, after dark, and at dawn to confirm their night locations.

Density Determinations

From 3 through 30 October 1992, we conducted a mark-recapture study of I. pinguis on Guana Island. We modified standard techniques by avoiding actual capture of individuals. Experience with I. pinguis on Anegada indicates that capture and handling makes individuals wary and unapproachable. Because an ancillary study involved observations of feeding behavior and food selection experiments (Goodyear, in prep.), it was important that iguanas be traumatized as little as possible.

Iguanas were approached within 3 m and marked with oil-based paint fired from a disposable 3 cc syringe. A single dot of red paint used to mark the lumbar region of first and most approachable female appeared to excite her. She peered over her shoulder to investigate it. Although this lasted only a few minutes, we switched to white paint for all subsequent individuals. None responded in any visible way to white, either when it hit them or later in the study. The paint splatter patterns and drips were distinctive on each specimen; there was no confusion of marked individuals seen in good light. (It was sometimes difficult to identify some individuals only partially visible in dens or burrows.) Population estimates were made using the Schnabel (1938) method and programs written by C.J. Krebs (198_). Because of the increased likelyhood of "recapture" of tame iguanas we felt inclusion of all sightings might artificially decrease the point estimator and constrict the confidence interval. We therefore used two data sets in all population estimates: one in which all recapture data were included, another in which recaptures counted only when new ones were marked that same day.

Our study area included regions of relatively high iguana and observer density. We calculated the perimeter of the study area (our equivalent of a "trapping grid") by mapping a polygon of outermost points of "captures" and "recaptures" -- sightings of identified individuals not carrying radiotags. For density estimates, we added a boundary strip to the study area equal to the average home range radius of radiotagged individuals, since, because of the animals movements, the sampling area is larger than the actual study area (Dice 1938). Water (ocean, salt pond) overlapped by the boundary strip was subtracted leaving a total sampling area of 18.8 ha.

In 1992, in addition to the two of us, we had two assistants dedicated to the project (K. Johnson and J. Randall), and two club staff who would spot and identify iguanas in the course of their work (L. Cooper and S.E. Henry). As many as 15 other club staff and eight scientists working in the study area would notify us if iguanas were seen. We did not consider sightings as "recaptures" unless confirmed by at least two of the six people (including us) who recognized the marks.

Minimum convex polygon, 95% ellipse, and harmonic mean home ranges were calculated using TELEM.88 (Colman, 1988). To check the accuracy of our telemetry readings and relate the movement data to topographic features of the study site we transferred the information to a GIS database (PC ARC/INFO, ESRI, Redlands, CA), using a DIGI-PAD 5 (GTCO Corp., Rockville, MD).

Results

Ten individuals were marked during October 1992: 1 adult male, 3 adult females, 6 juveniles. Radiotelemetry locations were made for each of the four adults for 3 to 7 days ($\bar{x}=5$). Visually-determined locations of individuals at outermost points of movement between 1990 and 1992 were included in the home range data set. The male's minimum convex polygon estimate of 7.3 ha was larger than that of all females ($\bar{x}$=1.7 ha, Table 1, Figure 3). Intensively-used areas (50% probability of occurrence contour, harmonic mean estimates) were smaller still (Table 1, Figure 4), and all encompassed areas within the sheep exclosure. Average home range radius of the four adults was 175 m.

It did not appear that iguanas moved between nighttime checks. Night locations varied: iguana 1 retreated to two different excavated burrows, iguana 2 to three excavated burrows and one tree, iguana 3 to two excavated burrows and one tree, iguana 4 slept semi-exposed in a crack between two rocks.

The population in the area sampled was estimated to be nine individuals (95% CI, 7 - 13) with all recaptures included, 12 individuals (95% CI, 6 - 28) when capture sessions were considered as only those days on which new iguanas were marked. In the 18.8 ha sampling area the density was 0.5 to 0.6 iguanas (all age classes) per ha.

