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CONTENTS

Human Population and Biomass ..... David Nicol 49
Artificial Hybridization of *Ruellia caroliniensis* and *R. geminiflora* (Acanthaceae) ..... Robert W. Long 53
Progressive Appointees on the Late White Court ..... Roger Handberg, Jr. 57
A New Species of *Sphaerodactylus* (Sauria, Gekkonidae) from the República Dominicana ..... Albert Schwartz 65
A Florida Troglobitic Crayfish: Biogeographic Implications ..... Kenneth Relyea, David Blody, and Kenneth Bankowski 71
Merritt Island Ecosystems Studies, 2. Bryophytes of Merritt Island ..... Henry O. Whittier and Harvey A. Miller 73
Summer Marine Algae at Vero Beach, Florida ..... L. Juett, C. J. Miller, S. J. Moore and E. S. Ford 76
Good News for the Junk Food Junkies ..... Marguerite F. Gerstell 80
Diversity and Succession of a Late Pleistocene Pond Fauna, Major County, Oklahoma ..... Graig D. Shaak 81
The Rhetoric of Global Resource Politics ..... Douglas C. Smyth 87
Established Exotic Cichlid Fishes in Dade County, Florida ..... Randall G. Hogg 97
Composition and Derivation of the North American Freshwater Fish Fauna ..... Carter R. Gilbert 104
Pollution Microbiology of Biscayne Bay Beaches ..... John D. Buck 111
Late Quaternary Mammals from the St. Marks River, Wakulla County, Florida ..... David D. Gillette 120
Additional Notes on Tropical Marine Fishes in the Northern Gulf of Mexico ..... Philip A. Hastings and Stephen A. Bortone 123
First Record of the Mountain Mullet, *Agnostomus monticola* (Bancroft), from North Carolina ..... Fred C. Rohde 126
New Locality Records for *Spirobranchus giganteus* var. *giganteus* in the Northeastern Gulf of Mexico ..... Keitz Haburay 127

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

FLORIDA SCIENTIST

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

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QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

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Conservation

HUMAN POPULATION AND BIOMASS

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Abstract: *The biomass of man now far exceeds that of any other large-sized species of animal that has ever lived on earth.*

Stanley (1973) has shown that when sizes of animals are plotted within classes, orders, and families, a positively skewed histogram results. This simply means that within groups of animals, there are many small- and medium-sized species and few species of large body size. Van Valen (1973) noted this same fact and also pointed out that species of large body size tend to have wider geographic ranges, but this rule does not apply to marine benthic and commonly sessile invertebrates, as, for example, the giant clam, *Tridacna gigas*. Van Valen (1973) also stated that even with a much wider geographic distribution, large-sized species are commonly represented by fewer individuals than small-sized species.

Although there are animal species, both extant and extinct, that are as large as or larger than *Homo sapiens*, their number is not great when one considers the total number of animal species. Let us assume that the avg-sized human adult weighs about 55 kg (121 lbs). How would this size rank among all living animal species? A somewhat condensed compilation of all living animal species, presented by Easton (1960) and also by Stokes (1966), is given as Table 1. Unfortunately, this compilation as presented by Easton and Stokes had some errors in addition, which in turn created errors in the percentages of species of the animal taxa. The estimate of the total number of species is slightly more than one million, which many zoologists would consider quite conservative.

It can readily be seen from Table 1 that almost 805,000 species are arthropods; i.e., four-fifths of all animal species belong to the phylum Arthropoda. All species of arthropods have a smaller avg body weight than man. Certainly this

TABLE 1. The animal phyla or groups of phyla showing the number of living species and percentage of living species.

Taxa	No. of species	Species %
Protozoa	27,000	2.7
Porifera	2,240	0.2
Coelenterata	9,500	0.9
Worms	36,000	3.6
Bryozoa & Brachiopoda	3,275	0.3
Mollusca	81,150	8.1
Arthropoda	804,898	80.2
Echinodermata	5,484	0.5
Chordata	33,640	3.4
Total	1,003,187	99.9

is true also of the 27,000 species of Protozoa, the 36,000 species of worms, the 3,275 species of Bryozoa and Brachiopoda, and the 5,484 species of Echinodermata. Probably all species of invertebrate chordates are smaller than man.

Among all of the invertebrates, comprising about 97% of all living animal species, probably no more than 20 species attain an avg size that equals the avg size of man. As shown in Table 2, this would include 16 species of mollusks (15 cephalopods and one pelecypod), two or three species of coelenterates (excluding colonial forms), and possibly one species of sponge (Kaestner, 1967). All of these 20 species are marine.

Among the 30,000 or so vertebrate animals, one finds almost all of the species that are as large as or larger than man: about 75 species of sharks, 50 species of fresh-water fish, 200 species of marine fish, 20 species of reptiles, one species of bird (the ostrich), and 300 to 350 species of mammals. The total number of living species of animals as large as or larger than man would be no more than 716. For greater ease in calculating, one may round this figure to 700 species. Of this number, the invertebrates account for only 3.0% of the total. In body size, *Homo sapiens* would rank among the top 0.07% of all of the living animal species.

Relatively few extinct species of animals were larger than man. Throughout the entire Cambrian Period and probably until the Middle Ordovician, with the advent of large nautiloids (Nicol, 1966), no animal was as large as *Homo sapiens*. This would mean that about 130 million years had elapsed since the beginning of the Phanerozoic Eon before an animal attained a body weight of 55 kg or more. Thus, it is true that man must be considered a very large animal.

Went (1968) has pointed out that among the many reasons why man has so successfully exploited the earth's resources is his large size. An ant is unable to use fire, the wheel, stone and metal implements, wind and water power, internal combustion engines, and atomic energy because of its small size.

It is well known and shown by figures in many biology textbooks that an increase in body size has been a common trend in hominid evolution and this increase in size is apparently still taking place in *Homo sapiens*. For a recent article on this subject, see Pilbeam and Gould (1974).

TABLE 2. Extant animal species weighing 55 or more kg.

Groups	Number of species
INVERTEBRATES	
Porifera	1
Coelenterata	3
Mollusca	16
VERTEBRATES	
Sharks	75
Fresh-water fish	50
Marine fish	200
Reptiles	20
Birds	1
Mammals	350
Total	716

Let us compare the present biomass of man with an equal biomass of a much larger and a much smaller species of terrestrial vertebrate. If we assume that an avg weight of *Homo sapiens* is 55 kg and that there are approximately four billion individuals living at present, the total biomass of this species is about 220 billion kg. It has been estimated that the weight of the dinosaur, *Tyrannosaurus rex*, was 20 tons, or about 1818 kg. In order to have a total biomass equal to that of man, there would have been 121,021,021 individuals of *Tyrannosaurus rex* living at one given time during the Cretaceous Period. Hotton (1963) noted that only one skeleton, two skulls, and a modest amount of scattered bones and teeth of this huge beast have so far been discovered. Even allowing for the incompleteness of the fossil record, it is unlikely that as many as one million individuals of this huge carnivore were living on the earth at any one time. The avg brown rat, *Rattus norvegicus*, weighs about 0.5 kg. In order for this pest to equal the present biomass of man, there would have to be about 440 billion living individuals. Obviously, disease and starvation would keep the number of brown rats down well below this stupifying figure. Some readers may question the estimates I have made of these three species as being somewhat too high because the young individuals have not been considered in the populations in estimating the avg-sized individual of each species. This is true, but the number of young individuals in man's total population would undoubtedly be less than in the more natural populations of *Tyrannosaurus rex* and *Rattus norvegicus*. Modern medicine has preserved a greater number of adults in the total population of *Homo sapiens*, particularly so in better developed nations.

As previously mentioned, although large-sized species generally have wider geographic ranges than small-sized species, the number of individuals of small-sized species is commonly far greater than the number of individuals of large-sized species. Consequently, the total biomass of most small-sized species is greater than that of the total biomas of large-sized species, as is shown by examples of pyramids of biomass and numbers given in most biology textbooks. There must be a greater biomass of producers and primary consumers in order

to sustain the commonly larger-sized secondary and tertiary consumers. This is a general rule in the biosphere. Man, however, has already upset this rule with the enormous number of individuals coupled with his large body size. At an avg weight of 55 kg and about four billion individuals, man has undoubtedly attained a much greater total biomass than any other large-sized animal species the earth has ever known. The huge biomass of man has already upset the ecological balance of the earth, and if allowed to go on increasing, much more damage to the earth's biota will occur. In other words, man has already upset at least one of the ecological rules we have seen operating on the earth since the beginning of life.

ACKNOWLEDGMENTS—I am indebted to several zoologists for size data on the following animal groups: Clyde C.F. Roper, Division of Mollusks, National Museum of Natural History, cephalopods; Carter R. Gilbert, The Florida State Museum, sharks, and fish; Sam R. Telford, The Florida State Museum, reptiles; David W. Johnston, Department of Zoology, University of Florida, birds; and Dale Guthrie, Department of Biology, University of Alaska, mammals. Pierce Brodkorb and Thomas C. Emmel, Department of Zoology at the University of Florida, both read the manuscript and suggested some improvements.

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ARTIFICIAL HYBRIDIZATION OF *RUELLIA CAROLINIENSIS* AND *R. GEMINIFLORA* (ACANTHACEAE)

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ABSTRACT: Ruellia caroliniensis *is a common species in eastern United States;* R. geminiflora *is a widespread species in the Caribbean basin. Although the two species are very similar morphologically, they are completely allopatric. Artificial* F_1 *hybrids were produced involving the two species, and the hybrids were vigorous, semi-fertile, and morphologically intermediate between the parental species. The genetic, evolutionary and taxonomic implications of this hybrid are discussed as it bears on the taxonomy of the genus.*

MOST STUDENTS of the Acanthaceae, and especially of the largely tropical genus *Ruellia*, are struck by the remarkable similarity between two entirely allopatric species, *R. caroliniensis* (Gmel.) Steud. of eastern United States and *R. geminiflora* Kunth of the Caribbean basin area. Except for minor differences in the size of the fruit, number of seeds per fruit, and morphology of the stigma, the plants are morphologically very similar—especially when viewed as herbarium specimens.

Ruellia caroliniensis is the most common species of the genus in Florida, and is the most variable element of the genus in southeastern United States (Long, 1974). *Ruellia geminiflora* was listed by Leonard (1951) in his *Acanthaceae of Colombia* as an erect or ascending pilose herb with relatively small, mauve corollas. This characterization of the plant apparently came entirely from herbarium specimens since it is inaccurate in a number of respects. Garden cultures of *R. geminiflora* are ascending and vigorously spreading, and the bright blue corollas are significantly larger than the range given by Leonard and other recent authors (cf. Adams, 1972). The species occurs widely in the American tropics in pastures, savannas, open hillsides, and fields from central America to the West Indies and to northern South America. Herbarium specimens have also been seen from Bermuda, Cuba, Hispaniola, Jamaica, Trinidad, and Mexico.

Because of the morphological similarity between the two species, biosystematic investigations were initiated to determine if the two were genetically related. Hybridization experiments were undertaken in 1971 and 1972 that resulted in the production of vigorous F_1 hybrids that were morphologically intermediate between the parental species. Moreover, the hybrids were semi-fertile, suggesting that the two species were genetically closely related.

METHODS AND MATERIALS—Techniques for hybridizing *Ruellia* species have been described in earlier reports. *Ruellia* taxa of the United States are facultative

[1]Contribution No. 96 from the Botanical Laboratories, University of South Florida, Tampa, Florida. Research supported by National Science Foundation Grants GB-35231 and BMS 72-02209 AO3.

cleistogamous plants with a definite aestival chasmogamous phase followed by a serotinal cleistogamous phase. The large chasmogamous flowers are incompletely dichogamous and self-compatible (Long, 1973). Just prior to hybridization, the stamens are removed and the corolla cut away. Fruit formation is initiated in 2-3 da and mature capsules are ready for harvesting in about 4-5 wk, depending on culture conditions. A race of *R. caroliniensis* (acc. no. 0401) from Hernando County, Florida, and a race of *R. geminiflora* (acc. no. 0-186) from Dzibilchaltun Ruins, near Merida, Yucatan, Mexico were used in the hybridizations.

Chromosome numbers were determined by means of aceto-carmine squash preparations of microsporocytes. The chromosomes are quite small and no extensive analysis was made of chromosome behavior in artificial hybrids. Pollen fertility was determined by differential staining in anilin blue in lactophenol. Two hundred grains were stained, and if the pollen absorbed the blue stain, they were adjudged fertile. Non-staining pollen was considered sterile.

Voucher specimens are deposited in the herbarium of the University of South Florida.

RESULTS—The most conspicuous character in the F_1 hybrids is the inflorescence pattern. Numerous, tight, many-flowered glomerules were produced in the upper axils, and these produced abundant fruits through self-pollination. The morphological intermediacy of the hybrid was evident in the length of the longest internode, leaf shape, and structure of the stigma (see Table 1). The hybrids are vigorous cultures in the experimental garden, and can be considered semi-fertile with pollen stainability 61-87%, as compared to 96% for *R. caroliniensis* and 57% for *R. geminiflora* (see figs. 1-3).

Both parental species have 17 bivalents during diakinesis with no observable meiotic abnormalities. The F_1 hybrid also exhibits 17 bivalents at diakinesis, and preliminary analysis of meiosis did not indicate any meiotic abnormality.

TABLE 1. Comparative morphology of the artificial hybrid *Ruellia caroliniensis* × *geminiflora*.

	R. caroliniensis	*R. caroliniensis* × *geminiflora*	*R. geminiflora*
habit	erect, branching	erect, branching	ascending, spreading
length longest internode	4.4 cm	5.1 cm	9.5 cm
cauline indumentum	glabrous	glabrous	puberulent
leaf shape	narrowly lanceolate acuminate	narrowly lanceolate, acuminate	broadly lanceolate attenuate
leaf length (max.)	4.4 cm	4.8 cm	4.7 cm
leaf width (max.)	1.4 cm	1.4 cm	1.7 cm
petiole length	0.5 cm	0.4 cm	0.8 cm
inflorescence	solitary, axillary, sessile	tightly clustered axillary glomerules	paired, axillary, sessile
corolla length (max.)	5.1 cm	4.1 cm	6.0 cm
stigma morphology	equally 2-branched	unequally 2-branched	unbranched, simple
fruit length (mature)	1 cm	1 cm	0.8 cm
stamens	didymous	didynamous	didynamous
no. seeds/fruit	8	4	4
chromosome number	n = 17	n = 17	n = 17
pollen fertility	90% fertile	61-87% fertile	57% fertile

Fig. 1. *Ruellia caroliniensis,* culture 0401, Hernando Co., Florida.
Fig. 2. *Ruellia geminiflora,* culture 0-186, Dzibilchaltun, Yucatan, Mexico.
Fig. 3. *Artificial hybrid* (0401 × 0-186) *R. caroliniensis* × *R. geminiflora.*

The dominance of *R. caroliniensis* characters in the hybrid was apparent in the general habit of the plants, corolla morphology, and fruit size. If the hybrid were examined without knowledge as to its origin, it would doubtless be identified as an aberrant *R. caroliniensis*. Students familar with the tropical species of the genus would be able to detect the influence of *R. geminiflora* especially in the number of seeds per fruit, and didynamous stamens.

Discussion—Biosystematic investigations of *R. caroliniensis* have been conducted for several years (Long, 1964, 1966, 1971, 1974). The general purpose of these studies was to clarify the relationships of the species to other North American taxa, and to determine the natural parameters of variation of the species in order to understand it taxonomically. The remarkable variability of *R. caroliniensis*, especially in Florida, was attributed to its nearly balanced breeding systems involving numerous floral morphs associated with chasmogamic and cleistogamic flowering. Thus, we now have a fairly complete picture of the variation of the North American species, and there remains the question as to the possible relationship of *R. caroliniensis* to tropical American species. The purpose of the present study was to test the hypothesis that *R. caroliniensis*

is genetically related to the widespread West Indian *R. geminiflora*. Since the two plants are similar morphologically, it was logical to assume they were also genetically related. In addition to the morphological differences between the two species cited above, the only other observable difference is based on slight variation in pollen sculpturing (cf. Long, 1973). However, on the basis of pollen differences Bremekamp (1969) described a new genus based on *Ruellia geminiflora* naming it *Ulleria geminiflora* (Kunth) Brememk. There is no genetic or strong morphological evidence to support this revision, and it tends to obscure the relationship of the species. Rather, *R. geminiflora* is clearly related to *R. caroliniensis* and to the tropical widespread species *R. tuberosa* L. (Long, 1973). There is no taxonomic justification for the establishment of a segregate genus based on *R. geminiflora*.

The existence of a genetic relationship between North American temperate species and tropical American taxa establishes the probable lines of origin of the temperate groups. If a strictly biological species concept is applied to the two population systems, it is apparent they would be reduced to sister subspecies of *R. caroliniensis* since they would both be elements of the same ecospecies (Clausen, 1951). At the present time is appears to be preferable to continue to recognize them as separate taxonomic species. Additional biosystematic investigation may demonstrate other relationships of the species that would have to be incorporated into any revised classification. Other tropical species may be involved in a reticulate pattern of taxonomic affinities, and until these studies have been completed it is doubtless premature to suggest that North American species are mere geographical races of tropical species. We can conclude, however, that *R. caroliniensis* is definitely related to tropical American species, and that *R. geminiflora* appears to be an element of a broadly defined *R. caroliniensis* population system.

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PROGRESSIVE APPOINTEES ON THE LATE WHITE COURT

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Abstract: *Behavior patterns of the United States Supreme Court during a period of progressive influence were examined. Decision patterns were analyzed by the use of cumulative scaling and the concept of a natural court. Justices appointed by progressive presidents were found in about half the instances not to conform to the expectations placed upon them by their appointer. For a variety of reasons, the progressive justices failed to significantly change the policy dimensions of the Court.*

Historical research on the United States Supreme Court has normally been in the form of descriptive studies of the institution as a whole (McCloskey, 1960), biographies of unique or great individual justices (Bowen, 1944; Mason, 1965), or analyses of some doctrinal point as it evolved over the years (Corwin, 1936). Quantitative or behavioral studies of the Court have been concentrated in the post-World War II era especially the era of the Warren Court. In the process of analyzing these most recent courts, a variety of research tools have been employed including cumulative scaling, bloc analysis, factor analysis, and nonmetric multidimensional scaling (Schubert, 1965 and 1974; Pritchett, 1969).

Quantitative studies in the period prior to World War II have been limited in number and scope. John Schmidhauser's classic study (1961) of court decision-making in the period prior to the Civil War is probably the best example of an effort to explain decisions on the issues of slavery and the commerce clause (Barnard, 1958). Our attention has been directed to the period 1916-1921 which was the high point of Progressive influence on the Supreme Court.

Theodore Roosevelt at the turn of the century had been the first progressively oriented President to have made appointments to the Supreme Court. Policy-wise, his three appointments produced sporadic results. Roosevelt's disappointment with Justice Holmes on the *Northern Securities Case* is well documented although Holmes' overall career cannot be labelled as anti-progressive in tone (Scigliano, 1971). Justice Moody was forced from the bench after a brief period because of illness. Justice Day proved to be more conservative than expected. In summary, the President's attempt to select men of the 'right' set of mind was not extremely successful. President Taft's Supreme Court selections were all openly selected to foster business interests and to further the development of the law as a bulwark against social change and economic regulation (Danelski, 1964).

President Wilson arrived in the White House clearly identified as a political progressive with aspirations for social/economic reform. We have examined the decisional patterns of the Supreme Court during this 5 yr period of relative progressive influence. We have used two concepts drawn from social psychology and political science: 1) the idea of a natural court and 2) the research tool of cumulative scaling.

Instead of using the legal category of term years, a natural court is determined by the membership and departure of an individual justice from the group terminates the natural court. Therefore, the natural court can and does extend across several legal court terms (Snyder, 1958; Sprague, 1968). The boundaries of this natural court are set by the arrival of John Clarke on the bench in 1916 and the death of Chief Justice White in 1921. The Justices present on the Court during this period were Chief Justice Edward White (WHT), Joseph McKenna (MCK), Oliver W. Holmes (HOL), William Day (DAY), Willis van Devanter (VAN), Mahlon Pitney (PIT), James C. McReynolds (MCR), Louis D. Brandeis (BRA), and John Clarke (CLK). The arrivals of Justices Brandeis, McReynolds, and Clarke brought significant representation of the progressive movement on the court. Although McReynolds was not truly a representative of this movement, he did arrive on the bench with some reputation as a trust buster. One could argue that at least economic liberalism was becoming a possible alternative, although it was not realized until the New Deal in a much different form. By the end of this period of court history, the threat of a nonconservative majority faded with a return to "Normalcy" and the arrival of Chief Justice Taft.

Cumulative scaling seeks to rank justices on some particular issue (Guttman, 1966; Schubert, 1959; Murphy and Tanenhaus, 1972). A Justice's votes can be evaluated as being favorable or unfavorable to the issue posed over a series of cases. From this series of responses, a justice's position on the issue relative to the other justices' present can be established. Therefore, as in Table 1, Justice Clarke is more favorable to civil liberties claims than justice McKenna. The underlying assumption is that only their attitude is measured toward that particular issue. Two measures have been devised to measure the degree of consistency in cumulative scales. The first, the Coefficient of Reproducibility (CR), is least satisfactory because of the difficulty in handling extreme marginals (i.e. 1-8 vote splits). A CR of .90 is considered acceptable evidence of scalability. The second measure is the coefficient of scalability (CS). The CS measures the proportion of potentially inconsistent votes that turned out to be consistent. A CS over. 60 is seen as indicating scalability. Only cases involving dissent are scaled since the existence of dissent allows one to observe value differences among the justices.

The scales reported here are traditional ones drawn from behavioral literature. The major scales with which the analysis began are those derived from *The Judicial Mind* (Schubert, 1965). Only three of the major scales ("C"—Political Liberalism; "E"—Economic Liberalism; and "N"—Federalism) meet the minimum requirements for scalability. The Federalism scale numerically meets the criterion but of the 14 cases, one is present because of jurisdictional dissents while seven of the remaining 13 cases are concerned with a single issue (253 U.S. 350).

This lack of significant dispute over the issue of federalism in terms of our scales is somewhat surprising given the vast literature devoted over the years to justifying the state or federal government as the most appropriate for solving social problems. Many of the possible issues involved in a dispute over federalism may be submerged into what are seen as the more pertinent struggles over other

TABLE 1. Results of Scales and Subscales.[1]

C		E		FCL		FCO		GOVT		STX	
a	b[2]	a	b	a	b	a	b	a	b	a	b
BRA	.50	CLK	.93	CLK	.93	CLK	.85	CLK	.90	BRA	.93
HOL	.50	BRA	.74	BRA	.44	PIT	.69	BRA	.80	CLK	.80
CLK	-.14	HOL	.47	HOL	.25	DAY	.46	HOL	.64	HOL	.73
WHT	-.43	PIT	.25	PIT	.11	BRA	.39	PIT	.51	PIT	.33
MCK	-.50	DAY	.14	DAY	.02	HOL	.23	DAY	.49	DAY	.07
MCR	-.57	MCK	-.02	WHT	-.28	WHT	.15	MCK	.26	WHT	-.13
VAN	-.71	WHT	-.03	VAN	-.28	MCR	.15	MCR	-.10	MCK	-.27
DAY	-.79	VAN	-.23	MCK	-.44	VAN	-.23	WHT	-.15	VAN	-.40
PIT	-1.0	MCR	-.56	MCR	-.80	MCK	-.46	VAN	-.23	MCR	-1.0
CR = .90		CR = .87		CR = .93		CR = .88		CR = .90		CR = .90	
CS = .65		CS = .62		CS = .76		CS = .66		CS = .74		CS = .66	

[1]Scales: C—Political Liberalism; E—Economic Liberalism. Subcomponents of E Scale: FCL—Fiscal Claims; FCO—Free Competition; GOVT—Government Regulation of Business; STX—State Taxation.

