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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

NATIONAL SCIENCE FOUNDATION

PROPOSAL RATING SHEET

DISSERTATION

Reviewer **David J. Rogers**
 Department of EPO Biology
 University of Colorado
 Boulder, Colorado 80302

Proposal No.: P3B1282
 Investigator: TUCKER, J.M.
 Institution: U. of Calif./Davis
 Please return to: Section Head
 If possible by: December 8, 1972

Comments (Continue on additional sheet if necessary)

I believe the scientific merit of this proposal to be good. The concepts are sound, and the leadership of Dr. Tucker in this topic makes it all feasible.

I am disturbed about some of the details, however. First, the amount of time allotted for the field work does not seem adequate to accomplishment of the objectives. The area to be covered is so large that just travel from one to the other may take much more time than that allotted. Even though the PI may have made contacts in the areas, this may not prove to be as satisfactory in practise as it sounds on paper.

The other comment on time deals with the processing of the data once the field work has been done. I do not know which computer programs will be used, nor who will actually run the programs. Are the programs Standardized and running, and does the PI have to depend upon someone else to do the programming for him? Or is the PI sufficiently well versed in programming to do the work himself? Of course, these comments are not necessarily applicable since this aspect is not one of the items for which funds are sought.

OVERALL RATING

- ☐ EXCELLENT
☒ VERY GOOD
☐ GOOD
☐ FAIR
☐ POOR

Signature of Reviewer

David J. Rogers

Date:

Dec. 1, 1972

Other suggested reviewers (optional):

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

November 17, 1972

Dr. David J. Rogers
Department of Botany
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. *DJR* Rogers:

Ref: P3B1282

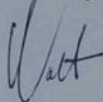
The National Science Foundation has received the enclosed proposal for a doctoral dissertation research grant on behalf of G. J. Muth of the University of California, Davis.

Would you kindly give us a brief statement of your view of it?

Since it is a dissertation research proposal, it is short, and the criteria of judgment should be somewhat different from those for a regular proposal. (See enclosed announcement of the program.)

I enclose a return envelope for your convenience.

Sincerely yours,



Walter H. Hodge
Section Head
Ecology and Systematic Biology

Enclosures

APPLICATION TO THE NATIONAL SCIENCE FOUNDATION
FOR RESEARCH SUPPORT

IMPROVING DOCTORAL DISSERTATION RESEARCH
IN THE BIOLOGICAL SCIENCES

- I. NAME AND ADDRESS OF INSTITUTION: Regents of the University of California
Davis, California 95616
Department of Botany
- II. TITLE OF PROPOSED RESEARCH: The Taxonomic and Floristic Relationships of
Quercus sadleriana to other Chestnut Oaks
- III. PROPOSED STARTING DATE: March 1, 1973
- IV. PERIOD FOR WHICH SUPPORT IS REQUESTED: March 1, 1973 - October 15, 1973
- V. DATE OF SUBMISSION OF REQUEST:
- VI. TOTAL SUPPORT REQUESTED: \$9690.00
- VII. OTHER SPONSORS: None
- VIII. CHECKS SHOULD BE MADE PAYABLE TO: The Regents of the University of California
c/o R.J. Frost, Accounting Officer
University of California
Davis, California 95616

APPROVALS

J. M. Tucker
PRINCIPAL INVESTIGATOR: J.M. Tucker
DEPARTMENT OF BOTANY
OFFICE PHONE: 916-752-1091
HOME PHONE: 916-753-3107
SOCIAL SECURITY NO. 555-01-7248

Gilbert L. Muth
GRADUATE STUDENT: G.J. Muth
DEPARTMENT OF BOTANY
OFFICE PHONE: 916-752-1091
HOME PHONE: 916-662-4151

C.R. Stocking
CHAIRMAN, DEPARTMENT OF BOTANY:
C.R. Stocking

Allen G. Marr
THE REGENTS OF THE UNIVERSITY OF CALIFORNIA
Allen G. Marr, Dean
Research Development
University of California, Davis 95616

Introduction: Statement by J.M. Tucker (Principal Investigator)

The evolutionary relationships of North American oaks have been a major research interest of mine for many years. One particularly intriguing problem is the relationships of our endemic of the Siskiyou Mountain Region Quercus sadleriana, the subject of this investigation. Strikingly different from any other species of the Pacific Coast Region, its affinities seem to lie either with (1) a small group of eastern North American species or (2) another group of eastern Asiatic species. To attempt any meaningful solution of the problems involved will require extensive field work in the Orient.

This grant proposal is being submitted on behalf of my student, Gilbert J. Muth, who will be conducting the field study, accompanied by two field assistants. Although in our earliest discussions of this whole problem I had seriously considered going with him, several events of recent months have ruled out this possibility. As Mr. Muth's major professor, I will, of course, be supervising his doctoral research.

Description of Research for Dissertation

It has been well known, since the middle of the last century, when the great American Botanist Asa Gray began examining collections from the Orient, that there were remarkable similarities between the flora of East Asia with that of Eastern North America (Gray, 1840). Since the time of Asa Gray, many botanists have collected in East Asia and many more detailed comparisons of East Asian and Eastern North American Species have been made (Gray, 1840, 1846, 1856, 1859, 1860; Diels 1900-1901, 1905; Handel-Mazzetti,

1929-1936; Hu, 1935, 1936; Lecomte, 1907-1937; Li, 1952; Maximowicz, 1859, 1833, 1866-1877; Miquel, 1865-1867; Rehder, 1923; Sargent, 1890, 1911-1917; Skan, 1899). This has not only given us a better understanding of the floristic relationships between the two continents but has also raised problems and questions which are hard to explain. One of these difficulties lies within the genus Quercus (oaks), whose members are distributed in the Northern Hemisphere in both the Old World and the New World.

A group, generally recognized but never formally defined, with leaves strongly resembling chestnut (Castanea) leaves is known as the Chestnut Oaks. These comprise the North American Series Prinoideae and Sadlerianae (Trelease, 1924; treated as Subsection Prinoideae and Subsection Sadlerianae by Camus, 1938-1939), and the Asiatic Subsection Diversipilosae (Camus, 1938-1939). Included under this subheading, Chestnut Oaks, are five species in Eastern North America and some eight species in East Asia, as would be expected by the floristic comparisons of the two continents and the similar natures of forests in these two regions. However, a paradox arises when we examine the forests of western North America for there we find a shrub form of a Chestnut Oak, Quercus sadleriana R. Br. Campst., in a totally different forest type and climatic regime. What makes this even more interesting is that it occurs as a seeming relict endemic in an area which Whittaker (1961) and other authors (Stebbins & Major, 1965; Wood, 1970; Wolfe, 1969) see as a major center of floristic diversity as is the case for the Southern Appalachian region of eastern North America.

The first question that comes out of all of this is, what are the relationships of Q. sadleriana? Is it more closely related to one group, than to the other of these groups? If so which one, the Eastern Asian group

or the Eastern North American group? Secondly, if there is a closer relationship to one of these groups how did this apparent lone survivor (Q. sadleriana) get to the west coast of North America? Thirdly, do all these (eastern North America, East Asia, Q. sadleriana) really constitute a natural group that might warrant formal taxonomic recognition? Hopefully this research will provide at least partial answers to these questions.

Getting at the first question is what this proposal is all about. Several methods are possible but the one which seems to have greatest promise is numerical taxonomy or taximetrics. This involves the measurement of as many different genetically inheritable characters as is practically possible to measure and quantify for each species; then coding them for the computer and finally letting the computer tabulate a list of characters for each species and then compare each species on a character by character basis. This comparison of a large number of characters, made by the computer, is a much more objective and statistically sound method than other current methods, and is the basis for determining the taxonomic relationships. My plan of attack is as follows:

- (1) From available herbarium specimens determine the most probable relatives of Q. sadleriana from both eastern North America and East Asia.
- (2) Choose three relatives of Q. sadleriana which appear to be the most closely related to it taxonomically from each of the two continents, and use these as a basis for comparison with Q. sadleriana.
- (3) As far as possible, make ten population samples of each species included in this study. Each population sample will consist of

a collection from 25 different individuals.

- (4) Return to the lab and assess, measure, and record the different characteristics of each of these population samples which will theoretically amount to 70 population samples of 25 individuals each, or data from 1750 individual plants.
- (5) This data is delivered to the computer for analysis which amounts to a character by character comparison of different population samples and different species.
- (6) From the computer printout and field knowledge of the species, draw conclusions as to the relationship of these species.

My request for funds revolves around step three. Steps 1 and 2 have already been completed. Also, I have already made my Eastern and Western North American collections thus leaving only the East Asian collection to make. This will be the major expense in my research and a key link in obtaining quality data. Therefore, I am requesting money to take myself plus two assistants and a certain amount of collecting gear to East Asia for approximately 2½-3 months starting about June 15, 1973 and ending about September 1-10, 1973.

The significance of this research and the data which it will produce can at least bring partial understanding to a number of different areas of prime interest in the field of Botany. Hopefully, it may provide answers not only to oak taxonomists but to phytogeographers, paleobotanists and others interested in the problems of floristic history and inter-relationships between North America and Asia, particularly during the Tertiary.

- (1) It will define carefully what is meant by the Chestnut Oaks and

may elevate them to some sort of infrageneric rank where they probably ought to be.

- (2) It will clear up some questions as to some of the growth habits, ecology, and ecological extremes of growth of not only Q. sadleriana but the Chestnut Oaks in general.
- (3) This study will also pinpoint the geographical and altitudinal boundaries of Q. sadleriana. Those for the eastern North American species have already been done by Little (1971). It would be impractical to try to do this for East Asian species at this time because of the inaccessibility of many parts of East Asia plus the problem of obtaining herbarium specimens from all the herbaria which might contain them in all parts of the world. Thus we will have to be content with generalized distributions for East Asian species.
- (4) This study may well produce evidence which will partially solve questions which phytogeographers and oak taxonomists have been puzzling over for years, as to the relationships of the Chestnut Oaks.
- (5) It will also bring in evidence which will extend our theories dealing with vegetational history during the Tertiary and certainly broaden the base for our theories concerning the significance of the Klamath Ranges of northern California and southern Oregon as a floristic center.
- (6) Finally, this study has created an interest in me to continue studying the Klamath Ranges and their floristic significance in the setting that I have been describing, when I finish this

dissertation and return to full-time employment as a teacher at Pacific Union College, Angwin, California.

The three species which I plan to study in the Orient are Q. aliena Blume var. acuteserrata Maxim., Q. glandulifera Blume and Q. griffithii Blume, which are all found in China. This would be the ideal place to study and make population samples of these species, however, there has been no reply to date from correspondence sent both to Ottawa, Canada, and Peking, China. I am still trying to get into the country and if possible I will go there to make my collections. However, the three species to be collected all occur and can be collected in the countries outside of China: Japan, South Korea, Taiwan, Hong Kong, Laos, Burma, Bhutan, and Sikkim.

The alternative plan is to make a total of fifteen collections in the following places, for which I have specific locations:

(1) Quercus aliena var. acuteserrata

- a. Kyushu, Japan
- b. Hondo, Japan
- c. South Korea
- d. Quelpart Island, South Korea
- e. Taiwan

(2) Quercus glandulifera

- a. Hokkaido, Japan
- b. Honshu, Japan
- c. Sado, Japan
- d. Shikoku, Japan
- e. Kyushu, Japan
- f. Seoul or Pusan, South Korea

- g. Quelpart Island, South Korea
- (3) Quercus griffithii
 - a. Plateau of Bolovens, Laos
 - b. Attopen, Laos
 - c. Manipar Mountains, Burma
 - d. Bhutan
 - e. Sikkim

Five population samples per species appears to be a more realistic goal in these East Asian collections than in the North American collections because distribution and specific location data is much less abundant and available.

The only source of information for specific collecting sites is from herbarium labels thirty or more years old. Thus, to insure more efficient location of collecting sites in the areas mentioned above, the following methods will be used:

- (1) Contact professional botanists at universities and institutions of higher learning, before leaving and upon arrival, for present easily accessible collection sites.
- (2) Contact professional foresters and amateur botanists prior to and upon arrival for the same kind of information as listed above.
- (3) Through travel agencies and other organizations, obtain maps with as much detail as possible for these specific areas.
- (4) Contact botanists, foresters and other people in this country that have worked in these countries in times past for advice and specific collection sites.

Lists of these people have been drawn up and correspondence is currently in progress.

The stop in Hong Kong will be a final attempt to obtain entry, through the embassy there, to the Peoples Republic of China, if our attempts thus far have not been successful.

The Oriental collecting phase of this research is most important in making this a well-rounded study. Although, as a feeble alternative, a study of sorts could be made using specimens borrowed from various herbaria, I have not really given this serious consideration. Your careful evaluation of this request, therefore will be greatly appreciated.

Bibliography

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Budget

Round-trip Air Fare (\$1500/person)	\$4500.00
Per diem (\$1080/person)	\$3240.00
Land Travel (@ 10¢/mile for 6000 miles)	\$ 600.00
20 Plant Presses (\$5/plant press)	\$ 100.00
Surface and Air Freight for Collecting Gear (500 lbs.)	\$ 800.00
Air Freight Specimens to UCD	\$ 200.00
Misc. Expense	\$ 250.00
Total	\$9690.00

The budget, as it appears above, is discussed on an item by item basis below, as to its relevance to the proposed research:

ROUND-TRIP AIR FARE: Round-trip air fare to Dacca, Bangladesh, is the closest international airport to Sikkim and Bhutan. From here it will be necessary either to go overland or to fly in an unscheduled commercial airplane into these two countries. This amount allows for such unscheduled flights and for enough mileage to make the flight back and forth to the different countries listed above.

The nature of the work which must be done requires a minimum of two assistants. In addition to making population samples, which requires one assistant, the necessity of making local floristic surveys will require the second assistant. Local floristic data is quite unavailable in Asia and is the basis for making floristic comparisons between the U.S. and Asia at the local level, and more generally at the regional level.

It is my plan to use two of my former students, one with a Master's Degree in Biology and the other working on same, as my assistants. Both have extensive field botanical experience and training in floristics and ecology. They will not only be of help in the actual collecting and preserving of specimens, but will be able to contribute much in the way of observation of floristic and ecological relationships between the species under study.

These men have already been contacted and have agreed to participate in this field trip, if the funds requested are approved.

PER DIEM: The per diem figure is impossible to estimate with any degree of accuracy. We will be in the field some days and in the cities waiting to go into the field other days. The porportion in each will also

be difficult to estimate, though probably about half and half. Obviously the cost of living in the field is much less expensive than in the city. Upon checking the MAXIMUM RATES OF PER DIEM ALLOWANCE FOR TRAVEL IN FOREIGN COUNTRIES, published by the Department of State, Washington, D.C., the rates varied from \$12-\$35 depending on the country and city. Thus I took the \$12 amount and multiplied it by 90 days to come up with at least an estimate for our per diem expenses per person per day. The only intention here is to set a figure which will cover our per diem expenses.

LAND TRAVEL: I can only estimate roughly how much land traveling we will need to do. I do know that public transportation is by far the cheapest way to go, and no doubt we will go that way as much as it is practical to do so. However, once we arrive at a village or town near where we want to collect, it will be necessary to get us and our collecting gear to the actual collecting site and it seems highly unlikely that public transportation would carry us even within a mile of the exact collection spot.

PLANT PRESSES: Plant presses will constitute the main bulk of the collecting gear. They aren't expensive items and it will cost a bit less than they are worth to ship them to East Asia where they are probably difficult to obtain. Therefore, the expedient thing seems to purchase them here and send them over by surface carrier so that they will be waiting for us when we arrive. When we finish with them there, they will not be worth the money to send them back, so we will donate them to some worthy institution.

SURFACE AND AIR FREIGHT FOR COLLECTING GEAR: It is necessary to have our collecting gear continually with us, thus the necessity of air freighting it as we travel from one country to another. After making the

last collection, we will dispose of it as indicated above. The figure of \$800 allows for approximately 500 lbs. to be sent surface to Tokyo and then by air freight to the various countries listed above to the ultimate destination of Dacca, Bangladesh.

AIR FREIGHT SPECIMENS BACK TO UCD: This is imperative! The risk of sending the specimens back by surface carrier where they might get lost, broken, damaged or ruined by water, is hardly worth the risk. By air freight they can be on the UCD campus within 24-36 hours after they have been put on the plane. The possibility of damage or loss seems much less under these conditions.

Time Schedule for Completion of Research

The time period for this phase of my research and thus for this proposal is from March 1, 1973 to October 30, 1973. This allows enough overlap time on both ends to buy plant presses, obtain tickets, ship plant presses, pay outstanding bills, etc. The actual collection and travel will take place between the dates of June 15 and September 10, 1973.

The last phase of my research, the measurement and coding of specimens, could be finished in a single quarter. However, this will depend upon whether my employing institution will extend my study leave till I am finished or ask me to return on a half-time teach half-time study appointment. If the latter occurs, I suspect that it would take a complete year to finish the research and write the dissertation, whereas the former would probably take only till March, 1974.

Biographical DataJohn M. Tucker, Principal InvestigatorBorn:

January 7, 1916

Married:

September 10, 1942 (to Katrine June Petersen); three children

Degrees:A.B. (with honors), Botany, University of California,
Berkeley, 1940.

Ph. D., Botany, University of California, Berkeley, 1950.

Professional Positions Held:Special Botanical Assistant, Santa Barbara Botanic Garden,
during vacation periods, 1938-1942.Botanist with the University of California Expedition to
El Salvador, Central America, six months in 1941-
1942 (under leadership of Dr. R.A. Stirton, Department
of Paleontology, U.C. Berkeley).

Teaching Assistant in Botany, U.C., Berkeley, 1946-1947.

Associate in Botany, University of California, Davis, 1947-
1949.Instructor in Botany, University of California, Davis,
1949-1951.Assistant Professor of Botany, University of California,
Davis, 1951-1957.Associate Professor of Botany, University of California,
Davis, 1957-1963.Professor of Botany, University of California, Davis,
1963-present, (Curator of Botany Department Herbarium,
Director of the Arboretum).Memberships and Honors:

AAAS (Fellow, 1963)

AIBS

Botanical Society of America (Chairman, Pacific Section,
1962)

International Association for Plant Taxonomy

American Society of Plant Taxonomists

Society for the Study of Evolution

California Botanical Society (President, 1958)

Sigma Xi

Guggenheim Fellow, 1955-1956.

Gilbert J. Muth, Graduate Student, UCD

Born:

March 1, 1938

Married:

August 23, 1959 (to Betty Lavelle Krier); two children

Degrees:

B.A., Biology, Pacific Union College, Angwin, California,
1961.

M.A., Biology, Pacific Union College, Angwin, California,
1967.

Professional Positions Held:

Instructor in Science and Mathematics, Napa Junior Academy,
1961-1966.

Instructor in Biology, Pacific Union College, 1966-1969.

Assistant Professor of Biology, Pacific Union College,
1969-present.

Memberships and Honors:

Outstanding Young Men of America, 1968

National Science Foundation Science Faculty Fellow,
1971-1972.

California Botanical Society
Sigma Xi

My current status with Pacific Union College, Angwin, California, is Assistant Professor of Biology, on study leave till June, 1973, which will automatically be extended to September, 1973, on a 12-month appointment, with full salary and fringe benefits of other faculty. The possibility of this study leave being extended till I finish my dissertation is probably 50:50.

Chester A. Ground is the assistant whose educational emphasis is floristic botany. He was born June 17, 1943, and holds a B.A. in Biology from Pacific Union College, 1970, and an M.A. in Biology from Pacific Union College in 1972. His Master's Thesis was A STUDY OF THE FLORA OF PRESTON PEAK, SISKIYOU COUNTY, CALIFORNIA. He is currently teaching the grades, 4, 5, and 6, in the Kelso-Longview Seventh-day Adventist Elementary

School, Longview, Washington and is on a 10-month appointment, being married and having one child.

James A. Marxmiller is the assistant whose educational emphasis is primarily ecological. He was born February 22, 1950, is married and has no children. His B.S. degree is from Pacific Union College, in Biology, 1971, and he is currently a student working on a teaching credential and an M.A. in Biology from the same institution, which he hopes to complete in 1973 and 1974 respectively. He has considerable experience as a Teaching Assistant plus a California State Scholarship for his undergraduate years as well as a Pacific Union College Fellowship this year, his graduate year.

NATIONAL SCIENCE FOUNDATION
PROPOSAL RATING SHEET

Reviewer David J. Rogers
Department of Environmental, Population
Organismic Biology
University of Colorado
Boulder, Colorado 80302
Comments (Continue on additional sheet if necessary)

Proposal No.: P3B0276
Investigator: BOWMER, Richard
Institution: Idaho St. Univ.
Please return to: General Ecology
If possible by:

As the principal investigator of this proposal points out, most of the work done to date on the dwarf mistletoes has been taxonomic. However, the PI has not done his homework thoroughly even in the taxonomic area, for he does not cite the definitive monograph of the genus, that of Hawksworth and Wiens, Feb., 1972, "Biology and Classification of Dwarf Mistletoes (Arceuthobium)", USDA Agricultural Handbook No. 401. While there is nothing wrong in the proposal as it stands, it would seem to me profitable for the PI to have communicated with either Hawksworth or Wiens because, as part of the above publication, the authors list a series of suggestions for further research. Amongst these suggestions are certain types of physiological research. The authors may be taxonomists, but they still know more about the general biological problems with the dwarf mistletoes than any other workers today. Two papers cited by Hawksworth and Wiens in the areas which the principal investigator is interested are not listed by the principal investigator. These are Blakely 1959, and Bonga and Chakraborty 1968. I cannot personally judge the significance of these two papers, but think they should have been mentioned by the PI.

There is no question of the need for physiological research on the dwarf mistletoes, but I do think the PI needs to do a little more work before submission of a grant request. He specifically should contact both Hawksworth and Wiens for their recommendations, and I would suggest very strongly that a problem with this much practical importance should, or very likely could, be supported by funds from the Forest Service.

OVERALL RATING

- ☐ EXCELLENT
☐ VERY GOOD
☐ GOOD
☒ FAIR
☐ POOR

Signature of Reviewer:

David J. Rogers

Date:

Sept 11, 1972

Other suggested reviewers (optional):

P 3 B 0276

Research Proposal Submitted to the National Science Foundation

NAME & ADDRESS of INSTITUTION: Idaho State University
Pocatello, Idaho 83201

TITLE of PROPOSED RESEARCH: Physiological Investigations of Arceuthobium

Amount Requested \$36,556 Proposed Duration 3 years Requested Starting Date 15 May 1973

Name of PI Dr. Richard G. Bowmer

Social Security No. 725 10 5248

Title Associate Professor - Botany

Telephone (w/area code) 208 236-2614

Other No. where message can be left 208 237-2648

Department Affiliation Department of Biology

Address if different from above same

Endorsements

Department Head

Approving Administrative
Official

Principal Investigator

Name Richard G. BowmerName Allan D. LinderName Vernon Lestrud

Signature

Title Assoc. Prof. BotanyTitle Chairman, Dept. of BiologyTitle Dir. of Devel. & Inst. Research

Date

18 July 197218 July 1972July 15, 1972

ABSTRACT:

The economic importance of Arceuthobium can best be illustrated by the following statement by Kimmey and Graham (21). "Dwarf mistletoes cause the greatest single growth impact (mortality plus growth loss) to commercial tree species in the Northern Rocky Mountain Region according to the best available estimates." Damage by dwarf mistletoes falls into four general categories: 1. increased mortality, 2. growth reduction, 3. quality reduction, and 4. seed reduction. In addition, heavy infection subjects the trees more readily to invasion by a number of other organisms such as bark beetles and the rot organisms, which make the tree easily susceptible to windfall.

If one examines the literature on dwarf mistletoe it is found that several articles on taxonomy, anatomy and embryology have been published, as well as many survey studies made largely by personnel of the U.S. Forest Service. Substantial physiological investigations until recently are few, although some earlier investigators have commented on certain aspects of the area. Recent investigations deal primarily with comparative nutritional requirements between Arceuthobium and Phoradendron and nutritional interrelationships between the parasite and the host. It would seem since the species of Arceuthobium are of such economic importance that additional physiological investigations would be a matter of much importance and value.

The first portion of the research will be devoted primarily to field collecting of the dwarf mistletoe. Both fresh and preserved material of various stages of development will be brought back into the laboratory for later analysis. Seeds will also be collected and grown in the laboratory to provide various stages of development for analysis. The mistletoe collected in the field and the laboratory grown material will be extracted utilizing various techniques.

The compounds in the extracts will be separated by thin layer chromatography or electrophoresis. Identification of the compounds separated by thin layer

chromatography will be made by running known standards of grow substances or amino acids on thin layer and comparing the compounds isolated from the extract to the known compounds. Any spot believed to be biologically active as a growth regulator will be removed, eluted, and used in appropriate bioassays to determine activity. Electrophoretic strips will be made at various stages of development of the mistletoe and compared to determine if significant changes in types of protein have occurred during development.

REVIEW OF LITERATURE:

Description of the parasite

The dwarf mistletoes are fleshy, glabrous, seed plants which grow as obligate parasites on conifers. According to Davis (5), four species varying in morphology and host relationships occur in Idaho.

These are:

1. Arceuthobium americanum Nutt. parasitic on Pinus, especially Pinus contorta.
2. Arceuthobium campylopodum Engelm. parasitic on Pinus.
3. Arceuthobium Douglasii Engelm. parasitic on Pseudotsuga.
4. Arceuthobium laricis (Piper) St. John. parasitic on Larix, rarely on Pinus.

Gill (7) however does not recognize Arceuthobium laricis (Piper) St. John. as a true species but instead assigns it to A. campylopodum forma laricis (Piper) comb. nov.

Many of these same species occur over other parts of the western states as well. (10, 13, 14, 20, 21)

The seeds of the dwarf mistletoes are disseminated by means of an explosive force upon dehiscence of the fruit. It has been estimated this explosive force will disseminate seeds from 30-60 feet away from the infected host. The shed seeds have adhering to them some of the mucilaginous pulp of the fruit and are glued to nearly anything they touch. Infection occurs most easily if the seed adheres to a young (1-2 year) twig (37) but infection can also occur on older twigs, in which case the penetration occurs near the sheath base of the needles. Generally, seed germination in the species mentioned is delayed until the following spring, at which time the growth occurs along a needle or twig until a suitable site for penetration occurs. At this point haustoria develop and penetrate the bark. Whether the penetration into and within the host is affected by chemical activity or primarily by mechanical force

has been a matter of past dispute (25, 32, 33). From the haustoria, threadlike strands develop and ramify throughout the bark. It appears however, that the parasite does not penetrate the xylem but is embedded in the wood by formation and growth of xylem tissue around the strands. The term used to describe the strands found in the xylem tissue is "sinker". According to Coehn (2) the sinker does not physically penetrate the cambium and none of the cambial cells or cambial derivatives are destroyed by the sinker. Strands other than the sinkers might produce buds which push through the host bark to form the aerial shoots some 2-5 years or longer after infection. A number of investigators have worked on the life cycle of various species of dwarf mistletoe (16, 17, 21, 22, 23, 26, 34).

Symptoms of infection

The surest symptom of infection of course, is the presence of aerial shoots of the mistletoe on the host. However, infected stands of trees can also be recognized by abnormalities that occur. These include witches' broom, which consists of malformed, twisted and swollen growths of twigs and branches in clumps.

A second abnormality, and the one which this study would be most concerned with, consists of cankers and swellings produced on infected branches, twigs, and stems. These swellings, depending upon the species involved, might vary from a slight increase in diameter to an increase three to four times greater than that of the normal branch (25). On the trunk large elongated and flattened cankers or spindle shaped swellings occur. Eventually the infections cause marked reduction in increment, foliar surface, and reproductive capacity of the tree. Under severe infections dying or dead trees may occur.

Economic importance

The economic importance can be best illustrated by the following statement from Kimmey and Graham (21) "Dwarf Mistletoes cause the greatest single growth impact (mortality plus growth loss) to commercial tree species in the Northern Rocky Mountain Region according to the best available estimates." In California and

the Intermountain West the losses due to dwarf mistletoe rank second only to heart rot (21). Reduction of such losses is now considered the most important forest disease problem in these areas. The parasite has also been found in the campgrounds of Yellowstone National Park, Craters of the Moon National Monument, many campgrounds in the intermountain area and other resort areas stretching over a rather vast area of the west. An especially heavy area of infection occurs in the lodgepole pine forests of southeastern Idaho and western Wyoming.

Damage by dwarf mistletoe falls into four general categories (21):

1. Increased mortality
2. Growth reduction
3. Quality reduction
4. Seed reduction.

In addition, heavy infection subjects the trees more readily to invasion by a number of other organisms such as bark beetles, and the rot organism, which make the tree easily susceptible to windfall (7).

It is rather interesting to note that the eradication or control involves killing the host, something which is done by the parasite, but with not as much dispatch as by man. The methods involve cutting, burning, or eliminating in some other manner all infected trees. Pruning is also used in situations where the infection is not severe, but these do not result in complete eradication of the parasite. The initial cost of eradication by removal of trees varies with the area involved, but when consideration is given to both the removal cost and the loss of future marketable timber the value is rather high.

Statement relating to the current research proposal

It is rather interesting that if one delves into the literature of dwarf mistletoe that it has been primarily concerned with the taxonomy of the group (8, 12, 24, 37), the anatomy and embryology of various members of the genus (2, 3, 4, 26, 27, 22, 23, 30, 32), and of course, survey studies made largely by personnel of the U.S. Forest

Service (8,9,10,11,13,20,21,28). Substantial physiological investigations until recently are few, although some earlier investigators have commented on certain aspects of this area (1,7). Recent investigations deal primarily with comparative nutritional requirements between Arceuthobium and Phoradendron (18,19) and nutritional interrelationships between the parasite and the host (27). It would seem since the species of Arceuthobium are of such economic importance that physiological investigations would be a matter of much importance and value. It is almost inconceivable that an effective control can be formulated with such a scarcity of physiological information.

PLAN OF PROPOSED RESEARCH:

The first portion of the research will be devoted primarily to field collecting of the dwarf mistletoe. Both fresh and dried material of various stages of growth will be brought back into the laboratory for use in later analyses. Seeds of the mistletoe will also be collected in the manner described by Scharpf and Parmeter (29) and Wicker (39). These seeds will be used in infection studies for which purpose fifteen pines are currently being grown in two PGV 36 growth chambers with experimental plans calling for an additional one hundred pines to be planted during March. Attempts to germinate the seeds in the laboratory under controlled conditions as described by Gill (7), Peirce (25), and Scharpf and Parmeter (29) will be made to obtain material of various ages to analyze for changes in concentration or types of growth substances, free amino acids, and protein.

A second portion of the research would be devoted to experimentation designed to determine if the swelling produced at the site of infection is the result of some growth substance produced by the mistletoe. This would involve attempts to extract and identify the growth substance chromatographically from both the parasite tissue as well as the swelling induced on the host. Comparative studies then could be made of the concentration of any compound present in the host with that of uninfected host tissue.

At the present time auxins seem to be the most highly suspected group of compounds. Various extraction techniques might be used to extract this class of compounds. Techniques would be modified as necessitated by experimental results. Chromatography and bioassays (coleoptile test; split pea test, etc.) will be used as aids in identification and in determining concentrations.

While the auxins are most likely to be involved in the abnormal growth, it would not be wise to overlook other growth substances that might be present. Therefore, different extraction techniques will be used in a effort to extract other suspected growth substances from the mistletoe. Another group of current interest would be the gibberellins which would be extracted by a procedure similar to that used by Phinney, et al (26) and West and Phinney (38). Again chromatography and bioassays (dwarf corn bioassay for gibberellins) will be used as aids in identification.

Attempts to induce swelling in healthy uninfected pines grown in controlled environmental chambers will be made by applications of any suspected compound extracted. During this experimentation special attention will be given to the concentration of the growth substances isolated, since DeRopp (6) has shown concentration to be a vital factor in inducing overgrowths with auxin.

