The Conservation Agency Exploration, Education, and Research

Fresident James D. Lazett, FhD 401-428-2652

For 1990

6 Sunnburne Street Conanient Island R.S. 02835 U.S.A.

April 8, 1991

Dr. Henry Jarecki Byewood, Timber Trail Rye, NY 10580

Dear Henry:

Herewith a report on 1990 Guana Island Wildlife Sanctuary and related scientific activities.

It was a peculiar year. A much reduced July session involved ongoing population biology work on <u>Anolis</u> lizards (Greg Mayer and assistants) and <u>Nasutitermes</u> (Margaret Collins). The idea was to obtain July data as in previous years to allow relevant comparisons to October - November data collected under the new deal scientists month. Thus, 1990 started out as a repeat of 1989, when the new scientists month of Oct. - Nov. was cancelled by Hugo.

The Oct. - Nov. scientists' month was a great success biologically, but a strain on the Guana staff. We decided, therefore, to abandon the idea and return to the original July scientists' month for 1991. Nevertheless, data collected on insects (Miller, et al.), Anolis lizards (Mayer and Lazell), Iquana (Goodyear, at al., inc. Lazell), and Nasutitermes (Collins) greatly enhances that collected in previous years. As we suspected, Oct - Nov is very different from July and many species are far more abundant or evident.

New projects were begun by Peter Chabora (insects) and Numi Goodyear (Iguanas and more).

I continue to tout restorations, including the gorgeous woodpecker and the elegant white-crowned pigeon. Both will happen in time, I am sure. I even believe we will get parrots.

New proposals involve marine turtles and frogs. Karen Koltes would like to pick up fish and other marine work again. About these items, more in my 1991 proposal, below. We have four new publications out since the last report, although one is only new to our knowledge having been published in 1988. (As the fruits of our work dispense it will become increasingly difficult to keep track of resulting publications. Scott Miller does a great job of this, however.) Relevant portions of each publication are

- included below. All make for exciting reading (but we love them anyway):
- Marsh, P.M. 1988. Revision of the tribe Odontobraconini in the western hemisphere (Hymenoptera: Braconidae: Doryctinae). Systematic Entomology 13:443.464.
- Slipinski, S.A. 1989. A review of the Passandridae (Coleoptera, Cucujoidea) of the world. II. Genus <u>Catogenus</u> Westwood. Polskie Pismo Entomologiczne 59:85-129.
- Epstein, M.E., and S.E. Miller. 1990. Systematics of the West Indian moth genus <u>Heuretes</u> Grote and Robinson (Lepidoptera: Limacodidae). <u>Proceedings of the Entomological Society of Washington</u> 92(4):705-715.
- Medler, J.T. 1990. Types of Flatidae (Homoptera) XIV. Walker and Distant types in the British Museum. <u>Oriental Insects</u> 24:127-195.

We continue to look for a publisher for <u>Island</u>..., and continue to amass data to make it better.

All the best,

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ENTOMOLOGY

I am not disappointed that beetle work progresses slowly and that the specialized collecting techniques Mike Ivie refers to have not yet been used. Of course, I want to save the best beetle work for Wenhua.

Slipinski's beetle paper is interesting to me because Guana's new species is named for Philip J. Darlington, one of my favorite professors - now sadly gone. Too bad Slipinski didn't pick Guana as the type locality! We did not know he was working on these (anyone can borrow Smithsonian specimens, even if they think the Smithsonian is in New York).

Kormilev is a previous author (see last year's report), working on weird bugs. His letter indicates more to come.

John Medler's work on Homoptera is little-known to me. I just got bits of the paper, sadly without the illustrations. I do not know how our West Indian species got into a work on Asian forms, or just what <u>Flatoides</u> (<u>Melormenis</u>) <u>basilis</u> looks like when it hits the shrimp creole on the dining terrace. Leafhoppers and cicadas are classy-looking insects and I will try to find out more. For this species, at least, Guana now sets the world standard.

I will make Peter Chabora aware of Marsh's work on parasitic wasps. This ties in with Fruit Flies, below.

Scott seems to have sent you most of his stuff independently, but I suspect the September revision of the list is new. Means little to any of us until it gets illustrated, but it is an enormous undertaking and will one day make us famous. I believe we should someday publish an illustrated "butterflies and moths of Guana Island."

Margaret's work on termites continues apace. Two reports from her are included here. The first deals with the biochemical work she is doing with colleagues like Barbara Thorne on the cuticular hydrocarbons: organic chemicals secreted from the exoskeleton of the termites that are believed to play a key role in species determination - both for the termites and now for us.

Then comes Margaret's mini-course on termites she drew up for the BVI Community College, or even for high school students. If and when we can seriously become involved with BVI-CC, this is the sort of local, hands-on, activity-oriented thing I believe we can use.



BISHOP MUSEUM

January 3, 1990

Dr. Michael A. Ivie Dept. of Entomology Montana State University 419A Leon Johnson Hall Bozeman, Montana 59717

Dear Mike:

Under separate cover, I am sending you 64 beetles collected on Guana Island by Vitor Becker after the hurricane. Unfortunately, my trip to join him there had to be canceled because of damage to the hotel on Guana Island. I am also including a few beetles from previous years that showed up in unsorted material.

Any further progress reports will be helpful in keeping the flow of beetles coming! We hope to return again in November of 1990.

Looking forward to you comments.

Sincerely,

Scale

Scott E. Miller Chairman Dept. of Entomology

cc: V. Becker

J. Lazell

MONTANA Entomology Research Laboratory UNIVERSITY

Montana State University Bozeman, Montana 59717 406-994-3860

2 June 1989

Dr. Scott E. Miller Department of Entomology Bishop Museum P.O. Box 19000A Honolulu, HI 96817

Dear Scott,

Just an update on the Beetles of the Virgin Island project, and the status of your British Virgin Island records. It must seem that nothing will ever come out, but though the wheels turn exceedingly slow, they do turn.

Your material has included some extremely interesting new material. Although approximately 90% of the specimens are well known Virgin Islands species, the other 10% has been a real surprise. I have judged the progress of the project by how many species new to the study turn up in each new batch of material. Based upon this method, I had believed I was approaching saturation for the Northern Virgin Islands, but your BVI material has shown that that is only true for the U.S. islands. It is amazing how diverse little Guana Island is! I have several new species known only from that island and your material, including a clerid and a chrysomelid that are ready to go to press. more important is the material from Sage Mountain and Virgin Gorda, where moist forests were completely unsampled. scarab is to be described from Sage Mt. next year.

Because I am working with co-authors, and because my project is totally unfunded, it does take a long time for things to appear in print. For instance, the Chrysomelidae of the Virgin Islands, with Shawn Clark, is over 100 pages in ms. We have a problem getting the illustration work done, and finding a way to publish. The clerid paper is with Bill Barr, who's health has not allowed us to get it finished and out, although it is so close I can taste it. I can go on with other examples, but I am sure you get the picture.

Again, thanks for sending all the material. I can assure you that it is useful. I just hope that you can get to more islands, and use some more specialized techniques next time.

Yours, of the

Michael A. Ivie

Assistant Professor and Curator

Nicholas A. Kormilev

5924 Gulfport Blvd. So. Gulfport, Florida 33707 U.S.A.

Dr Scott E. Miller, Chairman
Dt Intent of Intomology
B.P. Bishop Museum
Honolulu, Hawaii, 96817-0915

Lay oth, 1989

Dear Dr. Miller,

Yesterday came your parcel in good order and today your letter of May 1st, 1989, best thanks for both.

The single specimen is <u>Lophoscutus crassimanus</u> (Pabricius), o. Though it was described still by Fabricius, it is a good and rather rare species, known only in a few specimens. It was recorded previous: ly from the American Virgin Islands and Central America.

I thank you for giving me an opportunity to study this specimen.

I will return the specimen early next week.

Best regards,

purs sincerely

Wicholas A. Kormilev.

DATA: British Virgin Islands, Great Camanoe, 15-VII-1988, S.E. Miller & C. O'Connell.

HEMIPTERA: PHYMATIDAE

Oriental Insects, Vol. 24: 127-195, 1990.

TYPES OF FLATIDAE (HOMOPTERA) XIV. WALKER AND DISTANT TYPES IN THE BRITISH MUSEUM

JOHN T. MEDLER

Bishop Museum, P. O. Box 19000-A, Honolulu, Hawaii 96817, U.S.A.

ABSTRACT. Original label data associated with all extant known syntypes of Flatidae named by Francis Walker and W. L. Distant are recorded. Whenever available, the genitalia of holotype and lectotype males are illustrated. Assignment of species in genera currently accepted in Flatidae is reviewed, and new synonymies or new combinations are given where necessary.

Introduction

The types of Flatidae described by Francis Walker and William Lucas Distant were studied in connection with research on this family in the Indomalayan Region that was undertaken by the writer in 1980. It especially was necessary to study the Walker types that were based on materials collected by Alfred Russel Wallace in the Indomalayan Region, because during preparation of his comprehensive monograph on the Flatidae, Melichar (1901-02) named many species that had been collected by H. Fruhstorfer and other collectors in the same region. Synonymy was to be expected, as the Walker types were not available on loan to Melichar and it was well known that many species named by Walker could not be determined precisely on the basis of the original descriptions alone. The majority of the Walker names were found in his lists of specimens in the British Museum, Insecta Saundersiana, and two major reports on Wallace collections in Indonesia (Walker, 1851, 1857a, 1857b, 1858a, 1858b, 1870a).

After completing a data base for types in the Indomalayan Region, my study was extended to include all extant Walker and Distant types in the British Museum. A few Walker types found in the Museum of Victoria were reported earlier by Medler, 1986.

A review of Distant syntypes was important because many represented type-species of flatid genera proposed by Distant in his various publications, including a major contribution in the Fauna of British India. Also, in many cases Distant assigned new species to genera erected by Melichar (op. cit.) without a proper understanding of the taxa involved. No evidence was found in his published works that either Melichar types or specimens determined by Melichar were examined by Distant. During my review of Walker, Distant and Melichar types, I was helped considerably in recognition of existing errors by research on female and male genital characters. Illustrations of male genitalia were presented to support my proposals on new synonymy and new combinations reported at this time.

Although Distant was known principally as a student of the Hemiptera, he published 108 new species names in the Flatidae during the period from 1880 to 1918. His major contribution was made in connection with the monumental Fauna of British India, including Ceylon and Burma (Distant, 1906, 1916). In addition, he described new species from Transvaal, South Africa, from collections provided by the Wollaston Expedition in New Guinea and from specimens sent to him by correspon-



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17. atrilinea Walker, 1858b: 69 (Elidiptera)

Holotype F - (1) Type [green-ringed round label]; (2) Elidiptera atrilinea; (3) Mex [obverse]; 56/143 [reverse, round label].

Flatoides atrilinea (Walker); comb. by Fowler, 1900: 63.

The genus Flatoides Guérin-Méneville, is restricted to Madagascar. New genera are required for species of Flatoides auctorum in the New World.

18. basalis Walker, 1851: 419 (Flatoides)

Lectotype F - (1) 44/22 [round label]; (2) 27. Flatoides basalis.

As the male syntype cited in original description was not found in the British Museum, a plesiotype male from <u>Guana Isl.</u>, <u>British Virgin Isl.</u>, col. S.E. Miller, in the Bishop Museum, was selected for measurements and illustration of genitalia (Fig. 34). Closely similar genitalia were illustrated by Caldwell, 1950: 237, pl 45, for the species he named *Ormenis antillarum* Kirkaldy.

Measurements from plesiotype - Length: 6.0; v 0.08; f 0.91; p 0.33; m 1.49; t 5.15; pcl 0.83, Width: v 0.83; f 1.00; t 2.49. Spine formula: 2:6:7.

Anaya basalis (Walker); comb. by Melichar, 1923: 99.

Type-species of *Melormenis* Metcalf; original designation by Fennah, 1965: 107 [as the senior synonym of *Ormenis antillarum* Kirkaldy].

19. basistigma Walker, 1858b: 69 (Elidiptera)

Holotype M - (1) Type [green-ringed round label]; (2) Elidiptera basistigma; (3) Mex [obverse] 56/143 [reverse, round label].

Atracis basistigma (Walker); comb. by Distant, 1910a: 318.

Medler, 1988c: 143, restricted the genus Atracis Stål to New Guinea and Southeast Asia. Species of Atracis auctorum in the New World require disposition in other genera.

20. bigutta Walker, 1851; 441 (Colobesthes)

Lectotype M - (1) Type [green-ringed round label]; (2) Flata/sobrina Stål; (3) 9. Colobesthes bigutta [dissected/microvial].

The original description was based on a female, but syntypes a-c were cited that probably included the male (c) without locality as above.

Measurements from lectotype - Length: 24.0 (spread); v 0.13; f 1.66; p 1.00; m 2.99; t 6.31; pcl 2.49. Width: v 1.00; f 1.49; t 5.48. Spine formula: 2:7:9.

The lectotype genitalia are illustrated (Fig. 19).

Cryptoflata unipunctata (Olivier); syn. by Stål, 1866: 241. Characters of the genitalia confirm synonymy proposed by Stål.

5. P. Bishop Aluseum Entomology Departme

POLSKIE PISMO ENTOMOLOGICZNE BULLETIN ENTOMOLOGIQUE DE POLOGNE

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Wrocław

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Guara I., pg. 109

A review of the Passandridae (Coleoptera, Cucujoidea) of the world. H. Genus Catogenus Westwood

Przegląd światowych gatunków Passandridae (Coleoptera, Cucujoidea). II. Rodzaj Catogenus Westwood

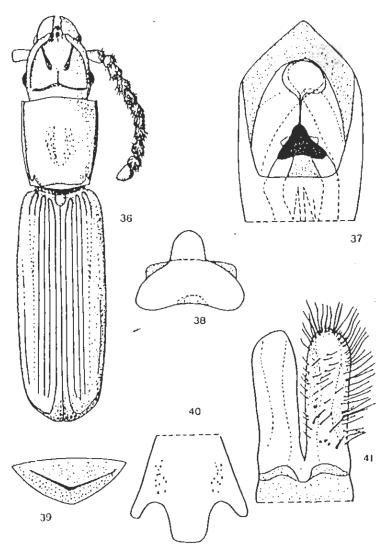
> STANISLAW ADAM ŚLIPIŃSKI Instytut Zoologii PAN, uł. Wilcza 64, 00-679 Warszawa

ABSTRACT. The world species of the genus Catagenus Westwood (= Scalidia Entenson, syn. n.) are reviewed and figured, and a key to their determination is provided. The Oriental and Afrotropical species of former Catogerius (C. carinatus Newman, C. dejeani Grouvelle, C. feai Grouvelle) are excluded from the genus, and are to be placed in a separate genus. Seven new species are described: C. asper (Brazil, Argentina, Venezuela); C. cayman (Cayman Isl., Puerto Rico, Trinidad); C. darlingtoni (Puerto Rico); C. depressus (Argentina, Paraguay, Brazil); C. grocilicornis (Argentina, Brazil); C. grouvellei (Brazil) and C. thomasi (USA: Arizona). The following new synonymy are proposed: C. castaneus (PERTY) (= C. concolor (BLANCHARD) C. distinctus Guerin-Meneville = C. integratus Sharp = C, germanus SHARP); C. collaris SHARP (= C. pusillus SHARP); C. lebasii Guérin-Méneville (-- C. sharpi Casty). Neotypes of Scalidia cylindricollis Lacordaire (Brazil) and of Isomotus castaneus Perry (Brazil) are designated. Aulonosoma MOISCHULSKY, 1858 (type-species, by monotypy: A. tenebrioides MOISCHULSKY) is transferred from Colydiidae to Passandridae and becomes a senior synonym of Laemoimenis Gerstaecker, 1871 (type-species, by monotypy: L. feringinent Gerstarcker) (syn. n.), and A. tenghrinides Motschulsky becomes

a senior synonym of L. rhyzophagoides (Walker, 1859) (syn. n.).

INTRODUCTION

This is the second contribution to a revision of the family Passan-dridae, and covers those species now recognized as belonging to the genus Catogenus Westwood. As here delimited, the distribution range of



36.41 C extinder allis, 36 = body outline, 37 = median lobe, apical piece, 38 = ostium region 39 = list ventrite, 40 = mesosternim, 41 = parameres

prosternum micropunctured; mesosternum smooth or with coarser punctures laterally (fig. 40), feebly impressed medially, last ventrite with angulate groove (fig. 39). Median lobe and ostium as in figs 37, 38, paramera as in fig. 41.

Neotype data: "Brazil, Santa Catarina, Nova Teutonia, December, F. Plaumann" (MCZ).

MATERIAL EXAMINED

21 specimens (MHNG, MNHN, MCZ, ZMB, IZPAN). Brazil: Santa Catarina, Nova Teutonia; Sao Paulo; Parana; Minas Geraez; Minas, Matusinhos; Goyas. Argentina: no locality.

REMARKS

As noted above, LACORDAIRE made an evident mistake placing his species in Scalidia sensu ERICHSON, 1845, and that was corrected by GROUVELLE (1878) who transferred this species to Catogenis and briefly redescribed it. Unfortunately the original specimens of LACORDAIRE and GROUVELLE are apparently lost, and the later could not be found in the GROUVELLE's collection in Paris. Both the original description and the redescription by GROUVELLE are not good enough to be perfectly sure the species considered was not conspecific with C. castaneus (PERTY). But since LACORDAIRE's original description and the colour figure might belong to the species here delimited as cylindricollis, that is apparently close to castaneus, I prefer to designate a neotype of the LACORDAIRE's name to stabilize the taxonomic status of the older name, than to synonymize it with castaneus and to describe the distinct species as a new one.

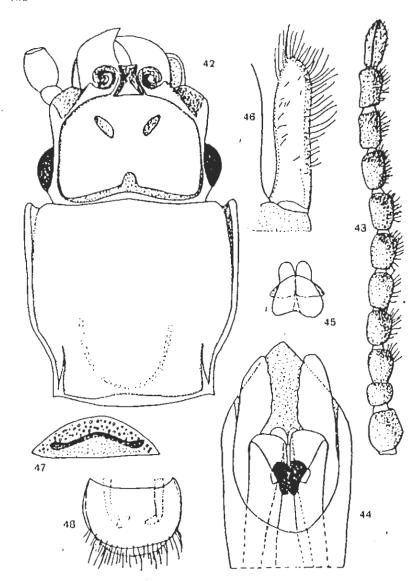
Catogenus darlingtoni sp. n. (Figs 42 48)

DIAGNOSTIC COMBINATION

Length 8.1 mm. Colour entirely brown; surface shiny. Head $0.7 \times$ as long as wide, moderately convex; median impressed line feebly marked, incomplete; occipital region deeply notched; elypeus modified as in fig. 42; admedian grooves shallow and limited; sublateral carina sharp and entire, joined to occipital groove, but this junction is not complete; eyes large; antenna $0.47 \times$ as long as body, as in fig. 44. Pronotum as long as wide; anterior angles obtuse; margins wide and entirely visible; disk subdepressed medially; median impunctate region narrow; admedian foveae shallow and joined basally, with punctures $1.5 \times$ as large as in







42 -48 C darlington, 42 - head and pronotum, 43 - antenna, 44 - median lobe, apical piece, 45 - ostium region, 46 - paramera, 47 - last ventrite, 48 - sternite and tergite VIII

lateral portions of pronotum. Elytra $2.4 \times as$ long as wide and $2.9 \times as$ long as pronotum; lines 1-4 entirely grooved, 5th grooved in basal 2/3, 6th entirely punctate, except for base; humeral carina very weak, marked as a line; intervals micropunctured. Venter: prosternum sparsely but coarsely punctured laterally; mesosternum foveolate, entirely bordered by lines laterally, sparsely punctured inside; last ventrite as in fig. 47. Apical piece of median lobe, ostium and associated sternite and tergite as in figs. 44, 45, 48, paramera as in fig. 46.

MATERIAL EXAMINED

Holotype 3: "P[uerto] R[ico], Maricao Forest, 2-3 000 ft, May 30-June 2, 1938, P. Darlington (MCZ).

Paratype: Virgin Islands, Guana Isl. 0-80 m, 13-26. VI. 1986. S.M. MILLER, M.G. Pogue (NMNH, New York).

Catogenus decoratus Newman

(Figs 49-53)

 Catogenus decoratus Newman, 1839; 303. Lectotype, here designated: Chile, MIING examined.

DIAGNOSTIC COMBINATION

Length 6-11 mm. Colour black, elytra with wide preapical red band (fig. 50), often elytral bases reddish; surface feebly shiny. Head 0.7-0.8 x as long as wide; median line absent; admedian grooves short but deep; lateral carina weak but complete, usually joined to transverse occipital groove, but rarely this junction is incomplete; antenna $0.5 \cdot 0.6 \times as$ long as body, antennomeres $1.2-1.7 \times as$ long as wide, moderately densely setose. Pronotum 1-1.05 x as long as wide with sublateral carinac unusually long (fig. 49); disk subdepressed medially, regularly punctate except for narrow impunctate region medially. Elytra $2.3 - 2.4 \times as$ long as wide, and $2.8-2.9 \times \text{as long as pronotum; lines } 1-4 \text{ entirely. 5th}$ often partly grooved, 6th always consists of punctures in a row, all lines apically obsolete; humeral carina weak, entire. Venter: prosterning coarsely punctured; mesosternum foveolate, laterally punctate but without marginal lines; last ventrite with not well defined impression (fig. 53) Apical piece of median lobe and paramera as in figs 51, 52, paramera strongly bent apically.

Lectotype data: "Decoratus New, Valparaiso/ Typus/ coll. Milly"

MATERIAL EXAMINED

15 specimens from Chile (BMNH, DEI, IZPAN, MSNG, MHNG, MNHNS, ZMB).

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Revision of the Tribe Odontobraconini in the Western Hemisphere (Hymenoptera: Braconidae: Doryctinae)

PAUL M. MARSH Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, D.C.

ABSTRACT. A systematic study is presented for the three genera of the braconid tribe Odontobraconini (Doryctinae) occurring in the Western Hemisphere: Odontobracon Cameron, Nervellius Roman, and Holcobracon Cameron. Nineteen species are described, of which eight are new. Keys for separating the world genera of the Odontobraconini and for distinguishing the species of the above three genera are provided.

Introduction

The tribe Odontobraconini of the braconid subfamily Doryctinae contains six world genera which share a common character, the extension of the postnervellus vein in the hindwing toward the wing tip (see Fig. 10). Many of the species are among the largest and most strikingly coloured Braconidae. Almost nothing is known about the biology of these wasps. Two of the species described here have been associated with cerambycid beetle larvae. The long ovipositor of most species and host records of other species in the Doryctinae would suggest that these wasps attack wood boring insects, probably only beetle larvae.

Marsh (1970) presented a discussion and key to the world genera of Odontobraconini and a revision of the North American species of the genus Odontobracon Cameron. Six genera were included in that study of which three occur in the Western Hemisphere: Odontobracon, Nervellius Roman and Holcobracon Cameron. Recently I received a large collection of specimens from the British Museum, most of which were collected in Costa Rica by D. H. Janzen. Included were several striking new species which

Correspondence: Dr P. M. Marsh, Systematic Entomology Laboratory, USDA, c/o U.S. National Museum of Natural History NHB 168, Washington, D.C. 20560, U.S.A.

prompted this study of the tribe for the entire Western Hemisphere. The study presented here is a revision of the nineteen Western Hemisphere species (of which eight are new) in these three genera.

The material on which this study is based is mostly from the British Museum (Natural History), London (BMNH), the U.S. National Museum of Natural History, Washington (USNM), the Canadian National Collection, Ottawa (CNC), and the California Academy of Sciences, San Francisco (CAS). Other material is from the American Museum of Natural History, New York (AMNH), the Natural History Museum, Leiden (LEID), the American Entomological Institute, Florida (AEI), the Museum of Comparative Zoology, Harvard University (MCZ), Texas A&M University, College Station (TAMU), the Fundacion Miguel Lillo, Tucuman, Argentina (TUC), the Swedish Museum of Natural History, Stockholm (SMNH), the Academia de Ciencias de Cuba, Havana (ACCH), and the Academy of Natural Sciences, Philadelphia (ANSP). I express by thanks to the curators of these collections for the use of this material. I am also thankful for the comments on the manuscript made by M. J. Sharkey, Biosystematics Research Centre, Ottawa, S. R. Shaw. Museum of Comparative Zoology, Harvard University, and D. M. Anderson and E. E. Grissell, Systematic Entomology Laboratory.

with raised oval area; fore tibia with single row of 5-8 stout spines, hind coxa without dorsal spine, at most with a raised dorsal swelling.

Remarks. This genus comprises one species from the Caribbean area and three from the Indo-Australian area.

Holcobracon limatus (Cresson) (Fig. 78)

Bracon limatus Cresson, 1865: 75. Holotype Q, CUBA (ANSP). [Examined.]

Liobracon manni Brues, 1919: 69. Preoccupied by Parabinarea manni Brues 1912 which was transferred to Liobracon. Holotype Q, HAITI (MCZ). [Examined.] Syn.n.

Liobracon bruesi Roman, 1924: 10. Replacement name for Liobracon manni Brues. Syn.n.

Female. Body length 8-10 mm; ovipositor length 3-4 mm. Colour: head, antenna, fore leg, middle leg, and hind tibia and tarsus, black; proand mesothorax, hind coxa, trochanters and femur varying from entirely black to entirely red or orange propodeum and abdomen red or orange. Head: malar space half eye height; antenna with 43-45 flagellomeres. Thorax: pronotum weakly rugose or smooth; notauli smooth anteriorly; scutellum smooth; subalar groove smooth; sternaulus shallow and smooth; propodeum usually entirely smooth, at most weakly areolate apically, with distinct median longitudinal carina, posterior lateral corners bluntly swollen. Abdomen: all terga smooth. Wings (Fig. 78): second segment of radius of forewing 2.5 times as long as first segment.

Male. Agrees with female except as follows: body length 4-7 mm; propodeum areolate; first and second abdominal tega longitudinally

Material examined. Holotype Q, Bracon limatus Cresson, CUBA (no other data on label) (ANSP). Holotype Q, Liobracon manni Brues, HAITI, St. Marc (MCZ). Other material, 6 99. 16 o'o' from the following localities: CUBA, Pinares; HAITI, Port-au-Prince, Grande Anse, Attelye; DOMINICAN REPUBLIC. Hatillo Palma, San Cristobal Prov.; PUERTO RICO, Naguabo; BRIT. VIRGIN ISLANDS, Guana Island; U.S. VIRGIN ISLANDS, Si Croix; BAHAMA ISLANDS, Cat Island, Andros Williams Island (USNM).

References

- Ashmead, W.H. (1894) Some parasitic Hymenopiera from Lower California. Proceedings of the California Academy of Sciences (Ser. 2), 4, 122–129.
- Ashmead, W.H. (1900) Hymenoptera, Pp. 501-613 in: Smith, J.B., Insects of New Jersey (1899)
- Brues, C.T. (1912) Brazilian Ichneumonidae and Braconidae obtained by the Stanford Expedition. Annals of the Entomological Society of America, 5, 192-229
- Brues, C.T. (1919) Note on the genus Liobracon, with the description of a new species (Hymenoptera; Braconidae). Psyche, 26, 68-71.
- Cameron, P. (1887) Family Braconidae. Biologia Centrali-Americana, Hymenoptera, 1, 312-419
- Cameron, P. (1905) On the phytophagous and parasitic Hymenoptera collected by Mr E. Ernest Green in Ceylon. Spolia Zeylanica, 3, 67-97.
- Cresson, E.T. (1865) On the Hymenoptera of Cuba. Proceedings of the Entomological Society of Philadelphia, 4, 58-91.
- Fahringer, J. (1928) Opuscula Braconologica. Wagner, Wien, 2(1-3), 224 pp.
- Fahringer, J. (1930) Opuscula Braconologica. Wagner, Wien, 3(1-2), 160 pp.
- Granger, C. (1949) Braconides de Madagascar. Mémoires de l'Institut Scientifique de Madagascar. Serie A, Biologie Animale, 2, 426 pp.
- Harris, R.A. (1979) A glossary of surface sculpturing.
 Occasional Papers in Entomology, Culifornia
 Department of Food and Agriculture, 28, 1-31.
- Marsh, P.M. (1970) The Nearctic Doryctinae, IX. The genus Odontobracon and notes on related genera. Pan-Pacific Entomologist, 46, 275-283.
- Marsh, P.M., Shaw, S.R. & Wharton, R.A. (1987) An identificaction manual for the North American genera of the family Braconidae (Hymenoptera). Memoirs of the Entomological Society of Washington, 13, 99 pp.
- Rohwer, S.A. (1917) Descriptions of thirty-one new species of Hymenopiera. *Proceedings of the United States National Museum*, 53, 151-179.
- Roman, A. (1924) Wissenschaftliche Ergebnisse der Schwedischen entomologischen Reise des Herrn Dr. A. Roman in Amazonus 1914–15. 10.
 Hymenoptera: Braconidae, Cyclostomi pro p. Arkiv für Zoologi, 16, 1–40.
- Shenefelt, R.D. & Marsh, P.M. (1976) Braconidae 9.
 Doryctinae, In: Hymenopterorum Catalogus, edit.
 van der Vecht and Shenefelt, 13, 1263-1424.
- Tobias, V.I. (1968) Problems in the classification and phylogeny of the Braconidae. N. A. Kholodkovski Memorial Lectures 1967, 43 pp.
- Tobias, V.I. (1971) Review of the Braconidae (Hymenoptera) of the USSR. Trudy Vsesovuznogo Entomologicheskogo Obshchestva. 54. 156-268.
- Vicreck, H.L. (1914) Type species of the genera of ichneumon flies. Bulletin of the United States National Museum, 83, 186 pp.

Accepted 9 September 1987



BISHOP MUSEUM

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June 21, 1990

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

RE: Moths and butterflies of Guana Island

Dear Skip:

This is to update you on progress on Lepidoptera (moths and butterflies) of Guana Island. Vitor Becker's October 1989 trip was very productive and resulted in many additions to the known fauna. After his trip to Guana, Vitor and I met at the Smithsonian Institution and worked through the pre-1986 Guana Island collections to integrate additional identifications and data into Vitor's intensive samples.

The previous list of names included 199 identified species. The current list includes 295 names. Some 100 species remain unidentified and in need of further work. Thus, the total Lepidoptera fauna of Guana Island is over 400! We suspect further sampling in fall and spring will add to that total.

We will continue to work on this list refining identifications of additional species. Some of this is being done by other specialists. For example, the Pterophoridae (plume moths) are currently under study by a specialist in Holland. Some must await additional visits to the Smithsonian and British Museum. Some just require more time for disections and comparisons of specimens.

In addition to trying to identify the overall fauna, we (and our collaborators) have various publications "in the works" on parts of the fauna. We will send reprints as they are published.