[2](b) The scale scores reported in this column indicate a Justice's relative position on the issue dimension. Scores vary from +1.0 to -1.0.

economic and political issues. Schmidhauser concluded this in his study of the Supreme Court where partisan affiliation was more important than purported attitudes about the issues of states rights and federalism (Schmidhauser, 1961). The differences between my study and Sprague's (1968) regarding the federalism issue are explainable primarily in terms of definition of scale content. Certain items such as taxation are treated here as an "E" scale subcomponent: state taxation, while federal taxation efforts were scaled under the "F"—Governmental Taxing Authority scale which had insufficient items for scaling purposes (Sprague, 1968).

The Political Liberalism—"C" Scale was defined:

" . . . to consist of claims to personal (as distinguished from property) rights and freedoms. In terms of constitutional norms, these included primarily claims based upon the personal freedoms (of speech, press, religion, assembly, and petition) cited in the First Amendment; the general and particular specifications of fair procedure in criminal trials (in federal courts) that are listed in Amendments 4-8; and the analogous freedoms and rights (in relationship to state governments) that are associated with Amendment 14; plus the norms relating to racial equality that the Court has associated with Amendments 14 and 5." (Schubert, 1965)

Many of these categories are null sets because the issues involved did not become significant issues before the court until the 1930's and 1940's and beyond. The subcomponents of the "C" scale represented here are fair procedure questions, issues involving citizenship status, and a smattering of the early subversion cases.

Substantively, the major issues examined by this court were those which were economic in nature. Given the historical events of the period, it would be expected that the legal system would be grappling with the problems of the still new industrial state. The "E" scale has been defined thusly:

"The economic scale related to conflicts of interest between the economically affluent and the economically underprivileged. The economic liberal would support the claims of the economically underprivileged, while the conservative would stand pat and resist economic change that would benefit the have-nots." (Schubert, 1965; Spaeth, 1963)

Operationally, the subcomponents are identified as fiscal claims, governmental regulation of business, union-management disputes, freedom of competition,

and the constitutionality of state taxation (Schubert, 1965). Generally, the liberal (or E+) position is to favor the claims for compensation made by injured employees; favor small business over large; and defendants in patent infringement suits; uphold state taxation of business; uphold interests of the unions; and uphold government regulation of business where that upheld freedom of competition or other underdog interests.

The data base consists of all formally decided non-unanimous decisions of the Court from the beginning of the 1916 Term until the end of the 1920 Term. The total number of such non-unanimous decisions was 261 of which 201 (or 77%) were "E" scale cases. Twenty-eight (10.7%) were "C" scale cases. Of the subcomponents, only the "E" scale subcomponents had sufficient cases for further analysis by means of cumulative scaling.

Clearly in Table 2, the number of non-unanimous decisions varied drastically by court term. A partial explanation of this fluctuation is clear when one considers the court's tendency to withdraw from potentially conflictful situations during time of war. The Court in effect puts itself on the backburner until the war ends and things return to some form of normality. During wartime, the Court generally either operates as a legitimizer of executive actions (e.g., the removal of Japanese-Americans from the West Coast) or concerns itself with relatively noncontroversial issues. This is pointed out in Table 2 by the lowered dissent rates during the immediate war years and the sharp rise the following term. In addition, the relatively high number of "C" scale cases in the 1919 and 1920 terms reflects both the normal delay in the court system in getting to the Supreme Court with issues generated by wartime regulations and statutes such as the various sedition and espionage acts and also a cautious approach to a possibly conflictual situation.

The bulk of the Court's strife centered on economic issues (see Table 2) while in no single term were there sufficient "C" scale cases to construct a cumulative scale. Within the economic cases 39% (N=78) were cases involving business regulation, both federal and state, with an additional 30% (N=61) concerned with various fiscal claims against either the government or a business. State taxation (N=30) and Free Competition (N=26) cases were involved in approximately 15% and 13% of the "E" scale cases.

Table 1 provides a summary of all the scales and subscales reported in this study. Readers can contact the author for copies of the complete tables listing cases and actual votes. Clearly, cases involving civil liberties such as free speech and association were not deemed of critical importance during this time period. Justice Pitney anchors the scale by casting not one vote favorable to a claim of civil liberties. Justices Brandeis and Holmes appear the most willing to support civil liberties claims while Justice Clarke presents a pattern of erratic support. Table 1 does point up one dilemma posed by the pooling operation used here: sufficient change occurs in 5 yr period among both the type of cases and the justices to reduce coefficients of reproducibility significantly. This problem can be recognized but the actual impact is unknown given that we do not know a Justice's position relative to a fixed point. All the cumulative scales presented

TABLE 2. Decisional pattern by Court term and overall.

Court Term	1916	1917	1918	1919	1920	Total
Total Cases	261	245	260	197	255	1218
Non-unanimous Cases	68	33	37	77	46	261
Dissent Rate	26%	13%	14%	39%	18%	21%
E Scale Cases[1]	61	28	30	49	33	201
C Scale Cases[1]	5	2	3	10	8	28

[1]E—Economic Liberalism; C—Political Liberalism.

here are marginally scalable despite this problem of drift. One is especially aware of this problem in the "C" scale area as the cases before and during World War I were relatively innocuous, while after the war, cases involving wartime espionage and sedition were prominent. These latter cases involved by proxy at least the survival of a state locked in combat with its mortal enemies. Sample cases included during this period are classic sedition cases such as *Schenck v. United States*, 249 U.S. 47 (1919) which established the "clear and present danger" test and *Abrams v. United States*, 250 U.S. 616 (1919). In both cases, substantial restrictions were placed on the individual's right of free speech during time of war. In the later case, Justice Clarke wrote the majority opinion upholding the Sedition Act of 1918 while Holmes, the author of the "clear and present danger" test, rejected this particular application. Later, Holmes and Brandeis resisted adoption of what was termed the bad tendency doctrine. These clearly present a more dramatic stimuli to a justice than discussion of a prisoner's right to a fair trial. Generally though, the Court was extremely hostile to individual claims under any of the civil liberties categories. Due process of law was an economic concept not a personal one at least in regard to state cases.

On the "E" scale, Justice Clarke ranks ahead of all other justices in support of the economic underdogs in society although Justice Brandeis is not far behind while Holmes appears as a moderate progressive. Justice McReynolds clearly is the least favorable of the justices to the claims of economic underdogs in whatever form their claim comes. He voted in favor of such claims about 25% of the time. President Wilson may have been successful in removing the irritating McReynolds from the Cabinet but the appointment was a lost one in terms of policy influence (Burner, 1969). More careful use of that appointment might have had a profound impact on policy since it would have established a four justice group capable of decisively shaping policy through the process of accepting cases and forming decisional coalitions. Appointment of a justice similar to Clarke and Brandeis would have created a solid three vote bloc which would have linked with Holmes and Pitney as the outriders on economic cases. It also, according to some limited historical evidence, would have been the more energetic bloc in the last years of the White Court as the older conservative justices became less able. All of this potential went by the wayside because of Wilson's desire, in effect, to kick McReynolds upstairs. In reviewing the "E" scale, it is

clear that the five justices appointed by progressively inclined presidents resulted in only three in any fashion meeting the expectations which motivated their appointments. Clarke represented an almost automatic progressive vote on economic issues with Brandeis only somewhat less progressive. Holmes' progressivism, if it can be so characterized, is a function of his willingness to allow the popular branches of government to do what they wish within the confines of the Constitution. An earlier example would be his dissent in *Lochner v. New York*, 198 U.S. 45, 75 (1905): "The Fourteenth Amendment does not enact Mr. Herbert Spencer's Social Statics. . . . A constitution is not intended to embody a particular economic theory, whether of paternalism . . . or of *laissez faire*." Justices Day and McReynolds were hard core conservatives with McReynolds the most extreme conservative in the group.

In terms of substantive policy, more interesting patterns are found by examining the subcomponents of the "E" scale. Four subcomponents had sufficient items (N-10) to be potentially scalable. A fifth subcomponent, unions, had only six cases, therefore, an insufficient number for scaling urposes. Referring to earlier materials, fiscal claims represents an important issue in economic policy. As part of a more complex and mechanical society, the potential for injuries to workers increases tremendously especially in jobs relating to the early railroads. Economic liberals or progressives felt the employer had an obligation to compensate the injured employee, while economic conservatives saw this as a normal risk of engaging in the trade or occupation. The defense was that the injury occured because of the mistake of the employee for which the owner could not be held liable. These suits were especially important since no effective workman's compensation laws existed plus no welfare system was available for the family of the victim. The Court was fairly hostile to such claims with Justice Clarke the one justice clearly in favor of such claims being counterbalanced by McReynolds who was almost completely hostile to such litigation.

McReynolds did have two areas of economic policy in which he faintly approached the expectations of the Wilsonian Progressives. These involved the areas of free competition and government regulation of business. Both *laissez faire* capitalism and the economic liberalism of the day converge in their upholding of free competition and the power of the market place. Small business was to be protected not against competition *per se* but rather against artificial restrictions on competion such as the economic trusts of the period. Governmental regulation of business in this time period represented another facet of the effort to maintain competition within the business community. The other less obvious functions of governmental regulation such as insurance of adequate profits and restriction on entry of new economic units into the market had not yet been recognized. McReynolds' partial acceptance of these policies represented some lessening of his otherwise unrelenting conservatism. In terms of relative ranks on subcomponents, Justices Pitney and Brandeis appeared to make the greatest conceptual distinction between the various issue areas. Brandeis moved from a fairly consistent position as second most progressive on economic issues to fourth on the subcomponent of free competition. Brandeis' re-

lative movement reflected his concern that the process of attempting to maintain competition through the Sherman Antitrust Act might actually "destroy the small competitor or force him into the arms of monopoly." (Mason, 1969) For Justice Day, the maintenance of competition in the business world appears to be a value of importance since he moves out of his position of moderate conservatism to embrace it. Day's position may be a reflection of the fact that his appointer, President Theodore Roosevelt, evaluated potential appointees on the basis of their views on the issue of trusts and unhindered competition. In fact, maintenance of free competition may be conceptualized as either a value of conservatism or liberalism in the context of the early twentieth century, the difference being how one goes about maintaining this free competition: by attempts at regulation, or by attempts at maintaining free competition through antitrust actions. Regulation was only in its early stages in the 1916-1921 period so that the two groups might not yet have clearly separated. The frontier ethic of competition so frequently mentioned in the biographical sketches of justices such as McReynolds may have been a relatively important value which finds its manifestation in this subcomponent. An example of the type of regulation then being considered is *Bunting v. Oregon*, 243 U.S. 426 (1917) where a split court upheld a 10 hr day law with an overtime provision for men. But acceptance of even this limited regulation of business fell by the wayside in the succeeding era under Chief Justice Taft.

Taxation of business or property was a major issue during the late nineteenth and early twentieth centuries. This can be best seen in the earlier decision in *Pollock v. Farmers' Loan & Trust Co*, 158 U.S. 601 (1895) which struck down a proportional income tax. Only in 1913 with the passage of the Sixteenth Amendment was a federal income tax possible. During the interim though, a number of states continued previous taxes and enacted new ones for various regulatory and revenue purposes. The Court had to determine whether the state tax encroached on some aspect of interstate commerce or was a violation of substantive due process of law. This was an important issue because the federal taxing authority was only beginning to be exercised in limited areas. The Court basically remained very solicitous of business with only minimal state impact allowed upon their operations through the taxing instrument. An example would be this comment by Justice Pitney on state taxes on net profit or gross receipts:

"The difference in effect between a tax measured by gross receipts and one measured by net income. . . . is manifest and substantial, and it affords a convenient and workable basis of that distinction between a direct and immediate burden upon the business affected and a charge that is only indirect and incidental. A tax upon gross receipts affects each transaction in proportion to its magnitude, and irrespective of whether it is profitable or otherwise. Conceivably it may be sufficient to make the difference between profit and loss, or to so diminish the profit as to impede or discourage the conduct of commerce. A tax upon net profits has not the same deterrent effect, since it does not arise at all unless a gain is shown over and above expenses and losses, and the tax cannot be heavy unless the profits are large." *United States Glue Co v. Town of Oak Creek*, 247 U.S. 321 (1918)

Nowhere in the Court's discussion was there any real concern with the policy this tax was supposed to implement. Rather the concern with maintaining profitability. This points up nicely the basic conservatism of the Court as a whole but especially of the majority group.

CONCLUSION—One of the enduring failures of the progressive movement (as distinguished from the Progressive Party) was its failure to restructure the United States Supreme Court. Of the six justices appointed by Roosevelt and Wilson, half were disappointments, although for different reasons. Justice Moody was forced into retirement shortly after he joined the Court because of disabling illness. Justice Day proved to be a conservative although not as extreme as McReynolds. The appointment of McReynolds voided any effort to establish a solid four vote progressive bloc on the Court. Such a group could on some issues have attracted the support of Justice Pitney and possibly Justice Day. Instead, McReynolds assumed as extremely hostile position to any effort at economic and social change. More importantly, Justice McReynolds' personality was such that he eventually drove Justice Clarke from the Court (Bickel, 1957). This left the more progressive justices as a distinct two or three man minority bloc into the late thirties. As the data presented here indicates, the possibility of change existed because even the most conservative justice had some issues upon which he held at least moderately progressive views. So on an issue by issue basis, winning coalition could have been constructed if the progressive justices had formed a cohesive four justice bloc but McReynolds' general personality and anti-Semitism as regards Brandeis made this an impossibility.

Part of this failure was unavoidable since it involved making judgements about individuals whose ultimate policy views were not clearly known. Unlike Franklin Roosevelt, these earlier presidents were not as conscious of the Court as a policy institution since their objectives and problems were more limited. One does not expect the Supreme Court to be an innovative institution but the failure to appoint progressive-minded justices left the Court in the rear-guard of reaction, culminating in the crisis of 1935 to 1937.

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Biological Sciences

A NEW SPECIES OF *SPHAERODACTYLUS* (SAURIA, GEKKONIDAE) FROM THE REPUBLICA DOMINICANA

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ABSTRACT: *A new species of* Sphaerodactylus *is described from the Península de Samaná and east central República Dominicana. Brief notes are given on the ecology of the species, and comparisons between it and other sympatric congeners are made.*

COCHRAN (1932) named a species of gekkonid *Sphaerodactylus samanensis* from four specimens collected by Gerrit S. Miller, Jr., at Boca del Infierno, El Seibo Province, República Dominicana, on the south side of the northeastern Hispaniolan Bahía de Samaná. This short series, collected in 1928, remained unique until Richard Thomas in 1969 secured a single *Sphaerodactylus*, apparently *S. samanensis*, across the bay on the Península de Samaná itself. Comparison of the Thomas individual with the type-series showed that the two were quite differently patterned, although related; however, with but a single specimen from the Península, it was considered premature to make any nomenclatural additions. In 1971, Danny C. Fowler secured a fifth specimen from near the type-locality on the south side of the Bahía de Samaná; this individual agreed in details of pattern with the type-series and once more assured the distinctness of the peninsular population. In 1974, Fred G. Thompson of the Florida State Museum secured two specimens from the Península, and in 1975 additional specimens were taken on the Península by Thompson, Ronald I. Crombie, Roy W. McDiarmid, and Howard W. Campbell. Later, Dr. Thompson secured five lizards from San Cristóbal and Sánchez Ramírez provinces, to the southwest of the Península and west of the only known station of *S. samanensis*. There is now a total of 5 specimens (1 male, 3 females, 1 juvenile) from the type-locality of *S. samanensis*, and 13 specimens (3 males, 10 females, 1 juvenile) from the

Península de Samaná and west. These two samples are readily differentiable from each other; the differences first noted in 1969 are amply confirmed, and for the population on the Península de Samaná and to the west I propose the name

SPHAERODACTYLUS CALLOCRICUS, *new species*

HOLOTYPE: USNM (United States National Museum of Natural History) 197300, an adult female, from 2.9 mi. (4.6 km) S Las Galeras, Samaná Province, República Dominicana, taken 22 February 1975 by Fred G. Thompson. Original number USNM Field Herp series 040287.

PARATYPES: (all from Samaná Province, República Dominicana, except as noted). MCZ (Museum of Comparative Zoology) 132362, same locality and date as holotype, R. W. McDiarmid; ASFS (Albert Schwartz Field Series) V21857, 7 km E Las Terrenas, 22 August 1969, R. Thomas; UF/FSM (University of Florida, Florida State Museum) 21557, 5 km ENE Sánchez, 250 m, 27 March 1974, F. G. Thompson; UF/FSM 21558, 10 km E Las Terrenas, 27 March 1974, F. G. Thompson; USNM 197301-03, 6.5 km S Las Galeras, 22 February 1975, R. I. Crombie, R. W. McDiarmid, H. W. Campbell; UF/FSM 21563, 13 km NW Sabana Grande de Boyá, 220 m, San Cristóbal Province, 3 April 1975, F. G. Thompson; UF/FSM 21559-62, Batero, 5 km N Cevicos, 60 m, Sánchez Ramírez Province, 4 April 1975, F. G. Thompson.

DEFINITION: A species of *Sphaerodactylus*, most closely allied to *S. samanensis*, but differing from that species by the combination of 1) body pattern with a pair of broad dark transverse bands, only slightly hollowed centrally, 2) head pattern consisting of a prominent dark occipital band and a median extension which may or may not join a median snout line and with a prominent dark line to the eye, this "W" head pattern similar in males and females (although adult males may lack a cephalic pattern completely), and 3) greater number of dorsal and ventral scales than in *S. samanensis*.

DESCRIPTION OF HOLOTYPE: An adult female with snout-vent length 23 mm and tail length of 24 mm; dorsal scales 31 between axilla and groin, ventral scales 32 between axilla and groin, 46 scales around body at midbody, 11 fourth toe lamellae, 1 internasal scale, and 3 supralabial scales to center of eye. Dorsal ground color gray-brown (as preserved), the back traversed by two dark body bands between the limbs, these bands slightly hollowed centrally but still maintaining their individuality; a broad black collar with a pair of very distinct white ocelli; a solid dark sacral band; 7 tail bands, the 3 more distal as complete tail rings, the interspaces unicolor with the dorsal ground color proximally, grading to white distally, the tail tip black; head pattern brown and complete, composed of an occipital band beginning just below the auricular openings on each side, connected to a longitudinal line through the eye and continuing onto the canthus rostralis, and medially to a line which begins on the snout, extends between the eyes, expands slightly on the parietal area, and then constricts slightly before it joins the transverse occipital band; limbs brownish, somewhat speckled or flecked with darker brown; venter immaculate white; underside of tail irregu-

larly stippled with grayish to black, the markings more coarse distally than proximally.

VARIATION: The paratypes include 3 males (with snout-vent lengths of 23mm, 25mm, and 28mm), 8 females (largest with snout-vent length 28mm), and 1 juvenile (snout-vent length 16mm). Dorsal scales in axilla to groin are 26-34 ($\bar{x}=29.5$) with 2—6 hair-bearing organs with 1 hair each, ventral scales between axilla and groin 25-32 (27.8), midbody scales 42-48 (46.0), fourth toe subdigital lamellae 10-15, 1 internasal in 6 specimens, 0 in 7, usually 3 supralabials to eye center (1 specimen with 4 supralabials unilaterally); escutcheon small and compact, not extending onto hindlimbs, 4-5 × 8-11.

The females are much as described as the holotype. There are two body bands of which the more posterior may be irregular or incomplete (ASFS V21857; see Fig. 1A); these bands may be solid (UF/FSM 21558) or they may be somewhat hollowed centrally (USNM 197300), but in the latter case they are still easily recognizable as transverse bands and not as simple transverse lines. The ocelli are prominent and white in a broad black collar. The tail is banded or ringed with dark brown; one female (ASFS V21857) has the tail bands arranged into pairs proximally to give two pairs of bands near the tail base and two rings more distally. The head pattern is dark and well expressed in all females; in 2 specimens (MCZ 132352, USNM 197302) the pattern is complete and like that described for the holotype; in the other females, the median snout line does not connect with the transverse occipital bar, but rather ends with an expansion behind the eyes (i.e., in the position of the expansion of the median line in the holotype). The juvenile has the dorsal pattern like that of the females, and the head pattern is incomplete medially.

The 3 males are much like the females except that the head pattern is incomplete (median line not attached to transverse occipital bar) in 2, and the third (UF/FSM 21559) lacks a cephalic pattern completely. The body bands are distinct but less intense than in females, and, although they are diffusely hollowed centrally, they are still distinctly body bands rather than transverse lines; the scapular ocelli are not so clear white (more grayish) and are asymmetrical in one male (USNM 197301), the right occellus with an anteromedian area of dorsal ground color; the venter is grayish rather than white in males, but there are no distinctive markings.

COMPARISONS: *S. callocricus* requires comparison only with Hispaniolan *S. samanensis*. The latter is well illustrated by Cochran (1941:113); this specimen (USNM 74970) is a male (and is the only male *S. samanensis* known). Fig. 1B shows a female *S. samanensis*. The male *S. samanensis* differs from male *S. callocricus* in having a restricted dark collar and in having the body bands so dissociated and fragmented that they are no longer definable as transverse bands but rather as individual transverse bars or lines. Two females (ASFS V35283 - Fig. 1B; USNM 74972) have the same dorsal pattern configuration: a broad dark collar with two pale ocelli, these ocelli opening laterally so that the collar is laterally divided, thus basically forming a transverse "H." The third female (USNM 74971) has this condition on the right side, but the left ocellus is circular and not

Fig. 1. A. Dorsal view of female *S. callocricus* (ASFS V2l857-paratype); this specimen is unusual in that the median snout line does not reach the posterior head figure. B. Dorsal view of female *S. samanensis* (ASFS V35283).

"pulled out" laterally. The body has four transverse lines or bars, these comparable to the bold edges of the completely hollowed transverse bands of *S.callocricus*. The juvenile (USNM 74973) shows the same condition as the adult females, but the four transverse bars are so arranged in this small lizard to show clearly their origin as the edges of dark transverse bands.