Associated with attempts to induce swelling would be experiments designed to see if inhibition of tumor growth can be accomplished. This would consist of applications of such compounds as anti-auxins in the manner used by DeRopp (6) in crown gall studies. DeRopp (6) found that Aminopterine, A-methopterine, A-denopterine, A-ninopterine and A-teropterine at a total dosage of as little as 0.05 ug to reduce tumor growth in crown gall infections. This could be reversed by an application of 1% folic acid. It is proposed to investigate such compounds as well as others to see if they might have a similar effect on the overgrowths produced by mistletoe. While it is doubtful that such a substance could be applied on a large scale it might be feasible to utilize it in areas where infections are of a small order.

Electrophoretic strips will be made from extracts prepared at various stages of development of the mistletoe and compared to determine if significant changes in types of protein have occurred during development. This type of preliminary analysis might lead to detection of changes in enzyme constituents of the mistletoe during germination, penetration of the host, and subsequent growth of the parasite. These changes might also be of consequence in control programs.

Steward (31) has suggested that host parasite relationships may involve in some way some of the nitrogenous compounds found in the free or soluble state. Mistletoe extract is being currently screened by thin layer chromatography for free amino acid content under a grant provided by the University Research Committee. It is proposed to continue this screening and to expand it to include other nitrogenous compounds .

Literature Cited

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3. Cohen, Leon I. 1963. Studies on the ontogeny of the dwarf mistletoes, Arceuthobium. II. Homology of the endophytic system. Am. Jour. Bot. 50: 409-17.
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L. J. Am. Chem. Soc. 81: 2424.
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douglas fir to Arceuthobium Douglasii. Plant Disease Reporter 53: 311-314.

FACILITIES:

Facilities include a greenhouse with automatic light and temperature controls, two PGV-36 environmental chambers, two CEL-8 growth chambers, thin layer chromatography equipment, a DB-G spectrophotometer, electrophoresis equipment, recorders, and other basic physiological apparatus and equipment.

INSTRUMENTATION REQUIRED:

One item of analytical use which would be a valuable aid in the current research project would be a gas chromatograph. This instrument would facilitate the identification of volatile materials extracted from either the host or parasite. Such an instrument is not currently present in the department. Either a Packard Model 8025 gas chromatograph with flame ionization and electron capture detectors or a Packard Model 7424 with temperature programmer and both detectors would be considered.

PERSONNEL:

Biographical sketch of principal investigator

Richard G. Bowmer. Birth: December 4, 1931. Spokane, Washington

Education: Elementary School: Regal Grade School, Spokane, Wash.
St. Maries Public Schools,
St. Maries, Idaho

High School: St. Maries High School, St. Maries, Idaho

College: University of Idaho 1949-1953; 1955-1957

Major: Botany

Minor: Chemistry

Degree: B.S., M.S.

University of North Carolina

Major: Botany

Degree: Ph.D.

Membership in Societies

Phi Beta Kappa -- 1953

Sigma Xi 1959 -- associate member; 1962 -- full member

American Society of Plant Physiologists -- 1959

Botanical Society of America -- 1958

Idaho Academy of Science -- 1961

Previous Research:

1. The use of di-sodium fluorescein and radioactive phosphorus in tracer studies. Master's thesis, Univ. of Idaho. 1957.

2. Conducted independent research on the anatomy of the cotton plant.
3. Conducted independent research on the anatomy of the bean plant.
4. Conducted research on the chromosome number of Claytonia (with R. J. Davis).
5. The influence of various factors on the rate of translocation of fluorescein in Gossypium hirsutum L. Doctoral dissertation, University of North Carolina, 1960.
6. The effect of the sieve plate on translocation rates of disodium fluorescein in Gossypium (in revision for publication).
7. The effect of growth substances on the rate of translocation of di-sodium fluorescein (with M. Christensen Masters Thesis, Idaho State Univ.).
8. Free amino acids in Arceuthobium.

Publications:

1956. (with J. Parker). Independent movement of fluorescein and p³² in the phloem of the cotton and bean plant (abstr.). Plant Physiol. suppl. Vol. 31: 16.
1960. The influence of various factors on the rate of translocation of fluorescein in Gossypium hirsutum L. Dissertation abstracts. Vol. 21: 1722, University Microfilms Inc. Ann Arbor, Michigan.
1966. (with R. Davis). Chromosome numbers of Claytonia. Brittonia 18: 37-8.

BUDGET

	Requested from NSF			ISU	Total Cost
	73-74	74-75	75-76		
A. Salaries & Wages					
1. Senior Personnel					
a. Richard G. Bowmer					
Principal Investigator	\$ 2,844	\$ 3,015	\$ 3,196		\$ 9,055
2 summer months					
10% 9 months salary				\$ 4,075	4,075
2. Other Personnel					
a. - - -	-0-	-0-	-0-	-0-	-0-
b. - - -	-0-	-0-	-0-	-0-	-0-
c. Graduate students	<u>3,000</u>	<u>3,000</u>	<u>3,000</u>		<u>9,000</u>
Total Salaries & Wages	\$ 5,844	\$ 6,015	\$ 6,196	\$ 4,075	\$22,130
B. Staff Benefits	<u>\$ 636</u>	<u>661</u>	<u>687</u>	<u>590</u>	<u>2,574</u>
C. Total Salaries, Wages & Staff Benefits	<u>\$ 6,480</u>	<u>\$ 6,676</u>	<u>\$ 6,883</u>	<u>\$ 4,665</u>	<u>\$24,704</u>
D. Permanent Equipment					
Gas Chromatograph	6,800	-0-	-0-	-0-	6,800
E. Expendable Equipment & Supplies	200	200	200	300	900
F. Travel					
1. Domestic, collecting trips, and meetings	300	300	300	-0-	900
G. Publication costs	-0-	100	100	-0-	200
H. Computer costs	-0-	-0-	-0-	-0-	-0-
I. Other costs	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>	<u>-0-</u>
J. Total direct costs	\$13,780	\$ 7,276	\$ 7,483	\$ 4,965	\$33,504
K. Indirect costs 44.4%	<u>\$ 2,595</u>	<u>\$ 2,671</u>	<u>\$ 2,751</u>	<u>\$ 1,809</u>	<u>\$ 9,826</u>
L. Total costs	<u>\$16,375</u>	<u>\$ 9,947</u>	<u>\$10,234</u>	<u>\$ 6,774</u>	<u>\$43,330</u>
REQUESTED FROM NSF -	<u>\$36,556</u>				

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

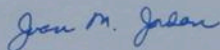
August 14, 1972

Dr. David J. Rogers
Department of Environmental,
Population & Organismic Biology
University of Colorado
Boulder, Colorado 80302

Dear Dr. Rogers:

Thank you for your attention to Dr. Carl Bock's proposal, P2B0084.
We did not realize you were now at the University of Colorado. We
would appreciate your additional comments on the methods as employed
and we are glad to have the additional reviewers you suggested.

Best regards,



(Mrs.) Joan M. Jordan
Assistant Program Director
General Ecology

August 4, 1972

John L. Brooks
Program Director for General Ecology
National Science Foundation
Washington, D.C. 20550

Dear Dr. Brooks,

Somehow my correct address has not caught up with you. I am presently in the Biology Department in the University of Colorado, and, therefore, a colleague of Carl Bock's (whose application to you, #P380084, proposal title: Computer Analysis of Audobon Society Christmas Bird Counts, you have asked me to review).

I am not certain of the propriety for me to review an application of a colleague in the same department. If it is your opinion that I can make useful comments on Dr. Bock's proposal, I shall be very happy to do so.

As you have all ready pointed out, I am not an ornithologist and cannot, therefore, properly determine the significance which ornithologists place upon the Christmas counts. However, as a biologist, it does strike me that this is one of the best potential sources of factual information in the field of biology. Dr. Bock intended this source of information to be made readily available not only to ~~be~~ ornithologists, but to all interested in biology. Through use of an appropriate computerized information retrieval system. I cannot but believe that we all will benefit.

Ecologists have had difficulty in providing factual documentation to back up their claims of environmental degradation. Given the capacity to rapidly and accurately extract these factual data, environmentalists of all kinds will be provided with many of the necessary facts which our policy makers demand.

I will, at your discretion, make more substantial comments on the methods employed. However, and again, since TAXIR was developed by me and my staff, you might not count my review as unbiased. A more objective review of the appropriateness of the information retrieval system chosen by Dr. Bock may be achieved by either or both of the following individuals:

Dr. Robert Menzies
Department of Oceanography
Florida State University
Tallahassee, Florida 32306

Dr. Carl Oppenheimer
Marine Laboratory
University of Texas
Port Aransas, Texas

They are both oceanographers, but with considerable knowledge of the I.R.
system TAXIR.

Sincerely,

David J. Rogers
Professor of Biology

BJR/jr

NATIONAL SCIENCE FOUNDATION

PROPOSAL RATING SHEET

Reviewer David J. Rogers
Taximetrics Laboratory
Department of Biology
University of Colorado
Boulder, Colorado 80302

Comments (Continue on additional sheet if necessary)

Proposal No.: P380084
Investigator: BOCK, Carl E.
Institution: U Colorado
Project: General Ecology
Pieces returned to: 6/14
If possible by:

This reviewer's comments are directed to the methods to be employed in this proposal, not to the substantive content.

The characteristics of the TAXIR system and a brief summary of the system, developed under my direction, is attached to provide an overview of the system's capability and applicability to this proposal. The software programs for TAXIR have been flow-charted and documented, and may be seen by anyone who has need to examine them for the sake of this proposal, if appropriate arrangements have been made.

Programming back-up and continued maintenance and development of the computer systems for TAXIR are guaranteed by the Taximetrics Laboratory. No computing system is ever "complete" and new means to improve the services of TAXIR are constantly under development. Therefore the Principal Investigator of this proposal will be continuously supported by the staff of the Taximetrics Laboratory.

TAXIR is a tested system, with several different biological and wider environmental applications now in a production phase, as follows:

TAXIR data banks of the genus Manihot, including specimen and bibliographic data.

Data banks of the cultivars of the cultivated species, Manihot esculenta are also maintained in production.

TAXIR is the information system chosen by the Regional Plant Introduction Station, USDA, Pullman, Washington for accessions of new crops, under the direction of Dr. Sam Dietz.

TAXIR, under the new acronym ENVIR, is the system of choice by the Gulf Universities Research Consortium, Mississippi Test Facility, Bay St. Louis, Miss. The applications are in biological, chemical and physical oceanographic studies and data are being incorporated into TAXIR (ENVIR) banks, particularly under the direction of Dr. Robert Menzies, Dept. of Oceanography, Florida State University, and Dr. Carl Oppenheimer, Director of the Marine Station of the University of Texas, Port Aransas, Tex. The data banks are equivalent, or larger than the total data bank for the Christmas Bird Count.

TAXIR has been designated as the information system for world Genetic Resource Centres, under the auspices of FAO and IBP. Two genetic resource centers, one in Bari, Italy, and one in Braunschweig, West Germany, are already using the TAXIR system.

TAXIR is the information system employed by the Amphibian Facility, Department of Zoology, University of Michigan, directed by Dr. George Nace.

OVERALL RATING

- ☒ EXCELLENT
☐ VERY GOOD
☐ GOOD
☐ FAIR
☐ POOR

Signature of Reviewer:

David J. Rogers

Date: August 21, 1972

Other suggested reviewers (optional):

One of the graduate students to be named in this project, Mr. Larry Lepthien, was trained in both the programming and application aspects of TAXIR in this Laboratory. Such training is an absolute essential to be certain that the complex programs and the various means of data structuring are most efficiently applied. Mr. Lepthien has participated in a pilot project which tested the TAXIR system as a means of information retrieval of the Christmas Bird Count data. The favorable results of the test led to the presentation of this proposal.

As indicated in this proposal, one of the most time-consuming aspects of any information system is that of data recording. The system proposed for data capture from the Christmas Bird Counts is as efficient and accurate as possible, both from time and accuracy standpoints. However, one of the areas of development in the Taximetrics Lab. is that dealing with this process, and where new techniques can be employed, they will be incorporated in this study (among several others). It should be pointed out that once the data are in machine-readable format, they need never again be copied by hand or keypunched, and can be used over and over again at electronic speeds. Use of graduate students and undergraduate assistants in this project insures relatively inexpensive labor costs, and at the same time, provides valuable training and experience in modern methods of data handling.

The Characteristics of the TAXIR Software System are:

- .. TAXIR has the capability to internally design an information retrieval program to the user's specification.
- .. Operates within 32K.
- .. All files are inverted. (Any selected unit of information may be queried.)
- .. TAXIR has a complete Boolean capability.
- .. Calculates the location of information within files to avoid linear search.
- .. Allows for a flexible data format and free field to store and manipulate alphabetic information, numeric information, coded information, and ordered information.
- .. Creates dictionaries from input data and permits the use of natural language in commands.
- .. Contains an update facility with the number of items open ended and permits the addition of descriptors and creates descriptors from existing data.
- .. Permits the deletion of items without disruption of files.
- .. Contains a correction and editing capability.
- .. Accommodates a virtually unlimited number of items and descriptors.
- .. Employs unique geometric data compression techniques.
- .. Always sustains a flexible selective retrieval capability with information organized and classified to ensure a rapid response to query.

The special capabilities of the TAXIR Software System are:

- .. The assembly of a "Living Atlas" as this applies to any area for which boundaries are defined. By "Living Atlas" we mean all, up to the minute, data and information available from any or all sources, in the full spectrum of Environmental Sciences and its presentation at a scale or scale meaningful to the problem/solution under study.
- .. The capability of instant recall and constant update of the "Living Atlas" subset by subset without rewriting files.
- .. The withdrawal and return of data from disparate banks and the automatic reformatting of new data from any agency or institution and its routing to the relevant archive.

- .. The use of the TAXIR system on the basis of English language query.
- .. The special capability of information transfer and the build-up of information banks appropriate to local problems in the local area.
- .. The automatic capability of converting "Archives" data to TAXIR format and the archive formatting of new data in accordance with the relevant "archive" requirements.

and finally, the possibilities that "fall out" as a consequence of general utilization of TAXIR, within universities and institutions, as an "INFORMATION GENERATOR", and a mechanism for information exchange.

- .. The application of TAXIR as an "INFORMATION GENERATOR" or, in other words, an analytical tool for scientists in special disciplines of "Environmental Sciences" such as genetics and breeding creates possibilities for the generation of an Information Bank in "Genetic Resources." Such a bank could be available for query or transferral in total to selected tributary points.
- .. Additional applications in the Information Generation mode are botanical gardens, museums, and other institutions wherein invaluable data and information exist but not, as yet, in "Query" or "exchange" format other than through the intellectual process.

SUMMARY OF TAXIR

TAXIR is a completely generalized Information Retrieval (IR) Program. As output, it provides items (things, concepts, etc.) that satisfy a given criterion, abstract descriptions of desired lists or sets and will identify unknowns as a response to descriptions. The program performs all logical operations and follows the rules of Boolean algebra. Thus, it can reorder, classify, sort or permute any data bank to the ultimate logical degree (2 to the power of the number of descriptors).

Three separate and distinct principles are fundamental to TAXIR and distinguish it from conventional computerized data information retrieval systems.

- .. Instead of searching one master file with diverse information contained under a single searching criterion, all information is distributed and ordered into inverted files and is directly retrievable. In the first instance, the information must be individually and sequentially searched for as with a library card catalogue. In TAXIR the information desired may be extracted by mathematical calculations.

- .. All numerical and alphabetical data (raw, reduced, classified, etc.) is compressed exponentially which enables very large amounts of information to be stored efficiently and economically with the added results of being a form allowing for manipulation of the information at electronic speeds.
- .. The TAXIR command options (part of the commands described below) enable the user to design the retrieval program to his own specifications. He is not bound by the kind, classification or volume of the input or the nature of the desired output.

TAXIR COMMANDS

Any "thing" that may be detailed, particularized, or described, will be called an ITEM with the understanding that a DESCRIPTOR is a basis or a structure for comparing these items. Specific statements regarding any item are states assignable to a descriptor.

Descriptor states for each item are input sequentially, separated by commas, in any of the mediums (cards, magnetic tape, paper tapes, teletype, etc.) acceptable to computers. The command, DEFINE ITEMS will read in, store, order, etc., the raw data into the computer in a format suitable for manipulation. The input data are screened for certain types of errors of omission or commission and these items will be automatically excluded from the data bank. The user is advised of this for each exclusion. A printout of the entire in/out bank is provided if the user desires.

COMMAND DEFINE DESCRIPTORS

This command with its accompanying definitions enables the user to design and build his information bank to his specifications. For instance, if a descriptor is specified as a "name" descriptor, the descriptor states are likely to be nouns or adjectives in some written language. TAXIR will construct the appropriate files for the dictionaries and the administration of these dictionaries (ordering, synonymy, etc.). If a descriptor is described as "coded," it will expect something of the nature of 1, 2, 3, etc., as input for a particular description with the instruction to permute and replace the 1, 2, 3, etc. A "from-to" type descriptor allows ranges of numbers to be specified such as all flocks of birds between 1,000 and 4,000, or temperature between 25°F and 25.8°F. The "equals" facility enables the user to use the same dictionary for more than one descriptor. The command "how many" simply prints out the count of the number of items that satisfy the query.

The command "print" may be formulated so that a single item, all the items, and/or a series of complex restriction conditions employing the and, or, not, and the parentheses of Boolean expressions will be printed out on any of a number peripheral processors (printers, CRT tubes, etc.).

"Generate" is a TAXIR command that will print out on a magnetic tape the selected information for input in 15 or so statistical programs. A series of commands are available for the maintenance of a data bank such as CORRECTION, DELETE STATE, DELETE ITEMS, AND DEFINE MORE DESCRIPTORS. It is also possible to create new descriptors from old information already input to the bank. A number of other commands (a total of 18) are useful in data management such as MEMO, TIME, etc.

A series of error messages (78 in number) are also incorporated in the program. These inform the user of errors of commitment on his part or of errors in the data and are useful in editing the information in the bank.

A Proposal to the
National Science Foundation
for the study of

P 3 B 0084

Gen. Sec.
1/7
WJ

COMPUTER ANALYSIS OF AUDUBON SOCIETY CHRISTMAS BIRD COUNTS

Name and Address of Institution: The Regents of the
University of Colorado
Boulder, Colorado 80302

Desired Starting Date: 1 January 1973

Amount Requested from NSF: \$ 55,895

Time Period for Which Support is Requested: Two Years

Principal Investigator: Carl E. Bock, Assistant Professor
Department of Environmental, Population
and Organismic Biology
University of Colorado
Boulder, Colorado 80302
Telephone: 303-443-2211, Ext. 7184
Social Security Number: 553-60-5760

Hobart Smith
Hobart Smith, Director
Department of Environmental,
Population and Organismic
Biology

Carl E. Bock
Carl E. Bock
Principal Investigator

I certify that the distribution of costs between the direct and indirect categories as shown in the proposal conforms to the usual accounting practices of the institution and to the distribution used by the cognizant Federal audit agency.

Lawson Crowe
Lawson Crowe
Provost and Vice President
for Research

ABSTRACT

There is a widely recognized need among ornithologists and ecologists for population data covering many years and broad geographic areas. Such data are scarce, however, because of problems involved in their collection.

The Audubon Society Christmas Bird Counts represent censuses of winter bird populations in the United States and Canada from 1900 to the present. They have never been extensively analyzed, and as such represent a vast collection of raw ecological data.

Pilot studies indicate that Christmas Count data do detect real bird population trends and fluctuations, both on local and continent-wide scales. Count data cover sufficiently broad areas over long enough time periods to be very valuable, but their bulk makes them essentially inaccessible. This problem can be overcome by entering the counts into a computerized information retrieval system. One such system, TAXIR, currently is in operation at the University of Colorado. A pilot project indicates that it is well suited to Christmas Count data storage and analysis.

This proposal discussed plans 1) to build a data bank containing 72 years of Christmas Counts using the TAXIR information retrieval system, 2) to conduct various analyses of these data, and 3) to make the counts available to ornithologists and ecologists who wish to use them.

I. Introduction

The field ecologist suffers, inevitably, from both spatial and temporal myopia. He cannot physically study a species population in its entirety, nor can he readily predict what will happen to a population in the future if there is no way of knowing what has happened to it in the past.

It would seem, then, that there would be a premium on population data gathered over long periods of time and over broad geographic areas. Most researchers agree, however, that even for a group as well known as birds, these sorts of data are scarce, because they are difficult to gather. Gibb (1961:417) noted that ". . . in general the habitats in which birds live are so varied that relatively small sample counts will not be of much value in assessing total populations of large areas"

Lack (1954) attempted to support the density dependent theory of population regulation by showing that natural populations fluctuate only within rather narrowly defined limits. In this connection he discussed some ten long-term population studies of birds conducted prior to 1952, and then observed that (op. cit.: 11) "Other published bird censuses refer either to too few individuals or to too few years to merit detailed consideration." Again, in 1966, Lack observed (p. 271) that "the proof or disproof of density dependent regulation involves measurements over many years . . . and nearly all the studies reviewed here have been carried on for too few years."

Von Haartman (1971:407) discussed the hypothesis that migratory bird species show less marked population fluctuations than non-migratory species, but noted that "no final conclusions can be reached at present, as too few species have been studied well enough."

Avian population data are valuable not only for what they can tell us about birds, but also are reliable indicators of man-caused and "natural" environmental disturbance. Joseph Grinnell (1928) was one of the first to observe that birds, because of their mobility, respond readily to habitat change. Bird populations have been shown to be highly sensitive to the effects of strip-mining (Karr, 1968), wild fires (Lawrence, 1966; Bock and Lynch, 1970), and to more subtle effects such as forest thinning (Kilgore, 1968). Because their diets and habitat preferences are well known, and because birds as a group are easy to observe, avifaunal analysis can provide a convenient and meaningful index to these sorts of changes.

From all of this it is obvious that long-term, widespread population data for North American birds would be extremely valuable not only to ornithologists but to ecologists in general. Yet with the exception of game birds, even the modest number of species which have been well studied have been largely European (see, for example, reviews by Lack, 1954, and von Haartman, 1971).

These and other considerations have resulted in the establishment of the annual "North American Breeding Bird Census," begun in the eastern United States in 1966 and expanded to include all states and southern Canada (Robbins and Van Velsen, 1969). The census is conducted under the direction of the U.S. Fish and Wildlife Service, using volunteer help from each state and province. The technique involves standardized road censuses placed strategically over the continent and conducted annually. Carefully gathered, compiled, and analyzed, these data should provide accurate information on populations of North American birds. They do not, however, give us any information on the relative size, fluctuations, or population trends of these species during the first 66 years of this century, nor have they been conducted long enough to reveal general patterns of population dynamics or long-term changes in the distribution of species.

The annual Audubon Society Christmas Bird Counts, begun in 1900 as a sort of national bird census and continuing to the present, represent 72 years of population data already collected for species of birds which winter in the United States and/or southern Canada. The counts have been conducted over a critical period in the history of man-caused modification of this continent, in regions of mass urbanization and industrialization, throughout an agricultural revolution, and before and after the introduction of persistent chemical toxicants into the environment. They also obviously cover a sufficient time and geographic spread to give an accurate picture of population fluctuations, trends, changes in distribution, etc. The Christmas Count data remain virtually untouched, and as such represent perhaps the largest single collection of raw ecological data in existence.

It is the purpose of this proposal 1) to describe the data contained in the Christmas Counts, 2) to discuss pilot projects indicating the value and limitations of these data, and 3) to describe an existing computerized information retrieval system by which these data can be made available to scientists without an inordinate expenditure of time and energy. It will be the objective of the project 1) to code all the seventy-plus years of data

into this information retrieval system, 2) to conduct sample studies using the data to publicize the system's applicability, and 3) to make these data available to the scientific community for any type of analyses desired.

A. Description and History of Christmas Counts

All Christmas Counts must take place during a prescribed period prior to or following Christmas Day. The observers participating divide themselves into a number of "parties," usually consisting of from one to as many individuals as can conveniently fit into an automobile. These parties then take to the field, counting as many birds as they can find in one day and within a circle fifteen miles in diameter centering on an officially determined point. The data for all parties are compiled into a total "count" and sent for publication to the editor of a journal originally entitled Bird Lore (1900-1946), then Audubon Field Notes (1947-1970), and now American Birds. Especially in the past twenty years, each Christmas Count volume has contained a considerable amount of information. For example, in 1966 there were 795 counts published; they were far from randomly distributed, but no state or province was unrepresented (Figure 1).

Each published count contains the following information:

1. The precise location of the center of the count circle.
2. An estimate of the habitats represented in the count area, by percent.
3. The date and time of the count.
4. Weather conditions.
5. The number of observers.
6. The number of parties.
7. Total party-hours (essential for making count results comparative):
 - Party-hours on foot.
 - Party-hours by car.
8. Total party-miles:
 - On foot.
 - By car.
9. A list of all species seen and the numbers of each.
10. Total species observed.
11. Total individuals observed.

While the labor involved in coding, keypunching, and editing seventy years of Christmas Count data will be considerable (see "Procedures and Work Timetable," below), it is but a small fraction of the time already spent in the original collection and compilation of these data. By totaling

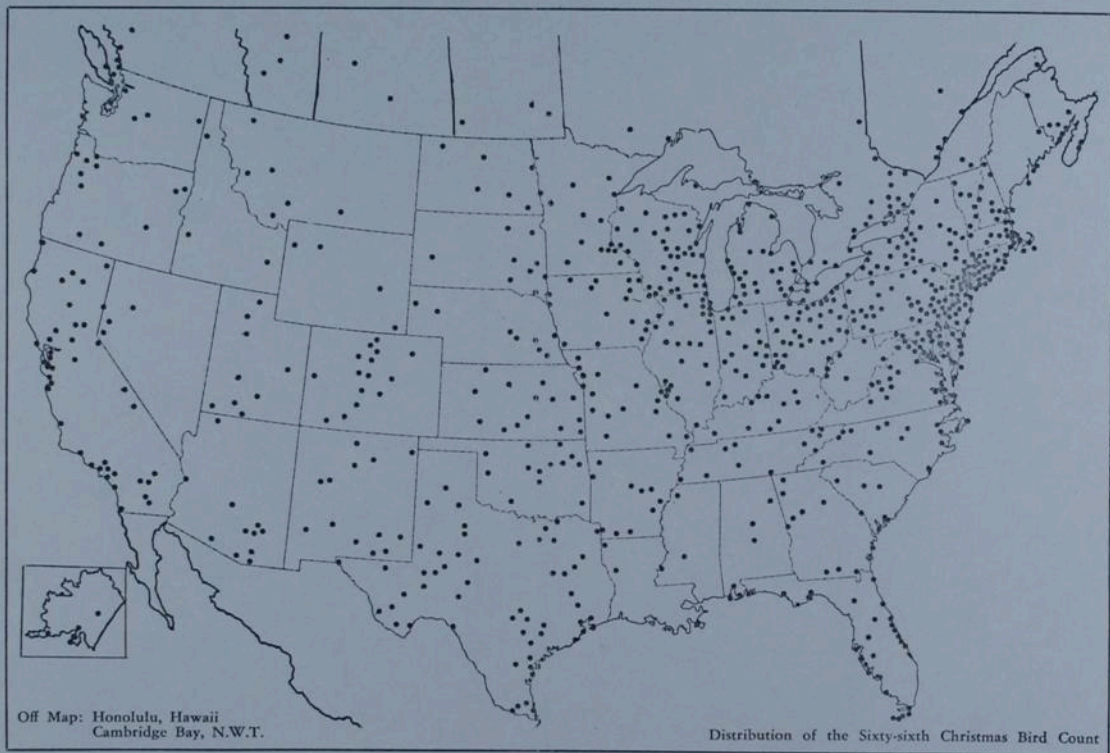


Figure 1. Distribution of Christmas Counts in 1966.

the number of party-hours in all counts for every tenth year since 1900 and calculating an average figure for each decade, we estimate that the count effort to date has involved over 880,000 party-hours of field work, or more than 2.5 million man-hours, using a conservative estimate of three observers per party. This figure does not include the many hours of compiling and editing necessary for the publication of each volume.

The first editor of the Christmas Counts wrote in the 1900 issue of Bird Lore (p. 193):

The results of the census are both interesting and instructive; interesting, because they are definite, comparative, and . . . instructive, because they give a very good idea of the distribution of winter birds on Christmas Day, with some indication of the number of individuals which may be observed in any given time.

Since 1900 the counts have grown into a staggering collection of data on the distribution and abundance of winter birds in North America. Yet these data have been little used by ornithologists and ecologists, in spite of the recognized need for such information. The following quote is from an earlier discussion of this problem (Bock and Smith, 1971:945):

We feel that there are two reasons for this [lack of usage]. First, the very bulk of the counts has prevented their being more fully exploited. The worker who is interested in one species or one habitat must sift a relatively small amount of wheat from a much larger amount of chaff. Furthermore the number of birds seen on a particular count varies not only with the size of the bird population but also with the magnitude of the count effort -- the more hours afield, the higher the count. Meaningful interpretation must include compensation for differences in count efforts, and while this information is published with each count, the time involved in analysis is great. Finally, it has been argued that uncontrolled variables such as weather and the relative skill of participants could render results erratic and unreliable.

The next two sections of this proposal discuss the value of the Christmas Count data, and the application of an information retrieval system to their analysis.

B. The Significance of Christmas Count Data -- Pilot Studies

1. Colorado, 1940-1969. To test the accuracy of Christmas Count data, a pilot project was conducted analyzing the results of counts in the state of Colorado from 1940 to 1969 (Bock and Smith, 1971). Twenty species were selected in a non-random manner, some because we suspected they had remained more or less stable over the thirty-year period, others because we knew they

had increased or declined in numbers. The primary purpose of the project was not to learn something new about these species but to determine if in fact Christmas Counts reflected what we knew to be reality.

After some experimentation it was determined that the best figure to use for comparative purposes was the number of birds seen per party-hour of effort per year. Figure 2 shows a sample plot, for the Hairy and Downy woodpeckers. It indicates the expected stability for these species since 1950, but seemingly violent fluctuations in the 1940's. This proved to be an artifact resulting from the very low number of counts in the state at that time. This artifact affected the results for all twenty species, and we were forced to restrict our analysis to 1950-1969. Table 1 gives the results for the species selected.

For this twenty-year period Colorado Counts quite accurately reflected known population trends. For example, the Canada Goose has been the subject of an intensive management program in Colorado over the past ten years, resulting in dramatic population increases. Obviously the Christmas Count data reflect this increase (Figure 3). The Blue Jay has become much more common in recent years in eastern Colorado; our tabulations (Table 1) suggest that this increase occurred rather suddenly in the mid-1950's. The Starling, which appeared in Colorado in the early 1940's, is still increasing in numbers. Starlings are known to occupy the nests of flickers, aggressively driving the latter species away. Our analysis suggests that the Flicker has declined over the same period as Starlings have increased (Figure 4). Finally, both the Red-Breasted Nuthatch and Red Crossbill showed marked fluctuations in numbers (Table 1), consistent with the fact that both are "invasion" species, moving south only in winters when conifer cone crops have failed in northern forests (Formozov, 1960; Bock and Lepthien, in press).

In summary, this first attempt at Christmas Count analysis is encouraging; it would appear that in spite of certain inherent problems (discussed below) this type of census does detect real population trends when the count effort is of sufficient magnitude.