Sincerely,

Scott E. Miller

Chairman

Pept. of Entomology

encI.

cc: H. Jarecki (with encl.); V. Becker; G. Mayer; M. Collins



BISHOP M U S E

1525 BERNICE STREET + P.O. BON 1966\(\text{A} \) + HONOLULU, HAWAPI + 96817 6916 + 18681 847 1511 + FAN (868) 841 8968

20 April 1989

Dr. Vitor Becker EMBRAPA-CPAC Caixa Postal 70-0023 70600-Planaltina, DF BRAZIL

Dear Vitor:

Gene Munroe has gone over your list of 1987 Guana Island pyralids, as well as my 1988 Guana Island collections (except for Phycitinae in both). His comments follow:

1987 list (not including minor spelling mistakes):

All your "Odontiinae" are Dichogaminae (except Cliniodes nomadalis)

Mesocondyla gastralis should be in Acrospila

Palpita costata should be in Stemorrhages, but Gene doubts the identification as well.

Palpita quadristrigmalis is "almost certainly" P. persimilis Munroe (see below)

"Pilocrocis" should be in quotes for eurypalpis

<u>Steniodes gelliasalis</u> identification is "very doubtful"

Syllepte ceresalis should be in Diaphantania

Syllepte onophasalis should be in Sathria

Synclera traducalis should be checked (see below)

"Tyspanodes" should be in quotes for santiagalis

1988 collection [also includes records for Necker I., north of Virgin Gordal

Chrysauginae

Streptopalpia minusculalis

Crambinae

Argyria diplomochalis (probably this sp., not dissected) Fissicrambus fissiradiellus (Walker) (dissected)

Cybalomiinae

One male appears to be a new genus and species! We will soon send around a photograph to allow extraction of this nondescript species from your specimens and the earlier collections at USNM.

Epipaschiinae

Tetralopha (?) sp. (7 specimens sent to Alma Solis)

Evergestinae

Evergestella evincalis [also from Necker I.]

Glaphyriinae

Chalcoela pegasalis

Glaphyria badierana [probably this sp., ONLY from Necker I.]

Odontiinae

Microtheonis ophionalis (Zeller) [ONLY from Necker I.]

Dichogaminae

Alatuncusia bergii [also from Necker I.]

Phycitinae

Hypargyria definitella

many other species, identifications not attempted

Pyraustinae

<u>Desmia</u> ufeus

Zellerina serpentifera

Synclera sp., not traducalis, probably n. sp. (dissected)

Achyra bifidalis (Fabricius)

Palpita persimilis Munroe (dissected)

Palpita sp. (smaller female, related to kimballi Munroe,

but need males; also, probably another sp., female from Tortola)

17

Apoecetes xanthialis (Guenee)

Steniodes mendica (Hedemann)

Sathria sp. maybe the same as your <u>onophasalis</u> - nearly plain reddish brown

Thanks for your letter of 30 March. I will deal with the <u>Podalia</u> manuscript when I have a chance. I've discussed your Guana Island plans with Skip, and there are no problems. He is confirming dates for you now, and I will pass them along to you soon. I should be able to make it to Guana Island in the middle of November, then to USNM for a couple weeks, then to the Entomological Society of America meeting in Texas in early December. More news later.

Best Regards,

Scott E. Miller

Chairman

Dept. of Entomology

CC: E.G. Munroe, J.D. Lazell

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Sept, 1990

LEPIDOPTERA OF GUANA ISLAND, BRITISH VIRGIN ISLANDS

A preliminary List ←

Vitor O. Becker Scott E. Miller

BUTTERFLIES HESPERIIDAE Hesperiinae

Choranthus vitellius (Fabricius)
Cymaenes tripunctus (Herrich-Schaeffer)
Panoquina sylvicola (Herrich-Schaeffer)
Wallengrenia otho (J. E. Smith)

Pyrginae

Euphyriades zephodes (Huebner)
Polygonus leo (Gmelin)
Pyrgus oileus (Linnaeus)
Urbanus dorantes (Stoll)
Urbanus proteus (Linnaeus)

LYCAENIDAE Eumaeinae

Chlorostrymon maesites (Herrich-Schaeffer) Electrostrymon angelia (Hewitson) Strymon acis (Drury) Strymon columella (Fabricius)

Polyommatinae

Hemiargus hanno (Stoll) Hemiargus thomasi Clench Leptotes cassius (Cramer) Strymon bubastus (Cramer)

> NYMPHALIDAE Danainae

Danaus plexippus (Linnaeus

Heliconiinae

Agraulis vanillae (Linnaeus) Heliconius charitonius (Linnaeus)

19

4:

Limenitidinae

Biblis hyperia (Cramer)

Nymphalinae

Junonia coenia (Huebner) Junonia evarete (Cramer) Vanessa cardui (Linnaeus)

> PIERIDAE Pierinae

Appias drusilla (Cramer) Ascia monuste (Linnaeus)

Coliadinae

Eurema elathea elathea (Cramer) Eurema lisa euterpe (Menetries) Phoebis sennae (Linnaeus)

PAPILIONIDAE

Battus polydamas (Linnaeus)

MOTHS
ARCTIIDAE
Arctiinae

Calidota strigosa (Walker)
Eupseudosoma involutum (Sepp)
Hypercompe simplex (Walker)
Utetheisa ornatrix (Linnaeus)

Ctenuchinae

Cosmosoma achemon (Fabricius)
Empyreuma pugione (Linnaeus)
Eunomia colombina (Fabricius)
Horama panthalon panthalon (Fabricius)
Horama pretus (Cramer)

Pericopinae

Composia credula (Fabricius)

Lithosiinae

Afrida charientissima Dyar Lomuna nigripuncta (Hampson) Progona pallida (Moeschler)

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BLASTOBASIDAE

Auximobasis brevipalpella Walsingham Auximobasis insularis Walsingham Blastobasis argillacea Walsingham Blastobasis subolivacea Walsingham

CHOREUTIDAE

Hemerophila biferana (Walker) Tortyra ignita (Zeller)

COLEOPHORIDAE

Coleophora picticornis Walsingham Coleophora pulchricornis Walsingham

COSMOPTERIGIDAE

Cosmopterix similis Walsingham
Ithome curvipunctella (Walsingham)

COSSIDAE

Psychonoctua personalis Grote

GELECHIIDAE

Anacampsis quinquepunctella Walsingham Aristotelia crassicornis Walsingham A. pulicella Walsingham

Recurvaria hippurista Meyrick, n. syn.

A. diolcella Forbes

Eucatoptus rubidella Walsingham, misid.

Brachyacma palpigera Walsingham

Commatica bifuscella (Forbes)

Compsolechia angulifera (Walsingham), n. comb.

Anacampsis succincta Walsingham, n. syn.

Compsolechia salebrosa Meyrick, n. syn.

Compsolechia melanophaea (Forbes)

Compsolechia plumbeolata (Walsingham)

Dichomeris zingarella (Walsingham)

Evippe evipella (Forbes)

Gelechia flammulella Walsingham

Helcystogramma trigonellum (Walsingham)

Polyhymno "luteostrigella Chambers"

Prostomeus brunneus Busck

Recurvaria ostariella (Walsingham)

Stegasta bosqueella (Chambers)

Stegasta capitella (Fabricius)

Symmetrischema capsicum (Bradley & Povolny)

Taygete parvella (Fabricius)

Telphusa translucida (Walsingham)

Tildenia gudmanella (Walsingham)

GEOMETRIDAE Ennominae

Erastria decrepitaria (Hubner)
Oxydia vesulia (Cramer)
Patalene ephyrata (Guenee)
Pero rectisectaria (Herrich-Schaeffer)
Semiothisa infusata (Guenee) [verify spelling]
Semiothisa paleolata (Guenee)

Geometrinae

Phrudocentra centrifugaria (Herrich-Schaeffer) Synchlora cupedinaria (Grote) Synchlora frondaria (Guenee) Synchlora herbaria sanctaecrucis Prout

Larentiinae

Pterocypha floridata (Walker)
Pterocypha praecurraria (Moeschler)
(=?Obila xantholiva Warren)

Sterrhinae

Acratodes noctuata Guenee
Acratodes suavata (Hulst)
Acratodes virgota Schaus
Idaea amnesta Prout
Idaea curtaria Warren
Idea eupitheciata (Guenee)
Leptostales oblinataria Moeschler
Leptostales bifasciata Prout, n. syn.
Leptostales variabilis (Dyar)
Lobocleta nataria (Walker)
Semaeopus castaria (Guenee)

GRACILLARIIDAE

Acrocercops attenuata (Walsingham) Caloptilia burserella (Busck) Dialectica sanctaecrusis Walsingham

HYBLAEIDAE

Hyblaea puera (Cramer)

MOMPHIDAE

Mompha piperatella (Walsingham)

NOCTUIDAE Acontiinae

Amyna octo (Guenee)
Bagisara repanda (Fabricius)
Cydosia nobilitella (Cramer)
Eublemma recta (Guenee)
Eumicremma minima (Guenee)
Ommatochila mundula (Zeller)
Ponometia exigua (Fabricius)
Spragueia dama (Guenee)
Spragueia margana (Fabricius)
Spragueia perstructana (Walker)
Thioptera aurifera (Walker)
Tripudia balteata Smith
Tripudia quadrifera (Zeller)

Agaristinae

Caularis undulans Walker

Amphipyrinae

Condica albigera (Guenee)
Condica sutor (Guenee)
Elaphria agrotina (Guenee)
Elaphria nucicolora (Guenee)
Magusa orbifera (Walker)
Micrathetis triplex (Walker)
Perigea bahamica Hampson [verify]
Spodoptera dolichos (Fabricius)
Spodoptera eridania (Stoll)
Spodoptera frugiperda (J. E. Smith)
Spodoptera latifascia (Walker)

Catocalinae

Mocis latipes (Guenee)
Mocis megas (Guenee)
Mocis repanda (Fabricius)
Ophisma tropicalis Guenee
Ptichodis immunis (Guenee)

Cuculliinae

"Catabena" n. sp. (Acc. Poole) Neogalea sunia (Guenee) Neogalea n. sp. (Acc. Poole)

Euteliinae

Paectes arcigera (Guenee)
Paectes obrotunda (Guenee)

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Hadeninae

Leucania multilinea Walker

Heliothinae

Heliotis subflexa Guenee

Berminiinae

Lascoria orneodalis (Guenee)

Hypeninae

Bleptina araealis Hampson Bleptina menalcasalis Walker Drepanopalpia latipennis (Herrich-Schaeffer) Hypena minualis Guenee, 1854

Noctuinae

Anicla infecta (Ochsenheimer)

Ophiderinae

Ascalapha odorata (Linnaeus) Baniana relapsa (Walker) Cecharismena abarusalis (Walker) Cecharismena cara Moeschler, 1890 =Matiloxix cubalis Schaus, 1916 Chabora versicolor (Fabricius) Concana mundissima Walker Diphthera festiva (Fabricius) Ephyrodes omicron Guenee Eulepidotis addens Walker Kakopoda progenies (Guenee) Gonodonta bidens Geyer Lesmone formularis (Geyer) Lesmone hinna (Geyer) [verify] Litoprosopus hatuey (Poey) [verify] Melipotis acontioides (Guenee) Melipotis contorta (Guenee) Melipotis famelica (Guenee) Melipotis fasciolaris (Huebner) Melipotis januaris Guenee Metallata absumens (Walker) Parachabora abydas (Herrich-Schaeffer) Plusiodonta clavifera Walker Sylectra ericata (Cramer)

Plusiinae

Pseudoplusia includens (Walker)

Sarrhothripinae

Collomena filifera (Walker) Characoma nilotica (Rogenhofer) Motya abseuzalis Walker

NOTODONTIDAE

Nystalea nyseus (Cramer)

OECOPHORIDAE Autostichinae

Schistonoea fulvidella (Walsingham)

Ethmiinae

Ethmia confusella (Walker) Ethmia julia Powell Ethmia submissa Busck

PSYCHIDAE

Cryptothelea watsoni (Jones)

PTEROPHORIDAE

PYRALIDAE Chrysauginae

Bonchis munitalis (Lederer)
Murgisca subductellus (Moeschler)
Streptopalpia minusculalis (Moeschler)

Crambinae

Argyria diplomochalis Dyar Fissicrambus haytiellus (Zincken) Fissicrambus minuellus (Walker) Microcrambus atristrigellus (Hampson) Microcrambus discludellus (Moeschler) Fissicrambus fissiradiellus (Walker)

Cybalomiinae

New genus and species

Epipaschiinae

"Pococera atramentalis Lederer"
Phidotricha insularella (Ragonot)

2

Evergestinae

Evergestella evincalis (Moeschler)

Galleriinae

Pogrima palmasalis Schaus Thyridopyralis gallaerandialis Dyar

Glaphyriinae

Chalcoela pegasalis (Walker) Glaphyria badierana (Fabricius) Glaphyria leucostictalis Hampson

Odontiinae

Cliniodes nomadalis Dyar Mimoschinia rufofascialis (Stephens) Tineopaschia minuta Hampson

Dichogaminae

Alatuncusia bergii (Moeschler)
Dichogama amabilis Moeschler
Dichogama gudmani Hedeman
Dichogama redtenbacheri Lederer

Phycitinae

Anabasis ochrodesma (Zeller)
Atheloca subrufella (Hulst)
Crocidomera fissuralis (Walker)
Ectomyelois decolor (Zeller)
Ephestiodes infimella Ragonot
Fundella argentina Dyar
Hypargyria definitella (Zeller)
Oryctometopia fossulatella Ragonot
Ozamia lucidalis (Walker)
Sarasota furculella (Dyar)

Pyralinae

Parasopia dissimilalis Moeschler

Pyraustinae

Achyra bifidalis (Fabricius)
Acrospila gastralis (Guenee)
Apoecetes xanthialis (Guenee)
Asciodes gordialis Guenee
Bocchoris algarrobalis Schaus (verify spelling)
Condylorrhyza vestigialis (Guenee)
Desmia ufeus (Cramer)

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Diaphania elegans (Moeschler) Diaphantania ceresalis (Walker) ?=Margaronia busccalis Schaus [verify spelling] Ercta vittata (Fabricius) Hydropionea basalis Hampson Lamprosema atrirenalis Hampson Loxomorpha cambogialis (Walker) Marasmia cochrusalis (Walker) Microthyris anormalis (Guenee) Oenobotys vinotinctalis (Hampson) Omiodes indicata (Fabricius) Palpita persimilis Munroe Palpita prope kimballi Munroe Palpita quadristigmalis (Guenee) [verify] "Pilocrocis" eurypalpalis Hampson Pseudopyrausta acutangulalis (Snellen) Pseudopyrausta minima von Hedemann [both synonyms?] Sathria onophasalis (Walker) Sathria sp. Spoladea recurvalis (Fabricius) Stemorrhages costata (Fabricius) [verify] Stenia ceddalis Schaus (verify combination) Steniodes gelliasalis (Walker) [verify] Steniodes mendica (Hedeman) Synclera traducalis (Zeller) [verify] Synclera n. sp. [not traducalis] Syngamia florella (Stoll) "Tyspanodes" santiagalis Schaus Uresiphita reversalis (Guenee) Zellerina serpentifera (Hampson), n. comb.

SPHINGIDAE Sphinginae

Agrius cingulatus (Fabricius)
Cocytius antaeus (Drury)
Manduca brontes (Drury)
Manduca rustica (Fabricius)
Manduca sexta (Linnaeus)

Macroglossinae

Callionima parce (Fabricius)
Cauthetia sp.
Erinnyis alope (Drury)
Erinnyis crameri (Schaus)
Erinnyis ello (Linnaeus)
Erinnyis obscura (Fabricius)
Eumorpha vitis (Linnaeus)
Pachylia ficus (Linnaeus)
Perigonia lusca (Fabricius)
Pseudosphinx tetrio (Linnaeus)
Xylophanes chiron (Drury)
Xylophanes pluto (Fabricius)

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Xylophanes tersa (Linnaeus)

TINEIDAE

Acrolophus angulatella (Walsingham) Acrolophus australis (Walsingham) Acrolophus noctuina (Walsingham) Acrolophus parva (Walsingham) Acrolophus poeyi Walsingham Acrolophus triatomellus (Walsingham) Lepyrotica brevistrigata (Walsingham) Lepyrotica diluticornis (Walsingham) Lepyrotica n. sp. (Acc. Davis) Lepyrotica reduplicata (Walsingham) Mea incudella Forbes, 1931 Oenoe pumiliella (Walsingham) Pompostolella aeneoalbida Walsingham Proboloptilia aeolella (Walsingham) Protodarcia argyrophaea Forbes Protodarcia bicollorella Forbes Protodarcia plumella (Walsingham) Protodarcia tetraonella (Walsingham) "Tinea" umbraticostella Walsingham [verify]

TISCHERIIDAE

Tischeria pulverea Walsingham

TORTRICIDAE Cochylinae

Saphenista bunteodes Forbes

Olethreutinae

Ancylis virididorsana (Moeschler) Crocidosema plebejana Zeller Episimus nesiotes (Walsingham)

Tortricinae

Apotoforma rotundipennis (Walsingham)
Coelostathma parallelana Walsingham
Platynota rostrana (Walker)
Platynota ichthyochroa Walsingham

YPONOMEUTIDAE

Yponomeuta triangularis Moeschler

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MUSE H O P ERNICE STREET + BO. BON 19000-A + BONOLULU. HAWAPI + 96817 0916 + 1808 (847-3511 + FAX 1808) 841-896

February 28, 1991

Mr. Louis Potter Planning Department BVI Government Road Town, Tortola BRITISH VIRGIN ISLANDS

Dear Louis:

I enclose a reprint of a recent paper reviewing the moth genus Heuretes, which is restricted to the West Indies. One species. Heuretes picticornis, is found in Puerto Rico and the Virgin The research for this paper began with my studies on Sage Mountain (I think you were along on that excursion) and grew over the years as the co-author and I added more complexities to the paper.

At our meeting in Road Town in November, you mentioned the BVI's need for a geographic information system (GIS) for conservation planning. Subsequently, I spoke with a representative from the Washington, DC, headquarters of Conservation International (CI) about conservation GIS matters. CI has developed a simple, low cost GIS for regional conservation use that is now being implemented in several South American countries. The person I spoke with said that they would probably not be able to support an implementation in the BVI at this time, because they have no programs in the West Indies and their GIS operates in Spanish.

I have not actually seen their GIS operate, but one of my colleagues was very impressed by its simplicity and capabilities. If you want more information, write to Conservation International, 1015 18th Street NW, Suite 1000, Washington, DC 20036.

Skip Lazell told me that he would explore what sort of databases The Nature Conservancy's International Program might be able to offer.

If I can be of assistance to you in anything, please let me know.

Sincerely,

Scott E. Miller

Chairman

Dept. of Entomology

cc: J. Lazell; G. Mayer encl.

Sec. 4

16 October 1990 PROC. ENTOMOL. SOC. WASH. 92(4), 1990, pp. 705–715

SYSTEMATICS OF THE WEST INDIAN MOTH GENUS HEURETES GROTE AND ROBINSON (LEPIDOPTERA: LIMACODIDAE)

MARC E. EPSTEIN AND SCOTT E. MILLER

(MEE) Department of Entomology, NHB 127, Smithsonian Institution, Washington, D.C. 20560; (SEM) Department of Entomology, Bishop Museum, Box 19000-A, Honolulu, Hawaii 96817.

Abstract.—The genus Heuretes Grote and Robinson, 1868, is revised. Heuretes was previously monotypic, comprised of H. picticornis Grote and Robinson, 1868, and known only from the Island of Saint Thomas, U.S. Virgin Islands. Monoleuca albicollis Forbes, 1930, known from Puerto Rico, is recognized as a junior synonym of H. picticornis. New records expand the range of H. picticornis to include the island of Tortola, British Virgin Islands. Heuretes daidaleos, new species, and H. divisus, new species, are described from the Dominican Republic. Phylogenetic analysis and transitional character states support placement of the new species in Heuretes. Heuretes appears to be closely related to other Caribbean genera Alarodia Moeschler and Leucophobetron Dyar.

Key Words: Puerto Rico, Virgin Islands, Hispaniola, Greater Antilles, systematics, cladistics, Caribbean, Zygaenoidea

In the Lepidoptera it is not uncommon for conspecific males and females to be described in different genera as different species. Epstein recognized Monoleuca albicollis Forbes (Limacodidae) as the junior synonym of Heuretes picticornis Grote and Robinson while examining a female syntype of the H. picticornis. Concurrently, fieldwork by Miller in the British Virgin Islands yielded good series of male specimens of a moth that matched the holotype of Monoleuca albicollis, known only from males. Later, Becker collected both males and females at the same locality in Puerto Rico, verifying the synonymy. These events, plus the finding of two new species from the Dominican Republic prompted us to revise and investigate the systematic placement of Heuretes.

This work is based primarily on specimens in the U.S. National Museum of Natural History (USNM), but we have also used material in or checked the collections of the American Museum of Natural History (AMNH), Bernice P. Bishop Museum (BPBM), British Museum (Natural History) (BMNH), Carnegie Museum of Natural History (CMNH), Natural History Museum of Los Angeles County (LACM), Museum of Comparative Zoology, Zoologisches Museum der Humboldt Universitaet (ZMHB), Zoologische Sammlungen des Bayerischen Staates, and V. O. Becker private collection (VOB). Color descriptions follow Smithe (1975).

Heuretes Grote and Robinson

Heuretes Grote and Robinson, 1868: 190.— Kirby, 1892: 551.—Dyar, 1905: 382; 1935: 1130.—Van Eecke, 1925: 53.— Fletcher and Nye, 1982: 77.

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Sec. 15.

Type species.—Heuretes picticornis Grote and Robinson, by monotypy,

Diagnosis.—Small moths, salmon to gray forewing and thorax, usually light-colored hindwing and abdomen. Conspicuous oval or quadrate spots present (at least) on male forewing apex or middle of inner margin. Male anterior thorax with dorsal collar of buff or white scales. Forcleg dark, with coxa and femur scarlet orange or dark brown. Mid- and hindlegs light colored. Hind tibia with two pairs of spurs. Male antenna bipectinate to tip or near, with light-colored scales in contrast at apex.

Discussion.—Presumed synapomorphies of Heuretes within Limacodidae include the scale patterns on the body and wings. These patterns include a distinct collar behind the head in males, dark-scaled forelegs in contrast to light mid- and hindlegs, and light-colored scales at the apex of the antenna in contrast to dark segments on all other segments or only near the apex.

Although found in other limacodid genera, the forewing radial vein pattern in *Heuretes*, R3+R4 branched off R2, may be independently derived. Presumed sister genera *Alarodia* Moeschler, *Leucophobetron* Dyar and *Phobetron* Huebner, possess wing venation pattern in which R3+R4 branch off R5 or nearby—the primitive condition according to Brock (1971).

Heuretes picticornis Grote and Robinson Figs. 1, 2, 5, 6, 9

Heuretes picticornis Grote and Robinson, 1868: 190. Grote, 1882: 17; 1888: 182. Dyar, 1905: 382; 1935: 1130. Van Eecke, 1925: 53.

Monoleuca albicollis Forbes, 1930: 166. Dyar, 1935: pl. 168, fig. g [not mentioned in text]. Wolcott, 1936: 505; 1951: 746. Martorell, 1948: 549; 1976: 33, 51, 175, 252. New Synonymy, New Combination.

Diagnosis. - Small moths with either salmon or dark-brown forewings. Front legs

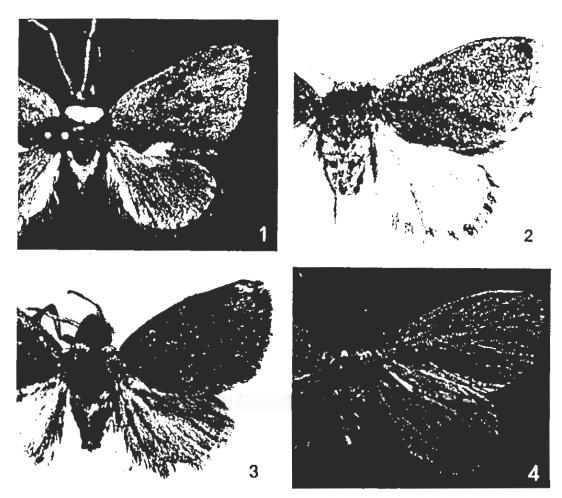
orange. Pale-form males have antemedian and postmedian bands on forewing visible, cream-colored hindwing; dark-form males with forewing bands not visible, either cream or dark-brown hindwing. Both male forms with conspicuous quadrate white patch medially along inner margin. Female without white patch. Male antenna broadly bipectinate, becoming unipectinate with branches abruptly shortening toward apex, scarletorange scales on shaft. Uncus unusually short, baglike, with lateral socii; gnathos S-shaped laterad. Valva bifid distally; aedoeagus straight basally, reaching end of valva, upturned distally.

Adult male (Fig. 1).—Forewing length 6-7 mm (one aberrant reared male, 8 mm).

Head: Frons mostly white. Vertex cream colored (54) (= color code in Smithe 1975). Antenna ca. half length of forewing; bipectinate, maximum width about 5× length of a segment, slightly tapering to near apex, then abruptly short. First two short apical segments bipectinate, remaining nine segments short, unipectinate, and bristly. Scales on shaft scarlet orange; scales on apex and pectinations buff (124). Labial palpus porrect, extending past frons, covered with searlet-orange scales. Haustellum coiled, longer than basal segment of labial palpus.

Thorax: Dorsum with white scale bundle behind head on basal one-fifth, remainder matching forewing. Foreleg with coxa and femur scarlet orange, tibia and tarsus burnt orange (116) with dark bands distally. Midleg and hindleg a lighter cream color, with brushlike scales dorsally on tibia and tarsus. Midtibia with one pair of spurs and hindtibia with two pairs. Forewing R3 and R4 nearly fused, arising from R2 (Fig. 5). Dorsal surface of forewing in two forms, either salmon or dark brown. Diffuse postmedian and antemedian bands of dark-brown scales visible only in pale morph (Fig. 1). These bands connect, with mostly dark-brown scales from wing base to tornus, below discal cell. Conspicuous white quadrate patch on middle of inner margin, smaller dark

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Figs. 1-4. 1, Heuretes picticornis, male wing pattern (USNM) (forewing 6 mm). 2, Heuretes picticornis, female wing pattern (USNM) (forewing 8 mm). 3, Heuretes daidaleos, male wing pattern (USNM) (forewing 6 mm). 4, Heuretes divisus, male wing pattern (CMNH).

spot where M2 and M3 arise from discal cell. Margins orange scarlet, preceded by dark brown scales on fringe and costal margin, scattered orange scales along veins. Ventral forewing with inner margin cream colored, base of costa scarlet, otherwise burnt orange. Dorsal hindwing cream colored, or dark brown, outer margin fringe with a few dark scales. Salmon-forewing morph with pale hindwing, dark-forewing morph with either pale or matching dark hindwing. Ventral hindwing warm buff (118) with hint of orange, more cream color along inner margin and fringe.

Abdomen: Cream colored. Genitalia as in Fig. 6. Valva bifid about three-fourth distance from base, Gnathos simple, with gently undulating margins. Uncus short, expanded ventrally above gnathos, caudal end of uncus divided. Socii forming lateral pockets with setae. Aedocagus straight and about same length as valva; stout basally, but beyond gnathos, becoming narrow, upturned 90° distally.

Adult female (Fig. 2).—Forewing length 7.5-8.0 mm.

Head: Frons salmon colored (106). Vertex cream colored. Antenna short, ca. one-

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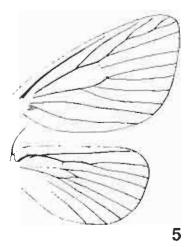


Fig. 5. Heuretes picticornis, male wing venation (USNM 28034).

third length of forewing, bristly, with short pectinations, curved at tip, cream colored to near apex, dark-brown scales and lighter scales distally, nearly buff. Palpus shaped as in male, covered with warm-buff and salmon scales.

Thorax: Dorsum with brown scales, without white scale bundle of male. Legs colored as in male. Forcwings as in male dark morph, less scarlet underneath, with white scale patch absent. Discal spot faint. Only pale hindwings known.

Abdomen: Genitalia as in Fig. 9. Bursa copulatrix short, with ductus seminalis broadly connected from base to middle of corpus bursae. Signum absent. Lobes of papillae anales disk shaped, irregularly toothed on margins, and covered with setae.

Types.—Lectotype female, here designated (ZMHB), and paralectotype female (AMNH) (*H. picticornis*); Holotype male, AMNH (*M. albicollis*).

Type localities.—[U.S. Virgin Islands], [Island of] Saint Thomas (II. picticornis); Puerto Rico, Coamo Springs (M. albicollis).

Hosts.—Buchenavia capitata (Vahl) Eichl. (Combretaceae) (USNM); Byrsonima coriacea (Sw.) DC (Malpighiaceae) (Martorell 1948: 549, as B. spicata (Cav.) Rich.; Wolcott 1951: 746, as B. spicata; Martorell 1976); Cedrela odorata Linn. (Meliaceae) (Wolcott 1951: 746, as C. mexicana Roem.; Martorell 1976); Montezuma speciosissima Sessé & Moc. (Malvaceae) (Wolcott 1951: 746; Martorell 1976); Swietenia mahagoni (Linn.) Jacq. (Meliaceae) (Martorell 1948: 549, 1976).

Immature stages.—This description of the previously undescribed larva is from an exuvium found inside a cocoon associated with an adult male ("Hopk. US 33101K," USNM). The exuvium was softened in 10% KOH and stored in glycerin (descriptions of tubercles are vague because precise interpretation was difficult).

Final instar: No prolegs or crochets, subdorsal row of tubercles well developed (T2-3, A2-9), extending to near middorsum, lateral tubercles short. Most subdorsal tubercles with long, filamentous hairs, maximum length ca. 1 mm, dark brown and light colored, with short lateral branches. Second or third subdorsal tubercle from anterior end with dense coat of short, filamentous hairs interspersed with long hairs, appearing darker than others. Unbranched urticating setae well developed on dorsal, basal portion of tubercles. Middorsal strip with small "skin spines."