It is in head pattern that the two species differ very strongly. The pattern in *S. callocricus* is basically a "W" with the anterior portion of the figure extending as far as the snout. There are no other pattern elements on the head anterior to the collar. In *S. samanensis*, the collar is first preceded by a fine transverse line or band from ear opening to ear opening across the occiput. This is in turn completely separated from what is basically a dark "U" composed of a canthal-postorbital line interconnected across the parietal region and without connection to the simple precollar dark line. The median snout line is not connected to the "U" in the 3 females and the juvenile. Thus, basically the precollar pattern in *S. samanensis* is a single transverse bar from ear to ear, preceded by a dark U-shaped figure, which in turn partially encloses a dark median line, whereas in *S. callocricus* the only precollar element is a complete or incomplete "W," this figure at times broken basally and medially to give a broad "U" and an incomplete median snout line.

As far as other differences are concerned, the samples are small in both cases and thus presumed differences may not be substantiated by further material. However, S. *samanensis* has less dorsals between axilla and groin (23-28 versus 26-34; $\bar{x}$ = 25.5 and 29.5), less ventrals between axilla and groin ($\pm$22-28 versus 25-32; $\bar{x}$ = 25.3 and 27.8), and always lacks an internasal (7 of 13 S. *callocricus* have this condition also). The patternless head in the male holotype of S. *samanensis* is in strong contrast to the well patterned heads of male S. *callocricus,* although one male of the latter species has a patternless head.

There may well be pigmental differences between the two species. Thomas's field notes on a female S. *callocricus* state that the dark bands are black with a light area on the head pale gray; the light neck band (presumably the region between the ear-to-ear band and the collar) was flesh-colored; the body was pale gray, becoming white on the distal part of the tail; the scapular ocelli were pale yellow; the venter was grayish and the throat immaculate gray; the iris was gray to gray-brown. In contrast to these are Fowler's notes on a female S. *samanensis,* which state that the dorsum was tan with dark brown to black transverse bars, the venter was tan with pink hues in the thoracic region and a yellow tinge on the throat; the scapular ocelli were white. Note in these two descriptions of color in life that the ocelli are yellow in S. *callocricus*, white in S. *samanensis*, that there is a differently colored neck bank in the former and not in the latter, and that S. *samanensis* has a tan to pinkish or yellowish venter, whereas in S. *callocricus* the venter is gray. S. *samanensis* has 4 to 8 hair-bearing organs on the dorsal scales, S. *callocricus* has 2 to 6 organs; in both cases there is 1 hair per scale organ.

REMARKS: I have field data on two specimens. Thomas took a S. *callocricus* under *Cocos* trash along the beach on the northern coast of the Península de Samaná near limestone cliffs; Fowler took a S. *samanensis* in a crevice in the limestone wall of a cave behind a pile of rocks, shells, bones, and *Cocos* husks. The Cuevas de Caño Hondo are sea-caves which are well known and offer temporary haven for fishermen from Sabana de la Mar; the cave floors are covered with trash and debris. The recently collected specimens of peninsular S. *callocricus* were secured under rocks and logs in mesic forest; I have searched in the area between Sánchez and Las Terrenas (where the road traverses the well-forested Sierra de Samaná) and also attempted to interest residents of this region in collecting sphaerodactyls for me. In both attempts I failed, and the species appears either to be peculiarly rare or ecologically restricted on the Península de Samaná. The same is true for S. *samanensis* south of the bay. The type-series was taken by Miller in the Cuevas de Caño Hondo (Cochran, 1932:183, by inference, and Wetmore and Swales, 1931:32) while searching for fossils. These caves lie near the eastern end of the karst *haitises* region on the south side of the Bahía de Samaña. A visit by Jeffrey R. Buffett and myself to Caba, on the southern shore of the Bahía de Samaná near its head, yielded no specimens of S. *samanensis*. Caba is a small fishing village positioned precariously on two small beaches at the very foot of the *haitises*, and from there one can easily ascend into this limestone region which has abundant rocks and crevices in the hardwood

forest. This would seem an ideal situation for a calcicolous or mesophilic lizard. The five specimens of S. *callocricus* from San Cristóbal and Sánchez Ramírez provinces are from the southern edge of the *haitises*.

S. *callocricus* seems to occur sympatrically (or perhaps syntopically) with S. *clenchi* Shreve on the Península de Samaná, and with S. *difficilis* Barbour and perhaps S. *darlingtoni* Shreve west of the bay. None of these three species is banded; all are basically brown to almost black lizards. S. *clenchi* and S. *difficilis* are flecked dorsally with darker brown, and S. *darlingtoni* has a pale head pattern on a dark ground.

Schwartz and Thomas (1975) included some locality records of S. *callocricus* in their distribution of S. *samanensis*; the latter is known only from the vicinity of the type-locality. It is of course possible that S. *callocricus* should be regarded as a subspecies of S. *samanensis*, but the short distance (38 km airline) between the type-locality of S. *samanensis* and the San Cristóbal S. *callocricus* very strongly suggests that we are here dealing with two related species.

The name *callocricus* is from the Greek "kallos" for "beautiful" and "krikos" meaning "ring," in reference to the prominently banded appearance of the species.

Acknowledgments—I wish to thank Fred G. Thompson of the Florida State Museum and Ronald I. Crombie of the National Museum of Natural History for allowing me to examine the material of the new species. Mr. Crombie and George R. Zug made it possible for me to study the type-series of S. *samanensis*. The two specimens of this duo of species in the ASFS are due to the efforts of Richard Thomas and Danny C. Fowler; Mr. Fowler worked under my direction in the República Dominicana under NSF grant B-023603. Financial assistance to Howard W. Campbell from the National Fish and Wildlife Laboratory resulted in the collection of 5 specimens of S. *callocricus*. The illustrations are the work of Alan Kaplan to whom I am grateful.

Specimens examined (S. samanensis): *República Dominicana*, El Seibo Province, Boca del Infierno (USNM 74970-73-holotype and paratypes); Cuevas de Caño Hondo (ASFS V35283).

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A FLORIDA TROGLOBITIC CRAYFISH: BIOGEOGRAPHIC IMPLICATIONS

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ABSTRACT: *The presence of an undescribed troglobitic crayfish in the St. Johns River drainage suggests that endemic populations of Florida troglobites and some fishes may be the result of the same geological phenomena.*

AN UNPIGMENTED, blind crayfish was collected on a 4 August 1973 by Blody and Relyea from one of the small "boils" above the main "boil" area of Alexander Springs, Marion County, Florida. The specimen, a female, is deposited at the National Museum of Natural History, catalogue number USNM 144848. On 1 June 1974, Bankowski and Relyea collected a Form II male, USNM 145578, at the main "boil". These represent the only records of a troglobitic crayfish from the St. Johns River drainage other than *Procambarus acherontis* which is known from Palm Springs and a well in Seminole County (Hobbs, 1942). We believe, as does H. H. Hobbs, Jr., that the Alexander Springs specimens represent a seemingly undescribed species of cavernicolous crayfish related to the troglobite *Procambarus pallidus* (Hobbs, 1940) known from caves and sinks of Alachua, Columbia, and Suwannee Counties. It may also be related to the epigean *P. pictus* which occurs in the same river basin (Hobbs, 1958). Formal description of this new species must await capture of a Form I male.

The first specimen from Alexander Springs was found outside of the subterranean system resting on the loose debris that accumulates in stagnant areas near Florida spring "boils". Numerous small "boils" dot the area and the specimen probably emerged from one of them. The second specimen was found at the cave entrance of the main "boil". The appearance of this crayfish outside of the subterranean system has similarities to records of *Procambarus acherontis* from Palm Springs (Hobbs, 1942), and to records of the only other Florida troglobitic crayfish typical of a large spring situations, *P. horsti* from Big Blue Springs in Jefferson County (Hobbs and Means, 1972). Most Florida troglobitic crayfishes are found in sinks and caves where organic energy is input as opposed to springs where energy flow is out, or input is impeded. Springs pose intriguing ecological problems and we lack data for them—in fact, data are almost nonexistent for energy flow in Florida cave ecosystems (Relyea and Sutton, 1973).

Nine species of cavernicolous crayfish are now known from Florida (Relyea and Sutton, 1975). Other populations such as those from Alexander Springs will probably be described as new species when more material becomes available. It now seems likely that troglobitic crayfish, and possibly other crustacea, may

occur in many subterranean areas of Florida, and are not especially rare. Each local subterranean system, however, may be unique in terms of faunal assemblage, representing, in essence, a subterranean island as proposed by Culver (1973) for more northern cave systems.

The records from Alexander Springs have biogeographic implications since Alexander, Juniper and Wekiwa Springs (adjacent to Palm Springs) contain relict populations of the Blue Nose Minnow, *Notropis welaka* (Yerger and Suttkus, 1962). Isolated freshwater populations of the brackish water cyprinodontid fish *Lucania parva* also occur in Alexander and Juniper Springs. Slightly to the southwest of Alexander Springs, in the lakes of the Eustis area, are two more endemic, isolated fishes, *Menidia beryllina atrimentis* (Atherinidae) and *Cyprinodon hubbsi* (Cyprinodontidae). The origin of the entire troglobitic (cavernicole) fauna of the Florida Peninsula may be similar to the origin of the endemic freshwater fish fauna. In addition to the above listed species, this fish fauna consists of the cyprinodontids *Lucania goodei*, *Jordanella floridae*, and *Fundulus seminolis* (Relyea, 1975). All of these endemic fishes probably were isolated from ancestral populations during some Pleistocene glacial period, though not necessarily simultaneously, and survived in constant temperature springs where they diverged from ancestral stocks. The troglobitic fauna which is essentially crustacean survived as relicts and evolved in the constant temperature subterranean system which is the source of the springs.

We express our gratitude to Dr. Horton H. Hobbs, Jr., USNM, for his critique of an earlier version of this manuscript, and for establishing so much of the groundwork for studies such as this.

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MERRITT ISLAND ECOSYSTEMS STUDIES, 2. BRYOPHYTES OF MERRITT ISLAND[1]

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ABSTRACT: *Mosses and liverworts were collected from 20 sites representative of the range of biological communities. Whereas only 2 mosses were previously known for Brevard County, 29 mosses, 19 hepatics, and 1 hornwort were found.*

ECOLOGICAL and biological survey studies have been underway on the National Aeronautics and Space Administration (NASA) lands comprising most of Merritt Island and the Kennedy Space Center (KSC) for over 3 yr. During the summer of 1975, the bryophytes were surveyed in each of 20 sites selected comparatively with the ecology research teams which had done the detailed ecological mapping of the NSAS-KSC preserve. Some sites were visited several times to assure that thoroughly representative collections were obtained. Some study sites will be resurveyed from time to time to evaluate seasonal aspects, if any, of the flora.

Three major natural vegetational types have been recognized on Merritt Island: 1) areas dominated by grass; 2) areas dominated by flatwoods to high shrub; 3) areas dominated by high shrubs to trees.

Grasslands yielded no bryophytes where saline water invaded creating facultative, if not obligate, halophyte communities. Freshwater perimeter sites supported *Riccia* in areas of partial shade. Xeric grassy sites yielded no bryophytes although ephemerals were sought.

Scrubby and pine flatwoods yielded only *Bryum argenteum* in disturbed sites in coastal oak scrub. This most cosmopolitan of all mosses is tolerant of extremes of temperature and moisture as evidenced by its ability to survive rather well in sidewalk cracks, for instance. Taller scrub of *Quercus* mixed with *Myrica cerifera* and occasional saw palmetto yielded *Frullania, Lejeunea,Microlejeunea, Sematophyllum* and, on palmetto trunks, *Octoblepharum albidum*. A pond margin supported *Riccia* aff. *fluitans* and some lower tree trunks and roots bore *Syrrhopodon incompletus*.

Areas of high shrubs and trees contain a bryovegetation and flora very much like that of the scrubby and pine flatwoods with a modest increase in abundance. An exception was found in the *Casuarina* plantings which were devoid of bryophytes—a condition we are tempted to attribute to the known allelopathic properties of these sometimes noxious trees. Some truly mesic sites were comprised

[1]*Merritt Island Ecosystems Studies, 1* was published without indication of its place in this series as *Elemental Analysis of Selected Merritt Island Plants* by David H. Vickers, Roseann S. White, and I. Jack Stout in Florida Scientist 38(3): 163-171. 1975.

of associations of palm, oak and wax myrtle, or palm hammocks, or oak hammocks. These intergrade into the hydric hammocks, and the bryophyte diversity increases parallel with that of higher plants. In such moist sites, Brachytheciaceae, *Pallavicinia, Riccardia,* and *Lophocolea* occur with some frequency. No bryophytes were found in either the black or white mangrove associations.

The following species were collected in the course of our study. Unless otherwise indicated, specimens cited were collected by H. O. and B. A. Whittier. Representative specimens are deposited in the herbarium of Florida Technological University (hb FTU).

Musci

Amblystegium serpens var. *juratzkanum* (Schimp.) Ren. & Card. 4162, on *Sabal* log.

Amblystegium varium (Hedw.) Lindb. 4269, Happy Creek hammock, on rotting wood.

Anomodon rostratus (Hedw.) Schimp. 4176, on base of maple tree.

Barbula cruegeri Sond. *ex* C. Mueller. 4173, on mud and snail shells; 4288, on limestone.

Brachymenium ?systylium (C. Muell.) Jaeg. & Sauerb. 2425, on coral sand.

Bryum argenteum Hedw. 4050, 4051, sandy shoulder of road in full sun.

Bryum ?capillare Hedw. 4162, on *Sabal* log; 4189, on ground covered by *Vitis*; 4266, in Happy Creek hammock, damp to wet soil.

Desmatodon sprengelii (Schw.) Williams. 4274, on limestone sand and rock; 4285, Pine-*Sabal* Community, on open ground with *Nostoc.*

Entodon macropodus (Hedw.) C. Muell. (*Entodon macropus* in Breen, 1963) 4373, Shiloh Marsh, on downed branch.

Fissidens garberi Lesq. & James. 4212 A, on oak bark in Happy Creek Hammock.

Forsstroemia trichomitria (Hedw.) Lindb. 4239 A, on *Ilex cassine.*

Haplocladium microphyllum (Hedw.) Broth. 4173, on mud and snail shells; 4226, Happy Creek hammock, on rotten log, traces only; 4271, on limestone rock.

Isopterygium micans (Sw.) Broth. 4155, on base of *Sabal* palm; 4621 E, traces, Happy Creek hammock, on *Sabal* base.

Leptodictyum riparium ssp. *sipho* (P. Beauv.) Grout. 4172, a single strand among *Octoblepharum albidium*; 4173, traces only, on mud; 4212 C, traces only, on oak bark.

Leucobryum albidum (P. Beauv.) Lindb. 2458 A, on base of *Sabal* palm.

Octoblepharum albidum Hedw. 4172, 4179C, 4278, on *Sabal* palm; 4178 on oak branch about 6 in diam; 4260, Happy Creek hammock on *Sabal* palm; *4271, on Serenoa repens;* 4281B, on *Pinus* stump; 4292, on burned *Sabal* palm leaf bases.

Oxyrrhynchium hians (Hedw.) Loesk. 4225, Happy Creek hammock, on ground; 4250, on debris around base of red maple.

Papillaria nigrescens (Hedw.) Jaeg. & Sauerb. 4226, 4239C, on *Ilex cassine* 1-1.5m above ground, Happy Creek hammock; 4253, on *Persea* base.

Rhynchostegium serrulatum (Hedw.) Jaeg. 4253, Happy Creek hammock, on *Persea* base; 4314, on *Sabal* log; 4328, on decayed log; 4378, on *Ulmus.*

Sematophyllum adnatum (Michx.) E. G. Britt. 4052, on tree bases in oak scrub; 4179 B, on trunks of *Sabal* palms; 4224, on *Quercus virginiana* bark.

Syrrhopodon texanus Sull. 4163, on *Sabal* log as traces; 4260, on maple roots; 4261, Happy Creek hammock, base of *Sabal.*

Thuidium recognitum (Hedw.) Lindb. var. *delicatulum* (Hedw.) Warnst. 4242, on decaying wood, c. fr.; 4240, on maple roots.

Sphagnum strictum Sull. Collected by Allen G. Shuey. Growing around periphery of pond in flatwoods.

Stereophyllum radiculosum (Hook.) Mitt. 4212 B, 4224 B, traces on *Quercus virginiana* bark in hammock.

Syrrhopodon incompletus Schw. 4152. on rotting *Sabal* trunk on ground; 4163, 4179A, 4203, 4205, 4238, 4284A, 4308, 4378A, on *Sabal* trunk.

Hepaticae and Anthocerotae

Cololejeunea cardiocarpa (Mont.) Steph. 4166, on grape stem in *Sabal*-maple hammock.

Frullania kunzei (Lehm. & Lindenb.) Lehm. & Lindenb. 4181, among lichens in *Sabal* hammock; 4191, on lichens on willow bark; 4262, Happy Creek hammock, with lichens on red maple bark.

Frullania squarrosa (R.B.N.) Nees. 4151, in *Sabal*-maple hammock on maple bark about 1m above ground; 4249, on rotted tree, overgrowing lichens, as traces.

Lejeunea cf. *cladogyna* Evans. 4162, 4163, on *Sabal* log in *Sabal*-maple hammock.

Lejeunea flava (Sw.) Evans. 4253, Happy Creek hammock, on base of *Persea*; 4259, base of *Acer rubrum* on organic debris and bark; 4378, Shiloh marsh, swampy area, on *Ulmus*..

Lejeunea floridana Evans. 4261 C. Happy Creek hammock.

Lejeunea laetevirens Nees & Mont. 4248, on *Ulmus*.

Lejeunea minutiloba Evans. 4257, base of *Sabal* palm.

Lophocolea martiana Nees. 4240, on maple roots; 4261A, Happy Creek hammock, on base of *Sabal* palm.

Microlejeunea ulicina (Tayl.) Evans ssp. *bullata* (Tayl.) Schust. 4053, Indian Mound hammock; 4156, 4181, on *Acer rubrum* bark; 4182, 4191, on *Celtis* bark; 4239 B, 4240, on *Acer rubrum* roots; 4253, traces on bark; 4378, Shiloh Marsh, traces on *Ulmus*.

Odontoschisma denudatum (Nees) Dum. 4240, on maple roots; 4258 B, Happy Creek hammock, on base of *Sabal* palm.

Odontoschisma prostratum (Sw.) Trev. 4261 B, Happy Creek hammock, traces.

Pallavicinia lyellii (Hook.) S. F. Gray. 4240, on *Acer rubrum* roots; 4272, Happy Creek hammock on base of *Sabal*; 4328, on humus soil among *Sabal* palms; 4348, Shiloh Marsh, on base of decaying stump.

Radula australis Aust. 4156, in mixed *Sabal* palm hammock; 4253, on bark.

Radula obconica Sull. 4248, on *Ulmus*, traces.

Rectolejeunea maxonii Evans. 2427, on *Ulmus* bark, Happy Creek hammock.

Riccardia multifida (L.) S. F. Gray. 4240, on debris on *Acer* roots; 4262, Happy Creek hammock, on rotting long, c. fr; 2427, on *Ulmus* bark.

Riccia aff. *fluitans* L. 4300, 4303, 4305, at base of *Salix*; 4327, in ditch.

Telaranea nematodes (Aust.) Howe. 4256, on base of *Ulmus*.

Anthoceros carolinianus Michx. 4320, rotting log; 4321, on damp, wet ditch soil; 4324, in wet ditch banks in heavy shade; also collected by James E. Poppleton in March, 1973, on *Serenoa* bordering *Spartina* marsh.

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SUMMER MARINE ALGAE AT VERO BEACH, FLORIDA

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Abstract: *The marine algae associated with a sublittoral reef at Vero Beach, Florida were investigated over a two month period during the summer of 1974. Habitat descriptions, zonation patterns, and floristic information are based upon field observations and laboratory determinations. One hundred nine species are reported, including 15 Cyanophyta, 19 Chlorophyta, 13 Phaeophyta, and 62 Rhodophyta;* Gelidiopsis gracilis *is newly recorded for Florida waters.*

Observations on the sublittoral marine plants of Florida's east coast between Cape Canaveral and Miami have rarely been reported. The algae of the intertidal rocks at Marineland, Florida, were studied by Humm (1952) and T. A. and Anne Stephenson (1952). Studies concerned with the seasonal variation in the marine flora have been performed at St. Lucie Inlet and adjacent Indian River, Florida, by Phillips (1961), in the Florida Keys by Croley and Dawes (1970), and in Bermuda by Bernatowicz (1952). General floristic accounts of the marine algae in the Bahamas (Howe 1920), Bermuda (Collins and Hervey 1919), Danish West Indies (Børgesen (1912-1920) and in Florida (Taylor 1928, 1960) continue to be the primary sources of information for this area. In an effort to expand the knowledge of the marine algae of Florida, a study of summer benthic flora was undertaken at Vero Beach.

Collections were made at Vero Beach on June 21, July 5, and July 19, 1974. Transects were employed and 10 cm samples were collected every 5m. Transect I began at the low tide line on the beach and extended seaward 120m over the reef. Transects II and III, each 40m long, were taken only across the reef. For the most part, collecting was possible while snorkeling but scuba equipment was utilized when working seaward of the reef. All specimens were preserved in 5% seawater formalin at the site. Representative herbarium specimens have been deposited in the herbarium, Department of Marine Science, University of South Florida, St. Petersburg.

A sublittoral reef composed of loosely consolidated sand, shell fragments, and worm tubes provides an ideal site for attachment by benthic marine algae. The northern limit of the reef occurs at Vero Beach and it extends southward to West Palm Beach. The collecting site for this study was 0.5 mile south of the public beach. The reef is approximately 30m offshore and it is nearly always submerged. Its uppermost surface is exposed only during spring tides.

The substrate extending from the beach to the reef is largely sand. Isolated rock outcroppings become more numerous closer to the reef. These outcroppings are never uncovered even by the lowest tides. Beyond the reef, toward the sea, there is very little sand, but coral heads and worm tubes are abundant.

A moderate surf (Tanner 1960), between 50 and 100cm high, is formed over the reef by low water and onshore winds. The tides at Vero Beach exhibit a diurnal periodicity and an amplitude of 1m. The water depth over the reef varies from 0.0-8.0m. Water movement continuously undercuts the reef, forming ledges and large fissures, some more than a meter deep. Wave activity and large quantities of suspended particulate matter contribute to low water transparency and light intensity beneath the surface. Visibility ranged from 0.0-2m.

Discussion and Observations—The summer marine flora at Vero Beach is diverse and abundant. All major divisions are well represented with 109 species reported. *Gelidiopsis gracilis* is a new record for Florida waters.

The habitat is unique in that a wide range of physical environmental conditions favors the growth of both shallow-water and deepwater forms in very close proximity. Three broad zones defined by substrate, light intensity, exposure and water movement were observed.

The area beyond the reef constituted the most physically stable zone and the lowest floral diversity was noted here. *Halymenia floridana*, *H. floresia* and *Chrysymenia halymenioides*, typical deepwater species, were indicative of this zone and grew in well shaded areas 5-8m deep. Dense stands of *Gracilaria mammillaris*, *Bryothamnion triquetrum*, and *Eucheuma nudum* dominated large areas of the substrate.

All portions of the reef proper displayed a great variety of algae. Vertical fissures in the reef provided sheltered locations, protected from surf and high light intensitites, for deep-water and delicate species.