2. Winter Eruptions of Red-Breasted Nuthatches in North America, 1950-1970.

A second pilot project was designed to determine what sort of continent-wide picture Audubon Christmas Counts could provide. We selected one species, the Red-Breasted Nuthatch, because of an interesting pattern revealed by the Colorado study. All counts were analyzed for the period 1950 to 1970. The results (Bock and Lepthien, in press) indicate massive and widespread southward "invasions" of Red-Breasted Nuthatches into the United States in 1951, 54, 55,

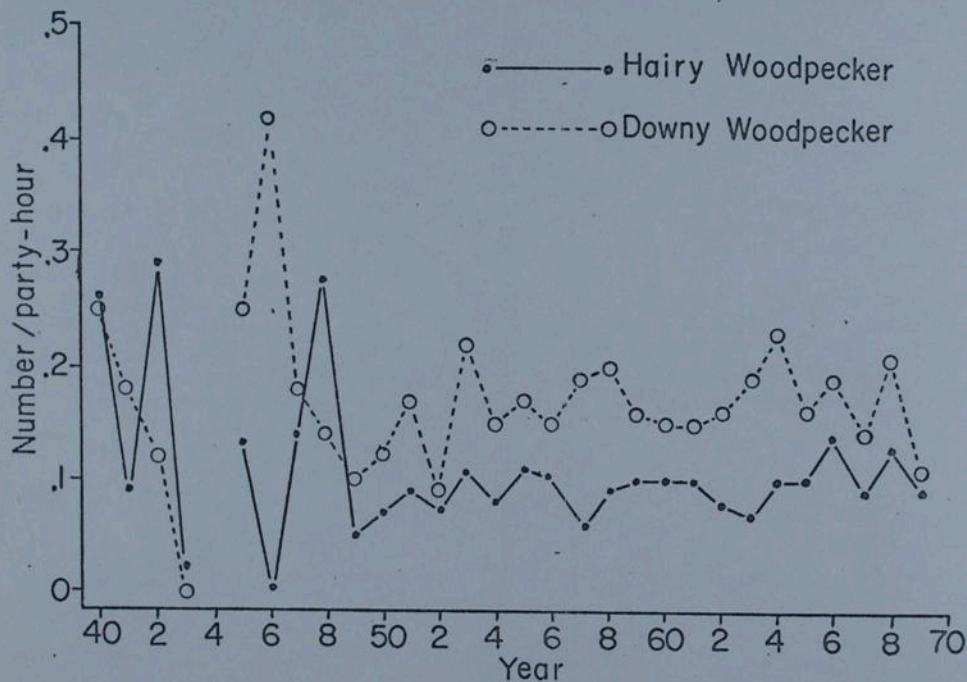


Figure 2. Hairy and Downy Woodpeckers counted in Colorado from 1940 - 1969.

Table 1. Average number of birds counted per party-hour and population trends for 20 species of Colorado winter birds, 1950-1969.

Species	Average number counted/ party-hour	Population trend
Canada Goose	7.63	dramatic increase*
Rough-legged Hawk	.09	stable
Red-Tailed Hawk	.10	stable
Prairie Falcon	.02	too few counted to give reliable data
Sparrow Hawk	.13	stable
Flicker	1.22	declining
Lewis Woodpecker	.07	slight decline
Hairy Woodpecker	.09	stable
Downy Woodpecker	.16	stable
Blue Jay	.06	sudden increase in mid- to late 1950's
Steller Jay	1.55	stable
White-Breasted Nuthatch	.14	stable
Red-Breasted Nuthatch	.11	marked fluctuations
Pygmy Nuthatch	.71	erratic, but no trends
Starling	11.46	increase
House Sparrow	8.89	stable
Western Meadowlark	2.67	stable
Red-Winged Blackbird	30.58	stable
House Finch	2.72	stable
Red Crossbill	.21	marked fluctuations

*Increases or declines listed in this table have been found statistically significant at the $p < .05$ level using the Mann-Whitney U test to compare one group of years with another. For example, counts of Flickers were significantly lower in 1960-69 than in 1950-59.

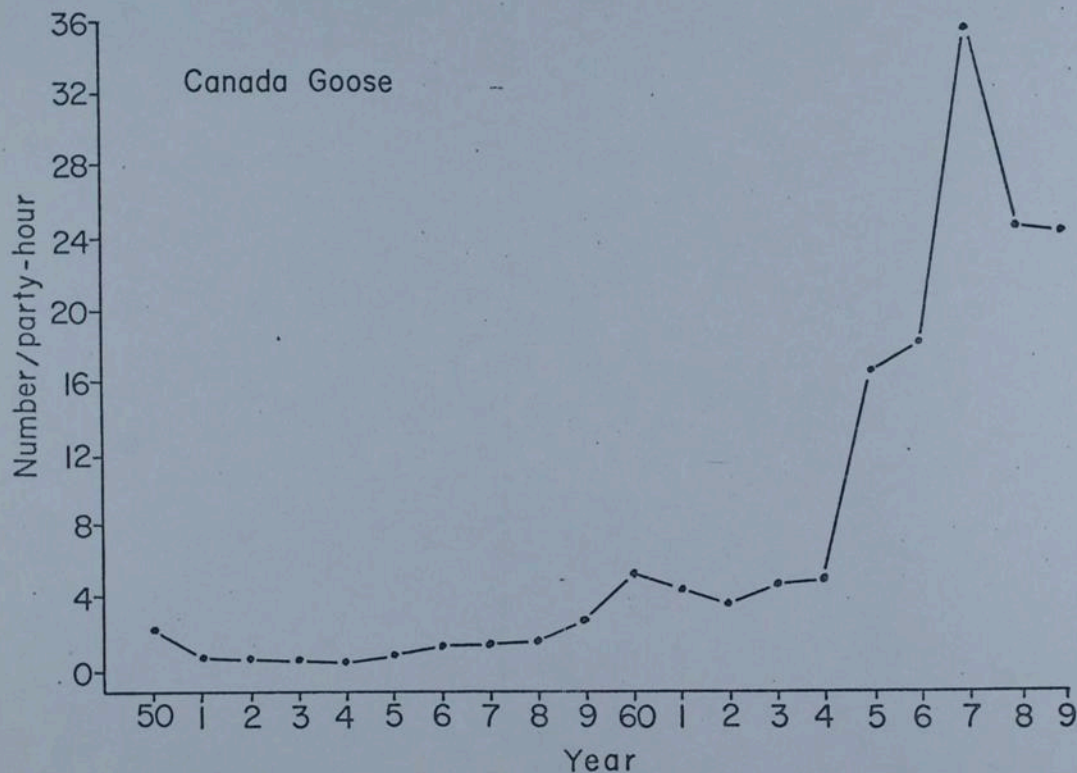


Figure 3. Number of Canada Geese counted in Colorado from 1950 to 1969.

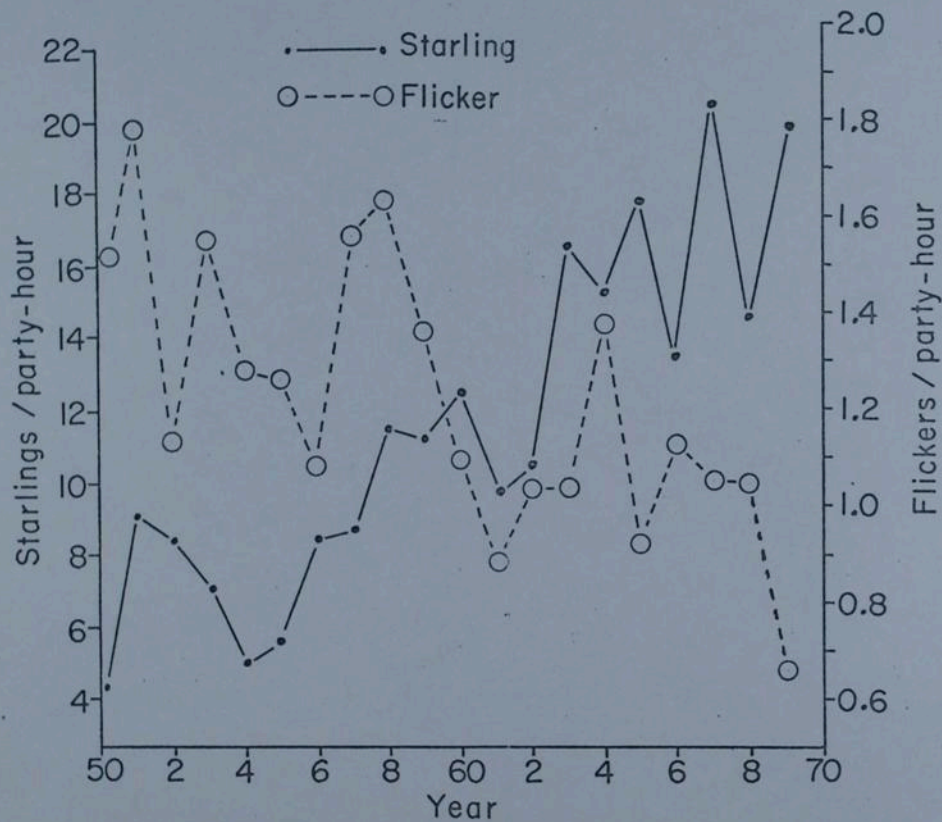


Figure 4. Starlings and Flickers counted in Colorado from 1950 to 1969.

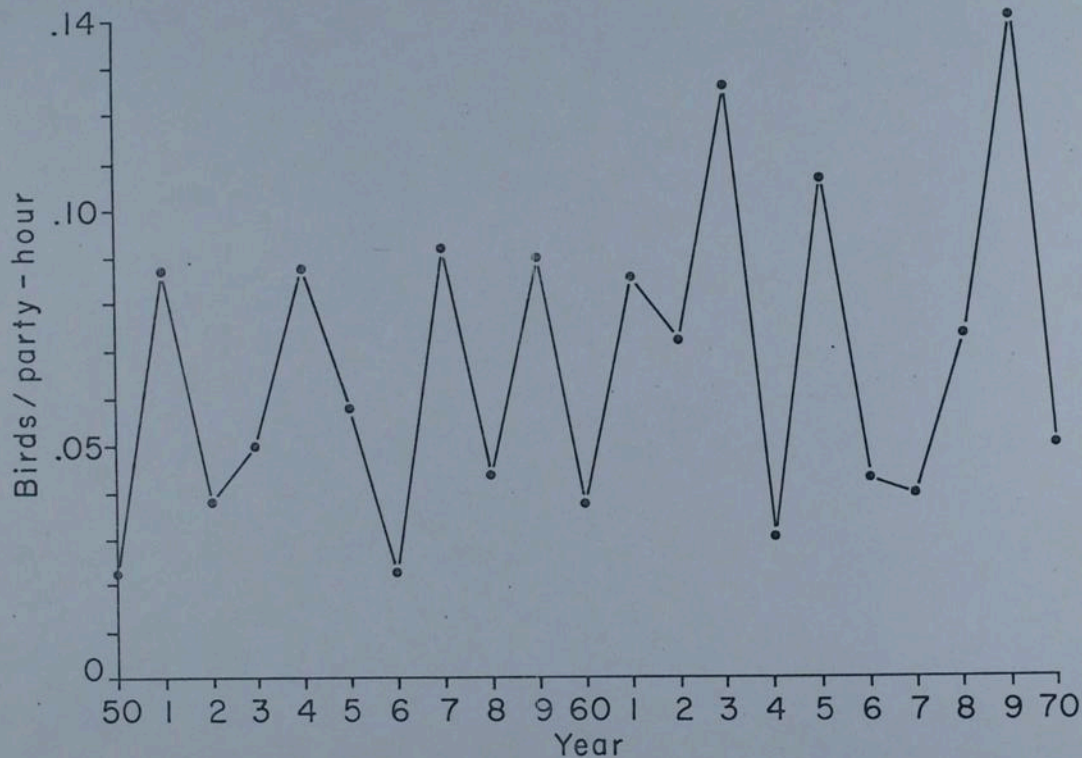


Figure 5. Numbers of Red-Breasted Nuthatches counted per party-hour for all states and provinces, 1950 to 1970.

57, 59, 61, 63, 65, 68, and 69, with very little movement in intervening years (Figure 5). These flights, according to the data, have been nearly continent-wide, yet they remained generally undetected until the Christmas Counts were analyzed.

The Nuthatch invasions seem to be correlated with northern conifer cone-crop failures, although data are scarce on this point. A literature search suggests that other boreal cone-seed-eating bird species may invade in the same years as the Red-Breasted Nuthatch. It would be extremely interesting to analyze the counts for all of these species. This indicates the value of getting all count data into an information retrieval system.) Manual extraction and compilation of twenty years' nuthatch data alone required some 250 man-hours of work; we have not yet had the opportunity to analyze more species. If, however, we could simply tap a computer data bank for this information, the picture for a dozen boreal forest species could be obtained in a few hours' (or minutes') time.

3. Limitations of the Data. There are a number of inherent sources of error in Christmas Count information:

- a. Weather conditions can seriously influence the number of birds which are active on any particular day, to say nothing of the enthusiasm of observers.
- b. The skill and experience of the observers varies greatly.
- c. Some observers record birds seen at feeding stations, giving unrealistically high counts.
- d. It is difficult to estimate accurately the number of birds in large flocks.
- e. The Colorado study, for example, shows the need for continuity in count locations and a fair number of counts in any area.

What our pilot projects suggest is that the great mass of the count data compensates for these sources of error -- that is, given enough counts each year the errors will cancel each other out.

There are of course, some things which count data can never do. They give no indication of absolute density, only the relative numbers present from year to year or place to place. Since some species are much more readily seen than others, between-species comparisons are not always meaningful. For example, it would not be valid to conclude from Table 1 that the Red-Winged Blackbird has been more than forty times as abundant as the Pygmy Nuthatch in Colorado over the past twenty years, since the blackbird is much

more easily observed and occupies a habitat occurring more frequently in count areas. However, the data for the three species of nuthatch (Table 1) are certainly comparable, since all occupy similar habitats (in Colorado) and are about equally conspicuous.

A point to emphasize here is that once Christmas Count data are computerized a researcher can be as general or as exacting with the data as he chooses. He can calculate all birds observed per party-hour per year everywhere, but he also has the option, for example, of computing the number of a particular species observed only for those counts north of a specified latitude, containing certain habitat types, and conducted under specified weather conditions. With these options available it is obvious that the counts would be extremely valuable. What remains is to get the data into such a usable form. The next section discusses an information retrieval system currently in operation at the University of Colorado which we believe can do this.

C. The TAXIR Information Retrieval System

The computer is a fast and efficient means of handling large bodies of information, but it is frequently costly both to code data in a manner acceptable to a computer and to develop a system of programs to manipulate and retrieve data. Fortunately there already exists at the University of Colorado a fully developed and highly efficient information retrieval system designed for biological problems.

The Taxonomic Information Retrieval System (TAXIR) was developed at Boulder in the late 1960's. TAXIR, like any information retrieval system, serves two functions. As Rogers noted (1969:147):

It must serve as a repository for information, and as an accessioner to abstract from the repository [certain selected subsets of] the information stored there. As the name implies, one of these functions is a passive one, to serve as a resting place for information, while the other of these functions is active, to abstract from the repository some of the information that is there.

TAXIR allows four types of "descriptors" (= ways of describing) for the objects to be entered into the data bank (in this case the "objects" would be Christmas Counts). For each descriptor there exists a given range of expression taking the form of a list of "descriptor states."

1. Named descriptors: The name may be any combination of letters or numbers up to ninety characters in length.

Example: Descriptor = town or area

States = Buffalo
Cortland
Schenectady
Watertown
etc.

2. Coded descriptors: Numeric codes, 1,2,...,n, for names which are often used or too cumbersome to write out for each entry.

Example: Descriptor = precipitation

States = 1 (= snow in AM)
2 (= snow in PM)
3 (= rain in AM)
etc.

3. Ordered names: Used when it is convenient to list names in a prescribed order.

Example: Descriptor = month

States = Jan
Feb
Mar
etc.

4. "From-to" descriptors: For use in describing numeric properties of objects (this will be by far the most common type of descriptor used for the Christmas Counts).

Example: Descriptor = number of observers

States = from 1 to 200

The "from-to" descriptor can optionally contain units of increment and labels.

Examples: 1) Descriptor = temperature

States = from -30 to 90
by 1 (= increment)
in °F (= label)

2) Descriptor = Starling

States = from 10 to 100,000
by 10 (= increment)
in "Starling" (= label)

The versatility of this set of descriptors is obvious. Nearly any object, and certainly all Christmas Counts, can be described in this manner. The examples given below are taken from a pilot study in which data from 1947 to 1970 for five count areas in New York State were coded into a TAXIR data bank.

Data are entered into the TAXIR system in "free field format," meaning that the location of the information on punched cards is fixed by order but not by position on the card, and that all labels are removed. The labels are not "lost," but are already contained by the system, which will reattach them when they are retrieved. Data are separated by commas, and TAXIR identifies each piece of information by the commas which bracket it (e.g., the "state" for descriptor 39 lies between the 38th and 39th commas for each count). What all this means is that data entered into the bank consist of names and/or numbers separated by commas, and TAXIR "knows" what each name or number represents by counting the number of commas preceding it in each count. This storage technique allows for great compaction of data, and saves both time and space. Figure 6 is an example of the 1949 Buffalo, N. Y., Christmas Count in acceptable free field format for TAXIR.

Editing and correcting of the coded data are accomplished by another program which counts commas and replaces the labels which coding removed. The output for the editing program is then compared to the original published version of the Christmas Counts, and errors, if present, are corrected. After each correction is made the data are again run through "edit." This process detects both coding and keypunching errors simultaneously, eliminating the need for costly "verification" of cards. Figure 7 is a printout from the editing program, with labels attached, of the coded data shown in Figure 6.

Once the data have been coded, the TAXIR system builds a data bank. The actual form of the bank is a matrix of binary digits and associated tables containing the labels and names. When the data bank is complete it is necessary to generate a "control vocabulary" which contains a listing of "descriptor" names, all possible states for those descriptors, and the number of printout spaces required for the largest possible printed output. The control vocabulary is completely user-specified, and is usually different for each data bank. Figure 8 is a part of the "control vocabulary" for the New York pilot study.

"Querying" a data bank is done by constructing a command in TAXIR language which specifies a) what information is desired for retrieval,

49,NY,BUFFALO,20,40,3,,,12,20,5,,,,,,,,,DEC26,60,70,0,8,15,4,14,1,48,17,126,,,48
 9,146,343,,1,3,4,2,1,,5,,2,,188,1209,12,,,,,7,2033,3,2988,3,2733,,270,,,59,,5,
 ,1,3179,67,11,,,,,1,30,27,15,,,,,43,,,,,137,,6,,,,,,1,,29,7401,287,,1894,,4,
 31,7,3,,7,1,,2,,,,,10,66,,1,26,,192,158,,,,,35,1,32,,,,,2,,,1,,,,,1832,779,5,
 9,6,1,20,,,,,1,2,,,,,,56,689,3,,6,,,65,26644*

Figure 6. TAXIR-coded Christmas Count -- Buffalo, N. Y., 1949.

YEAR	49	MARSH HAWK	30
STATE	NY	ROUGH LEGGED HAWK	27
CITY OR AREA	BUFFALO	RED TAILED HAWK	15
\$DECIDUOUS WOOD	20	SPARROW HAWK	43
\$FIELD AND PASTURE	40	RING NECKED PHEASANT	137
\$SWAMP AND MARSH	3	BLK CROWN NITE HERON	6
\$TOWNS	12	GLAUCOUS GULL	1
\$RIVERS AND HARBORS	20	BLACK BACKED GULL	29
\$CITY PARKS	5	HERRING GULL	7401
DATE	DEC26	RING BILLED GULL	287
TIME START	60	BONAPART GULL	1894
TIME FINISH	70	ROCK DOVE	4
DEGREE OVERCAST	0	MOURNING DOVE	31
TEMP LOW	8	SCREECH OWL	7
TEMP HIGH	15	GREAT HORNED OWL	3
WIND LOW	4	SHORT EARED OWL	7
WIND HIGH	14		
SNOW DEPTH	1		
NO OF OBSERVERS	48		
NO OF PARTIES	17		
TOTAL PARTY HOURS	126	BARN OWL	1
TOTAL PARTY MILES	489	BELTED KINGFISHER	2
ON FOOT MILES	146	HAIRY WOODPECKER	10
IN CAR MILES	343	DOWNY WOODPECKER	66
PRECIPITATION	1	HORNED LARK	1
TIME OF PRECIP	3	BLUE JAY	26
DEGREE OF PRECIP	4	COMMON CROW	192
COMMON LOON	2	BLACK CAP CHICKADEE	158
RED THROATED LOON	1	WHITE BREAST NUTHATCH	35
HORNED GREBE	5	RED BREAST NUTHATCH	1
DBL CREST COMORANT	2	BROWN CREEPER	32
MALLARD	188	ROBIN	2
BLACK DUCK	1209	GOLD CROWN KINGLET	1
PINTAIL	12	STARLING	1832
READ HEAD	7	HOUSE SPARROW	779
CANVASBACK	2033	EASTERN MEADOWLARK	5
RING NECKED DUCK	3	RED WING BLACKBIRD	9
GREATER SCAUP	2988	RUSTY GRACKLE	6
LESSER SCAUP	3	BROWN HEAD COWBIRD	1
COMMON GOLDENEYE	2733	CARDINAL	20
BUFFLEHEAD	270	PINE SISKIN	1
OLDSQUAW	59	AMERICAN GOLDFINCH	2
WHITE WING SCOTER	5	SLATE COLOM JUNCO	56
RUDDY DUCK	1	TREE SPARROW	689
COMMON MERGANSER	3179	WHITE THROAT SPARROW	3
RED BREAST MERG	67	SONG SPARROW	6
HOODED MERGANSER	11	TOTAL SPECIES	65
SHARP SHINNED HAWK	1	TOTAL INDIVIDUALS	26644

Figure 7. Printout from the edit program of the 1949 Buffalo, N. Y., Christmas Count.

1. YEAR
 NO. OF CHARACTERS IN LONGEST STATE: 7
 OPTION: ORDER NO. OF STATES: 81
 FROM 0
 TO 80
 BY 1
 IN YEAR

2. STATE
 NO. OF CHARACTERS IN LONGEST STATE: 3
 OPTION: NAME NO. OF STATES: 1
 NO. OF DELETED STATES: 0
 NO. OF DICTIONARY ENTRIES RESERVED: 50
 NY

3. TOWN OR AREA
 NO. OF CHARACTERS IN LONGEST STATE: 76
 OPTION: NAME NO. OF STATES: 5
 NO. OF DELETED STATES: 0
 NO. OF DICTIONARY ENTRIES RESERVED: 100
 BUFFALO
 CORTLAND
 HAMBURG-E. AURORA
 SCHENECTADY
 WATERTOWN

4. \$DECIDUOUS WOOD
 NO. OF CHARACTERS IN LONGEST STATE: 13
 OPTION: ORDER NO. OF STATES: 100
 FROM 1
 TO 100
 BY 1
 IN \$DECID WD

38. PRECIPITATION
 NO. OF CHARACTERS IN LONGEST STATE: 6
 OPTION: CODE NO. OF STATES: 3
 1. SNOW
 2. RAIN
 3. SLEET

39. TIME OF PRECIP
 NO. OF CHARACTERS IN LONGEST STATE: 7
 OPTION: CODE NO. OF STATES: 4
 1. AM ONLY
 2. MIDDAY
 3. PM ONLY
 4. ALL DAY

Figure 8. A portion of the control vocabulary used in the New York pilot study.

and b) what locating criteria are to be used. The locating criteria are listed by descriptor and descriptor state, connected by the logical "operators" AND, OR, and NOT. Figure 9 is a sample query from the New York study asking for location, habitat data, weather, and the numbers of certain hawk species sighted, on Christmas Counts in Buffalo or Cortland, with snow and moderate winds.

Using only the logical operators AND, OR, and NOT, it is possible to specify $2^{24,000}$ different subsets of the Christmas Count data, not all of which would be useful or interesting, but which demonstrate that any logical combination of descriptors and states can be utilized as locating criteria.

Currently there are available two types of output from the TAXIR system. One is printed output as shown in Figure 9. The other is a tape containing all numeric information suitable for statistical analysis and input into graphing and mapping programs. The statistical package is already functional and the mapping and graphing programs are under development. These will be essential for analysis of the data.

II. Objectives

The objectives of this project will be as follows:

1. Enter Christmas Count data into TAXIR information retrieval system.
 - a. Code data.
 - b. Key punch data.
 - c. Verify data (= edit program).
 - d. Build data bank.
2. Develop and utilize manipulative programs for retrieved data.
 - a. Numerical conversion and treatment of data (e.g., conversion to "birds per party-hour" and similar measures).
 - b. Statistical analyses (already available through University of Colorado Computing Center).
 - c. Graphing of results.
 - d. Distribution mapping.
3. Conduct a series of studies to show the applicability of the data bank to ornithological and ecological problems.
4. Make data system available to the general scientific community.

ID1 QUERY FOR HAWKS WITH COMPLEX LOCATING CRITERIA

DATE 01/13/72

PRINT: (YEAR, STATE, TOWN OR AREA), (\$LAKE, \$RIVERS AND HARBORS), (DATE, TIME START,
TIME FINISH, TEMP LOW, TEMP HIGH, WIND LOW, WIND HIGH), (SNOW DEPTH, PRECIPITAT
ION, TIME OF PRECIP, DEGREE OF PRECIP), COOPERS HAWK, SHARP SHINNED HAWK, MARSH
HAWK, ROUGH LEGGED HAWK, RED TAILED HAWK, SPARROW HAWK FOR ALL COUNTS
WITH PRECIPITATION, SNOW AND WIND HIGH, FROM 10 TO 20 AND (TOWN OR AREA, BUF
FALO OR CORTLAND)*

NO. OF ITEMS IN QUERY RESPONSE = 9

NO. OF ITEMS IN THE DATA BANK = 102

PERCENTAGE OF RESPONSE/TOTAL DATA BANK = 8.82

48 YEAR NY CORTLAND

10 \$LAKE ---

DEC26 70 TIME START 60 TIMEFINISH 16 TEMP LOW 20 TEMP HIGH 2 WIND LOW 20 WIND HIGH
3 SNOW DEPTH SNOW ALL DAY INT LIGHT

1 SHRPS HAWK

3 REDTL HAWK

1 SPARROW HK

49 YEAR NY BUFFALO

20 \$RIVER+HAR

DEC26 60 TIME START 70 TIMEFINISH 8 TEMP LOW 15 TEMP HIGH 4 WIND LOW 14 WIND HIGH
1 SNOW DEPTH SNOW PM ONLY INT LIGHT

1 SHRPS HAWK

30 MARSH HAWK

27 PLEA HAWK

15 REDTL HAWK

43 SPARROW HK

49 YEAR NY CORTLAND

10 \$LAKE ---

JAN2 70 TIME START 60 TIMEFINISH 23 TEMP LOW 28 TEMP HIGH 2 WIND LOW 20 WIND HIGH
8 SNOW DEPTH SNOW ALL DAY INT LIGHT

1 COOPR HAWK

4 SPARROW HK

Figure 9. A sample query and partial printout from the New York pilot study.

III. Procedures and Work Timetable

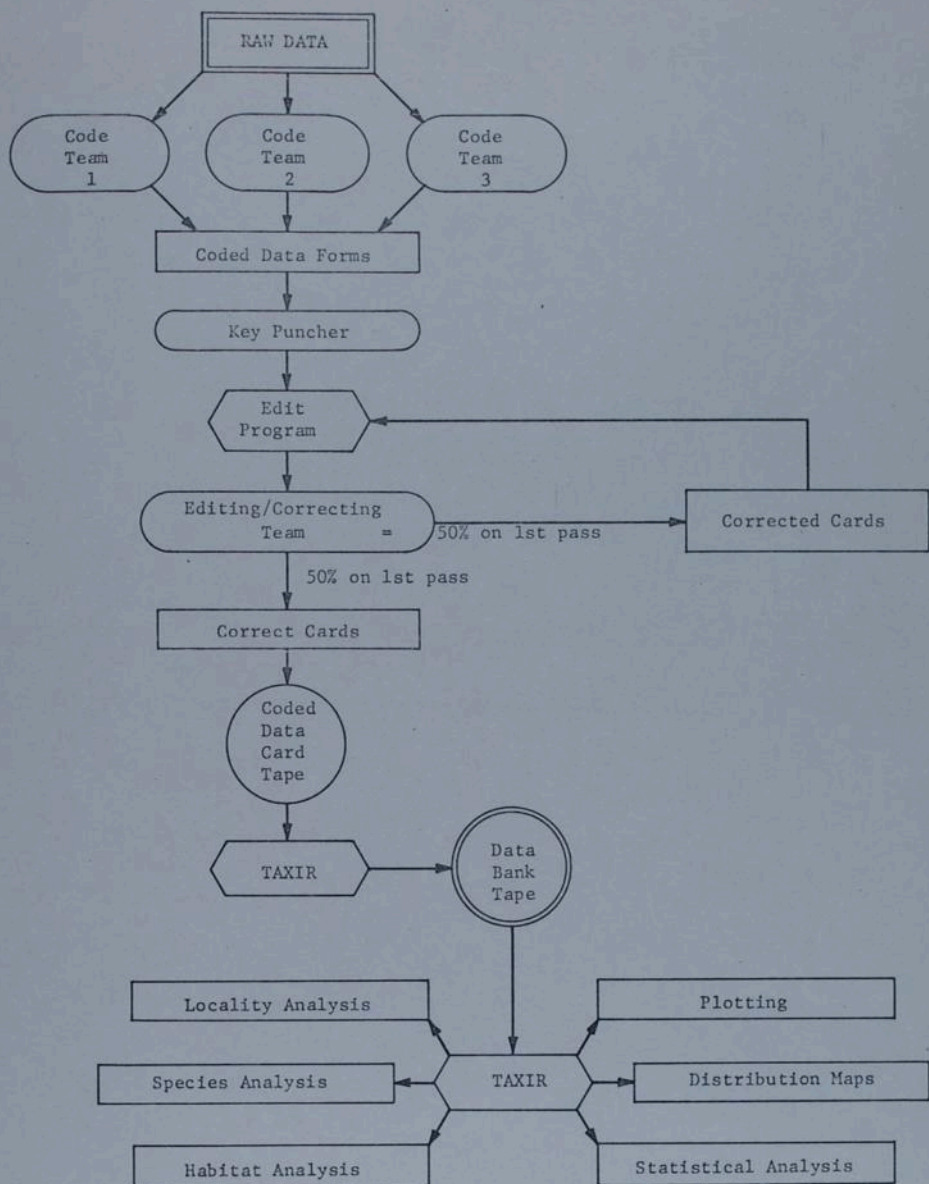
The accompanying flow chart shows the various steps needed to take raw Christmas Count data through coding, into a data bank, and through various sorts of analyses. Coding will be the most time-consuming task; therefore we have planned for three "coding teams" consisting of two individuals each. These teams will convert data into the free field form adapted to TAXIR, using pre-printed data forms. A keypuncher then punches the coded data onto computer cards. Using the "edit" program (see above), a printout with labels attached is generated. It is expected that about 50 percent of the coded counts will be correct on each pass through the edit program.

Any desired analysis of the data bank will require very little time compared to the preceding steps, since it can be done entirely by the computer. An almost endless variety of analyses can be performed using the TAXIR output tape with numeric information (see above). For example, it will be possible with appropriate queries, simple arithmetic manipulations, and a "graph" program to plot the number of any species observed per party-hour per year for all counts, or only those counts containing certain "descriptor states" (e.g., warm weather, a particular region of the continent, a minimum of ten observers, etc.). It will also be possible, simply by varying the type of query, to obtain plots for all species in a specific region, or in count areas containing only specific habitat types. The versatility of this system is its greatest virtue.