Young iguanas, smaller than the original colonists, were first observed in 1987 and hatchlings have been observed each year in late summer and early fall. On 12 September 1991 a clutch of 10 eggs was accidentally unearthed in a sand pit during road work mid-way along the road paralleling North Beach (Figure 5). One egg was destroyed but the clutch reinterred, and apparently the rest hatched on 17 September. Two hatchlings located measured 9.5 and 10 cm SVL.

Discussion

Home range sizes for the four I. pinguis on Guana were considerably larger than previously published estimates for West Indian iguanas. Iverson's (1979) work with Iguana carinata and Carey's (1975) work with Iguana pinguis home ranges on Anegada showed that all males and females had home ranges less than 0.1 ha in size, more comparable to the size of the Guana iguanas' centers of activity (Table 1). Goodyear (in prep) found home range sizes on Anegada similar to those reported here for Guana. Because animals on Guana were directly approached after each telemetry-determined location-check we know that the size differences were real, not due to telemetry error.

Field evidence indicates that I. pinguis distribution is patchy on Guana Island. Certain areas appear to have no iguanas at all. From 1990 through 1992, ca. 3350 hours of island exploration off the study area by capable observers yielded 27 sightings of unmarked iguanas in seven areas (Figure 5). Individuals may have been counted more than once or, prior to October 1992, may have been animals we later marked. Five of the areas are within normal travel distance, or within home ranges, of iguanas inhabiting the study area (Figure 3). An isolated individual was seen on one occasion at the center of the island, but apparently the only discrete subgroup inhabits the extreme east end of the island (Figure 5).

We estimate the total adult iguana population at 20 animals. There are doubtless individuals we have not seen; at this point, however, very few. Two were reported on the study site that we never saw: a large male and a subadult (1 - 2 years old). In late August through October flushes of hatchlings are regularly observed. Dispersal outward and upward from their natal beach in response to early-morning insolation might explain the numbers of hatchlings seen along the Club's east slope and ridge top. We see few subadults and much unoccupied habitat. In one case we observed an adult female iguana chase a hatchling away from an area in which she was being fed. Adult territoriality may decrease recruitment of hatchlings in prime areas of habitat.

For adults, three factors seem to influence habitat quality and determine the distribution and abundance of I. pinguis on Guana: vegetation, aspect, and shelter. The most striking difference between the relatively densely populated iguana habitat associated with the Club and the rest of the island involves the understory vegetation as it is affected by sheep. Sheep have been present on guana since at least the 1930's when the Bigelows' acquired the island. Shortly after, the Club area was fenced and the roads into it were pipe-grated to form a sheep exclosure. Since 1980 continual efforts have decreased sheep numbers from about 100 (Lazell, 1980) to less than 50 (pers. obs.) but reproduction still occurs. Though the fence is now deteriorating, sheep rarely enter the exclosure and vegetation around the Club is notably different from the surrounds.

Outside, sheep have browsed desirable understory vegetation (non-toxic, palatable, nutritious species) up to a height just under 2 m, and left a sparse covering of toxic and noxious plants (e.g. Lantana spp. and Croton spp.). I. pinguis adults generally forage on or within a meter of the ground and we expect that either the low quantity of ground cover or the quality of the cover is preventing their establishment on most of the cay. We do not know if the success of the iguanas within the environs of the Club's sheep exclosure is due to the presence of an ungrazed understory of native plants or the suite of edible exotic species there (e.g. Hibiscus spp. and Ixora spp.). Species composition aside, Lazell points out that Guana appears more verdant than many islands where iguanas are abundant. To date however, iguanas have failed to evenly populate the cay. The relationship of sheep to suppression of the iguana population may be clarified if iguana distribution and numbers increase once sheep are extirpated from the cay and the natural understory recovers island-wide.

Topographically and geologically, Guana and Anegada are dissimilar: Guana is largely rugged igneous rock hills with some sandy lowlands (maximum elevation, 246 m), Anegada is an old reef tract: half limestone, half sand (maximum elevation, 7 m). On Guana, because of its relief, aspect may be important to iguanas and influence their distribution. While Guana has east-facing slopes that do not seem to support iguanas, these are generally shaded in early morning by relief to the east. All sleeping sites (n=7) except one occupied by the male were on ridge tops or had eastern exposure. As Carey (1975) reported for iguanas on Anegada, and Goodyear has frequently observed, iguanas bask near sleeping sites prior to foraging in morning hours. It may be advantageous for cold, sluggish iguanas to bask near burrows to facilitate escape from predators. We found they frequently retreat into burrows when approached just after sunrise.