Rock outcroppings projecting from the sandy substrate nearest the beach supported a large population of algae. *Ulva lactuca* and *Spyridia clavata* characterized this zone.

Several of the coarse algae found at Vero Beach served as host plants for a variety of epiphytes. The large blades and fibrous holdfasts of *Spatoglossum* and *Padina* provided attachment sites for three species of *Giffordia*, *Colpomenia sinuosa*, and *Sphacelaria tribuloides*. We recorded 15 epiphyte species from *Bryothamnion seaforthii*, *B. triquetrum*, and *Dictyurus occidentalis*.

During the summer months, a progressive diminution in the size and numbers of brown algae was observed. *Dictyopteris* appeared to be normal in the last collection but *Padina* and *Spatoglossum* were rare and very stunted in form. *Colpomenia* and *Dictyota* were absent in mid-July.

Our observations indicate that further investigations in this vicinity would be beneficial. Studies of algal distribution and seasonality in the Vero Beach area would contribute significantly to an understanding of the ecology of the marine flora of the Florida east coast.

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SPECIES LIST

Cyanophyta

Anabaena fertilissima Rao
Anacystis aeruginosa Drouet and Daily
A. dimidata Drouet and Daily
A. marina Drouet and Daily
A. montana (Lightfoot) Drouet and Daily
Calothrix crustacea Thuret
Entophysalis conferta Drouet and Daily
Hormothamnion enteromorphoides Grynow, Bornet and Flahault
Microcoleus lyngbyaceus (Kützing) Crouan
M. vaginatus (Vaucher) Gomont
Nodularia spumigena Mertens var. *major* (Kützing) Bornet and Flahault
Oscillatoria submembranacea Ardissone and Strafforello
Porphyrosiphon miniatus (Hauck) Drouet
Schizothrix arenaria (Berkeley) Gomont
S. calcicola (C. Agardh) Gomont

Chlorophyta

Bryopsis pennata Lamouroux
Caulerpa mexicana (Sonder) J. Agardh
C. microphysa (Weber-Van Bosse) J. Feldman
C. peltata Lamouroux
C. prolifera (Forsskal) Lamouroux
C. racemosa (Forsskal) J. Agardh
C. sertulariodes (Gmelin) Howe
Chaetomorpha media (C. Agardh) Kützing
Cladophora brachyclona Montagne
C. delicatula Montagne
C. prolifera (Roth) Kützing
Codium decorticatum (Woodward) Howe
Derbesia vaucheriaeformis (Harvey) J. Agardh
Enteromorpha compressa (Linnaeus) Greville
Entocladia virides Reinke
Halimeda discoidea Decaisne
Rhizoclonium kerneri Stockmayer
R. riparium (Roth) Harvey
Ulva lactuca Linnaeus

Phaeophyta

Colpomenia sinuosa (Roth) Derbes and Solier
Dictyopteris delicatula Lamouroux
Giffordia conifera (Bφrgesen) Taylor
G. duchassaigniana (Grunow) Taylor
G. mitchellae (Harvey) Hamel
G. rallsiae (Vickers) Taylor
Padina vickersiae Hoyt
Pocockiella variegata (Lamouroux) Papenfuss
Rosenvingea intricata (J. Agardh) Bφrgensen
Sargassum cymosum C. Agardh
Sphacelaria tribuloides Meneghini
Spatoglossum schroederi (Mertens) Kützing

RHODOPHYTA

Acanthophora muscoides (Linnaeus) Bory
Amphiroa brasiliana Decaisne
Botryocladia occidentalis (Bφrgesen) Kylin
B. pyriformis (Bφrgesen) Kylin
Bryocladia cuspidata (J. Agardh) De Toni
Bryothamnion seaforthii (Turner) Kützing
B. triquetrum (Gmelin) Howe
Callithamnion byssoides Arnott *in* Hooker
C. halliae Collins
Ceramium byssoideum Harvey
C. corniculatum Montagne
C. fastigiatum (Roth) Harvey
Centroceras clavulatum (C. Agardh) Harvey
Champia parvula (C. Agardh) Harvey
Chondria dasyphylla (Woodward) C. Agardh
C. sedifolia Harvey
C. tenuissima (Goodenough and Woodward) C. Agardh
Chrysymenia halymenioides Harvey
Cryptonemia crenulata J. Agardh
C. Luxurians (Mertens) J. Agardh
Dasya collinsiana Howe
D. corymbifera J. Agardh
D. pedicillata (C. Agardh) C. Agardh
D. rigidula (Kützing) Ardissone
Dictyurus occidentalis J. Agardh
Erythrotrichia carnea (Dillwyn) J. Agardh
Eucheuma nudum J. Agardh
Falkenbergia hillebrandii (Bornet) Falkenberg
Fosliella atlantica (Foslie) Taylor
F. lejolisii (Rosanoff) Howe
Galaxaura cylindrica (Ellis and Solander) Lamouroux
G. marginata (Ellis and Solander) Lamouroux
Gelidiopsis gracilis (Kützing) Vickers
G. intricata (C. Agardh) Vickers
Gigartina acicularis (Wulfen) Lamouroux
Gracilaria cervicornia (Turner) J. Agardh
G. compressa (C. Agardh) Greville
G. cylindrica Bφrgesen
G. ferox J. Agardh
G. mamillaris (Montagne) Howe
Grateloupia filicina (Wulfen) C. Agardh
Griffithsia globulifera Harvey
Halymenia floridana J. Agardh
H. floresia (Clemente) C. Agardh
Heterosiphonia gibbesii (Harvey) Falkenberg
Hypnea cervicornis J. Agardh
H. musciformis (Wulfen) Lamouroux
Jania adhaerens Lamouroux
Laurencia microcladia Kützing
L. obtusa (Hudson) Lamouroux
L. poitei (Lamouroux) Howe
Lithophyllum sp.

Nitophyllum punctatum (Stackhouse) Greville
Peyssonnelia rubra (Greville) J. Agardh
Polysiphonia denudata (Dillwyn) Kützing
P. macrocarpa Harvey
P. sphaerocarpa Bφrgesen
Soliera tenera (J. Agardh) Wynne and Taylor
Spermothamnion speluncarum (Collins and Harvey) Howe
Spyridia clavata Kützing
Titanophora incrustams (J. Agardh) Bφrgesen
Wrangelia argus Montagne

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GOOD NEWS FOR THE JUNK FOOD JUNKIES—*Marguerite F. Gerstell,* Department of Engineering Sciences, Florida Institute of Technology, Jensen Beach, Florida 33457.

Abstract: *Coca-cola is absolved. Bologna and potato chips are brain foods.*

A recent article in Science links the production of serotonin in the brain with high ingestion of carbohydrates. Serotonin is the well-known "smart" chemical without which you get PKU and general stupidity. If you can't have chutney without mangoes, you certainly can't have serotonin without tryptophan. This has been common knowledge for some time.

What is relatively new is the finding that more tryptophan will get to the brain when hyperinsulinism causes the tissues to absorb the other amino acids in the bloodstream, leaving the tryptophan level high in relation to the level of alanine, arginine, and all those others you can't remember.

Pork entrails appear highest on Documenta Geigy's list of efficient dietary sources of tryptophan. Studies in progress on the part of this author may show that potato chips, too, constitute a significant fraction of American tryptophan consumption, as if their previously documented importance as a potassium source weren't enough to vindicate them.

Presumably, a big bologna sandwich and a pile of Pringle's will make you smart—but only if you wash it all down with a couple of Cokes.

DIVERSITY AND SUCCESSION OF A LATE PLEISTOCENE POND FAUNA, MAJOR COUNTY, OKLAHOMA

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Abstract: *A small deposit of Quaternary freshwater sediments was trench sampled to analyze the total invertebrate fauna. Five bulk samples were disaggregated by the Amine 220 technique; taxonomic frequencies were adjusted to reflect standing crop; and adjusted data were programmed into standard diversity and equitability indices. A predictable pattern of community succession emerged with earliest environments of high stress and supporting a few eurytopic organisms. Under favorable conditions stenotopic organisms were dominant but as conditions deteriorated, the colonization process was nearly reversed.*

Dynamics of an invertebrate community in a shallow benthic freshwater environment were reconstructed by applying modern ecological concepts including information theory. Most paleoecological studies of invertebrates have been in marine realms, however, Taylor's (1960) monograph on High Plains molluscan faunas is an outstanding example of a freshwater faunal study. Hibbard and his coworkers provide a useful stratigraphic framework for the Pleistocene of North America. For example, Schultz (1969) contributes extensive stratigraphic and vertebrate paleontologic data from studies in Kansas. He has reconstructed the Late Pleistocene sequence using faunal, floral and stratigraphic evidence. The Doby Springs local fauna, as described by Stephens (1960), provides much data for climatic and ecologic reconstruction. Schultz and Stephens were strongly dependent on fossil Mammalia.

The study area lies in Major County, northwestern Oklahoma in the Great Plains physiographic province. The site is a roadcut on the east side of State Route 58, 3 miles south of Ringwood and 4.1 miles south of intersection with U.S. Route 60 (Fig. 1). Site location is SW ¼, SW¼, sec. 34, T.22N., R.10W. on the Fairview SE sheet (Johnson, 1972). The deposit represents a Late Pleistocene temporary pond or backwater area on an ancient floodplain. The fossils were found in a layer of buff and light gray clayey sand. The sediments are easily distinguished from the red Permian bedrock and underlying and overlying sands that were derived from the Permian red beds and deposited by the Cimarron River.

This deposit evidently was laid down in a temporary pond as defined by Kenk (1949). Evidence for a temporary pond is high clay content, gray to gray-brown color (high organics) and freshwater snail species that prefer shallow pools of standing water (Johnson, 1972). The sediments are rather homogeneous throughout their thickness. Water accumulated in small depressions such as ponds or backwater areas on Pleistocene flood plains. Water level in these depressions is a function of the local water table and fluctuates accordingly. Shallow depressions certainly would undergo alternating periods of flooding and

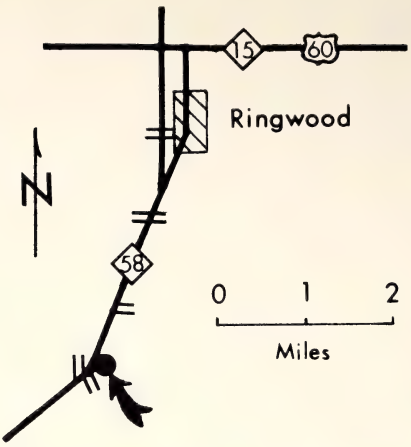

Fig. 1. Site location map, Major County, Oklahoma.

desiccation. Clastics filling the pond have local provenance. Permian sands, gravels and clays, High Plain Ogallala Formation, and Pleistocene sands provided most of the detrital sediments.

As we approach the Recent, biology and ecology of descendants can be applied to their ancestors more soundly than to more ancient animals. We may assume that the limiting factors of Late Quaternary molluscan species are the same as now. We may also assume that fossil forms morphologically and structurally similar to modern forms are conspecific. However, there are some other very real problems: (1) many groups of molluscs have taxonomic characters based solely on soft part anatomy; (2) ecological data are unknown for many modern species; and (3) taxonomy of many groups sorely needs revision. Thus, many ecological inferences that are potentially possible cannot be made.

Methods—The outcrop thickness of 1.5m was trenched to expose fresh surfaces. Five equal samples of 0.3m weighing approximately 0.5 kg were collected via the stratified sampling technique of Griffiths (1967). This sampling design was used to eliminate collecting bias. Spot samples were collected to aid in the identification of the fauna. Observations were recorded on the state of fossil preservation.

The 0.5 kg bulk samples were disaggregated by the Amine 220 technique (Lund, 1970). The disaggregate was wet sieved thoroughly to remove all traces of Amine 220. Sediment and fossils were retained on sieve numbers 10, 40, 70, 100 and 120. The five samples provided 25 individual sieve fractions. The sieve fractions were split with a standard sampler splitter to a workable quantity of approximately 1.50 gm from plus 70 and coarser material and 0.15 gm for finer material. All fossils greater than 50% complete were identified and counted from each split.

Recorded taxonomic frequencies must be adjusted to a common standard to compare the different samples as combined weights of fossils and sediments of each sieve sample split vary. Thus, initial frequencies were adjusted to a

weight standard of 500 g. For example, if the weight of the counted sample (both fossils and sediment) was 25 g; the individual frequencies would be increased by a factor of 20, approximating totals that would be found if 500 g were initially counted (Shaak, 1975).

Taxonomic frequencies were further adjusted to a "reflection" of standing crop (Shaak and Rollins, 1972). This reflection is simply a generation overlap correction. Gastropod frequencies were adjusted to the average gastropod longevity of 1 yr. This 1 yr value is defined as unity. Ostracods avg three generations per year, thus their frequencies were reduced by a factor of three. Also their counts were reduced by an additional factor of nine (taking into account their 9 ecdysis stages per year). In this manner all species counts were adjusted to represent a single generation.

Diversity—In view of the low number of taxa in this study and the dominance by ostracods, it was decided to use two types of diversity indices. The Simpson index (1949) is of the species diversity type and is calculated from the following equation (N = number of taxa per sample and n = number of individuals per taxon):

$$D_s = \frac{N\ (N-1)}{\Sigma n\ (n-1)}$$

The Simpson index is affected by sample size. Simpson values range from 1.288 to 5.103 in this study.

A good index of the numerical percentage composition type is the Shannon-Weaver information function (1949) (s = total number of species and p_r = observed proportion of individuals that belong to the r^{th} species [r = 1,2, . . . s]):

$$H(s) = -\sum_{r-1}^{s} pr\ \log_2 pr$$

The Shannon-Weaver function is affected by equitability. These values range from 0.550 to 2.510 in this study.

Equitability—A measure of numerical equality or evenness of distribution is important in interpreting diversity values. The Donahue index (Shaak, 1975) measures numerical equality: $\frac{\text{Simpson Index}}{\text{number of taxa}}$

Where D_s is divided by the number of taxa in that sample. Recorded equitability values range from 0.549 to 0.729. A perfectly equitable distribution would have an index of 1.0 and decreasingly smaller values indicate increasing numerical dominance by one or a few taxa.

Faunal Succession—Diversity values were calculated and plotted in an effort to trace succession through the history of the pond. Diversity should increase from low initial values to a peak and decrease as the pond permanently dries up. As these temporary bodies of water passed through a cycle of wetting and desiccation, succession and thus diversity still should follow a corresponding cycle. There is a natural succession during stages of community development (Shaak, 1975). The steps involved in a temporary body of water would represent

a discontinuous succession. Many components of the community must be adapted to survive in a dormant stage. Thus, there may be a seasonal succession as well as a long range succession. These rigorous conditions however are favorable for many pond inhabitants, as predation and interspecific competition are low (Odum, 1971).

Succession is a process of internal or self-organization in any cybernetic system within the bounds of the ecosystem (Margalef, 1968). Environments and communities change with time and this change is to a degree predictable. Information theory provides the mode of comparison between real data and predictions.

Diversity values were calculated and plotted for each sample (Fig. 2). Total fauna and then total fauna less terrestrial snails were calculated for the purpose of comparing change within aquatic and terrestrial habitats. Equitability was similarly calculated and plotted (Fig. 2). It is interesting to note the similarity of the two diversity curves. Simpson values are higher because of the nature of the index. Diversity reaches a peak in sample 4 as the Simpson value is 5.10 and the Shannon-Weaver value is 2.51. If interpretations were made using data including terrestrials, the maximum diversity would peak in sample 3. However, the equitability curve drops drastically in sample 3 (Fig. 2). As diversity increases, the maturity level of the system and corresponding equitability values ought to increase. The low equitability figure for sample 3 is due to dominance by *Promenetus* and *Helisoma*, two freshwater planorbid snails (Table 1). Their dominance is so marked that they outnumber the ostracods in the sample. The simple faunal diversity remains the same in sample 4, but the frequencies are

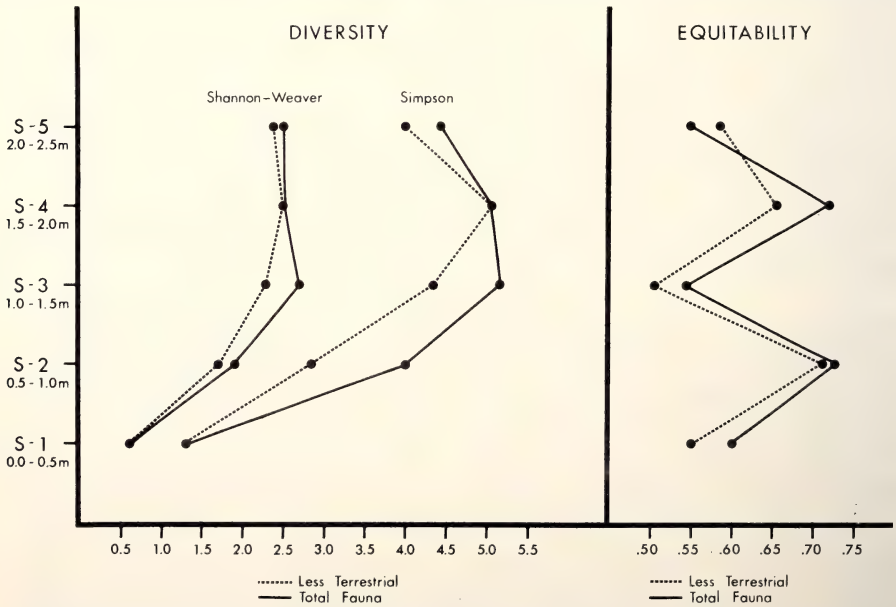

Fig. 2. Summary of diversity and equitability for a Major County, Oklahoma, Late Pleistocene pond fauna.

more equitable. The highest level of successional maturity is reached within sample 4. And, as expected, this is complemented by an equitability high. Sample 5 shows a decrease in diversity and equitability, thus indicating a deterioration of the community. Equitability decreases as dominance increases. The pond has passed the point of maximum successional maturity and is on the decline.

TABLE 1. Adjusted faunal frequencies, Ringwood Site, Oklahoma.

Species	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
OSTRACODS					
Candona fluviatalis	103	480	992	1266	691
Cypridopsis vidua	15	155	204	354	225
GASTROPODA					
Succinea sp.[1]		580	655		246
Gyraulus sp.		1087	354	1703	2211
Promenetus sp.		435	2048	993	369
Pupilla muscorum[1]		72			
Fossaria sp.			901	142	983
Gastrocopta cristata[1]			82		
Helisoma sp.			2211	1135	614
Physa sp.				426	246
BIVALVIA					
Pisidium sp.			246		
Musculium sp.			26		

[1]denotes terrestrial.

CONCLUSIONS—Components of information theory can be applied meaningfully to ecologic realms other than shallow benthic marine and terrestrial. Pond communities undergo succession, thus quantification of data should reflect certain aspects of the pond's wet-dry cycle. Early stages of colonization are marked by low diversity and high dominance. These frontal environments of high stress would support only a few species. As more favorable conditions are reached, diversity increases and dominance decreases, and the system trends towards equilibrium. Then, as the cycle continues, stress conditions increase and the more vulnerable species are biologically winnowed out, nearly the reverse of the colonization stage.

This quite predictable pattern is shown by use of diversity and equitability measures. These ecological tools help in the interpretation of subtle irregularities in community succession. Their usage is much more valuable if the raw faunal frequencies are adjusted to reflect a single generation of animals or "reflection" of standing crop. One problem is the lack of seasonal data. Inasmuch as the sediments were lithologically homogeneous, the sampling scheme cannot be blamed. Had the sediments been varved, superb control could have been exercised. Feeding and habitat subtleties cannot be discerned. This is in part due to inadequacy of data concerning ecology and distribution of many species.

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THE RHETORIC OF GLOBAL RESOURCE POLITICS

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Abstract: *Statements made at the U. N. Sixth Special Session, April, 1974, were coded according to the general causes for world economic problems mentioned, and for the solutions proposed. Existence of a Third World Consensus was then tested by comparing attitudinal positions against the U. N. categories: developing market economies (developing nations); developed market economies (western nations); and non-market economies (communist nations). Causes mentioned demonstrated significant consensus among developing nations and significant differences between developing and western or Communist nations respectively; differences within the Third World on the basis of economic status were not significant; the same was true of 3 of the 7 general solutions proposed; and 3 of the remaining specific solutions proposed by developing nations differed from proposals by developed nations.*

Rhetoric of the Third World has been widely discussed as an inaccurate reflection of its international interests. In numerous conferences until the present decade, elite representatives of the Third World expatiated upon the plunder and domination of the Colonial Era and blamed much of their nations' current troubles upon this heritage. As decades have followed, economic, political and social problems have accelerated despite the absence of external political domination. The same old tired formulas nevertheless have been trotted out ritualistically to underscore the common experience of Third World Countries. Conflicts between Third World nations appeared to render spurious these appeals for a common front, tactics merely to increase the leverage of the more ambitious rival leaders. (Miller, 1967; Kahin, 1956; O'Brien, 1963; Hunt, 1960).

Common among most of these interpretations has been the assumption that the common interests of the Third World have been largely theoretical and ritualistic. What was of paramount importance, as far as the rest of the world was concerned, was their more striking conflicts and differences, which tended to divide them in their dealing with both western and communist nations.

I believe that this has changed. The rhetoric of the Third World now must be taken seriously, because it does represent common interests, and because it has already had more than theoretical consequences. Underlying the rhetoric of the forbears of modern Third World politics has long been the assumption that underdeveloped countries were somehow still subject to economic discrimination and exploitation by the industrialized nations despite their putative independence. The warnings against economic domination put forth by Nehru in 1948 (Norman, 1965) and the neocolonial theories of Sukarno, Nkrumah and others were clearly in line with a Marxian interpretation of relations between 'First' and 'Third' World nations (Legge, 1972; Nkrumah, 1970), and as such were also promoted in extreme fashion by the Chinese. These views were clearly

rhetorical tools to build superficial unity in opposition to cold war alliances. It represented a far from unanimous Third World position as long as the issues involved were not clearly related to their common economic interests. When international economic issues such as trade, commodity agreements, prices for raw materials and the monetary system moved into the forefront, however, the rhetoric of neo-colonialism gradually became a more relevant common reference point for a growing majority of nations in Asia, Africa, Latin America and the Middle East.

Beginning with UNCTAD in 1964, Third World nations have seen their interests more clearly converge despite the many regional, tribal and historic conflicts which divide them. Their rhetorical position no longer represents a superficial unity, historically subscribed to in the abstract but meaningless in practice. At the international level this position began to produce concrete results as early as the 1964 UNCTAD, but perhaps it could be argued still that the results were only paper proclamations. That such a case could be made was as much due to the intransigence and inertia of developed nations as it was due to the divisions within the Third World.

Events of the early 1970's have clearly eliminated some of the major barriers to Third World expressions of common interest. Detente has eliminated the relevance of the division between neutralist and anti-communist developing nations and made it possible for Marxist interpretations of international economic relations to become respectable even among some of the most conservative and "pro-western" of Third World regimes. At the same time, the salience of economic issues has increased, helped along by the floating monetary system, intensification of food problems, acceleration of investment by multi-national corporations in developing countries, and pre-eminently, by growing success of the Organization of Petroleum Exporting Countries (OPEC) after earlier apparent failures.