Based upon the New York State pilot project, we can estimate the labor involved in building a Christmas Count data bank to be approximately as follows:

1. Coding = twenty man-minutes/count (= ten man-minutes per team)
2. Key punching = four man-minutes per count.
3. Editing = six man-minutes/count (= three per team)
4. TOTAL = thirty man-minutes labor per count

There have been roughly 24,000 Christmas Counts since 1900; therefore it should require about 12,000 man-hours of labor (plus time for programming, etc.) to enter these counts into a TAXIR data bank. The budget included in this proposal is based on a plan to accomplish this in 1.5 years (two nine-month periods).



While 12,000 man-hours is a considerable amount of labor, two points deserve mention at this point:

1. This figure is only about 0.5 percent of the field time already expended in gathering the Christmas Count data.

2. Once the data bank is built, it will be convenient and relatively inexpensive to query the data for a very large amount of ecologically and ornithologically significant information. Indeed, it is hard to imagine ever exhausting the possibilities for such analyses. We expect the system to pay for itself after initial expenses if users are charged nominal fees for retrieval of specific information. We hope, for example, that it would become routine for ornithologists to ask for a plot of whatever species they are studying and for ecologists to query counts from their study areas.

This project will begin with the 1970 count and work backwards to 1900. This way, should our time estimates be conservative (and we do not believe they are), the "best" data (i.e., from recent, more comprehensive annual counts) will be entered first into a TAXIR data bank. While the flow-chart indicates that analysis will follow coding and editing, it will be both possible and desirable to initiate studies using the data after the first ten years or so have been completed.

IV. Literature Cited

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- VON HAARTMAN, L. 1971. Population dynamics. In Avian Biology, Vol. I (D. S. Farner and J. R. King, eds.). Academic Press: New York.

V. Personnel Data

Principal Investigator: Carl E. Bock

Education:

A.B., University of California (Berkeley); June, 1964
Ph.D., University of California (Berkeley); September, 1968

Professional Experience:

Associate Chairman, Biology Department, University of Colorado
(1970-)
Assistant Professor, Biology Department, University of Colorado
(1968-)
Teaching Assistant, University of California, (1964-1966)
Research Assistant, University of California (1965)

Fellowships:

Honorary Woodrow Wilson Fellow, 1964-65
NSF Summer Teaching Fellowship, 1966
NSF Graduate Fellowship, 1966-1968
University of Colorado Research Initiation Fellowship, summer 1969

Current Support:

NSF Grant No. GB30917: The relationship of territoriality and food availability to population regulation in the dipper (Cinclus mexicanus).

Amount: \$30,000

Time Period: October 1, 1971 to March 31, 1974

Publications:

- Bock, C.E., and R.E. Johnson 1967. The role of behavior in determining the intertidal zonation of Littorina planaxis Philippi, 1847, and Littorina scutulata Gould, 1849. The Veliger, 10:42-54.
- Bock, C.E. 1969. Intra- vs. interspecific aggression in pygmy nuthatch flocks, Ecology, 50:903-906.
- Bock, J.H., and C.E. Bock 1969. Natural reforestation in the Northern Sierra Nevada - Donner Ridge Burn. Proc. Annual Tall Timbers Fire Ecology Conference; 1969:119-126.
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- Bock, C.E., and R.B. Smith 1972. An analysis of Colorado Christmas Counts. Abstract, Colo.-Wyo. Acad. Sci - AAAS, 1972.
- Bock, C.E., and L.W. Lepthien 1972. Winter eruptions of Red-breasted Nuthatches in North America. Abstract, Cooper Ornithol. Soc., 1972.
- Miller, A.H., and C.E. Bock 1972. Natural history of the Nuttall woodpecker at the Hastings Reservation. Condor, in press.
- Norris, D.O., and C.E. Bock 1972. Age and condition of two Colorado Brook Trout Populations. Abstract, Colo.-Wyo. Acad. Sci.-AAAS, 1972.

VI. Current Support and Pending Applications

A. Current Support

NSF Grant GB30917, "Relationship of Territoriality and Food Availability to Population Regulation in the Dipper," beginning October 1, 1971 and expiring March 31, 1974. Personal support from this grant consists of one month's summer salary in 1972 and 1973; A.Y. time-commitment: 10 percent.

B. Pending Applications

No other support is currently available for the proposed research. This proposal is being submitted to NSF only.

6/72

NATIONAL SCIENCE FOUNDATION

Research Grant Budget

Institution: The Regents of the
University of Colorado
Boulder, Colorado

Title: Computer Analysis of
Audubon Society Christmas
Bird Counts

Starting Date: January 1, 1973

Duration: Two Years

Principal Investigator: C. E. Bock

	<u>1st year</u>	<u>2nd year</u>
<u>A. Salaries and Wages</u>		
Principal Investigator: C.E. Bock		
7.5% time, 9 mos. A.Y.	\$ 980(1MM)	\$ 1,060(1MM)
50% time, 2 mos. summer	1,405(1MM)	1,515(1MM)
Graduate Research Assistant		
50% time, 12 mos.	4,260(6MM)	4,260(6MM)
Undergraduate Research Assistants (3)		
50% time, 9 mos. A.Y.	5,760(14MM)	5,760(14MM)
Undergraduate Assistants (Work-Study)		
Hourly basis	<u>1,100</u>	<u>1,100</u>
Total Salaries and Wages	13,505	13,695
<u>B. Fringe Benefits</u>		
TIAA: 7% of faculty salaries	165	180
<u>C. Permanent Equipment</u>		
None	-0-	-0-
<u>D. Expendable Supplies and Equipment</u>		
Office and file maintenance supplies	100	100
<u>E. Travel</u>		
None	-0-	-0-
<u>F. Publication Costs</u>		
Page costs and reprints	200	500
<u>G. Other Direct Costs</u>		
Keypunching services	4,500	4,500

	<u>1st year</u>	<u>2nd year</u>
Other Direct Costs Continued:		
Computer costs: CDC 6400 @ \$60/hr. peripheral time, \$300/hr. central processing	\$ 3,500	\$ 3,500
Printing of data-coding forms	<u>300</u>	<u> </u>
Total Other Direct Costs	8,300	8,000
H. <u>Total Direct Costs</u>	22,270	22,475
I. <u>Indirect Costs</u>		
On campus: 41% of Salaries and Wages	<u>5,535</u>	<u>5,615</u>
J. <u>Total Costs</u>	<u>\$27,805</u>	<u>\$28,090</u>

TOTAL REQUESTED FROM NSF FOR TWO YEARS: \$55,895

This institution will cost-share in compliance with NSF policy.

UNIVERSITY OF COLORADO PARTICIPATION

	<u>1st year</u>	<u>2nd year</u>
A. <u>Salaries and Wages</u>		
Principal Investigator: C.E. Bock 7.5% time, 9 mos. A.Y.	\$ 980(1MM)	\$ 1,060(1MM)
B. <u>Fringe Benefits</u>		
TIAA: 7% of faculty salaries	70	75
C. <u>Tuition Waiver*</u>		
Graduate Research Assistant	470	470
D. <u>Indirect Costs</u>		
On campus: 41% of Salaries and Wages	<u>400</u>	<u>435</u>
Totals	<u>\$1,920</u>	<u>\$2,040</u>

TOTAL C.U PARTICIPATION FOR TWO YEARS: \$3,960

*The University waives the difference between out-of-state and in-state tuition for research assistants. The average cost of such waivers for all research assistants is \$470 per research assistant per year, which is shown as a University contribution. This amount will be adjusted periodically to reflect actual experience.

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

February 17, 1971

Dr. David Rogers
Department of Botany
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. Rogers:

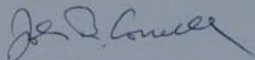
The National Science Foundation has received the enclosed request for research support. In view of your experience and interest in this general area, we would greatly appreciate your assistance in the evaluation of this proposal. A brief critical review would be valuable to us in determining its final disposition.

The fact that you reviewed the proposal will be held confidential, and your evaluation will not be shown to the applicant. However, it is often helpful to pass on suggestions and criticisms to applicants. Unless you request otherwise, we may transmit certain of your comments anonymously, in summary or paraphrased form.

Enclosed with the proposal are rating sheets (one copy to be returned and one for your files) and a postage-paid return envelope. The proposal itself need not be returned.

Many thanks for your help in this matter. The review would be most helpful to us if the rating sheet could be returned by the date indicated.

Sincerely yours,



John B. Cornell
Program Director for
Anthropology

Enclosures

PLS0338, Berlin

DIVISION OF SOCIAL SCIENCES
NATIONAL SCIENCE FOUNDATION
PROPOSAL RATING SHEET

Please evaluate this proposal for scientific merit including the competence and potential of the investigator(s). Comments are also solicited on the appropriateness of the budget for carrying out the work proposed. An overall rating for merit as well as a brief discussion will be appreciated.

Proposal No.: PI 80338-A
Investigator: Berlin - Patton
Institution: U California (B)
Please return
if possible by:

Comments (Continue on additional sheet if necessary)

This is an excellent proposal. It is in a much needed area, and should prove highly significant to improve our knowledge of the South American Amazonian biota (including man).

The amount of information to be gathered is quite ambitious. I agree that the types of information are valuable, but wonder whether the time allotted to this work will be sufficient to accomplish even half of the stated objectives. I am disturbed that no mention is made of the use of information retrieval systems as a means of keeping, retrieving, and correlating the various data.

I am glad that Dr. Ferreyra is an integral part of the team. His knowledge of the Peruvian flora is outstanding. I am not certain that he has been allotted sufficient time to get appropriate samples of the cultivars of manioc, along with other samples of the flora. A special technique is required to provide documentin herbarium materials necessary to differentiate between the 25 cultivars which Berlin mentions are being used in one field. From my experience, many other cultivars will be found when he begins field work. Since manioc is the primary food source, it is extremely important that the best possible documentation be made in this study.

I may have missed the point, but I am not as surprised as the PI that the local people have produced a fairly sophisticated folk taxonomy. Most such people are more cognizant of their local environment than are "sophisticated" people who live in cities. I doubt that the information gained from studying their taxonomy will be particularly useful in modifying a botanical classification, but it can be useful in the general context of the ethnology of the people.

OVERALL RATING

- ☒ EXCELLENT
☐ VERY GOOD
☐ GOOD
☐ FAIR
☐ POOR

Signature of Reviewer:

Institution

David J. Rogers
Dept. of Biology
University of Colorado
Boulder, Colo. 80302

RESEARCH PROPOSAL SUBMITTED TO THE NATIONAL SCIENCE FOUNDATION

by

The University of California, Berkeley
Berkeley, California, 94720

TP1S0338

Ethnobiological Aspects of Tropical Forest Adaptation in Amazonian Peru

Principal Investigator (correspondent)

Brent Berlin, Ph.D.
Associate Professor of Anthropology and
Co-Principal Investigator,
Language-Behavior Research Laboratory

Department of Anthropology
University of California, Berkeley
Berkeley, California, 94720

Social Security No. 455-54-0090

Co-Principal Investigator

James L. Patton, Ph.D.
Assistant Professor of Zoology and
Assistant Curator of Mammals,
Museum of Vertebrate Zoology
University of California, Berkeley

Senior Scientific Collaborator

Ramón Ferreyra, Ph.D.
Professor of Systematic Botany and
Director, Museo de Historia Natural,
Universidad Nacional Mayor de
San Marcos, Lima, Peru

This is a New Request to NSF

Desired starting date: May 1, 1971

Proposed duration: 24 months (over a
39 month period)

Amount requested: \$ 218,600

Endorsements

Principal Investigator

Brent Berlin, Ph.D.
Associate Professor of Anthropology

Co-Principal Investigator

James L. Patton, Ph.D.
Assistant Professor of Zoology

Burton Benedict, Ph.D.
Chairman, Department of Anthropology

Oliver P. Pearson, Ph.D.
Director, Museum of Vertebrate
Zoology

Paul Kay, Ph.D.
Principal Investigator,
Language-Behavior Research Laboratory

Lincoln Constance, Ph.D.
Director, University Herbarium

For the University

Loy L. Sammet
Vice Chancellor - Research

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	1. Report of Principal Investigator to the Wenner-Gren Foundation for Anthropological Research of first pilot survey work in Amazonian Peru.	
	2. Universal Nomenclatural Principles in Folk Science. Paper read at the 68th Meeting of the American Anthropological Association.	

I. Abstract of the Proposal

Building on the results of more than six years of research in the area of botanical ethnography by the principal investigator, he and his colleagues propose to initiate basic ethnobiological research among the Aguaruna, a Jivaroan speaking people residing along the Upper Marañón River and its many tributaries in Northern Amazonian Peru. The major focus of the study will aim at (a) firmly establishing the relationship of a primitive people's ethnobiological knowledge of both the flora and fauna in a biologically rich environment to cultural adaptation in the tropical forest setting; (b) testing recent hypotheses concerning the nature of principles of classification of the natural world by pre-scientific peoples which promise to reveal universal mental processes common to all mankind; and (c) increasing our knowledge of tropical biota and ecosystems at a time when such research is absolutely essential. This compilation of basic information will not only allow for our increased understanding of tropical environments but hopefully will as well provide suggestions for their intelligent use by man.

II. Research Proposal: Ethnobiological Aspects of Tropical Forest Adaptation in Amazonian Peru

A. Purpose

For the last six years, and with the support of the National Science Foundation through grants GS-383, GS-1183 and GS-2280, the principal investigator and his collaborators have been exploring the nature of native botanical knowledge among the Tzeltal, a Mayan people of Highland Chiapas, Mexico (Berlin, Breedlove and Raven 1966, 1968, in preparation). Out of this work has grown not only a more thorough knowledge of a particular cultural system of plant classification and utilization but, as well, hypotheses concerning the nature of primitive man's conceptualization of the natural world which appear to be highly general if not universal (see Appendix 2 and Berlin 1969, 1970, in preparation, n.d.; Berlin, Breedlove and Raven n.d.; Berlin, Breedlove, Laughlin and Raven in press; Berlin and Kay in preparation; Kay in press; Hunn n.d.; Werner in press).

Having obtained a rather thorough, first-hand knowledge of one aspect of ethnobiological understanding in a particular society, it now appears especially fruitful to gain an equally detailed comparative appreciation of the ethnobiology of a different culture. Such a comparative view would allow for the building of a larger, more detailed, data base one which the validity of hypotheses relating to pre-scientific man's adaptation to the Tropics could be tested.

Furthermore, by selecting a society in the American Tropics, our knowledge of man in this critical area of the world would be greatly increased. For while there are a few ethnobiological studies of pre-scientific man's adaptation to the forest of the Indo-Malayan Rain Forest Formation (e.g., Conklin 1954, 1957; Bulmer 1967; Bulmer and Tyler 1969) as well as the African Tropics (e.g., Dieterlen 1952; Grialule 1941; Turnbull 1961), no systematic ethnobiological study has ever been attempted for a primitive society in the American Tropics, the largest continuous mass of Rain forest in the world and perhaps the most poorly known. The proposed research is perhaps unique in that it

proposes to describe fully both the ethnozoology and the ethnobotany of a particular society in the American Tropics and the interrelationships of these two critical domains of the natural world to aboriginal man's adaptation to his environment.

Finally, it is apparent to many anthropologists, ecologists and biologists "...that our knowledge of the ecology of man in South America, in spite of some remarkable advances over the last 20 years, is pitifully inadequate and very much fragmentary. In view of the fact that the pace of change is growing faster from year to year altering the lives and cultures of even the most isolated groups and threatening some of these with complete extinction...it becomes imperative to organize multidisciplinary teams of research workers to study the ecology of such groups in South America...in order to fill some of the gaps in our knowledge before it is too late" (Lowenstein 1969:409). There can be no question that such knowledge can be of major relevance to modern man--given his renewed (if belated) concern with his natural environment and how to wisely utilize what is left of it. As pointed out in the recent anthropological report to the Organization for Tropical Studies, the study of man's adaptation to the tropical setting is one of the most pressing and challenging tasks of science in the next decade (Keslin 1970). The proposed project would combine the skills of specialists from the disciplines of anthropology, linguistics, zoology, botany and food science in a truly collaborative effort aimed at exploring the complete ethnobiological knowledge of a people residing in one of the most biologically rich areas of our earth.

B. Considerations relevant to the selection of the society and field site.

In selecting a primitive society in the American Tropics well-suited for a long-term and well-rounded ethnobiological study, several critical considerations should ideally be met. Firstly, in order to contribute most effectively to our knowledge of elementary agricultural systems, the society should practice some form of swidden horticulture. On the other hand, it would be maximally revealing, in light of comparative work in other areas of the world, if the society's primary stable crop were not corn (Berlin, Breedlove and Raven, in preparation), rice (Conklin 1957) or yams (Barrau 1957). Several aboriginal societies in Tropical South America satisfy this criterion in that the cultivation of manioc constitutes the major food crop. Along with the importance of horticulture, an ideal society would also be one which places a good deal of emphasis on its relationship with the zoological world, a major portion of time and energy being devoted to the hunting of wild game and fishing.

Secondly, the biological richness in which the society finds itself should ideally be maximally diverse, presenting as varied an array of both plants and animals as possible to the aboriginal tropical forest dweller. The society's conceptualization of this complex biological environment should provide much information concerning opportunities and restricting factors relating to its ability to effectively exploit the natural resources of the tropical Rain forest.

Thirdly, in an effort to understand the relationship of ethnobiological knowledge to cultural adaptation of pre-scientific man, the society should be little influenced by Western culture and technology. However, the responses of a technologically inferior society to impinging civilization in the tropical forest areas of the New World, especially as it affects their means of subsistence, should be of considerable interest to the student of cultural change.

Fourthly, it would be advantageous in selecting a group for study if some ethnographic and linguistic work had been already accomplished, reducing the time required to begin serious study and ultimately making the combined effort of collaborative research considerably easier.

After considerable time spent in searching the literature and in personal consultation with colleagues knowledgeable of South American tropical forest ethnography, the principal investigator has selected the Jivaroan speaking Aguaruna Indians of Northern Amazonian Peru as satisfying most of these above conditions.

During August, 1970, a grant from the Wenner-Gren Foundation allowed the principal investigator to spend approximately one month traveling among the Aguaruna conducting a preliminary ethnobiological survey (see Appendix 1). The following summary, outlining the suitability of this group for ethnobiological research, is based in part on information obtained during this exploratory expedition.

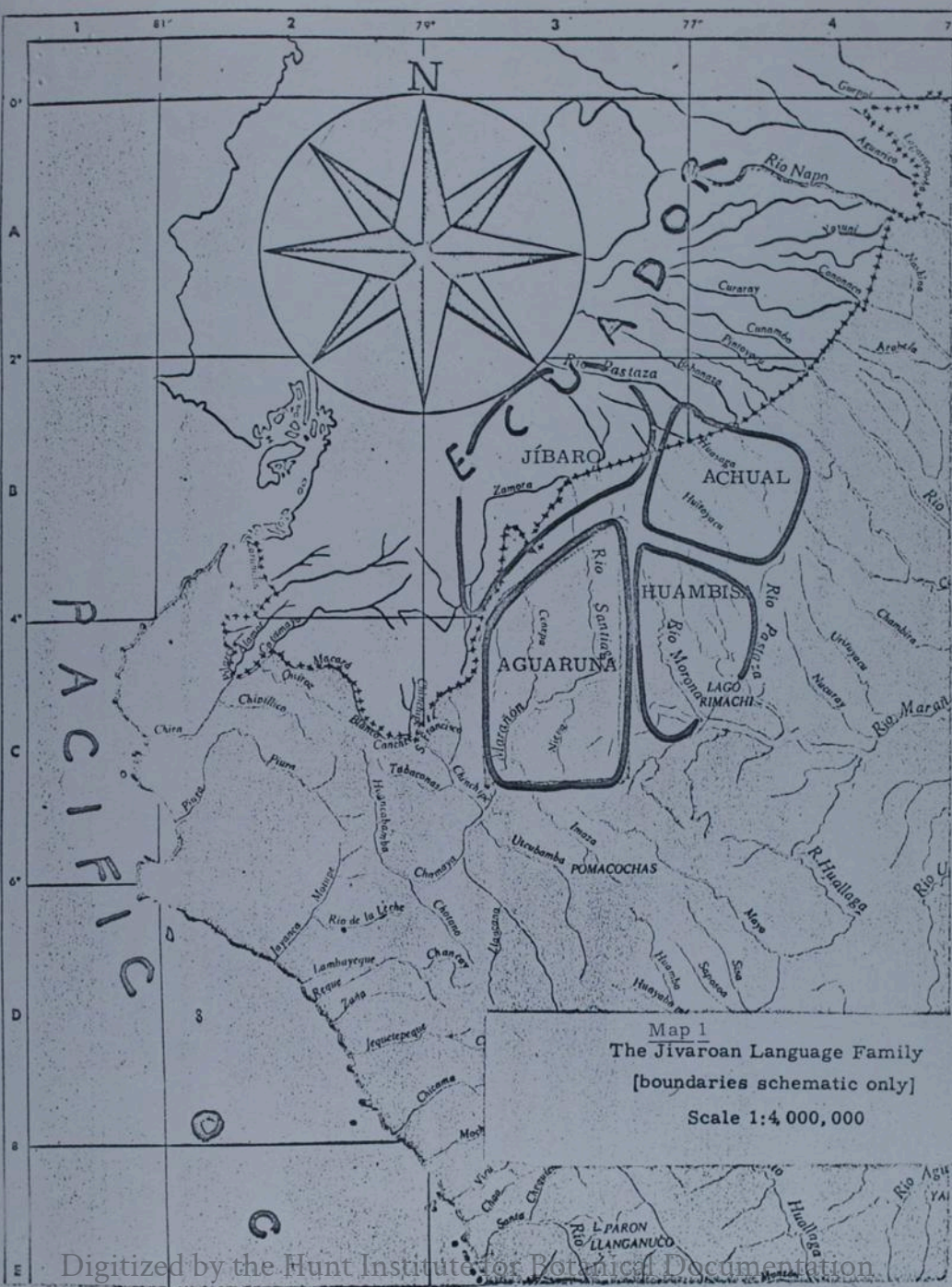
The Aguaruna of Amazonian Peru

The Aguaruna are a little known tribe of primitive horticulturalists residing along the Upper Marañón River and its many tributaries in the department of Amazonas, Peru. Almost nothing is known about their exact numbers, and estimates range from as few as 8,000 to as many as 15,000, making them one of the most populous aboriginal groups in Peru.

Linguistically and culturally, the Aguaruna are considered to be one of the four large tribes which comprise the Jivaroan language family (McQuown 1955). Jívaro proper, the best known and most well studied of the family (Harner 1963, 1970) is found primarily in Ecuador, although some speakers may now reside in northern Peru. Huambisa is a group located in the Northern Santiago River area. Achaul, the third language group, is found between the Santiago and Morona Rivers and their tributaries north of the Marañón. Aguaruna is clearly the largest of the four major tribes and is linguistically thought to be the most divergent (see Map 1).

The region of tropical forest in which speakers of Aguaruna are found is a vast one running from 4° - 6° south latitude to $78^{\circ}30'$ - 79° west longitude. Their area may, in fact, cover no less than 10,000 to 15,000 square miles. Our survey revealed that no large concentrations of Aguaruna are to be found, most members of the tribe being widely dispersed and living in quite isolated extended family dwellings. While the majority of the population reside along the larger rivers and tributaries, many speakers are reachable only by rugged mountain trails covered by dense Rain forest (see Map 2).

The results of this first field session, while admittedly sketchy, indicate clearly that the Aguaruna represent a society where long-term ethnobiological research can be productively carried out. As regards the criterion relating to subsistence activities, the Aguaruna were found to practice an extensive form of swidden horticulture, cultivation of manioc being the society's major staple. Hunting, however, continues to represent a major activity of the Aguaruna male and, as will be pointed out below, is psychologically a central aspect of his role in this society.



Data collected during our short field survey indicate unquestionably that the Aguaruna's appreciation of his complex tropical forest environment is nothing less than phenomenal. A passage from the final report submitted to the Wenner-Gren Foundation illustrates this point:

Walking through dense tropical forest with an Aguaruna guide is a fascinating and awe-inspiring experience. One is quickly provided with a separate distinct name for what appears to be each botanically distinct tree. On numerous occasions, we were presented with a piece of bark taken from a tree that could barely be seen in the dim forest light. Our guide would smell it, taste it, and then firmly provide us with the plant's correct name. From a resting spot on a jungle trail, one Aguaruna informant easily listed names of no less than forty distinct trees visible from his place on a fallen trunk. Reports from the naturalist José Maria Gualart, a Jesuit priest who has resided among these people for fifteen years, indicate that the group recognizes no less than fifty distinctive classes of palms. One recently discovered species of Chamedorea recognized by the Aguaruna proved to be new to science.

Extensive linguistic diversification is found in cultivated plants, many of which are, botanically speaking, a single species. The common sweet manioc, Manihot esculenta Crantz, is cultivated in large quantities. In the brief time available to us, we were able to elicit as many as twenty-five distinct specific names for manioc varieties. While unable to determine the extent to which this knowledge is widely shared by all members of the society, we did ascertain that the classes are reliably recognized by those speakers for whom they apply. The following summary provided the Wenner-Gren Foundation by the principal investigator again substantiates this view more fully:

After having elicited the set of names for kinds of manioc (máma), I instructed my poorly bilingual Aguaruna male informant to ask one of his wives to bring me an example of each kind. I followed her into her manioc plot to observe her as she went about this task. I was amazed to find that all varieties are apparently planted in the same field in a rather haphazard fashion. Nonetheless, walking slowly and examining the stem and leaf characters of the mature plants, the woman recognized the variety in question with ease and brought me a portion of each. She was equally adept in assigning the appropriate name to the tubers of the respective classes regardless of their

striking similarity to the eyes of the untrained ethnographer. Since manioc is rather uniform in its gross morphological characteristics, such differentiation on the part of primitive ethnobotanists will be of considerable interest to the anthropologist interested in perception and classification of the natural world.

The basic taxonomic structure of the Aguaruna plant world appears to conform in many respects to plant taxonomies found in primitive societies elsewhere in the world and provides further evidence on the nature of pre-scientific systems of classification (Berlin, Breedlove and Raven 1966, 1968, in preparation; Berlin n.d., 1969, 1970; Conklin 1954). There is, for example, no single linguistic expression for 'plant' in general. On the other hand, at least three major classes, referring to major life-forms, are recognized linguistically--númi 'tree', daék 'vine' and dápa 'herbaceous plant'. Again, in conformity with primitive principles of classification of the plant world which appear to be highly general, culturally significant and "morphologically aberrant" plants are conceptually treated as separate botanical classes (cf. Berlin, Breedlove and Raven 1968; Berlin, Breedlove, Laughlin and Raven in press). Thus, all palms are given distinct names and are not included in the class 'tree'. Likewise, ferns, epiphytes and other "morphologically aberrant" forms are considered as unique, unaffiliated taxa. All cultivated plants, e.g., manioc, yams, corn, peanuts, etc. are separate taxa regardless of morphological characters which might place them in one of the three major classes.

Nomenclaturally, Aguaruna plant names follow strict linguistic principles which have been suggested elsewhere to be universal (Berlin in preparation, n.d., 1969). Thus, the vast majority of names are monomial generic expressions and only a very restricted set of plant names are binomial specifics. Binomial nomenclature appears to refer to cultivated plants such as manioc, e.g., dáya máma, púmkum máma, úmiy máma, etc.; sweet potato, e.g., káye idáuk, kukúyu idáuk, apáy idáuk, etc., or the like. This finding,

in conjunction with evidence obtained in other research, suggests the following testable hypothesis: Binomial nomenclature will be restricted to organisms which can be shown to have major cultural significance in pre-literate ethnobiological classification.

The Aguaruna knowledge of the zoological domain appears to be as diverse and complex as their appreciation of the plant world. One of the only published studies on Aguaruna ornithological vocabulary (Guallart 1964b) reports at least 151 distinct generic bird names. No less than 1/6 of the total vocabulary published in a small missionary dictionary of the language refers to classes of animals (Larson 1966).

As regards the domain of birds, particularly, tentative evidence from our first survey reveals similarities of ornithological classification which may also prove to be universal among pre-scientific peoples with an intimate knowledge of nature, i.e., the possibility that the classification of bird life by preliterate peoples matches Western scientific taxonomy in an almost perfect fashion (cf. Diamond 1966). Mr. Eugene Hunn, who accompanied the principal investigator on our preliminary expedition, files the following report in this regard:

Very few of the terms elicited for birds appeared in response to more than one species. Therefore, despite our small sample, we might conclude that the Aguaruna terminal taxa correspond closely to the specific level taxa of the ornithologist. The exceptions noted so far (which are examples of "lumping") are curious. Three kingfishers (family Alcedinidae), varying greatly in size, are lumped as cáhi. Two 'shorebirds' (sub-order Charadrii), differing greatly in size, plumage pattern and manner of flight, are both called tiigkig. Two riverside flycatchers are also lumped. These three cases all involved riverside species. A possible explanation: The Aguaruna are not so much 'river people', that is, adapted to living on and off of the rivers, as 'forest people'. Hence, they may have a relative lack of concern for birds restricted to a riverside habitat. Overall, however, it appears that Aguaruna bird names will map more closely with Western biological taxonomy than any ethnobiological domain yet described.

The importance of hunting can also be taken as an indication of the relevance of the zoological world for these people. For the Aguaruna male, hunting continues to occupy a large part of his time and he is apparently introduced to the animal world at a very early age. Guallart (1964b) reports the significance of the first kill to the young Aguaruna boy who must master the use of the blowgun. Our informants took delight in our efforts to collect birds in nets and exhibited intense interest in our attempts to obtain their correct names. The importance of animal hides sold for trading purposes continues to be a major incentive for the hunting of larger mammals. Clearly, much of the efforts of the Aguaruna are spent in activities directly related to their appreciation of the animal kingdom.

As regards the environment in which the Aguaruna reside, one can state that the biological diversity with which this tropical forest society is presented is one of the most complex in the world. Ecologically, the Aguaruna span that rich transition zone connecting the true Amazon Basin with the rugged tropical and subtropical foothill or montana region that lies east of the Andes. The area's biological wealth has, on the other hand, been very poorly described. Very little biological collecting has been carried out in this region and there is no doubt that extensive discoveries of both flora and fauna new to science will result from research here (cf. Lowery and O'Neill 1964).

The Aguaruna have been little acculturated insofar as fundamental changes are concerned. Contact with persons who knew Spanish during the exploratory expedition was minimal and estimates of monolingual speakers of Aguaruna as high as 90 - 95 per cent would not be out of line. Minimal changes in the dress of some individuals, notably males, was observed during the reconnaissance, but this does not appear to indicate a desire to move toward greater participation in Peruvian national culture. On the other hand, some more acculturated Aguaruna have begun to grow peanuts and dry rice, and there is an increased production of bananas as cash products. The effects of these changes on the aboriginal subsistence pattern are not yet known though surely worthy of investigation. Likewise, the demand by Western markets for pelts and certain animals, especially exotic mammals and birds, has resulted in overhunting in

some areas, and there is some evidence that this may be affecting aboriginal settlement patterns.

As regards the criterion of prior studies in the area, it can be said that while the Aguaruna are perhaps as poorly known as any Jivaroan group, some linguistic research has been conducted by the Summer Institute of Linguistics (Larson 1966, Pike and Larson 1964). This material will represent a major starting point in mastering the language, clearly an important attribute of any serious ethnobiological research effort and essential in this particular society.

C. Methodological considerations.

A critical question essential to any ethnobiological study is the following: What are the natural resources, defined by the society in question, that are available for human use, and how are these resources treated? Such a question immediately requires a detailed analysis of man's classification of the natural world, for exploitation of this world is to a large extent dependent on his conceptualization of that environment (cf. Harding 1967:407; Rappaport 1968:237-240; Conklin 1954, 1957, 1969). Ideally, an adequate ethnobiological analysis of any society's relationship to its natural world should specify explicitly the cultural knowledge held by members of that particular society which enables people to behave appropriately in any and all cultural contexts where biological events are of relevance.