Geological differences between Anegada and Guana also may affect the quality and number of shelter sites. Central regions of Anegada have thousands of naturally occurring limestone cavities which are used as refuge and sleeping sites by iguanas. Iguanas excavate burrows there in sandy areas only. On Guana, all refugia are excavated from hard-packed soil with associated rock outcrops. This requires greater energy expenditure than the alternatives on Anegada (no digging, or digging in sand) which may explain why refugia are less densely spaced on Guana. Decreased burrow density on Guana may result in the arboreal tendencies we noted there. In a similar study on Anegada (four one-month sessions from 1988-1991) Goodyear and three assistants never observed an iguana sleeping in a tree (Goodyear, in prep.).

Decreased burrow density may also increase vulnerability to predation. On Anegada and Guana, frightened iguanas flee towards burrows. On Anegada, shelter sites are always within 30 m. On Guana, iguanas have been found 250 m from their closest known burrow considerably increasing their exposure during flight. Red-tail hawks (Buteo jamaicensis), or perhaps now-extinct nesophontid insectivores, are likely to have been the only native predators of I. pinguis, but must have preyed largely on hatchlings or eggs. Humans and their associated cats and dogs prey on both juveniles and adults. At the advent of human colonization, iguanas that inhabited islands with volcanic terrain may have suffered a new and unacceptable level of predation. Low density of shelter sites may have been critical if it hindered escape, and may explain the recession of I. pinguis from most of its former distribution on the Puerto Rico Bank. In concert, the porous limestone habitats on Anegada and the relatively small human population may have provided a critical refuge for I. pinguis, its last natural stronghold.

Many would argue that Guana's population is to small to call a success, far lower than the "minimum viable population" of 500 individuals commonly used as a guideline (Dodd and Seigel 1991, Grumbine 1990). We believe Guana's I. pinguis population to be both normal and viable. Populations descended from a few individuals are the norm on oceanic islands -- we believe the entire present West Indian herpetofauna must have arisen from a small number of founders. It is difficult to envision multiple scenarios in which 500 individuals of each ancestral species arrive. More plausibly, offspring from single gravid females or the occasional pair underwent the scrutiny of natural selection in each novel environment. If high fecundity characterized colonizers, evolution and adaptation to local conditions could sweep small gene pools. Further, small populations (< 500 individuals) are persistent in the West Indies. Many islands presently populated by endemic species are so small that they cannot support 500 individuals. Carrot Rock, southeast of Peter Island, British Virgin Islands, is a 1.3 hectare protrusion from the sea supporting a spectacularly distinct undescribed species Mabuya (Lazell and Mayer 1992). The speciation that has occurred is testament to both the persistence in isolation and viability of the small populations that occur on that rock. Other examples are given by Craig (1991) and Simberloff et al (1992). Certainly many West Indian cays support tiny but tenacious populations of sheep and goats, Guana being no exception. We suspect that minimum viable population size may have to be assessed on a case-by-case basis. On Guana, the small population of I. pinguis could be called inviable only if it failed to respond to local selection pressures or expand when given the opportunity.

Conclusions

A reproducing population of Iguana pinguis is now established on Guana Island, where it had certainly been absent for more than half a century prior to 1984. None of the eight original colonists brought from Anegada between 1984 and 1986 is known to survive, but a population of 9 to 12 occupies 19 ha, 3 ha of which is apparently optimal habitat. All 10 marked individuals were hatched on Guana, six appear to be young of the year. On the rest of the 300 ha of Guana Island iguana distribution is patchy and sparse. We approximate that 20 adults inhabit the cay. If predation and foraging competition by humans and their domestic animals are curtailed I. pinguis may be capable of expanding its population on the cay. The experiment on Guana continues: predation by non-native animals has been eliminated on the Guana Island Wildlife Sanctuary (with the demise of the last cat), we hope the last sheep will not be far behind.