Five times meetings in 1974 clearly were dominated or strongly influenced by the Third World nations, and in each case (Resources and Raw Materials, Law of the Sea, Food, Population and the United Nations Assembly meeting) proclamations, programs and institutions have been initiated or changed substantially to reflect not the western, or the communist, but the Third World point of view. In other words, Third World rhetoric cannot be discounted as rhetoric alone, because it has had far reaching consequences. That the New International Economic Order for example, is being studiously ignored by industrialized nations does not eliminate its significance. It has legitimized a number of ideas among our most loyal supporters in the Third World which we cannot ignore for long; among these are producer country organizations, international regulation of multi-national corporations, and the right to nationalize private foreign holdings. The outcry last winter among Latin Americans over our proposal to exclude Venezuela and Ecuador from special trade preferences because of their OPEC membership supports this contention. (U. S. State Department, Special Report No. 18, May 1975). The United States is being denounced for discriminating against nations for economic practices specifically encouraged by

the United Nations and clearly within the interest of any developing country which exports primary products. (Whether a cartel organization for sugar or bananas is a viable possibility, however, is not within the scope of this paper.)

What in fact is this rhetoric, i.e., how do the "spokesmen" for the Third World articulate their perception of global problems? I propose to examine Third World positions on economic issues as they have been developed, first by intellectual spokesmen, next as official government positions at the Sixth Special Session of the United Nations, next the incidence and intensity of these positions, and finally the degree to which these positions are reflected in the New International Economic Order and Plan of Action adopted by the Special Session.

Sources of the Rhetoric—The rhetoric of neo-colonialism and external dependency now being advanced by many Third World spokesmen flows logically from three different sources: anti-colonial positions of early Third World leaders; economic dependency theories developed by Western and Latin American economists; and Lenin's theory of imperialism. As previously noted, the early spokesmen for the Third World gained much of their inspiration for charges and warnings against "neo-colonialism" from the early frustrations of their high hopes upon independence.

Nationalist leaders such as Nehru and Sukarno had warned against continued economic domination by former colonial powers even before independence in their several states was achieved. These warnings tended to be vague, based upon casual impressions and larely hortatory in content, however. On the other hand, there were Marxian analyses derived from Lenin's theory of imperialism which gained contemporary currency in South Asia, Africa and Latin America. They documented exports of capital from developing to developed countries, terms of trade in the world market which favored manufactured and capital goods over the primary products exported by developing nations, the oligopoly practices of transnational corporations operating in these countries, and the relationship between foreign aid and trade, especially denouncing the former as "frequently no more than political bribes given to the ruling circles of such states." (Zhukhov, 1970) While communist analysis going this far may not be acceptable to many, to Third World elites who are recipients of such aid, the denunciation of tied aid, and political intervention is clearly acceptable. In fact untied multilateral transfers of resources from rich to poor nations has been claimed as just reparations by such disparate writers as Frantz Fanon, (Fanon, 1968) Mahbubul Haq (Ward et al. 1971), and Raul Prebisch.

Raul Prebisch, Latin American economist and former Executive Secretary of the U. N. Economic Commission for Latin America and Secretary General of UNCTAD until 1969, has carefully documented his claims that external trade relations of Latin American countries have been largely disadvantageous to development and that international trade relations need to be substantially restructured. (Prebisch, 1971) The circle of economists and sociologists influenced by Prebisch and the experience at UNCTAD is large. The general consensus among them is that the terms of trade between the developed and developing countries is increasingly disadvantageous to the latter, because of the tendency

for primary products to decline in price relative to manufactured goods. Proposed solutions range from commodity price agreements and special preferences for the goods from developing countries, to the reinvestment of multinational corporation profits within the host Third World countries, to national policies that discriminate against foreign companies and institute greater state control of investment and foreign trade. For example, Celso Furtado (Furtado, 1970) and Osvaldo Sunkel draw parallel examples of Japanese and Soviet politics towards foreign investment controls as examples to be emulated rather than following the models of Canada or Puerto Rico, which Sunkel terms branch plant countries" (Sigmund, 1972).

Furtado states further:

> The hegemony which the United States exercises in Latin America constitutes a serious obstacle to the development of the majority of the countries in the region, since it inordinately reinforces the anachronistic power structures. The "foreign-aid strategy" of the United States Government, which creates privileges for large corporations and which exercises preventive control of "subversion", contributes to the preservation of the most retrograde means of social organization . . . The idea that the international economy would necessarily tend to be controlled by a few large American corporations is a hypothesis that has been amply refuted by reality. Even though, under present conditions, it may not be possible to establish the precise outlines of the way the new polycentrism is a growing force. (Furtado, 1970)

Even when viewed from different perspectives, the three sources of current Third World rhetoric all lead to similar conclusions: 1) the economic relationships between developed and developing nations invariably favor the former, and 2) the established world institutions perpetuate these relationships. They differ on proposed solutions, however. Early nationalist leaders offered few specific solutions beyond non-alignment, and massive domestic development. Marxist writers have urged a shift to "Socialism" involving at least the nationalization of foreign owned businesses and preferably a withdrawal from market relations with developed countries, and ultimately to industrialize and to collectivize agriculture in the Soviet or Chinese pattern (Zhukov, 1970). While nationalization, and even collectivization, of agriculture has been accepted by some Third World nations, few favor withdrawal from market relations. They prefer to restructure the market.

Third World economists have not so much rejected capitalism as they have capitalists, especially foreign ones. Solutions such as special preferences, commodity agreements, import substitution policies, discrimination against foreign corporations and national development planning are all aimed at minimizing the negative impact developed nations can make: providing a market for manufacturing exports; a source for capital equipment and a pool of technology and capital resources.

Official Positions at 6th Special Session. The Sixth Special Session at the United Nations was convened on an Algerian initiative in response to American and French counterproposals to have an international oil crisis. The Algerian call to the special session was designed to focus attention on all raw materials and their impact upon developed and poor developing nations. The new focus was obviously more favorable to a coalescence of Third World interests, since it was defined in terms which most developing countries could identify with.

The issues examined here center on how developed and developing nations defined the world's economic problems and how they proposed to resolve them. The most complete statement of the anti-western Third World position was offered in the opening speech by President Boumedienne of Algeria:

Owing to the fact that the developed countries have virtual control of the raw materials markets and what practically amounts to a monopoly on manufactured products and capital equipment, while at the same time they hold monopolies on capital and services, they have been able to proceed at will in fixing the prices of both the raw materials that they take from the developing countries and the goods and services that they furnish these countries . . . This is the basis of the economic order of the world in which we live today. Inasmuch as it is maintained and consolidated and therefore thrives by virtue of a process which continually impoverishes the poor and enriches the rich, this economic order constitutes the major obstacle standing in the way of any hope of development and progress for all countries of the Third World." (Algerian Mission to UN, April 1974)

There was range of opinion evident in the Third World, but the sentiment expressed by Mr. Rabasa of Mexico was relatively widespread and represented a mildly anti-western position despite the fact that Mexico was one of the few Third World nations active in the debate that was not a member of "the 77", the non-aligned countries which had met in Algiers the previous September (only 8 out of 47 making statements).

. . . In order to achieve rapid, excessive and monopolistic earnings today, we speed up the poverty of those countries which are developing and tomorrow they will not have anything with which to buy goods. Thus the industrialized countries are digging their own graves. The insolvent opulent society of today will be transformed into the humble poverty of tomorrow, unless they understand that it is in their own interests to alleviate the situation of the developing countries. (United Nations, 2215th Meeting of General Assembly, April 15, 1974)

More moderate statements among Third World nations were relatively scarce. However, Mr. Vignes of Argentina stated:

. . . the developed countries . . . control in fact all that can be controlled: their markets and goods and services, financial flow, the international supply of their products and . . . all that may serve their interests. It should therefore come as no surprise to them when the developing countries exercise similar controls . . . (Argentine Mission to UN, April, 1974)

Perhaps somewhat more restrained, in style at least, was the statement by the Indian foreign minister:

We are glad that OPEC's action has revealed the inequities and the weaknesses of the international economic system in all its aspects, and more particularly in the conduct of world trade in raw materials. These have been at the root of the failure of the first development decade and could jeopardize the prospects of the second. (Indian Mission to UN, April 19, 1974)

India and Brazil as well as Iran and Algeria could catalogue numerous instances where the prices of their raw material or primary commodity exports had declined while the prices for finished products derived from these materials had increased several fold. The major primary raw materials exporting countries tended to put it most cogently, however. According to the representative from Zaire, a major copper exporter:

Interpretation of economic laws on the world market seems to depend on the direction in which the price of raw materials fluctuates. If prices stagnate, that betokens economic health; if they increase that means a crisis. The example of petroleum is eloquent. The producers of that raw material had only to decide to adjust the price of petroleum for the term "energy crisis" to hit the economic headlines. Similarly, one might mention wheat. The price of that commodity has quintupled without the slightest protestation from the wealthy countries that produce it and sell it worldwide. The same is true of manufactured goods . . . (United Nations, 2215th Meeting General Assembly, April 15, 1974)

The developed countries, while conceding that the world economic system needed to be restructured and that raw materials prices ought to reflect a fairer share of the value of finished products were predictably restrained in contrast, in blaming the economic difficulties of development upon the nature of developed industrial economies. Dr. Kissinger attempted to caution against resource politicking. "If the weak resort to pressure, they will do so at the risk of world prosperity and thus provoke despair," (United States State Department, April 15, 1974) and tried to steer debate back to energy, to development, and to food and population. He proposed that raw materials prices be negotiated between producers and consumers in the framework of GATT in order to reach price levels which would be optimum for all.

Other developed countries had initially been more receptive to the Special Session and the positions they took seemed somewhat more attuned to the developing nations. Thus Canada's foreign minister, while pointing out " . . . the common interest of exporters and importers of developed and developing countries alike, in an effective international trade and payments system . . ." also made a point of explicitly recognizing their right to ". . . dispose of their natural resources in the interest of their own economic development . . ." (United Nations, 2211th General Assembly Meeting, table 16).

Similarly, the Foreign Minister of the Netherlands stated:

The conclusion the world should draw from the common actions on the part of the developing countries is that they reflect their justified desire for full participation in the world economic system. (United Nations, 2212th General Assembly Meeting, Table 3)

Neverless, the definition of the problem addressed did differ fundamentally between developed and developing nations.

Incidence and Intensity. In order to compare the rhetoric of developed, communist and developing nations official statements at the Special Session were coded into 7 categories depending upon whether the representative assigned blame in defining the current economic situation, if so what international institutions were identified, and if those identified had negative or neutral content (rapacious industrial economies vs. industrial economies, for example). The statements of 74 nations were coded, including 46 Third World nations, 17 western nations, and 11 communist nations. As a sample of the General Assembly these 74 nations could not be considered randomly selected, but do represent nearly all of the members active in the assembly debate of the 6th Special Session.

Treating the positions taken as votes "for" or "not for" (1 and 0), highly significant differences were revealed between western and other nations. First of all, only among western nations did a significant proportion (41.2%) assign no blame in the current world situation. ($\chi^2 = 14.77$, df = 2, significance = 0.0006) A significant proportion of communist nations (45.5%) blamed individual nations (usually the United States, or the U.S. *and* U.S.S.R.) which set them apart from all but 6.5% of the Third World nations. ($\chi^2 = 16.63$, df = 2, significance = 0.0002)

A clear majority of Third World nations (63%) agreed that the problem at hand was at least a consequence of industrial economies in general, while only

35.3% of western nations and no communist nations agreed. (χ^2 = 15.43, df = 2, significance = 0.0004) On the other hand only a minority, 37%, went further to identify as blameworthy such institutions of capitalism as the multi-national corporations. The minority was in agreement with a predictable majority of the communist countries. (χ^2 = 13.27, df = 2, significance = 0.0013)

Are the Third World nations a solid bloc, however? It was clear that there were differences in degree among them, but that these did not reflect either regional or ideological lines. It was hypothesized that these nations might differ according to their relationship to raw materials production. Consequently the developing nations were subdivided into OPEC members, other major strategic minerals exporters and the remainder. A significant division between raw materials producers and consumers did not emerge, since in all three categories positions were more consistent between them than between any one of them and either the communist or western positions. None of the positions taken by Third World nations were statistically distinct one group from another except in a proposal to ensure Free Trade. Yet five or six positions assigning causes to the current economic crisis revealed statistically significant differences between Third World countries and western and communist nations. Positions on three of the seven major proposals for handling the problem also showed significant differences between Third World and other nations (Table 1). Some minor differences did appear. OPEC countries were more likely to blame industrial economies than the other two categories and were more likely to name capitalist institutions such as multi-national corporations as major causes of difficulties. In the latter they were more in agreement with communist nations than were other Third World nations.

In general terms, therefore, it could be said that the OPEC nations apparently represented a somewhat more militant position within the Third World rhetoric, at least in assessing the causes of current economic problems. However there were no significant differences among the three groups.

Table 1. Industrialized economies to blame.

World Position	Not Mentioned	Mentioned	Total
Developed Countries	11 (64.7%)	6 (35.3%)	17
Communist Countries	11 (100.0%)	0	11
Third World	17 (37.0%)	29 (63.0%)	46
Total			74
Third World Categories			
OPEC Countries	1 (10.0%)	9 (90.0%)	10
Other Minerals Exporters	5 (41.7%)	7 (58.3%)	12
Other	11 (45.8%)	13 (54.2%)	24
Total			46

Proposed Solutions. The Sixth Special Session was not just a forum for allotting blame. In each official statement a variety of proposals were offered, ranging from the removal of trade barriers to promoting producer organizations like the OPEC. Majorities of each category of nations proposed commodity agreements in order to stabilize prices of raw materials at levels which would guarantee fair remuneration to the producers, but be reasonably acceptable to consumers. Yet Third World nations approached commodity agreements from a somewhat different perspective as for example, articulated by the representative from Guyana:

> We must negotiate, or try to negotiate, the prices of coffee, of cocoa, of sugar, of tea, of sisal, of copper, of tin, of bauxite. Yet do we ever negotiate the price of tractors, the price of industrial plants, the price of steel . . . ? Do we ever negotiate international freight rates? Is it any wonder that the prices of primary products have been historically depressed and the prices of manufactured goods consistently bouyant . . . ?
>
> We must move to a regime of equitable relationships between the prices of primary products and of manufactured goods. (Guyana Mission to the United Nations, April 15, 1974)

The developing nations approached commodity agreements as an opportunity for relating the prices of the products which they export to the goods which they import, while developed nations tended to mention only the primary commodities as subject for negotiated accomodation.

A second proposal put forward by almost 70% of the participants, and including large majorities of all groups but the communist nations, was the need for more foreign aid. However, developed nations tended to favor proposals to "maintain their traditional programs of assistance and expand them if possible." (Kissinger, April 15, 1974)

Developing nations, however, repeatedly called for multilateral aid, untied aid, etc., since "financial aid and assistance in personnel have all too often, unfortunately, served the purposes of exploitation . . ." (Zaire Mission to the United Nations, April 15, 1974)

Proposals for reform of the monetary system were primarily initiated by the Third World nations. ($\chi^2 = 7.08$, df = 2, significance = 0.029) A majority of this group (52.1%) favored such changes, mentioning more equitable distribution of voting rights in the World Bank, recognition of the new financial strength of the OPEC nations, the use of special drawing rights for development purposes, and "indexation" of the goods developing countries export to developed countries with the goods they import from developed countries. Only minorities of the western or communist countries (17.6% and 27.3% respectively) proposed monetary reforms.

Another popular proposal, initiated by OPEC nations, and supported most strongly by other Third World nations was the proliferation of OPEC-style producer organizations as at least a partial answer to the inequitable relationship obtaining between raw materials exporters and consumers. ($\chi^2 = 7.41$, df = 2, significance = 0.025) The non-OPEC raw materials exporters were most widely in favor of such an idea along with 45% of OPEC members, but the larger group of other Third World nations also favored this proposal. (Differences not significant. $\chi^2 = 0.925$, df = 2, significance = 0.625) When they did they were not always clearly as enthusiastic, as for example in the case of India:

> The developing countries, producers of raw materials, must enjoy the full weight in determining the prices of their raw materials. The mere establishment of associations of producers will, however, not be enough in all cases . . . For some commodities, even market action may prove to be inadequate. (India Mission to UN, April 19, 1974)

Only one western nation—Finland—and two communist nations—Albania and China—favored additional cartels, while the United States, Canada and Britain specifically warned against them. Many of the 60% of Third World nations which did not specifically propose additional producer cartels, however,were favorably disposed towards them. For example, the delegate from Argentina, where the traditional export is beef, did not propose producer associations, but he did say:

> The oil crisis served to focus world attention on the phenomena and characteristics . . . interdependence, the growing determination on the part of nations to exercise their political will to redress situations that cannot be corrected with the traditional rules of play; concerted action through groups of countries . . . (Argentine Mission to the UN, April, 1974)

Before the opening conference, the Shah of Iran had proposed a special development fund of $2 to $3 billion to be financed jointly by the OPEC and developed countries, to which he pledged $1 billion. This was a popular proposal among the other OPEC nations and among the potential recipients, those nations without major raw materials exports, of whom some were in major economic difficulty. Almost 37% of developing nations endorsed this proposal specifically. By contrast, only one western country (Australia) and no communist nations supported the proposal. (χ^2 = 10.86, df = 2, significance = 0.048) Further, half of those endorsing the OPEC special fund also endorsed new cartel organizations. (χ^2 = 4.15, df = 1, significance = 0.041) In other words, about a third of the developing countries became vocal supporters for the OPEC position, perhaps because they wanted to please the new potential aid givers—fuel controllers.

The last proposal made by a significant number of countries was to regulate multinational corporations. Curiously, although it would sound like an anti-western proposal, there was no real difference among the various categories of nations. (Between Third World and others, χ^2=0.157, df=2, significance = 0.924; within Third World χ^2 = 0.349, df = 2, significance = 0.89) Between 16 and 25% of each group proposed regulating multi-national corporations. Nevertheless, among communist and developing nations, those which had identified MNC's as obstacles to development had also tended to propose their regulation, (χ^2 = 4.17, df = 1, significance = 0.041) while only Finland, among western nations, saw things from that perspective.

Results—An *Ad Hoc* committee of 37 nations sponsored a series of recommendations for the session which, after much negotiation, were drafted in a Declaration of a New International Economic Order and a Programme of Action which was to provide guidelines for carrying out the declaration. Both the Declaration and the Programme were adopted by consensus, but the United States, Britain, France and other western countries stressed that "consensus is not unanimity", (the United States representative likened the process to a "steamroller"), and endorsed the Declaration and Programme adopted with reservations.

The reservations point up the nature of the two documents. They include most of the most militant Third World ideas proposed in the General Assembly. These include in the Declaration:

> Sovereignty of a state over its natural resources and economy, including the right to nationalize or transfer ownership to its nationals; regulation of transnational corporations; regulation of prices of developing country exports with prices of the goods they import, i.e. indexation; more favorable conditions for financial transfers from rich to poor nations; reform of the international monetary system to promote the development of developing countries; promotion of trade between developing countries and the extension of preferential non-reciprocal treatment by developed countries; and promotion of producer's associations.

The Programme of Action is a detailed set of recommendations for action including both emergency measures and longer term economic actions to carry out the principles stated in the declaration. For example, it was recommended that developing nations be more adequately represented on the governing boards of the IMF, World Bank, and the IDA, and that additional special drawing rights should be made available for their development, and regulation of MNC's should include regulation of their repatriation of profits.

One substantive program was begun by the "Programme of Action", a "Special Programme" to provide emergency aid to those developing countries most seriously affected by the economic crisis. The fund was the institutional result of Iran's proposal to establish a $2–$3 billion emergency development fund from oil money and industrialized nation contributions.

Although the U.S. has pledged emergency aid in response to appeals by the United Nations Secretary General, it has avoided donation to the Special Fund, perhaps because of its control by an *Ad Hoc* 36-member committee appointed by the United Nations Secretary General.

What does the experience of the Special Session teach us? Third World nations did articulate positions distinct from both western and communist nations. Furthermore, most of them were adopted by the General Assembly in the Declaration and the Programme of Action. This took place despite the opposition of major industrialized countries, including the United States. On the one hand, little can really be done without their cooperation, but on the other hand if developed countries fail to cooperate, developing countries, including OPEC, have now legitimized a variety of principles which will make it increasingly difficult for developed countries to maintain such unilateral dominance in the future.

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Biological Sciences

ESTABLISHED EXOTIC CICHLID FISHES IN DADE COUNTY, FLORIDA

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Abstract: *Eight species of exotic cichlid fish were present in Dade County in March 1975. Three species have expanded their known ranges in the county by 8-16 km between July 1972 and October 1974;* Cichlasoma meeki *and* Tilapia mariae *are newly established cichlids in Florida's open waters and* Tilapia zillii, *a voracious herbivore, was collected in a small enclosed lake.*

Fishes of the family cichlidae are among the exotic species recently added to the fauna of central and southern Florida. Of the 25 exotic fishes known to be established in the state's fresh and brackish waters, 8 are cichlids. Several of these, such as *Cichlasoma bimaculatum* (black acara) and *Tilapia aurea* (blue tilapia), are widely distributed and have become dominant in biomass in some areas (Courtenay et al., 1974). Some have shown the ability for rapid increase in percentage biomass (Buntz and Manooch, 1968) and all available data indicate that cichlids are becoming important components of aquatic communities.

Courtenay and Robins (1973) suggested that the major source of introductions of exotic fishes and their establishment arises from carelessness and convenience by the ornamental aquarium fish industry. This idea is supported by the occurrence of high numbers of exotic species, both clearly established and otherwise, near fish breeding and rearing operations (Courtenay et al., 1974).

Detailed observations have not been made previously of the rate of spread of fish species from probable sources of introduction. Spread is mostly facilitated in south Florida by interconnecting flood control canals but little is known about the likelihood of fish dispersal through natural marsh areas as most previous studies have concerned populations in lakes and canals. Considering the potential impact on the future of native Florida fishes, knowledge of the range, dispersal, habitat requirements and ecologies of exotics is of great importance.

Dade County, in the southeast extremity of the state, is one of the areas most strongly affected by cichlid introductions, with nearly all of the fresh and brackish waters showing some degre of infestation. Statewide sampling by Courtenay et al. (1974) revealed 4 established cichlids in the country by July 1972 (Table 1). The present report raises this number to 7 and extends the known ranges of several species. The diversity of Dade County cichlid populations compared to other counties is probably related to the high number of Dade County fish farming operations (fig. 1). For instance, Collier County, adjacent to the west, has only one established cichlid (Kushlan, 1972).

Movement of exotic fish populations should be monitored, especially in areas such as Dade County where protected natural habitats (e.g., Everglades National Park) may be threatened. This study was made to record recent changes in range, to estimate speed and direction of dispersal and to update Courtenay et al. (1974) with information on new introductions of cichlids to the county and state since July, 1972.