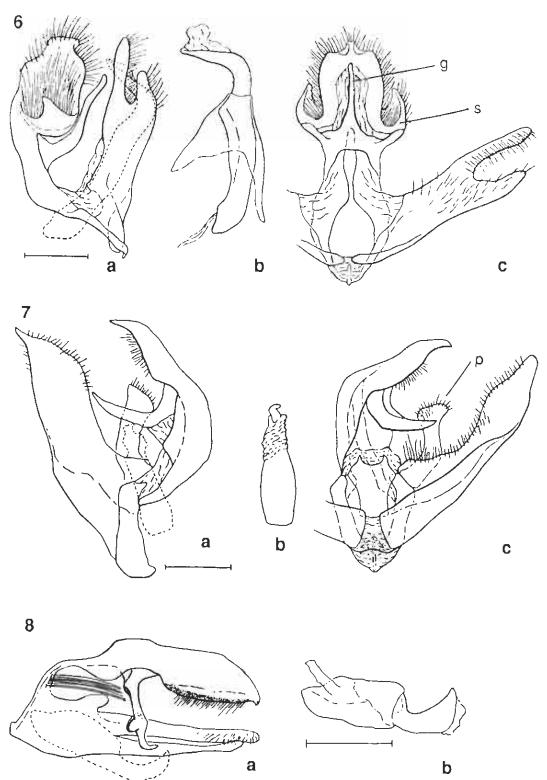
Cocoon: Ovate, about 5 mm long, 4 mm wide, 4 mm high. Typical circular emer-

Figs. 6–8. 6, Heuretes picticornis, male genitalia: a) lateral view, right aspect (dotted outline indicates position of aedoeagus) (USNM 28109); b) aedoeagus (USNM 28025); c) ventral view of slide mounted specimen with aedoeagus removed (g = gnathos; s = socius) (USNM 28025) (scale = 0.5 mm). 7, Heuretes daidaleos, male genitalia: a) lateral view, left aspect (USNM 28110); b) aedoeagus (USNM 28358); c) ventral view of slide mounted specimen with aedoeagus removed, right valva (p = valval process) (USNM 28358) (scale = 0.5 mm). 8, Heuretes divisus, male genitalia: a) lateral view, right aspect (CMNH); b) aedoeagus (CMNH) (scale = 0.5 mm).

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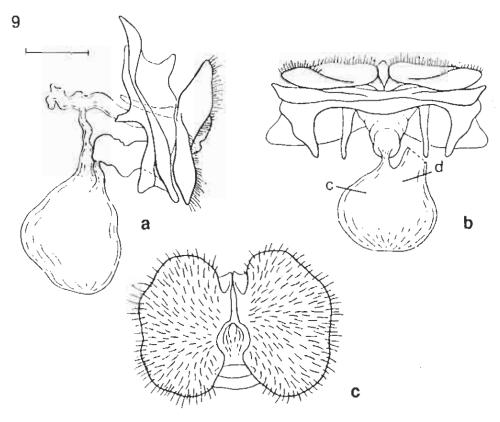


Fig. 9. Heuretes picticornis, female genitalia (ZMHB lectotype); a) lateral view; b) ventral view (c = corpus bursae, d = ductus seminalis; c) papillae anales (scale = 0.5 mm).

gence hatch at end. Whitish, mottled with brown, surface smooth and hard.

Flight period.—December to August.

Distribution.—Puerto Rico and the Virgin Islands, above 360 m.

Material examined.—65 males and 5 females. PUERTO RICO: Coamo Springs, 5—7 June 1915 (AMNH, holotype of *M. albicollis*); El Semil, near Villabla, 1700 feet [520 m], 10-V-1940, W. A. Hoffman (USNM); El Verde Field Station, Luqillo Experimental Forest, 435 m, 29-XII-1970 to 21-I-1971, C. P. Kimball (USNM); Hotel Barranquitas, Barranquitas, 650 m, 22-26-II-1971, Kimball (USNM); Maricao, 11-14-VIII-1987, V. O. Becker (VOB); Maricao Fish Hatchery, 23-XII-1962, P. & P. Spangler (USNM); Reserva Forestal Guajataca, 360 m, 18-28-III, 14-20-IV-1971, Kimball

(USNM); Patillas, [Sierra de Cayey, ca. 20 km NE Campamento Real], 590 m, 5-25-VIII-1987, Becker (USNM, VOB); Villabla, ex Buchenavia capitata, Hopkins no. 33101K, 1-V-1940 (USNM); U.S. VIRGIN ISLANDS: [Island of] Saint Thomas, [no further data] (ZMHB, lectotype of H. picticornis; AMNH, paralectotype); BRITISH VIRGIN ISLANDS: [Island of] Tortola, Mount Sage National Park, 480 m, 7-8-VII-1985, S. E. & P. M. Miller, 22-24-VII-1986, S. E. Miller & M. G. Pogue, 13-15-VII-1987, S. E. Miller & V. O. Becker, ultraviolet light trap in "aridulate rain forest" (USNM, BMNH, CMNH, LACM, VOB, BPBM).

Discussion.—The scarlet orange front coxa and femur in both male and female led to uncovering the synonymy between

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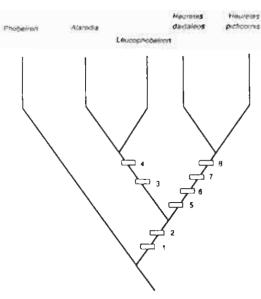


Fig. 10. Preliminary cladogram of genera related to Heuretes (Leucophobetron based on type species only). Synapomorphic characters include: 1) urticating spines in late instar larvae both branched and unbranched (known only in A. slossoniae and H. picticornis); 2) valvae asymmetrical (reversed in H. picticornis, see text); 3) white groundcolor; 4) uncus with dorsal process; 5) uncus with simple dorsum and curved end; 6) forewing R3+R4 branched off R2; 7) dorsal collar of white scales behind head; 8) antennal scales light colored at apex, in contrast to preceding scales.

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Heuretes picticornis and Monoleuca albicollis. Collection of males and females at the same localities in Puerto Rico by Becker (see above) confirmed this finding, since the two types are from separate, though neighboring, islands of Saint Thomas and Puerto Rico.

This species is restricted to the Puerto Rican Bank, where it occurs between 360 and 2500 m. Martorell (1948: 549) [as M. albicollis] considered it "fairly common" on Puerto Rico. In the United States Virgin Islands the species has not been recorded since the original description of specimens from Saint Thomas. This could be due to lack of subsequent collecting and destruction of native forest. We record it for the first time from the British Virgin Islands, from the moist forest on the top of Tortola

(termed "aridulate rain forest" by D'Arey 1967: 392). The forest in Sage Mountain National Park on Tortola appears to be the only suitable habitat in the British Virgin Islands (see also Lazell and Jarecki 1985). The species was not found in ultraviolet light surveys on Virgin Gorda and Guana Islands.

This distribution pattern makes sense biogeographically, because the islands of the Puerto Rican Bank have been extensively connected within recent geologic time. The principal islands of the Virgin Islands (except Saint Croix) lost their connection with each other and with Puerto Rico only about 8000 to 10,000 years ago, due to custatic rise in sea level (Heatwole et al. 1981).

Heuretes daidaleos, New Species Figs. 3, 7

Diagnosis.—Small moth with speckled gray-brown forewing without fascia, hindwing pale buff. Small buff-colored oval spot on forewing apex. Male antenna bipectinate to apex and gently tapering; light scales throughout except dark brown subapically. Uncus oblong, tapered to well sclerotized, clawlike tip. Valvae entire, slightly asymmetrical, curvilinear process on costal base and tegumen. Aedoeagus only about half length of valvae, with short obliquely curved process at distal end. Adult female and immature stages unknown.

Adult male (Fig. 3).—Forewing length 5.5-6.0 mm,

Head: Frons buff colored (124), infuscated with gray-brown scales. Vertex cream colored (54). Antenna length as in male H. picticornis, but pectinations relatively short and bipectinate to tip. Pectinations at maximum ca. $3 \times$ length of a segment, gently tapering apically. Shaft and pectinations with pale-buff scales except distal fourth with dark-brown scales, buff on last two. Labial palpus and haustellum similar to H. picticornis except palpus buff scaled.

Thorax: Dorsum directly behind head with narrow band of burnt orange scales

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(116), followed by wider collar of buff scales in basal seventh, remainder matching forewing. Foreleg as in H. picticornis, bands of dark scales alternating with buff rather than scarlet orange. Midleg, hindleg and thorax mostly buff ventrally. Tibial spurs as in H. picticornis. Forewing R veins as in H. picticornis, but wing shape differs. Outer angle more rounded, extending posteriorly, with inner margin short. Dorsum with dark graybrown scales speckled over glaucus (79-80) to pale-buff scales; only one color morph known. Apex with small, conspicuous, palebuff oval spot (0.7 mm long). Fringe dark gray brown; costal margin yellow orange. Venter with dark scales in discal cell and along outer margin; buff on inner margin and apex. Hindwing with basal and fringe scales buff, hint of gray toward outer margin.

Abdomen: Buff colored. Genitalia as in Fig. 7. Valvae entire, digitate and acuminate distally, slightly asymmetrical, left valva larger. Narrow, curvilinear process articulated with base of costa and vinculum. Uncus oblong, simple, tapering to downcurved and well-sclerotized tip. Gnathos relatively short, not reaching end of uncus. Aedoeagus short, ca. half length of valvae; globular at base, with short, curved hook pointing obliquely upward from left to right at distal end.

Type.—Holotype male, USNM.

Type locality.—Dominican Republic, Dajabon Province, Rio Massacre, Balneario Don Miguel, 7 km SW Dajabon, 40 m elevation.

Flight period.—May and July.

Distribution. – Known only from the Dominican Republic.

Material examined.—Five males from the type locality (holotype and 4 paratypes) collected 26-V-1973 by D. & M. Davis (USNM, BMNH).

Etymology.—Daidaleos (Gr.) means dappled or spotted, descriptive of the forewing in this species. The unlatinized nomen is treated as indeclinable in accordance with

Article 31b in the International Code of Zoological Nomenclature (1985).

Discussion.—Heuretes daidaleos shares several male genitalic character states with Alarodia and Leucophobetron Dyar, including valval asymmetry and a costal process, absent in its congener H. picticornis. However, phylogenetic evidence and transitional character states in another new species below support placement of II. daidaleos in Heuretes. The costal process on the valva is believed to be plesiomorphic with respect to Heuretes, found in Phobetron.

Although the simple, oblong shape of the uncus of *H. daidaleos* appears to be closer to the limacodid groundplan than that found in *H. picticornis* or *Alarodia*, it may represent the loss of the dorsal process found in the latter group.

Heuretes divisus, New Species Figs. 4, 8

Diagnosis. — Male genitalic characters diagnostic (see below). Known from one male specimen.

Adult male (Fig. 4).—Forewing length 5.5

Head: Frons and vertex dark brown. Antenna length as in other Heuretes, bipectinate to near the tip, pectinations long as in H. picticornis, gently tapering apically. Shaft and pectinations with dark-brown scales throughout, buff on last two. Labial palpus similar to other Heuretes, the former dark scaled.

Thorax: Dorsum with buff scales behind head (remainder undetermined). Foreleg with dark-brown scales. Midleg, hindleg, and ventral thorax mostly buff. Tibial spurs as in other Heuretes. Forewing R3 and R4 fused, arising from R2. Dorsum appears to have gray and buff scales, with salmon scales on anterior discal cell (badly rubbed).

Abdomen: Buff colored. Genitalia as in Fig. 8. Valva deeply divided less than half it s length from base into two thin digitate arms (hence the name divisus), the one ventrad slightly shorter. Process articulated with

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base of costa and vinculum greatly reduced compared to *H. daidaleos*. Tegumen narrow with long setal brush near costa. Uncus simple, similar to *H. daidaleos* though broader. Gnathos undulated as in *H. picticornis*, but with knoblike structure ventroproximal to apex. Aedoeagus similar to *H. picticornis*, though relatively shorter and broader.

Distribution. — Known only from the Dominican Republic.

Material examined.—One male (holotype) from Pedernales Province, La Abeja, 38 km NNW Cabo Rojo, 18°09'N, 71°38'W, 1250 m, 15-VII-1987, J. E. Rawlins & R. L. Davidson (CMNH).

Discussion. — Male genitalic character states in Heuretes divisus are plausible transitions between character states of H. daidaleos and those in rather atypical H, picticornis. The curvilinear process at the base of its costa, much reduced compared to H. daidaleos and absent in H. picticornis, appears to be functionally replaced by the coastal arm of the deeply cleft valva. The valva in II. picticornis, in turn, may be derived from fusion of arms, as in H. divisus. to near the distal end. Other character states in H. divisus appear intermediate between II. daidaleos and H. picticornis, including shapes of uncus and gnathos, and relative size of aedocagus. Shape of the aedocagus more closely resembles that of H. picticornis.

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Relationships of Heuretes

Forbes (1930) suggested that Monoleuca albicollis [H. picticornis] "might be better placed in Protalima," but included it in Monoleuca Grote and Robinson based on wing pattern. Similarity in male antennal pectinations between the type species, Monoleuca semifascia Walker, and M. albicollis, may have also influenced Forbes' generic placement. Forbes (1930) considered M. albicollis [H. picticornis] to be a "primitive" Monoleuca based on the "nearly united" forewing R3 and R4 (R3 and R4 are fused in North American Monoleuca).

Other than Forbes' treatment (1930, as Monoleuca), the placement of Heuretes has remained uncertain. Grote and Robinson (1868: 190) considered Heuretes near Tortricidia Packard. Dyar (1905: 382) stated the "generic position [of Heuretes] is uncertain."

Heuretes is not congeneric with Monoleuca as the latter is presently defined, nor is Heuretes phylogenetically related to the Parasa complex of Epstein (1988) where Monoleuca belongs. Characters of Monoleuca (sensu stricto) that distinguish it from Heuretes are: 1) spiny type larva similar to those found in Euclea (Epstein 1988), 2) fused forewing R3+R4 arising from R5, rather than R2 as in Heuretes, 3) haustellum absent, 4) labial palpus stout, upturned, 5) signum present, and 6) one pair of hind tibial spurs.

Heuretes shares presumed apomorphic larval character states with Alarodia (only A. slossoniae known), Phobetron, and Isochaetes Dyar (Dyar 1899: 244); the "tropic hairy eucleids" of Dyar (1899). This group is defined by tubercles that are strongly developed subdorsally and weakly developed laterally, and branched, filamentous hairlike setae. Larval Phobetron differ from Heuretes and Alarodia by having tubereles: 1) with short and stout hairs only, 2) without unbranched urticating setae, and 3) that are deciduous, later incorporated into the cocoon. Immature characters shared between Heuretes and Alarodia include: 1) larval tubercles with long filamentous hairs, 2) short, unbranched urticating setae, and 3) white cocoons. Socii found on the uncus in Alarodia slossoniae (Packard) and H. picticornis, absent in all other taxa in both genera, are independently derived according to the phylogenetic analysis below.

Leucophobetron argentiflua (Geyer) from Cuba, the type species of Leucophobetron, is probably congeneric with Alarodia (Epstein in prep.). Leucophobetron includes one other species from Colombia, Leucophobetron punctata (Druce). Though we have not

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examined it, L. punctata is of uncertain family status (Dyar unpublished, Nat. Agri. Libr.; Becker and Epstein in press). There are a number of taxa of this general description in several moth families in South American. Whereas, no other white species of Limacodidae are reported in the neotropics outside of the Caribbean basin.

A detailed phylogeny of the genera related to Heuretes and resolution of generic limits of Alarodia and Leucophobetron are beyond the scope of this paper. However, we present the results of a preliminary phylogenetic analysis that we undertook to determine the correct generic placement of H. daidaleos (H. divisus was not included because it was discovered after completion). The analysis was performed using McClade, with Phobetron as the outgroup. Alarodia, Leucophobetron (based on the type species only). and two species of Heuretes were the other terminal taxa. Eight characters with a total of 21 states were used in the analysis, and multistate characters were ordered with morphoclines.

Heuretes daidaleos was found to be the sister species of II. picticornis in two equally parsimonious cladograms (including Fig. 10, consistency index of .93). Figure 10 and a cladogram with Alarodia as sister group to Leucophobetron + Heuretes are supported biogeographically, since the Puerto Rican Bank (H. picticornis) is closer to Hispaniola (H. daidaleos) than it is to Cuba (Leucophobetron and Alarodia), or Jamaica (Alarodia).

Alarodia (Dyar 1897, 1935) and now Ileuretes are the only genera in Limacodidae (ca. 300 neotropical species), with more than one described species in the Greater Antilles (Becker and Epstein in press). Two undescribed species, one of uncertain placement (not in Alarodia or Heuretes) from Cuba and the Bahamas (USNM, AMNH, CMNH), the other in the Perola complex from the Dominican Republic (CMNH), indicate that the limacodid fauna may increase with future examination. Limacodid genera Perola Walker and Semyra Walker

have one described species each in the Lesser Antilles. There is one undescribed species in the *Natada* complex in this region.

Poor dispersal ability of Limacodidae (Wood 1984), and related families Dalceridae (Miller in press) and Megalopygidae, may explain their low species richness in the West Indies. Dalceridae (85 spp.) and Megalopygidae (>200 spp.), mostly neotropical families, have only one West Indian species each.

ACKNOWLEDGMENTS

Miller's fieldwork, as well as preparation of the illustrations, was supported by The Conservation Agency, with a grant from the The Falconwood Corporation. L. Laszlo Meszoly and Epstein illustrated the genitalia. We thank the curators of the collections consulted for use of specimens. R. W. Hodges, D. R. Davis, N. L. Evenhuis, and S. J. Weller reviewed the manuscript.

LITERATURE CITED

Becker, V. O. and M. E. Epstein. Limacodidae. In Heppner, J. B., ed., Atlas of Neotropical Lepidoptera. Checklist: Part II. E. J. Brill. (In press.)

Brock, J. P. 1971. A contribution towards an understanding of the morphology and phylogeny of the Ditrysian Lepidoptera, J. Nat. Hist. 5: 29-102.

D'Arcy, W. G. 1967. Annotated checklist of the dicotyledons of Tortola, Virgin Islands. Rhodora, 69: 385-450.

Dyar, H. G. 1897. On the white Eucleidae and the larva of Calybia slossoniae (Packard). J. New York Entomol. Soc. 5: 121-126, pl. V.

——. 1899. The life-histories of the New York slug caterpillars.—(conclusion). J. New York Entomol. Soc. 7: 234–253, pl. VI–VIII.

——. 1905. A list of American cochlidian moths, with descriptions of new genera and species. Proc. U.S. Natl. Mus. 29: 359-396.

— 1935. Limacodidae. In Seitz, A., ed., Die Gross-Schmetterlinge der Erde. Stuttgart, Alfred Kernen. Volume 6, pp. 1104–1139.

Epstein, M. E. 1988. An overview of slug caterpillar moths (Lepidoptera: Limacodidae) with emphasis on genera in the New World *Parasa* group. Ph.D. Thesis, Univ. Minnesota. xi + 149 pp.

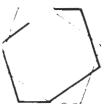
Fletcher, D. S. and I. W. B. Nye. 1982. In Nye, I. W. B., ed., The generic Names of Moths of the World, volume 4. London, British Museum (Natural History). xiv + 192 pp.

- Forbes, W. T. M. 1930. Insects of Porto Rico and the Virgin Islands—Heterocera or moths (excepting the Noctuidae, Geometridae and Pyralidae). Sci. Surv. Porto Rico Virgin Islands 12: 1–171.
- Grote, A. R. 1882. New Check List of North American Moths. New York, New York Entomol. Club. 73 pp.
- ——. 1888. The classification of the Bombycidae (third paper). Can. Entomol. 20: 181-185.
- Grote, A. R. and C. T. Robinson. 1868. Descriptions of American Lepidoptera—No. 4. Trans. Amer. Entomol. Soc. 2: 179-206, pl. 2-3.
- Heatwole, H., R. Levins, and M. D. Byer. 1981. Biogeography of the Puerto Rican Bank. Atoll Res. Bull. 251: 1-55.
- Kirby, W. F. 1892. A synoptic catalogue of Lepidoptera Heterocera. (Moths.) Vol. I. Sphinges and Bombyces. London, Gumey and Jackson. xiii + 951 pp.
- Lazell, J. D., Jr. and L. Jarecki. 1985. Bats of Guana, British Virgin Islands. Amer. Mus. Novitates 2819: 1-7.
- Martorell, L. F. 1948. A survey of the forest insects

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- of Puerto Rico, J. Agr. Univ. Puerto Rico 29: 69-608. ("1945")
- ——. 1976. Annotated Food Plant Catalog of the Insects of Puerto Rico. Agr. Exp. Sta., Univ. Puerto Rico. 303 pp.
- Miller, S. E. Systematics of the Neotropical moth family Dalceridae (Lepidoptera). Bull. Mus. Comp. Zool. (In press.)
- Smithe, F. B. 1975. Naturalist's Color Guide. New York, American Museum of Natural History.
- Van Eecke, R. 1925. Cochlidionidae (Limacodidae). Lepidopterorum Catalogus (32): 1-79.
- Wolcott, G. N. 1936. "Insectae Borinquenses": A revised annotated cheek-list of the insects of Puerto Rico, J. Agri. Univ. Puerto Rico 20: 1-627.
- ———. 1951. The insects of Puerto Rico. J. Agri. Univ. Puerto Rico 32: 1–975. ("1948")
- Wood, B. J. 1984. Implementation of integrated pest management in plantation crops, pp. 295-309. In
 Lee, B. S., W. H. Loke, and K. L. Heong, eds., Integrated Pest Management in Malaysia. Kuala Lumpur. Malay. Plant Protection Soc.





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December 9, 1990

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

Dear Skip,

We were sorry to hear of your loss and give you our condolences. Roberta's mom, with whom she was very close, passed away this past July and our sympathy and empathy are acute.

We were also sorry to have missed you, for you had departed Guana Island just before our arrival. Should such a thing as a free couple of days ever arise, and should you be in RI, we could take a ride to say hello.

Thank you very much for the opportunity to visit Guana Island, and to experience the Gireckie's hospitality. We were disappointed that we did not get to speak with Dr. Girecki, but we did have the opportunity to meet Mrs. Girecki at the dock as she was leaving Tortola. To totally escape academics for awhile was truly wonderful. With a stay in Puerto Rico following the time Guana (we presented a couple of seminars to remind us of our academic commitment), it was a fortunate mid-semester occasion. The only difficulty was that Roberta picked up a flu that is going around Puerto Rico, so she had a fever most of last week, and is still under the weather this week.

Our collections were most successful. At this time we have established cultures of each Drosophila species (melanogaster, simulans, dunni, dunni?, cardini?, penninsularis, richardsoni, latifasciaformis (which does not work well in culture), anannassae, and a few others that require Dave Bruck (UPR, Rio Piedras) works on drosophilids of the dunni group, and prior to our trip suggested that we probably would not find dunni on Guana. We did find them in abundance in the areas surrounding the habitations, however, and there appear to be two somewhat different forms - one fitting the typical dunni (found on Puerto Rico through St. Thomas), and the other which Bruck did not recognize. I believe that a closer examination will show that it's not dunni, but some other species. This past week I've been preparing two sets of samples to be examined by experts of Caribbean drosophila: Dave Grimaldi, at the American Museum of Natural History, and Mary Wasserman, Queens As soon as they confirm our determinations, Roberta and I will begin sorting the thousands of alcohol specimens which are site, bait, and time specific. I suspect that we shall apportion time during our

Lazell, December 9, 1990 Page 2

Guadeloupe trip (January) for that task.

Since my interest is in the wasp parasites that attack drosophilids, I was most pleased at finding individuals of three species. Two species were equally common. Each of them has been determined to belong to a new genus by Goran Nordlander, the only expert on this group. As of this time, no names have been given to these species, and they are simply known as PB 26-4 and PB 26-7, which are the collection numbers assigned by Yves Carton and me when we first collected them in Guadeloupe. The third species is another common, but unnamed species, of the Caribbean region. This one is indicated by code number G-365. Believe it or not, these three species have been used experimentally and their code numbers have been published - particularly by behaviorists in The Netherlands.

It looks as if I have been successful in establishing cultures of all This is surprising because I've been collecting PB 26-4. three species. which appears to be the most common species in the Caribbean, for at least 11 years now, and I've only been able to have the cultures temporarily limp along using D. willistoni as host. I have not been able to rear this species on any other host. I did in Guana what I have done many times before, which is to place a mixture of field collected flies in a vial with food, permit the flies to lay eggs for a day or two, transfer the flies to a fresh vial, then place a wasp female into the vial to allow oviposition on the hatching larvae. I was amazed to find that a large number of parasite offspring had begun to emerge this past Friday. These offspring are being placed on each single species culture of host on a daily basis. Hopefully, we'll now be able to determine the proper host species, something which has been avoiding detection for a long time. Perhaps, however, the Guana parasites are locally adapted to host species that are different from those on other localities in the Caribbean. PB 26-7 is also doing well, as indicated by the numbers of developing parasite larvae, but so far no adults have emerged due to their longer As with PB 26-4, this species had also been poorly developmental time. cultured on D. willistoni, and sustained cultures have been impossible.

The wasp called G-365 is also common in the Caribbean, and I've been able to successfully culture it on a number of host species. Only one specimen was found and it did parasitize a few larvae. Its generation time is in excess of 30 days, so we have to wait. This species, like the other two, is parthenogenetic. Some females occasionally do produce males, but they are non-reproductive. I now have cultures of this species from Puerto Rico, Marie Galante, and Guadeloupe. Only the Marie Galante population continuously produces males, so it will be interesting to see what happens with this population. Perhaps this could be a case in which microorganisms induce sex determination. Also interesting is the fact that this species successfully attacks a broad range of host species hosts belonging to quite different species groups, while PB 26-4 and PB 26-7 have, previously, only been poorly successful on willistoni and would not even attempt to oviposit in other host species with which they were

Lazell, December 9, 1990 Page 3

confined. Such differences in the abilities of parthenogenetic species have interesting implications for the evolutionary patterns of this group, particularly given the high diversity which we are finding in the Caribbean.

We expect to be able to produce a final report with species abundance data by the end of January. Copies will be forwarded to you and to Dr. Girecki when available. Voucher specimens will be prepared and distributed at that time.

Again, we appreciate the opportunity you have provided and look forward to future development of our projects. I would like to explore the possibilities of graduate student research opportunities, but that can wait until we have a chance to meet.

Our best wishes to you for a pleasant holiday season and a rewarding and successful New Year.

Our warmest wishes,

H.Roberta Koepfer

Peter C. Chabora

USE OF CUTICULAR HYDROCARBON ANALYSES FOR TAXONOMIC AND ZOOGEO-GRAPHICAL STUDIES OF CARIBBEAN TERMITES

- The termites of the Caribbean are a varied, multi-source assemblage comprising representatives of one primitive and two specialized families of the order Isoptera, Kalotermitidae, Rhinotermitidae, and Termitidae.
- 2. We have at present only an inadequate survey of, and identification keys for, the termite species found on the several islands of the Caribbean. Exhaustive collecting and preparation of detailed descriptions of termites using the powerful tool of the scanning electron microscope, in addition to traditional tools will permit improvement in the available keys based on morphological features.
- 3. Information on present-day distributions can contribute to our understanding of dispersal routes.
- 4. Survey of the termite fauna of islands left after submergence of low-lying connecting areas, such as the Puerto Rico Bank can provide information about the effects of isolation and reduction of habitat on species diversity.
- 5. Critical to the establishment of dependable keys and appraising the variability developing in isolated populations is a detailed picture of cuticular hydrocarbon profiles. Obtaining reliable profiles in even difficult groups like the nasute termites by increasing the sample size will allow us to achieve this information for all three of the termite families of the area. Samples of the same species should be obtained from each island on which it occurs.
- 6. A practical benefit accrues from precise knowledge of the indigenous termite fauna: this permits ready recognition of an invading group, hopefully before a pest species could become established.
- 7. Instructional activities on the several islands could increase the number of competent collectors, inform residents of the vital role termites play in the ecology of the island, and secure assistance in facilitating work of visiting entomologists.
- 8. Liasons with control companies, and ptovision of up-to-date information on avoidance of damage and the ecological and physiological characteristics of potential pest species should be effected.
- 9. Collecting, describing and providing dried material for cuticular hydrocarbon analysis could be a cooperative venture, shared by termite specialists with access to a desired island or habitat.

The number of islands subject to close scrutiny is growing: Trinidad, Turks and Caicos, Guana and neighboring small islands have been surveyed. Many have worked on Puerto Rico, but this large and diverse island may require much further sampling. Hispaniola, Jamaica and members of the Lesser Antilles group should be studied further. Vieques and Mona Islands are of exceptional interest, and one of us (MSC) has access to both. Pooling resources from interested investigators (Darlington, Su, Scheffrahn, Thorne, Collins) will permit adequate coverage.

Tasks associated with this project include: collection and preservation of reference material, along with pertinent ecological information; preparation of scanning electron micrographs and good illustrations of important taxonomic characters; updating and improving available taxonomic information and descriptions; collecting, sorting, drying and forwarding samples of termites for cuticular hydrocarbon analyses; performing cuticular hydrocarbon analyses and circulating the results; conducting information programs and training future collectors on target islands; establishing liasons for exchange of specimens and information with pest control operators in desired areas; and coordinating efforts of separate investigators.

Individuals interested and qualified to participate in this study so far include :

- Dr. Joanna Darlington, University of the West Indies, Trinidad
- Dr. Michael Haverty, Pacific Southwest Forest and Range Experiment Station, USDA, Berkeley, California
- Dr. Rudolph Scheffrahn, Ft. Lauderdale Research and Education Center, Ft. Lauder-dale, Florida
- Dr. Nan-Yao Su, also at Fort Lauderdale
- Dr. Barbara Thorne, Department of Biology, Harvard University, Boston, Mass.
- Dr. Margaret S. Collins, Smithsonian Institution and the Conservation Agency, Conanicut, Rhode Island

Callections remaiter limited in soil, Prepared by Joanne Dailington Nay in quality. No cuticular against carbon analyses; some of the includes included interest thank there incompletely remercies. This is the starting point, LIST OF TERMITE SPECIES RECORDED FROM THE CARIBBEAN ISLANDS

Sources:

Sn = Snyder 1956

Ad = Adamson 1940 or 1948

AMNH = Emerson's collection in Amer.Mus. Nat. Hist.

JPECD = collection of JPEC Darlington

MSC = collection of MS Collins in Smithsonian Inst.