The conservation status of the other iguanas of the northeastern Antilles, I. iguana and I. delicatissima has not been reported since Lazell (1973). The relevant field work for that report was done in 1963-4. Lazell (1973:26) pointed out population declines and island extirpations, but complained "...there is no evidence that man, mongooses, dogs, cats, goats, or pigs -- singly or in combination -- have affected them." In Lazell's field notes are frequent comments that iguanas were "very common" at many sites, including St. Barts and Gaynor's Gut, Antigua, where man and associated exotic animals were also dense.

Carey' descriptions of population structure on Anegada indicated a sort of false prosperity (1975:225): adults represent close to 90% of the population six months after the hatching period. Adults appeared numerous and demonstrably breeding, but there was low recruitment. We have noticed the same trends in age structure on Anegada (Goodyear, in prep.), and Lazell observes the population as a whole appears to have decreased since his first visit in 1980. Low numbers of sub-adults may be due to predation of young by cats and dogs (Carey, 1975) or, after young have passed their more carnivorous juvenile phase, competition with feral livestock and adult iguanas for quality mast and foliage (Goodyear, in prep.).

With these scenarios in mind, it is now important to revisit such sites as Ile Forchue, northwest of St. Barts, where in 1963 Lazell recorded "at least 40" individuals and noted: "Huge colonies swarm..." (Lazell, 1973: 22). Ile Forchue is larger than Guana Island, ca. 535 ha, as is Ile Chevreau, ca. 448 ha, also said to have a large population of I. delicatissima (Lazell, 1973: 22).

The Goat Islands, off the south central coast of Jamaica, formerly had a large population of I. collei (Grant, 1940). After introduction of mongooses it was assumed that iguanas were extirpated there. They may not have been so drastically affected. Seemingly prosperous populations of iguanas occur in many places where mongooses are abundant, like Hispaniola, St. John, and St. Thomas (Schwartz and Henderson, 1991). If iguanas persist on the Goat Islands a program mongoose and goat (and other exotic species) removal might restore these islands to excellent habitat. If iguanas have been extirpated, then elimination of exotica might be easy, because a poisoning campaign could be carried out without risk to iguanas. Captive stock of I. collei (Ehrig, 1990) could be reestablished. Great Goat Island, ca. 230 ha, is certainly large enough to support a population, Little Goat, ca. 100 ha, may well be too.

We believe relatively small islands may be the key to long-term prosperity of many species of iguanas.

Roy Snelling
Charles J. Krebs
~~Fred Kraus~~

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dedicate this work to memory of two great Antillean herpetologists and biologists: William P. Maclean and Albert Schwartz.

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Table 1. Home ranges in hectares of three adult female and one adult male I. pinguis on Guana Island, British Virgin Islands.

		HOME RANGE (ha)		
IGUANA	SEX	MINIMUM CONVEX POLYGON	95% ELLIPSE (non-circular method)	50% CONTOUR HARMONIC MEAN
1	female	0.9	1.1	0.1
2	male	7.3	21.5	1.5
3	female	3.5	4.2	0.4
4	female	0.7	1.9	0.1