Certain systematic procedures developed over the last several years in cognitive anthropology (Frake 1962a, 1962b, 1964; Conklin 1962; Metzger and Williams 1966; Berlin 1968; Percheronck and Werner 1967), cultural ecology (Rappaport 1968, Vayda 1969, Leeds 1969, Conklin 1957, Carneiro 1960, 1961, 1964) and ethnobiology (Berlin, Breedlove and Raven 1968, in preparation; Conklin 1962; Barrau n.d.; Fowler and Leland 1967; Bulmer 1967, n.d.; Bulmer and Tyler 1969; Anderson 1968; Wyman and Bailey 1965) will be employed in carrying out the proposed research. These methods will be utilized to collect ethnobiological data in the following areas of knowledge which are felt to be essential to an adequate ethnobiological description.

a) Detailed collection of the flora and fauna of the natural environment must be made that will allow for complete botanical and zoological determinations of the organisms involved.

b) An exhaustive terminological designation must be elicited, in the native language, of all linguistically designated plants and animals, as well as linguistic information relating to ethnophytography, growth stages, and the like. The native conceptualization of the natural world should be arranged not only in terms of conventional Western biosystematic categories, but also in terms of the folk taxonomic structure discovered to be operative in that particular society. The final description

of the folk classification should specify all those significant ethnobiological contrasts made by the native speaker.

c) A compilation of complete cultural data must be obtained concerning the treatment and utilization of the flora and fauna, including those aspects of the environment which are culturally ignored as well as those which are of major cultural significance. The collection of such information leads one to be concerned with man's relationships to both domestic plants and animals and encompasses such areas of knowledge relating to diet, horticulture, hunting and folk medicine.

Methods to be employed in making a complete survey of the flora and fauna of this area are the well known and proven techniques of field botany and zoology. It is proposed that general botanical collections be made in sets of twelve inasmuch as this region of the American Tropics is so poorly known. The extent of such collecting, while presenting several difficulties to the field worker, will allow large numbers of Amazonian specimens essential for the study of tropical plants to be distributed to the world's major herbaria.

Zoologically, our major efforts at the moment will include detailed collections of mammals, birds, reptiles and fish. At a later period we would hope to initiate collections of insects and related organisms but the difficulty of this task makes it unwise for the present project. Collections will be made, of course, of all insects and related organisms which receive Aguaruna designations.

Procedures to be followed in the description of native ethnobiological classification are similar to those followed in earlier ethnobotanical research supported by NSF grants GS-383 and GS-1183 and reported in Berlin, Breedlove and Raven 1966, 1968, in preparation. Our methods will incorporate the suggestions of others who have worked systematically with ethnozoology (cf., for example, Bulmer 1967, n.d., Bulmer and Tyler 1969, Wyman and Bailey 1965, Anderson 1968). Aguaruna linguistic designations will be obtained for plants and animals from a wide range of informants in an effort to determine variability due to ecological factors. This should be of crucial importance considering the extent of dispersion found to be present for the tribe as a whole.

The use of specimens collected in 'field museums' [see Schedule of Research] will permit experiments on classification, naming, and principles of identification to be carried out with large numbers of Aguaruna informants. The use of these field museums will thus allow for the establishment of conditions similar to those of the psychological laboratory and at least some of the advantages relating to conduct of controlled experimentation can be gained.

Concomitant with the collection of information on classification will be the initiation of a data archive on native treatment and utilization of the flora and fauna, collected both from verbal records in the native language as well as by traditional means of observation in the field situation. A thorough dietary study is planned for the second field session where daily schedules relating to Aguaruna diet will be obtained following procedures outlined by the Interdepartmental Committee for Nutrition in National Development in the ICNND's Manual on Nutrition Surveys (1963).

Information will be collected on such basic topics as food preparation techniques, food habits, nutrient intake levels and sources of nutrients. Dietary information of this sort is scarce for South American Tropical societies and there are no studies which encompass the time span envisioned by the proposed research program. While we are under no false illusions as to the difficulty of collecting reliable nutritional data among primitive peoples, there can be no doubt that information on this topic will be of special importance to studies concerned with illuminating primitive man's adaptation to various climates (cf. Lee 1969, Baker 1964, Mazess & Baker 1964, Winton [1968]).

The complete horticultural cycle will be observed and described and permanent photographic records are planned for this area of human activity (Conklin 1961). Questions relating to such matters as stages of succession (from first cleared field to take-over by dominant forest), methods of plot selection, native principles of soil classification (as they correspond to scientific standards, see Facilities), and so on will be collected (cf. Carneiro 1964).

Insofar as possible, efforts will be made to collect information on native medicine as it relates to folk biology. The importance of such information for the development of modern medicine is obvious inasmuch as aboriginal pharmacological knowledge of plants in the American Tropics has contributed greatly to the development of

several critical drugs (e.g. quinine, curare). We will be prepared to take live plant materials, in sufficient quantities allowing for their adequate chemical analysis, of those plants said to have special medicinal properties.

D. Schedule of research

The time period for which ethnobiological research is proposed among the Aguaruna is twenty-four months. Two separate field periods are planned, the first during the summer of 1971, the second, a full fifteen-month period beginning in the summer of 1972 and continuing until Fall, 1973. The last period of the research will be devoted to analysis and write-up and is planned for the Spring and Summer of 1974.

a) First Field Session: Summer 1971 (three months)

While the Upper Marañón River area of Peru does not have two distinct seasons, a 'rainy' and 'dry' season, the months of June, July and August nonetheless receive less rainfall than other times of the year. As such, the summer months represent an excellent time to establish a semipermanent field base, most likely at Santa Maria de Nieva, located at the confluence of the Nieva River with the Marañón or at Imazita, a Peruvian Army base just north of the confluence of the Imaza and Marañón. Initial collecting will be carried out during this time. Early work on language learning and the training of ethnographic informants will be begun during this period. Efforts will be made to train native Aguaruna informants in methods of botanical and zoological data collection, a procedure which has proved to be highly effective in earlier work on ethnobotany (Berlin, Breedlove and Raven 1968) and ethnozoology (Patton n. d.).

Curating of plant and animal material collected during the first three-month field period will be continued during the academic year of 1971-72 at the Museo de Historia Natural in Lima and at the University Herbarium and Museum of Vertebrate Zoology in Berkeley, although no Foundation support is requested for this period. Ethnographic and linguistic materials collected relating to plant and animal classification, cultural significance and agriculture will also be analyzed during the academic year 1971-1972. Linguistic materials collected for pedagogical purposes will be prepared at this time for use by project personnel in Aguaruna language study.

b) Second Field Session: Summer 1972 to Fall 1973 (15 months)

In June, 1972, a fifteen month field period is scheduled to begin during which the major ethnobiological data collections will be carried out. A transect of the Aguaruna area, essential inasmuch as the total area cannot be covered, will be selected based on information collected by the first field party. The transect will aim at adequately sampling each of the major ecological zones to be found in the area. This period will also allow for observation of Aguaruna subsistence activity through its full cycle and will constitute the major period for collection of data on nutrition.

Collections of both plant and animal materials will be sufficiently large at this time to establish 'field museums' for certain selected groups, especially the more prominent plants and mammals and birds. As indicated earlier, such museums will allow for research on classification, naming and principles of recognition to be carried out in a more-or-less controlled setting.

Collection of linguistic data on Aguaruna ethnobiological knowledge will be begun on a large scale, with several Aguaruna informants being taught to write, an essential aspect in any research requiring the production of large amounts of textual materials.

It is likely that at least two field sites will be developed during this field session, one hopefully near the mouth of the Cenepa and Comaima Rivers. Informants from this area are quite unacculturated, and it is almost unknown biologically.

c) Write-up and Analysis: Spring, Summer 1974 (six months)

Final analysis and write-up of materials collected during the major field session of 1972-73 will be carried out in Berkeley and Lima. While we cannot expect that all biological collections will be fully determined at this time, the six month period separating the last field session from the write-up periods should allow for a major portion of them to be identified.

E. Facilities available for the research

The proposed study represents an international collaborative effort between individual members of the University of California, Berkeley, and the Universidad Nacional Mayor de San Marcos, Lima, Perú. In addition to scientists from these two institutions, the field party will consist of individual members of Louisiana State University and the Los Angeles County Museum of Natural History. Personnel from these other institutions will be on leave from their respective organizations and those for whom support is requested from the Foundation will be employed on the proposed research project by the University of California while actually working on the project.

Principal facilities at the University of California of California include the Language-Behavior Research Laboratory, a research organization devoted to the study of the importance of language in its cultural and social setting, the University Herbarium, the University Botanical Garden and the Museum of Vertebrate Zoology. Determinations of plant materials will be greatly simplified in that the University Herbarium has extensive collections of Peruvian plants due largely to the efforts of faculty in the Department of Botany who have strong interests in the Peruvian flora. Likewise, the Museum of Vertebrate Zoology has had a long history of work in Peru and is well equipped to handle animal collections resulting from the research. The facilities of the Los Angeles County Museum, especially those relating to the curating of fish and reptiles, will be available to us as well as the Museum of Zoology at Louisiana State University which has one of the best collections of Peruvian birds in the world due, in large part, to the research of one of the participating Research Associates. Each of these research organizations has offered its facilities and will fully participate at all periods of the research, but especially during the later stages when analysis and distribution of plant and animal material to specialists is required.

In Lima, the Museo de Historia Natural will represent an essential and critical link in the research process, its Director, Dr. Ramón Ferreyra, being on the project. A special section of the Museo will be constructed at the Museum's

expense and set aside for storage and initial sorting and labeling of plant and animal collections made in the field.

In Amazonia proper, we will be able to rely on the cooperation of Dr. Stéfano Varese who, as Director of the Centro de Investigaciones de Selva del Instituto Raúl Porras Barrenechea, is also conducting research among the Aguaruna. The results of our project should contribute in a complementary way to Dr. Varese's who is interested in the effects of the Peruvian Government's recent colonization plans for the jungle on its aboriginal inhabitants. Dr. Varese's aid in procuring permission from Peruvian government officials, especially the Military, will be of importance in allowing freedom of access into several areas near the Ecuadorian-Peruvian border, a region of political dispute where restrictions on movement are great.

The field party will also be aided by the cooperation it can expect from the Jesuit Mission at Santa Maria de Nieva. The Jesuits have been working in the Aguaruna area for many years and have numerous contacts with Aguaruna informants which can be utilized especially during the early stages of research. One Jesuit, Padre José Maria Guallart, is also a trained naturalist and clearly the most knowledgeable person on Aguaruna ethnobiology at the present time (Guallart 1964a, 1964b). In addition, Padre Luís M. Uriarte, also of the Mission at Nieva, is a trained anthropologist and is in fact at this time engaged in ethnographic work among the Aguaruna. Both Fathers Guallart and Uriarte, as well as the other personnel at the Mission, have offered their kind cooperation in our research effort.

Finally, we may hope to receive the support and mutual exchange of basic data from Ing. Neminio Canelo A., Jefe de Planificación y Programación, Oficina Regional de Desarrollo de Norte, who is conducting detailed climatological and soil analysis research in the Aguaruna area of Peru.

While open scientific cooperation between scholars of two different countries might be considered to have only minor significance as concerns international relations, such cooperation is nonetheless important to develop and maintain, especially so for anthropologists who are finding it more and more difficult to gain access to those few areas of the world where traditional anthropological research can still be carried out.

F. Significance of the research

The proposed research will be of significant scientific value in at least four major respects:

(a) it will firmly establish the relationship of a primitive people's ethnobiological knowledge of both the flora and fauna to cultural adaptation in one of the most biologically rich areas of the world, the American Tropics;

(b) it will provide additional detailed data relevant to the testing of primitive classification and ethnobiological nomenclature suggested to be applicable to all pre-scientific peoples;

(c) it will represent the first systematic description of both the ethnobotany and ethnozoology of a tropical forest society which effectively exploits the knowledge of specialists in anthropology, linguistics, botany, zoology, and food science by collaborative field work;

(d) it will increase our poor knowledge of tropical biota and ecosystems at a time when such research is absolutely essential. As outlined in the Charter of the Organization for Tropical Studies, "The Tropics, perhaps the last great frontier on earth, constitute one of the most challenging areas left for scientific study" (Organization for Tropical Studies 1970). Hopefully, the proposed research will make for the compilation of information on tropical resources which will not only allow for our increased understanding of tropical environments but will as well provide suggestions for their intelligent use by man.

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Publication No. 2.

- 1964 Shifting cultivation among the Amahuaca of eastern Peru. Volkerkundliche Abhandlungen (Hanover)
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1954 The relation of Hanunóo culture to the plant world. 471 pp. Unpublished Ph.D. dissertation in anthropology. Yale University. New Haven.
- 1957 Hanunóo agriculture: a report on an integral system of shifting cultivation in the Philippines. FAO Forestry Development Paper No. 12, xii, 209 pp., illustrated, index, bibliography, glossary. Rome: Food and Agriculture Organization of the United Nations.
- 1961 The study of shifting cultivation. Current Anthropology 2:27-64.
- 1962 Lexicographical treatment of folk taxonomies. pp. 119-141 In: F. W. Householder and S. Saporta (eds.) Problems of lexicography. Indiana University Research Center in Anthropology, Folklore, and Linguistics Publication 21 (and) International Journal of American Linguistics 28.2 (part 4). Bloomington.
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1966 Zoological classification system of a primitive people. Science 151:1102.
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1952 Classification des végétaux chez les Dogon. Journal de la Société des Africanistes 22:115-158. Paris.
- Fowler, Catherine S. and Joy Leland
1967 Some northern Paiute native categories. Ethnology 6:381-404.
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1962a Cultural ecology and ethnography. American Anthropologist 64:1:53-59. Menasha.
- 1962b The ethnographic study of cognitive systems [with "comment" by H. C. Conklin]. pp. 72-93 In: T. Gladwin and W. C. Sturtevant (eds.) Anthropology and Human Behavior. Washington: Anthropological Society of Washington.

- 1964 Notes on queries in ethnography. pp. 79-98 In:
A. K. Romney and R. G. D'Andrade (eds.)
Transcultural studies in cognition. American
Anthropologist 66.3 (part 2), Special Publication.
Menasha.
- Griaule, M.
1941 Les mammifères dans la région des Dogons. Mammalia
5:104-109. Paris.
- Guallart, José Maria
1964a Nomenclatura Jibaro-Águaruna de especies de aves en al
alto Marañón. Biota 5:210-222.
- 1964b Los Jíbaros del alto Marañón. América Indígena
24:315-332.
- Harding, Thomas
1967 Ecological and technical factors in a Melanesian
gardening cycle. Mankind 6:403-408.
- Harner, Michael
1963 Machetes, shotguns and society: an inquiry into the social
impact of technological change among the Jivaro Indians.
Unpublished Ph.D. dissertation, Department of Anthropology,
University of California, Berkeley.
- 1970 Technological and social change among the Eastern Jívaro.
In: XXXVII Congreso Internacional de Americanistas,
Republica Argentina, Actas y Memorias, Vol. I, pp. 363-388.
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n.d. The ethnobiological implications of the classification of
'gulls' by American birdwatchers. (ms) University of
California, Berkeley.
- Kay, Paul
in press On taxonomy and semantic contrast. Language.
- Keslin, Richard O.
1970 Anthropology and the Organization of Tropical Studies:
Recommendations of the Anthropological ad hoc Committee.
Organization for Tropical Studies. Coral Gables, Florida.
- Larson, Mildred
1966 Vocabulario Aguaruna de Amazonas. Série Linguística
Peruana, Número 3. Instituto Lingüístico de Verano.

- Lee, Richard B.
1969 ! Kung Bushman subsistence: an input-output analysis.
In: Andrew Vayda (ed.) Environment and Cultural Behavior.
New York: American Museum of Natural History.
- Leeds, Anthony
1969 Ecological determinants of chieftainship among the Yaruaio
Indians of Venezuela. In: Andrew Vayda (ed.)
Environment and Cultural Behavior. New York: American
Museum of Natural History.
- Lowenstein, F. W.
1969 Some aspects of human ecology in South America. In:
E. J. Fittkau et al. (eds.) Biogeography and Ecology in
South America, Vol 1. Junk N. V.: The Hague.
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1964 A new genus and species of tanager from Peru.
The Auk 81:125-131.
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1963 Interdepartmental Committee on Nutrition for National
Defense. National Institutes of Health. Bethesda, Md.
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1964 Diet of Quechua Indians living at high altitudes, Numoa,
Peru. American Journal of Clinical Nutrition.
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1955 The indigenous language of Latin America.
American Anthropologist 70:501-570.
- Metzger, Duane and Gerald Williams
1966 Some procedures and results in the study of native
categories: Tzeltal firewood. American Anthropologist
65:389-407.
- Organization for Tropical Studies, Inc., Bulletin
1970 Opportunities for graduate education and research in the
tropics in 1970. OTS Publication No. 5, Coral Gables,
Florida.
- Percheronck, Norma and Oswald Werner
1969 Navaho systems of classification: some implications for
ethnoscience. Ethnology.
- Pike, Kenneth and Mildred Larson
1964 Hyperphonemes and non-systematic features of
Aguaruna phonemics. In: A. H. Marckwardt (ed.)
Studies in Languages and Linguistics. English
Language Institute. University of Michigan: Ann Arbor,
pp. 55-67.

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1968 Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People. New Haven: Yale University Press.
- Patton, James L.
n.d. Unpublished notes on Cashiniua zoological collecting.
- Turnbull, Colin
1961 The Forest People: A Study of the Pygmies of the Congo. New York: Simon and Schuster.
- Vayda, Andrew
1969 Expansion and warfare among swidden agriculturalists.
In: Andrew Vayda (ed.) Environment and Cultural Behavior. New York: American Museum of Natural History.
- Werner, Oswald
in press On the universality of some lexical semantic relations.
International Journal of American Linguistics.
- Winton, Marianne Yvonne
[1968] The secular essential nature of some South American Indians. Unpublished doctoral dissertation. Department of Anthropology, University of California, Berkeley.
- Wyman, L. C. and Flora Bailey
1965 Navaho Indian ethnoentomology. University of New Mexico Publications in Anthropology, No. 12, Albuquerque.

III. Personnel

Principal Investigator. Brent Berlin

A. Born December 20, 1936 in Pampa, Texas. Married Elois Ann Sanner, 1957. Two children.

B. Formal training.

University of Oklahoma, Norman, Oklahoma	1955-59	B. A. in Anthropology
Stanford University Stanford, California	1959-60	M. A. in Anthropology
Linguistic Institute Austin, Texas	Summer 1960	
Stanford University Stanford, California	1960-64	Ph.D. in Anthropology

C. Teaching experience.

1964-65	Instructor in Social Anthropology, Department of Social Relations, Harvard University.
1965-68	Assistant Professor of Anthropology, Department of Anthropology, University of California, Berkeley.
1968-present	Associate Professor of Anthropology, Department of Anthropology, University of California, Berkeley.

D. Field and Research experience.

1960-61	(12 months) Descriptive linguistic research on the Tenejapa dialect of Tzeltal in Chiapas, Mexico. [University of Chicago's "Chiapas Project"]
June 1962 - January 1963 (7 months)	Descriptive semantic studies in the same dialect of Tzeltal, Chiapas, Mexico.
January 1964 - June 1964 (7 months).	Completion of descriptive semantic work culminating in Ph.D. dissertation.

July 1964 - October 1964 (3 months). Participation in ethnographic research on patterns of drinking in five Chiapas communities; initiation of research on Tzeltal botanical ethnography.

July 1966 - present. Continuing research on Tzeltal botanical ethnography; initiation of comparative ethnobotany for Tzeltal and Tzotzil.

August 1970 Ethnobiological survey of the Aguaruna area of Amazonian Peru.

Ethnographic field work to date: four years

E. Fellowships, Awards, Research Grants, Administrative Responsibilities

1959-60 Woodrow Wilson National Fellowship, Stanford University.

1960 (summer) American Council of Learned Societies Grant-in-Aid, Linguistic Institute, University of Texas.

1960-61 Research Assistant in Linguistics, National Science Foundation Grant, "Linguistic and Socio-cultural Change in the Highlands of Chiapas, Mexico" [Norman A. McQuown, principal investigator].

1961-62 Stroud Fellowship in the Behavioral Sciences, Stanford University.

1962-64 Research Assistant, National Science Foundation Grant, "Semantic Structure in Tzeltal" (Tzeltal numeral classifier research) [A. K. Romney, principal investigator].

1964-66 Research Associate, National Science Foundation Grant GS-383 "Comparative Ethnobotany of Two Tzeltal Speaking Communities of Highland Chiapas" [A. K. Romney and Peter H. Raven, co-principal investigators].

1964 (summer) Co-Senior Investigator, National Institute of Mental Health Grant, "Coordinated Study of Tzeltal-Tzotzil Drinking" [Duane Metzger, Gerald Williams, co-principal investigators, Paul Kay, co-senior investigator].

- 1964-65 Pilot Study Grant, Laboratory of Social Relations, Harvard University, "Comparative Descriptive Semantics of Tzeltal-Tzotzil Numeral Classifiers".
- 1966-68 Co-principal Investigator, National Science Foundation Grant GS-1183, "Studies in Tzeltal Botanical Ethnography" [Peter H. Raven, Co-principal investigator].
- 1968-69 Principal Investigator, Center for Advanced Study in the Behavioral Sciences, National Science Foundation Grant 2280, "Studies in Mesoamerican Botanical Ethnography".
- 1968-69 Fellow, Center for Advanced Study in the Behavioral Sciences, Stanford, California.
- 1967-present Co-principal Investigator, Language-Behavior Research Laboratory, Institute of International Studies, University of California, Berkeley.
- 1967-68 Principal Investigator, Institute of International Studies Research Grant, University of California, Berkeley, "Comparative Semantics of Numeral Classifier Systems: A World Survey".
- 1970 (summer) Principal Investigator, Wenner-Gren Foundation for Anthropological Research, "Ethnobiological Survey of Amazonian Peru".
- 1970 - present Vice-Chairman, Department of Anthropology, University of California, Berkeley.

F. Bibliography

- 1962a The Tenejapa Dialect of Tzeltal: An Outline of Morphology. Anthropology Research Projects. Stanford University.
- 1962b Diccionario del Tzeltal de Tenejapa, Chiapas [with Terrence Kaufman]. Anthropology Research Projects. Stanford University.
- 1962c Esbozo de la Fonología del Tzeltal de Tenejapa, Chiapas, Estudios de Cultura Maya 2:17-36.
- 1962d A Tzeltal Origin Myth. Folklore 73:230-233.

- 1963a Linguistic Acculturation and Culture History in the Tzeltal-Tzotzil Region of Chiapas, Mexico [with Terrence Kaufman]. Unpublished manuscript, Berkeley, California.
- 1963b Some Semantic Features of Reduplication in Tzeltal. International Journal of American Linguistics 29:20-32.
- 1963c A Possible Paradigmatic Structure for Tzeltal Pronominals. Anthropological Linguistics 5:1-5.
- 1964 Descriptive Semantics of Tzeltal Numeral Classifiers [with A. Kimball Romney]. In: Transcultural Studies in Cognition. A. Kimball Romney and Roy G. D'Andrade, (eds.) American Anthropologist Special Issue, pp. 29-43.
- 1966 Folk Taxonomies and Biological Classification [with Dennis E. Breedlove and Peter H. Raven]. Science 154:273-275. (Reprinted in Cognitive Anthropology. Stephen Tyler (ed.) New York: Holt, Rinehart and Winston 1969).
- 1967 Categories of Eating in Tzeltal and Navaho. International Journal of American Linguistics 33:1-6.
- 1968a Covert Categories and Folk Taxonomies [with Dennis E. Breedlove and Peter H. Raven]. American Anthropologist 70:290-299. (Reprinted in Readings in Social and Cultural Anthropology. E. A. Hammel and W. Simmons, (eds.) New York: Little, Brown.)
- 1968b Tzeltal Numeral Classifiers: A Study in Ethnographic Semantics. Janua Linguarum (series practica) 70. The Hague: Mouton and Company.
- 1970 Basic Color Terms: Their Universality and Evolution [with Paul Kay]. Berkeley: University of California Press.
- 1970 A universalist-evolutionary approach in ethnographic semantics. In: Ann Fischer (ed.) Current Directions in Anthropology. Bulletin of the American Anthropological Association, No. 3, Part 2, pp. 3-18.
- in press Studies in Tzeltal-Tzotzil Comparative Ethnobotany [with Dennis E. Breedlove, Robert M. Laughlin and P. H. Raven]. In: M. S. Edmonson (ed.) Meaning in Mayan Languages. Mouton: The Hague.
- n. d. Evidence for the Concept of Genus in Folk Science [with Dennis E. Breedlove and Peter H. Raven]. (ms.) Language-Behavior Research Laboratory, University of California, Berkeley.

- n. d. Speculations on the Growth of Ethnobotanical Nomenclature.
Accepted for publication In: D. H. Hymes (ed.)
Man, Language and Society.
- in Ethnographic semantics [with Paul Kay]. To appear in
preparation T. Sebeok (ed.) Current Trends in Linguistics, Vol. 12,
Mouton: The Hague.
- in Ethnosystematics: Primitive Man's Classification of Living
preparation Things. (ms.) accepted with the University of Chicago Press.
- in Formal aspects of ethnobiological classification.
preparation Accepted for McCaleb-Seiler Series in Anthropology.
- in Studies in Tzeltal Botanical Ethnography I: Principles of
preparation Classification [with Dennis E. Breedlove and Peter H. Raven].

G. Other Professional Activities

- | | |
|--|----------------|
| Member, American Anthropological Association | 1960 - present |
| Member, Linguistic Society of America | 1960 - present |
| Member, New York Academy of Sciences | 1968 - present |
| Associate, Society for Tropical Bio-Geography | 1969 - present |
| Member, Association for Tropical Biology | 1969 - present |
| Secretary, Linguistic Society, University of California,
Berkeley | 1967 - 68 |
| Member, American Association for the Advancement of
Science | 1968 - present |
| Member, <u>Ad-Hoc</u> Committee of Anthropologists,
Organization for Tropical Studies, Inc. | 1970 - present |
| Corresponding member, Smithsonian Center for
short-lived phenomena. | 1969 - present |

Co-principal Investigator. James L. Patton

A. Born June 21, 1941 in St. Louis, Missouri. Married Carol Porter, 1966.
No children.

B. Formal training.

University of Arizona Tucson, Arizona	1959-63	B. A. in Anthropology
University of Arizona Tucson, Arizona	1963-65	M. S. in Zoology
University of Arizona Tucson, Arizona	1965-69	Ph.D. in Zoology (minor in Geochron- ology)

C. Teaching experience.

1963-69	Teaching Assistant and Teaching Associate, Department of Biological Sciences, University of Arizona.
1969-present	Assistant Professor of Zoology and Assistant Curator of Mammals, Museum of Vertebrate Zoology, University of California, Berkeley.

D. Field and Research experience.

1963-present	Periodic but continuous field work on the biosystematics of heteromyid and geomyid rodents in the western United States and northern Mexico, culminating in Ph.D. dissertation and numerous additional publications.
1964-65	Research Associate under grant "Biology of Desert Drosophila" awarded to W. B. Heed, University of Arizona, through the National Science Foundation.
1966 (June-August)	Research Associate, Section of Cytology, The University of Texas M. D. Anderson Hospital and Tumor Institute, Houston, under grant "Chromosome studies of mammals" awarded to T. C. Hsu through the National Science Foundation.

- 1968 (June-August) Biosystematic collection of mammals with the Cashinahua Indians of the Purus drainage of southeastern Peru, funded by the Museum of Vertebrate Zoology, Berkeley.

E. Fellowships, Awards, Research Grants, Administrative Responsibilities.

- 1964-65 American Cancer Society Grant-in-Aid "Cytogenetic studies of rodents" (W. B. Heed, University of Arizona, principal investigator)
- 1966-69 National Defense Education Act Title IV fellowship
- 1969-70 Principal Investigator, Bio-Medical Sciences Support Grant from National Institutes of Health, "Chromosome studies of pocket gophers, genus Thomomys"
- 1969-present Assistant Curator of Mammals, Museum of Vertebrate Zoology, and Undergraduate Advisor, Department of Zoology.

F. Bibliography

- 1965 Elevational differences in gene arrangements of D. pseudoobscura in the Santa Catalina Mountains, Tucson. Dros. Info. Serv. 40:69 (with W. B. Heed).
- 1966 Inversion frequency analysis of Drosophila pseudoobscura in the Santa Catalina Mountains, Arizona. Jour. Ariz. Acad. Sci. 4:105-117 (with W. B. Heed and C. H. Lowe).
- 1966 Somatic chromosome numbers of 31 species of North American Chiroptera. Mamm. Chromo. Newsletter, no. 20:66-67 (with R. J. Baker)
- 1967 Chromosome studies of certain pocket mice, genus Perognathus (Rodentia: Heteromyidae). Jour. Mammalogy 48:27-37.
- 1967 Karyotypes and karyotypic variation of North American vespertilionid bats. Jour. Mamm., 48:270-286 (with R. J. Baker).

- 1967 Natural hybridization in pocket mice, genus Perognathus. Mamm. Chromo. Newsletter 8:263-264 (with O. H. Soule).
- 1967 Chromosomes of the golden mouse, Peromyscus nuttalli (Harlan). Jour. Mamm., 48:637-639 (with T. C. Hsu).
- 1967 Karyotypic evolution and speciation in lizards (genus Sceloporus) during evolution of the North American Desert. Syst. Zool. 16:296-300 (with C. J. Cole and C. H. Lowe)
- 1967 Chromosomes and evolutionary trends in the pocket mouse subgenus Perognathus (Rodentia: Heteromyidae). SW Nat. 12:429-438.
- 1968 Chromosome studies of pocket gophers, genus Thomomys. I. The specific status of Thomomys umbrinus (Richardson) in Arizona. Jour. Mamm., 49:1-13 (with R. E. Dingman).
- 1968 Intraspecific chromosome variation in the bat, Macrotus waterhousii Gray. Jour. Mamm., 49:706-712 (with W. A. Nelson-Rees, A. J. Kniazell, and R. J. Baker).
- 1969 Bone marrow preparations for chromosome studies. In: Mammalian Chromosome Cytology, Springer-Verlag, New York; Ed. by K. Benirschke, p. 454-460 (with T. C. Hsu).
- 1969 Karyotypic variation in the pocket mouse, Perognathus penicillatus Woodhouse (Rodentia-Heteromyidae). Caryologia 22:351-358.
- 1969 Chromosome evolution in the pocket mouse, Perognathus goldmani Osgood. Evolution, 23:645-662.
- 1970 Chromosome studies of pocket gophers, genus Thomomys. II. Variation in T. bottae in the American southwest. Cytogenetics 9:139-151.
- 1970 Karyotypic variation following an elevational gradient in the pocket gopher, Thomomys bottae grahamensis Goldman. Chromosoma 31:41-50.
- 1970 Parallel evolution of multiple sex-chromosome systems in the phyllostomatid bats, Carollia and Choeroniscus. Experientia, in press (with A. L. Gardner).
- in preparation Cytophylogeny of New World marsupials (with O. A. Reig, N. O. Bianchi, and A. L. Gardner).

- in preparation A complex system of chromosomal variation in the pocket mouse, Perognathus baileyi.
- in preparation Natural hybridization in pocket gophers, genus Thomomys.
- in preparation Chromosome studies of pocket gophers, genus Thomomys.
III. Genetic consequences of meiosis in T. bottae.
- in preparation Karyotypes and systematic relationships among oryzomyine rodents (Cricetidae). (with A. L. Gardner).
- in preparation Cytogenetics of rodents. (to be published as a monograph in a series entitled Animal Cytogenetics, ed. by Bernard John and published by Gebruder Borntraeger Verlag, Stuttgart).