RHS+ = Scheffrahn et al., in press

RHS+ = SCHEITTANN et al., in	press		
ANTIGUA Nasutitermes costalis (Holmgren)		Sn	Ad
BAHAMAS A=Andros, B=Bimini, E=Eleuthera, N=Nassau, SS=San Salvador Cryptotermes cavifrons Banks Incisitermes schwarzi (Banks) Incisitermes snyderi (Light) Neotermes jouteli (Snyder) Heterotermes cardini (Snyder) Heterotermes tenuis (Hagen) Nasutitermes nigriceps (Haldeman)	N N B A A N A N	Sn Sn Sn Sn Sn	
Nasutitermes rippertii (Rambur) Parvitermes brooksi (Snyder)	ABEN	Sn Sn	
BARBADOS Cryptotermes brevis (Walker) Cryptotermes havilandi (Sjostedt) Incisitermes incisus (Silvestri) Neotermes castaneus (Burmeister) Neotermes wagneri (Desneux) Coptotermes havilandi Holmgren Heterotermes convexinotatus (Snyder) Heterotermes tenuis (Hagen) ? Rhinotermes marginalis (Linnaeus) Nasutitermes costalis (Holmgren)		Sn Sn Sn Sn Sn	Ad (Ad) (Ad) (Ad) (Ad) Ad Ad Ad Ad
BERMUDA Cryptotermes cavifrons Banks Incisitermes bequaerti (Snyder) Incisitermes snyderi (Light) Kalotermes approximatus Snyder		Sn Sn Sn Sn	
CUBA Cryptotermes brevis (Walker) Cryptotermes cavifrons Banks Glyptotermes posticus (Hagen) Incisitermes bequaerti (Snyder) Incisitermes schwarzi (Banks) Incisitermes snyderi (Light) Neotermes castaneus (Burmeister)		Sn Sn Sn Sn Sn Sn	

Neotermes cubanus (Snyder)

Sn

Neotermes jouteli (Snyder) Heterotermes cardini (Snyderi) Heterotermes convexinotatus (Snyder) Prorhinotermes simplex (Hagen) Anoplotermes schwarzi Banks Nasutitermes costalis (Holmgren) Nasutitermes hubbardi Banks Nasutitermes lividus (Burmeister) Nasutitermes rippertii (Rambur) Parvitermes brooksi (Snyder) Parvitermes discolor (Banks) Obtusitermes aequalis (Snyder) Termes hispaniolae Banks	Sn Sn Sn Sn Sn Sn Sn Sn Sn		
CURACAO Cryptotermes brevis (Walker) Nasutitermes nigriceps (Haldeman)	Sn Sn		
DOMINICA Cryptotermes brevis (Walker) Neotermes castaneus (Burmeister) Heterotermes tenuis (Hagen) Nasutitermes costalis (Holmgren)	Sn Sn Sn Sn	Ad	
GRENADA Cryptotermes brevis (Walker) Kalotermes sp Neotermes wagneri (Desneux) Neotermes sp Coptotermes testaceus (linnaeus)	Sn	Ad Ad (Ad) (Ad) Ad	
Nasutitermes costalis (Holmgren)	Sn	Ad	
GUADELOUPE Cryptotermes brevis (Walker) Cryptotermes havilandi (Sjostedt) Cryptotermes sp ?nov Incisitermes incisus (Sylvestri) Incisitermes tabogae (Snyder) Neotermes sp Procryptotermes corniceps (Snyder)	Sn		JPECD JPECD JPECD JPECD JPECD JPECD
Heterotermes tenuis (Hagen)	Sn	Ad	JPECD
Rhinotermes ?marginalis Nasutitermes costalis (Holmgren) Nasutitermes ephratae (Holmgren) Termes sp	Sn Sn	Ad	JPECD JPECD JPECD JPECD
HISPANIOLA Cryptotermes brevis (Walker) Cryptotermes cavifrons Banks Glyptotermes posticus (Hagen) Neotermes castaneus (Burmeister) Heterotermes cardini (Snyder) Heterotermes convexinotatus (Snyder) Heterotermes tenuis (Hagen) Rhinotermes marginalis (Linnaeus)	Sn Sn Sn Sn Sn Sn Sn		

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Anoplotermes meridianus Emerson Anoplotermes spp. Nasutitermes costalis (Holmgren) Nasutitermes lividus (Burmeister) Parvitermes flaveolus (Banks) Parvitermes pallidiceps (Banks) Velocitermes antillarum (Holmgren) Velocitermes toussainti (Banks) Microcerotermes arboreus Emerson Termes hispaniolae (Banks)	Sn Sn Sn Sn Sn Sn Sn Sn Sn
Cryptotermes brevis (Walker) Glyptotermes liberatus (Snyder) Glyptotermes posticus (Hagen) Incisitermes milleri Emerson Incisitermes schwarzi Banks Neotermes castaneus (Burmeister) Neotermes sp. Procryptotermes corniceps (Snyder) Coptotermes havilandi Holmgren Heterotermes convexinotatus (Snyder) Heterotermes tenuis (Hagen) Prorhinotermes simplex (Hagen) Nasutitermes costalis (Holmgren) Nasutitermes hubbardi Banks Nasutitermes nigriceps (Haldeman) Termes hispaniolae (Banks) Termes sp.	Sn S
MARTINIQUE Heterotermes tenuis (Hagen) Rhinotermes marginalis (Linnaeus) Anoplotermes meridianus Emerson Nasutitermes costalis (Holmgren)	Ad Sn Sn Sn Ad
MONA Incisitermes incisus (Silvestri) Incisitermes snyderi (Light) Neotermes mona (Banks) Procryptotermes corniceps (Snyder)	Sn Sn Sn Sn
MONTSERRAT Neotermes castaneus (Burmeister) Heterotermes tenuis (Hagen) Nasutitermes ephratae (Holmgren)	Sn Sn Sn
PUERTO RICO Cryptotermes brevis (Walker) Cryptotermes cavifrons Banks Glyptotermes pubescens Snyder Incisitermes snyderi (Light) Neotermes castaneus (Burmeister) Procryptotermes corniceps (Snyder) Heterotermes convexinotatus (Snyder)	Sn Sn Sn Sn Sn Krishna 1962b Sn Sn

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3 48

Heterotermes tenuis (Hagen) Prorhinotermes simplex (Hagen) Anoplotermes meridianus Emerson Nasutitermes costalis (Holmgren) Nasutitermes nigriceps (Haldeman) Parvitermes discolor (Banks) Parvitermes wolcotti (Snyder) Microcerotermes arboreus Emerson	Sn Sn Sn Sn Sn Sn Sn		
St.KITTS Cryptotermes brevis (Walker) Nasutitermes costalis (Holmgren)	Sn Sn	Ad	
St.LUCIA Calcaritermes temnocephalus (Silvestri) Kr Cryptotermes brevis (Walker) Neotermes sp Nasutitermes costalis (Holmgren)	ishna Sn Sn	1962a Ad Ad Ad	a
St.VINCENT Calcaritermes temnocephalus (Silvestri) Cryptotermes brevis (Walker) Glyptotermes tuberifer Krishna & Emerson 1962 Kalotermes sp Neotermes wagneri (Desneux) Heterotermes tenuis (Hagen) Nasutitermes costalis (Holmgren)		hna 19 Ad (Ad) (Ad) (Ad) Ad Ad	962a (Ad)
TOBAGO Cryptotermes brevis (Walker) Cryptotermes dudleyi Banks Glyptotermes adamsoni Kryshna & Emerson Neotermes holmgreni Banks Coptotermes testaceus (Linnaeus) Heterotermes tenuis (Hagen) Nasutitermes costalis (Holmgren) Nasutitermes ephratae - (Holmgren) Nasutitermes gaigei Emerson Microcerotermes arboreus Emerson Termes hispaniolae (Banks)	Sn Sn Sn Sn Sn Sn	Ad (Ad) Ad Ad Ad Ad Ad	JPECD
<u> </u>	ishna Sn 1962		, ,

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1990 Collection Records : Caribbean M.S. Collins

Tuesday, 24 July

- GUA 90-1 Guana Island, foraging group from runway on tree beside road to summit, Guanaberry Trail; tiny masutes
- Wed.,25 July: GUA 90-2- Large carton colony on Sea Grape near White Bay Beach, Guana; Alates, Workers, dried; Soldiers in alcohol
- GUA-90- 3 July 27. Kalotermitid (probably <u>Procryptotermes corniceps</u>)large colony, NN,LL,PS,s, (92 dried); others preserved
- GUA 90-4 -July 30 . woods near North Bay Beach, near site of large N. nigriceps bisected nest; Im., S, N, Ps., L Pres.; some dried
- GUA 90-5- end in soil-rock mixture at shed end of garden, WB flats. G.I. K,Q,S, Ps, 11 prese preserved, 95 dried
- GUA 90-6 Large nest fallen and bisected by Ralph Rusher in woods near North Bay Beach; nodules found and harvested in 1989; some harvested in 1990 (MSC); top half still has queen , probably, many other termites ; no nodules located in it. Dried: W - 100; dealate imagoes - 57
- GUA 90-7- Oct. 26- Heterotermes sp. from stem of dead century plant, large colony in wall; above Anegada, in thich scrub. Many dried.
- GUA 90-8. Nov. 1, 1990. Sample from laundry nest cut down and moved; 100 W dried, many W,S preserved; colony with eggs and babies, probably also a queen

VIEQUES (first visit; all but dried sample lost, preserved material OK

- VI-1- Oct. 20, 1990. ca 1000' elevation; at summit of mountain Beside parking are; branch from large down dtump, runways on side; Nasutitelmes sp.
 - /I-2. " <u>Heterotermes</u> sp. ; first stop going down road from summit, ca 700 ft.; S, W under bark of large down tree on rotten granite; W to dry Valley east of Monte:
 - VI-3 Pirata near abandoned magazine, ca 50 'elev.; nest sample taken, large, tough,
 - VI-4. Beside road to entrance of Monte Pirata, on Flamboyant- large nest ca 15' up, many runways; foragers sampled
 - VI-5. Carton nest beside road, same locality as 4; 100 W dried
 - VI-6. Globular carton nest on down tree near road in mangrove swamp, sea level.
 - VI-7 Dead mangrove stump, near road beside swamp- Incisitermes sp.; sample brought back alive to raise alates; in culture now, S.I.; some dried (76),(30)
 - VI-8. Dead standing mangrove stump- pres.

Second trip: Nov. 11, 1990

- VI-9. Kalotermitid from standing dry stump beside road to beach, Naval Station; Mangrove, Sea Grape, Coconut association 40 Ps. dried
- VI-10. same type of data as 9 ; 30 Ps dried; S, N, Silverfish pres.
- VI-11. Large colony of Kalotermitida, with several species of ants and Embiids in same wood; K and Q pres. 90 Ps dried
- VI-12. Kalotermitid, dead, dry hard wood branch; 60 Ps dried
- VI90-13. Nasutitermes sp. prob nigriceps- good sample, but none preserved in alky.
- VI-14. Nasutitermes. sp. from same location; 100 W dried, many S preserved
- VI-15. as in 14, but different nest some dired, some preserved
- VI-16. Same as 14, but on sea grape

GREAT CAMINO Oct.24, 1990

- Collecting at ca 350' elevation above Indigo Plantation landing, just past "Our Way" estate
- GC-1. Nasutitermes sp. from base and stem of old Agave; 35 W dried, termite-eating ants (TEA-1) collected.
- GC-2. Parvitermes sp. dead down branch with red soil workings on outside and under stones; 128 W dried; SS, WW preserved.
- GC-3<u>Incisitermes</u> sp. from hard, dead, dry stem at building site (350'); S,W pres.;

 30 dried

Bacons

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15 -0

Caribbean Collection Record, 1990 (page 2)

GC-4 :

GC5 - Stick hollowed out on ground near very large carton nest on Gumbo-Limbo tree across from "Our Way" plantation; ca 250' elevation

Scrub Island (Neck area) Oct. 27, 1990

- SI-1. Incisitermes (?) sp. dead branch on living tree clump; pres. sample, dried sample
- SI-2. Same clump, small sample, all preserved
- SI-3. Larger branch, same kind of tree, hopefully a larger colony
- SI-4. Dead branch on a Pisonia; plus ants; 31 Ps dried, others preserved
- SI-5. Kalotermitid with alates; dead branch of tree on flat; Tina helped break loose, alates flew like <u>I</u>. <u>snyderi</u> (exploded |) later in room; 70 Ps dried, also L,
- SI-6. Kalotermitid from same type of wood, same area, small sample; only pres.
- SI-7. Nasutes from dead Sea Grape stem; too hard to finish (10:30 PM; get sample to dry from laundry-bag colony (150 Ws)

GUANA ISLAND, PINGUIN GHUT TRAIL (PG series) Oct. 30

- PG-1. Kalotermitid, 1 S, 2 Ps. In small standing dead branch with colony of dead ants
- PG-2 Kalotermitid from dead branch beside trail; 62 Ps. dried
- PG-3 very large Kalotermitid colony; S,Ps, i Primary preserved; 90 Ps dried; Tenebrionid to Scott

GUANA ISLAND, PYRAMID TRAIL 6 NOV. 1990

- GUA 90, PT-1 Kalotermitid, dead stob with ants; pres. S, Ps; dried, 64 Ps.
 - PT-2. <u>Parvitermes</u> sp. hollow dead branch on ground, filled with soil and galleries; 132 dried, some pres.

LITTLE CAMINO - just nest/tree records, see book

PUERTO RICO, GUANICA NATIONAL FOREST : 10 November

- PR 90-1. Nasutitermes prob. costalis; state forest, ca 1 km. west of Hotel Copamarina, in dead, rotten Gumbo-Limbo; coll. H. Haneke Rt. 333
 120 W dried; sample preserved
- PR 90-2. Heterotermes sp. same locality, H. Haneke, in small piece of wood
- PR 90-3. Nasutitermes sp.prob costalis, same habitat, coll. MC; larger sample in bandana

Nearer beach :

- PR 90-4. Heterotermes sp. , in large dead tree; coll. G. Proctor
- PR 90-5. N. nigriceps, large sample with babies; 120+ dried; S,W pres. Coll. H. Haneke
- PR 90-6. Incisitermes sp. prob. <u>snyderi</u>; last stop at former proposed Club Med site; in dead Prosopis

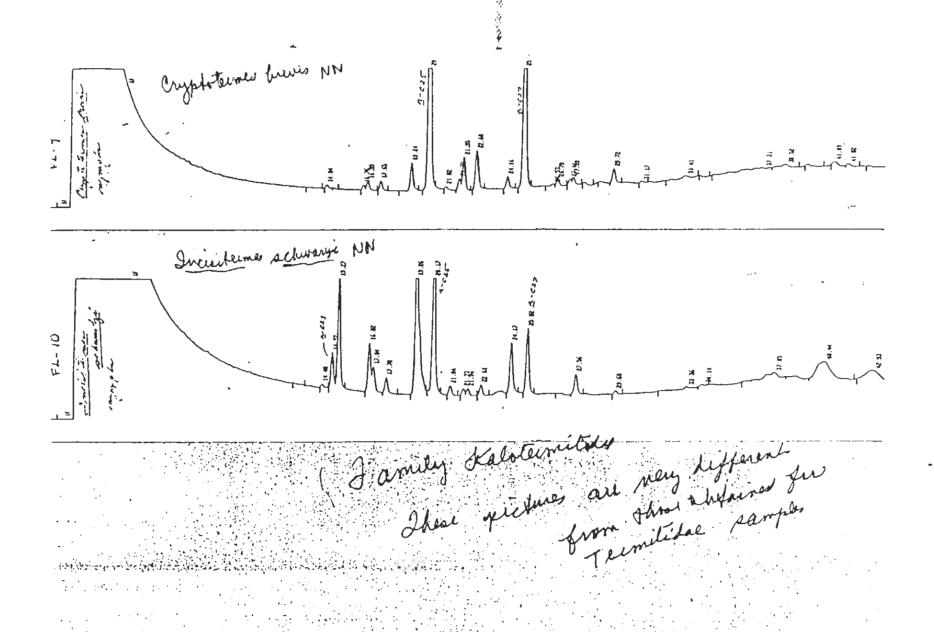
<u>Code</u>

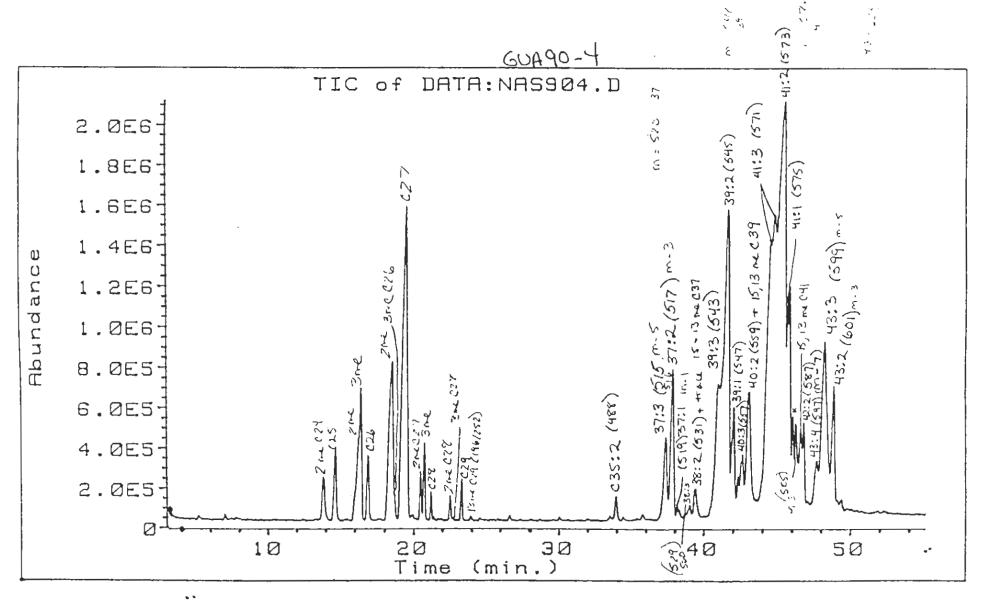
₩ = worker

S = soldier

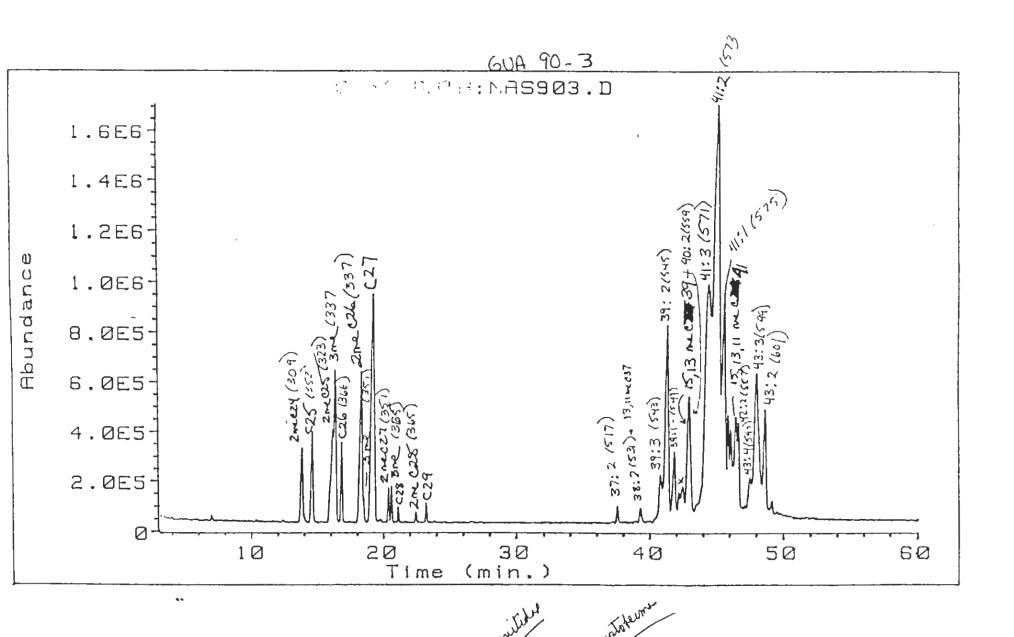
Ps = Pseudergate

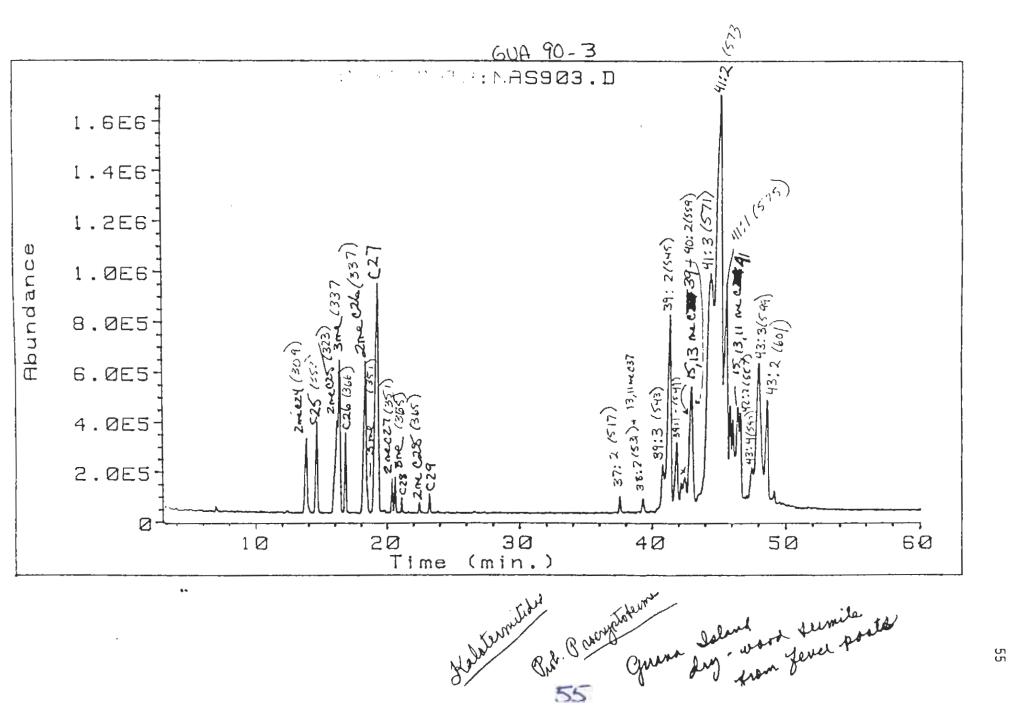
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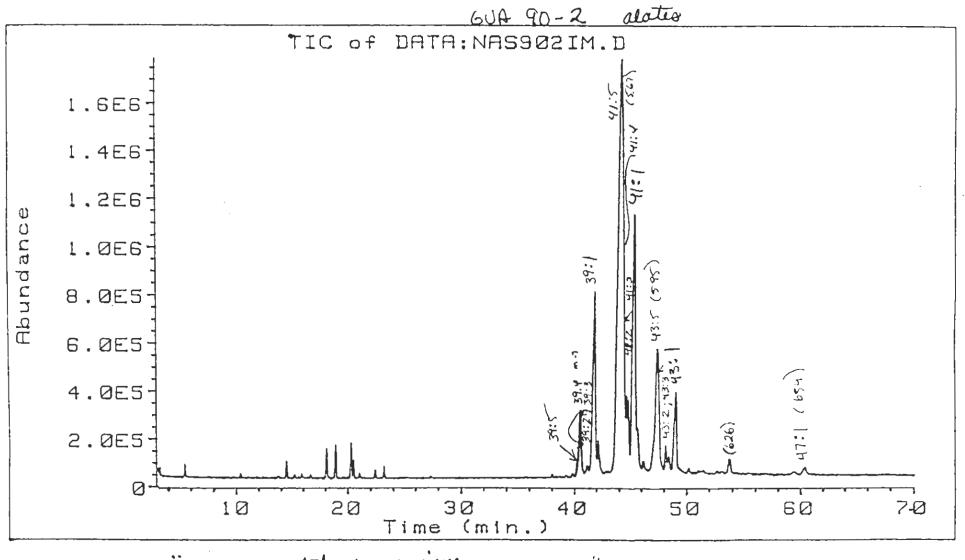


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Family Termitidae his next from Guan

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CUTICULAR HYDROCARBONS OF DAMPWOOD TERMITES, Zootermopsis:

Intra- and Intercolony Variation and Potential as Taxonomic Characters¹

MICHAEL I. HAVERTY, 2 MARION PAGE, 2 LORI J. NELSON, 2 and GARY J. BLOMQUIST³

¹Isoptera: Termopsidae.

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Department of Biochemistry University of Nevada Reno, Nevada 89557-0014

(Revised April 6, 1987; accepted June 3, 1987)

Abstract-Colonies of Zaatermopsis were collected from the central Sierra Nevada and the Monterey Penninsula in California, and from southern Arizona. Cuticular hydrocarbons were identified by gas chromatography-mass spectrometry (GC-MS) and quantified by gas-liquid chromatography (GLC) for each caste of all colonies. Four consistent and distinct cuticular hydrocarbon patterns, or chemical phenorypes, were identified. Unique and abundant monomethyl- and dimethylalkanes, and an n-alkene provided easy separation of the various phenotypes. Significant differences in the proportions of the various components were found among castes within a colony and colonies within phenotypes from California. Differences in the hydrocarbon proportions for castes were not consistent between colonies. The current taxonomy of the genus Zaotermopsis recognizes three species. Our identification of four consistent, unique cuticular hydrocarbon phenotypes from the three described species should alert systematists and others to a major concern. If there are truly only three extant species, then the hypothesis. that cuticular hydrocarbon profiles in this genus are species specific is not acceptable. Conversely, if cuticular hydrocarbon profiles are truly species | 🔏 specific, then there is at least one new, undescribed species of Zootermopsis.



Key Words-Chemotaxonomy, Isoptera, Termopsidae, termites, methylbranched hydrocarbons, lipids, agonisitic behavior, cuticular hydro-carbons.

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SURFACE HYDROCARBON COMPONENTS OF TWO SPECIES OF *Nasutitermes* FROM TRINIDAD¹

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(Received November 28, 1989; accepted February 23, 1990)

Abstract-Colonies of Nasutitermes costalis (Holmgren) and N. ephratae (Holmgren) were collected from five locations in Trinidad. Cuticular hydrocarbons were characterized by gas chromatography-electron impact mass spectrometry and quantified by capillary gas chromatography. Sixteen major components were identified; all but one component (12, 16-dimethyltriacontane) were common to both species. The methyl-branched hydrocarbons were predominant in N. costalis, while the majority of the hydrocarbon components in N. ephratae were n-alkanes. One hydrocarbon (11,15-dimethylheptacosane) was found in abundance in samples of N. ephratae from Trinidad but was not previously reported from collections of this species in Panama. In addition to the morphology of the soldiers and alates and the architecture of the arboreal nests, N. costalis and N. ephratae from Trinidad can easily be separated by chromatograms of the hydrocarbons. N. costalis has an enormous 13,17-dimethylhentriacontane peak (mean = 42.4% of total hydrocarbon). In N. ephratae this peak is much smaller and the 12,16dimethyltriacontane peak is completely missing. N. costalis from Trinidad and N. corniger from Panama appear to have cuticular hydrocarbon profiles that are more similar to one another than are those of N. ephratae from Trinidad and Panama.

¹Isoptera: Termitidae: Nasutitermitinae.

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XVI) Frome Source, Congress

CUTICULAR HYDROCARBON ANALYSIS: A FUNCTIONAL TOOL IN EVALUATING BIOLOGICAL DIVERSITY IN INSECTS

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The outer layer of the cuticle of all terrestrial insects consists of a thin layer of wax. Hydrocarbons are ubiquitous components in this wax; they provide protection from desiccation, microorganisms, and toxic chemicals, and play a role in chemical communication. Insects synthesize most, if not all, of their complement of cuticular hydrocarbons de novo, and generally have from 10 to 40 major components in their hydrocarbon mixtures. This relatively large number of possible hydrocarbon components, ease of identification, and apparent species-specific compositions for many insects, make hydrocarbons attractive characters for studying biodiversity.

We have been studying existing taxonomies, that are based on morphological, genetic and/or behavioral characteristics, to evaluate the utility of cuticular hydrocarbons as taxonomic characters. Our results have helped unravel species complexes in termites, have identified sibling species in bark beetles, cone beetles and cone moths, and have substantiated recent synonymies in other forest insects. Ideally, these chemical characters should be used much as classical taxonomists use morphology, behavior or genetics, i.e., to sort the groups of insects on the basis of chemical characters first, rather than after groups have already been sorted on the basis of existing nonchemical criteria. We have found that characterization of cuticular hydrocarbons often leads to subsequent biological or chemical studies which clarify taxonomic questions, especially when it it difficult to test the biological species concept.

Key Words: Systematics, Taxonomy, Termites, Bark Beetles, Cone Insects, Biodiversity, Speciation.

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BIOLOGICAL DIVERSITY I. INVENTORIES & MONITORING ... TERRESTRIAL DIVERSITY & BIOGEDGRAPHY

CUTICULAR HYDROCARBONS FOR SPECIES DETERMINATION OF TROPICAL TERMITES

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Insect species have unique mixtures of cuticular hydrocarbons in their integument. We use hydrocarbons to evaluate biodiversity among termite populations. Coptotermes and Nasutitermes are among the most economically and ecologically important termites in the tropics. In the U.S. there are no qualitative differences in hydrocarbon components among four geographically distant populations of C. formosanus; quantitative differences separate them into different concentration profiles. Our results suggest that C. formosanus colonies from the mainland are not closely related to those from Hawaii. C. formosanus was probably introduced into Louisiana twice. Hydrocarbon profiles of C. formosanus from the U.S. are qualitatively different from Coptotermes from Australia, Southeast Asia and the Caribbean. N. costalis and N. ephratae were collected from five locations in Trinidad. Sixteen major hydrocarbon components were identified; all but one component were common to both species. N. costalis has tremendous quantities of 13,17-DimeC31, whereas in N. ephratae this hydrocarbon is insignificant. Furthermore, 12,16-DimeC31 is completely missing in N. ephratae. N. costalis from Trinidad and N. corniger from Panama appear to have cuticular hydrocarbon profiles that are more similar to one another than are those of N. ephratae from Trinidad and Panama. Hydrocarbon profiles from additional species of Nasutitermes in the Caribbean confirm the utility of this technique for species determination.

Key Words: Systematics, Taxonomy, <u>Nasutitermes</u>, <u>Coptotermes</u>, <u>Biodiversity</u>, Speciation.

X ...

BIOLOGICAL DIVERSITY I. INVENTORIES & MONITORING TERRESTRIAL DIVORSITY & BIOGEOGRAPHY SHORT COURSE : BIOLOGY OF TERMITES OF THE BRITISH VIRGIN ISLANDS

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SHORT COURSE : BIOLOGY OF TERMITES, BRITISH VIRGIN ISLANDS

Lecture/Demonstration Schedule

- I. Termites as social insects Characteristics of 1) Insects and 2) Social animals
 - A. Morphology, Castes; Families found in the region
 - 1. Imago : Body form, key characters, functions
 - 2. Soldier : Body form, key characters, functions
 - 3. Worker : Body form, potential key characters, functions
 - 4. Construction of a taxonomic key
 - B. Biology of Caribbean Termites
 - Families: Feeding habits, nest structure, colony size; roles in the ecosystem; symbiotes
 - 2. Flight times and patterns ; climatic factors of significance
 - 3. Formation of new colonies
 - 4. Desirable information to be discovered
 - C. Beneficial and destructive activities of termites
 - 1. Detecting structural damage and determining the type of termite involved
 - 2. Avoiding or reducing damage by termites
 - a. House construction, site sanitation
 - b. Lighting
 - c. Use of termite-resistant construction materials

Sample Narrative outline for section 1A

Termites are social insects living in small -to-large colonies (few hundredover 1 million individuals) in or on trees, buildings or below the soil surface.
The life cycle includes eggs, young of several stages variously resembling the adult,
and the adult. Termite colonies contain individuals of different body types,
specialized in different directions. These are the <u>Castes</u>. The most specialized
termites in this area possess 3 adult castes, the winged reproductives (Kings
and Queens) (Imagos), the <u>soldiers</u>, and, most numerous, the <u>workers</u>. The large
dry-wood and furniture termites are less specialized and have only 2 adult castes,
the reproductives and the soldiers. Work in such a colony is done by the younger
individuals who will later develop into either soldiers or reproductives. These
forms are called "pseudoworkers" or "pseudergates". The true worker in the strict
sense cannot develop into another caste.