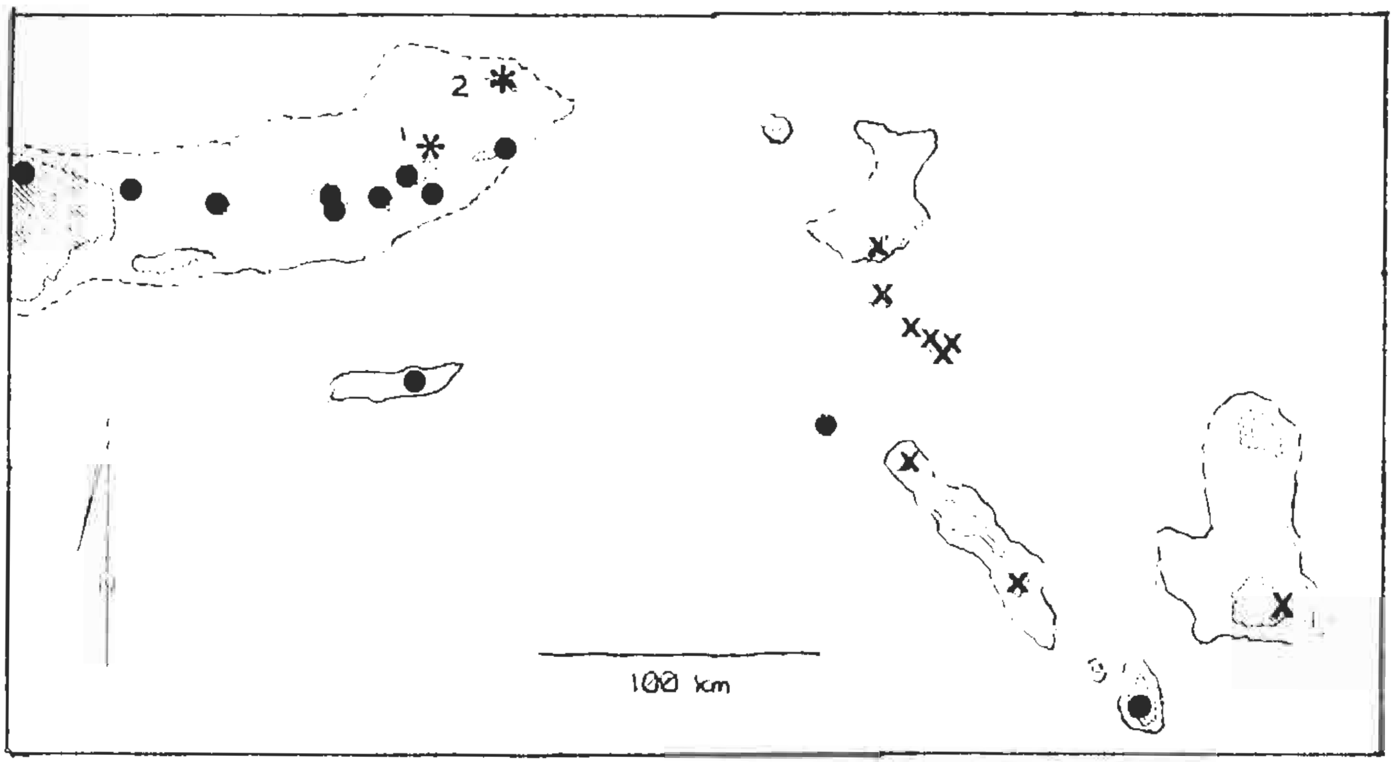
Figure 1. Northeastern West Indies showing known populations of Iguana: I. pingus, asterisks. I. iguana, dots. I. delicatissima, crosses. 1, Guana, 2, Anegada, British Virgin Islands. 3, St. Barts and satellite cays Ile Forchue, Ile Chevreau, and Ile Fregate. 4, Gaynor's Gut, Antigua. Islands are hatched. Bank edges, land limits at glacial maximum, are dashed.

Figure 2. Male Iguana pinguis in a loblolly (Pisonia subcordata) tree on Guana Island at sunrise.

Figure 3. Minimum convex polygon home ranges of four adult Iguana pinguis on Guana Island. Iguana 1, 3, and 4 are female; Iguana 2 is male. Black polygons are Club buildings; closely-parallel lines are roads.

Figure 4. Centers of activity of four adult Iguana pinguis on Guana Island as shown by 50% contours of harmonic mean home ranges. Iguana 1, 3, and 4 are female; Iguana 2 is male. Buildings and roads as in Figure 3.

Figure 5. Guana Island. The study area (horizontal lines), its associated boundary strip, and six areas (diagonal lines) outside the study area in which adult iguanas have been observed. Numbers in circles are numbers of sightings. Black polygons are Club buildings.