Methods—From March through October 1974, intensive surveillance was made of Dade County waters, including nearly all accessible canals and lakes. Marsh and swamp areas, including water conservation areas and Everglades National Park were surveyed but were covered less thoroughly because of limited access points to large areas. A fully representative sample of these habitats was beyond the scope of this short-term study.

The most valuable sampling technique proved to be observation from shore in shallow areas during periods of spawning activity in spring and summer. At these times cichlids are highly conspicuous, maintaining territories in areas of low cover, with aggressive behavior towards other fish and development of bright colors. Spawning depressions made by clearing away algae and scooping out substrate were also quite noticeable. Systematic observations made throughout the county during the height of this activity provided a more detailed assessment of species distribution than has previously been made and one that is reproducible without undue destruction of habitat. Fish collections by nets and angling and creel censuses were also made in some areas but these rarely provided data that had not been obtained by observation. All specimens have been deposited in the University of Miami collections under the supervision of Dr. Burton Hunt.

Results and Discussion. Eight cichlid species were observed and collected from Dade County (Table 1), including all 4 known from previous work Courtenay et al., 1974). Seven of these are known to be established, inasmuch as young

TABLE 1. Cichlid species observed and collected in Dade County, Florida from March to October 1974. (E) following a name indicates that the species is established as indicated by collections of young.

Astronotus ocellatus (Agassiz)—Oscar	(E)[1]
Cichlasoma bimaculatum (Linnaeus)—Black Acara	(E)[1]
Cichlasoma meeki (Brind)—Firemouth Cichlid	(E)
Cichlasoma octofasciatum Regan—Jack Dempsey	(E)
Hemichromis bimaculatus Gill—Jewelfish	(E)[1]
Sarotherodon mossambicus (Peters)[2]—Mozambique Tilapia	(E)[1]
Tilapia mariae (Boulenger)—Spotted Tilapia	(E)
Tilapia zillii (Gervais)—Striped Tilapia	

[1]Species was established in open waters of Dade County in 1972 (Courtenay et al., 1974).
[2]Species has been known until recently as *Tilapia mossambica.*

have been collected, and the eighth, *Tilapia zillii* (striped tilapia) is probably established in a small lake.

In general, cichlid populations appear to be most abundant in canals as opposed to lakes or marsh areas. About 70% of the county canals have one or more species present; only canals south of Homestead appear to be cichlid free. The ranges presented in figures 2-8 are based largely on canal populations. Only 25% of the observed lakes with no obvious connections to canals contained cichlids and these tended to be located in areas of high public use, such as city parks. Apparently human transport is a factor in fish dispersal. Only very scattered sightings of cichlids were made in the marshes examined. Because of the density of plant cover in these areas fishes could have easily escaped notice. Oscar T. Owre (personal communication) reports an increasing incidence of *Cichlasoma bimaculatum* in fish collections from an alligator hole in the Big Cypress Swamp, Collier County. Other exotic fishes, such as *Belonesox belizanus* (pike killifish) and *Clarias batrachus* (walking catfish) were occasionally sighted in marsh habitat. The disturbed nature of canal habitat and the continuing influence that urban development is having on these waterways may render them more susceptible to invasion by exotics than relatively undisturbed marshes (McDowall, 1968; Lachner et al., 1970; Courtenay and Ogilvie, 1971).

Astronotus ocellatus—Oscar. Oscars are now established in most canal systems north of and including Black Creek Canal, having spread from 2 separate populations (fig. 2). Canals newly infested since 1972 include Snake Creek Canal, Miami Canal, Coral Gables Waterway and Tamiami Canal (Figs. 1 and 2). The movement of this fish from place to place by sport fishermen (Courtenay et al., 1974) has contributed to dispersal.

Cichlasoma bimaculatum—Black acara. This species is the most abundant and widespread cichlid in Dade County and has an extensive range also in Palm Beach, and adjoining Broward and Collier counties. Although it is still quite abundant in the northern two-thirds of Dade County (fig. 3) where it was found in 1972 (Courtenay et al., 1974), it has seemingly been unable to utilize canal habitat in the southeast portion of the county. Many canals in that region are subject to continual salt encroachment and contain faunas characteristic of brackish water. Aquarium studies showed that the black acara is relatively in-

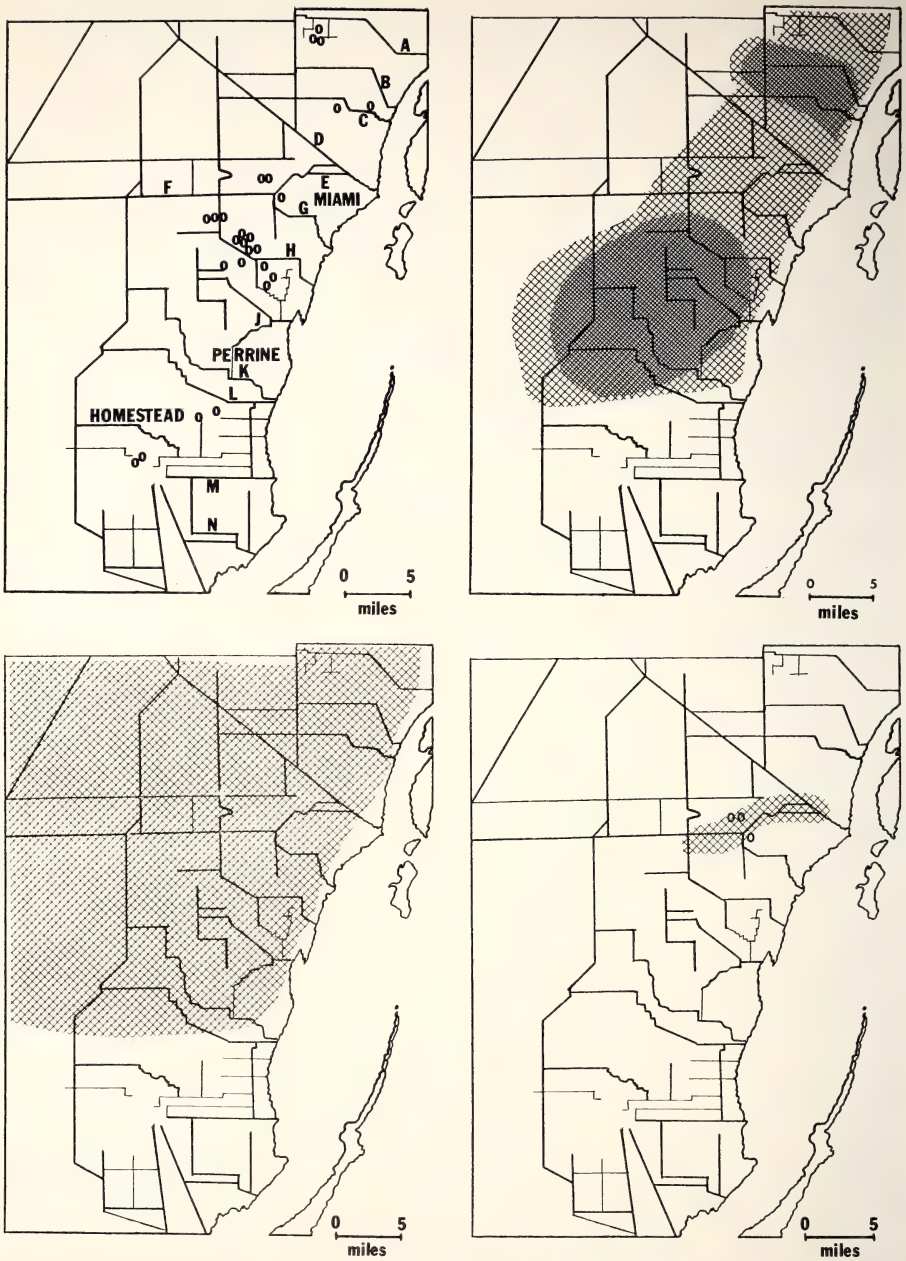

Fig. 1. (upper left) Major canal systems in Dade County, Florida and locations of fish farming operations. Actual county lines exist 18 km (13 miles) west and 9.3 km (7 miles) south of the indicated borders. A—Snake Creek Canal; B—Biscayne-Opa Locka Canal system; C—Little River Canal; D—Miami River Canal system; E—Comfort Canal; F—Tamiami Canal; G—Coral Gables Waterway; H—Snapper Creek Canal; J—C-100 Canal; K—Black Creek Canal; L—C-102 Canal; M—Florida City Canal; N—Model Land Canal. Small circles indicate fish farming operations registered with Florida Game and Fresh Water Fish Commission.

tolerant of salinity. Salinities of 60% sea water were fatal to gradually acclimated *C. bimaculatum* whereas other cichlids survived salinities up to that of sea water. It has not been determined with any certainty, however, that this factor is responsible for the failure of *C. bimaculatum* to colonize southern Dade canals.

Cichlasoma meeki—Firemouth cichlid. The firemouth is established in Comfort Canal in Miami and its range extends west to several small canals south of the Tamiami Canal (fig. 4). This species was not known to be established in any of the state's open waters previous to this study. Assuming that *C. meeki* was released from an aquarium fish farming operation near its present range (fig. 4), it has been dispersed at least 8 km to the east in 2 yr. It is now quite abundant throughout its range.

Cichlasoma octofasciatum—Jack Dempsey. Encountered by Courtenay et al. (1974) only in Palm Beach and Hillsborough counties in the vicinities of fish farms from which they escaped, the Jack Dempsey is now established in Snapper Creek Canal over an 8 km area (fig. 5). Fish farms at the west end of this range are assumed to be the origin of this population.

Hemichromis bimaculatus—Jewelfish. This fish has expanded its range several km southward into the Comfort Canal since 1972 when it was found in the Miami Canal and canals on the west side of Miami International Airport (fig. 6). It is very common over its range, second in abundance among exotics only to *C. bimaculatum* near the airport (C. R. Robins, personal communication).

Sarotherodon mossambicus—Mozambique tilapia. This cichlid, which has been established in the Comfort Canal in Miami since before 1972 (Courtenay et al., 1974), has been sighted also in the Miami River within several km of its mouth at Biscayne Bay (James Eggert, personal communication). It has also spread westward through the Airport Lakes to their confluence with Tamiami Canal (fig. 8). Isolated individuals were sighted in Opa Locka Canal and in a small canal connecting with Snapper Creek Canal but establishment in these areas is uncertain. The euryhaline nature of *S. mossambicus* (Potts et al., 1967) has undoubtedly figured in its movement into the brackish Miami River and may facilitate further dispersal by enabling the fish to move through Biscayne Bay.

Tilapia mariae—Spotted tilapia. First seen in Snapper Creek Canal in April 1974 near a concentration of fish farms (Hogg, 1974),this newly established cichlid exists in 2 large areas in Dade County (fig. 7). The southern population, which originated in the vicinity of Snapper Creek Canal, has spread rapidly 8-16 km to the north, west and south. The fish is increasing its abundance in much

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Fig. 2 (upper right) Dade County, Florida range of *Astronotus ocellatus* as of October 1974. Doubly hatched area indicates range as of July 1972 (Courtenay et al., 1974).

Fig. 3 (lower left) Dade County, Florida range of *Cichlasoma bimaculatum* as of October 1974. This range is continuous with range in Collier County to the west and Broward County to the north.

Fig. 4. (lower right) Dade County, Florida range of *Cichlasoma meeki* as of October 1974. Small circles indicate fish farms from which the species probably escaped.

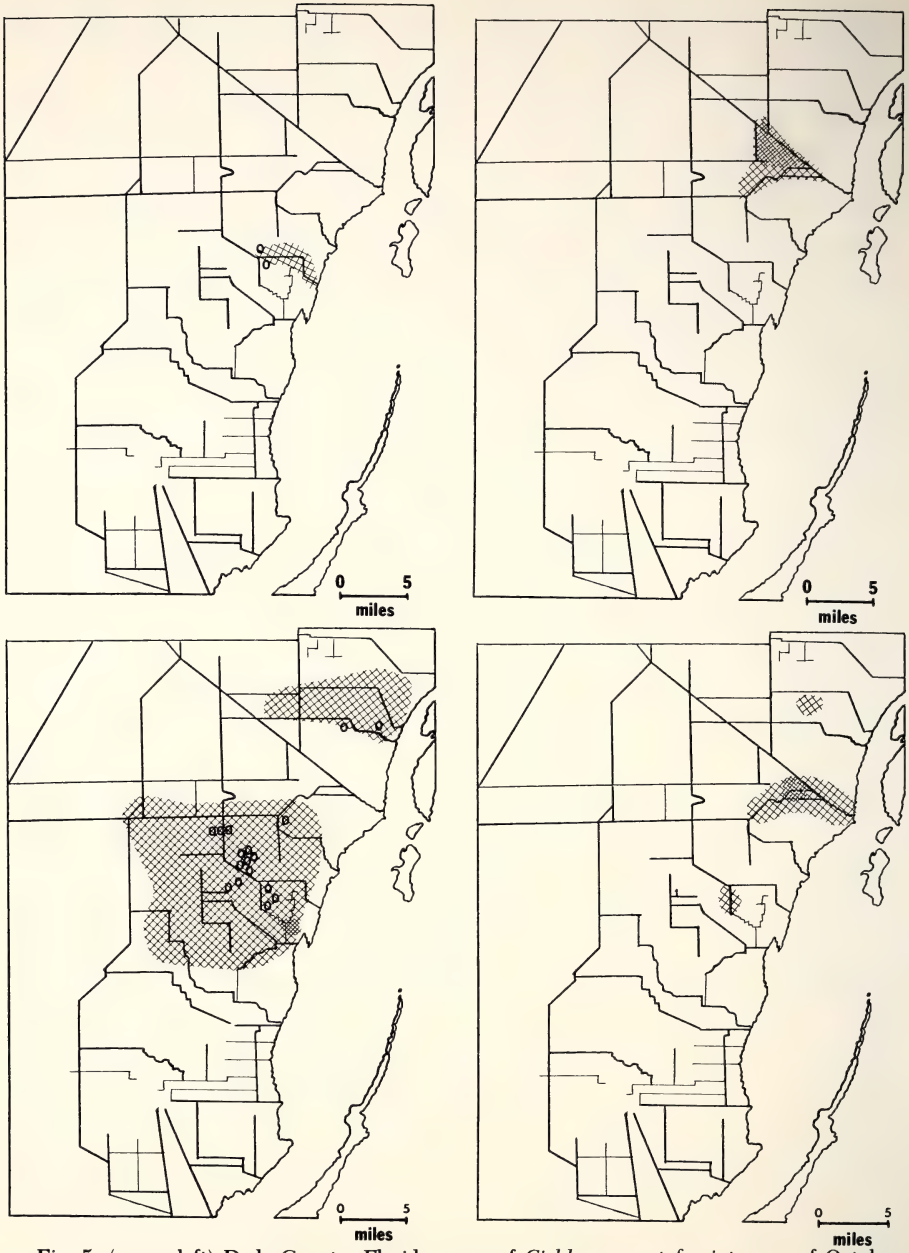

Fig. 5. (upper left) Dade County, Florida range of *Cichlasoma octofasciatum* as of October, 1974. Small circles indicate fish farms from which the species probably escaped.

Fig. 6. (upper right) Dade County, Florida range of *Hemichromis bimaculatus* as of October 1974. Doubly hatched area indicates range as of July 1972 (Courtenay et al., 1974).

Fig. 7. (lower left) Dade County, Florida range of *Tilapia mariae* as of October 1974. Doubly hatched area indicates approximate location of a quarry lake near Perrine where a morphologically distinct population of *T. mariae* is established and six *T. zillii* were collected. Small circles indicate fish farms from which *T. mariae* probably escaped.

of this area. The northern population is less concentrated. Collections and observations of *T. mariae* were made over a 64 km^2 area involving lakes and canals in the Little River, Biscayne and Opa Locka canal systems (fig. 7). This range extends 8 km north and 8-16 km west of local fish farms. It is not known whether exchange of individuals occurs between these two populations but interconnecting canals exist which would allow it. A small population of *T. mariae* isolated in a quarry lake near Perrine (fig. 7) exhibits striking differences from the canal populations in coloration, body shape and fin size. This population most certainly represents a separate source of introduction.

Tilapia zillii—Striped tilapia. Six individuals, varying from 4 to 17 cm total length, identified as *Tilapia zillii*, were collected from a small quarry lake near Perrine (fig. 7). Neither reproductive activity nor young were observed. The discovery of this fish has prompted the Florida Game and Fresh Water Fish Commission to initiate rotenone sampling of the area and a complete renovation may be undertaken shortly in an attempt to prevent spread of this fish to nearby canals. The species is known to be largely herbivorous (Thys van den Audenaerde, 1966), and Walter Courtenay (personal communication) has called it "the most destructive fish to submerged vegetation known next to the grass carp". The peril of continued random introductions is underscored by the discovery of this undesirable exotic. New and unplanned introductions continue to be made despite restrictions on importation of fish (*Tilapia* and *Sarotherodon* species are on the Florida Game and Fresh Water Fish Commission's prohibited fishes list) and all other recommended precautions (Courtenay and Robins, 1973).

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Fig. 8 (lower right) Dade County, Florida range of *Sarotherodon mossambicus* as of October 1974. Doubly hatched area indicates range as of July 1972 (Courtenay et al., 1974).

COMPOSITION AND DERIVATION OF THE NORTH AMERICAN FRESHWATER FISH FAUNA

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Abstract: *Composition and derivation of the North American freshwater fish fauna is reviewed with reference to new fossil discoveries. Acceptance of the theory of continental drift has changed ideas regarding the derivation of this fauna and its relationship to that of Central and South America. Composition of the North American fish fauna is markedly different east and west of the Continental Divide north of the Mexican Plateau, although this difference was less pronounced before renewed uplifting of the Rocky Mountains began about 20 million yr ago, and several families now restricted to eastern drainages are known as fossils from western drainage areas. Six faunistic groups are defined and discussed in reference to origin of the extant fauna.*

In 1959, Miller published a summary of the recent and fossil freshwater fish fauna of western North America. This was later expanded (Miller, 1965) to include all of North America north of the Isthmus of Tehuantepec. These publications include maps of present and past distributions of the various families, maps and listings of known fossil localities, information pertaining to the fossil histories of the various families of North America freshwater fishes, and a complete literature summary. Several papers describing new fossil finds have appeared since 1965, as well as some major publications on zoogeography (Myers, 1966, 1967; Hubbs, Miller, and Hubbs, 1974). In some cases these have resulted in new fossil records for North America (families Umbridae and Hiodontidae), or have placed the time of arrival of some families in North America earlier than previous estimates (families Esocidae and Cyprinidae). The purpose of the present paper is to complement those of Miller by providing a somewhat different approach to the subject, and also to update the fossil history.

The geographical area covered here does not include the entire North American continent but, like Miller's papers, extends south only to the Isthmus of Tehuantepec in southern Mexico. The decision to so restrict the area under discussion was based on the highly distinctive nature and largely independent origin, particularly as concerns North America, of the Central American freshwater fish fauna. The composition and origin of this fauna have been the subject of two excellent summaries (Myers, 1966; Miller, 1966).

Since publication of Miller's paper in 1965, widespread acceptance of the theory of continental drift, more specifically plate tectonics, has resulted in changes in ideas that have had far-reaching consequences in zoogeography (Dietz and Holden, 1970; Dewey and Bird, 1970; Dewey, 1972; Hallam, 1973). Some ancient groups of North American freshwater fishes such as gars, sturgeons, and bowfins, whose presence on this continent dates back to the mid-Mesozoic era (Romer, 1945), conceivably could have reached this continent directly from Europe, or could have moved in the opposite direction, at a time

when North America and Europe were joined and before the Atlantic Ocean had reached its present size. Of far greater significance, however, is the role North America is now thought to have played with regard to the derivation of the South American freshwater fish fauna. Darlington (1957) believed that the bulk of the South American fauna, primarily characins and catfishes, was derived from precursors that had migrated, probably during the Cretaceous period, from southeastern Asia, across into northwestern North America, and from there down through Central America into South America. Once in South America, they subsequently became isolated as a result of partial submergence of the Central American landmass. This was presumed to have occurred rapidly, geologically speaking, the idea being based on 1) the absence today of either fossil or recent characins and neotropical catfishes from North America, and 2) the fact that the Cretaceous period, as a whole, has a very poor vertebrate fossil record. Myers (1966, 1967) has shown that the origin of the South American freshwater fish fauna could be explained much more plausibly if it were assumed to have a common ancestry with that of Africa, having arisen at a time when the two continents were either joined directly or were in very close proximity. He (1966) also has shown convincingly how the present Central American freshwater fauna strongly corroborates this idea, since that fauna is quite different in composition from what might logically be expected had characin and neotropical catfish precursors used the region as a pathway in times past. This explanation removes a most troublesome obstacle to one's interpretation of North American faunal history.

North America has a moderately rich freshwater fish fauna, containing approximately 950 species from Canada and Alaska south to the Isthmus of Tehuantepec, in southern Mexico. This compares with about 230 species for Australia, 250 for Europe, 1500 for Asia, 1800 for Africa, and 2200 for South America. The totals for the last three continents are probably too low, inasmuch as vast areas have never been adequately explored and many species remain to be discovered. For example, some authorities estimate that the final count for South America, by far the most poorly known continent, will ultimately be well over 3000. The fish fauna of North America, by contrast, is extremely well known, and new species are now encountered relatively infrequently, particularly north of Mexico.

The above differences in faunal size are the result of interrelated historic and climatic factors. Most of North America is situated in a temperate region, where cooler water and greater temperature extremes are the rule, as compared to the warmer and more even temperatures encountered in tropical areas. Cooler and less even temperatures are usually accompanied by more impoverished faunas. In addition, North America has been subjected, during the past 1-2 million yr, to periodic advances of glacial ice, which each time have covered the northern half of the continent. Each advance undoubtedly resulted in the direct or indirect extermination of certain species, and the time that has elapsed since has not been sufficient to permit evolution of a comparable number of replacement forms. Glaciation similarly affected Europe and northern Asia, and

the reduced number of species found in those areas today is due in large part to its effects. The overall richness of the Asian fish fauna results from the heavy concentration of species in the tropical southeastern part of that continent.

In North America, as elsewhere, the species are not evenly distributed throughout. Canada and Alaska, though comprising well over half the total landmass of the continent, have only a small percentage of the total species (about 180, or 19%); of these, only about ten are restricted to the above areas, and all but three (a lamprey, a smelt, and a sucker) belong to the cold-water inhabiting family Salmonidae. The western drainages of North America have a disproportionately small number of species (fewer than 300, or about 30% of the total fauna) (Miller, 1959). The fossil record shows that the western fauna was larger in the past (e. g., Cavender and Miller, 1972), when that region was much wetter than it is today. However, climatic changes over the past 5 million yr or so, which are related to the formation of the Sierra Nevada and Cascade mountain ranges, have resulted in a progressively more arid environment over much of the region. This increased aridity has been accompanied by the extinction of many fish species, a process that continues today (Miller, 1961).