How can one recognize the several castes of termites ?

- Imagoes: Deep body color, brown to black; compound and simple eyes present;
 2 pairs of wings with a breakage suture near the base of each; legs comparatively strong, with a rugged appearance; chewing mouthparts Functions: Dispersal, reproduction, colony initiation and organization, pheromone secretion
- Soldiers: Body relatively lightly pigmented; eyes may be present in some of the Kalotermitidae, but they are small and may lack pigment; otherwise, eyes and wings are lacking; legs variously thickened, usually lightly pigmented; mandibles well developed and prominent in Kalotermitidae and Rhinotermitidae, where they are specialized in the direction of increased defensive capacity, while in the Termitidae, the soldier mandibles are much reduced, and observable only with magnification; pronotum variously shaped, as wide as the posterior margin of the head, or clearly narrower, depending upon family

Functions : Defense, pheromone secretion, alarm and recruitment, nitrogen fixation

Workers (or pseudergates) : yellow-brown to pale cream individuals resembling younger stages of termites; no eyes, ocelli or wings; antennal article number variable ; chewing mouthparts; digestive tract at least partially visible through abdominal wall in paler specimens Functions : Colony nest construction; care (feeding, cleaning, etc. of eggs, young, and other castes; aid soldiers in defense in some species

Examine the demonstration material of living termites of the several castes. Can you find additional features to add to the listed characteristics ?

Construction of a taxonomic key

A taxonomic key is usually synoptic (one that gives alternate descriptions of characters and numbers or letters to follow after choosing the applicable alternative). Following the choices correctly can lead to the taxonomic category to which the subject animal belongs. For example :

- (if not true, follow (b) b. Insects lacking wings.....past 5 b. Only one pair of wings, the second pair reduced to strap-like structures, 3. a. Wings membranous in texture, both pairs about the same length...4 b. Fore wings of different texture from the hind wings......5 4. a. Wings capable of being folded down the back when at rest......Isoptera,
- the termites
 - b. Wings held outstretched, not capable of being folded.....Odonata, Dragon Flies
- 5....Continue in this fashion

Given the information to follow and the example above, can you construct a key to the families of termites living in this area?

IMAGO CHARACTERISTICS BY FAMILY

Common BVI representatives : Incisitermes snyderi, I. Kalotermitidae Cryptotermes brevis, Procryptotermes corniceps

- 1. Base of wing with 3 or more sclerotized veins (counted at suture edge of wing scale)
- 2. No fontanelle
- 3. Clypeus simple
- 4. Ocelli present
- 5. Antennae with fewer than 22 articles
- 6. No spines on tibial shaft
- 7.Left mandible with an apical tooth and 2 large, subequal, closely-spaced marginal teeth
- 8. Cerai 2-segmented

CCNSULT FIGURES AND DEMONSTRATIONS FOR MEAN-

INGS OF TERMS 9. Tibial spurs 3:3:3



II.Rhinotermitidae

Common BVI representatives : Heterotermes , Coptotermes

- 1. Two sclerotized veins at suture edge of of wing scale
- 2. Fontanelle present
- 3. Clypeus 2-lobed (sometimes inconspicuously so)
- 4. Forewing scale considerably longer than hindwing scale, usually overlapping it at base
- 5. Wings translucent
- 6. Mandibles :

Left mandible with one apical and 3 marginal teeth above a molar plate Right mandible with an apical and 2 marginal teeth and a molar plate; with a small subsidiary tooth at base of 1st marginal tooth; second marginal tooth broad, nearly as broad as the molar plate

- 7. Pronotum about as wide as head, rather flat
- 8. Wings pigmented or colorless, usually transparent
- 9. Tarsi 4-segmented
- 10. Tibial spur count 3:2:2 or 2:2:2

III. Termitidae

.Common BVI representatives : Nasutitermcs sp. Parvitermes discolor

- 1. Base of wing with 2 sclerotized veins at suture edge of wing scale
- 2. Fontanelle present
- Ocelli present
- 4. Clypeus divided into two parts by a medial suture
- 5. Forewing scale short, not reaching to base of hindwing
- 6. Wing venation reduced
- 7. Tarsi 4-segmented
- 8. Cerci reduced, 2-segmented
- 9. Tibial spurs usually 2:2:2

SOLDIER CHARACTERISTICS BY FAMILY

I. Kalotermitidae

- Tarsi 4-segmented
- 2. Fontanelle absent
- 3. Tibial spurs 3:3:3
- 4. Cerci short, 2-segmented
- 5. Antennae with 10-20 articles
- 6. Head robust, long or truncated and plug-shaped
- 7. Eyes present but rudimentary; sometimes pigmented
- 8. Epicranial suture present
- 9. Mandibles usually robust
- 10. Mandibular dentition variable: left mandible with 1 apical and 3 marginal teeth (may be much reduced); Right mandible with an apical and 2 marginal teeth in most representatives

II. Rhinotermitidae

- 1. Tarsi 4-segmented
- 2. Fontanelle present, may be large and anteriorly-directed
- 3. Tibial spur count 3:2:2
- 4. Pronotum flat in lateral view, without anterior lobes; usually narrower than posterior margin of head
- 5. Eyes absent
- 6. Mandibles smooth, lacking teeth or serrations in outer portion
- 7. Antennae with 14-18 articles
- 8. Cerci very short, 2-segmented

-4-

III. Termitidae

- 1. Tarsi 4-segmented
- 2. Fontanelle present,
- 3. Eyes absent
- 4. Pronotum saddle shaped, with anterior lobes
- 5. Mandibles vestigial
- 6. Nasus prominent
- 7. Cerci reduced, 2-segmented
- 8. Tibial spur count 2:2:2

ILLUSTRATIONS TO BE PROVIDED

The following figures, drawn from a number of listed sources, will permit interpretation of the preceding material. These figures are to be used in conjunction with slides and both living and preserved specimens in the laboratory. Questions are encouraged. The vocabulary is to be built as we progress through this section, from the figures and lecture material.

- 1. Dorsal views of Imago heads, pronota, showing antennae and clypeal arrangements
- 2. Mandibles of selected imagoes showing teeth
- 3. Wings and wing scales
- 4. Dorsal and lateral views of soldier heads ; antennae shown separately
- 5. Dissected mandibles of selected soldier types
- 6. Dorsal views of worker heads with mandibles dissected and so mounted as to show arrangement of teeth
- 7. Figures showing the gut of workers through the abdominal wall

SELF TEST: SAMPLE

Progress in mastering the material may be judged by a series of self-tests such as :

Tibial spur formula	Termite family
1. 3:3:3 2. 3:4:3	
3. 3:2:2 4. 2:2:2	-
4. 2:2:2	

Choices: 1. Kalotermitidae

2. Rhinotermitidae

Termitidae

Place the number of the family in

the appropriate space, above

Check your answers at the bottom of the page

LABORATORY AND FIELD SCHEDULE

Laboratory

- Termite morphology: Imagoes, Soldiers, workers representing <u>Incisitermes</u>, <u>Cryptotermes</u>, <u>Procryptotermes</u>, <u>Coptotermes</u>, <u>Heterotermes</u>, <u>Nasutitermes</u>, <u>Parvitermes</u>
- 2. Use of taxonomic key (to families, then genera)
- 3. Behavior flight and post-flight, defensive behavior

Field

- 1. Termite nest types
 - Subterranean, wood-dwelling and aerial nest-building representatives
- 2. Detecting infestations in structural timbers
 - a. identifying pellets vs beetle frass
- 3. Detecting infestations in houses or other buildings (with Control Company Operative

COOPERATIVE PROJECT

- 1. Describe the outstanding characteristics of the guts of workers or pseudergates of termites of the 3 families represented in the area; can you separate them to genus and/or species?
- Describe the relationship between the width of the posterior margin of the head and the width of the pronotum of soldiers of the species represented here
- Identify a group of "Unknowns"
- 4. Construct a key to the termites of Guana Island

Needed facilities and materials will be listed separately.

VOCABULARY

The following words are to be defined, understood, and added to your working vocabulary.

Agonistic

Antenna

Apical

Caste

Cercus (i)

Clypeus

Compound eye

Dispersal

Dissected

Ecosystem

Family

Fontanelle

Genus

Isoptera

Mandible

Marginal

Molar plate

Morphology

Nasus

Ocellus

Order

Pellet (fecal)

Pheromone

Pigmented

Pronotum

Pseudergate

Sclerotized

Segmented

Serration

Species

Spine

Spur

Subequal

Subsidiary

Suture

Symbiote

Tarsus

Taxonomy

Tibia

Translucent

Vein

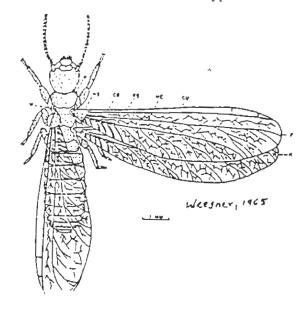
Vestigial

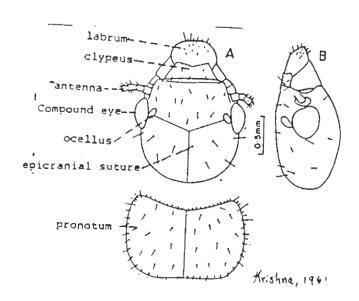
Figures taken from the following works :

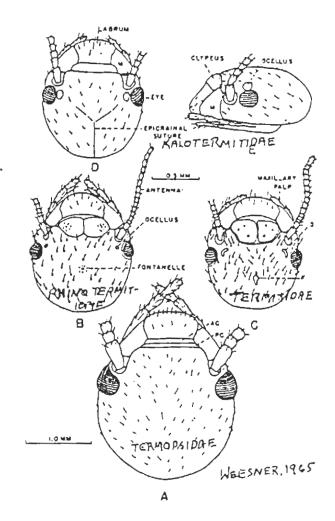
Harris, W.V. 1961. <u>Termites</u>, <u>their Recognition and Control</u>. Longmans, Green and Co., Ltd. London. 187 pp.

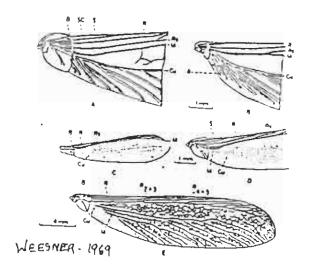
Krishna, K. 1961. A Generic Revision and Phylogenetic Study of the Family Kalotermitidae (Isoptera). Bull. Amer. Mus. Nat. Hist. 122, art. 4 New York

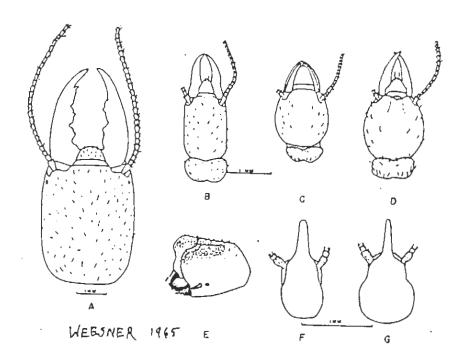
Krishna, K. and F.M. Weesner, eds. 1969. <u>Biology of Termites</u>, vol. 1, Academic Press, New York and London. 643 pp. Weesner, F. 1965. The Termites of the United States, a Handbook. Nat. Pest Control Assoc. Elizabeth, N.J. 70 pp.

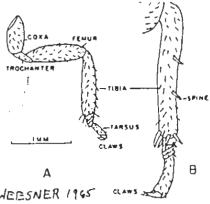




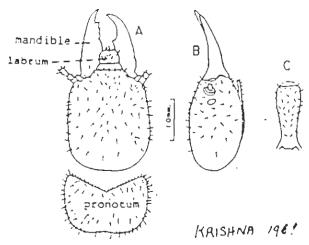








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Small soldier of Incretainnes schmersi (Banks), A. Heed and prenotive from above, B. Heed from side, C. Postmentum from balaw, Hamptype from Caral Gables, Florids,

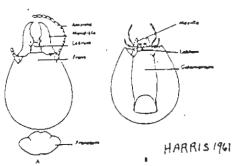
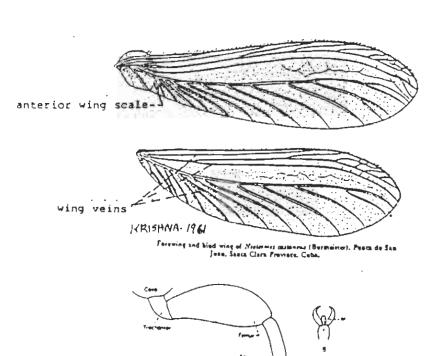


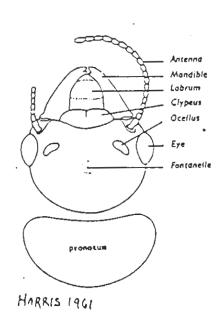
Fig. 6

The soldier head, showing the principal parts. A. 188441



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A: The sincture of the leg in Europeanopsi angeriands. Mare the somes on the shift of the ribin species in many recovers it (Shiethed from a histon minute of the ribin for ky of a salder). B. The legionist portion of the large of Timeromographist principal (Shiethed from an already Personal the same class).



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ICHTHYOLOGY

I was disappointed when we discontinued our marine work (done because of your concerns over insurance). I think we should resume it. Karen Koltes and her husband, John, are excellent marine biologists, working on fishes, crabs, and marine turtles. Karen is slow about writing up results, but I believe that Guana would be a sufficient inducement to speed up if she believed a return was possible. More on this in the 1991 proposal.

P.O. Box 544 Garnett Park, MD 20896

15 March, 1989

Dear Skip:

Thanks so much for the travel reimbursement from last summer. It has spared another scientist from debtor's prison (temporarily at least!).

No doubt I have probably risen to the top of your S--- list, having taken so long to get this report to you. I had hoped to be able to include in my report the notification of publication of the parrotfish manuscript, but alas, it has been turned down again(!), this time for statistical reasons (last time for insufficient data). I will try again. It's a real challenge to get manuscripts out these days without benefit of the support I had at the Smithsonian, particularly the illustrator's assistance. I'm now doing my own drafting and finding I'm not especially proficient, but it doesn't seem to be the main impediment to publication.

It has been (and continues to be) quite a year. I am still casting around for a position, making the short list for several jobs (including #2 at National Academy of Sciences), but as of this writing, "close" is all I've accomplished. Having done such interesting things over the past several years, I am admittedly being picky about the jobs I apply for, but the financial realities are beginning to assert themselves over loftier goals! Waitressing anyone? Or maybe I should try delivering phone books?!

I spent several weeks working on the green turtle project with John in Tortuguero in August, then returned here to hone my carpentry skills. I've been doing most of the work on an addition we put on the house (shingling, installing windows, insulating, sheetrocking, trim, finish, etc., etc., etc.), "paying" myself to do the work which we'd intended to contract out before I knew I'd be jobless. I've learned a lot on my sabbatical and enjoyed the break while I figure out where to go from here.

John and I returned to Belize in December/January to work on the spider crabs again. We had an enormously successful month, measuring and tagging a record 275 crabs! I've applied for a post-doc with Austin Williams at SI to continue the work, but won't learn the fate of my proposal until mid-April. I know I'm handicapped in the competition by having already been at the SI. Incidentally, did Greg make the deadline for his post-doc?

Vitor wrote to say you were in Brazil and had a fantastic trip. He said you were a good "field mate" and would have lots of stories to share. No doubt!! Vitor also said he plans to return to Guana in November under the new schedule. Assuming you'll even speak to me after the delay in submitting this report, that you still have a need for a marine biologist-extraordinaire, and that my job status permits, I'd like to return as well. I think this year I'd split the work between parrotfish and spider crabs. I'd like to return to the spawning ground to look at seasonal trends. I also have a manuscript on the population variation in Mithrax spinosissimus crabs from several Caribbean sites and the Keys, but there are no specimens

from the Virgin Islands and I'd like to sample them. I saw one or two crabs in very shallow water at Long Point in 1987, so they are around although very difficult to find. Night diving is the best way to collect them.

You are no doubt in China or some other far-flung place so I'll send this report to your RI address for forwarding. Thanks again for the contribution to this non-profit organization! It has been a real help in this year of transition. All the best and keep in touch.

Warmly,

Further Investigations of the Spawning Behavior of the Stoplight Parrotfish at Guana Island, B.V.I:

A test of the Transitional Hypothesis.

Karen H. Koltes, Ph.D.

In July, 1987, a spawning ground was located for the stoplight parrotfish, Sparisoma viride at Long Point, Guana Island. Observations were made on their spawning behavior during 25 scuba dives to the site. Results indicated that the brightly colored terminal-phase (TP) males established territories from 17 - 25 m depth along the wall just inside the point to Muskmelon Bay. Territories were contiguous, averaged about 65 m2, and were vigorously defended against other TP males. Drab-colored initial-phase (IP) fish moved through the territories in groups of from one to four individuals. Several courtship and spawning sequences were observed between IP fish and TP males. In some cases, IP fish were driven from the territories. Since IP fish can be either females or functional males in the early stage of sex reversal ("transitionals"), it was suggested that the IP fish being driven from the territories were transitionals attempting to gain access to females on the spawning grounds. However, visibility was very poor (often less than 3 m) and many aspects of the courtship, spawning and territory defense could not be observed.

In July, 1988, we returned to the spawning grounds and found that visibility was much improved over the previous summer, with up to 20 m visibility on some days. This provided an excellent opportunity for more detailed observations of the courtship/spawning sequence. The study was

divided into two parts: 1) an initial period (8 days) of observation on the spawning sequence, territory size, density, etc., including transect mapping of the area, and 2) a sampling period during which individuals were captured on the spawning grounds for determination of their reproductive condition. This was accomplished by stationing an observer in the water column above the spawning ground and observing IP fish as they entered the territory of a TP male. The response of the male (including ignoring) was noted and the IP fish captured. Length and weight were recorded for all fish sampled and gonads were removed, examined and weighed after preservation in alcohol.

Observations made during the first part of the study revealed several new details about the spawning behavior of the stoplight parrotfish. The increased visibility permitted an "overview" of the spawning grounds which had not been possible under the low visibility conditions during the previous year's study. On most dives to the site, at least 3 territorial males could be observed simultaneously so that the interactions among adjacent territory holders and between them and 'visitors' to the spawning grounds could be observed.

Observations made in the morning and afternoon showed that the number, size and approximate position of the territories remained stable over the course of the day (and study). There was some indication that spawning activity was greater in the morning and when ebbing tidal currents were at their maximum, but this was not quantified. Territories were established along the wall from the outermost point to about 200 m inside the bay and from 11 m to the bottom at 26 m. Although an accurate measure of the total area of the spawning ground was difficult to make due to topography and visibility, the spawning ground was estimated to cover an area approximately 16,000 m2.

The densest concentration of territories occurred at about 50 m inside the point and about 20 m depth. Territories were evenly spaced at about 7.5 m in this zone, suggesting the area was "packed". This was a gently sloping area with rocky outcrops over which the males would often position themselves. It also had an abundance of soft coral which IP's used for cover as they moved through the territories and over which pairs would often spawn.

Courtship between a territorial male and an IP fish was observed on 77 occasions. Courtship ranged from a low intensity response in which the territorial male merely swam excitedly toward the female (18 cases) to a full display culminating in spawning (19 cases). The full display usually lasted less than 1 minute and began when a female entered the territory and took refuge in a soft coral where she assumed a 'head-up' position. The male would rise up in the water column and slowly circle above the female, who then rose slowly up to meet him. Both would swim haltingly, turning frequently and moving slowly toward each other. The final stage consisted of the "spawning rush" in which the pair swam parallel, inclined on their side and virtually touching in a rapid burst to the top of an arc about 5 -6 m above the substrate where they released their gametes. They then descended rapidly to the substrate and had a cigarette. The most common sequence observed was an abbreviated spawning rise in which the male rose up in the water column above the female then returned to the substrate (30 cases).

Thirty chases by a territorial male of IP individuals were observed.

Although some chases apparently involved females (see below), many of these individuals likely were transitionals. Three spawning sequences were observed in which a second IP fish dashed up to the point at which the spawning pair had just released their gametes. In all cases, the TP male chased the

interloper on his way down. Although not verified by capture, it appeared that these intruders were transitionals attempting to spawn over the pair's gametes.

In addition to the territorial and/or spawning defenses, more than 30 aggressive displays between territorial males were observed. Threat displays consisted of a territorial male charging rapidly toward an intruder with his dorsal spine erect and inclined to one side. Chases of non-territorial TP males who wandered through the territories were also noted. These males would often swoop down through the area in a small group and be driven from successive territories in vigorous territorial defenses.

The second part of the study, consisted of correlating the behavior of individual fish with their reproductive condition. A total of 33 fish were captured - 29 IP and 4 TP. Three of the 29 IP fish captured were transitionals. All three had been vigorously chased, in some cases across several territories and by more than one TP male. At least three other vigorous chases were observed, but the fish evaded capture. Sixteen IP fish were captured which had been "courted" by a territory holder. All sixteen fish were gravid females with the exception of one fish which appeared to contain only maturing eggs. Five IP fish were captured which had been "ignored" by a territory holder. One of these was gravid but the other four contained from few to zero ripe eggs and may have been spawned out, not fully mature or reproductively inactive. The remaining five IP fish were females chased by territory holders. Three of these were gravid females and two were immature females. Although immatures were presumably chased from territories due to their lack of reproductive potential, the reason(s) for driving off the gravid females was not clear. All four TP males contained viable sperm.

One of the interesting contrasts between the spawning population at Guana Island and that at Grand Turk, Turks and Caicos Islands, B.W.I. (Koltes, in press) is that females reproduce at a much smaller size at Guana Island than at Grand Turk. The average size of the gravid females captured at Guana Island was 234 mm (SD = 2.46 mm) standard length while those at Grand Turk was 291 mm (SD=18.2). The smallest ripe female captured at Guana Island was 198 mm while the smallest ripe female at Grand Turk was 269 mm. The average size of the three transitionals (204 mm) was comparable to those captured at Grand Turk (195.5 mm).

The difference in the size at which females spawn at Guana Island versus those at Grand Turk may be due to different reproductive strategies in different habitats at the two locations. At Grand Turk, only shallow-water reefs within and along the margins of the lagoon were sampled. There, TP males appeared to hold loosely structured harems which moved as a group about the reefs. No spawning was observed, but several ripe females were captured at the exposed sites suggesting that spawning occurred there. At Guana Island, males maintained fixed territories at depths of not less than about 8 m. Males remained on their territories courting females which moved through the spawning ground.

Although the number of transitionals captured was small, results from this year's study confirm the hypothesis that transitional males play a significant role in the mating system of this species. Transitional males are found in higher numbers at the spawning ground than in the population (Koltes, in press) and apparently gain access to ripe females through a process of interference spawning. This mating strategy was suggested to explain the high reproductive potential of transitional males (very large gonads relative to

body size), but had not been observed in previous studies at Grand Turk. Thus it appears that the male stoplight parrotfish has two spawning opportunities during its lifetime. The first occurs as a transitional when the relatively large gonad produces ample quantities of sperm which may be used to 'swamp' the gametes of a territorial male at the time of spawning. After assuming full TP coloration, the gonad regresses in size (Koltes, in press) and the male apparently enters a period in which energy is diverted from reproduction to growth. After achieving sufficient size, the TP male is able to gain access to females, either as territory holders (Guana Island mating system) or as harem holders (Grand Turk mating system).

Results from the Guana Island studies also demonstrate that the reproductive condition of IP fish can be assessed by the TP male at the time of, or even prior to, the IP individual entering his territory. The mechanism(s) by which a TP male determines an IP's reproductive status is not known. It is possible that this information is communicated visually (either behaviorally and/or by subtle color changes in the case of transitionals) or chemically via pheromones as the IP enters the territory.

Results from these studies and surveys conducted around the island in 1988 and 1987 demonstrate that Long Point is a (perhaps the) major spawning ground for certain species of parrotfish at Guana Island. In addition to stoplight parrotfish, at least three other scarid species were seen spawning at Long Point - striped, princess and yellowtail parrotfish. This year's observations demonstrated that Long Point is an extremely active site and is one of the critical habitats locally.

The new schedule for the research program at Guana Island would allow observations on the spawning activity of the stoplight parrotfish during the

latter part of the rainy season. This would add valuable information concerning seasonal patterns in reproduction. A second part of the research effort would be directed toward collecting specimens of the spider crab, Mithrax spinosissimus. This is a relatively uncommon species, but one with potential commercial importance. Investigations of this species at several Caribbean sites have suggested a high degree of regional variation, particularly in size (Iglehart et al., 1989). Two individuals were observed at Long Point during 1987 while conducting the parrotfish studies. Specimens Guana Island would be compared to those from other sites since no crabs have been collected in this area.

- Koltes, K.H. Aspects of the biology and social structure of the stoplight parrotfish, Sparisoma viride, at Grand Turk, Turks and Caicos Islands, B.W.I. (in press)
- Iglehart, J.M., R.V. Ruark and K.H. Koltes. 1989. Population density and structure of Mithrax spinosissimus at six Caribbean sites and the Florida Keys. In: Adey, W.H. (ed.). The biology, ecology and mariculture of Mithrax spinosissimus utilizing cultured algal turfs. Mariculture Inst. (Chapt. 3).

HERPETOLOGY

Our population biology work continued for Anolis lizards with the usual July survey (as in 1989 and previous years) and an October census. These data are yet to be analyzed. Pitfall traps for Sphaerodactylus geckos were not opened in 1990. We have no mark-recapture data on these lizards since 1988. This is my fault: I simply have not had time to resume pit-trapping.

Snakes and ground lizards have also been neglected. Joe Walsh started out to work on these but has been bogged down in course work and getting into grad school for a couple of years now.

Greg and I are finishing up our skink work. I collected the first specimen of the new species of skink - related to Guana slipperybacks - in 1985. We got three more in 1988. Because the genus Mabuya is tropicopolitan and there are dozens of species, it has taken a long time to make all the required comparisons.

The new species is from Carrot Rock, south of Peter Island. Guana slipperybacks have been critical in our comparative studies. We plan to name the species for Bill MacLean in view of his contributions to Antillean herpetology (two papers on Guana lizards). Copies of my skink illustrations and maps follow.

I really want to see us begin to pay attention to our sea turtles. Lianna has an interested colleague. One of the paying participants for 1991 is willing the hunt the beaches at night. A letter from Karen Eckert, the principal authority, follows; and an article of signal relevance on green turtles, the larger of the two species so far recorded as nesting on Guana (other is hawksbill).

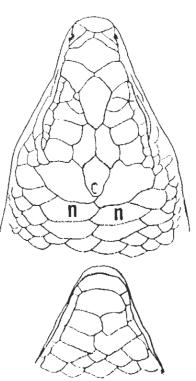
Tom Sinclair returned to catch Amphisbaenas: the weird, burrowing, legless lizards he is so singularly good at finding. In response to requests from two colleagues, we shipped eight live ones via University of Michigan to University of Texas: correspondence follows.

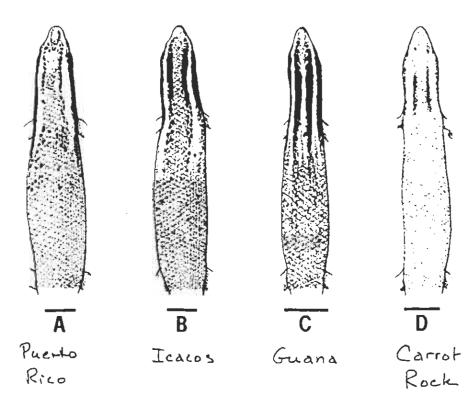
Numi has completed her study of Anegada iguanas and begun studying ours on Guana. They are doing very well. Her report follows. They are not wholly confined to the sheep exclosure: I located one well out on the Pyramid and she admits one lives well south along White Bay. However, the high density inside the exclosure is certainly impressive. I believe we have really saved this species with our efforts on both Anegada and Guana. I believe we should restock other BVI localities like Necker and Fallen Jerusalem before sending them elsewhere.

Numi's report, Guana on p. 3, follows.

We still have not solved the questions of the precise identity and number of species of Guana's frogs. Dr. Zhao Ermi, China's foremost frog expert, from the Zoological Institute in Chengdu, Sinchuan, is at Cornell. I have invited him to join us in July, 1991. Correspondence follows and I'll mention him again in my proposal.

The new skink from Carrot Rock. Bar = 4 mm.





Bar = 1 cm 74

Slippergbacks and the new species of Skink: known localities. Solid dots are Slippergbacks, as on Guana, # 1. The new species is only on Carrot Rock, # 2.

The Puerto Rico form is known only

from San Juan, #3, and

a couple of other north

Coast localities Greg

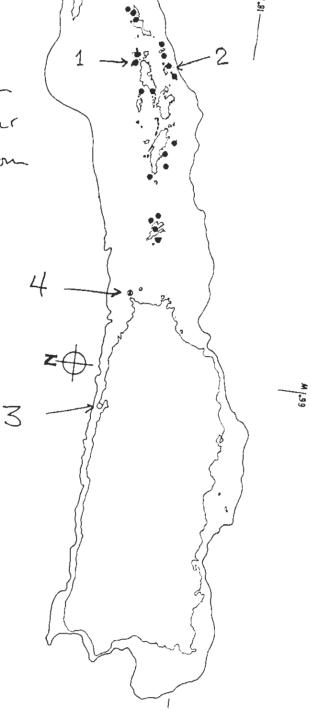
hasn't sent me yet.

An intermediate between

the P.R. form and our

Slipperyback comes from

Icocos, # 4.



The south end of Peter Island and Carrot Rock. Dot is for regular Guana-type slipperyback. New species is from C. Rock.