G. Other Professional Activities

- | | |
|---|----------------|
| Member, American Society of Mammalogists | 1964 - present |
| Member, American Association for the Advancement of Science | 1964 - present |
| Member, Sigma Xi | 1966 - present |
| Member, Genetics Society of America | 1968 - present |
| Member, Society for the Study of Evolution | 1968 - present |
| Member, Society of Systematic Zoology | 1968 - present |
| Member, Nomenclature Committee, Amer. Soc. Mamm. | 1970 - present |

Senior Scientific Collaborator. Ramón Ferreyra

A. Born

Present mailing address: Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru

B. Academic training

Universidad Nacional Mayor de San Marcos, Lima	1942	B. S. in Biological Sciences
Arnold Arboretum, Harvard University	1943	
Universidad Nacional Mayor de San Marcos, Lima	1945	Ph. D. in Biological Sciences

C. Present teaching and research positions

Professor of Systematic Botany and Director, Academic Program of Biological Sciences, Universidad Nacional Mayor de San Marcos, Lima

Director, Museo de Historia Natural, "Jarvier Prado", Universidad Nacional Mayor de San Marcos, Lima

D. Awards and distinctions

President, Organization of the Flora Neotropica	1968-71
Honorary Vice President, 11th International Botanical Congress, Seattle, Washington	1969
Delegate of the Museum of Natural History at the inviation of UNESCO, reunion of the organization of the Flora Neotropica	1968
Member of Fullbright Commission of Peru, Selection Committee and Committee on Plans and Program	1966-68
Gold medal and diploma, National Association of Peruvian geographers	1966
Delegate of the Museum of Natural History at the invitation of the Smithsonian Institution and the Department of Scientific Affairs of the Panamerican Union at the Smithsonian bicentennial.	1965

Charter member, Latin American Committee on National Parks	1964
UNESCO invited Peruvian delegate to the Conference on Flora Neotropica, San Paulo	1964
Delegate of the Museum of Natural History to the 10th International Botanical Conference, Edinburgh, Scotland	1964
Visiting Professor, Organization of Tropical Studies, Universidad de Costa Rica	1964
Member of the subcommittee for the 11th Pacific Science Conference	1963
Charter member, Association of Tropical Biology	1962
Charter member and member of the Executive committee for the Association of Tropical Biology	1962
Peruvian delegate to UNESCO for the Conference on the Humid Tropics, San Paulo, Brazil	1962
Peruvian delegate to the first Neotropical Conference at the invitation of the Imperial College of Agriculture, St. Augustine, Trinidad	1962
Delegate of the Museum of Natural History, "Jarvier Prado", to the 10th Pacific Science Congress, Honolulu, Hawaii	1961
National Museum, Department of Botany, Smithsonian Institution	1950-51
Honorable mention "Premio de Fomento a la Cultura"	1950
Delegate of the Museum of Natural History, "Jarvier Prado" to the 2nd South American Biological Congress	1948
Botanical coordinator for UNESCO for the scientific expedition to the valley of Huallago, San Martin and Loreto	1948
Peruvian Government fellowship to Harvard University	1942-45
President, Committee for the Preservation of Natural Areas of Peru	
Vice President, National Committee for the Protection of Natural Resources	
Member, National Academy of Sciences [of Peru]	
Charter member, Organization for Flora Neotropica	

E. Publications [1964 - 1970]

- 1964 Revision de las especies Peruanas del genero Barnadesia (Compositae), Museo de Historia Natural, Ser. "B", No. 16.
- 1965 Las especies de Arnaldoa del Perú, Museo de Historia Natural, Ser. "B", No. 20.
- 1965 Dos especies nuevas de Liabum para el Peru, Museo Historia Natural, Ser. "B", No. 20.
- 1966 Some efforts toward the conservation of natural areas in Peru. Eleventh Pacific Science Congress, Tokio, Japon.
- 1966 Raimondi Botánico, en Mem. Coleg. Antonio Raimondi, pp. 5-8.
- 1967 Instrucciones generales para coleccionar plantas. Revista de Agricultura 39, No. 11-12, San Jose, Costa Rica.
- 1969 Some aspects of the Peruvian vegetation. Eleventh International Botanical Congress, Seattle, Washington, U.S.A.
- 1970 Flora invasora de los cultivos de Pucallpa y Tingo Maria A. Malezas B. Comunidades nativas, Museo de Historia Natural.
- 1970 Angiospermas, monocotiledoneas, con especial referencia a la flora Peruana. Museo de Historia Natural.

F. Works in progress

Flora de la costa Peruana. A. Las Lomas B. Algarrobal.

Comunidades vegetales del alto Huallaga (Hilea Amazonica)
A. Pajonal B. Ceja de la montana.

Note: From 1944 until 1963 the same author has published 35 articles and reviews in botanical bulletins in Peru, Argentina, the United States and the Philippines.

Research Associate. John Patton O'Neill

A. Born April 12, 1942 in Houston, Texas. Unmarried.

B. Formal Training.

University of Oklahoma, Norman, Oklahoma	1960-64	B.S. in Zoology
Louisiana State University, Baton Rouge, Louisiana	1964-70	M.S. in Zoology
	1970-present	Continuing work on Ph.D. in Zoology

C. Teaching Experience.

Graduate Teaching Assistant in General Biology, General Zoology, Ornithology, and Mammalogy courses at Louisiana State University.

D. Field and Research experience.

1961 (3 months)	Introduction to Peru and Peruvian avifauna
1962 (3 months)	Beginning studies of Peruvian avifauna with concentration in Departments of Huánuco and Loreto.
1963 (3 months)	Continuing studies of Peruvian avifauna; initial trip to Rio Curanja area in Department of Loreto.
1964-65 (12 months)	Continuing studies of Peruvian avifauna with concentrations in Departments of Amazonas, Lima, Loreto, and Puno including two trips to Rio Curanja.
1966 (3 months)	Continuing studies of Peruvian avifauna with concentration on Rio Curanja region.
1967 (3 months)	Continuing studies of Rio Curanja area.
1968 (3 months)	Continuation of above.
1969 (3 months)	Observer in Section of Cell Biology, M. D. Anderson Hospital and Tumor Institute, Houston, Texas for the purpose of collecting chromosome data on birds of the Order Falconiformes.
1970 (2 months)	Participant in Houston Zoological Society's Expedition to Venezuela and one month study of avifauna of Andean slopes in Department of Ayacucho, Peru.

E. Fellowships, Awards, Grants, etc.

- 1964 Participant in National Science Foundation Undergraduate Research Participation Program through Louisiana State University.
- 1969- Recipient of Grant from Frank M. Chapman Memorial Fund of the American Museum of Natural History, New York.
- Observer in Section of Cell Biology, M. D. Anderson Hospital and Tumor Institute, Houston, Texas.
- Other
- 1965- Part-time curatorial duties in Museum of Zoology, Louisiana State University.

F. Publications.

- 1964 A new genus and species of tanager from Peru. Auk 81:125-131 (with George H. Lowery, Jr.).
- 1965 A new species of Cacicus (Aves: Icteridae) from Peru. Occas. Papers Mus. Zool. Louisiana State Univ. 33:1-5 (with George H. Lowery, Jr.).
- 1966 A new genus and species of cotinga from eastern Peru. The Auk 83:1-9 (with George H. Lowery, Jr.).
- 1966 Notes on the distribution of Conothraupis speculigera (Gould). The Condor 68:598-600.
- 1969 A new species of antpitta from Peru and a revision of the subfamily Grallariinae. The Auk 86:1-12 (with George H. Lowery, Jr.).
- 1969 Distributional notes on the birds of Peru, including twelve species previously unreported from the Republic. Occas. Papers Mus. Zool. Louisiana State Univ. 37:1-11.
- 1969 The taxonomic status of Sturnira bidens (Chiroptera: Phyllostomidae) with notes on its karyotype and life history. Occas. Papers Mus. Zool. Louisiana State Univ. 38:1-8 (with Alfred L. Gardner).
- in preparation An analysis of chromosome patterns among selected members of the avian Order Falconiformes.
- in preparation A review of the black-throated races of Aulacorhynchus prasinus.
- in preparation A new species of Sturnira (Chiroptera: Phyllostomidae) from Peru (with Alfred L. Gardner).

Illustrations.

Color plate of Dendrocolaptes certhia sheffleri in:

- 1965 Binford, Laurence C. Two new subspecies of birds from Oaxaca, Mexico. Occas. Papers Mus. Zool., Louisiana State Univ., no. 30:1-6.

Color plate of Rhynchortyx cinctus in:

- 1968 Monroe, Burt L., Jr. A distributional survey of the birds of Honduras. Orn. Monog., no. 7:1-458.

9 color plates in:

- 1969 Alden, Peter. Finding the Birds in Western Mexico; A Guide to the States of Sonora, Sinaloa, and Nayarit. Tucson, Arizona. The University of Arizona Press. 138 pp.

Color plate of Odontophorus capueira in:

- 1970 Flieg, G. Michael. Observations on the first North American breeding of the Spot-winged Wood Quail (Odontophorus capueira). Avicultural Magazine, 76:1-2.

Color plates of Dendrortyx barbatus and Odontophorus guttatus in:

- in preparation. Johnsgard, Paul. A treatise on all quail and grouse in North America north of Guatemala.

30 color plates in:

- in preparation. French, Richard. A field guide to cover the birds of Trinidad and Tobago (with Don R. Eckelberry).

Also: frontispieces in descriptions of new species from Peru.

G. Other Professional Activities.

Life Member, American Ornithologists Union

Member, American Society of Mammalogists

Member, Cooper Ornithological Society

Life Member, Wilson Ornithological Society

Research Associate.

John William Wright

A. Born July 9, 1936 in Winslow, Arizona. Married. Three children.

B. Formal training.

University of New Mexico Albuquerque, New Mexico	1961	B.S.
University of New Mexico Albuquerque, New Mexico	1963	M.S.
University of Arizona Tucson, Arizona	1965	Ph.D.

C. Professional experience.

1965 Instructor, Department of Zoology, University of Arizona.

1965-67 Assistant Professor, Department of Biological Sciences,
Western New Mexico University.

1967-present
Curator, Section of Herpetology, Los Angeles County Museum of
Natural History.

1967-present
Adjunct Associate Professor, Department of Biological Sciences,
University of Southern California.

D. Field and Research experience.

1962-70 (1 week to 2 months, annually) Herpetological research during
numerous short trips to various parts of Mexico.

1968 (2 months) Ecological distribution of the herpetofauna of the Sierra
Cuchumatanes, Guatemala.

1968 (2 months) Systematics and ecology of the herpetofauna of the upper
Marañón Valley and coastal Peru.

1970 (2 months) Herpetofauna of East Africa, northern Kenya.

E. Fellowships, Awards, Research Grants, Administrative Responsibilities

1962 (summer) National Science Foundation Summer Fellowship

1963 (summer) Theodore Roosevelt Memorial Fund Grant from the American
Museum of Natural History.

1966-68 National Science Foundation Grants GB-5647 and GB-6830 -- Systematics
of Cnemidophorus: Interspecific Hybridization and Chromosome
Characteristics of Bisexual and Parthenogenetic Species.

F. Bibliography

- 1962 The type locality of Cnemidophorus perplexus (with William G. Degenhardt) Copeia (1):210-11.
- 1963 Cnemidophorus gularis in New Mexico. Southwest. Nat. 8(1):56.
- 1964 Species of the Cnemidophorus exsanguis subgroup of whiptail lizards (with Charles H. Lowe) J. Ariz. Acad. Sci. 3(2):78-80.
- 1965 The rediscovery of Cnemidophorus arizonae Van Denburgh (with Charles H. Lowe) J. Ariz. Acad. Sci. 3(3):164-168.
- 1966 Variation in two sympatric whiptail lizards (Cnemidophorus inornatus and C. velox) in New Mexico. Southwest. Nat. 11 (1):54-71.
- 1966 Predation on the Colorado River toad, Bufo alvarius. Herpetologica 22 (2):127-128.
- 1966 Chromosomes and karyotypes of cnemidophorine teiid lizards (with Charles H. Lowe). Mamm. Chrom., Newsletter 22:199-200, + 2 plates.
- 1966 Chromosomes and karyotypes of sceloporine iguanid lizards in the North American Southwest (with Charles H. Lowe and Charles J. Cole) Mamm. Chrom., Newsletter 22:201-203, + 2 plates.
- 1966 Evolution of parthenogenetic species of Cnemidophorus (whiptail lizards) in Western North America (with Charles H. Lowe) J. Ariz. Acad. Sci. 4(2):81-82.
- 1966 Analysis of the herpetofauna of Baja California, Mexico. IV. The Baja California striped whiptail, Cnemidophorus labialis, with key to the striped-unspotted whiptails of the Southwest (with Charles H. Lowe and Kenneth S. Norris) J. Ariz. Acad. Sci. 4(2):121-127.
- 1967 Sex chromosomes in lizards (with Charles J. Cole and Charles H. Lowe) Science 155:1028-29.
- 1967 A new uniparental species of whiptail lizard (genus Cnemidophorus) from Sonora, Mexico. Jour. Ariz. Acad. Sci. 4(3):185-193.
- 1967 Hybridization in nature between parthenogenetic and bisexual species of whiptail lizards (genus Cnemidophorus). (with Charles H. Lowe) Amer. Mus. Novitates 2286, 36 p.
- 1967 Evolution of the alloplid parthenospecies Cnemidophorus tessellatus (Say) (with Charles H. Lowe) Mamm. Chrom., Newsletter 8(2): 95-96, + 2 plates.
- 1968 Weeds, polyploids, parthenogenesis, and the geographical and ecological distribution of all-female species of Cnemidophorus (with Charles H. Lowe) Copeia (1):128-138.
- 1968 Karyotypes of eight species of toads (genus Bufo) in North America (with Charles J. Cole and Charles H. Lowe) Copeia (1):98-100.

- 1968 Variation in three sympatric sibling species of whiptail lizards, genus Cnemidophorus. J. Herp. 1(1-14):1-20.
- 1968 A new plethodontid salamander from Sonora, Mexico (with Charles H. Lowe and Clyde J. Jones) Contr. Sci., Los Angeles Co. Mus. Nat. Hist. 140:1-11.
- 1969 A new stream breeding frog from Oaxaca, Mexico (Anura, Hylidae) (with Ian R. Straughan). Contr. Sci., Los Angeles Co. Mus. Nat. Hist. 169:1-12.
- 1969 Status of the name Cnemidophorus perplexus Baird and Girard (Teiidae). Herpetologica 25(1):67-69.
- 1969 Sex chromosomes in teiid lizards (genus Cnemidophorus) (with Charles J. Cole and Charles H. Lowe) Amer. Mus. Novitates 2395:1-14.
- 1970 Natural hybridization between the teiid lizards Cnemidophorus sonorae (parthenogenetic) and Cnemidophorus tigris (bisexual) (with Charles H. Lowe, Charles J. Cole and Robert L. Bezy) Systematic Zool. 19(2):114-127.
- 1970 Chromosomes and evolution of the species groups of Cnemidophorus (Reptilia: Teiidae) (with Charles H. Lowe, Charles J. Cole and Robert L. Bezy) Systematic Zool. 19(2):128-141.
- 1970 A preliminary karyological analysis of scincid lizards. Mamm. Chrom., Newsletter 11(3):95-96, + 1 plate.
- in Review of the lizard genus Dicrodon in Peru.
preparation
- in Review of the members of the lizard genus Tropidarus in Peru
(with James R. Dixon)
preparation

G. Other Professional Activities.

- | | |
|---|--------------|
| Member of Board of Governors, American Society of Ichthyologists and Herpetologists | 1970-present |
| Fellow, Herpetologists League | 1965-present |
| Member, Society for the Study of Reptiles and Amphibians | 1965-present |
| Member, Southwestern Association of Naturalists | 1965-present |
| Member, American Society of Ichthyologists and Herpetologists | 1965-present |

Research Associate.

Robert J. Lavenberg

A. Born March 11, 1937 in Los Angeles, California. Single.

B. Formal training.

University of Southern California Los Angeles, California	1960	B.A. Zoology
University of Southern California Los Angeles, California	1962	M.A. Zoology
University of Southern California Los Angeles, California		Ph. D.

C. Professional experience.

1959-63	Teaching Assistant, Department of Biological Sciences, University of Southern California.
1963-70	Lecturer, Los Angeles County Museum of Natural History, Science Workshop (Ichthyology).
1965-66	Instructor, Department of Biological Sciences, University of Southern California

D. Field and Research experience.

1959-60	(7 months) Research Assistant, Ecogeographic analysis of the herpetofauna of Costa Rica, University of Southern California.
1960	(7 months) Research Assistant, in charge of marine biological studies aboard the Drifting Ice Station Bravo (T-3), University of Southern California.
1960-61	Research Assistant, Ecologic survey of the midwater populations of fishes and decapod Crustaceans in the San Pedro Basin off southern California, University of Southern California.
1961-62	Research Assistant, Application of x-ray techniques to osteological study, University of Southern California.
1963-68	Member, University of Southern California research cruises to southern California basins and open ocean, ecology of midwaters.
1964	Member, California Fish & Game R/V <u>Alaska</u> cruise to Gulf of California, ichthyological studies of coastal and offshore areas along peninsula.
1966	Party Chief, University of Southern California biological program aboard the USNS <u>Eltanin</u> , zoogeography of the sub-tropical convergence in the South Pacific.

E. Fellowships, Awards, Research Grants, Administrative Responsibilities.

- 1959 (4 months) Student Professional Worker, Ornithology, Los Angeles County Museum of Natural History.
- 1960 Volunteer Curatorial Assistant to renovate and reorganize the Allan Hancock Foundation Ichthyological Collection.
- 1962-65 Junior Research Associate, National Science Foundation, Comparative ecologic study of the mid-water fishes, cephalopods, and Crustaceans in the San Pedro Basin and Santa Catalina Basin off southern California, University of Southern California.
- 1963-66 Assistant Curator of Ichthyology, Los Angeles County Museum of Natural History.
- 1965-67 Co-Investigator, National Science Foundation, University of Southern California, A comparative ecologic study of the mid-water faunas of the open ocean and the southern California shelf.
- 1966-68 Associate Curator of Ichthyology, Los Angeles County Museum of Natural History.
- 1969-present Senior Investigator, National Science Foundation, University of Southern California, A comparative ecologic study of the mid-water faunas of the open ocean and the southern California shelf.
- 1969-present Curator of Ichthyology, Los Angeles County Museum of Natural History.

F. Bibliography.

- 1964 An ecologic analysis of the midwater fishes of the San Pedro Basin, California. Master's Thesis, Univ. of Southern California, pp. 1-151.
- 1965 A new species of searsiid fish, Normichthys campbelli, from the eastern north Pacific Ocean. Bull. So. Calif. Acad. Sci. 64(1):22-26.
- 1965 Normichthys yahganorum, a new searsiid fish from Antarctic waters. Contr. Sci., Los Angeles Co. Mus. Nat. Hist. (90):1-7.
- 1965 A new species of microstomatid fish (Nansenia) from California waters. Copeia 1965 (3):281-285.
- 1966 Annotated list of fishes collected by midwater trawl in the Gulf of California, March-April 1964 (with John E. Fitch) Calif. Fish & Game 52(2):92-110.
- 1966 Distribution of midwater fishes among deep-water basins of the southern California shelf (with A. W. Ebeling) Symposium volume, Santa Barbara Botanic Gardens "The Channel Islands."
- 1968 Deep-water Teleostean fishes of California (with John E. Fitch) Univ. Calif. Press, 155 pp.

- 1970 Ecological groups of deep-sea animals off southern California (with A. W. Ebeling, R.M. Ibara and F.J. Rohlf) Bull. Los Angeles Co. Mus. Nat. His. 6:1-43.
- in The food and game fishes of California (with J. E. Fitch) Univ. Calif. Press.
- preparation in Feeding mortality in a deep water fish (with J. R. Paxton) Records of the Australian Museum.
- preparation in The chiasmodontid fishes. Dana Report.

G. Other Professional Activities.

Member, American Society of Ichthyologists and Herpetologists	1960-present
President, Phi Sigma	1959
Member, Sigma Xi	1967-present
Member, Society for the Study of Evolution	1962-present
Member, Society of Systematic Zoology	1963-present
Member, Systematics Association	1963-present
Member, Southern California Academy of Sciences	1960-present
Managing Editor, Southern California Academy of Sciences	1970
Managing Editor, scientific publications, Los Angeles County Museum of Natural History	1967-present
Member, Wilderness Society	1969-present
Member, Audubon Society	1965-present
Member, Western Society of Naturalists	1965-present

A. BUDGET SUMMARY -- 24 MONTH PERIOD

A.	SALARIES AND WAGES	\$ 120,387
B.	FRINGE BENEFITS	4,236
C.	PERMANENT EQUIPMENT	6,920
D.	EXPENDIBLE SUPPLIES AND EQUIPMENT	7,819
E.	TRAVEL	26,530
F.	PUBLICATION COST	1,100
G.	OTHER COSTS	<u>19,100</u>
H.	TOTAL DIRECT COSTS	\$ 186,092
I.	INDIRECT COSTS (27 per cent of Direct Salary and Wages)	32,504
J.	TOTAL AMOUNT REQUESTED (H & I)	\$ 218,596 → <u><u>\$218,600</u></u>

B. RESEARCH GRANT PROPOSAL BUDGET

(24 month period)

Budget category	NSF funded man-months			Amount requested NSF
	Cal	Acad	Sum	
A. SALARIES AND WAGES				
1. Senior personnel				
O. B. Berlin (ethnology, linguistics)	4	8		\$ 22,059
J. L. Patton (mammalogy)		4		5,469
R. Ferreyra (botany)				24,288
2. Other personnel				
a. Research associates				
J. P. O'Neill (ornithology)	3	9		9,864
J. W. Wright (herpetology)		--		
R. J. Lavenberg (ichthyology)		--		
b. Non-faculty professional				
1 scientific illustrator at \$692/mo.	6			4,152
c. Research assistants (graduate students) 4 research assistants with training in linguistics, anthropology and zoology, 24 mos. 50 per cent time at \$344/mo.	48	48		35,604
d. Professional school student 1 Registered Nurse, 12 mos. 50 per cent time at \$310/mo.	9	3		3,720
e. Secretarial-clerical 1 secretary-typist clerk 24 mos. full-time at \$584/mo.	18	6		15,231
Total Salaries and Wages				<u><u>\$120,387</u></u>

B. FRINGE BENEFITS

* 13 per cent on academic salaries:

Brent Berlin	\$ 940
J. L. Patton	--

10 per cent on non-academic salaries:

J. P. O'Neill	986
Scientific illustrator	415
Registered Nurse	372
Secretary	1,523

Total Fringe Benefits \$ 4,236

Total Salaries, Wages and Fringe Benefits (A + B) \$ 124,623

C. PERMANENT EQUIPMENT

1. 2 Uher tape recorders and accessories for linguistic and ornithological recording	\$ 1,000
2. 1 - 250 mm Nikon lens	200
3. 1 portable linguistic typewriter	150
4. 1 Everest pocket altimeter	50
Estimated California sales tax on above items (5 per cent)	70
** 5. 1 Chevrolet truck	4,500
6. 1 wooden boat	100
7. 1 40 horsepower Evinrude motor	850

Total Permanent Equipment \$ 6,920

* no fringe benefits on academic summer salaries and research assistants.

** items 5, 6, & 7 will be purchased in Peru

D. EXPENDIBLE SUPPLIES AND EQUIPMENT

	NSF
1. zoological collecting equipment	
a. traps	\$ 800
b. mist nets	300
c. guns and ammunition	500
d. fishing gear	700
2. karyotype equipment (slides, slide boxes, chemicals, centrifuge, etc.)	500
3. botanical collecting equipment	
a. 500 labels	200
b. 2,000 tie-on-tags	50
c. 12 pruning shears	60
d. 10 plant presses	60
e. 10 pairs plant press straps	37
f. 1,000 corrugated cardboard	30
g. 2,000 felt drier	140
h. 16,000 newsprint	256
i. 500 seed packets	100
j. 1,000 plastic collecting bags	50
k. 4 geologist collecting hammers	28
l. 1 aluminum table	15
m. 1 aluminum ladder	15
n. 1 extension clippers	20
4. preservation equipment	
a. formalin and ethyl alcohol	400
b. cotton	120
c. preserving containers	100
d. wire	80
5. dietary study equipment	
a. scales, platform-type, 300 lb. cap., 1/4 interval (1)	67
b. triple beam balance, 600 gm (1)	12
c. balance, dietetic scale, spring, 500 gm, movable dial (1)	7

d. scale, Triner, model ME-8DB, cap. 8 kg x 1 gm, metric beam (1)	80
e. dietary record forms, record books, etc.	25
f. clipboards	3
g. waring blender (1)	40
h. marking crayons	10
i. kitchen spatulas	5
j. plastic sample containers (8-10 doz., 500-1000 ml sample cont.)	2
k. plastic reagent bottles with screw caps, small mouth (1 doz. 500 ml & 1/2 doz. liter)	20
l. oxalic acid, reagent grade, 3 lb.; potassium hydroxide, reagent grade 1 lb.	10
m. alcohol, ethyl, 95 per cent (2 qt.)	2
n. chloroform, reagent grade, 2 lb.	2
o. hydrochloric acid, reagent grade, 2 lb.	2
p. cylinder, graduated, 100 ml (plastic)	3
q. pH paper (range 4.5-8.5 pH and range 2-5)	10
r. labels for sample containers	6
s. hand-calculator	130
t. slide rule	5
u. marking tape 1" x 60 yards, 6 rolls	3
v. felt markers	5
w. thermometer, pocket, 20°-105°	12
x. numbering machine	18
y. pressure cooker	11
z. research books	40
6. camping and field facilities equipment	
a. 2 kerosene pressure lanterns	60
b. 3 primus stoves	40
c. 40 gallons of kerosene	10
d. cooking gear, 5 men	75
e. gasoline for boat	400
f. out-board motor maintenance	150

g. 2-9 x 12 tents with floor	250
h. 2-two man all-weather tents	100
i. 1 generator	50
j. 1 converter	20
7. medicine (malaria prophylaxis, antidiuretics, antivenom kits, for full party)	500
8. film (35 mm, Super 8 mm)	300
9. magnetic recording tape	100
10. miscellaneous (cheese cloth, chuno, borax, insecticide, candles, saws, silica-gel, lights, batteries, etc.)	300
Total Expendible Supplies	\$ 7,446
Estimated 5 per cent California sales tax	373
Grand Total Expendible Supplies	\$ 7,819

E. TRAVEL

1. Domestic (scientific meetings, museums, and herbaria in the United States for six investigators)	\$ 6,130
2. Foreign (United States to Lima, round-trip \$ 600/person)	
a. Summer 1971 (7 persons)	4,200
b. Summer 1972 (6 persons)	3,600
c. Fall 1972 (4 persons)	2,400
d. Summer 1973 (7 persons)	4,200
Total Foreign Travel	\$14,400
3. In field travel (includes subsistence time spent in Lima, Peru, and necessary travel away from field site in Amazonia for six investigators)	\$ 6,000
Total Travel	\$ 26,530

F. PUBLICATION COSTS

1. Report preparation	\$ 500
2. Reprints	200
3. Printing of labels	100
4. Supplies, postage, phones, telegrams, etc.	300
Total Publication Costs	\$ 1,100

G. OTHER COSTS

1. field assistants	\$ 10,500
2. ethnographic informants	5,100
3. photographic services	500
4. shipping of materials and equipment	3,000
Total Other Costs	\$ 19,100

H. TOTAL DIRECT COSTS \$ 186,092

I. INDIRECT COSTS (27 per cent of Direct Salary and Wages) 32,504

TOTAL AMOUNT REQUESTED (H + I) \$ 218,596 → \$ 218,600

C. NOTES ON BUDGET

Scientific research in the remote Tropics is perhaps as costly as anywhere in the world. Nonetheless, the importance of such research cannot be overestimated. The budget considered to be essential for adequately conducting the program outlined in the Research Proposal is presented below. Every effort has been made to recognize budgetary limitations of the Foundation. We have requested only those items and personnel support which we feel are crucial for the success of the project.

A. Salaries and Wages

Salaries and wages of all investigators are computed in accordance with regular institutional salary scales and reflect an anticipated 5 per cent per year cost of living increase. Regular merit increases (each 2 years for the principal investigators) are also anticipated and are included.

1. Senior personnel

The three senior investigators will jointly devote 63 man-months of full-time research to the project. Foundation support is requested for 35 man-months of this period only, the remaining 28 months of salary expenses being covered by the investigators' respective research organizations. The monthly salary breakdown of the senior investigators follows.

Monthly Salary Breakdown

Principal Investigator

Brent Berlin

23 months (NSF 12, UC 11)

Winter	Spring	Summer	Fall	
		3 NSF \$4,866 field		1971
		*3 UC \$5,424	*3 UC \$5,424 field	1972
*2 UC \$3,616 1 NSF \$1,808 field	3 NSF \$5,424 field	3 NSF \$5,695 field		1973
	*3 UC \$5,695	2 NSF \$4,266		1974

- * Institutional support, 11 months. Five months of Berlin's academic salary is paid by the University of California sabbatical leave. The salary for the remaining 6 months is contributed by the Language-Behavior Research Laboratory of the University of California.

Monthly Salary Breakdown

Co-principal Investigator

James L. Patton

20 months (NSF 4, UC 16)

Winter	Spring	Summer	Fall
		*2 MVZ \$2,386 1 NSF \$1,193 field	1971
		*2 MVZ \$2,658 1 NSF \$1,329 field	*3 UC \$3,987 1972 field
*3 UC \$3,987 field		*2 MVZ \$2,792 1 NSF \$1,396 field	1973
	*2 UC \$2,792	*2 MVZ \$3,102 1 NSF \$1,551	1974

- * Institutional support, 16 months. Four of Patton's 8 academic months is paid by the University of California sabbatical leave. Salary for the remaining 4 academic months and the 8 summer months is contributed by the Museum of Vertebrate Zoology of the University of California.

Monthly Salary Breakdown

Senior Scientific Collaborator

Ramón Ferreyra

21 months (NSF 12, MHN 9)

Winter	Spring	Summer	Fall	
		3 NSF \$5,635 field		1971
* 1-1/2 MHN	* 1-1/2 MHN	3 NSF \$5,917 field	* 1-1/2 MHN	1972
* 1-1/2 MHN	* 1-1/2 MHN	3 NSF \$6,213 field	* 1-1/2 MHN	1973
		3 NSF \$6,523		1974

* Nine month's institutional support provided by the Museo de Historia Natural of the Universidad Nacional Mayor de San Marcos, Lima, Perú.

2. Other personnel

a. Research Associates

Three Research Associates will join the Senior Investigators in carrying out the research project. Each is affiliated with a museum which will provide a major portion of his salary during the project.

A total of 34 man-months will be spent on the project by the faculty Research Associates. Foundation support is requested for only 12 of these months.

Monthly salary breakdown of the three Research Associates follows.

Monthly Salary Breakdown

Research Associate

John P. O'Neill

18 months (NSF 12, LSU 6)

Winter	Spring	Summer	Fall
		3 NSF \$2,319 field	1971
		3 NSF \$2,436 field	3 NSF \$2,436 field 1972
		3 NSF \$2,673 field	1973
	* 3 LSU	* 3 LSU	1974

* Six month's institutional support. O'Neill will require support during the 12 months that he will be collecting in Amazonia proper. No support is requested for the 6 months involved in analysis at Louisiana State University where he will be sponsored by the Museum of Zoology.

Research Associate

J. W. Wright

No Foundation salary support is requested for Wright who will be paid from funds from the Los Angeles County Museum. He will spend a total of eight months, or one third of his research time, on the project over the 24 month period.