Although the western North American fish fauna was once richer than today, it is doubtful that it ever attained the size or diversity seen in eastern North America. The latter region is characterized by several large, ecologically diverse river systems containing relatively stable aquatic environments. The largest of these by far is the Mississippi, which contains about 325 total freshwater fish species, and is clearly the system from which the faunas of the smaller surrounding drainages were derived. No drainage system approaching the Mississippi in size, stability, or ecological diversity apparently has ever existed in western North America (the largest fish-species list for any western drainage today—that of the Colombia River—numbers less than 60), and this, together with the present aridity of much of the region, explains in large degree the relative impoverishment of the fauna. Furthermore, unlike the Mississippi, the fauna of no single western drainage shows an obvious ancestral relationship to those of all neighboring drainages.

Eastern North America is characterized by the recent explosive radiation of two families, the Percidae (true perches) and Cyprinidae (minnows). Evolution of a comparable nature is not known to have occurred in the west. The Percidae, which on this continent are entirely restricted to the eastern drainages, and apparently always have been, comprise over 130 species, of which all but three belong to the uniquely North American group known as the darters (subfamily Etheostomatinae). The explosive evolution of the North American minnows is, in large degree, concentrated in the genus *Notropis*, whose members comprise about 45% of the approximately 280 total North American cyprinid species and about 60% of the eastern cyprinid species. This genus is strictly eastern in its distribution, except in Mexico where several species have recently succeeded in crossing over into certain Pacific drainage systems.

The distribution of the genus *Notropis* demonstrates the sharp faunal differences existing on the two sides of the continental drainage divide. This faunal

independence, though somewhat less pronounced in Mexico where the less mountainous terrain in the immediate region of the continental divide has permitted numerous recent faunal exchanges, is one of the most characteristic features of the North American freshwater fish fauna. Of the 21 strictly or predominantly freshwater fish families inhabiting the United States and Canada, 11 are known only from the east (of which the Percidae are the most prominent), none is exclusively western, and 10 are shared. Of the 107 genera included in these 21 families, only 16 are shared. These figures strongly suggest that eastern and western North America have had a long, largely independent faunal history. However, fossil remains of seven eastern families—the freshwater catfishes (Ictaluridae) (Miller, 1959; Miller and Smith, 1967; Lundberg and Case, 1970), pikes (Esocidae) (Cavender, Lundberg, and Wilson, 1970), pirate perches (Aphredoderidae)(Miller,1959), mooneyes (Hiodontidae) (Cavender, 1966, 1968), gars (Lepisosteidae) (Lundberg and Case, 1970), bowfins (Amiidae) (Cavender, 1968; Lundberg and Case, 1970), and paddlefishes (Polyodontidae) (MacAlpin, 1947; Lundberg and Case, 1970)—are known from western North America, thus indicating that the present faunal differences were once much less pronounced—i.e., in pre-Pliocene times. It is believed that the present differences have come about through a combination of three things: 1) the renewed uplifting of the Rocky Mountains beginning about 20 million yr ago; 2) the later formation of the Sierra Nevada mountain range farther west; and 3) the indirect effects of Pleistocene glaciation. The combined results of these three phenomena have been 1) the elimination of most faunal movement across the continental drainage divide, 2) the gradual desiccation of the "Great Basin" region situated between the above two mountain ranges, and 3) periodic decreases in mean annual temperature, particularly to the north. These have resulted in the gradual elimination of much of the western freshwater fish fauna, including the seven families listed above. One family (Umbridae) is represented in the west today by 2 species (one confined to Alaska), and 2 other families (Centrarchidae and Percopsidae) have one western species each.

In terms of origin, the North American freshwater fish fauna may be divided into six groups, which are listed here in decreasing order according to numbers of species involved: 1) Europe and Asia (Eurasia); 2) North America, comprising those groups whose evolution to the family level occurred entirely on this continent; 3) groups of marine origin, many or most species of which live in the ocean; 4) Central America; 5) South America; and 6) relict archaic groups, likely of Old-World origin, that are now largely or entirely restricted to North America. The above are not always mutually exclusive. This is especially true of group 3, which includes families of which certain genera have evolved entirely in fresh water and whose distributional histories thus are exclusively freshwater in nature.

Those families having an Eurasian origin include the Cyprinidae (ca. 280 North American species), Percidae (ca. 130 species), Catostomidae (suckers, ca. 60 species), Esocidae (pikes, 4 species), and Umbridae (mudminnows, 4 species). All are believed to have migrated to North America across the Bering land

bridge, which has united the Asian and North American continents at various times in the past. Conditions at those times probably also were warmer than at present, as evidenced by the almost total absence today of members of the above families from the immediate area of crossover. Three species only are found: *Catostomus catostomus* (Catostomidae), *Dallia pectoralis* (Umbridae), and *Esox lucius* (Esocidae). Not all of those families reached North America at the same time, and, for some groups at least, there is strong evidence of multiple invasions. Of these, the suckers seem to have appeared first in North America, extinct genera having been recorded from Eocene deposits at least 40 million yr old (Miller, 1965). The minnows and mudminnows are known from middle to late Oligocene deposits 30—35 million yr old (T. Cavender, personal communication; Cavender, 1969). The first record of pikes from North America is not until the late Miocene some 15—20 million yr ago (Cavender, Lundberg, and Wilson, 1970), although European records for the family date back to the Oligocene. There is some question as to how long the true perches have been present in North America. The first unquestioned fossil record for the group from this continent is from Pleistocene deposits, and is based on *Perca flavescens*, the living yellow perch (Uyeno and Miller, 1963). However, this family almost certainly has been present in North America longer, as evidenced by the extensive speciation that has occurred among the darters (subfamily Etheostomatinae). An Eocene fossil, *Mioplosus*, has been placed by some (Bailey, 1938) in the Percidae, but whether this is really a percid, a centrarchid, or another kind of primitive perciform fish is still in question. One argument against placement of the Eocene *Mioplosus* in the Percidae is related to the North American distribution of the family, which is unknown, either from recent or fossil records, from west of the continental divide except for one obviously recent headwater crossover in Mexico. One may logically assume that percids, had they been present on this continent prior to renewed uplifting of the Rocky Mountains, would have entered the western drainages as did other freshwater fish families. Based on this circumstantial evidence, it is conceivable that the Percidae reached North America relatively recently, possibly not before the Pliocene.

Seven families have an exclusively North American distribution and presumed origin. These include the Ictaluridae (freshwater catfishes, ca. 40 species), Centrarchidae (sunfishes and black basses, 35 species), Goodeidae (goodeids, 35—40 species), Amblyopsidae (cavefishes, 6 species), Hiodontidae (mooneyes, 2 species), Percopsidae (trout-perches, 2 species), and Aphredoderidae (pirate perches, 1 species). All except the Amblyopsidae occur, or are known to have occurred, in western North America. Fossil remains of aphredoderids and hiodontids date back to the Eocene (Miller, 1959; Cavender, 1966), and ictalurid fossils are known from the late Paleocene (Lundberg and Case, 1970). Unquestioned centrarchid remains date back to the Oligocene, and if the genus *Priscacara* represents a centrarchid, as Regan (1915) has claimed, the group would date back to the Eocene. The Goodeidae evolved entirely on the Mexican Plateau, probably from a cyprinodontid-like ancestor, and have moved only narrowly outside this area where they occur on both the Atlantic and Pacific coasts.

The Ictaluridae live throughout much of eastern North America, but in the west native populations are found today only in certain Pacific drainages of Mexico; however, fossil remains are known from several areas in western United States (Miller, 1959; Miller and Smith, 1967; Lundberg and Case, 1970). The remaining families are represented in western North America today only by one species of Percopsidae, the Columbia trout-perch, *Percopsis transmontanus,* found in the Columbia River system of Washington, Oregon, and Idaho; and one species of Centrarchidae, the Sacramento perch, *Archoplites interruptus,* which is native to the Sacramento-San Joaquin River system of central California. Other species of Centrarchidae have been widely introduced throughout the west.

Thirty North American families having freshwater species are basically marine or have marine representatives. They encompass a wide variety of "life styles." Some, such as the Lutjanidae (snappers), Syngnathidae (pipefishes), Pomadasyidae (grunts), and Carangidae (jacks) are entirely marine, but have certain species that move short distances into fresh water under specific environmental condtions. Some families contain groups that have had a long independent freshwater existence, resulting in distinctive freshwater genera of frequently large size; prominent examples are the Cottidae (sculpins), Sciaenidae (croakers or drums), Gadidae (codfishes), and Atherinidae (silversides). Others, such as the Cyprinodontidae (killifishes or topminnows) and Petromyzontidae (lampreys), are largely freshwater in distribution and possibly origin, but have a few marine and brackish-water species. Certain species of Salmonidae, particularly Atlantic and Pacific salmon, and Percichthyidae (the striped bass, *Morone saxatilis,* being a prime example) are anadromous, spending most of their adult life in the ocean and returning to fresh water to spawn. The American eel, *Anguilla rostrata,* of the family Anguillidae, is catadromous and has a life history basically the reverse of anadromous fishes.

The Poeciliidae (livebearers), with about 60 North American species, comprise the only freshwater family clearly of Central American origin. It apparently is derived from the Cyprinodontidae, and like that family, is salt-tolerant, with some species occurring in salt or brackish water and others being found in fresh waters of distant islands that have never had a direct connection with the continental landmass.

Fishes of South American origin include the Cichlidae (cichlids, 20—25 species), Characidae (tetras, ca. 5 species), and Pimelodidae (neotropical catfishes, 2 species). None has penetrated far into North America. A few cichlids and characins range northward along the Atlantic and Pacific coasts of Mexico, but only two, a cichlid (the Rio Grande perch, *Cichlasoma cyanoguttatum*) and a characin (the Mexican tetra, *Astyanax mexicanus*), reach the United States in southern Texas.

The archaic fishes, though few in species, nevertheless comprise one of the most interesting and characteristic elements of the North American freshwater fish fauna. All have long fossil histories dating back 75 million yr ago to the Cretaceous period or earlier, and all had more species and wider distributions than today. Four families are involved, of which two, the bowfin family Amiidae,

with a single genus and species, *Amia calva*, and the gar family Lepisosteidae with a single genus, *Lepisosteus* having 7 species, are confined to eastern North America or closely adjacent areas. One species of gar is restricted to Cuba and a second to Middle America. The Polyodontidae comprise one eastern North American species, the Paddlefish (*Polyodon spathula*), with a second genus and species found in the Yangtze River system of eastern China. The sturgeons (Acipenseridae), with 2 genera (*Acipenser* and *Scaphirhynchus*) and 8 species in North America, are the only family in the group with a world-wide distribution, also being represented throughout much of northern Europe and Asia. It also is the only one of the four archaic North American families still found in western North America and the only one in which certain species regularly spend part of their lives in the ocean.

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Biological Sciences

POLLUTION MICROBIOLOGY OF BISCAYNE BAY BEACHES

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Abstract: *Water, sediment, and sand from recreational and other areas in the southern Biscayne Bay region were examined over a three month period (Sept.-Nov.) for the presence of both "indicator" and potentially pathogenic bacteria and yeasts. The Miami River was the most significant source of pollution (>10^5 total coliforms 100/ml); however, bathing beaches showed low densities of all microorganisms sought.*

Extensive use of nearshore marine areas for disposal of treated and untreated domestic and industrial wastes has led to increased concern for the health hazards of coastal bathing areas (Flynn and Thistlethwayte, 1965; Hoffman, 1971; Krishnaswami, 1971; Moore, 1971; Foster et al., 1971). A newer aspect of the problem concerns the apparent survival of indicator and pathogenic microorganisms following sewage effluent chlorination (Shuval et al., 1973; Davis and Keen, 1974; Silvey et al., 1974; Englebrecht et al., 1974). Epidemiological data on illness correlated with bathing is equivocal (Geldreich, 1974). A detailed, adequately controlled study has been reported to be in progress (Cabelli et al., 1974) and should add clarity. Meanwhile, an expanded public demand for coastal bathing areas dictates constant surveillance and application of appropriate microbiological monitoring methods.

Biscayne Bay represents an area of intensive recreation use on an annual basis. The impact on the Bay of both existing offshore outfalls (Federal Water Quality Administration, 1970; Lee and McGuire, 1973) and land drainage (Gerba and Schaiberger, 1973) have been discussed. Clearly, the potential for occasional unsatisfactory bathing water exists.

The present study provides some updated information on the occurrence of indicator and other microorganisms at a variety of locations in the southern portion of Biscayne Bay (south of Government Cut).

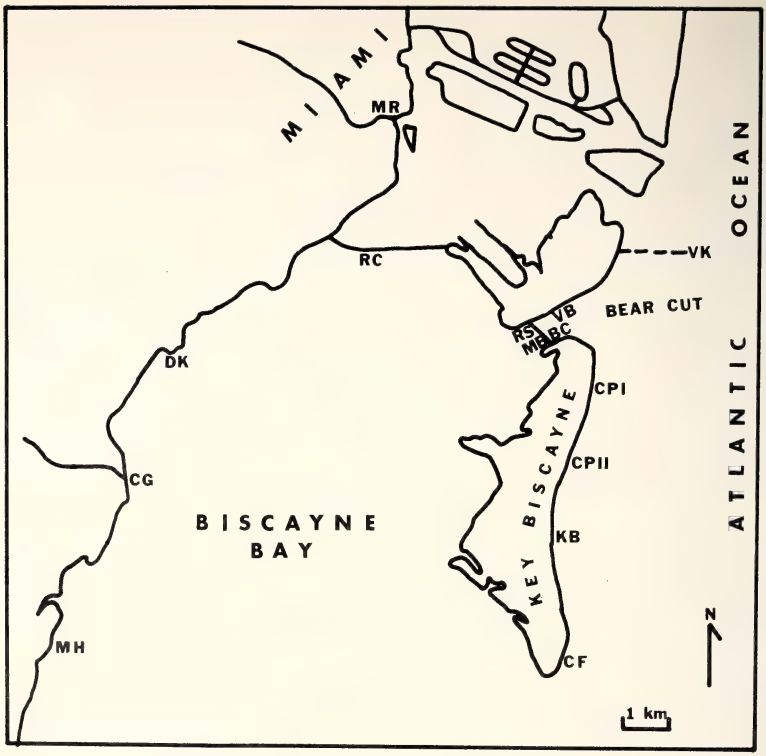

Fig. 1. Sampling locations in the Biscayne Bay area.

Methods—Samples were collected between September and November 1972. Popular bathing areas included Rickenbacker Causeway (RC), Virginia Beach (VB), Bear Cut (BC), two sites in Crandon Park (CPI, CPII). Cape Florida (CF), a Key Biscayne beach (KB) and Matheson Hammock (MH). Two beaches not used for bathing located on opposite sides of Bear Cut and west of the causeway bridge (RS and MB), and several possible sources of pollution to the Bay were included also. The latter included sampling in and around the Virginia Key sewage outfall "boil" (VK), the Miami River (MR), an effluent pipe at Dinner Key (DK), and the Coral Gables canal (CG). One "control" bathing beach was sampled on Lower Matecumbe Key (LM), approximately 150 km southwest of Miami. See Fig. 1 for sampling locations; some areas were sampled more than once (see Table 1).

At all sites, subsurface (10 cm) water was collected in sterile, wide-mouth polypropylene bottles. At all beaches, water at waist depth (1 m) was sampled. In addition, bottom sediment was collected since recent studies have indicated a greater abundance of potential pathogens in sediments compared with overlying waters (e.g., Van Donsel and Geldreich, 1971) and the possible release of coliforms and other organisms by sediment disturbance (Grimes, 1975). Sediments were collected by diving and plunging alcohol-rinsed plastic core liners (3.5 cm diam) to a depth of approximately 10 cm. Cores were capped at the

TABLE 1. Indicator and other microorganisms in Biscayne Bay beach waters, sands, and adjacent areas.

No. per 100 ml (water or per gram (sediment; beach sand)

Date	Location	TC	FC	FS	PA	S	Y
9/7/72	Virginia Key outfall "boil" (VK)	690	< 10	< 10	2	°	< 10
	25 m N of "boil"	< 10	< 10	0	0	°	< 10
	75 m N of "boil"	< 10	< 10	< 10	0	°	< 10
	Fla. Current; 4 km NE of "boil"	20	< 10	< 10	0	7	< 10
	Dock in Bear Cut (RS)	18,000	< 10	< 10	0	°	< 10
9/28/72	VK	25	18	0	8	0	0
	300 m N of "boil"	4	0	0	0	1	8
	300 m S of "boil"	0	0	0	0	0	1
10/26/72	VK	420	30	4	4	0	12
	300 m NW of "boil"	18	1	4	1	0	28
	300 m SW of "boil"	0	0	1	0	0	16
	200 m S of "boil"	2	0	3	0	0	2
11/2/72	VK	730	36	2	1	°°	°°
11/14/72	Dinner Key (DK) storm sewer	400	180	°°	0	°°	6
10/6/72	Miami River, S.E. 5th St. (MR)	150,000	30,000	10,000	670	0	300
10/30/72	MR	210,000	3,000	3,000	< 20	°	1,700
	Coral Gables canal mouth (CG)	2,000	100	< 100	450	°	92
9/18/72	Crandon Park (CPI) water	> 100	2	16	14	°	14
	CPI sediment[1]	< 3	< 3	< 3	< 3	10	3
	CPI sand[2]	< 3	< 3	< 3	< 3	< 5	< 3
9/25/72	Crandon Park (CPII) water	730	35	25	24	< 5	44
	CPII sediment	°°	0	12	2	< 5	10
	CPII sand	440	4	12	3	< 5	120
	CPII sand (10 m)[3]	4	0	0	0	< 5	10
	CPII sand (70 m)	2	0	5	0	< 5	0

TABLE 1. (continued)

Date	Location	TC	FC	FS	PA	S	Y
10/3/72	Key Biscayne beach (KB) water	530	10	17	1	0	4
	KB sediment	16	< 1	4	0	0	4
	KB sand	8	< 1	6	0	0	1
	KB sand (15 m)	< 1	< 1	11	0	0	30
	KB sand (40 m)	< 1	< 1	1	0	0	14
10/10/72	Cape Florida Park (CF) water	400	7	5	18	50	26
	CF sediment	7	< 1	< 2	0	0	46
	CF sand	8	< 1	< 1	< 1	< 1	4
	CF sand (10 m)	*	< 1	4	< 1	< 1	*
	CF sand (30 m)	*	< 1	2	*	< 1	*
9/13/72	Bear Cut beach (BC) water	60	28	47	9	*	*
	BC sediment	25	15	**	0	< 5	0
	BC sand	5	3	< 5	0	75	30
10/16/72	Virginia Beach (VB) water	200	2	2	< 2	< 50	1
	VB sediment	*	< 1	< 5	< 10	< 10	128
	VB sand	2	< 1	< 5	< 10	< 10	0
	VB sand (10 m)	2	< 1	< 1	< 10	500	2
	VB sand (25 m)	72	7	1	< 10	< 10	65
11/2/72	Nonbathing beach (RS) water	70	8	16	1	< 5	11
	RS sediment	< 1	< 1	< 1	< 1	< 5	< 1
	RS sand	< 1	< 1	< 1	< 1	< 5	1
	RS sand (7 m)	7	3	12	< 1	*	*
	RS sand (15 m)	< 1	< 1	< 1	< 1	50	*
11/6/72	Nonbathing beach (MB) water	25	5	12	1	< 1	35
	MB sediment	< 1	< 1	< 1	< 1	< 1	6
	MB sand	< 1	< 1	< 1	< 1	< 1	2
	MB sand (5 m)	< 1	< 1	< 1	< 1	< 1	10
	MB sand (10 m)	< 1	< 1	6	< 1	40	164

TABLE 1. (continued)

Date	Location	TC	FC	FS	PA	S	Y
11/9/72	Matheson Hammock beach (MH) water	315	12	6	79	••	98
	MH sediment	<1	2	2	2	<1	10
	MH sand	••	14	2	1	••	10
	MH sand (3 m)	24	1	<1	<1	••	10
11/21/72	Rickenbacker Causeway beach (RC) water	270	18	4	3	<1	4
	RC sediment	1	<1	<1	<1	<1	10
	RC sand	<1	1	1	<1	<1	26
	RC sand (3 m)	<1	<1	<1	<1	<1	56
	RC sand (7 m)	150	1	14	••	<1	58
10/24/72	Lower Matecumbe Key beach (LM) water	<10	<1	<1	1	<10	2
	LM sediment	<1	<1	<1	5	••	1
	LM sand	<2	<1	8	1	••	3
	LM sand (10 m)	<2	<1	5	••	••	11
	LM sand (15 m)	<2	<1	6	••	••	70

•colonies confluent or overgrown; confirmations made but no count recorded
••dilutions inappropriate; no count recorded
[1]sediment under water sampled; water depth 1 m
[2]sand at edge of water
[3]distance of sand sampled from water

bottom after carefully withdrawing from the sediment, overlying water was decanted, and the top of the corer was capped. In addition, wet surface beach sand at the edge of the water was collected to a depth of 2 cm as well as dry surface sand up the beach at varying distances from the water. These sands were collected in sterile glass widemouth quart jars to a preetched level of 50 ml. All samples were iced until returned to the laboratory for processing, a period not exceeding 2 hr.

Beach sediments were extruded from the corer and the upper 2 cm was collected aseptically and placed in jars as above. Jars containing sediment or mud were filled to a total volume of 500 ml with sterile seawater resulting in a dilution of 1:10. Further decimal dilutions, as needed, were prepared in sterile seawater. Dilutions were shaken thoroughly and particulate matter allowed to settle.

The membrane filter technique was used to enumerate all microorganisms sought; volumes of water and sediment/sand dilutions filtered were at least 20 ml. Except as noted below, Millipore membranes (white, grid, 0.45 μ porosity, presterilized) were employed. Procedures for total (TC) and fecal (FC) coliforms and fecal streptococci (FS) were those generally accepted (APHA et al., 1971). Media and techniques for enumeration of *Pseudomonas aeruginosa* (PA) were described by Levin and Cabelli (1972) including confirmation of suspect colonies on milk medium. Mannitol salt agar was used to culture staphylococci (S). Since extensive yeast (Y) data are available for the Biscayne Bay area (e.g., Fell et al., 1960; Ahearn et al., 1968) and Simard (1971) has suggested the use of pink yeasts as potential indicators of sewage pollution, these organisms were enumerated on Millipore membranes (black, grid, 0.8 μ porosity, presterilized) on the following medium: Bacto-nutrient agar pH 6, 2.3%; yeast extract, 0.1%; malt extract (Diamalt, Standard Brands), 0.2%; chloramphenicol (Sigma), 50 mg%; distilled water. Incubation was at 18°C for 3-5 days, depending on degree of fungal overgrowth.

Initially, attempts were made to enumerate *Vibrio parahaemolyticus* using both TCBS agar and the medium of Twedt and Novelli (1971). Also, salmonellae were sought on a variety of media including desoxycholate, brilliant green, MacConkey's, bismuth sulfide, *Salmonella-Shigella*, and DSE (Raj, 1966). After several samplings, little success was achieved with any of these media; colonies which developed did not confirm as members of *Vibrio* or *Salmonella* and procedures were discontinued.