Franklin College of Arts and Sciences Department of Zoology

24 February 1989

James D. Lazell, PhD The Conservation Agency 6 Swinburne Street Conanicut Island Rhode Island 02835

Dear Skip,

Thank you for your letter re:tagging sea turtles on Guana Island. I would be happy to provide you with technical assistance in this regard. Do you have evidence that June is a peak month for nesting sea turtles on the island? Will you be tagging green turtles (Chelonia mydas) or hawksbill turtles (Eretmochelys imbricata)? Both species are very shy and can be difficult to tag. Particularly the hawksbill, as the female often wedges herself into suppralittoral vegetation prior to oviposition. In either case, no tagging should be permitted before the eggs are actually laid. I am interested in knowing what the reasons are for tagging during June only — of course I realize that one deals within the framework of volunteer time and limited funds, but naturally you are aware that little will be gained with the exception of limited intra— and inter—annual renesting frequencies and perhaps some movement data if a tagged animal shows up dead somewhere (or entangled). What are your motivations in this regard?

There are several tag options; none of them are flawless, but some are better than others. Your advantage is that you will not need many tags and thus can afford to buy better quality (e.g., titanium). Does Nancy Linsley have any experience with sea turtles (was her EARTHWATCH experience with sea turtles?). If not, there are methodologies that should be taught and I would be happy to provide some field training. Why don't you just give me a call someday when you are thinking about specifics? I'd be happy to discuss equipment, budget, technique, objectives... 404-542-3410; that office number is good most evenings too, but if you get no response, try home 404-548-0999. All the best.

Sincerely yours

Karen Eckert, PhD

Director, WIDECAST Secretariat

A Genetic Test of the Natal Homing Versus Social Facilitation Models for Green Turtle Migration

Anne B. Meylan, Brian W. Bowen, John C. Avise

Female green turtles exhibit strong nest-site fidelity as adults, but whether the nesting beach is the natal site is not known. Under the natal homing hypothesis, females return to their natal beach to nest, whereas under the social facilitation model, virgin females follow experienced breeders to nesting beaches and after a "favorable" nesting experience, fix on that site for future nestings. Differences shown in mitochondrial DNA genotype frequency among green turtle colonies in the Caribbean Sea and Atlantic Ocean are consistent with natal homing expectations and indicate that social facilitation to nonnatal sites is rare.

arine Turtles often use nesting beaches that are hundreds or even thousands of kilometers removed from their foraging grounds. The hypothesis that marine turtles return to nest on their natal beach (perhaps guided in part by olfaction) (1) is derived primarily from the strong nest-site fidelity of adult females, as revealed by repeated capture of tagged individuals on the same beach in successive nesting seasons (2–7). Despite the fundamental importance of this possibility to an understanding of turtle life histories, the

88.0.

natal homing hypothesis remains unproven. The main obstacle to testing it has been the lack of a physical tag that persists on a turtle for the estimated 30 or more years that clapse between hatching and sexual maturation (8). Colonial nesting and nest-site fidelity are known to be especially well developed in the green turtle (Chelonia mydas) (2, 3, 4, 7); only in rare instances (9, 10) have marked adult females been observed at a nesting beach other than the one at which they were originally tagged.

Hendrickson (11) and Owens et al. (12) advanced an alternative theory for nest-site selection that is also consistent with the observed site fidelity of adult females. Under their social facilitation model, virgin (mature, unmated) females randomly encounter experienced females on foraging grounds. They then follow the experienced females to

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B. W. Bowen and J. C. Avise, Department of Genetics, University of Georgia, Athens, GA 30602.

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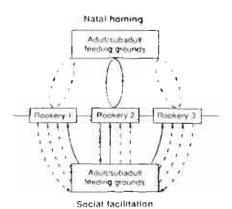


Fig. 1. Schematic representation of the single-generation migratory circuits (hatchlings to sub-adult/adult feeding grounds to nesting beaches) expected under the natal homing versus social facilitation scenarios of female green turtle movement. Under the natal homing hypothesis (upper half of figure), the closed migratory circuit between each rookery and the foraging grounds implies no mtDNA gene flow between nesting beaches, under the social facilitation hypothesis (lower half of figure), the open migratory circuits imply extensive mtDNA gene flow between rook-

a nesting beach and after having a "favorable" nesting experience, fix on that site for future nestings.

When females from different nesting colonies share foraging grounds, expectations regarding the geographic distribution of maternally transmitted mitochondrial DNA (mtDNA) genotypes at the nesting beaches

are distinctly different under the natal horning and social facilitation models (Fig. 1). If female turiles return faithfully to their natal brach to nest, maternal lineages in different colonies should evolve independently from one another and accumulate mtDNA differences over time. Alternatively, under the social facilitation model, exchange of lineages among nesting colonies should result in considerable mtDNA gene flow among colonies.

For the genetic test reported here of the natal homing versus social facilitation hypotheses, green turtle populations in the Caribbean Sea and Atlantic Ocean were selected because they have been extensively studied (1, 4, 13-15), migration patterns in the area are well documented, and turtles from at least two nesting beaches overlap on numerous foraging grounds (Fig. 2). Restriction site analysis of mtDNA was used because of its proven sensitivity in revealing geographic population structure in other animals (16-19). The maternal mode of inheritance makes mtDNA especially appropriate for studies of female natal homing in marine turtles because the effects of male migratory behavior do not confound mtDNA phylogeographic patterns.

Sample sizes and localities (Table 1) were dictated largely by permit limitations on this endangered species. Laboratory methods are described elsewhere (20–22). Fourteen informative restriction enzymes were used in the mtDNA digestions: Ava II, Bel I, Dde I, Eco RJ, Eco RV, Hine II, Hind III, Mbo I,

Msp I. Nde I, Pvu II, Spe I, Str II, and Stu i (23) All changes in mtDNA fragment profiles on gels could be accounted for by specific restriction site gains or losses. Thus genetic distances (base substitutions per nucleotide) between mtDNA genomes were estimated by the site approach (24).

In terms of nucleotide sequence, the mtDNAs from the four nesting colonies appear lightly similar, sharing at least 96 of the approximately 98 restriction sites scored per individual. Among the 49 assayed turtles, only three different mtDNA genotypes (hereafter denoted A, B, and C) were observed. The sequence divergences estimated between genotype pairs A-B, A-C, and B-C were P = 0.002, P = 0.001, and P = 0.001, respectively. In our assays, genotype A differed from C by a single Spe I site loss; B differed from C by a single Hine II site gain; and A differed from B by these two restriction sites (see figure 2 of (24)).

In terms of mtDNA genotype frequencies, however, three of the four rookeries were distinct (Tables 1 and 2). Ascension Island appeared fixed for genotype C, which was observed at no other locality; Aves Island exhibited in high frequency (87%) the genotype B, which was not seen elsewhere. Only the Florida and Tortuguero samples were indistinguishable in our as-

Slatkin and Maddison [(25), see also (26)] recently introduced a method for estimating gene flow between populations based on the minimum number of migration events nec-

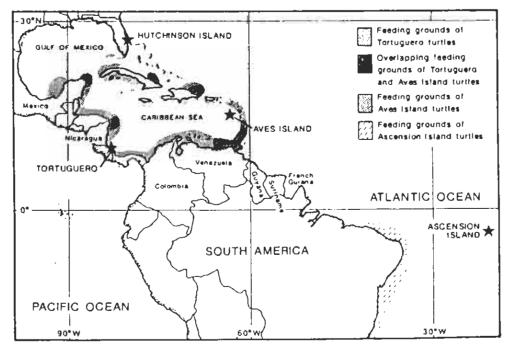


Fig. 2. Map of the Caribbean and Western Central Atlantic Ocean showing the foraging grounds used by green rurles that nest at three of the four surveyed rookeries (the foraging grounds of the Florida colony are unknown). Information on the foraging grounds is derived from (6, 13, 14, 30).

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Table 1. Numbers of individuals showing mtDNA generations A, B, and C at the four green titrite resilecties. Significant heterogeneity in genotype frequency exists among locales ($G_{\rm H} \simeq 90.0, P < 0.005$)

Lexation	MiDNA				
	A	п	(
Aves Island (Venezuela)	t	7	()		
Torruguero (Costa Rica)	15	0	U		
Ascension Island (U K.)	0	0	16		
Hurchipson Island, FL (U.S.A.)	10	0	0		

essary to account for an observed geographic distribution of rntDNA haplotypes whose phylogenetic relationships are known or hypothesized. The approach yields an estimate of Nm, where N is the size of each local population and m is the migration rate. In general, values of Nm much greater than I indicate that gene flow (or historical associations among populations, or both) have been sufficient to prevent substantial divergence at neutral loci by genetic drift. The results of the Slatkin-Maddison approach as applied to our data (Table 2) strongly support the contention that female mediated gene flow between the assayed rookeries (with the possible exception of Tortuguero-Florida) has been rare.

The geographic distribution of mtDNA genotypes is largely consistent with expectations of the statal homing hypothesis and appears to be at odds with predictions of the social facilitation model. Nonetheless, several caveats should be considered before this conclusion is accepted in unqualified form.

First, the foraging grounds associated with the Ascension colony are not known to overlap with those of the other colonies studied. Thus, mtDNA gene flow between Ascension and the other nesting beaches could be limited primarily by natal homing

on a regional geographic scale, rather than lack of social facilitation between adjacent reoderies

Second, we were unable to distinguish the Florida and Tortuguern samples in our mtDNA analyses (Table 1). Although this might be attributable to high, continuous gene flow (as under the social facilitation model), alternative explanations can also be advanced. (i) perhaps more refined tests would reveal genotypic differences between Florida and Torniguero turtles, or (ii) perhaps the Florida rookery has been established very recently by turtles carrying Torniguero-like mtDNAs (15). A confounding factor for the Florida rookery involved the release there of several thousand 1-year-old Torruguero rurtles during a restocking effort conducted from 1960 to 1971 (27). The success of this effort is unknown because most of the juveniles were released untagged, but it is possible that some of these turtles contributed to the nests that we sampled in 1987.

A third qualification to the conclusion of strict natal homing in green turtles concerns the comparison between the Torruguero and Aves colonies. Turtles from these nesting beaches are known to share numerous. foraging grounds in the Caribbean (Fig. 2). Among eight rurdes from Aves tested, one exhibited the mtDNA genotype A that characterized all 15 Tortuguero samples (Table 1) These results yield an estimate of Nm = 0.5, with 95% confidence limit 0.0 to 2.1 (Table 2). Unless the A genotype has arisen more than once by a convergent mutation, its presence in both colonies must be due either to shared descent from an ancestral population (that is, symplesiomorphy) or to past or ongoing gene flow. Such gene flow could have resulted either from imperfect natal homing or occasional social facilitation.

This uncertainty raises a more general

issue concerning expectations of population genetic structure under the natal horning versus social facilitation hypotheses (Fig. 1) Unless natal homing is perfect (and social facilitation to nonnatal resilieries nonexistent), these two models of migratory behavfor can converge with respect to predictions on magnitude of gene flow between nesting localities. In other words, occasional "mistakes" in naral homing, or occasional instances of social facilitation, or a combinanon, would lead to a sharing of genotypes between rookeries and to estimates of Nm >0 (as is true for Aves-Tortuguero). Thus, by hard criteria, our data cannot eliminate the possibility that occasional social facilitation may spread genotypes among proximal nesting localities. However, since the reciprocal exchange of even a single migrant per generation (Nor = 1) should be sufficient to prevent the fixation or near fixation of different genotypes among rookeries, the highly significant genotype differences among green turtle tookeries in the Caribbean and Atlantic strongly suggest that natal homing predominates. We conclude that social facilitation to nonnatal sites must be rare.

Green turtles have colonized oceanic islands and mainland coasts in tropical regions around the world. Each colonization event involved at least one breakdown in fidelity to a nesting beach and clearly cannot be attributed to social facilitation. Thus, natal homing must be imperfect. However, the striking mtDNA population genetic structure among most nesting colonies indicates that maternal genetic exchange is quite rare. This discovery has an important bearing on conservation efforts. As noted by Carr (25), if turtle rookeries are genetically distinct, they are likely to be demographically independent. Protection afforded to one colony would not likely have an immediate impact on others, and consequently, management or recovery plans would have to be implemented on a rookery-specific basis.

Table 2. Above diagonal: results of 2×2 tests of independence between mtDNA genotype and nesting locality for pairwise comparisons of the assayed green turtle rookeries, with the use of the G-statistic with Yates' correction for small sample size (29). In each test, df = 1, and probabilities (P) are indicated. Below diagonal: estimates of Nm (and 95% confidence limits) for individual pairs of localities by the methods described (25, 26). Multiple comparisons used to calculate the individual pairwise values of Nm are not statistically independent. Abbreviation: NS, not significant

	Aves	Torruguero	Ascension	Florida
Aves		G = 8.1 ($P < 0.005$)	G = 11.2 (P < 0.005)	G = 6.2 ($P < 0.05$)
Tortuguero	$N_{\rm PM} \approx 0.5$ (0.0-2.1)		G = 17.0 ($P < 0.005$)	G = 00 (NS)
Ascension	Nm = 0 (0.0~0.4)	$N_{\rm ret} = 0$ (0.0-0.3)		G = 591 ($P < 0.005$)
Florida	Nm = 0.5 (0.0-2.1)		$N_{\rm int} = 0$ (0.0-0.4)	

REFERENCES AND NOTES

SCIENCE, VOL. 248

A. F. Catr, So Excellent a Fisher: A Natural History of San Tueffer (Settbener, New York, 1967, rev. ed., 1984); A. L. Kisch, A. Carr, D. W. Ehrenfeld, J. Theor. Biol. 22, 163 (1960).
 G. H. Balaza, U.S. Dep. Commer. SOAA Tech.

Memo Natl Mar Lish Serr , NOAA TM NMES SWEC 36 (1983)

A. F. Carr and M. H. Carr, Ecology 53, 425 (1972)
 A. B. Meylan, Bull. Am. Mor. Sat. Hist. 162, 1 (1978)

⁵ G. R. Hughes, Oceanier Res. Inst. (Duchan) Invest. Hep. 36, 1 (1974)

⁶ C. J. Limpus, thesis, University of Queensland, St. Lucia, Queensland (1985)
7 J. P. Schulz, Zool. Ureh. (Leiden) 143, 1 (1975)

P. Schult, Zool. Unit. (Linder), 143, 1 (1973)
 N. B. Frazer and L. M. Ehrhart, Copyria 1985(1), 73-11095.

⁹ J.Y. LeGalf and G. R. Hughes, Amphib Repulse 8, 277 (1987)

- 10. A. Kontos et al., Mar. Tiertle Newed. 42, 10 (1988).
- 11 J. R. Hendrickson, I'm Zool. See London 130, 455 (1958)
- 12 D. W. Owens, M. A. Grassman, J. R. Hendrickson, Herpetologica 38, 124 (1982)
- 13 C Gremone and J. L. Gomez, Isla de Aves como Area de Desove de la Toringa Verle (Fundación para la Defensa de la Naturaleza, Caracas, Venezuela,
- 14 J. A. Mortimer and A. Carr, Copeia 1987(1), 103 (1987)
- 15. C. K. Dodd, Brimleyana 7, 39 (1982).
- 16 J. C. Avise, Philos. Trans. R. Sor. London Ser. B 312, 325 (1986)
- 17. J. C. Avise et al., Annu Rev. Ecol. Syst. 18, 489 (1987)
- 18. C. Moritz, T. E. Dowling, W. M. Brown, ibid., p.
- 19. W. M. Brown, M. George, A. C. Wilson, Proc. Natl. Acad Sci U.S. A. 76, 1967 (1979).
- 20. R. A. Lansman, R. O. Shade, J. F. Shapira, J. C. Avisc, J Mel Evel 17, 214 (1981).
- 21. B. W. Rowen, A. B. Meylan, J. C. Avise, Proc. Natl. Acad Sci U.S. A. 86, 573 (1989)
- 22. W. M. Brown, ibid. 77, 3605 (1980).
- 23 Nine additional endonucleases (Bam HI, Bgl I, Bgl II, Bst EII, Cla I, Kpn I, I'st I, Sae I, and Xba I) were

- also employed. Since each produced only zero or one mtDNA cut in our assays, they were uninformarive and not included in the estimates of sequence divergence
- 24 M Noi and W H Li, Proc Natt Acad Sci U.S.A. 76, 5269 (1979)
- 25 M Slatkin and W P Maddison, Genetics 123, 603 (1989)
- M. Slatkin, ibid. 121, 609 (1989)
 A. F. Carr. Natl. Geogr. Mag. 131(6), 876 (1967)
 Copen. 1975, \$47 (1975)
- R. R. Sokal and F. J. Rohlf, Biometry (Freeman, San Francisco, CA, 1969).
- G. Medina and G. Sole, personal communication
- We thank C. Lagueux, G. Medina, J. Ross, and R. Witham for help obtaining samples G. Medina and G. Sole furnished unpublished data on Aves Island Permits or logistic support were provided by B Campbell, D. Carr, C. Carson, G. Cruz, E. Possardt, J. Woody, the U.S. Air Force, and the Cambbean Conservation Corporation We thank A Huff, L French, and J. Leiby for comments on the manuscript. Supported by the National Geographic Society and by NSF grants to B W B and J C A.
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DEPARTMENT OF ZOOLOGY

THE UNIVERSITY OF TEXAS AT AUSTIN

Institute of Reproductive Biology Patterson Laboratories Bldg. Austin, Texas 78712

September 5, 1990

Dr. James D. Lazell, Jr. 6 Swinburn Street Jamestown, Rhode Island 02835

Dear Skip:

Carl Gans suggested that I write to you about the possibility of acquiring some live specimens of amphisbaenians. We are doing a survey of the occurrence and distribution of estrogen receptors in the brain of different reptiles and have been finding some surprising results. Using techniques well established in birds and mammals, Dr. Manfred Gahr, a postdoc in my laboratory, has found that alligators, snakes, and all but one lizard (*Eublepharis macularius*) tested to date have immunoreactive estrogen receptors in all the expected places. What is very surprising is that in now more than 15 species covering five families of turtles, there is no evidence for estrogen receptors. We know that they must occur but the techniques utilized so far have failed to identify them. This may indicate a relatively trivial finding reflecting epitope differences or it may represent a major discovery.

We would very much like to see what amphisbaenians look like. We need no more than four live specimens; sex and species is not important. We would of course be more than happy to pay for any shipping costs. I hope that you will be able to help us.

Sincerely,

David Crews
Professor of Zoology
and Psychology

BITNET address: ZOED414@UTXVM FAX 512/471-6078 Phone 512/471-1113

DC/mts



The University of Michigan

DEPARTMENT OF BIOLOGY

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26 October 1990

Dr. John E. Cadle Academy of Natural Sciences 19th and the Parkway Philadelphia, PA 19103 Dr. David Crews
Department of Zoology
The University of Texas at Austin
140 Patterson Laboratories Buildin.
Austin, Texas 78712

Dear Colleagues:

News from Skip Lazell indicates that I should, within a little while, receive several specimens of Amphisbaena fenestrata. I gather that David wishes to look for estrogen receptors, I am interested in one or two fully everted hemipenes and John needs tissue. For that matter, Skip would like to have the skin (and skull) remain intact so that the specimens may be used for morphometric studies.

David, would you be willing to handle the separation of the beasts? It is quite clear that we need to have one lab do this and yours is the most likely one. John's share would presumably have to be shipped in deep-frozen condition. John, please comment on this or otherwise communicate with David.

I hope to take some film records of locomotion before any of the specimens go off and will transmit them with individual bags accompanied by my tag numbers. It would be useful if the tag was to remain with each specimen and also, if the skull could remain undamaged.

In hopes that this complex arrangement will work, and with best wishes to the two of you, and thanks to Skip for his efforts.

Cordially,

Carl Gans

CG:klv

c: James D. Lazell, Jr.



Department of Biology

The University of Michigan Ann Arbor, Michigan 48109-1048 2127 Natural Sciences Building



Telephone (313) 763-4253 Fax (313) 747-0884 6 November 1990

Dr. James D. Lazell Guana Island Club Guana Island c/o St. Thomas U.S. Virgin Islands 00801

Dear Skip:

Just a brief note of thanks for those animals which arrived here and left quickly. We were able to carry out some substantial experiments.

More later.

Cordial regards and many many thanks.

Best,

Carl Gans

PRELIMINARY FINDINGS AND RECOMMENDATIONS CONCERNING ANEGADA ROCK IGUANAS

Prepared for the National Parks Trust
Ministry of Natural Resources
Road Town, Tortola
British Virgin islands

by

Numi C. Goodyear, Ph.D. The Conservation Agency Jamestown, Rhode Island USA 02835

PRELIMINARY FINDINGS AND RECOMMENDATIONS CONCERNING ANEGADA ROCK IGUANAS

Prepared by: Numi C. Goodyear, Ph.D.
The Conservation Agency, Jamestown, Rhode Island, USA 02835

Funded by the National Parks Trust since 1988, I have been studying the declining population of Anegada rock iguanas. The research portion of the study is finished and I wish to submit some preliminary findings, discuss their implications, and suggest a conservation strategy for this unique beast.

RESULTS

After two and one-half years my research team has gathered long-term natural history information on nine Anegada rock iguanas which we have been radiotracking year-round in the Bones Bight/Low Cay area.

Home Range'

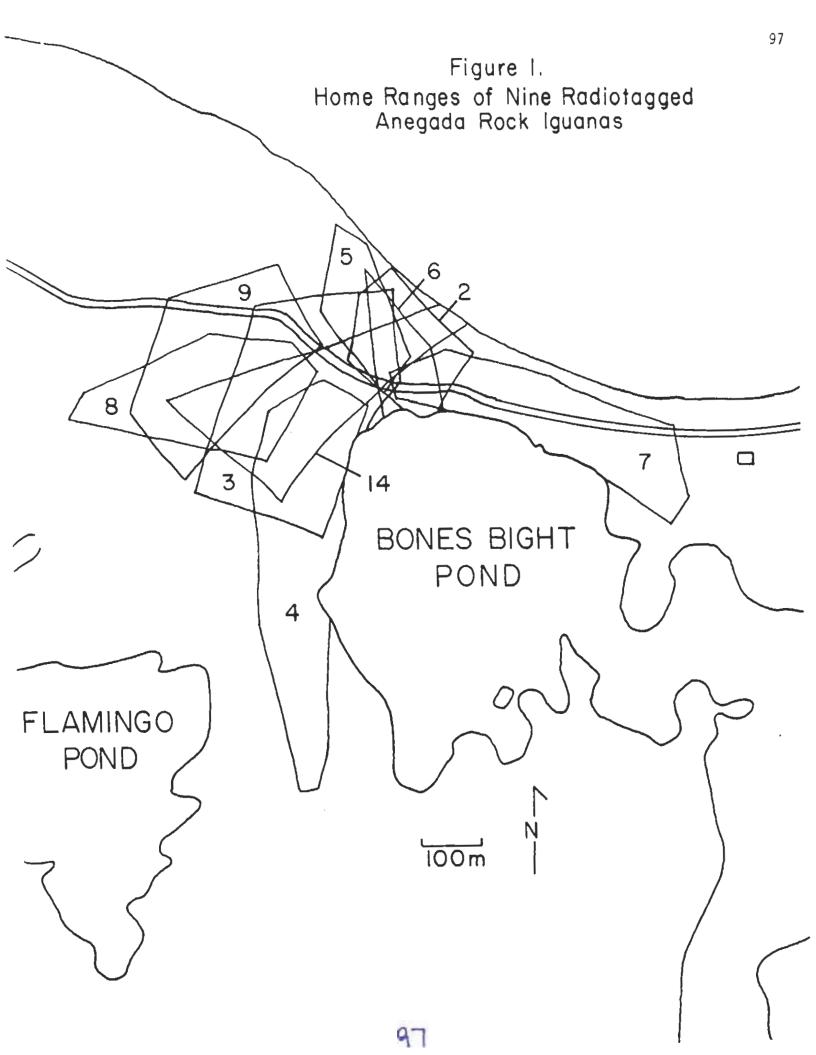
This study showed that each iguana uses more land than previously suspected. Past studies have shown the iguanas occupying home ranges less than a tenth of a hectare (1/4 acre) in size. The long term radiotracking study demonstrated that both males and females occupy much larger areas, an average of 6 hectares (about 15 acres). Home range sizes ranged from 2.4 hectares (5.3 acres) to 8.8 hectares (21.8 acres). Their home ranges overlapped considerably, however, as can be seen on the map of of the study area (Figure 1). The nine iguanas are identified by number (2-9, and 14).

Population Density

During the course of the study we had 22 captures of iguanas (11 individuals) in a 12 hectare (29.7 acre) area at 8ones 8ight and Low Cay. Using an formula developed by Chao (1980. J. Wild. Manage., 52(2):295-300) I estimated that the area had a density of 1.4 animals per hectare, about 0.6 per acre (95% confidence interval: 1.1 to 2.3 per hectare, 0.4 to 0.9 per acre). This point estimator is lower than the 1968 estimate of 2.03 per hectare (0.8 per acre) for the Citron Bush (Carey. 1975. Bull. Florida State Mus. Biol. Sci., 19:189-234) and may indicate that the population of Anegada iguanas is declining. In fact, through field-work and interviews with residents, we have documented a progressive iguana population decline on Anegada since the 1930's, and the iguana's apparent disappearance from the Citron Bush where they were once common.

Females were less abundant than males. Only three of the 11 individuals we captured were female. This is strikingly less than the 1:1 sex ratio found by Carey in 1968 and may be further indication that the population is in poor condition. Two female iguanas were radiotracked: numbers 8 and 14 on the map of home ranges (Figure 1).

¹ The area used by an individual for feeding, breeding, and shelter.



Diet

The iguanas on Anegada eat primarily fruit and the leaves of plant species that are toxic or unpalatable to grazing stock animals. Analysis of 21 fecal pellets and the contents of one stomach revealed items present in the diet in the following percentages:

	PERCENT OF DIET										
				30							
Byrsonima lucida Gooseberry - fruit				••••							
Croton discolor Mehikie - leaves	• • •	• • • • •	••••								
Cocoloba uvifera Grape - fruit		• • • • •	• • • • •								
Eleodendron xylocarpum Nutmeg - fruit	• • •	•••									
Lantana involucrata Sage - leaves	• • •	•									
Byrsonima lucida Gooseberry - leaves	••										
Acacia anegadensis Pokinboy - fruit	•										
Cordia rupicola Blackwood - leaves	•										
Ernodea littoralis	•										
Guapira fragrans fruit	•										
Zizyphus rignonii Tomberry - fruit	•										
Erithalis fruticosa	•										
Crossopetalum rhacoma Maidenberry - fruit	•										
Solanum persicaefolium Covberry - leaves	•										
Grase	•	•									
Beetles	•		•								
Iguana skin	٠										
Unidentified material	••	• •									

Competition by Grazing Stock Animals

The most commonly eaten fruits (gooseberry, grape, and nutmeg) and leaves (mehikie and sage) are generally left untouched by grazing cows, goats, burrows, and sheep on Anegada. Three of the species are known to be toxic to or repellent to mammals: mehikie, cowberry, and sage. It was not clear whether these items found in the Anegada iguana's diet were preferred items or simply all that remained to eat after areas were grazed by stock.

The distribution of iguanas on Guana Island may answer whether the iguanas diet on Anegada is a result of competition or preference. Anegada iguanas which were introduced to Guana Island in the 1980's. Although they initially spread over much of the island, the iguanas now occur in areas where sheep do not graze. These iguana are separated from sheep by exclusion fences and cattle grates on the road. Though the iguanas can pass through the fence, they appear to stay close to or inside the ungrazed area. Their present distribution on Guana is essentially restricted to areas where heavy grazing does not occur.

Thus it appears that grazing stock animals influence the distribution of iguanas, which indicates that they compete with iguanas for food as originally suggested by Carey in his 1975 report.

Island-wide grazing of livestock on Anegada began in the early 1970's. Prior to this period many of the stock animals were fenced in. On Anegada, the iguana population has no sanctuary from which grazers are excluded. Consequently, competition from grazers forcing a restrictive and inadequate diet may be one factor causing population decline.

Predation by Cats and Dogs

Cats and dogs commonly prey on iguanas and cause further population decline. Iverson (1990. Iguana Times, 1(1)) documented that a population of 15,000 iguanas was "almost completely extirpated" from Pine Cay (Caicos Islands) over a two-year period by dog and cat predation. Wild cats occur in many areas of Anegada and are abundant in the Bones Bight/Low Cay area. Dogs frequently roam the area when goats are hunted.

Habitat Loss

It is clear that Anegada iguanas do not do well in populated areas. Those that venture into the Settlement are usually young individuals who either leave or do not survive to maturity.

As a result of this study we know that Anegada iguanas require much more vegetated open space to survive than previously thought. Clearing of vegetation and loss of open space, as well as the presence of cats, dogs, and grazing animals, are always associated with human habitation. The last native population of this iguana will dwindle and dissapear if wilderness areas are not preserved.

RECOMMENDATIONS

I hope that all concerned with conservation decisions, land-use planning, and land allocations, will consider the following recommendations:

Designate an Aneqada Rock Iquana Sanctuary

If Anegada wishes to preserve the unique creature that forms a part of its heritage it will be necessary to set aside some land as a sanctuary. I propose the following areas for inclusion in a sanctuary (mapped on Figure 2): regions of Bones Bight north and south of the road, Low Cay, Middle Cay, and Windberg Cay. As indicated by hatching on Figure 2, the proposed sanctuary encompasses a 245 hectare (604 acre) area.

If the density of iguanas in the Sones Sight/Lov Cay study area is used to extrapolate the population that might reside on the proposed sanctuary we might expect a population of 270 - 550 iguanas to be preserved there.

Develop an Active Management Program for the Sanctuary

The possibility of erecting stock-exclusion fences should be considered. Since the Ridge of land between the Bones Bight and the salt ponds (Bones and Flamingo) is relatively narrow the might consider fencing on the northeast and northwest regions of the Sanctuary. Another fence might be erected isthmus where Middle Cay connects to northern areas. Remaining free ranging stock could be driven out of the fenced area.

Dogs should be prevented from entering the Sanctuary by the exclusion fence. An active program to eradicate cats should be undertaken, however.

Create a National Park

The more active the approach to conservation of the iguana the more British Virgin Islanders will benefit. It is possible that development of Anegada can be carefully controlled to bring profit to the island and preserve its rural and unique qualities.

Portions of the salt ponds are already designated as Bird Sanctuary. If the The Conservation Agency's Flamingo donation is accepted, flamingos may soon be living and breeding in these ponds. It is noteworthy that the existing Bird Sanctuary surrounds the islands and abuts other lands proposed for the Iguana Sanctuary. If these beautiful areas, and the unusual animals on them, are preserved they will become a natural attraction for visitors. Park designation could be associated with the 30th anniversary of the B.V.I. Government.