Research Associate

R. J. Lavenberg

No Foundation salary support is requested for Lavenberg who will be paid from funds from the Los Angeles County Museum. He will spend a total of eight months, or one third of his research time, on the project over the 24 month period.

b. Non-faculty professional (scientific artist)

A critical portion of the final report will include detailed illustrations of many of the plant and animal materials collected during the field research. A trained scientific artist will be essential for executing numerous line drawings acceptable for publication.

c. Research Assistants (Graduate students)

Funds are requested for the services of four graduate students with training in linguistic anthropology, botany and zoology. These individuals will be involved not only in the basic data collection and curating in Peru, but as well in the analysis of materials taken to the States.

d. Professional School Student

During the second field session, funds are requested for the services of Elois Ann Berlin, a Registered Nurse with training in nutrition, who will be responsible for the initiation of dietary research on Aguaruna food habits. She will be in charge of the twelve month diet survey work, collecting information on food preparation techniques, food preferences, nutrient intake levels and sources of nutrients. She will also coordinate data collection on manioc cultivation, an area of knowledge which lies solely within the province of the Aguaruna women. Mrs. Berlin is the wife of the principal investigator and her participation on the project has been approved by the University of California.

e. Secretarial-Clerical

While much of the general typing required in the preparation of material for publication will be done by the cooperating organized research units, their regular clerical staffs cannot handle the amount of data that will be accumulated during the project. The project typist will be involved in the time-consuming task of preparing linguistic texts and typing labels for both the plant and animal materials.

The monthly salary breakdown of these personnel follows.

Monthly Salary Breakdown

Research Assistants

132 months (96 NSF, 36 UC)

Winter	Spring	Summer	Fall	
			3 NSF	1971
			\$1,032(\$4,128)**	
*2 UC	* 3 UC	3 NSF	3 NSF	1972
\$688 (\$2,752)	\$1,032 (\$4,128)	\$1,083 (\$4,332)	\$1,083(\$4,332)	
* 2 UC	3 NSF	3 NSF	3 NSF	1973
\$722 (\$2,888)	\$1,083(\$4,332)	\$1,137 (\$4,548)	\$1,137(\$4,548)	
*2 UC	3 NSF	3 NSF		1974
\$758 (\$3,032)	\$1,137 (\$4,548)	\$1,209 (\$4,836)		

* 36 months of institutional support provided by the University of California.

** The figures in parentheses indicate the amount for 4 research assistants.

Monthly Salary Breakdown

Pre-professional student: Registered Nurse (12 months, NSF)

Winter	Spring	Summer	Fall	
		--	--	1971
--	--	--	3 NSF \$930	1972
3 NSF \$930	3 NSF \$930	3 NSF \$930	--	1973
--	--	--	--	1974

Monthly Salary Breakdown

Secretary-Clerical

33 months (24 NSF, 9 UC)

Winter	Spring	Summer	Fall	
		--	--	1971
1-1/2 NSF \$876	1-1/2 NSF \$876	1-1/2 NSF \$920	3 NSF \$1,839	1972
* 1-1/2 UC \$876	* 1-1/2 UC \$876	* 1-1/2 UC \$920		
1-1/2 NSF \$920	1-1/2 NSF \$920	1-1/2 NSF \$966	3 NSF \$1,932	1973
* 1-1/2 UC \$920	* 1-1/2 UC \$920	* 1-1/2 UC \$966		
3 NSF \$1,932	3 NSF \$1,932	3 NSF \$2,118		1974

* 9 months institutional support provided by the University of California.

B. Fringe Benefits

Benefits at Berkeley are calculated as follows. No benefits are allowed on salaries of Research Assistants or summer salaries of academic personnel. Non-academic personnel benefits are 10 per cent; academic personnel salaries (exclusive of summer) are 13 per cent.

C. Permanent Equipment

1. Two Uher tape recorders and accessories are requested for essential linguistic recording and transcription. They will also be used in ornithological data collection of bird calls.

2. A 250 mm Nikon lens will be added to other photographic equipment purchased with National Science Foundation funds on grant GS-1183. Cinema cameras will be provided by the Department of Anthropology at Berkeley.

3. A portable typewriter with special linguistic keyboard will serve as a field typewriter for all personnel. Final research reports will be produced on an IBM electric typewriter purchased earlier on National Science Foundation funds, GS-1183.

4. An Everest pocket altimeter is essential for accurate information on elevations.

5. Reliable transportation in and out of Amazonia with irreplaceable biological collections, as well as that required for professional personnel, will necessitate the purchase of a truck. Cost of the vehicle is reduced by one-half due to our plans for its purchase in Peru where we will not be required to pay 100 per cent duty charges. Public transportation within the area to be covered is sporadic and time-consuming. Air transport of equipment is possible only within a limited area and is quite costly. No upkeep costs are requested as these will be covered by the Museo de Historia Natural.

6., 7. Travel in the Aguaruna area proper can only be made by water transport. For this purpose we plan to have a 9-1/2 meter wooden boat constructed in Santa Maria de Nieva which will be outfitted for transporting dried plant and animal materials. Its cost is minimal in comparison with that required for a comparable aluminum craft. The 40 horsepower Evinrude outboard motor has been found to be the most efficient and reliable engine for traversing this portion of the Marañón and its larger

tributaries. A smaller motor is ineffective in moving up-river against heavy current; a larger one is difficult to maintain and susceptible to breakage in shallow waters. In addition, numerous Peruvian pilots use the same engine and there is now a small but nonetheless critical inventory of parts in and around the village of Nieva.

D. Expendible Supplies

1. & 2. Zoological collecting and karyotype equipment are required for mammals, birds, fish and reptiles. This figure is low due to contributions of additional gear from the cooperating Museums.

3. & 4. These supplies are essential for collection and preparation of plant and animal materials. The figure is low due to contributions from the University of California Herbarium and the Museo de Historia Natural.

5. Standarized data on native diet and food habits will require the purchase of special equipment such as scales, balances, food preservation chemicals and reference books.

6. Camping field facilities cover costs of normal gear and outboard motor fuel and upkeep. Tents will not only be used in areas where native housing is unobtainable but are also effective as drying ovens for both plants and animals. An effective generator and converter will allow for a reliable light source in our permanent field site.

7. A small amount is requested for essential medicine and emergency medical equipment.

8., 9. & 10. These categories include required film, recording tape and miscellaneous equipment.

E. Travel

1. Domestic travel will be required for three senior investigators and three research associates to scientific meetings, herbaria and museums (United States National Museum, Field Museum, American Museum and others).

2. Foreign travel is computed at tourist round-trip air fare from San Francisco to Lima. Funds are requested for five investigators (Berlin, Patton, O'Neill, Lavenberg and Wright) and two research assistants during the first field session. In June, 1972, Berlin will arrive for a 12 month field period when he will be accompanied by his wife, a Registered Nurse, and his two small children. In June of 1973, Patton, O'Neill, Lavenberg, Wright and two graduate assistants will join the investigator for the last summer period. Ferreyra will make one trip to the United States where he will visit herbaria in Berkeley, Chicago, Washington and New York.

3. In field travel. Our plan is to establish a semipermanent field site from which the field parties will be able to make periodic trips into different areas of Aguaruna territory. In the initial stages certain subsistence expenditures in Lima will be incurred by project personnel. We request \$ 24/day for fourteen days in Lima for each of five investigators.

In field travel and subsistence costs are estimated at \$ 5/day for 200 days per investigator for six investigators over the 18 months that the field party will be in Peru.

F. Publication Costs

Funds are requested in this category to cover expenses related to manuscript preparation, reprints, printing of labels, and supplies such as postage, etc., not normally covered elsewhere.

G. Other Costs

1. In addition to the research assistants from the United States, we request funds for two Peruvian field assistants with training in field botany. These assistants will aid Dr. Ferreyra in botanical collecting, drying and distribution of botanical specimens. Their salaries are calculated at \$ 250/month for 9 summer months and \$ 200 per month for 15 academic months over the full grant period.

2. Aguaruna field assistants (ethnographic informants) must be reimbursed for time spent on the project. We anticipate using six trained Aguaruna full time over the 17 months of actual field time. Additional Aguaruna informants will be paid on a piece-work basis for their services. Salary rates of \$ 50 per month per informant are

in line with salaries they would receive doing comparable work.

3. We anticipate a small expense for film processing and printing.

4. While some shipping costs will be covered by the participating institutions, funds are requested for transporting the large amount of data and equipment sent to Lima and returned to the States.

APPENDIX 1

An Ethnobiological Survey of Amazonian Peru:
The Aguaruna Area of the Upper Marañón River

Final Report Submitted to the Wenner-Gren Foundation for
Anthropological Research

Brent Berlin

An Ethnobiological Survey of Amazonian Peru:
The Aguaruna Area of the Upper Marañón River.
Final Report Submitted to the
Wenner-Gren Foundation for Anthropological Research

by
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Introduction

During the month of August, 1970, I led an anthropological expedition into the Upper Marañón River area of Amazonian Peru. The expedition was generously supported by a grant from the Wenner-Gren Foundation for Anthropological research whose aid is gratefully acknowledged. I provide below an outline of the expedition's field session, its major findings, and my plans for future ethnobiological research made possible by this initial pilot project.

Initial preparations

As outlined in my earlier proposal to the Foundation, I planned to spend the first week in August attending the meetings of the 39th International Congress of Americanists which were held in Lima, August 2-9. This period allowed me to contact interested persons involved in Amazonian ethnography as well as to initiate preliminary talks with Peruvian officials concerning permission required for long-term research in the country. I learned at this time that Dr. Stéfano Varese, Director of the Centro de Investigaciones de Selva del Instituto Raúl Porras Barrenechea was also planning to begin basic anthropological research in the Aguaruna area and that possible collaboration with his project and mine might be arranged. More importantly, at least so far as this first pilot study was concerned, I met

ment of Anthropology, University of Bergen, Bergen, Norway. Dr. Siverts and I had both worked on separate tribes of the Tzeltal, a highland Mayan group of Chiapas, Mexico. Quite independently, both of us had decided to shift our ethnographic foci to South America and to a tribe of the Peruvian Jivaro. After initial surveys, each independently had selected the Aguaruna.

While my interests lay in the ethnobiological aspects of Aguaruna cultural knowledge and its relation to adaptation, Dr. Siverts hoped to survey Aguaruna socio-political organization. Clearly, our interests complemented one another in important ways and we at once decided to join forces in this preliminary study. In addition to Dr. Siverts, and myself, the field party included Mr. Eugene Hunn, Department of Anthropology, University of California, Berkeley, who was accompanying me and responsible for a preliminary study of Aguaruna Ethno-ornithology.

The Field Survey

The Aguaruna are a little known tribe of primitive horticulturalists residing along the Upper Marañón River and its many tributaries in the department of Amazonas, Peru. Almost nothing is known about their exact numbers and estimates range from as few as 8,000 to as many as 15,000 persons. Linguistically, and culturally, the Aguaruna are considered as one of the four large tribes which comprise the Jivaroan language family (McQuown 1955).

Jivaro proper are found primarily in Ecuador and as a tribe are without doubt the best studied of the family. Huambisa is a group located in the Northern Santiago River area. Aschaul, the third language, is found between the Santiago and Morona Rivers and their tributaries north of the Marañón. Aguaruna is clearly the most populous of the four major tribes and is linguistically the most divergent member of the family.

Ecologically, the Aguaruna span one of the most biologically diverse areas of the American Tropics, i.e., that rich transition zone connecting true Amazon Basin with the rugged sub-tropical foothill or montaña region which lies east of the Andes. They practice an extensive form of swidden horticulture, sweet manioc representing their most important staple.

The region of tropical forest in which speakers of Aguaruna are found is a vast one running from 4-5° south latitude to 77-79° west longitude. It may, in fact, cover an area of no less than 10,000 to 15,000 square miles. Our survey revealed that no large concentrations of Aguaruna are to be found; most members of the tribe are widely dispersed and living in quite isolated extended family dwellings. While the majority of the population reside along the larger rivers and tributaries, our expedition indicates that an adequate survey of the total population in all its diversity will be a most difficult task.

Since we could not hope to survey the full area inhabited by Aguaruna in the brief time allotted us, we planned to cut a broad circle through the center of their territory in an effort to maximize our chances of seeing as diverse an area as possible. Given these goals, we organized the following expedition (see accompanying map). From the small settlement of Chiriaco (indicated as 1 on the map), we set out through dense tropical forest in an eastwardly direction towards the Tuntungus River, a tributary of the Chiriaco. Our first major leg of the survey was to take us across the Southern frontier of Aguaruna country, always hiking almost due east to the headwaters of the Nieva River. This represents a distance of approximately twenty-five air miles, but the difficulty of the jungle terrain, with its many ridges and numerous streams, makes the journey by foot considerably longer. We were able to make the trek (from Chiriaco to the Nieva) in a week, stopping at Aguaruna homesteads on the Tuntungus River (2), at the interior homestead of Ankushim (3) and at several hamlets

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on the River Cachiaco, (3,4), a tributary of the Nieva.

At the confluence of the Cachiaco and the Nieva, (5) we obtained a canoe for our water trip down the Nieva, one of the larger tributaries flowing northward into the Marañón. This journey, which was to take us three days, allowed us to observe some of the more acculturated Aguaruna settlements along the Nieva (6,7) as well as to gain some idea of how rapidly the tropical forest in this particular area is giving way to the farming efforts of recent immigrants from the Peruvian Sierra. The Aguaruna along the Lower Nieva have been radically effected by the government's plans to develop this portion of the jungle and, while certain efforts are being made to adequately provide sufficient land for the aboriginal inhabitants, many Aguaruna are being forced out of the most habitable locations.

The termination of our voyage down the Nieva was reached when we arrived at the small settlement of Santa María de Nieva (8), a village of approximately 250 people, which was formed primarily due to the efforts of the Jesuit Mission there. The Mission and its active personnel clearly are the major driving force of the town. Large numbers of Aguaruna children, mostly young boys but now, a greater percentage of females, attend primary school where they are instructed in Spanish. The Mission at Nieva also administers a large number of outlying schools through the Aguaruna area, all with the cooperation and authorization of the Peruvian government. We were gracefully received by the Mission fathers and their help was especially useful to us in carrying out our reconnaissance. Several of the Jesuit priests are very well informed as to aspects of Aguaruna culture and one of them, trained as an anthropologist, is actively conducting ethnographic studies among this group.

From Santa María de Nieva, we proceeded up the Marañón to the Cenepa River (9,10) and from there northward to the military outpost of Chavez Valdivia at the confluence of the Cenepa and the Comaima(11).

We had reports that some of the least acculturated Aguaruna live on the upper Cenepa and Comaima. The efforts of the schools is most recent here and no government projects for settling this area have yet gone into effect. Our stops along the Cenepa verified this observation. Numerous Aguaruna males continue to wear their hair in traditional style, long and tied in a long braid down the back. The tipi, the long wrap around skirt, is also found in abundance.

Because of restrictions placed on our movement by the military officials at Chavez Valdivia, we were unable to continue on with our journey up the Comaima and to the Mumpatakay River to the West. Nonetheless, we did learn at this time of a possible migration of Ecuadorian Jívaro into the Northern Cenepa area. No Aguaruna are found in this region and we are told that a major reason is the fact that they fear the more war-like Jívaro. There is at least one verified report of an Aguaruna family being murdered by a Jívaroan raiding party in this area and Peruvian army reconnaissance parties operating in helicopters report settlement patterns which correspond in all respects to Jívaro type found in Ecuador.

From our trip up the Cenepa we returned again to the Marañón and completed our journey coming full circle by moving upstream to Imaza, the last army-department of agriculture experimental station located at the end of the new road and the confluence of the Imaza river with the Marañón (12).

General Observations

One of my primary concerns throughout the month-long survey was to obtain a tentative idea of the typical Aguaruna's knowledge of his natural world. As outlined in my original proposal to the Foundation, the major purpose of the expedition was to "...collect basic ethnographic, ecological and linguistic information pertinent to the selection of several appropriately isolated and unacculturated Aguaruna communities in which long-term

ethnobiological research can be conducted." These data were not to provide me with a more realistic picture of the field situation in the area under consideration so that I might draft a comprehensive proposal for a major grant to the National Science Foundation. I am pleased to report to the Foundation that the expedition was a success as concerns these major goals. I have made extensive photographic records of the expedition, both 35mm slide and Super-8mm cinema film, copies of which I have deposited with the Lowie Museum of Anthropology, University of California, Berkeley. The complexity and difficulties of ethnographic field work in the tropical forest is now more fully appreciated and I will be able to make my plans accordingly. Through the efforts of Mr. Eugene Hunn, we have a preliminary idea of some of the major outlines of Aguaruna ethnoornithological knowledge, a report of which is found as an Appendix of this summary.

Data collected during our short field survey indicates unquestionably that the Aguaruna's appreciation of his complex tropical forest environment is nothing less than phenomenal. Walking through dense tropical forest with an Aguaruna guide is a fascinating and awe-inspiring experience. One is quickly provided with a separate distinct name for what appear to be each botanically distinct tree. On numerous occasions, we were presented with a piece of bark off a tree that could barely be seen in the dim forest light. Our guide would smell it, taste it, and then firmly provide us with the plant's correct name. From one resting spot in the forest, one Aguaruna informant easily listed names of no less than forty distinct trees visible from his place on a fallen trunk. Reports from the naturalist José Maria Gualart, a Jesuit priest who has resided among the Aguaruna for fifteen years, indicate that the group recognizes no less than fifty distinctive classes of palms. One recently discovered species of Chamedorea recognized by the Aguaruna proved to be new to science.

Extensive linguistic diversification is also found in cultivated plants, many of which are, botanically speaking, a single species. The common sweet manioc, Manihot esculenta Crantz, represents the Aguaruna's basic staple and is cultivated in large quantities. In the brief time available to us, I was able to elicit as many as twenty-five distinct specific names for manioc varieties. While unable to determine the extent to which this knowledge is widely shared by all members of the society, I did ascertain that the classes are reliably recognized for those speakers for whom they apply. A brief example will illustrate this view more fully. After having elicited the set of names for kinds of manioc (máma), I instructed my poorly bilingual Aguaruna male informant to ask his wife to bring me an example of each kind. I followed her into her manioc garden to observe her as she went about this task. I was amazed to find that all varieties are apparently planted in the same field in a rather hap-hazard fashion. Nonetheless, walking slowly and examining the stem and leaf character of the mature plants, the woman with ease recognized the variety in question and brought me a portion of each. She was equally adept in assigning the appropriate name to the tubers of the respective classes regardless of their striking similarity to the eyes of the untrained ethnographer. Since manioc is rather uniform in its gross morphological characters, such selection and differentiation on the part of primitive ethnobotanists will be of considerable interest to the anthropologist interested in perception and classification.

The basic taxonomic structure of the Aguaruna plant world appears to conform in many respects to plant taxonomies found in primitive societies elsewhere in the world (Berlin, Breedlove and Raven 1966, 1968, Berlin n.d., in press, Conklin 1954). There is, for example, no single expression for 'plant'. On the other hand, at least three major

classes, referring to major life-forms, are recognized linguistically--númi 'tree', dák 'vine' and dapa 'herbaceous plant'. Again, in conformity with primitive principles of classification of the plant world, culturally significant or morphologically aberrant plants are conceptually treated as separate classes. Thus, all palms are given distinctive names and are not included in the class, 'tree'. Likewise, ferns, epiphytes and other morphologically aberrant forms are considered as unique, unaffiliated taxa. All cultivated plants, e.g., sweet manioc, yam, corn are separate taxa regardless of morphological characters which might place them in one of the three major classes.

Nomenclaturally, Aguaruna plant names follow strictly linguistic principles which I have suggested elsewhere to be universal (Berlin n.d., in press). Thus, the vast majority of names are monomial generic expressions and only a very restricted set of plant names are binomial specifics. As would be predicted, binomial nomenclature occurs only in cultivated plants such as manioc, e.g. dáya máma, pumkúma máma, úmiy máma, etc., clearly an organism of major cultural significance. (For an identical observation on ethno-zoological nomenclature see report by E. Hunn, Appendix).

The Aguaruna knowledge of the zoological domain appears to be equally as diverse and complex as their appreciation of the plant world. One of the only studies on Aguaruna ornithological vocabulary (Guallart 1964) reports at least 151 distinct generic bird names. No less than 1/6 of the total vocabulary published in a small missionary dictionary of the language refer to classes of animals (Larson 1964).

The importance of a knowledge of animals is indicated as well in the centrality of hunting. For the Aguaruna male, hunting continues to be a major activity and he is apparently introduced to the animal world at a very early age. Our informants took great delight in our efforts to collect birds in nets and exhibited intense interest in our attempts to ob-

tain their correct names. The importance of animal hides sold for trading purposes, while on the decline due to over-hunting in some areas, continues to be a major incentive for the hunting of larger mammals. Clearly, much of the time of the Aguaruna male is spent in activities directly related to his appreciation of the animal kingdom.

Future research plans made possible by Wenner-Gren Foundation pilot study.

As a consequence of this first reconnaissance, I plan to apply for an initial two-year exploratory project hopefully to be funded in part by the National Science Foundation of the U.S. Government. The project will represent an international collaborative effort between the University of California, Berkeley, the Universidad Nacional Mayor de San Marcos, and the University of Bergen. The ethnobiological program will be coordinated by myself, (ethnology section) Dr. James Patton, University of California, Berkeley, Museum of Vertebrate Zoology (zoology section), and Dr. Ramón Ferreyra, Universidad Nacional Mayor de San Marcos, Museo de Historia Natural "Jarvier Prado" (botany section).

The project, "Ethnobiological Aspects of Tropical Forest Adaptation in Amazonia Peru" is scheduled to begin in June, 1971. If funds are forthcoming, the first field party will spend the summer of 1971 establishing a field base, most likely at Santa María de Nieva, located at the confluence of the Ríos Nieva and Marañón, or at Imazita, a Peruvian army base just above the confluence of the Ríos Imazita and Marañón. Initial collecting will also be carried out during this time. Curating of plant and animal material will be continued during the academic year of 1971 at the Museo de Historia Natural in Lima and the Museum of Vertebrate Zoology in Berkeley.

In June, 1972, a fifteen month field period is scheduled to begin

during which the major ethnobiological data collection will be carried

out through a selected transect of the Aguaruna territory. A further six months of analysis and write-up will close this first phase. Should our first two-year project be successful, further support will be sought which will tentatively cover a period of five to seven years.

Significance of the Proposed Research

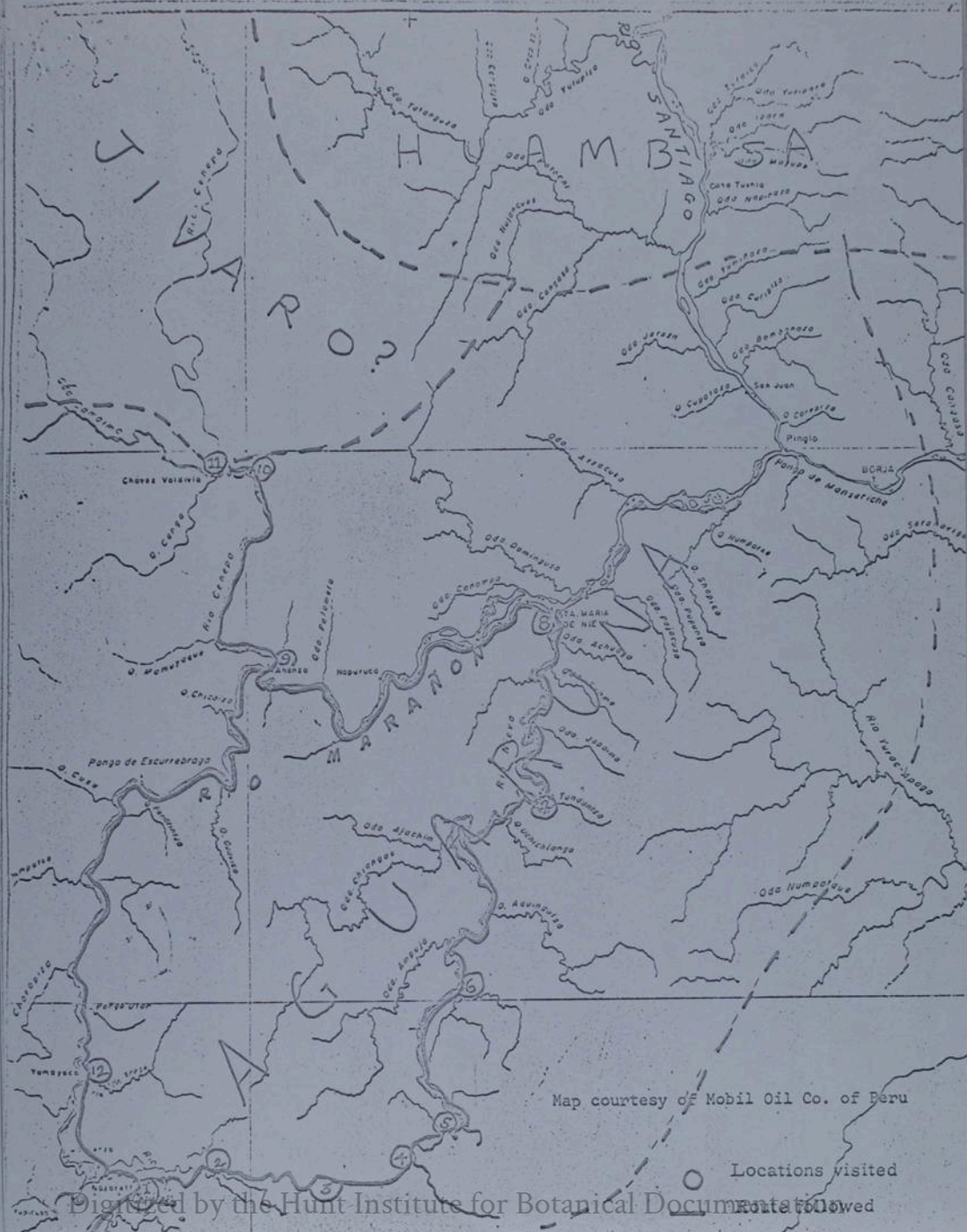
As pointed out above, the area under consideration represents one of the most biologically diverse areas in the world, some seven tropical and sub-tropical ecological zones being found, yet is almost completely unexplored. There is no question that many new species and most probably genera yet unknown to science will be discovered as a direct result of the proposed research. Furthermore, no coordinated effort aimed at capturing the knowledge of the tropical forest by a pre-scientific people has yet been carried out anywhere in the world which systematically includes information for the anthropological, botanical and zoological sciences.

While there is no indication that the Aguaruna, who may number as many as 15,000 people, are in danger of extinction, it is clear that the tribe will ultimately be absorbed into national Peruvian society. As such, a detailed description of their adaptation to the tropical forest and their knowledge of this rich environment becomes a matter of urgent anthropological concern.

Finally, recent ethnobiological investigations by myself and others dealing with the principles of classification employed by pre-scientific peoples in diverse areas of the earth suggest important general underlying similarities that promise to reveal universal mental processes common to all mankind. The proposed project would hope to further explore these ideas and will undoubtedly form an important data-base from which scientific generalizations can be formulated.

Acknowledgements

In addition to the Wenner-Gren Foundation for Anthropological Research, I would like to formally acknowledge support provided by the Language-Behavior Research Laboratory, the Center for Latin American Studies, and the Lowie Museum of Anthropology all of the University of California, Berkeley. Persons in the United States and in Peru who have been especially helpful are Dr. Henning Siverts, Department of Anthropology, University of Bergen; Padre Luís M. Uriarte, S.J., Padre Jesús María Guallart, S.J., Padre José Hernandez, S.J., all of the Jesuit Mission in Santa María de Nieva; Dr. Ramón Ferreyra, Herbario San Marcos, Museo de Historia Natural "Jarvier Prado"; Dr. Lincoln Constance, University Herbarium, University of California, Berkeley; Dr. Oliver Pearson, Museum of Vertebrate Zoology, University of California, Berkeley; Dr. Stéfano Varese, Centro de Investigaciones de Selva, Instituto Raúl Barenchea; Mr. John O'Neill, Museum of Zoology, Louisiana State University; Dr. Eugene Loos, Summer Institute of Linguistics; Dr. Mildred Larson, Summer Institute of Linguistics; Mr. Edward Purcell, United States Embassy, Lima; Mr. Richard Leonard, Mobil Oil Company of Peru; and Sergeant II G.A. Gregorio Bela Rituay, Chiriaco, Amazonas. I also thank Dr. Kenneth Kensinger, Dr. John H. Rowe, Dr. Robert Carneiro, Dr. Michael Harner and Mr. Warren DeBoer for useful advice in selecting the Aguaruna as a potential tropical tribe for ethnological study.



Appendix

Preliminary Report on Aguaruna Ethno-ornithology

Eugene Hunn

During our first reconnaissance of the Aguaruna territory we recorded 68 Aguaruna bird names with specific scientific referants, most elicited in response to live birds, captured or in flight, or skins. This sample of terms may be considered a more or less random 10% sample of the Aguaruna ethno-ornithological lexicon. The following features of Aguaruna bird nomenclature should prove to be of special interest to the ethnobiologist.

- 1) The great majority of terms elicited are generic as defined by Berlin (in press). One term, Píšak, may name a super-generic residual category of "dicky birds," including a large number of generically named categories. Another term, pínčú, appears to be transitional between generic and super-generic. This term could be glossed as Hawk-Falcon. It is used much as the term "duck" in the combination "Mallard Duck," an admissible utterance but less preferred than "Mallard" alone. There are four generic terms in our sample which are included in pínčú. Only one case of truly specific nomenclature appeared, two classes of šúwi (gloss: Oropendola), muun šúwi (*Gymnostinops yuracares*: "big" šúwi) and suwák šúwi (*Psarocolius decumanus*).
- 2) As yet no term for "bird" in general has been elicited. This raises the question whether "bird" is best considered a unique beginner and birds a domain, rather than a major class within the domain of animals.
- 3) Very few of the terms elicited appeared in response to more than one species. Therefore, despite our small sample, we can conclude that the Aguaruna terminal taxa correspond closely to the specific level taxa of the ornithologist. The exceptions noted so far (which are examples of "lumping") are curious. Three kingfishers (family Alcedinidae), varying greatly in size, are lumped as šáhi. Two "shorebirds" (sub-order Charadrii), differing greatly in size, plumage pattern and manner of flight, are both called tífikig. Two riverside flycatchers are also lumped. These three cases all involve riverside species. A

possible explanation: the Aguaruna are not so much "river people," that is adapted to living on and off of the rivers, as "forest people." Hence a relative lack of concern for birds restricted to a riverside habitat. There is also, however, tentative evidence of some lumping of parrots, toucans, Ciconiiformes and swallows which needs further investigation.

4) Since the domestication of native birds is rarely and unsystematically practiced, the "cultural relevance" (cf. Berlin, Breedlove & Raven 1966; Berlin, Laughlin & Raven, in press) of bird species will be a minor factor affecting the Aguaruna system of classification. Thus deviations from the etic "grid" should reveal as yet unanalyzed factors associated with "lumping" or "splitting." Overall it appears likely that Aguaruna bird names will map more closely to the etic grid than any ethnobiological domain yet described.

5) Idiosyncratic and geographical variation may be minimal. Names elicited for the same species from more than one informant in more than one area were identical in the few cases so far documented.

6) The problem of sexual dimorphism has not "confused" the Aguaruna in the cases uncovered so far. We netted three pair of the Silver-beaked Tanager, Ramphocelus carbo. The males are velvet black with blood-red feather tips on the head and a silver lower mandible. The females are identical in size and shape but uniformly rufous-brown with an all-dark bill. Several Aguaruna present agreed that the males were áyšman and the females núa of the same species kanampóš. A skin of a female Lemon-throated Barbet, Capite richardsoni, and a male Golden-headed Manakin, Pipra erythrocephala, were properly sexed by an Aguaruna informant. This suggests an incredibly intimate knowledge of even the smallest birds, the skins of which are used for decoration, but which otherwise are of no economic importance.