2
100 km
1

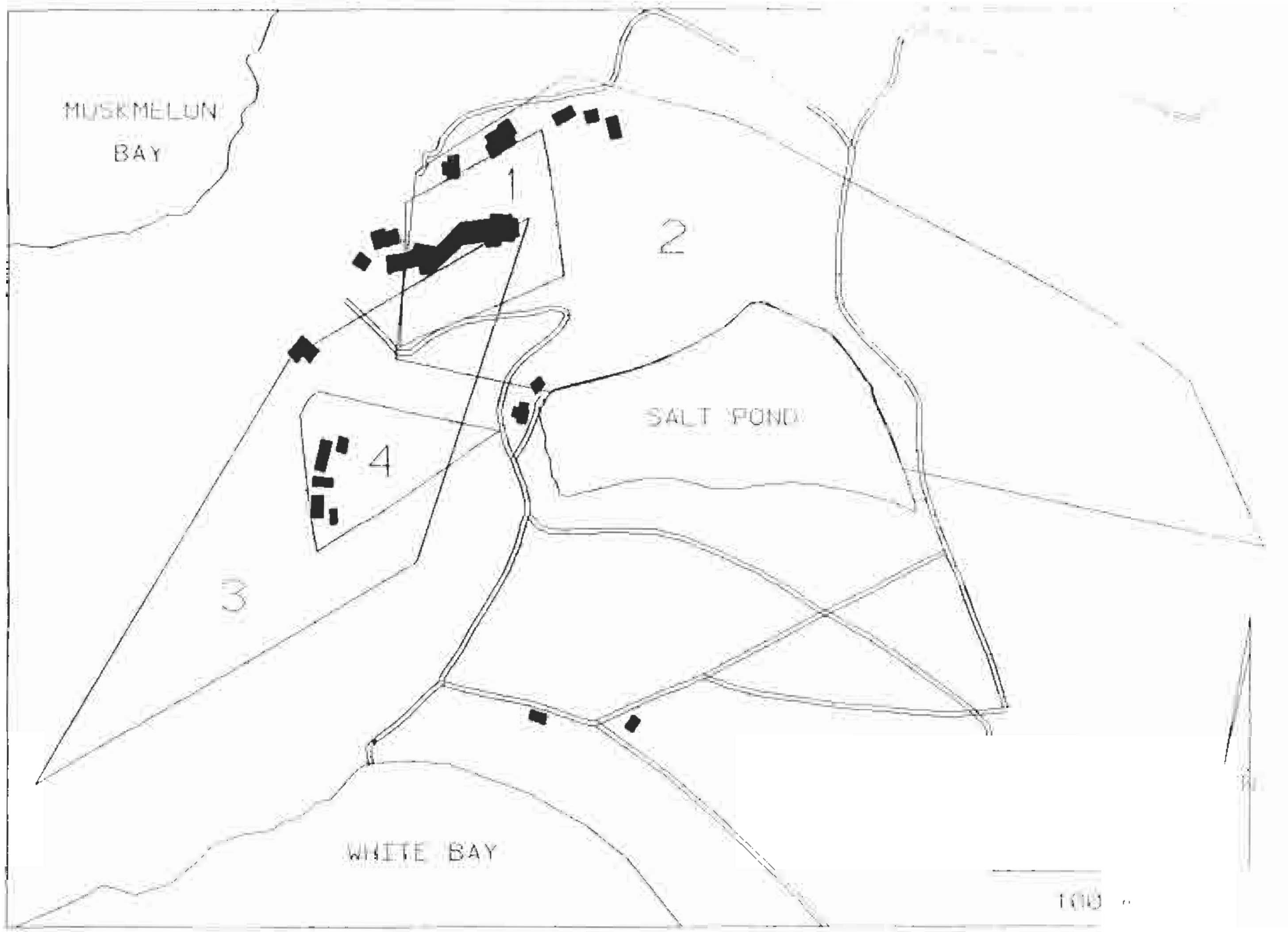

MUSKMELON
BAY
1
2
SALT POND
4
3
WHITE BAY

Fig. 5