Possible features of the park might be:

- Free-ranging tame iguanas.
- 2. Nature trails leading to iguanas and flamingos
- Guided nature walks
- 4. Huseum/gift shop

This report of Preliminary Findings was prepared for the National Parks, Trust, Ministry of Natural Resources, Road Town, Tortola, British Virgin Islands by:

> Numi C. Goodyear, Ph.D. The Conservation Agency 97B Howland Avenue Jamestown, Rhode Island 02835

Phone or fax: (401) 423-0866

I will continue to be available to consult on this project. I would like to thank the many residents of Anegada who have helped me complete the research phase. Thanks as well to the National Parks Trust, the Friends of the National Parks Trust, the Guana Island Wildlife Sanctuary, and private donors, who provided funding for the project.

ANEGADA, BRITISH VIRGIN ISLANDS

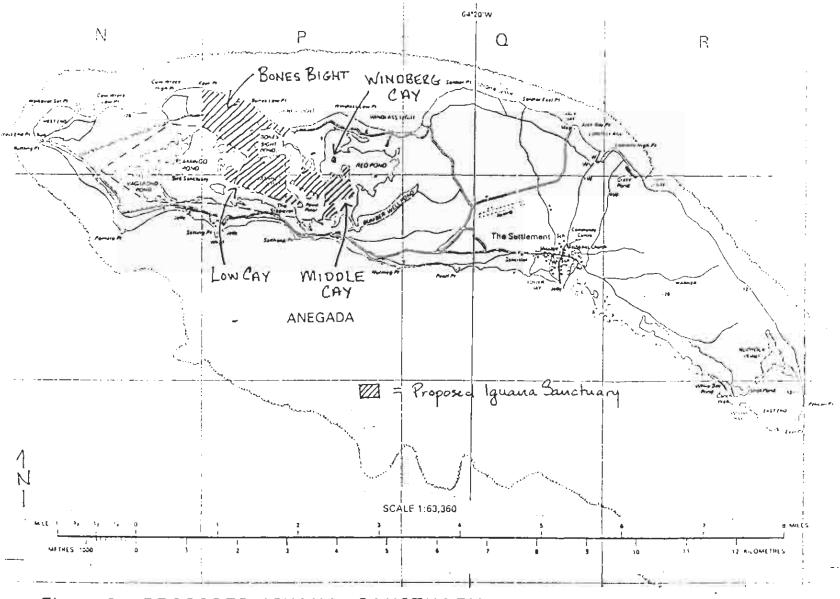


Figure 2. PROPOSED IGUANA SANCTUARY

The Conservation Agency

Exploration, Education, and Research

President James D. Cazell, LhD 401-428-2682

6 Sunahurur Street Comanicus Sland R.S. - 02885 - U.S.A

March 12, 1991

Dr. Zhao Ermi Museum of Vertebrate Zoology, UC 2593 Life Sciences Bldg. Berkeley, CA 94720

Dear Ermi:

Your note reached me in Mississippi where I am working on salamanders. Sorry for the delay.

Once again this year we will go to Guana Island for the month of July. So far, we have found only one species of frog, \underline{E} . antillensis, there but we suspect also \underline{E} . schwartzi occurs. On nearby islands are both of those, plus \underline{E} . cochranae and \underline{L} . albolabris. Also, possibly, the toad \underline{Bufo} lemur.

We could probably arrange some time for you on other islands, such as Puerto Rico. We can cover your airfare and all expenses for room and board for as much time as you care to come. These frogs are not always easy to find, although in July we usually do get them.

If you call 401-423-2652 you can arrange details and get more information from Lu Wenhua at my HQ. Call after 7 p.m. Also you can often call me direct at 601-355-4243 after 8 p.m.

We hope you can join us!

Best Wishes,

James Lazell, Ph.D.

Skip

The Conservation Agency

Exploration, Education, and Research

President James D. Lazell, LhD 401-428-2652

6 Sunaharno Street Conanaut Island R.I. 02835 U.S.A.

March 27, 1991

Dr. Zhao Ermi Museum of Vertebrate Zoology University of California Berkeley, CA 94704

Dear Ermi:

Don't get your hopes too high for Puerto Rico! I have a lot of good friends there, and will try to secure you a place to stay free, but I cannot promise that. The University guest rooms are about \$15 per night. For about \$10-15 per day you could eat fairly well, I think.

All I have funding for is the British Virgin Islands, based on Guana. That much I can promise.

We will be on Guana all of July. You can come for all or part of the month. I think to come for less than two weeks is too short. A lot of herpetological work would be concentrated in the second two weeks, and it usually gets more rain as the month progreses, so more frogs. But I cannot ever be sure there will be any rain or any frogs.

You might plan to come early in July. Then, if we can arrange it, you could stopover in Puerto Rico for a few days near the end of the month. The best procedure is for you to decide when in July you want to arrive. Let me know. I will be working on Puerto Rico plans meantime.

Also let me know how much you could afford to spend per day in Puerto Rico. You will be at Ithaca, New York, at departure time, so travel to Guana will be relatively quick and easy (compared to San Francisco).

Now we do have to worry about your visa. Is it single entry? If so, there are two choices. First and easiest is to get US Immigration to give you a letter stating that the British Virgin Islands are a "contiguous country", like Mexico or Canada. Then your single entry is OK. Second, you just come anyway and we send your passport off by courier to Antigua (no US Immigration office in the Virgin Islands) and get you another visa.

Dr. Zhao Ermi March 27, 1991 Page 2

Liao has done it both ways. Second way takes a couple of weeks, sometimes.

If you have a multiple entry visa, no problem (Liao could never get one).

No matter what anyone tells you, you do not need a visa before going to the British Virgin Islands. It is not like Hong Kong. When you arrive you tell them at BVI Immigration you are going to Guana Island, and you get an instant visa right there. They will be expecting you. I will be there to meet you.

All the best,

James D. Lazell, Ph.D. 1140 Monroe Street Jackson, MS 39202

The Conservation Agency

Exploration, Education, and Research

Lecsident James D. Lazell, ShD 401-428-2652

6 Sunahuruc Street Conanun Island R.I. 02885 U.S.A

March 27,1991

Dr. Richard Thomas Department of Biology University of Puerto Rico Rio Piedras, PR 00931

Dear Richard:

Zhao Ermi, China's top herpetologist, from Chengdu, Sichuan, is coming to Guana Island in July. He wants (much more) to visit PR and look for Eleuths in the rain forest.

Will you be around in late July? Any neat ideas how we could house and feed him in PR? He will be relatively penniless, of course.

I'm at 1140 Monroe Street, Jackson, MS 39202 till at least June. Phone 601-355-4243 - nights or Sundays best.

Did you ever find the big MCZ field tagged St. Thomas Amphisbaena? I'd love to get it back

All the best,

ORNITHOLOGY

Liao produced another hundred-plus pages of field notes, mostly in chinese - which is not a problem for Wenhua. We did not get a paper prepared for the International Congress, and Liao did not attend it. No matter, we will next time, and it will be even better. I strongly support Liao's proposal to return to Guana and hope he will be back soon. Meantime, I offer Zhao as a replacement Chinese scientist for 1991.

Chip (Dr. Robert Chipley) continues to struggle getting his bridled quail dove study published: letter follows. His annotation on it says: "Skip - despite this date [21 August 1990], MS didn't get to me until Oct. Am sending (still late) revised revision out on Friday [5 April 1991]..." This will be a major paper.

I am trying daily to set up a white-crowned pigeon airlift to Guana with Jorge Moreno in Puerto Rico. No problem except the birds didn't nest in sufficient numbers last year. A lot of their nesting trees got blown down. We hope things will be better this year: trees grow fast in Puerto Rico. I know you have little regard for Rob Norton, but his article on the stately white-crowns illustrates their plight: habitat destruction plus shooting. We have a great opportunity to really help restore this endangered bird.

Ace woodpecker and owl man Dr. Jerry Jackson and his wife Bette would make great additions to our program. I wrote to see if he remembered me from my Nature Conservancy work in Mississippi in 1974-5. His enthusiastic reply follows, and an article of the Jacksons' (plus former graduate student) on Bahama woodpeckers.

I finish up this section with a bit on flamingos and the Salt Pond: mostly a recasting of what I have said before. Numi tells me that Sandy Sprunt (National Audobon) got wind of our ongoing plans and is exerting influence against us - even in Bonaire. I do not know how much influence he has, but I may have to eventually declare war. The man is an idiot and has obstructed good conservation (especially in the Florida Keys) for years.

CARIBBEAN JOURNAL OF SCIENCE **FACULTY OF ARTS AND SCIENCES** UNIVERSITY OF PUERTO RICO COLLEGE STATION MAYAGUEZ, PUERTO RICO 00708

Stop Juguth windall,

21 August 1990

Dr. Robert M. Chipley The Nature Conservancy 1815 N. Kent St. Arlington, Virginia

Dear Dr. Chipley:

Your manuscript, Caribbean Journal of Science no. 1296, is back from review. Both external reviewers recommend publication; however considerable revision will be necessary before the manuscript can be accepted. The reviewers' written comments and marked copies are returned to guide you; note that I have also made numerous editorial comments in red pen on msc. copy # 2.

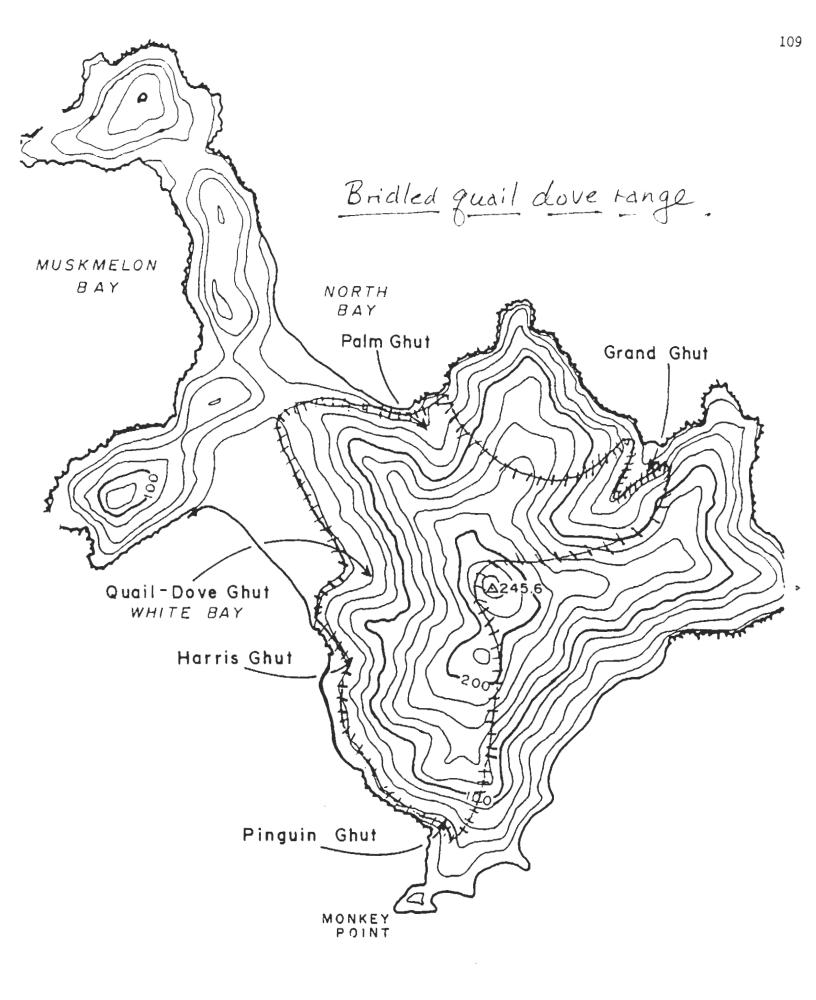
In your revision, please avoid use of the first person singular. I feel the manuscript is much too long, especially based on the limited observations. The sections on predators, dispersal and population size should all be eliminated as should the section on conservation (editorializing is not appropriate for the Caribbean J. Sci.). Please make sure that the Hilty reference is cited or omit the reference from the bibliography. Table I can be omitted; simply say that the home ranges are from 2-9 hectares. For Fig. 1, we will need an original print for reproduction. This print must be submitted as the correct size as described in "instructions to Authors". I am enclosing a copy of the "Instructions".

Please submit your revised manuscript (along with the marked reviewers' copies) directly to Dr. Allen Lewis, Editor, at your earliest convenience.

Sincerely,

David L. Ballantine Assistant Editor

S. Dl. Bel-t



Skip, Bestrigande 110 Nobel Mark

POST-FLEDGING DISTRIBUTION OF WHITE-CROWNED PIGEONS BANDED IN ST. CROIX, VIRGIN ISLANDS

4

ROBERT L. NORTON AND GEORGE A. SEAMAN

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Vol. 56, No. 4, Autumn 1985

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Vol. 56, No. 4, Autumn 1985

Post-Fledging Distribution of White-crowned Pigeons Banded in St. Croix, Virgin Islands.—Wiley and Wiley (Wildl. Monogr. 64:54 pp. 1979) describe the breeding biology of the White-crowned Pigeon (Columba leucocephala) in Puerto Rico with the exception of migration. From 1950 to 1960 Seaman banded 1271 white-crowned chicks at Krause Lagoon, St. Croix, prior to its eventual dredging and development as an industrial complex. Banding recoveries of these chicks provide information on post-fledging and pre-breeding movements. From this effort there are 57 recoveries (4.5%) reported from 1950–1960 (Table 1).

Recoveries ranged as far afield as Puerto Rico to the northwest and Barbuda to the east. Fifty-one percent of the recoveries were reported from St. Croix, 28% from St. Martin, St. Kitts and Barbuda, and 21% from the Puerto Rico Bank (Fig. 1). This suggests a departure toward the east of most birds surviving the breeding season. However, a fairly large movement to the north is evident from recoveries from St. Thomas to Vieques. Fall recoveries away from the natal colony at Krause Lagoon indicate a strong movement to the northern Lesser Antilles (Table 1).

A recovery from St. Martin in May could indicate late migration to the natal colony through the Lesser Antilles or recruitment of Krause Lagoon birds breeding in other locations in the region. A June recovery from Vieques also suggests recruitment to other colonies. The median egg-laying date for initial nesting at Puerto Rico in 1974-1975 was

TABLE 1. Numbers of White-crowned Pigeons banded at Krause Lagoon, St. Croix, and recovered from the northeastern Caribbean from 1950-1960.

	Month of harvest									
	Jan	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
St. Croix	1	1			1	10	9	5	1	1
St. Martin			1				3	5	1	
Vicques				1	t	4	2			
St. Kitts						3	2			
St. Thomas						1	1	1		
Puerto Rico					1					
Barbuda							1			
Total	t	t	1	1	3	18	18	1.1	2	1

mid-March to mid-April (Wiley and Wiley 1979). Wiley and Wiley (1979) report a sexually-mature, known-aged female incubating a clutch only 10 months after fledging. Five of seven after-hatching-year pigeons collected during the breeding season were taken outside the natal colony. Perhaps as much as 9% of Krause Lagoon birds were recruited to other colonies during these years. Considering the hunting pressure at other West Indian breeding sites, the Krause Lagoon population must have been a major portal for immigration.

Analysis of band recoveries indicates that most white-crowneds were taken outside the limits of the regulated hunting period prescribed by the Migratory Bird Treaty Act (1916). Ten- to 16-month-old white-crowneds shot between May and August were harvested during their first or second breeding cycles. White-crowneds may nest three times a season. Table 1 shows a significant amount of hunting was taking place during the nesting season

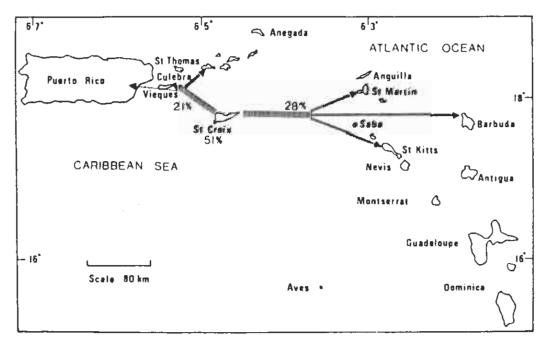


FIGURE 1. Distribution of White-crowned Pigeon recoveries (57) of chicks banded at St. Croix, U.S. Virgin Islands, from 1950-1960.

418]

in St. Croix. Seaman banded 436 squabs in July during this 10-year period. Harvest in July accounted for 5% of recoveries, while harvest in August accounted for 32%. Hunting in the U.S. Territories of Puerto Rico and St. Croix accounted for about 22% of the breeding-season harvest based on these returns.

In sum, these data suggest that the substantial decline in the White-crowned Pigeon population in the northeastern Caribbean, particularly at St. Croix, post 1960, may be a result of out-of-season harvest and the destruction of the lagoon habitat for industrialization. The loss of this extensive salt marsh-mangrove complex is one of immeasurable magnitude and no doubt affected white-crowned recruitment to other West Indian colonies. Band recoveries from hunters in the region show that nearly half of all pigeons taken were harvested out-of-season, 14% of which were hatching-year birds. Although white-crowned longevity is 12+ years (Beatty unpubl. data) or older (20+ in captivity, Jules Petit, pers.-comm.), little hope is expected even for this fecund species in areas where poaching continues and enforcement of wildlife laws is not taken seriously.

Acknowledgments.—Funding for this and other wildlife restoration projects has been available from Pittman-Robertson Wildlife Restoration Federal Aid grants FW-1, FW-2, and FW-3 to the Territorial Government of the Virgin Islands, Department of Conservation and Cultural Affairs, Division of Fish and Wildlife. Charlene Vaughan helped with manuscript preparation.—ROBERT L. NORTON, Department of Conservation and Cultural Affairs, Division of Fish and Wildlife, 101 Estate Nazareth, St. Thomas, U.S. Virgin Islands 00802, and GEORGE A. SEAMAN, Windward Side, Saba, Netherlands Antilles. Received 11 Apr. 1985; accepted 28 July 1985.

MISSISSIPPI STATE UNIVERSITY



DEPARTMENT OF BIOLOGICAL SCIENCES P.O. DRAWER GY MISSISSIPPI STATE, MISSISSIPPI 39762-5759 PHONE (601) 325-3120 FAX (601) 325-7939

19 January 1991

Skip Lazell
The Conservation Agency
6 Swinburne St.
Conanicut Island
RI 02835

Dear Skip:

In performing the ritual of my annual desk-cleaning, the avalanche that nearly buried me uncovered your letter of 9 October. Sure I remember you. No, you had not sent me the reprint ex CryptoZool. Thanks.

Reestablishment of PRW'ps on Guana sounds exciting and indeed, I would like to get involved. Either with the PRW or owl. The owl particularly interests me, but my wife would be more interested in the PRW. I've been getting involved in the Society for Caribbean Ornithology and would very much like to really be established as a researcher in the area. Spent a few days on Jamaica last summer (annual meeting of the Society) and you know of my work in Cuba. I've also been working in the Bahamas a bit.

You know I share your enthusiasm for the Feds. I've been up to my ears in law suits and threats of suits. Last year the Feds tried to keep me from continuing my RCW work on Noxubee National Wildlife Refuge. They questioned (1) whether or not I was following the scientific method, (2) whether or not I had done an adequate literature survey, and (3) the nature of the statistics I would use to analyze my data! Sierra Club Legal Defense Fund and the Attorney General of Mississippi came to my aid and I finally got a permit, but so restrictive that it almost isn't worthwhile.

The Ivory-bill story is another tale of Fed problems and lack of concern.

Good to hear from you. Let's get together!

Best regards,

Jerone A. Jackson Professor of Biological Sciences

Salah Carana Carana

Wilson Bill, 103(1), 1991, pp. 124-125

1000 C

Classical polyandry in the West Indian Woodpecker on Ahaco, Bahamas,—Oring (1986) divides axian polyandry into two general types, classical and ecoperative. In cooperative polyandry, groups of cooperating males share a single breeding female. Cooperative polyandry has been confirmed for the Acorn Woodpecker (Melanerpes formicivorus) (e.g., Mumme et al. 1983, Koenig et al. 1984, Oring 1986). In classical polyandry, individual males breed solitarily, while females divide their attention among males. We here report a case of classical polyandry in the West Indian Woodpecker (M. superciliaris).

Study area and methods.—From 10 May to 4 August 1988 and 13 May to 25 June 1989, West Iodian Woodpeckers were observed on Abaeo, Bahamas. Birds were observed in Marsh Harbour, Dundas Town, Bahama Palm Shores, Casuarina Point, Little Harbour, Snake Cay, and the pine forest south of Bahama Palm Shores. The interior vegetation of the islands consists mainly of large stands of Caribbean pine (Pinus caribaea); in settlements the dominant vegetation consists of coconut palms (Cocos nucifera) and other introduced tropical trees.

All adult birds referred to in this study were captured on the nest and color banded for individual identification. Observations were made about 10 m from the nest using binoculars. Willimont was at the study site during the summers of 1988 and 1989, and the Jacksons were there from 18 to 25 June 1988.

Results and discussion.—One color-banded female was observed at three nest sites with two different males during the 1988 season (no polyandry was observed during the 1989 season). Four nesting attempts involving this female occurred during the 1988 breeding season (Fig. 1). The female was actively involved at two nests through most of the season, and at one point was involved at three nests. The three nest sites were in dead coconut palms in residential areas of Marsh Harbour. Nest A was 5.5 m high in a 7 m palm, DBH 23 cm. Nest A2 was 2.5 m high in a 4 m palm, DBH 25 cm. Nest B was 3 m high in a 5 m palm, DBH 26 cm.

The female shared incubation at nest A with color-banded male 1 while male 2 was excavating at nest B approximately 0.7 km away. Initially, both adults helped feed the chicks at nest A. By 26 May, only male 1 was observed feeding the chicks and the female was observed at nest B with male 2. On 15 June, two days after the chicks from nest A fledged, the chicks in nest B hatched. Both male 2 and the female fed chicks at nest B, although the female contributed approximately 1/2 as many (25 of 76) feeding trips as the male. While male 1 was feeding chicks at nest A, the female was incubating at nest B and also excavating at nest A2 approximately 50 m from nest A. Incubation at nest A2 began on 10 June, five days before the chicks hatched at nest B. During this time the female incubated at both nests. Nest A2 failed on 21 June, the day the first chick hatched. On 23 June the female and male I were observed mutually tapping at nest cavity A, thus re-establishing the pairbond (Kilham 1958). Renewed exeavation by male 1 began at cavity A while the female was feeding chicks at nest B. On 13 July, male 2 was killed, presumably by a cat, and the female took over the feeding of the chicks. The chicks at nest B fledged on 14 July. On 19 July the female was again at cavity A with male 1. Incubation began shortly thereafter, and their chicks hatched on 4 August.

From 30 July to 4 August (when observations ended), an unbanded male excavated in nest cavity B. During this time the polyandrous female was not observed near this nest.

Polyandry allows the female to produce multiple clutches (Emlen and Oring 1977). In the case described above, the female successfully increased her reproductive success relative to other female West Indian Woodpeckers studied. Of 28 pairs observed during 1988, only

process of the same

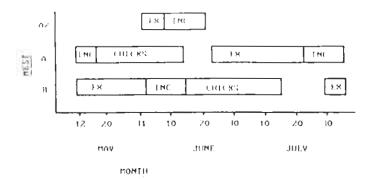


Fig. 1. Nesting phenology of a color-handed female West Indian Woodpecker at Marsh Harhour, Abaco, Bahamas, EX. 5 excavation, INC 5 incubation.

five were known to have more than one brood, including the polyandrous female. It is possible that other pairs also had more than one brood or were polyandrous. However, we cannot be certain of this since we were not able to follow them throughout the entire breeding season. During 1989, 29 pairs were observed. No polyandry was noted among these pairs, but it was not possible to follow them throughout the entire breeding season or even to second broods. The polyandrous female successfully fledged two nests in 1988 (one with four chicks, the second with at least two chicks) and had chicks in a third nest when the study ended. The breeding season on Abaeo appears to be long enough for two but not three broods. Polyandry may be a strategy for overconving this limitation.

Jeknowledgments.—We thank the Bahamian government for permission to conduct field research, and the logistical support of S. Pinder (Ministry of Agriculture), S. Chambers and J. Hook (Ministry of Lands and Surveys). Financial support was provided by grants from the Association of Field Ornithologists, Eastern Bird Banding Association, North American Bluebird Society, World Nature Association, Wilson Ornithological Society Paul A. Stewart Awards, and Mississippi State Univ. We especially thank J. Hedden for his support and hospitality. We thank R. Mumme and L. Oring for helpful comments on an earlier draft.

LITERATURE CITED

EMLEN, S. T. AND L. W. ORING. 1977. Ecology, sexual selection, and evolution of mating systems. Science 197:215–223.

Killiam, L. 1958. Pair formation, mutual tapping and nest hole selection of Red-bellied Woodpeckers. Auk. 75:318–329.

KOENIG, W. D., R. L. MUMME, AND F. A. PITELKA. 1984. The breeding system of the Acorn Woodpecker in central coastal California. Z. Tierpsychol. 65:289–308.

Mumme, R. L., W. D. Koenig, and F. A. Pitelka. 1983. Male guarding in the Acorn-Woodpecker in a cooperative breeder. Animal Behav. 31:1094–1106.

ORING, L. W. 1986. Avian polyandry. Current Ornithol. 3 309-351

LOREA, WILLIMONT, JEROME A. JACKSON, AND BETTE J. S. JACKSON, Dept. Biological Sciences, Mississippi State. Univ., P. O. Drawer GY, Mississippi State, Mississippi 39762. (Present address LAW; USFWS, P. O. Box 12559, Charleston, South Carolina 29412. BISJ. Div. Mathematics and Natural Sciences, Mary Holmes College, P. O. Drawer 1257, West Point, Mississippi 39773), Received 22 Jan. 1990, accepted 10 April 1990.

FLAMINGOS AND THE SALT POND James Lazell

I continue to believe the Guana Salt Pond will support a few flamingos - either without artificial feeding, or with very little - indefinitely. The key is, of course, "a few." Based on my calculations, from the literature and the maps of Bonaire, I reckoned four birds as the likely maximum to live on Guana's Pond with artificial feeding.

However, I never anticipated or recommended a steady-state Pond. I envisioned our worst problem as dry-up. This happened regularly in the early '80's. For this reason, I recommended pumping in sea water whenever the Pond dried down to puddles of 70 parts per thousand (ppt) of salt. I now know flamingos are all right at even higher concentrations, at least for a few days.

At 70 ppt, I continue to recommend pumping in sea water. I believe it is not necessary to pump the pond full to overflowing, although I do not believe that could hurt. In the absence of rain, that only brings the salinity down to 35 ppt.

But I do believe the Pond level must fluctuate. Corixids do well at lower salinities, brine shrimp at higher. Plovers and stilts need the mud flats. Ducks love deep water.

When it rains no sea water should be pumped in. I cannot believe the Pond will stay "too fresh" for long because I believe it will always dry down rapidly after rains. Even Hurricane Klaus, which scoured the Pond and turned it totally fresh, affected it only for a few weeks. (I wasn't there to see what H. Hugo did.)

Temporary feeding - say for one month - might be necessary with a four bird flock in very rainy years - say every fifth year. The feeding would normally have to be done in summer, the rainy season. Without pumping the Pond should dry down to a greater salinity than sea water by November.

The only problem with pumping sea water into the Pond but not overflowing it is that salinity will tend to increase more rapidly with evaporative dry-down. So, the Pond will reach the 70 ppt threshold at a higher water level than it would after dry-down from rain filling. So salinity has to be monitored constantly.

So:

- 1. Do not let the Pond dry up completely.
- Do not let it stay above 70 ppt of salt for more than a few days.
- 3. Do not try to maintain a constant level.
- 4. Do let there be mud flats most of the time.

* * * * * * * * *

Now, as for getting flamingos, Bonaire looks better-n-better. I just talked to a herpetologist who spent a couple of weeks there. He says the Gov't is very laid-back, no collecting permits or onerous regulations, and thousands of flamingos. He did not ask, but expects a deal could be easily reached.

If Richard Winchell does not give us joy, lets definitely explore Bonaire. Do not get discouraged: we will get more flamingos.

COMMUNITY COLLEGE

Margaret Collins and Greg Mayer have put a great deal of effort into getting a relationship established with BVI-CC. I cannot say much is happening, but that is certainly not their faults. Margaret's material is back in Entomology. Greg's follows. Also, I lead off with correspondence received from Bill MacLean, who is also deeply involved.

I believe something good will eventually come of all of this. I will be contacting Louis Potter (who seems the most useful person) about having some students and/or teachers over in July. A perennial problem with July is that school is not in session. Both students and teachers are usually working elsewhere at this time, so getting them involved is difficult.

British Virgin Islands Community College

~ "Our Tomorrow Begins Today" ~



MEMO

TO : Curriculum Committee

FROM : Dr. Theodore Provo &P

DATE : December 7, 1989

SUBJECT: Committee Meeting

We must begin to plan for next year. The hiring of a full time librarian and full time faculty are a high priority. The heart of a good college is the library and the college's life blood is its faculty.

We must begin to put together an Associate of Arts/Science program for those who want to get an Associate's degree. We want to develop a systematic to approach building a faculty based on need with a small core of faculty at the start of the program and enlarging the faculty as the college expands.

I will need your valuable input and I will be asking the Chairperson to convene the Committee in the very near future, so that we might discuss the vital topic.



January 19, 1990

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

Dear Dr. Provo:

I write on behalf of the University of the Virgin Islands community to congratulate you and the people of the British Virgin Islands on the opening of the BVI Community College, and to offer my continued assistance to your institution. I wished very much that I could have been in attendance at the dedication ceremonies, but the invitation arrived only today.

We in the United States Virgin Islands have always felt a close kinship to the people of the BVI, and we desire very much to see this kinship continued in the relationship between our two institutions. To follow through on my commitment to be of assistance in any way we can, I am asking Mr. Malcolm C. Kirwan, our Vice-President for Business and Financial Affairs to serve as a point of contact and liaison with your institution to help facilitate and coordinate any assistance we can provide. You will find him to be a person who would be very helpful in the areas of planning, administration and financial management. He is also, in his own right, a valuable workshop resource for short supervisory and management courses and seminars. I will ask him to follow-up with you to better understand how we might help.

As the first President of the BVICC, we recognize that you will be challenged by the special problems associated with creating and developing a young institution, and we stand ready to provide technical and other assistance within our means. I extend an invitation to you to visit our campus when you are next on St. Thomas so that we can become better acquainted.

Our very best wishes for your success.