Clearly the Aguaruna will tell us many things about man's urge to name and classify the natural world around him.

Eugene Hunn

September 1, 1970

Aguaruna Bird Lexicon

1. ačanyáp (ačayáp) (ačangáp) /áyšman/
Pipra erythrocephala, /male/ Skin, Ankushim: DS 256f;
 & P. chloromeros ? Guallart.
2. ačnts šifk(see 112) Malacoptila sp Guallart
3. ampšš Pulsatrix perspicillata Guallart
4. ámuntaey (ámuntai) (amunte)
Anhima cornuta Guallart; DS 39.
5. apingka pángka /áyšman : núwa/
Taraba major /male : female/ DS 176f; 224f.
6. apu Tigrisoma sp Guallart
7. apu pininši(see 88) Pteroglossus castanotis Guallart
8. atáštas Rallidae sp. Larson
9. ataš chicken In yard, Tuntungus.
 hen Larson.
- 9A. atáš ányum (áyum) rooster In yard, Tuntungus;
 (see 14) Larson
- 9B. atáš núwa hen In yard, Tuntungus.
- 9C. atášš ušiji chick Larson
10. áu (auš) (au) Dacnis lineata Guallart
Cotinga nattererii & DS 256f.
11. augu Nyctibius griseus Guallart
12. ačnts Penelope jacquacu Guallart
13. ayášui montet (pájaro grande) Larson
14. áyum (see 9A) rooster Larson
15. ayumpšji (see 36) Sarcorhamphus papa Guallart
 (see 133)
16. baháey (not pinšu) Pandion haliaetus & DS 55

Appendix 4.

17. bait (maito) (see 23) Crotophaga ani Guallart
locrere (ave parecido el ani) Larson
18. báYu (máYu) Mitu mitu Guallart
Mitu salvini DS 32f
19. bašúkit (mašúkit) Arremon aurantiirestria & DS 384f
amodromo (ave) Larson
20. bihájiš Tyrannidae sp. size of IF, Marañon.
Ochthornis littoralis but
with yellow rump and tail.
Skulks along river banks.
21. bíškin Sayornis nigricans IF, Nieva.
Ochthornis litteralis IF, Marañon.
22. biyúma Colonia colonus & DS 272f.
23. boutu (see 17) Crotophaga ani IF, Imacita.
24. cášínšín (see 40) Scaphidura oryzivora IF, Nieva.
25. šahi (šáji) Ceryle torquata IF
Chloroceryle amazona IF
C. americana IF
26. šamikit Sporophila castaneiventris DS 384f
27. šánkš (šágke) (šanque) Ramphocelus nigrogularis Guallart; Skin,
Tuntungus.
28. šápay (šipi) Ognorhynchus icterotis & DS 96f
Leptocittaca branickii & DS 96f
29. šiamš / áyšman / Teleonema filicauda /male/ In hand, Tuntungus;
(šiamš) DS 256f.
30. šigki ave de caza Larson
31. šijai nanclero Larson
32. šikiwi Buteo magnirostris Skin, Tuntungus;
(šikiwi) (šikiwi pinšu) In hand, Ankušim
33. šinšim (šinšimp/i/) (šinšimp) Atticora fasciata (see 113) IF.
Reinarda squamata IF

Appendix 5.

- | | | |
|---|--|---|
| 34. Ĕiwa (Ĕira) | <u>Psophia crepitans</u> | Guallart; In yard, Cenepa. |
| 35. ĔiwaĔiwa | espeie de ave semejante al trompetero | Larson |
| 36. Ĕuano ayumpĕji (see 15) (see 133) | <u>Sarcorhamphus papa</u> | Guallart |
| 37. Ĕuāng (Ĕuāg) (Ĕuānc) (not pīnĕu) | <u>Cathartes melambrotus</u> | IF |
| 38. Ĕŭwi | <u>Psarocolius decumanus</u>
<u>Gymnostinops yuracares</u> | IF
IF |
| 38.1. muun Ĕŭwi | <u>G. yuracares</u> | IF |
| 38.2. suwĕk Ĕŭwi | <u>P. deumanus</u> | IF |
| 39. Ĕuwitām (Ĕurintan) | <u>Pseudocolaptes sp.</u>
(<u>P. boissonneautii</u>) | Guallart |
| 40. ĕanĕenĕĕ (ĕen-ĕen-ĕĕ) (ĕaĕānĕān : see 24) | <u>Scaphidura oryziera</u> | IF, Nieva. |
| 41. ĕānu | <u>Iridosornis rufivertex</u> ♂ | DS 368f. |
| 42. ĕayāg | imitador | Larson |
| 43. ĕejedŭk | especie de ave | Larson |
| 44. ĕejĕemna | small bird; black with some red and blue feathers | Larson |
| 45. ĕŭĕumanĕ | <u>Sterna superciliaris</u> | IF, Marĕon. |
| 46. ĕŭka | <u>Rupicola peruviana</u> ♂ | DS 256f. |
| 47. ĕŭkaka (ĕukagkā) (ĕucangā) | <u>Ramphastos cuvieri</u> | Bill |
| 48. ĕĕto | <u>Merganetta armata</u> ♂ | DS 40. |
| 49. ĕĕbĕkĕt | <u>Cyanerpes cyaneus</u> ♂ | DS 320f. |
| 50. ĕĕmpi (ĕĕmpe) (ĕĕmpue) | <u>Eutexeres condamini</u>
<u>Tumbaco vallei</u> ♂
genérico : <u>Trochilidae</u> | In hand, Tuntungus.
Guallart
Guallart |
| 51. ĕjŭminu | pipping chick | Larson |
| 52. ĕkĕ k | <u>Aulacorhynchus prasinus</u> ♂ | DS 96f |

Appendix 6.

53. ima	<u>Egretta (Leucophoyx) thula</u>	IF, Marañon; Gualart
54. jempéuau (jempueúó)	<u>Eusifera ensifera</u>	Gualart
55. kahúam (kijuanam)	(cajúnan) <u>Selenidera reinwardtii</u> <u>Andigena hypoglaucha</u> ♂	IF. DS 96f.
56. kaip (caipi)	black eagle sp. <u>Pandion haliaetus</u> (see 16)	IF; Larson Gualart
57. kanampóy (áymán : núwa)	<u>Ramphocelus carbo</u> (male : female)	In hand, Tuntungus.
58. kándut (kántut)	<u>Tyrannus melancholicus</u>	IF.
59. káu	búho	Larson
60. kawáu	loritos	Larson
61. Kawáu (cawó)	<u>Amazona amasonica</u>	Gualart
62. kéjua (quéjua) (kúhua)	tucán chico small toucan	Larson. Verbal description.
63. kíjus (quijus)	<u>Brotogeris jugularis</u> ♂?	Gualart
64. koót@	<u>Pharomachrus pavoniunus</u> (male)	DS 120f.
65. kúhua (see 62)		
65. kújak	curaca, cacique	Larson
66. kunúó	bird	Hunn
67. kúpi (cupi)	<u>Leistes militaris</u> or <u>Pezites militaris</u> .	Gualart
68. kuúte	halcón	Larson
69. kúyu (cugu)	<u>Pipile cumanensis</u>	Gualart
70. kúyu kúyu	tagna	Larson
71. makantáu (macantó) (makantáu pinú)	<u>Herpetotheres cachinnans</u> <u>Micrastur semitorquatus</u>	DS 16, Ipakuma; Skin, Marañon. Gualart.
72. máyu (see 18) mašúkit (see 19)		
72. nanamáy	<u>Chaetura brachyura</u>	IF, Ankushim.

Appendix 7.

73. našipkit	<u>Tangara xanthogastra</u>	Skin, Ankushim.
74. numkángit	<u>Coccopis gularis</u>	DS 384f.
75. nayáp	<u>Elanoides forficatus</u>	Guallart
76. 6o8ap /áyšman/	<u>Euphonia saturata</u> /male/	In hand, Tuntungus.
77. pašpa	pave	Larson
78. pagkuán	perdiz que vive en eslas o riveros del rio (<u>Tinamidae?</u>)	Larson
79. páipain	huishhuinchu	Larson
80. pauái	<u>Aratinga mitrata</u> ?	Guallart
81. pángka (see 5)		
81. papajú	gaviota	Larson
82. pátu	<u>Cairina moschata</u> (domesticated) <u>Phalacrocorax olivaceus</u> and <u>Anatidae</u> (generic)	In yards. Guallart
83. paúm (páu)	<u>Geotrygon frenata</u>	Guallart
84. paumít	palometa	Larson.
85. Piğša	tucáu	Larson
86. piłtsa (pitsa)	like paujil (see 18)	Larson
87. pínđu (pínđui)	<u>Acciptridae</u> and <u>Falconidae</u> (super-generic)	
87.1. šikiwi (š. pínđu) (see 32)		
87.2. makantáu (m. pínđu) (see 71)		
87.3. sai pínđu (see 98)		
87.4. tútu (t. pínđu) (see 127)		
87.5. ukukwi (u. pínđu) (see 132)		
88. pinínđ (nínínđ)	<u>Pteroglossus flavirostris</u> & <u>Pteroglossus</u> sp.	DS 96f IF, Tuntungus.
88. A. apu pinínđ (see 7)		
89. pingša (see 85) (see 47)	<u>Ramphastos cuvieri</u> ??	IF, Cachiayace.
89. piš@k (piš@ak)	"todos los pájaros del mundo" gallo, pato, gallinazo, etc.	except pave, pave del monte, Perhaps a residual generic. Santos.

Appendix 8.

90. Píŕi	<u>Cissopis leveriana</u>	In hand, Tuntungus
91. pitít	kind of black bird	Larson
92. piúŕa	<u>Myiotriccus ornatus</u>	IF, Ankushim
93. piwi (piyei)	<u>Eurypyga helias</u>	Guallart
94. piyái	buitre	Larson
95. púmpuk	<u>Bube virginianus</u>	Guallart
96. púh /múwa/	<u>Capito richardsoni</u> /female/	Skin, Ankushim
97. púus	<u>Odontophorus</u> sp	Guallart
98. sai pínŕu (see 87.3)	(sai pínŕui) (see 71) <u>Herpetotheres cachinnans</u>	Guallart
99. sánti	tuquituqui	Larson
100. saŕsa (sasa)	<u>Opisthocomus hoazin</u>	Guallart; DS 67
101. sawáke	little woodpecker	Larson
102. sékuŕ (sécuŕ)	<u>Tinamus tao</u>	Guallart
103. séuk	unchala	Larson.
104. sétak	kind of bird	Larson
105. simanŕúk (semanŕúk)	<u>Tangara chilensis</u>	Skins, Ankushim; Guallart
106. súgka	kind of large black bird	Larson
107. suntín	<u>Glaucidium brasilianum</u>	Guallart
108. ŕaámak	<u>Ara militaris</u>	Guallart
109. ŕanáŕna	<u>Daptrius ater</u>	Guallart
110. ŕiik (see 2)		
110. ŕimpa	<u>Leptotila verreauxi</u>	Guallart
111. ŕugháem	arrendage	Larson
112. ŕuk (see 2)	<u>Bucco macrodactylus</u>	Guallart
113. ŕwimpá (ŕuwímbip) (ŕumpip) (ŕuimpipi)	<u>Tachycineta albiventer</u> <u>Alopocheilidon fucata</u> ?? <u>Atticora fasciata</u> (see 33) <u>Progne modesta</u>	Gaullart, IF Verbal description Guallart Guallart

Appendix 9.

114. tágtag sinsente Larson
115. takihim /núwa/ Teleonema filicauda /female/ In hand, Tuntungus
(see 29)
116. takúm (Tacúys) guacamayo Larson
117. tánta (tuantá) Ardea cocoi IF, Nieva; Guallart
Jabiru mycteria DS 35
118. tátašam (Tátasan) Phloeoceastes rubricollis In yard, Cachiyaco
Dryocopus lineatus Guallart
119. táttsi Sicalis flaveola & DS 384f.
120. táwai Trogon viridis /male/ DS 160f.
121. táyu Steatornis caripensis peruvianus Guallart
122. teéš (Tees) Cacicus cela Guallart
123. tíngking Actitis macularia IF, Marañon
Hoploxypterus cayanus IF, Marañon
124. tíngħaša (tejušš) (Tejasa) Melanerpes cruentatus In yard, Cachiyaco;
Guallart
125. tinku (Tincó) Loro grande Larson
126. túngki Aramus guarauna & DS 68
127. tútu (t. pínšu) Falco ruficularis ? IF
(See 87.4)
128. tututag (tututá) Piaya cayana ? Guallart
129. tuwíš (tuwíš) (tubiš)
Pionus menstruus &
Forpus conspicillatus & DS 96f
Pionus sp. Guallart
130. tuyúyu Ciconiidae sp. Picture in Larson
131. úgkum toropischo Larson
132. ukukwi (u. pínšu) (ucucui) (see 87.5)
Buteo albonotatus Guallart
Spizaetus ornatus & DS 16f
133. ukúm t (see 15) Sarcorhamphus papa IF, Nieva
(not pínšu)
úuš p (see 76) Euphonia (Tanagra) xanthogaster /male/ DS 368f.

Appendix 10.

134. uwačáu (Huachú)	<u>Aburria aburri</u>	Guallart
135. uwágmás	lore	Larson
136. wáča (Huača)	guacamyo	Larson
137. wága	<u>Tinamus major</u> <u>Tinamus guttatus</u> ?	Guallart In yard, Cachiyaco
138. wagkúš	aldarta, perdiz pequeño	Larson
139. wáh wípia	<u>Elaenia albiceps</u> ♀	DS 272f.
140. wakáts	manacaraco	Larson
141. wakám	<u>Hypocnemis cantator</u> /male/	In hand, Tuntungus
142. wankúš (Huancúš)	<u>Crypturellus undulatus</u>	Guallart
143. wapatág	marabú (<u>Ciconiidae</u>)	Larson
144. wáyuim	"Gallinazo de cabeza negra" (<u>Coragyps atratus</u> ?)	Verbal description
145. wíčuču	Large, white night-flying bird	Larson
146. wíyum	quetzal (<u>Trogonidae</u>)	Larson
147. yákakan (yácace)	<u>Daptrius americanus</u>	Guallart
148. yámakau	kind of bird	Larson
149. yampíngpíts	<u>Columbigallina (Columbina) minuta</u>	DS 96f
150. yampíts (yámpits)	<u>Osculatia saphrina</u> & <u>Zenaidura macroura</u> ?	DS 96f. Guallart
151. yúsa	<u>Ara macao</u>	Guallart
152. yusánun	guacamayo (rojo)	Larson

Major Class Terms in Aguaruna

1. "Todos los animales del mundo" (sic) except "monos," "perros," etc.
kúntin
2. "...pájaros..." except pavo, pavo del monte, gallo, pato, gallinazo, etc.
piʒək
3. "...culebras..."
dāpi
4. "...pescado..."
mamayák
5. "animales que viven en el río" but not lagartes.
yantána
6. "...monos..."
yakúm
7. "...ranas..." (edible)
kuhwó
8. "...sapos..." (inedible)
takáʃu

<u>Key</u>					
ɛ	s	j	h	—	@ ± I /áysman/ /núwa/
c	s	j	fi	accent	nasalization male in Aguaruna female, ditto
ɛ	j, h	ɛ	/i/	DS	
Species named may not occur in the area.		equivalent	ts	unvoiced	DeSchauensee, R.M. <u>Birds of Columbia</u>

IF

Bird identified in flight.

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Universal Nomenclatural Principles in Folk Science

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Introduction

Since about 1954, modern field research has been carried out by a number of ethnographers and biologists in an effort to more fully understand the nature of folk taxonomies. Much of this work has been devoted to studies dealing with the folk classification of plants and animals by non-Western societies. It has now become apparent that several important and far reaching generalizations can be formulated which promise to throw considerable light on primitive man's classification and naming of his natural universe.

In this paper, I will summarize briefly some of the findings that will be more fully documented in future publications (see Berlin, Breedlove and Raven n.d.; Berlin n.d.; Berlin, Breedlove and Laughlin n.d.).

The reality of natural groupings

A first generalization growing out of empirical ethnobiological studies of the last several years concerns the obvious--yet undocumented--imperative need of man to order his natural universe into some understandable system.

In societies which maintain a direct and intimate contact with nature, it is inevitable that overt linguistic recognition be given naturally occurring groupings of organisms of the biological universe. Bulmer, in a recent series of perceptive papers on the ethnosience of the Karam of New Guinea (1965, 1967, 1968, n.d. Bulmer and Tyler 1965) has presented the most explicit statements in this regard. Such a position has been argued as well by Lévi-Strauss and others.

It is clear from these researches that these natural groupings of organisms are "... marked off by multiple distinctions of appearance, habitat, and behaviour... (Bulmer and Tyler 1965:24). They are seen as objective units by native speakers and represent the minimal, habitually designated classes of flora and fauna.

These minimal units may or may not correspond in a one-to-one fashion to modern biologically defined taxa (see Bulmer and Tyler 1965, Berlin, Breedlove and Raven 1966). They are logically comparable, whoever, in that in numerous instances such groupings are formed on the basis of "...objective regularities and discontinuities in nature" (Bulmer n.d. 6).

Universal nomenclatural regularities

A second generalization reveals that the nomenclatural principles which are applicable in the linguistic designation of these natural groupings are essentially identical in all languages.

In examining the ethnobiological lexicon of many languages, one is immediately struck by the fact that the vast majority of all plant or animal names fall into one of two classes. One class is comprised of forms which are, for the most part, unique, "single-word" expressions which can be said to be semantically

unitary and linguistically distinct. Examples of such unique forms may be illustrated by the terms oak, pine, spruce and maple in English folk botany. A second group of expressions is comprised of members of the first class in variously modified form, e.g., black oak, white pine, blue spruce, sugar maple, etc. Psychologically, examples from the first class of terms may be seen to be more "basic" or "salient" than those of the second (the latter having been derived from the former) in much the same sense that the color lexemes red, yellow and green are more basic than reddish, yellowish and greenish.

The ethnobotanist H. H. Bartlett recognized this fundamental difference in his paper, "History of the Generic Concept in Botany" (Bartlett 1940). For Bartlett, the "concept of genus must be as old as folk science itself" (1940:341). He defined the notion as any class "...which is more or less consciously thought of as the smallest grouping requiring a distinctive name" (ibid.:356). While fairly vague as a definition, Bartlett's idea concerning the fundamental nature of generic taxa and their corresponding distinctive labels is essentially correct in essence. In fact, generic names can be seen to exhibit a readily identifiable linguistic structure which allows, in most cases, for their immediate recognition (see now, Berlin, Breedlove and Raven, n.d.; cf. also Conklin 1962:122).

Several criteria--linguistic, taxonomic and psychological--may be utilized in recognizing generic and non-generic names in ethnobiological nomenclature. Linguistically, generic names satisfy most of Conklin's (1962) criteria for unitary lexemes, i.e., expressions "...no segment of which may designate categories which are identical with, or superordinate to, those designated

by the forms in question" (1962:122). Names such as oak, pine and maple would thus be analyzed as simple unitary lexemes while jack-in-the-pulpit, poison oak, and kiss-me-over-the-garden-gate would be complex unitary forms (see Table 1).

A non-generic name may be recognized, in most cases, as satisfying Conklin's definition of composite lexemes, i.e., any expression "...one or more segments of which, under specified conditions may (a) designate the same categories as those designated by the forms in question (abbreviation) [e.g. lima, in lima bean] or (b) designate categories superordinate to those designated by the forms in question (generalization) "[e.g., oak in port oak, since port oak is a kind of oak]." (Some expressions, such as tulip tree, planer tree, pipe vine, to name a few, are superficially analyzed as composite lexemes but are, on semantic and taxonomic criteria, actually unitary forms.)

Taxonomic criteria are also important in recognizing generic names. The smallest groupings of plants and animals labelled by unitary lexemes may be defined as generic taxa. The unitary lexemes which label such taxa may be defined as generic names. It is almost invariably the case that taxa of less inclusiveness than folk genera are labelled by composite lexemes and can be shown, taxonomically, to be immediately included in generic taxa.

Finally, psychological criteria also are of relevance in recognizing generic names. Generic names, like basic color names, are highly salient psychologically. They are most readily elicited from native informants and most easily recalled by them. There is evidence from one investigation (Stross, n. d.) that generic names are learned by children as the first expressions in the ethnobiological lexicon.

The structure of specific names

Names for groupings of organisms of lesser inclusiveness than the folk genus also can be seen to exhibit a well-defined uniform structure, which appears to be a near-universal.

The general nomenclatural rule in specific name formation is to modify the generic name with a single attributivizing expression. The resulting form is logically identical to the Linnean binomial. In actuality, it is more correct to state the the Linnean binomial is generated in terms of the principles found in common speech and from which the scientific forms may be seen to have developed. [While this point has often been assumed by biologists, it has never been documented with large bodies of systematically collected ethnographic data].

The vast majority of all specific taxa in folk taxonomies are simple binomial expressions which make up specific contrast sets comprised of two (rarely more) specific names. Thus, one commonly finds some generic name x , partitioned with two specific categories, ax and bx where a and b mark values on dimensions such as color (black-red), size (large-small), texture (rough-smooth) or the like. Specific contrast sets of more than two taxa are almost invariably groupings of organisms which have high cultural significance.

A widespread, and perhaps totally general nomenclatural principle observed in the formation of specific names is reflected by what has been referred to in phonological analysis as marking. Thus, it is very common to observe specific contrast sets of two expressions where one specific class will be recognized as the type-specific, or ideal type, and will appear unmarked while the

second specific class will be marked. Invariably, the type-specific will be polysemous with its superordinate generic in characteristic usage. Examples can be seen in many languages (see Table 2).

Wyman and Harris, writing on Navaho ethnobotany described this nomenclatural rule as follows: "The situation is as if in our binomial system the generic name were used alone for the best known species of a genus, while binomial terms were used for all other members of the genus." (Wyman and Harris 1941:12).

While many languages find no need to obligatorily mark the focal type-specific within a particular grouping of specific names, a situation which I suggest is characteristic of the process employed in the earliest specific name formation, instances of social intercourse may arise whereby one must be able to linguistically differentiate the type-specific from its contrasting neighbor(s). The linguistic process by which this contrast comes to be indicated is also universal. Invariably, the type specific will be modified with an attributive-like expression best glossed as 'genuine', 'real', or 'ideal-type'. Such a situation is found characteristically in many languages, of which Tzeltal, Hanunóo, and Karam may be cited as examples (see Table 3).

In the Tzeltal classification of chili-peppers, ʔiĉ, the generic name, in most contexts, can be used alone to refer to the most prominent specific class. However, when greater precision of designation is required, the attributive bac'il 'benuine' is readily applied to distinguish this specific class, bac'il ʔiĉ 'genuine chili pepper' from its contrasting coordinate specific classes.

An identical nomenclatural principle has been described for Hanunóo. Conklin, in an as yet unpublished ethnobotany of this people, notes that "...a shared term [i.e., a generic plant name partitioned by two or more specific names] when not followed by an

attribute, may be read as that term plus ʔurunan 'real'. The resulting name is a preferred synonym, required where the designated plant name is distinguished from others in the same set" (Conklin 1954:259).

The depth of folk taxonomies

A third important generalization about folk taxonomies is that all such structures are characteristically shallow if one focuses solely on the named taxa of each system. Superordinate taxa of greater inclusiveness than the folk genus are invariably few in number, refer generally to life forms of large groupings of organisms (e.g., 'tree', 'vine', 'grass', 'flying animal', 'large mammal', or the like) and are inclusive of the majority of all named taxa. Subordinate taxa smaller than that of the folk species are likewise few in number and occur predominantly in those taxa with critical cultural importance (e.g., cultivated plants or domesticated animals).

It appears that most folk taxonomies are comprised primarily of named generic and specific classes. The concepts of genus and species may be seen as essentially adequate, then, for the classification of pre-scientific man's knowledge of his biological universe.

Covert 'mid-level' categories may be seen to exist in many taxonomies and their recognition is of crucial importance to a full understanding of the complete structure (see Berlin, Breedlove and Raven 1968). However, the fact that these mid-level categories have not been labelled suggests that the need to distinguish such classes is as yet relatively unimportant in most cultural contexts. Named higher order groupings which include generic taxa and which are themselves included in superordinate major class taxa appear primarily as the result of conscious classificatory efforts characteristic of Western science.

The growth of folk taxonomies

Finally, in the brief time available, I can only mention the findings made thus far on the growth of folk taxonomic structures. Given the difficulty of obtaining reliable data on numerous languages, much of what I am about to say can best be interpreted as a logically sound hypothesis which is amenable to refutation or confirmation only on the basis of further evidence.

One thing is clear. Folk taxonomies, like languages, are not stable, inflexible structures. They change through time. It seems obvious that early man's lexicon relating to the classification of his biological universe was more limited in sheer number of elements than that of the ethnobiological vocabulary of man at some later period of development. Given this fact, one may ask: If man's ethnobiological vocabulary, specifically, names for classes of plants, has developed over time, can one observe formal processes of growth which are general for all languages spoken by societies which must deal effectively with their floral and faunal environment? If such patterns can be described, are they related to other aspects of man's socio-cultural development? Finally, do the processes appear to have productive and non-trivial implications for the evolution of vocabulary generally?

The hypothesis suggested here based on tentative evidence for the growth of ethnobiological lexicon may be stated simply as follows: (a) That portion of the ethnobiological lexicon of all languages which refers to names for plants and animals can ultimately be described given the recognition of at least four ethnobiological categories -- generic, sub-generic, supra-generic, and unique beginner. (b) The encoding of these four categories in the life history of individual languages is said to follow the fixed order seen in Table 4.

Furthermore, there is evidence to suggest that languages may be classified in terms of the number of ethnobiological nomenclatural categories which have become encoded in language. While all languages possess expressions which we have referred to as generic names, very few possess habitual higher-order expressions such as 'plant' or 'animal.' These expressions clearly appear late in the life histories of individual languages. Likewise, there is further evidence to suggest that certain languages have only recently evolved names which may represent supra-generic categories. Thus, in many languages the supra-generic term for 'tree' can be seen to be polysemous with a generic name referring to the most important tree, e.g. Shoshone sohóvi 'tree, cottonwood,' Western Apache tíís 'tree, cottonwood'. Likewise, in several languages the supra-generic terms for such major life forms as fish and animal can be shown to be polysemous with important generic kinds, e.g., salmon, in several California languages -- or 'bear' in Orok (see Table 5).

Polysemy of this sort is clearly suggestive that such higher order terms are relatively new in the ethnobiological lexicon of these lexicons. In fact, on comparative evidence, the word for 'tree' in English can be shown to be fairly recent.

Historical evidence from Indo-European provides support for this supposition. Friedrich, who recently has completed a detailed linguistic reconstruction of the Proto-Indo-European arboreal system (Friedrich, in press) states: "...almost all [Proto-Indo-European] monolexemic terms are generic, and what eventually became the general word for 'tree' probably comes from PIE terms for 'oak', which was environmentally one of the most prominent, and of course central in religious symbolism, and so forth" (Friedrich, personal communication).

Buck, in his massive compilation of synonyms of the major Indo-European languages, comes to a similar conclusion: "A widespread group of words for 'tree', many of them meaning also 'wood', go back to an IE word which probably denoted a particular kind of tree, namely the oak" (Buck 1949:48). And again, "Noteworthy is the primacy of the oak, as shown in mythology and in the recurring use of 'oak' as the tree par excellence, for 'tree'" (ibid.:528). Finally, Buck notes the reconstruction "'Oak'. 1. IE*derwo-, dru-, etc., in words for 'oak' and for 'tree', 'wood', the former, specific use being probably the earlier" (ibid.).

In closing, it now appears that the study of principles of ethnobiological classification may contribute in a significant way not only to synochric theories of human cognition but as well to that heretofore tabooed area of scholarly inquiry -- the evolution of language.

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Table 1

Examples of English generic and specific plant names

GENERIC PLANT NAMES

(unitary simple lexemes)

oak	-
pine	-
maple	-
bean	-
squash	-
cedar	-

(unitary complex lexemes)

jack-in-the-pulpit
horse tail
Queen- Ann's lace
hens-and-chickens
tulip tree
pipe vine

SPECIFIC PLANT NAMES

(unitary simple lexemes)

jack oak
ground bean
blue spruce
stinking ash
broad bean
sugar maple

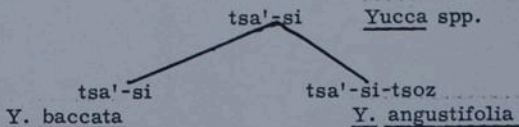
(composite lexemes)

Handout: Brent Berlin,
 Universal Nomenclatural Principles in
 Folk Science (November , 1969)

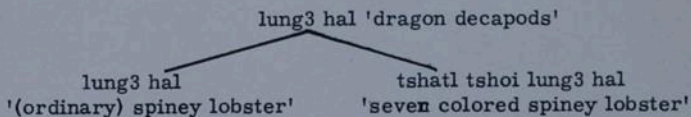
Table 2

Examples of ethnobiological nomenclature indicating polysemy
 of type specific and superordinate generic

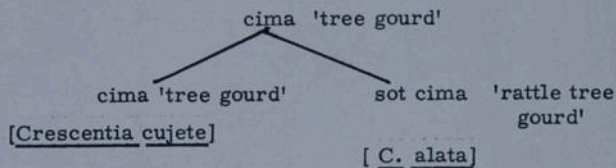
Navaho (Matthews 1886:767)



Chinese (Anderson 1968:71)



Tzeltal (Berlin, Breedlove and Raven, in preparation)

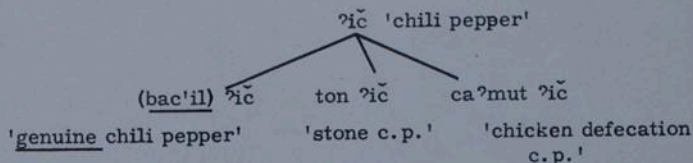


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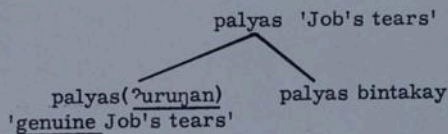
Table 3

Examples of ethnobiological nomenclature illustrating type-marking

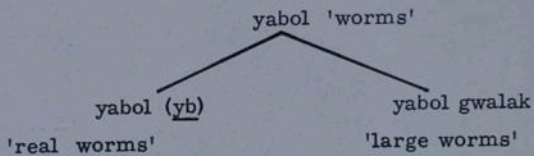
Tzeltal (Berlin, Breedlove and Raven, in preparation)



Hanunóo (Conklin 1954:342)



Karam (Bulmer 1968:624)



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 Universal Nomenclatural Principles in
 Folk Science (november, 1969)

Table 4

Basic categories of ethnobiological nomenclature and
 hypothetical order of their encoding in the history of any language

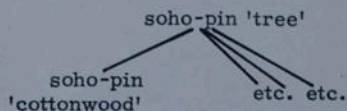
	GENERIC	SPECIFIC (sub-generic)	SUPRA-GENERIC	UNIQUE BEGIN- NER
I	+			
II	+	+		
III	+	+	+	
IV	+	+	+	+

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 Nomenclatural Principles in Folk Science
 (November, 1969)

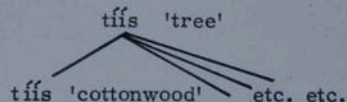
Table 5

Examples of languages possessing polysemous generic and supra-generic terms which suggest the recent encoding of the higher order category

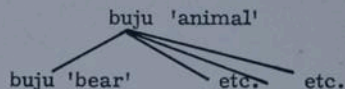
Shoshone (Miller, personal communication)



Western Apache (Basso, personal communication)



Orok [Sakhalin Is.] (Austerlitz 1959:211)



Pomo (Merriam, n.d.)