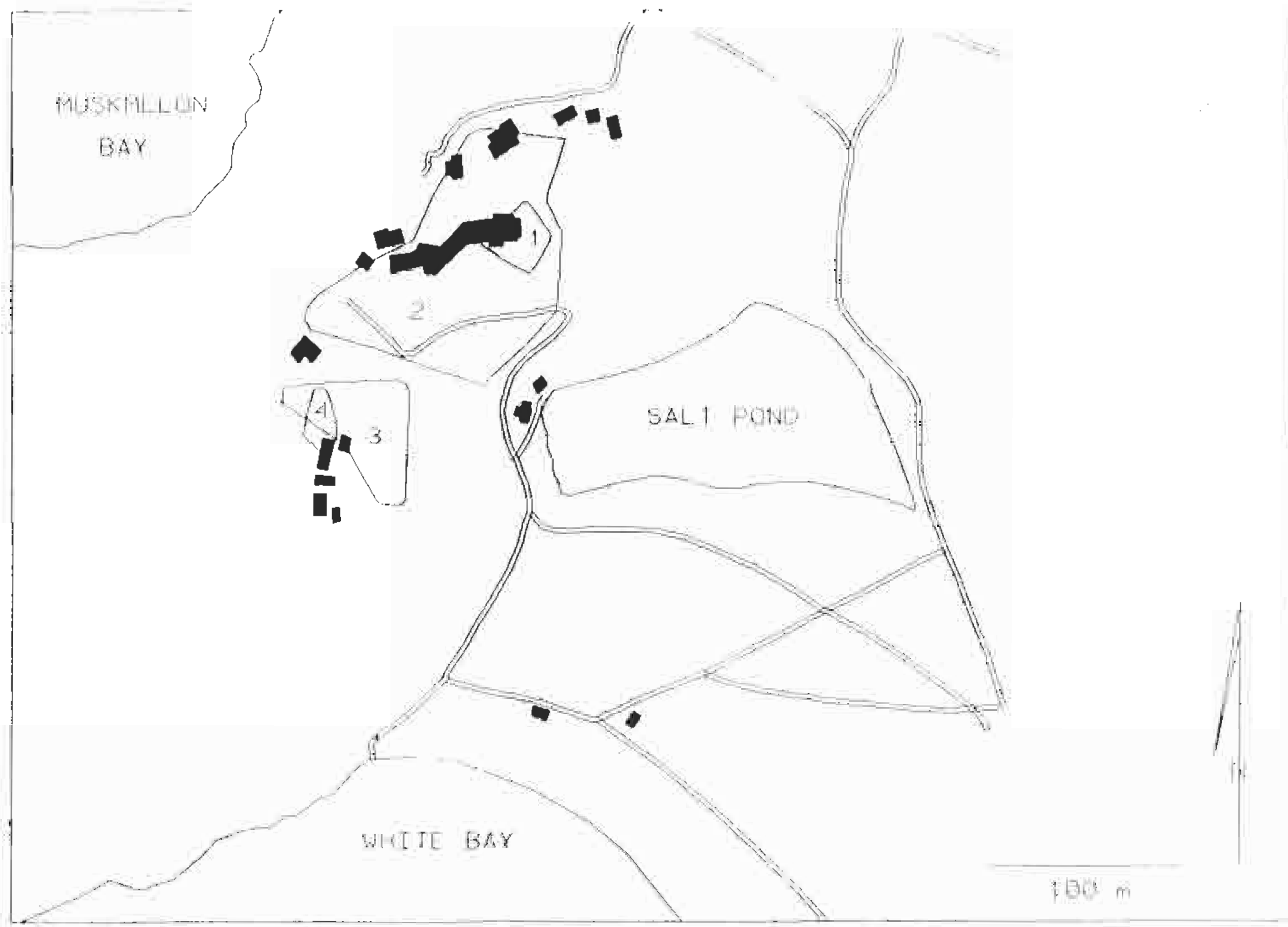
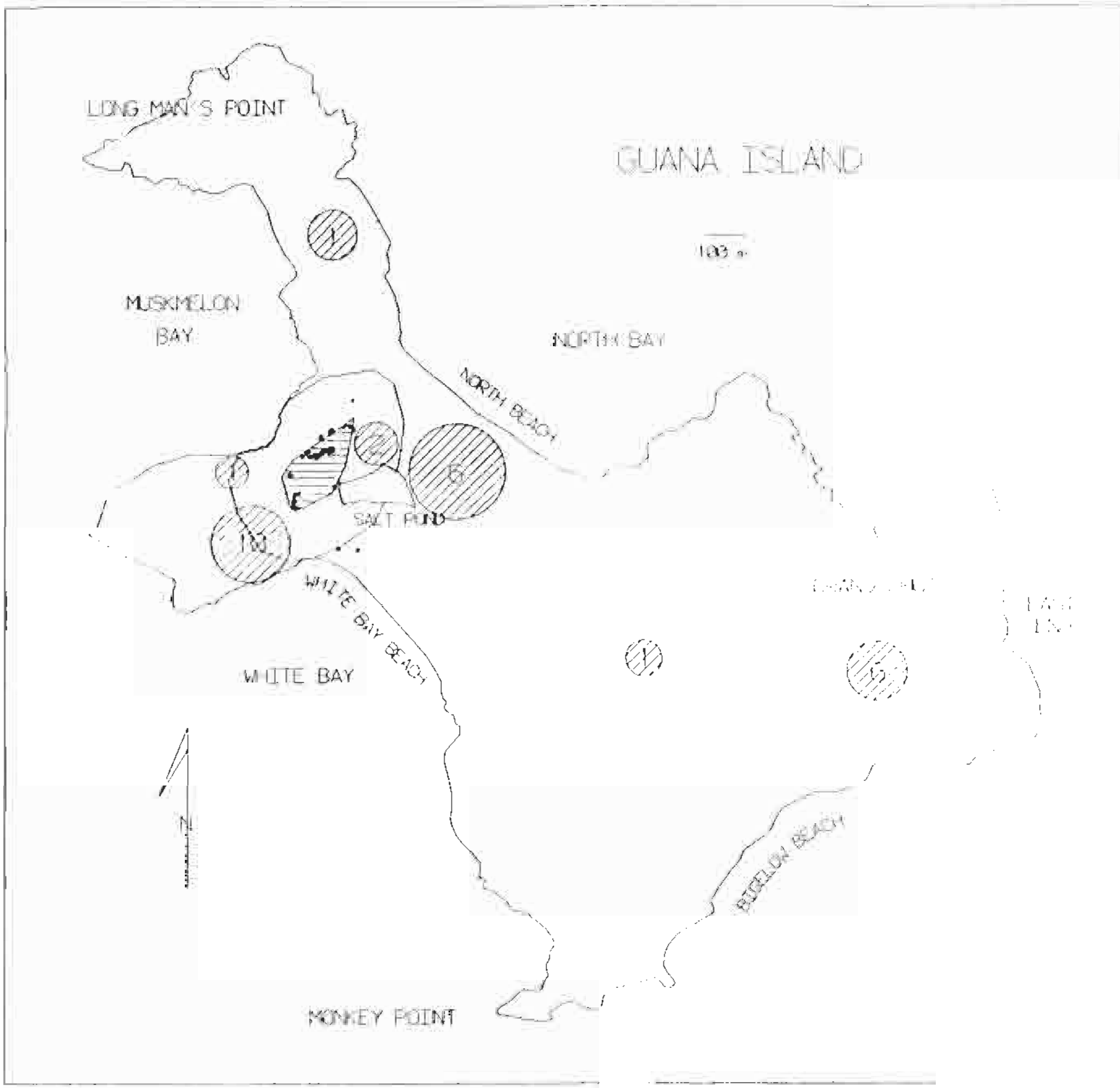


Fig. 5


LONG MAN'S POINT
GUANA ISLAND
MUSKMELON BAY
NORTH BAY
NORTH BEACH
SALT POND
WHITE BAY BEACH
WHITE BAY
BIGELOW BEACH
MONKEY POINT
N