Results and Discussion—All data are recorded in Table 1. Clearly, the major source of indicator bacteria identified in these samplings was the Miami River. The FC/FS ratio on the two samples considered were 1.0 and 3.0 which represent pollution of uncertain and predominantly human origin, respectively (Millipore Corp., 1972). Dinner Key and Coral Gables canal samples showed considerably fewer indicator organisms; data inadequacies preclude ratio computation. Three of four samples taken in the Virginia Key outfall "boil" showed ratios >4.0 which indicated strong evidence of human wastes. The absolute numbers present were relatively low due probably to effluent chlorination.

All bathing areas on the ocean side of the Bay (CPI, CPII, KB, CF) showed indicator bacteria counts nearly as high as the VK outfall. Although the counts decreased with distance from this possible source, the bacterial levels were still high considering the expected dilution. Few, if any, people were bathing when the samples were taken; therefore, direct human influence was unlikely. There was no substantial rain prior to the sampling dates which indicated that freshwater runoff was not a factor. Thus, no obvious source of the high indicator bacteria counts was evident.

Beaches along the Bear Cut shores of Virginia Key and Key Biscayne (BC, RS, VB, MB) showed low levels of total coliform bacteria, generally below those shown for ocean-facing areas. Tides were low or near low at all sampling times. Rain fell the nights preceding BC, RS, and MB sampling while there had been no precipitation for several days before VB samples were taken. The latter water showed the highest total coliform counts of these four areas. These data indicate that, if Biscayne Bay received heavy coliform loads as a result of freshwater drainage from rainfall, these increased bacterial counts were not reflected in beach water along Bear Cut the next day on a low tide. In fact, the reverse was noted; i.e., highest counts (VB) following a dry period. One sampling of Bear Cut water (9/7) showed very high total coliform counts (18,000/100 ml) but no fecal coliforms or streptococci. This level was much higher than numbers recorded in the VK outfall on the same day, within an hour.

The two beaches sampled within the Bay (RC, MH) showed indicator bacteria counts slightly higher than Bear Cut beach waters. Both samplings occurred after heavy rainfall the night before but were taken at low (RC) and high (MH) tides. No obvious correlation was apparent.

Of the traditional indicator bacteria considered in this study, only the total coliform group was found in any abundance in water samples except for Miami River samples. Two beach waters (BC, CPII) had the highest counts of fecal coliforms and fecal streptococci. Total coliforms were high in one case (CPII) and low in the other (BC). Again, no clear explanation was obvious.

While no standards are used currently for the pathogens *Pseudomonas aeruginosa* and *Staphylococcus aureus* in recreational water, neither organism was generally abundant in beach water—highest counts of *P. aeruginosa* were found in samples at MH; *S aureus* was most prevalent at CF. No distinct correlations could be made between counts of either organism and indicator bacteria. Similarly, there were no definite relationships between yeasts and indicators in any of the waters sampled other than for the Miami River where highest yeast counts recorded corresponded with maximum counts of pollution-indicating bacteria. Miami River and Coral Gables canal waters were the only waters sampled which showed pink yeast counts as high as 30% of the total yeasts recovered. In all other waters and all sediments and sands, pink yeasts were absent or present in low numbers. Yeast distributions in Biscayne Bay and adjacent areas were discontinuous as reported earlier (Fell et al., 1960; Ahearn et al., 1968) probably because yeasts are associated with a variety of organic matter, including sewage effluent, which varies widely with space and time. The highest

yeast density shown in bathing water was at MH which also had the greatest number of people bathing at the time of sampling. Current studies (Buck, unpublished data) on specific human-associated yeasts isolated from 37°C incubation have shown levels of *Candida albicans* up to 1,000/100 ml in bathing waters during the summer at a large northeastern U. S. beach. The use of this organism as an indicator of recent pollution or as a "people indicator" requires additional evaluation.

None of the indicator or pathogenic bacteria sought were abundant in bottom sediments at beaches sampled. If sediments are a reservoir of organisms, heavy recreational usage could, through roiling, release pathogens into the overlying waters. The data here do not indicate any serious public health hazard at the areas sampled.

In general, beach sands did not harbor any large concentrations of organisms studied, although exceptions were noted. Sand at the waters edge at BC showed high concentration of staphylococci. The bacterium was found also in especially high numbers in beach sand at VB with relatively high levels in RS and MB beach sand. All of these areas border Bear Cut; however, no large numbers of staphylococci were recovered from VK effluents, a possible source. The temperature of beach sand from the surface to a depth of 2 cm was recorded routinely as 30—40°C which would probaby allow survival of straphylococci for a short period of time. Still, the source and significance of these organisms is uncertain.

Yeast populations were frequently high in sediments and beach sand. "Pockets" of organic matter of human and/or animal (bird?) origin may contribute to this distribution. High tides may also deposit organic debris on the beach as a source of yeasts.

The one "control" area sampled in the Florida Keys showed very low concentrations of indicator and pathogenic bacteria. The few fecal streptococci and yeasts recovered from beach sand indicate that there is, in fact, a low "background" count of these microorganisms to be expected at any beach site. LM beach was totally unoccupied when sampled and for several hours before and is subject to no sewage discharge for at least several miles in any direction.

Biscayne Bay is a very large and complex body of water in a hydrographic sense. No systematic study was made herein of current and tide patterns in and around the Bay. Bear Cut, for example, represents a significant transport area for water between Biscayne Bay and the Atlantic Ocean and is subject to a a variety of influences. All samples were taken during a slack annual period of beach usage; the heavy summer beach populations had abated and sampling preceeded the winter tourist season. Also, no extended periods of heavy rainfall occurred. Any or all of these factors could affect microbial populations.

Nonetheless, these data confirm the general sources of bulk sewage pollution to the Bay but indicate that, during the period sampled, none of the beaches studied showed evidence to warrant concern,by existing standards, regarding the health hazards of bathing in the study areas of Biscayne Bay.

None of the conclusions and observations offered here negate the comments

of others cited above. Bathing beach waters in the Bay may well be subject to high densities of indicator and (thus?) pathogenic microorganisms from time to time. More detailed studies including bacteriological monitoring in conjunction with hydrographic and climatic variations are suggested. Future planning of expanded or additonal sewage treatment facilities must consider the recreational potential of Biscayne Bay.

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LATE QUATERNARY MAMMALS FROM THE ST. MARKS RIVER, WAKULLA COUNTY, FLORIDA

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Abstract: *Fifteen species of late Pleistocene and Recent mammals were recovered from St. Marks River localities. The western-most record in Florida for the extinct bog lemming,* Synaptomys australis, *is the only extinct species at a St. Marks locality otherwise yielding only Recent species.*

Fossil mammals recovered from the St. Marks River in northern Florida comprise three extinct and twelve extant species. The fauna is noteworthy for extension of known range for one extinct species, and for reducing gaps in the known Gulf Coastal distribution for several others.

The fossils were collected from two general areas, both in Wakulla County: the "basin", a broad, lake-like expanse of open, shallow water in the first mile of the river's course after its final spring head at Natural Bridge Sink in southernmost Leon County[1]; and farther downstream, not far in either direction from the U.S. Highway 98 bridge in the vicinity of Newport[2]. Both localities are situated within the Gulf Coastal Plain at elevations not exceeding 10 ft MSL. All specimens have been deposited in the Florida State Museum, Gainesville, and bear the vertebrate Paleontology catalogue numbers 12118-21301.

Without doubt, the mammals listed represent but a fraction of the Quaternary fauna of the St. Marks River. It is hoped that this report will call attention to the fauna and encourage future collecting parties to submit their finds to knowledgeable professionals. The faunal list to date includes representatives from seven mammalian orders:

[1]Collected by Storrs Olson and associates, 1968-1970; and by collecting parties sponsored by Tall Timbers Research Station in the summer of 1974.
[2]Collected by Nick Fallier and associates in the summer of 1962.
[3]Now at Department of Biology, College of Idaho, Caldwell, Idaho 83605 (note added in proof).

From the basin:

RODENTIA

Geomys pinetis Southeastern Pocket Gopher
Ondatra zibethicus Muskrat
Neofiber alleni Round-tailed Water Rat
Castor canadensis Beaver
Synaptomys australis Extinct Bog Lemming

LAGOMORPHA

Sylvilagus sp. Rabbit

CARNIVORA

Procyon lotor Raccoon

PERISSODACTYLA

Equus sp. Horse

ARTIODACTYLA

Bison sp. Bison
Bison bison Extant Bison
Odocoileus virginianus White-tailed Deer
Bos taurus Cow

From the river, vicinity Highway 98 bridge:

PROBOSCIDEA

Mammut americanum American Mastodon
Mammuthus sp. Mammoth

PERISSODACTYLA

Equus sp. Horse

ARTIODACTYLA

Bison sp. Bison
Bison bison extant Bison
Odocoileus virginianus White-tailed deer

PRIMATES

Homo sapiens Man

The fauna is typical for the Gulf Coastal Plain in a riverine setting. The muskrat, water-rat and beaver are expected in an aquatic environment such as exists along the river today. The muskrat is not found in the vicinity today, however, and lacks an historic record for the area. It was common in the late Pleistocene of the Southeast and is present wherever small mammals are recovered in late Quaternary deposits. The proboscideans, raccoon, rabbit and ungulates are ubiquitous in late Quaternary faunas of the Southeast. The record of Man is based on a partial cranial fragment, and assuredly represents a Recent individual. Although not expected in an aquatic setting, the pocket gopher likely lived in the suitable habitat provided by the sandy soil adjacent to the river in the vicinity of the basin.

The St. Marks *Synaptomys australis* is the western-most and northern-most record for this extinct species in Florida (see faunal lists in Webb, 1974). However, I have recovered an extinct bog lemming from a cave locality near Marianna, Jackson County, Florida, some 70 miles northwest.

The age of the St. Marks fauna is unquestionably late Quaternary. Mastodonts and mammoths were late survivors of the Pleistocene, and may represent post-glacial time in the St. Marks fauna. The presence of the extinct bog lemming in the basin, which has an otherwise totally extant fauna with modern distribution (nominally excepting the muskrat) is puzzling. Perhaps it was a late holdover from the Wisconsin glaciation and became extinct during Recent rather than Pleistocene, time, i.e. between 5000 BP and the present.

The nearest reported Quaternary faunas are the Aucilla River (Jefferson County) and Wakulla Springs (Wakulla County) assemblages listed by Webb (1974). Published records for both are incomplete. Preliminary results of intensive exploration and study of the distinctive Aucilla River fauna by the author indicate an assemblage similar to that of the St. Marks River, but with considerably more extinct species representing a substantially greater time span. In contrast, the St. Marks River local fauna seems to be confined to latest Pleistocene and Recent time, and constitutes a valuable assemblage for its restricted temporal representation.

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ADDITIONAL NOTES ON TROPICAL MARINE FISHES IN THE NORTHERN GULF OF MEXICO

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Abstract: Halichoeres poeyi *is recorded from the Gulf of Mexico and its presence is attributed to the transport of pelagic eggs and larvae from more southerly populations; and* H. radiatus *is now known to occur at Destin, Florida perhaps by recruitment of individuals from offshore reefs. A second Gulf locality for* Oostethus lineatus *and a second specimen of* Corniger spinosus *are also reported.*

Recent studies (Smith et al., 1975; Bright and Cashman, 1974) have revealed the presence of essentially tropical fish faunas at offshore reefs in the northern Gulf of Mexico. Additionally, other authors have reported on the periodic occurrence of tropical marine fishes at inshore localities in the northeastern Gulf (e. g., Hastings, 1972; Caldwell, 1959, 1963; Haburay, Crooke, and Hastings, 1969; Haburay et al., 1974). Caldwell (1963) attributed the presence of these tropical fishes to recruitment through transport of pelagic eggs and larvae by currents from populations occurring in southern, tropical areas and from populations inhabiting offshore reefs. Caldwell (1959) also suggested the importance of floating seaweed as a vector for fish dispersal into the northern Gulf from southern regions. Hastings (1972) speculated that some tropical fishes may move into shallow, inshore areas in the summer and return to deeper, offshore reefs in the winter.

We report on further collections of tropical marine fishes in the northeastern Gulf which lend evidence that each of these factors may account for the presence of tropical marine fishes at inshore localities in the northern Gulf of Mexico. All specimens collected were measured as to standard length and were deposited in the University of West Florida Fish Collection (UWF).

Labridae

Halichoeres poeyi (Steindachner). 1, 75mm (UWF 347), East jetty at East Pass, Destin, Okaloosa County, Florida, 10 August 1974. The specimen was speared at a depth of 5m. Several additional specimens of *H. poeyi* were observed, but not collected. Other labrids observed during our underwater investigation near the jetty were *Halichoeres bivittatus*, *H. caudalis*, *H. radiatus* (see below), *Thalassoma bifasciatum*, and *Hemipteronotus novacula*. Briggs (1958) gave the distribution of *H. poeyi* as from the Tortugas, Florida to Rio de Janerio, Brazil. Similarly, Bohlke and Chaplin (1968) stated that *H. poeyi* is known from the Bahamas and Florida to southeastern Brazil. We found no reference to its occurrence in the Gulf of Mexico and apparently this is the first report of this

species from the Gulf. The presence of *H. poeyi* at Destin extends its known range 735 km NW of the Dry Tortugas. The occurrence of *H. poeyi* in the northern Gulf of Mexico may be the result of transport of pelagic eggs and larvae from southern, indigenous populations by currents such as the Loop Current. It is doubtful that its presence at Destin can be attributed to reproducing populations on deeper reefs in the northern Gulf as the species generally occurs at shallow, inshore localities (Bohlke and Chaplin, 1968).

Halichoeres radiatus (Linnaeus). Several individuals (approximately 60-80 mm) were observed near the East jetty at Destin also on 10 August 1974. Randall (1968) reported that *H. radiatus* occurs from Bermuda and North Carolina to Brazil, including the southern Gulf of Mexico. Bright and Cashman (1974) recorded *H. radiatus* from the northwestern Gulf and Richmond (1968) indicated its occurrence near Horn Island, Mississippi. Hastings (1972) collected it from the jetties at the entrance to St. Andrews Bay, Panama City, Florida but did not record it from the Destin jetties. This is apparently a new locality in the northeastern Gulf for *H. radiatus*. The occurrence of *H. radiatus* in the coastal northern Gulf may also be the result of transport of pelagic eggs and larvae from southern populations. However, its presence probably results from movement by individuals from offshore populations as this species has been observed at offshore sites such as the Florida Middle Grounds (SAB—personal observation).

Syngnathidae

Oostethus lineatus (Valenciennes). 1, 72mm (UWF 632), entrance to Choctawhatchee Bay, 200m S of US 98 Bridge, Destin, Florida, 17 May 1975. The specimen was dipnetted at the surface from a patch of floating *Sargassum*. Other species collected from the *Sargassum* were *Syngnathus louisianae*, *Monacanthus hispidus*, *Histrio histrio*, and two larval Blenniidae. Bohlke and Chaplin (1968) stated that *O. lineatus* occurs on both sides of the Atlantic and in the western Atlantic from South Carolina and the Bahamas, among the Caribbean Islands, along the Central American coast, and throughout the Gulf of Mexico. Other authors (Briggs, 1958; Walls, 1975) have stated that *O. lineatus* is distributed throughout the Gulf of Mexico. However, Dawson (1970) presented the only substantiated records of *O. lineatus* from the Gulf coast north of Mexico. Our specimen is apparently the second published record of *O. lineatus* from the northern Gulf and is the first specimen collected from floating *Sargassum* in the Gulf of Mexico. Adult *O. lineatus* apparently prefer brackish or fresh water (Hubbs, 1929) and are capable of reproducing in these areas (Gilbert and Kelso, 1971; Dawson, 1970; Hildebrand, 1939). Gilbert and Kelso (1971) found evidence that juveniles inhabit the ocean during early development. Bohlke and Chaplin (1968) state that floating *Sargassum* is possibly the normal habitat of this species. The collection of our juvenile specimen would tend to substantiate the findings of Bohlke and Chaplin. However, the degree of association between *O. lineatus* and floating *Sargassum* is unknown at present as extensive collections of fishes from the *Sargassum* community by Dooley (1972), C. E. Dawson (per-

sonal communication), and the authors have produced no other specimens of *O. lineatus*.

Holocentridae

Corniger spinosus Agassiz. 1, 112mm (UWF 795), offshore from Pensacola, Florida, May, 1974 (exact data not available, but was collected by hook-and-line and probably taken near the "29 Fathom Curve"). Haburay et al. (1974) first reported this species from the Gulf and as our specimen was taken apparently from the same general area off Pensacola, this species may be a permanent resident of the offshore reefs.

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FIRST RECORD OF THE MOUNTAIN MULLET, *AGONOSTOMUS MONTICOLA* (BANCROFT), FROM NORTH CAROLINA

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ABSTRACT: *Range of the species is extended northward 540 km to Royal Oak Swamp off Lockwood Folly River.*

A MOUNTAIN MULLET (UNC 10444), *Agonostomus monticola* (Bancroft), was seined 21 October 1975 in Royal Oak Swamp, a tributary of the Lockwood Folly River in southeastern coastal North Carolina, 1 km north of Supply, Brunswick County. It has been recorded in streams of the Atlantic drainage of Florida, Pinellas County on the west coast of Florida (Carr and Goin, 1955); the Mississippi River at a la Hache, Plaquemines Parish, Louisiana (Suttkus, 1956); and in Texas in the Port Aransas ship channel and near Galveston (Schlicht, 1959). Suttkus (1956) stated that it is common in Mexico, Central America, and the West Indies. Occurrence of this species in North Carolina represents a northward range extension of approximately 540 km. Anderson (1957) reported larvae from the open ocean off the Bahamas and south Atlantic Coast of the United States. From this he suggested that *A. monticola* was a catadromous species.

Meristic data agree with that of Suttkus (1956) as follows: total length, 88mm; standard length, 74mm; dorsal spines and rays, IV-9; anal spines and rays, II + 10; caudal rays, 14; scales in lateral series, 43; predorsal scales, 20; circumferential scales, 26; scales around caudal peduncle, 21. Basal scales were present on the dorsal and anal fins. A caudal spot was present. A dusky yellow color was present in all fins while scales on the upper half of the body were edged with black. Royal Oak Swamp is a small Coastal Plain stream approximately 5m wide and from 0.3 to 3.0m deep. Water current was moderate. Some rooted vegetation was present. Salinity was 0 ppt and water temperature was approximately 20°C. Other fish collected were *Anguilla rostrata*, *Notropis chalybaeus*, *N. cummingsae*, *Noturus gyrinus*, *N. insignis*, *Aphredoderus sayanus*, *Fundulus lineolatus*, *Gambusia affinis*, *Enneacanthus gloriosus*, *Lepomis punctatus*, *Etheostoma olmstedi*, *and E. serriferum*.

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NEW LOCALITY RECORDS FOR *SPIROBRANCHUS GIGANTEUS* VAR. *GIGANTEUS* IN THE NORTHEASTERN GULF OF MEXICO

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ABSTRACT: *The range is extended 200 miles westward in Florida.*

OFF the northeastern Gulf coast between Panama City and Pensacola, Florida, scattered coral heads and limestone outcrops occur which bear elements of the Caribbean reef fauna. The existence of a tropical ichthyofauna on the Eastern Gulf Shelf has been well documented (Briggs, 1973; Smith et al., 1975); whereas, published reports on the species composition of an associated tropical and subtropical invertebrate fauna are few (Lyons and Collard, 1974). According to Bright and Pequegnot (1974) the scattered coral heads and limestone outcrops are members of a distontinuous ring of reefal structures which occupy the continental shelf of the Gulf of Mexico. The particular portion of the Eastern Gulf Shelf between Panama City and Pensacola is part of the Mississippi–Alabama Shelf region which extends from the eastern Mississippi Delta to Cape San Blas (Lyons and Collard, 1974). Diving trips to many of the limestone outcrops are scheduled throughout the year by local SCUBA enthusiasts.

A specimen of the "Christmas tree" serpulid worm, *Spirobranchus giganteus* var. *giganteus* (Pallas, 1766), was collected 29 June 1974 by David Graham, a Pensacola SCUBA diver, who pried the solitary worm tube off a limestone ledge located 1.68° from the Destin Sea Buoy and approximately 3.7 miles south of the Destin Pass, Florida. The specimen was taken at a depth of 30m in an area known to local SCUBA divers as "Amberjack Rock". The worm agreed fully with Ten Hove's (1970) description of *Spirobranchus giganteus* and the specimen has been accessioned into the annelid collections of the U. S. National Museum (USNM–uncataloged). Data for the specimen are as follows: operculum with 3 horns (2 branched latero-dorsal horns and single prominent medio-ventral horn with broken tip); branchial filaments spiraled, 6 whorled and 8 whorled; ca. 194 abdominal segments; length of abdomen and thorax, 80mm.

Several specimens of the Atlantic thorny oysters, *Spondylus americanus* and *Spondylus ictericus* were also taken in the same area by Graham. Work (1969) reported a tropical molluscan fauna inshore on the jetties of St. Andrews Bay inlet which included the species *Spondylus ictericus*.

Ten Hove (1970) listed the range of *Spirobranchus giganteus giganteus* as Caribbean Sea, Gulf of Mexico (from Florida to and including Trinidad), Bahia (Brazil), Tropical Pacific Coast of America (from Gulf of California to and including the Galapagos) and probably the Gulf of Catalina (California): all these localities in the tropical and subtropical coasts. Day (1973) recorded *Spirobranchus giganteus* from off Beaufort, N. C., on corals at a depth of 18m and extended its distribution northward in the warm waters along the Atlantic coast. Ehlers (1887) and Monro (1933) recorded the species from the Dry Tortugas, Florida. Wills and Bright (1974) reported the species as abundant on the West Flower Garden coral reef off Texas in the northwestern Gulf of Mexico. Carpenter (1956) reported the species (as *Spirobranchus tricornus*) as common on

rough bottom about 10 miles SE of Alligator Point near Whistle Buoy 26, Franklin County, Florida, at a depth of 12m. Except for Carpenter's record, the author has found no other published account of its occurrence in the eastern half of the Gulf of Mexico. According to Tom Perkins (personal communication), Department of Natural Resources, Marine Research Laboratory, St. Petersburg, Florida, a specimen of *Spirobranchus giganteus* was collected 30 July 1973 off Tampa Bay by Gregory B. Smith, approximately 6 miles west of Egmont Key, Florida, at a depth of 12m. The author has examined specimens of *S. giganteus* taken from the Florida Middle Ground by Ron Breedon, a former University of West Florida biology student. Barry Vitto, of the Marine Environmental Sciences Consortium, Dauphin Island Sea Lab, has recorded the species as a frequent member of the benthic fauna on artificial reefs located in the Gulf of Mexico approximately 15 miles off Gulf Shores, Alabama (personal communication).

The new locality records for *Spirobranchus giganteus*, on the West Florida Shelf and along the Mississippi-Alabama Shelf, indicate that the species is widespread throughout the eastern half of the Gulf of Mexico. This report extends the known range of the species approximately 200 miles westward along the northeastern Gulf coast from the previously northernmost recorded locality in Franklin County, Florida.

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