Sincerely,

Arthur A. Richards

President

cc: Malcolm C. Kirwan, Vice-President Business and Financial Affairs

THE UNIVERSITY OF WISCONSIN ZOOLOGICAL MUSEUM

250 NORTH MILLS STREET

MADISON, WISCONSIN 53706

TELEPHONE [608] 262 4766

(608) 262-4831 fax: (608) 262-5395

28 September 1990

Dr. James D. Lazell, Jr. The Conservation Agency 6 Swinburne St. Jamestown, RI

Dear Skip:

Enclosed is a copy of the letter I sent to Provo outlining what I think should be taught to their teachers in a 2 or 3 day workshop, which is what he had requested. It consists of things that I think that two or three of the usual Guana scientists could handle. I have two questions. First, do you think this is on the right track, both in regard to content and the extent of our involvement with the Community College? I view these suggestions as preliminary, with plenty of opportunity for revision of content, and also relatively modest, so that we could decide to scale our commitment up or down depending on how productive our association with the Community College is. Second, and perhaps more important, should I send a copy to Henry as well? I shall follow your advice in this regard.

Regards,

P.S. My home phone # is (608) 251-8568.

phone: (608)262-4831 fax: (608)262-5395

25 September 1990

Dr. Theodore Provo
British Virgin Islands Community College
Box 3097
Road Town, Tortola
BRITISH VIRGIN ISLANDS

Dear Dr. Provo:

Dr. Jarecki told me that he had sent to you a copy of my letter to him outlining potential areas of cooperation between the Community College and scientists involved in the Guana Island project. He also sent to me a copy of your letter of response to him. I apologize for being so long in replying, but since returning from the BVI at the end of July, I have moved from the National Museum in Washington to the University of Wisconsin, and the move has taken up most of my time.

Your suggestion of providing a teacher training session is an excellent one, and something that I think we can do. The following is an outline of what I think could and should be included in such a session I have discussed some of this with other scientists, but it is largely reflective of my own point of view, and should be taken more as an initial suggestion than as a final curriculum. Three important factors which need to be taken account of in preparing a final plan are the previous education and training of the teachers, the time devoted to training, and which scientists are available.

The intent of what follows is to outline what I believe to be the set of basic facts and principles required for an intelligent understanding of the environment and natural history of the British Virgin Islands. How much of this the teachers would then pass on to their students would depend on whether they were high school or grade school teachers. While emphasizing facts and examples from the BVI, it introduces general principles of geology and biology which will be of value for those students who might continue their education.

I. The Origin and Geological History of the British Virgin Islands.

The BVI are composed largely of old igneous rocks, with more recent shallow water sedimentary rocks (limestones) here and there. They formed about 110 million years ago as the Atlantic sea floor plunged below the Caribbean sea floor, giving rise to a volcanic island arc. The rudiments of plate tectonics can be taught, in so doing explaining how the BVI came to be formed. Another important principle, the extent of geological time, should also be introduced

here. Practical work might involve identification of rocks and geological features in the landscape in the field. This field work would benefit from having someone who knows more geology than I do available.

II. Flora and Fauna of the British Virgin Islands.

- i. Systematics and the Diversity of Life. The basic principles of systematics (species, classification) should be introduced as a way of discussing the diversity of life in the islands. The major kinds of plants and animals should be introduced, i.e. arthropods, mollusks, vertebrates, etc. Some basic anatomy might also be discussed here, as the means by which we identify the different kinds.
- ii. Common Plants and Animals of the BVI. This would be an introduction to the common species that people will often encounter: palms, seagrape, termites, lizards, thrashers, etc. This would be best done in combination with examination of actual specimens or observation in the field. Various aspects of the morphology, habits and importance of the different species could be discussed.
- iii. Origin of the Flora and Fauna. The geographic origin and relationships of the BVI flora and fauna should be presented along with some of the principles of biogeography, e.g., the distinction between oceanic and continental islands, dispersal and fragmentation.

III. The Biology of Islands.

- i. Characteristics of Island Life. Island biota are characterized by being depauperate in numbers of species, showing evidence of having dispersed, and being differentiated from the biota of its source areas. These phenomena can be demonstrated in the plants and animals of the BVI. Another characteristic of island life, adaptive radiation, should also be explained.
- ii. The Structure and Function of Island Communities. How plants, animals and their environment exist together to form ecosystems. Basic ecological principles and processes, e.g., food webs, predation, competition, mutualism, primary production, etc., could be introduced and illustrated with island examples.
- iii. Conservation of the Natural Heritage of the British Virgin Islands. An introduction to the effects of man on the island ecosystem, endangered species and habitats, and how wise use and preservation can maintain the Islands' natural resources. A visit to some National Park Trust land might be worthwhile.

I believe that it should be possible to present this material in a two or three day workshop conducted by a few scientists. Examination of natural history specimens should accompany the lecture/discussion portion, and the workshop might be concluded

with a field trip to some suitable area to demonstrate various facts and principles.

The outline is influenced by my own interests in the ecology, evolution and zoogeography of terrestrial vertebrates, but I have tried to include the important parts of other disciplines (geology, etc.), and also to take into account the relevance of general principles to the local conditions. Other scientists who might be involved would undoubtedly have somewhat differing perceptions of what is most important (e.g., I have left out any specific mention of the marine environment, partly because it is largely outside my own competence, but also because I believe the islands', with their unique biota, are much more interesting than the marine realm, which is largely the same from Florida to Brazil), but, as I said above, this should be considered a preliminary outline, and subject to much revision.

I would be most interested to know if this might be useful to the College, and is along the lines of what you had in mind. The most important consideration in preparing a workshop should be the needs of the College's educational program. I would be most happy to work with you in developing an appropriate workshop and other aspects of cooperation with the College.

Sincerely,

Gregory C. Mayer, Ph.D. Guyer Fellow in Zoology

Dear Henry and Gloria,

While you were on Guana during science month, you (Henry) asked me if I would write up a description of what I thought "Science Month" should be like. I have thought at length about this, and I have talked to Skip regarding his goals for science on Guana. Skip and I are in general agreement that Guana has immense potential for scientific research as well as for conservation and education, and we would both like to see this potential developed to its fullest. However, within the constraints of science month as it has existed for the past several years, there is little further that could be done here without further support from both you and others involved in running the hotel. Skip and I disagree on some specifics but, all in all, I believe compromises would not be difficult. Some of the present limitations of Science Month reflect Skip's inability to spend more time on it than he does. I would be willing to dedicate much of my time to developing scientific/ conservation/ educational activities on Guana. It is likely that I will have the opportunity to live and work on St. John for the next couple years; in which case, I will be able to spend my weekends on Suana continuing research, conservation, and education efforts and developing new programs. Your interest in continuing your strong support for such activities on Guana will be a <u>major deciding factor</u> in whether I accept or reject the job I have applied for at the National Park on St. John. (if, in fact, I am offered it). If I am not offered this job, I would still like to implement some of the programs I have in mind, although I will not be able to commit as much time to Guana as I would if I were working in St. John.

Following this letter is an outline of problems, changes, and additions that I feel would greatly benefit the scientific program on Guana, as well as some questions regarding the future of the Guana Island Wildlife Sanctuary. Many of these changes are reactions to problems experienced either by Skip and other scientists involved in science month, problems experienced by Fred and me during our tenure, or problems that you and/or Gloria have expressed about scientists and their activities. I did not describe specific programs that could be developed on Guana, as those chosen will depend upon mutual priorities.

- 1. Problems with Science Month and their potential solutions:
- a. Not enough diversity of subjects studied; there is a disproportionately large number of herpetologists and their assistants

- Fire 1. Expand the marine program; encourage ecological/behavioral studies (see problem c.).

 2. Field assistants should not be brought in just for specific projects, but instead should help with all projects, if possible, and they should be encouraged to view the experience as educational experience.
 - b. Many individual projects do not seem to be well planned or goaloriented. I make this judgement based only on my impressions, which may be biased by insufficient communication or cohesiveness among Science. Month participants, resulting in ignorance of each others research plans. However, the judgement is also based on the paucity of published scientific

Admin Research projects should be formalized:
principle investigators should be required to write proposals for their work on Guana indicating specifically what will be needed (in terms of time, equipment, transportation to other islands, etc.), how long the study will take, and what will be accomplished. This will give us a means to maximize efficiency of research here; i.e. it will eliminate the need to wonder whether some scientists are here on vacation or not.

2. All participants working on a particular project of work on Guana. This work on Guana. This work on Guana. This work on Guana.

I disosue

- observations for each others work, and this can greatly enhance. success. In general, greater communication will strengthen cohesiveness and cooperation among participants, and perhaps even between managers/staff and participants.
- There are too many museum-based scientists (specimen collectors). working on Guana. I have no objection to some museum-types, and I am personally very interested in systematics (the field most museum) scientists are in). However, I feel that collection for systematic and biogeographical purposes should be limited to those groups that are highly diverse and as yet not well known, such as insects. I discourage further emphasis on herp (reptiles and amphibians) collecting, as they have been collected extensively from Guana for the last ten years, and they are one of the least diverse groups present. Recently, further collection has seemed to serve only the purpose of spreading specimens to more museums.

suggestion:

Encourage ecological and behavioral projects.

HJ's constraints problem: Ecological and behavioral studies generally need to be conducted over long time periods, usually involving varying times of the year.

solution:

- 1. Extend science month to three months (whole summer), if possible.
- 2. Create opportunities for individual scientists involved in Science Month(s) to conduct research on Guana for short periods at other times of the year. A <u>resident scientist</u> (see section II) should be able to collect some data for ongoing studies other than his/her own.

 3. Assign a room to serve as a <u>permanent science laboratory</u> (see section II) on Suggest to provide for all the short to be seed to be seed

(see section II) on Guana to provide facilities for year-round research.

d. Prior to Fred's and my tenure, conservation efforts were aimed at species re-introduction rather than protection and management of the existing native habitat. This is the reverse of logical order; the protection and maintenance of existing native habitat should be given priority over species re-introduction.

> suggestions: Because Guana's habitat is already in fairly good condition, harmful exotic eradication and species re-introduction could occur at the same time, but:

1. Harmful exotic eradication should be given priority: sheep, invasive exotic plants, cats, and rats should all be the focus of serious, long-term eradication efforts, although each can be approached as individual projects.

2. The introduction of exotics should be terminated. If it is absolutely necessary to bring in exotic plants for horticultural or agricultural purposes, then the species brought in should be non-invasive and should be planted only in cultivated areas (e.g. not along the path to Ralph's house or behind North Beach).

Planting of exotics should be kept to a minimum and should eventually be replaced by planting native species cultured in the native plant nursery.

by a thorough investigation into the behavior and ecological interactions of the introduced species and a series. All re-introductions of animals or plants should be preceded. interactions of the introduced species, and a protocol for re-

May and 3

establishment should be drawn up with the advice of experts in the husbandry of the particular animal or plant.

4. All re-introductions of animals or plants should be followed. by marking the parent individuals and offspring, if possible, and by tracking their behavior, distribution, and ecological effects on Guana and also on other islands if and when they disperse.

5. Build a permanent nursery for rare and native plants on Guana. This nursery will serve the horticultural needs of the hotel as well as reforestation needs in overgrazed or sensitive areas in Guana's forest. It could include all rare plants native to the Puerto Rico-Virgin Island bank, including those species that are not known from Guana. These rare plants can be increased in number, thus increasing the chances of species survival, by planting them both on Guana and other islands. We may also consider donating cultivated native plants to reforestation efforts initiated by the BVI government in their parks. George Proctor has expressed willingness to collect seeds from rare plants in P.R. and surrounding islands for this nursery if it were established, and Gary Ray has expressed willingness to oversee its construction/ development and maintenance. Fred, time permitting, would be most willing to donate his time and expertise to helping establish such a nursery. For day to day maintenance, either a gardener, resident scientist, or both would have to be responsible for watering and weeding, etc.

 e. Some scientists involved in Science Month are not good field workers. This may be a harsh criticism, but one can't deny that younger, agile, dedicated naturalists get a lot more work done than older, less ambitious naturalists. Also, I feel that the practice of drinking alcoholic beverages every evening is not only unnecessary but unproductive.

suggestions:

- Invite a mix of younger scientists and older ones, but be sure. that they are physically able to do the work they propose. I have very specific examples of the right and wrong people for Guana's science month, but I don't want to get too personal. I particularly object to inviting certain people for "political" reasons. Graduate students are generally good targets for younger, more energetic and ambitious additions to Science Month.
- Discontinue open bar service. Provide alcohol for group parties,

Lots of the Core at .

such as on Saturday nights or special occasions. This form of alcohol availability will discourage habitual drinking and encourage infrequent social drinking, and an occasional party will enhance group spirit.

f. During active science months, the recent managers have attempted to run Guana as a hotel rather than as a research facility.

suggestions:

- 1. Serve meals at times convenient for scientists; e.g. earlier
- breakfast to maximize productive daylight hours.

 2. Vehicles, phone lines, etc. should be available for scientific business when needed business when needed.
 - In general, managers should recognize that the scientists are on. Guana to work and need their support. The attitude that scientists are only here as an excuse to be on vacation and are a burden to the hotel creates a very unproductive environment in which to work.
 - g. Guana's scientists do not interact enough with the BVI government.

suggestions: Establish programs for the BVI through Science Month.

Nature Conservancy. History.

2. Push the protection of Muskmelon and White bays and cooperate with coral reef monitoring programs implemented by the conservation office (I have already started doing this).

3. Create an intern program during Science Month.

couple Tortolan students, preferable at the college level, can be exposed to field research and assist in a veriet

4. Pursue international grants for conservation in the BVI, as suggested recently by Peter Chaboura.

h. Scientists on Guana are taking more than they are giving.

suggestions: There are many ways that scientist can benefit, or give something back to, Guana and the BVI in general. Most scientists are quite willing, if not eager, to do so, but they lack the proper channels. We should establish programs in which there are obvious and convenient ways for visiting scientist to donate their time and knowledge for the benefit of Guana and the BVI. For example:

 Participants with connections to educational/research facilities may be able to donate books and/or equipment to Guana's museum and science laboratory (Margaret and Skip have already donated such materials)

2. Core scientists should be used as a resource for information about the ecological impact of hotel/human activities on Guana

and elsewhere in the BVI.

- 3. Participants can present demonstrations created in the travelling display program (proposal submitted previously) to schools on Tortola.
- 4. Science Month participants as a group can participate in conservation efforts when massive manpower is needed. This oscurred during October when many participants helped carry buckets of water into the forest to water the parched Sida saplings.
- 5. Participants who photograph wildlife can contribute to the natural history slide collection, which I am in the process of compiling and categorizing.
- Each year, participants can give a one-day symposium, arranged by the National Parks Trust, to the general public (this has been done in previous years, and L. Potter and G. Cambers expressed interest in having one next year).
- 7. Scientists publish papers relating to Guana...obviously this is: already the main goal of science month, but I included it for completeness.
- 8, Scientists can conduct biological surveys of B.V.Islands to establish a heritage program (see problem g., suggestion 1).
- organisms on Guana for use in species identification. They should also write up summaries of their studies and results, so that a "proceedings of Science Month" can be included in the library (akin to the Guana Report, but more comprehensive and for control of the summaries of their studies and results. review).

Resident scientist and permanent laboratory

A competent, well-rounded, and physically active resident scientist with good communication skills would be an indispensable asset to science/conservation activities on Guana. A position for such a person on Guana should be established with adequate funding for his/her research and for maintaining ongoing science programs, and we should seek to keep this position filled at all times. The resident scientist could care for the museum, library, and scientific equipment, oversee the daily care of the native plant nursery, coordinate visiting scientists, interact with the BVI government, collect essential data for ongoing research projects throughout the year, lead hikes or other naturalist activities for quests, conduct

her/his own research or conservation project, and maintain an active science laboratory for the use of all visiting scientists.

- III. Questions I have about the future of science and conservation on Guana:
- a. Do you plan to continue support of science and conservation on Guana indefinitely?
- b. Do you wish to eventually develop a year-round scientific field station/educational laboratory on Guana?
- c. How much more building will occur on Guana, and will building be restricted to the club hill?
- d. Will you commit to protecting Guana's natural resources? E.g. stop mining sand from North Beach.
 - e. Will you ensure long-term legal protection of Guana?

I hope I haven't turned you off by being excessively demanding, trying to establish rules and illicit promises, etc. In some instances, I found it impossible to be unbiased and open-minded. Much of it involves my personal opinions or other people's personal opinions, and many points can and should be argued. I in no way mean to imply that the work that has so far been. accomplished on Guana or the efforts towards conservation have been unimportant, but I do feel that, at present, science is Guana Island Hotel's hobby. Although this is certainly the more monetarily profitable situation, I firmly believe that it is in the Jarecki family's best interest to run Guana as a wildlife Sanctuary and second residence of family members, with the hotel business as a hobby. I could expound at length the benefits of managing Guana as a bona fide wildlife sanctuary, but this article is perhaps too lengthy already. I also realize that many of my suggestions for documentation and follow-up research of conservation projects may seem: unnecessary and time-consuming. However, Guana Island has the potential to conduct conservation programs at a level of sophistication and efficiency well beyond that of many other islands and mainland parks. For this reason, I feel that proper documentation and research in our programs is absolutely necessary so that others can follow our example, learn from our mistakes. etc. In effect, we will be leaders in the field of conservation, particularly in the Carribean, and we will be discovering knowledge that can only be passed on through proper documentation and publication. That is, we should function to inspire a scientific community beyond the confines of Guana Island and the influence of Science Month participants.

Skip 123

December 4, 1991

Dr. Henry Jarecki Byewood, Timber Trail Rye, NY 10580

Dear Henry:

Skip showed me Lianna's letter to you re. Science Month. Skip showed me his responses as well but I wanted to add comments about subjects he didn't address. I agree with much of the substance of Lianna's letter though she sounds somewhat disillusioned by things which don't bother me. I think her ideas concerning increased information transfer between scientists are good. I do not believe increasing restrictions on scientists will improve the environment or productivity, however. I feel that most are not taking advantage of the situation; I think they just enjoy their work and the chance to socialize with their peers.

I was not in agreement with the "old and slow" comments. Not to sound overly loyal to any old-timers I might care about but, these folks are frequently walking encyclopedias: an inspiration to younger workers. Let the golden retrievers of the science world bound ahead, and circle back with what they've found. Bringing results to the older, more experienced and, granted, more sedentary biologist often generates exactly the type of interchange of ideas Lianna is looking for. Further, as I recall, one "old sage" has recommended most of the programs that the younger set is feverishly undertaking.

Skip did not address the comment I felt most strongly about, however. Lianna notes (p. 2) a "paucity of published scientific papers dealing specifically (not tangentially) with...Guana." Having been accused of being an "Anegadaphile" (someone truly not dedicated to research on Guana) I would like to suggest that lack of specificity may be a healthy thing. Restricting research efforts to Guana will not undermine "discovery-phase" projects (e.g. entomology or botany where new species are still being found on the island), or self-confessed small-scope studies (e.g. anecdotal ecological observations or localized terrestrial or marine experiments). A policy of decreasing or eliminating our ability to compare island systems, however, will decrease the relevance, utility, and significance of any documents generated.

Biogeography, for example, is an old and still highly-active branch of ecology. It has based its tenants on inter-island comparisons of hertepological community structure. If you had to list the five biggest topics in Ecology over the past thirty years this would be one. If we limit research to Guana-based projects we would no longer support biogeographic research. Gee, I really think we should keep our hand in. We may have to tolerate a few "museum-types" however.

In my particular case, should I have limited my work to iguanas to on Guana Island, my results would have been irrelevant to conservation and preservation of iguanas on Anegada where there is a problem with declining numbers. The life history of the two populations is completely different: they do not eat the same things or live in the same places. Because I was able to *compare* their natural histories, however, I found evidence that stock animals compete with iguanas on Anegada. Further, by comparing Guana iguana response to Anegada iguana dietary items this fall I've determined that the diets of iguanas on Anegada are low-quality. Working on either population alone, I would still be guessing what the problem was. In large part it was the comparative study which is yielding the management plan for the BVI's iguana.

One of the good things about the long-term support scientists have received from the Guana Island Sanctuary is that we have the time and ability to work on and say something about the Virgin Islands, not just one cay. Limiting our ability to study the VI archipelago will limit the significance of our work. This will, in the end, work against the goal of increasing our involvement with other BVI scientists who will regard us, predictably, as too insular.

Yours,

Numi C. Goodyear, Ph.D. Research Biologist

The Conservation Agency 129

Exploration, Education, and Research

President James D. Lazett, Ph.D. 401-428-2652

6 Swinburne Street Conunient Island R.J. 02835 U.S. C.

Dr. Henry Jarecki Byewood, Timber Trail Rye, NY 10580

Dear Henry:

Lianna's undated letter of late November to you and Gloria is utterly different in tone and substantially different in content from her conversation with me on Guana in October. While I strongly agree with most of what she says therein, it is apparent that she simply knows little or nothing or the history of the project or the constraints put upon me.

To wit:

- Restriction to about 400 bednights.
- Termination of my marine project for reasons of insurance.
- Roles and accomplishments of field assistants
- Existing administrative procedures and policies (which Fred and Lianna sought to short cut).
- The value of herpetological research; the reasons for its disproportionate value; and the enormous amount that remains to be done.
- Seasonal restrictions placed on our research.
- The fact that it was me, published in 1980 and continuing ever since as loudly as possible, who advocated removal of sheep, cats, and other exotics. Fred and Lianna may have finally persuaded you, but they did not bring the light of new logic and wisdom. They are Johnny-comelatelies to the problems of habitat conservation and exotic removal.
- The facts that every planned species restoration has always involved exactly what Lianna implies is missing: planning by the foremost experts - except some of the plant introductions carried out by Fred and Lianna.
- The fact that I have tried repeatedly to adjust mealtimes, and succeeded under Mary and Paula.
- The fact that an intern program has traditionally existed, but could not during the time (October) when school is in session.

I intensely dislike being put in a defensive role, but given the facts that almost all of what I say and do gets

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forgotten from year to year, I do feel I have to set the record straight.

I firmly believe Lianna is my basic ally in advancing science on Guana, but I think she has an enormous amount to learn in practical terms about funding, administrative time, inter-personal relations, the processes of converting scientific data to published papers, and what I actually do when not on the island.

See You Saturday.

All the Best,

James Lazzell

The Conservation Agency

Exploration, Education, and Research

Lresident James D. Lazell, Lh.D. 401-428-2652

15 March 92

6 Surinburne Street Gonunicut Island R.I. 02885 U.S.A.

Sara Oldfield
The Old Plough
2 Caxton Road
Great Gransden, Nr. Sandy
Beds SG19 3BE, UK

Dear Sara:

The Conservation Agency, in cooperation with the National Parks Trust of the British Virgin Islands and the Guana Island Wildlife Sanctuary, has made signal advances in the last few months.

James Lazell, reporting in the Puerto Rico Departmento de Rucursos Naturales <u>Publicacion Cientifica Miscelanea</u> No.1 (1991) claims successful reintroduction of the stout iguana (<u>Iguana pinquis</u>) to Guana Island, where the species had been extirpated by 1930. The present Guana population is thriving and hatchlings have been documented annually now since 1985 (see also <u>BBC Wildlife Magazine</u> vol. 4, no. 12, p. 622, 1986).

The Bermuda Aquarium, Natural History Museum, and Zoo, has donated 20 Caribbean flamingos (Phoenicopterus r. ruber), including several proven nesting pairs, for restoration efforts for this species no both Guana and Anegada Islands. The flamingo lift, requiring chartering of a private jet aircraft, was completed in March 1992. The flamingo release featured a celebration presentation with representatives of all the conservation organizations involved and BVI government dignitaries.

World Wide Fund for Nature (WWF)-UK has funded The Conservation Agency to work with the BVI National Parks Trust to develop a real National Park on Anegada - with iguana and flamingo as centerpiece species - and manage for both wildlife and ecotourism. Anegada harbors nesting populations of several rare birds, including snowy plover and several terns, several endemic plants, and two newly described, endemic butterflies: Calisto anagadensis and a tawny skipper Copaeodes eoa (Smith, et al, 1991. Bulletin of the Allyn Museum 133).

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Restoration plans for white-crowned pigeon, West Indian whistling duck, and Puerto Rican woodpecker to the British Virgin Islands are in progress.

All the best,

James Lazell

FORUMNEWS

CONSERVATION NEWS 6

NGO FORUM FOR THE UK DEPENDENT TERRITORIES

FEBRUARY 1992

PROTECTED AREAS SYMPOSIUM IN BRITISH VIRGIN ISLANDS

A Regional Symposium on Public and Private Cooperation in National Park Development was held in Tortola, British Virgin Islands, in August 1991. Mrs Rosamund DeRavariere, the recently appointed Director of the National Parks Trust sent this account of the meeting:

The BVI National Parks Trust celebrated its thirtieth anniversary in 1991. Over the years the Trust has managed, conserved and promoted designated natural and cultural areas, terrestrial and marine, in ways that contribute to the improvement of the quality of life in the British Virgin Islands. With more parks and protected areas either being declared or proposed and the increased need for the ecotourism product to be developed and marketed in a sustainable manner, the focus of the thirtieth anniversary celebrations was education and public awareness.

In this context the regional symposium to plan a strategy for involving the private sector in parks developmentwas held. The symposium allowed many respected Caribbean conservationists and environmentalists to share their successes as well as their thoughts on the promotion, protection and management of the green heritage.

The programme was very successful in meeting its objectives which were:

- to share information regionally on public and private cooperation in National Parks;
- to promote awareness locally and regionally of national parks and particularly those of BVI;
- to initiate a strategy for encouraging public and private cooperation in park development in the sub-region.

40 people participated in the symposium and papers were presented on parks in a regional context, marine parks, economic aspects of park development, case studies in park management and parks in the British Virgin Islands, Symposium organisation and administration was carried out by Dr Gillian Cambers, Conservation Officer, BVI. The project was jointly sponsored by the British Virgin Islands Canadian and Governments. Proceedings of the symposium are available (see Recent Publication).

RECENT PUBLICATION

Proceedings of the regional symposium on public and private cooperation in national park development. BVI, National Parks Trust. Price US\$15 plus postage.

This report is a useful compilation of papers on various aspects of protected area conservation. Based on experiences within BVI and other Caribbean islands, the papers provide studies and general reviews which will have much wider application. Practical aspects of marine park management are covered alongside policy issues. Several papers look in detail at the ecology and biodiversity of important site within BVI. A paper by Fred Kraus. for example, describes a conservation project on Guana Island. This involves the removal of exotic, introduced species, and surveyand re-introduction of endangered plant species - a local example of island conservation priorities which apply throughout the world. The proceedings are strongly recommended to all involved in island conservation.

The proceedings may be obtained from the BVI National Parks Trust, PO Box 860, Road Town, Tortola, BVI.

Richard Milner and Natural History

Gloria got Richard and me together, discussing an article on Guana, and a trip to Guana for Richard. We talked at length and decided the iguanas themselves make the best focus, and scientists' month in October the best time.

Natural History does not do conservation stories, so the flamingos will be mere trimming on the edges of any story we do. I have written an outline, and Richard wants part phased out and part expanded. Basically, he is most interested in evolution, speciation, and biogeography, less interested in ecology and behavior. Suits me fine.

Photographs will be critical. The idea would be to have me (author), Richard (editor), and photographer(s) on the island at the same time in October. Jan Soderquist, who did my original 1982 Guana photography, and her husband Gareth have applied for the job. Gareth is an excellent nature photographer. Jan specializes in close-up work. I think it all looks like a winning proposition.

Numi and I are planning radio-tracking, mark-recapture, and a morphological (scale count) study of Guana's 'guanas in October anyway. As plans progress I will keep you posted.

PROPOSAL FOR 1991

Basically, I want to return to the situation as it was <u>ca</u> 1987. The 1988 scientists' month was the most productive ever in terms of data and specimens, but there were many complaints of too many people. I believe about 20 people and about 400 bednights make good targets. Of course, I would like to be flexible.

I expect to be on Guana for the entire month of July. I hope Wenhua can come down as my assistant and also begin her own work on beetles.

Greg Mayer will head up the herpetology population biology team, with his wife Nan and a couple of assistants. His assistants will be Univ. Wisconsin students in Zoology.

Two excellent amateur herpetologists Tom Sinclair (of Amphisbaena fame) and Bill Holzmark (who was on 1990's South China Sea Islands trip) will come for parts of the month. Bill is also a superb wildlife photographer.

Dr Zhao Ermi, Chengdu Institute of Zoology, will be at Cornell from early May through the summer. He is a frog expert, as noted above, and we would like to have him on Guana for about three weeks to find frogs and do general herpetology. It would be a great educational experience for him, as he has almost no tropical experience - and none in the New World. We may also hope he will find our missing "bo-peep" frog.

Dr. Cora Brayton, who did the flamingo autopsy, might like to join us and will be invited.

The librarian, Mary Stevens, at the Mississippi Museum of Natural Science has long been a major benefit to The Conservation Agency. She has done sea turtle tagging and wants to come as a field assistant. Her husband, John, is a lawyer specializing in personal bankruptcy. He too is willing to work. Because both are unknown quantities in the field, and relatively impoverished, I have asked Gloria if they can come on the "at cost" basis, as have others before (Michael's women friends, for example). She said OK.

I expect some of our regulars, like George Proctor, and Margaret Collins, and Bill and Ellen Maclean, will return.

Scott Miller doubts he can come, or that much remains for him to do during July. He is the scientist probably most adversely affected by the loss of the Oct-Nov scientists' month. That was getting him (and Vitor Becker) new things. He may ask to return some year again in November. Scott is looking for specialized entomologists now for Guana. We especially need an ant expert and Wenhua for beetles.

Drs. Jerome and Bette Jackson of Mississippi State University, are the authorities on New World woodpeckers. I hope they can come.

As of now, I have about 20 people in mind, and about 320 bednights. Most will plan to arrive after July 5.

We missed out on boat days last year. In previous years we have had five boat days. Because we did not get them last year, I would like to have seven boat days this year. If possible, we would like to have Ralph run the boat.

I would like to have seven airfares: my own, my assistant, Greg Mayer, Zhao Ermi, and the previously allocated as two entomologists and an ornithologist. I have not decided how to allocate those three and await word from Scott Miller.

Here is a very rough approximation. Asterisks indicate airfare provided. Number is bednights.

Lazell * 30 Collins 15 Assistant Lu * 30 Proctor 15 Zhao * 21 Entomologist 1 * 15 Mayer, G * 21 Entomologist 2 * 15 Ornithologist * 15 Mayer, N 10 Assistant 1 15 Brayton 7 Assistant 2 15 Stevens, M 7 Stevens, J 7 Holzmark 21 Sinclair 15 Goodyear 30

I hope this meets with your approval.

I have not heard more about Ven Samarita's proposal on biting insects. Some of his points, like removal of all water-containing vessels (tip the bird bath out daily), tightly screening the cisterns, and installing big fans at the beach bar, were great. Of course I oppose any use of insecticides. These would exterminate life in and around the Salt Pond.

I will be in Rhode Island for most of May, then in Mississippi until the end of June. I will keep in touch, and update names and dates.